LOCK-PICKING

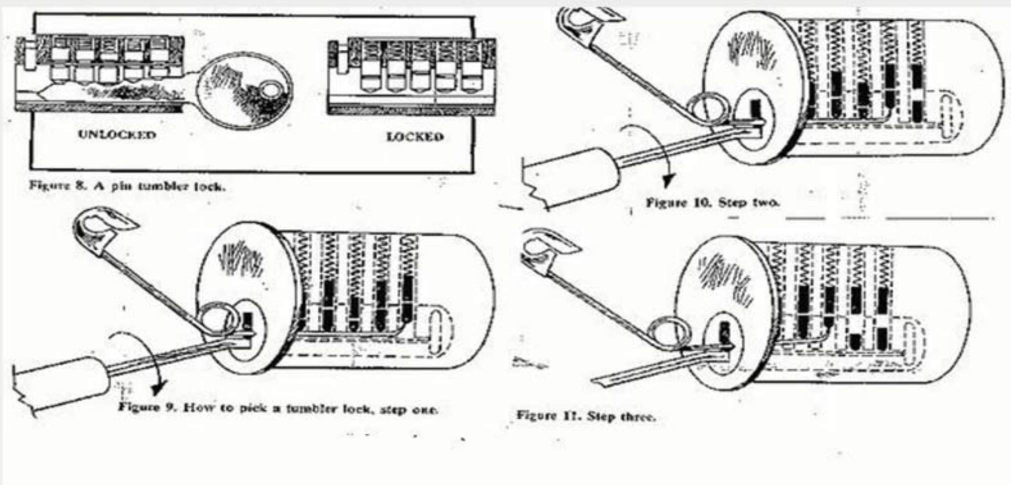


Figure 8. A pin tumbler lock.

Figure 9. How to pick a tumbler lock, step one.

Figure 10. Step two.

Figure 11. Step three.

BERSERKER

BOOKS

Contents

Cautions, Rejoinders, and Disclaimers:

The least serious charge involved in any burglary is breaking and entering, but it is a two-part thing. You can break a lock *or* any other part of a house or grounds, or you can enter any part of the house or grounds. The entering part can be as trivial as the mere insertion of a probe into a lock, or putting the tip of a fishing pole through an open window. The law is specifically left very loose for ease of prosecution, so all burglars aspiring to a greater level of skill than the Watergators displayed, heed well this warning.

Loompanics, and/or eddie the wire, assume no responsibility whatsoever for any damages incurred, either real or incidental, as a result of the proper use or misuse of the information contained herein.

The making, use, or possession of the tools and appliances described herein may be illegal in some jurisdictions, and Loompanics, and/or eddie the wire, assume no responsibility whatsoever for any damages incurred, either real or incidental, as a result of the manufacture of these tools.

Please be sure to observe all manufacturers' safety precautions when using any of the tooling, materials, and techniques described herein.

Chapter One
Foreword

Anybody who's been to a locksmiths' conference or even a local meeting knows that the real lowdown you get comes at the bar after the meeting while talking with other locksmiths. Starting from a friendly swap of oddball key codes and sneaky tricks, invariably these sessions produce a "I know something hot that you don't" discussion and it was at one of these that I displayed one of my first bench-made picks. That is really how this whole thing started. A few of the guys wanted to know where to buy one of those ultra-skinny picks, and I just had to mouth off and explain that I had made it myself. That started a flood of questions that eventually seems to have led to *PLT (How to Make Your Own Professional Lock Tools, Volume One)* being written. After three more PLT books and a long time lapse, eddie the wire now offers you this book. It is a complete update of *PLT 1-4* with nearly double the material and new and better ways of doing almost everything in the way of making lock picks.

How frustrating would it be if you could magically learn everything a master locksmith knew about picking locks, but didn't have the actual tools used to pick a lock? Now reverse that problem. Suppose you bought an entire tool case from a master locksmith, but had no idea how to use the myriads of tools inside. The point is that both the book-learning of lock picking techniques and the workshop making of the tools to pick locks are two halves of the same skill.

Any professional locksmith who has not learned the art of making tools and made a personal set is missing the boat. You will not get the best use of your skill from using an off-the-shelf trade set. Similarly, the pickmaker also must be skilled in locksmith picking abilities in order to know what design and qualities to shoot for in tools. Of course you must also know exactly how or why the tools and techniques work.

While there are at least a few books in print (and not restricted) on lock picking skills, there is little or nothing on making tools. This book will lead you step-by-step in the hand crafting of lock picks. Master the skills revealed in this book and your picks will be the finest available. You will be able to make dozens of pick designs that do not even exist on the commercial market. The CIA should be so lucky as to have this book on file.

When I started my apprenticeship as a locksmith, I remember well the day I was first initiated into the mysteries of the lock pick. My teacher opened his hip wallet (the big kind with the leather fold-out side wings) to reveal at least fifty types of picks. I asked him which type went to what lock and he did something I will never forget. He reached in and pulled out a single lifter lock pick, and said "This is the only style you ever need use." After a year I realized he was both right and wrong. The commercial pick assortments have lots of rake-style picks but only one or two types of lifter. What he said that was right is that only a lifter-type attack guarantees an opening (if you do it right). What was wrong was that many more than two or three lifters are needed. The master locksmith finds that no less that seven or eight different lifters are a working minimum tool kit.

At some point early on in any aspiring locksmith's practice, although possessing a fair amount of skill at the pure techniques of lock picking, he just plain cannot open this or that lock no matter what. Did the skill level go down, was the lock defective or jammed up slightly... what's the story? The smith who really wants to know might take a lock of that same make and model and examine it on the bench, working it over to find out what makes it different from the rest, if anything. The real answer lies in a little-known truth. The locks are not so much to blame, nor are the skills; the tools are the real problem. Locksmiths deal every day with an increasingly vast number of different lock brands and/or code series, each one designed to a specific set of keyway dimensions and bitting increments. Code books and key blanks to service each lockset that may walk in the shop or appear in the field are the essential tools of the trade, and incidentally that's what separates the pro from the key cutters.

With all this vast library of variations in cuts, depths, angles, increments, and warding variations it is naive to assume that a working set of three lifter lock picks will fit every lock. The best chance of success when doing a pure picking opening is the utilization of a correspondingly large number of opening tools that are matched to each lock! It has been my experience that such tools, custom-designed for a given keyway and set of bitting increments, will greatly increase the ease of any such opening. A side benefit is in technique, which seems to improve when the working feeling of a tool is the same for vastly different locks, because the tool puts consistency into the envelope of manipulation.

Since no such set of tooling lists from any supply house, the first step along these lines is in filing down the shank on a commercial pick to get more clearance in some keyway. We've all done this at some time, often with a bit of "I'll get you" desperation at some balky lock. You soon find out that the shank can stand only a little thinning before it caves in. The problem is usually an indifferently tempered low carbon steel. Altering the tip working height is another common step. It is easy to file it lower, but so difficult to file it higher. After a few trials trying such more or less random alterations, you will either give up or you may ask around for some master-level knowledge. The purpose of this book is to give you those skills.

In other words, the master locksmith can only do the best job using tools that cannot be purchased, but instead must be made. This book will tell you how to design and make those lock picks in the easiest, best ways possible.

You will learn that a lock pick is a tool at its best because it must excel at being as strong as possible, yet be as small as possible. Only attention to detail and care will produce such a minimal tool. Commercially available picks fall way short on accuracy and cross section. They have actually very large profiles to compensate for the poor strength that low-carbon steel offers, and to minimize the warpage a small shank will undergo due to the punching process. A better steel would allow that smaller working cross-section, but is difficult to punch cleanly without heavy punch die wear and high costs. Because the steel in commercial picks is of low quality, grinding the shank to more acceptable working dimensions at your own shop only causes you grief when that pick bends from lack of strength.

The advantage for hand-finished tools then is their minimal, unique designs executed in high strength carbon steel. The uniqueness of picks that you have designed and built for yourself is easily worth the effort of mastering the skills of making them.

There are other advantages in taking time to learn how to produce your own personal tool systems for lock picking. You can design and build a lock pick and promptly get ideas on its performance by using it in day-to-day field servicing. By doing this your designs will evolve and mature and in turn your hand technique will modify and improve to match your tools. Some of the pick designs I commonly rely on and produce today have undergone five or six cycles of modification. One of my friends might come in and complain he couldn't get this so-and-so pick into such-and-such a lock, so I measured it and cut it to another likely size. A week later he came back all smiles and I made a note of the lock type and the new size.

Anything you can imagine can be designed and built. Those first tools will be followed by gradually refined designs. Eventually the layout of a set of picks will be based completely on working drawings with nothing left to chance, and it is then that your pick-making skills must really be up to speed.

Once designs are completed the primary concern in lock pick making becomes precision execution. It is very easy to grind right up to the layout lines and finish the pick with a #4 die file, but you cannot really know what the actual dimensions of the pick tip are until you gauge them with the proper instruments. As little as eight-thousandths of an inch either way will noticeably affect pick feel, so you should make and use a set of working drawings, and learn to follow them. No extensive precision tooling is required to gauge work with tolerances in the + or – .008 range, just a dial caliper, a tool all locksmiths should possess anyway. A rough record of each design's use, lock preferences, and reliability is maintained, and filed with the working drawing for that pick, so that it can be altered if improvements suggest themselves. This dictates that your work is precise at the beginning so you can modify the pick design with the same tolerance as it was built to. If records are not kept, an unusually good working design will be hard to duplicate. Measuring with great precision also makes it easier to finish a pick. Instead of guessing, you will KNOW if it's right.

One other thing needs pointing out. After the fourth or fifth keyway you tool up for, you may have twenty or more tools, each almost identical to the others to the naked eye. The temptation is strong then to settle for these twenty. My advice is don't do it. Knowing that you are using a pick sized to match a keyway gives you a good psychological boost during an opening attempt, and as your experience with custom tools grows, it becomes self-evident to you that those size variations of five- or ten-thousandths will indeed spell the difference between an easy working and failure. Develop as large a working base of tools as you can, and keep them all in good working condition. The time saved will more than compensate for the effort. Before we start cutting steel allow eddie a brief moment of philosophizing, if you please.

Have you ever wondered just exactly why lock picking is viewed with such fascination by people in all walks of life? I get mail from all over the map and I often wonder about the almost universal attraction. Doctors, teachers, whoever; show them a lock pick set and the interest level soars. The desire to learn the art of picking a lock has complex roots. To some it is puzzle-solving on a mechanical hands-on level, kind of like a high-tech wire nail puzzle. Charles Babbage, the inventor of the mechanical computer, was reportedly very interested in locks and their picking.

For others it is the satisfaction of being immune to being locked out of anything no matter what the lock is, to have the necessary skill to wield that magic passkey where others cannot. To many it is belonging to a small and secretive group of people who know how to pick a lock, like secret agents, detectives and skilled gem thieves. Merely being in the know when someone else discourses on the subject of lock picking, and knowing the jargon for lock picking like "plug wrench," "ball pick" and so on is exciting to many. With eddie it was the same, at first. I wanted to be able to pick, pick quickly, and pick well, just like in the movies. After that wore off I still wanted to pick, but to pick and rarely, if ever, to be defeated by a lock. Nothing can match the frustration level of a guy who uses a lock pick on a lock and ends up on the outside looking in. It's worse than dealing with the government! Eddie's resolve to make his openings quicker and cleaner led to making tools that would actually work. Nearly twenty years later, eddie's tools are even better.

As a parting comment, because of the mind set of the lock pick artists they are often drawn to other fields. In particular master lock pick experts often enjoy learning playing-card manipulations like second dealing, the pass, the side slip, and so on. Not self-working card tricks, but pure skill moves. I'm proud of this new book series, and I think it will be the bible on the subject for a generation or so. In the interest of making it the absolute complete guide, I have compiled a list of some great card manipulation books. Most are in print, most are really reasonable. Try reading and doing tricks and whatever from this list. It may not increase your lock picking skill physically, but it may put you more in the mindset.

Card Control: Practical Methods & Forty Original Card Experiments, by Arthur H. Buckley, Dover, 1993.

The Card Magic of Le Paul, published by EZ Magic/D. Robbins Co.

Roughingly Yours, by Aldini. Mickey Hades Enterprises.

Expert Card Technique, by Jean Hugard and Frederick Braue. Dover, 1975.

Card Manipulations, by Jean Hugard. Dover, 1993.

Greater Magic: A Practical Treatise on Modern Magic, by John N. Hilliard. Visionary Experiences, 1994.

Chapter Two
Lock Pick Design Principles

Understanding how a lock pick acts on the lock mechanism makes it easier to make good lock pick design decisions. So before attempting to learn lock pick design principles, you should first have a working knowledge of the operation of each of the four main lock types; in order of complexity they are: 1) warded locks; 2) disc tumblers; 3) pin tumblers; and 4) lever tumblers. You must fully understand how each part works in relation to the other parts, and mentally you must be able to project how each part of the system interacts. Trouble is, this book would be twice as large if I explained all that, so I'll concentrate on making tools. ***The Complete Guide to Lock Picking*** covers skills and the "eddie" way.

Lock pick design decisions have just one goal: adjusting the range of motion or action of the part of the pick that enters the keyway. The goal is to apply pressure exactly where it is needed while avoiding tool contact with parts in the lock you wish to leave undisturbed. "Range of motion" might be better expressed as "envelope," an area within which the pick can work safely.

These two design limitations of the lock pick dictate opposite goals, namely that the pick be as strong as necessary, yet be as small as possible. Simply put: the more working slack in the keyway, the easier to work the lock, but a too-small tool will fold under lifting pressure.

The "parts you want to avoid" are of course all the tumblers you are not trying to presently lift or manipulate. The "Friday the 13th" type opening is when you are working a back tumbler that must be picked first because it is binding first, and a front tumbler that has a very low combination (a deep key cut). This means any fat shank problems will lift, perhaps overlift the deep key cut tumbler, and if it gets overlifted and hangs up above the shear line, man, you got troubles many. That's why this chapter is here. Just worried about fat shanks? Suppose the range of motion of your lifter is insufficient to lift that back tumbler fully without the shank angling up enough to bump again on that front tumbler? That's a problem that is specific not so much to the particular lock type as to the key or the tumbler coding. The lock pick artist expresses it as a tumbler code because keys are never worried about things like first binding tumblers.

Working with the design process will also add to your physical picking skill in an ongoing way. If you have verified that your design will move and act in a certain way inside the lock, then you have a mental goal that can be transferred into positive "feel" feedback when working the lock. You have a target to work for.

Let's begin the design process by drawing up a list of requirements. We need some hard performance numbers to start with.

The first consideration is the thickness of the pick stock that should be selected. This is the only dimension that is difficult to alter quickly by grinding, although you will learn how to wedge or sharpen the very tip of a lifter to get it to "dig in" to a tumbler surface. A lock pick could be as thick as the keyway across were it not for the warding of the keyway. Warding and mushroom tumblers are the two major anti-pick systems employed.

Remember that the highest warding projecting into the keyway is what the lower tumblers bottom out or rest on! To do this job the warding must project to almost the middle of the tumblers. Some types of locks have warding that extends well past the midline of the tumblers, and furthermore in some other makes of lock the warding is very thick (up to down). Both of these types of warding limit very free access of the pick tip to the tumbler ends. That's the whole idea.

It should be noted that then higher-security locks, like early-style Yales, incorporated both types of warding into their design. The early Yale lock designer was intent on making their "new" locking system pick proof, so they developed this system which is called paracentric warding. Naming things by throwing in Greek and Latin root words was fashionable at that time, and indicated high class goods. Paracentric is Latin for beyond or past the center of something. The warding projects past the center of the keyway.

The question we are trying to get around to is how thick to make the lock pick steel. I could just tell you, but I want you to know why. Stick with me and read on.

In modern security design, the cost of production is king. It gets more attention than high-security questions, and since paracentric warding is very costly both in key blanks and other areas of manufacture, today's keyways are much less restrictive. Since the 1920s, the U.S. Government Postal Service has purchased the copyrights to several of the Yale keyways for exclusive Postal use. This move was done mostly to limit the commercial availability of key blanks which would obviously compromise the security of the Postal system. If you have your own keyway, you have the highest security from most key duplication. Since most of these keyway profiles were of the difficult paracentric design, it is wise to have tools that will defeat these as well. I made a conscious decision to design those of my tools that were not targeted for a specific brand or keyway so that they would function in the difficult paracentric warding geometry. This means they enjoy just that much more warding clearance when working the average lock.

Examine Figure 1 and you will notice how two different warding systems work to limit pick access. This relationship is the most important factor to consider when selecting a pick thickness. In locks like the "Best" brand, the keyway is severely choked by the warding and the lifter pick designed for this lock must be higher than the average to span the diagonal, yet still very thin to fit in the space available. The warding that projects into the cylinder key slot is designed to limit access and elbow room in this critical area. The corrugation or profile of the key blank is radically offset to clear this warding and so the smaller the tool thickness the more room in the area defined by the end of the warding and the side of the keyway.

After long experience I have come up with the following rule of thumb for thickness selection, and another rule for width of pick shank. Notice that a thicker steel can use a thinner width and vice versa.

Thicknesses in the .025 to .031″ range seem to be the most practical balance between strength and thinness, and a shank width of .045-.050″ with a thickness of .025-.031″ is my usual starting point in design. Let me emphasize that I have made picks as light as .020″ thick also. The relationship between thickness and shank width is a ratio. A thinner pick has to have a wider shank and so on. It is not a one-to-one ratio. If bending is a problem with a .050″ width shank pick, thickness must be increased far more to compensate for this, so the .031″ is home base, so to speak. Not by chance it is also the thickest dimension you can easily obtain shim stock in. Not only do thickness and width combine to set the total

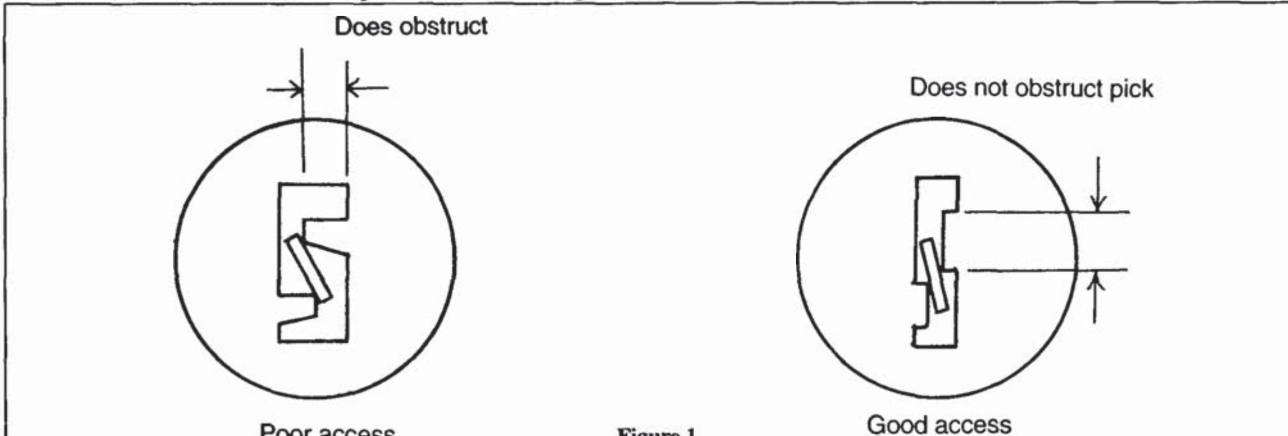


Figure 1

bending resistance, you must also consider the amount of force that needs to be applied. Suppose you had a really strong pick, say .031″ thick and .075″ shank width. Such a tool could easily move a weight like a shot glass full of J.D. across a table without hardly flexing. To verify this make sure to try it at least four different times by emptying and refilling the shot glass. This is called the empirical scientific method. Now try to move an eight ounce tumbler of J.D. and that strong pick flexes way over and probably takes a permanent set or bend. The difference is the amount of force that must be applied. The questions are: how much pressure is needed to lift up a pin tumbler; how strong is that spring; and how much drag is caused by the friction of the pin sliding in the lock as you apply turning pressure to the core with the tension wrench? You can take it from me that the spring tension is usually very slight. Most locks are provided with springs that are easily flexed with the very weakest of pick shanks. So it's reduced to a three-way split of pick shank strength, amount of turning tension applied (operator) and the ability of the tension wrench itself to transmit turning force without bending as well.

Beginning lock pick artists are continually reminded not to apply too much wrench tension to the lock for that very reason. Excessive twist will make even the strongest pick bend.

So let's leave the lock pick briefly and examine some tension wrench criteria. As you know, the whole object of picking an individual tumbler, either a pin or a disc tumbler, is to lift it with a tool until its edge catches and holds on the shoulder or lip created by the misalignment of the cylinder and the keyway plug. As eddie says, it is easy to build a torque wrench tool that can exert so much force on the sides of the tumbler via the plug that the pick will bend instead of overcoming the friction and lifting the tumbler. Should you then make the torque wrench weaker, or use it with a weaker hand, exerting less force so the pick will not bend? Do you make the pick stronger to compensate? Consider the system mentally or on scratch paper before you answer these questions. Try to simulate various tool design approaches and see them in your mind's eye before you try them.

The essential question to ask is: "How little turning torque will hold the tumblers up at the shear line without their springs slipping them back off?"

You may be surprised at the negligible amount of weight necessary to hold a pin tumbler, and therefore the tiny amount of additional friction bearing on the pin tumbler over and above the usual spring tension of the tumbler driver spring. With such a small amount of friction to overcome, the lock pick can have a correspondingly very small cross-section without bending in the lock. We never did answer the question asked in the first paragraph; is it better to make the tension wrench weak so as not to "freeze" the pins with excessive torque, or make the pick stronger? The answer is to make the pick as small (and therefore weak) as possible, and allow excessive tension or torque to be controlled firstly by the operator, secondly by the springiness of the tool shank, and I'll explain this in detail. The itty-bitty living room of the keyway usually leaves picks cut to fit comfortably within it pretty weak, so strong picks are usually not a big problem.

There are two types of wrench "feel" to experiment with, and two types of tip fit. Those wrenches with rigid, heavy shanks often also have the tight fitting tips, and those wrenches with light springy shanks have the loose fitting tips. But, it is by no means written in stone that you cannot build a springy shanked wrench with a tight fitting tip, or vice versa. This freedom of design is what makes the locksmith who builds his own tools the one who succeeds in opening locks more times than his unskilled counterpart. Picking styles will again vary widely, but you should know the advantages of each type, as it will aid you in pick designing. The squishy feel of a lightweight shank can rob you of tumbler feedback. Tumbler feedback is when you feel the pin throughout its entire movement up to the shear line. This feedback allows you to adjust wrench tension precisely, and detect if a pin is being lifted beyond the shear line.

A solid shank, however, still demands a springy grip (not necessarily a loose grip) to produce that vital lightness of torsion. Put another way, it is much easier to over-torsion a lock cylinder with a solid shanked tension wrench than it is with a springy shanked wrench. It is perhaps this fact that makes the springy shank more of a pop culture favorite, since it requires less initial skill in manipulation, and one size fits many. Superior picking technique also demands that the wrench tension must vary during the opening. This wrench manipulation is at least as important as the pick movement itself, and the two always complement each other.

To provide the best possible feel if you are just starting out as a locksmith, try a tricky bit of tool design. The wrench is cut from wire stock whose shank has been ground very slim over a long portion of its shank for the springy feel, but the tip is left very tight in its fit to the keyway under attack. It is that tight, almost wedging fit that ensures good feedback while still retaining the advantage of a springy shank. The springy wrench will always allow finer increments of tension with less muscle tension in the hands. In very tight-fitted locks the loose fit tip, such as comes from cutting out of shim stock instead of wire, will slip and slide under the very low torque required, often fumbling away from the lock and making repicking necessary.

The amount of torque a given wrench exerts also depends on how long it is and where the fingers will contact it to manipulate. The almost universal practice for the key-in-knob lock is to hold onto the doorknob with the left hand fingers and manipulate the wrench with the thumb. This practically limits the working length of the wrench to about three inches. In most other situations, such as pin tumbler cylinders set flush with door surfaces, the hand manipulated tension wrench is still most comfortable at this same length, and I have standardized on this length by producing 6″ wrenches with two working ends. Many operators sneak a finger or two around the slight protrusion of the cylinder to anchor their hand for precise manipulation. I also do this. The effective working length thus remains three inches or so due to finger/thumb length.

I would like to point out that once the pick shank has been slimmed to its desired width overall, it is still possible to do spot slimming right at the radius tip of the tool, especially in a lifter. The actual tip may also be reduced to a near-knife edge by filing on the SIDES of the pick tip. This results in no real loss of strength, since the force is exerted almost straight up and down and the pick will have enormous strength in that position. This near-knife edge seems to offer a better feel in determining which tumbler is which, and the keen edge will also bite into the brass and keep the tool tip from sliding off the polished tumbler surface into areas where its intrusion may be undesirable. It is also possible to slim the thickness of the pick back into the shank area, but the temptation to do this should be avoided; in short, don't do it. There is a tendency when cutting or slimming a pick either in width or thickness to cut off just one more little shaving. The psychology of the cutting process is that less steel will give you a better chance at using the pick successfully, so the brain thinks more cutting is better, but the more time expended in cutting the more you will lose if you make a tool that crumples when first used. Avoid over slimming, over cutting, and never cut down the shank width past a proven smallest width. Never ever alter shank thickness from what the shim stock was packaged as. You will lose far more than you will gain, since side-to-side clearance past the wards is usually not a critical problem, nearly as much as up-and-down clearance past the tumblers.

It is a very good idea for you to start a library or card file listing information that you will accumulate over your career. The form I use is reproduced on page 9, and you have permission to reproduce it as well for your own private files. I got this idea when I did some work for a precinct house and had to walk through the latent print classification office several times to get to the cages. Their cards looked like a pretty good layout and so I copied one and came up with a system of my own. Notice that it lists tip angle (both lead and rebate) shank length, shank width and taper, pull angle, tip height, bias (if any), thickness, and handle details. This card has a cross reference number on it that keys to another card file of keyways.

A final word: the lock pick artist who can't master a lock will never know why unless he examines the tool design to prove that it is physically capable of doing that lock. Just cussing out the lock or the pick won't get you in, or make your skills better. By contrast, whoever opens a lock has two sources of pride: not only did you do the impossible and pop the lock, you actually made the tool that made the opening possible. Nothing compares to that lift.

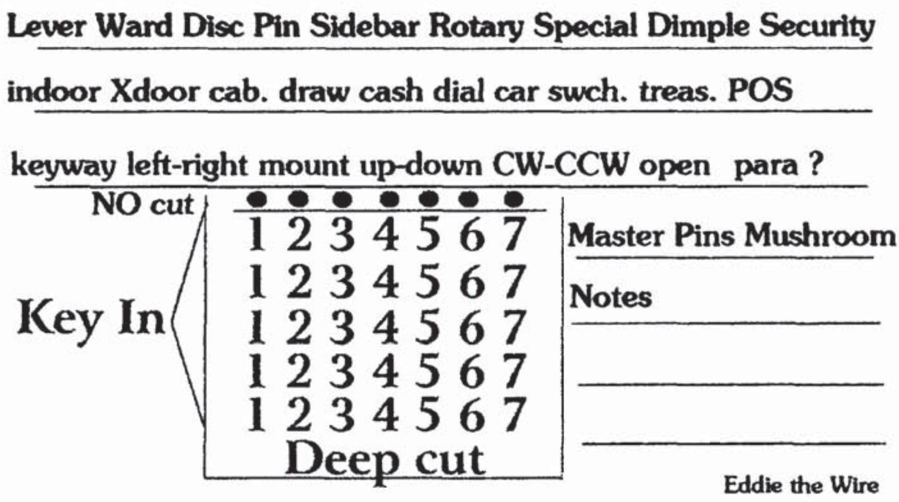


Figure 2
Lock Classifying Form. Circle each row for lock type, lock mount, keyway details and circle suspected bitting depth for each tumbler stack and join circles with graph-like lines.

Chapter Three
Steel Stock

The raw material you will be cutting most of your picks from is called feeler gauge or precision ground gauge stock. It comes in different steel alloys like stainless, high- and low-carbon steel, and different hardness tempers from brittle to blue spring. Each type has different characteristics, since it is targeted to a specific kind of industrial shim usage. Eddie considers the spring tempered high-carbon type the best for making lock picks. This is not surprising considering the capacity of high carbon steel for high hardening yet allowing re-tempering to precise specs. The brand I used twenty years back was made by DiArcro Co. but this is difficult to obtain now. A good substitute is Precision brand C1095 steel, and it comes pre-hardened and tempered to Rockwell 48-62. The Rockwell scale is a measure of what degree of temper the steel has been treated to be. It is gauged by pressing a small point into the surface of the steel with a predetermined force, and then measuring the depth to which this force was able to drive the point into the sample being tested. The tempers and Rockwell numbers are listed in the next column, but they are not important to know, just interesting. Don't spend any time memorizing Rockwell tables.

The Precision company also offers a low-carbon product called 1010 steel shim, but this is unusable for picks because it will not hard temper. It is supplied in 6″ and greater widths, and so is not easily confused with the C1095. If in doubt, ask, since the low-carbon will only waste your time. Shim or feeler stock is surface ground to a tolerance of .00067″ plus or minus, and has excellent alloy consistency from batch to batch. It is the only material you should consider for picks. Take advantage of the mighty industrial machine that kicked ass in WWII and buy the best. It's obtainable for just pennies.

HEAT TREATMENT OF METALS
Hardness Conversion Table

Rockwell C 150 kg. Load 120° Diamond	Tensile Strength 1000 psi
–	*440*
–	*420*
–	*401*
70	*384*
68	*368*
66	*352*
64	*337*
62	*324*
60	*311*
58	*298*
57	*287*
55	*276*
53	*266*
52	*256*
50	*247*
49	*238*
47	*229*
46	*220*
45	*212*
44	*204*

Figure 3
Rockwell Numbers

Temper Color of Steel	Degrees F.
Faint yellow	430
Straw color	460
Dark straw	470
Brown yellow	500
Purple	530
Blue	550
Full blue	560
Polish blue	580
Dark blue	600
Pale blue	610

Figure 3a

Hacksaw blades are too uneven in temper, pallet banding too low-carbon; no matter anyway, nothing is as good as shim. It is the perfect product for picks, cheap at the price, and of superior quality. I have never had so much as one bad piece at all. The industrial machine in America can supply you with the best available, so use it with pride. I will say that foreign or imported shim is coming on the market, especially in 50 foot coils. But if you can't get a brand name or find one on the packaging, I would not recommend it. Stick with the domestic stuff.

This same advice applies to using plumbing snake as stock. This steel is or rather used to be suitable, but recent samples are not of sufficient carbon content to make a good pick. Also, eddie's picks have gotten a lot slimmer in width as his technique has improved. If you cut two identical picks, one plumbing snake and one from shim stock, and start slimming the width, the snake will fold early on and the shim won't. At eddie's shop it's called an envelope. The envelope of a given steel or a given pick is its working ability measured by how small a throat it can pass, yet how much force it can exert without bending. See Figure 4. For a superior envelope use only the best.

It is worth noting that shim steel as supplied is tempered a little bit softer than it should be for lock picks with very minimal shanks (extreme envelopes). In the chapter on custom tempering of pick shanks, eddie talks about making that specialized harder pick for a difficult job, like very limited keyway access. For these pick tools, which are cut narrower than normal, a harder temper will work better without fracturing. It is not a hard and fast thing, and you may develop a different preference for degree of hardness (springiness) as you gain experience using your tools. The difference between custom hardness and temper-as-supplied is very slight for a beginner. It is better that you should use the steel tempered as is until you gain experience, but an expert lock pick operator will always adjust temper to suit.

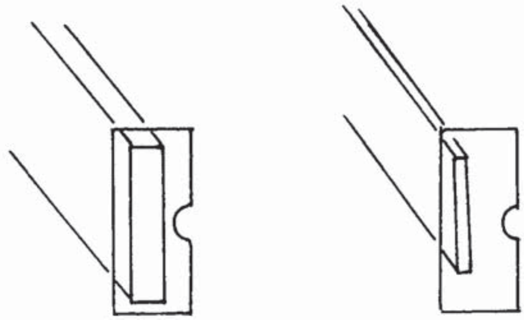


Figure 4

Since the legitimate use for shim stock is to shim parts to precise relationships, it necessarily demands a very wide range of sizes. It is usually supplied in .001″ steps up to .025″ and from there in skipping steps to .034″ thick. It is available in 12″ and 5″ flat lengths and 25′ coils. It is tempting to order in the finished 5″ size for grinding integral-handle picks, so go ahead. The coil offers a broader choice of lengths, and since eddie constantly experiments, he uses coil exclusively in the shop. It is quite possible that you may prefer and settle on a working length above or below the usual 5 to 5½″ average. For these lengths a coil stock works better than 5″ or 12″ pieces. A further advantage is if you buy shim stock in the 25-foot coil, those more desirable smaller sizes may still be chopped off from the coil, and without any waste at all. Don't get me wrong on losing a little bit of shim steel. Wasting steel by leaving a lot of ends here and there is not any concern, in the final analysis. The average lifetime steel bill for maintaining a working set of lock picks is so insignificant, it does not pay you to economize with it at all.

The coil is under tension and it can get away from you as you unpack it unless you take precautions. The recommended method is to sandwich it between two pine boards, and put one foot on this sandwich on the floor while you cut the holding bands. Some steel is packaged in self-dispensing cardboard boxes and need not be unpacked further. If you use the foot-long steel, it can be removed and wiped with a rag soaked in lacquer thinner to remove the packing grease, and then laid on top of the sleeve it came in. Ten or twelve of them can be aligned on the workbench and sprayed all at once with layout dye. After a minute of dry time they can all be replaced in their sleeves and held until needed. This will give the dye a chance to age. Layout dye will rub off on your hands if you subject it to hard pressure and water (rough grinding) while still soft, so let it dry a day or so. The dye mark on the sleeve tells you it's ready for layout. That about covers pick steels, so let's look at tension wrench stock.

For making tension wrenches, Precision also offers drill rod and music wire products that work well. The music wire comes in a coil, or it can be specially ordered in cut and straightened lengths, and the sizes run from .006″ to .187″. The steel is a high-carbon alloy. The drill rod is a far better choice for tension wrenches. It comes pre-straightened, and the water hardening W-1 is in the same general alloy family of steels as their feeler stock. Since you will be heating and tempering the tension wrenches considerably, and under bench conditions of less than perfection, the W-1 or the O-1 is far preferable to the more temperamental music wire, which is difficult to consistently control when hardening with a gas torch. The music wire is also available at the hobby shop, and quality is usually good. Even though it's called music wire, it will not be found at a guitar or keyboard shop.

When you have standardized on a pick working length, you can then spend an hour or so and cut the entire buy to size for enough tooling to last for three or four keyway set-ups. For the very fortunate tool-owner the steel may be power-sheared. A year's supply of cutting would only take ten minutes on a machine like a cold shear. If you can locate one in a nearby machine job shop take your steel down and get it processed. As an alternative, the locksmith's grinding wheel can be used. Instead of cutting through the width of the steel, turn it so the shim stock face is at the wheel's outer edge and cut through the thickness of the steel with a corner of the wheel. Stop and softly bend and break it off when the tempering color starts to show through at the middle. If you bend before the steel is very weak, you will curve the ends. These curves must be removed or straightened, so use only a very little finger pressure to do the break. If the steel resists just grind a little more. The end can then be squared by being coolant-ground to remove the burned steel at the cut ends. Remember that semi-abusing the sharp corner of the wheel like this means you must frequently redress the wheel to restore just the wheel corner.

Chapter Eleven on tension wrenches refers to melting pieces of wire off to form lengths for tension wrenches, and the same technique can be used to melt off lengths of shim stock for picks. If your oxy-acetylene torch will heat the steel fast enough, even a heat sink is unnecessary. Just aim the flame in the middle at the cut line and wait until small sparks spontaneously form. The sparks are an indicator that the steel is heated enough to combust chemically. A second or two later the steel will droop and fall off. As in making tension wrenches, the cut pieces should be arranged to fall in a tray of oil. Eddie prefers olive oil 'cause it smells like cookies baking, but the oil costs like anything. Don't use water because the thermal shock is too great. If the torch heat untempers the steel very far from the melt site, a heat sink may be needed, and a machinist's clamp or locking tweezers will serve well. The real problem with this technique is that it does leave a fairly large band of untempered and curved steel and blobs of steel that must be ground off for the tool to be useful. So while it is easy and quick, it is not very economical. The one advantage is it is so fast. With coils of steel stock you can melt off ten picks just like that, and one end will also be pre-annealed for drilling a hole. For a combination-style tool set, this saves a small step or two. Beware though, because even that small torch can easily draw temper from the entire piece, which would then ruin the working shank. To control the torch burn and anneal precisely, a heat sink is needed.

A set of two small machinist's clamps side-by-side on the shim stock make a desirable heat sink, or even one clamp in a pinch. The steel end area to be cut is inserted between the two, one set back from each projected end with two inches showing. A pair of vise grips applied to the areas where heat is unwanted will also protect the steel. After you fire up the torch keep the heat directly in the middle of the stock, and let the heat build up rapidly in the middle, which will minimize conduction to the ends. Keep the temper a minimum of one and one-half inch from the point where the shank will begin to be ground down.

I should remind you that the bluish or straw oxidation colors blooming on the surface of the steel are proof that the precision factory temper has been shifted softer. These oxidation colors are formed when the exposed surface of the steel goes through a chemical change under heat and parts of the steel alloy combine with the oxygen in air to form compounds that have these colors. Each compound indicates a different temperature level by its color. The physical universe is really well constructed in this regard. The colors can be re-polished back to bright steel when needed to next gauge temperature.

Although grinding is fast, the absolutely quickest way to sever blanks from the steel coil is to fracture the brittle steel with a sharp cold chisel driven by a machinist's hammer. To lay out a cut line, lightly file a line with a triangular single cut, then seat the edge of the chisel into this trough. A strong blow from a sharp chisel cleanly fractures this thin and highly tempered steel like a shot.

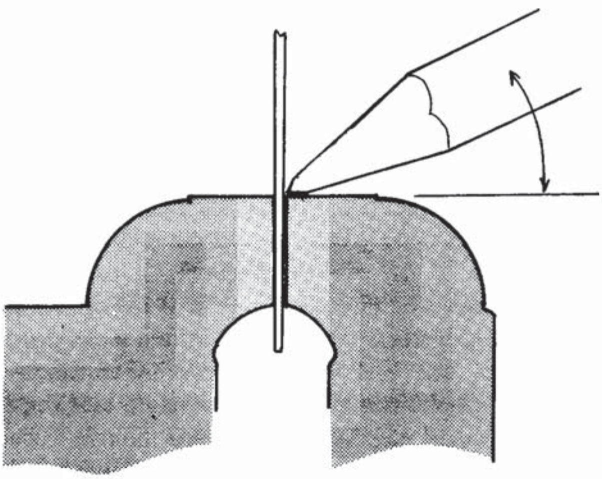


Figure 5
Cutting pick steel blanks with chisel & vise.

It is also possible to clamp the stock in a heavy bench vise with the required length of steel protruding above the jaws of the vise. The cold chisel is applied into the right angle formed by steel and vise jaw top, and the cut made with a sharp rap on the hammer. For a nice cut the chisel should be held at an angle to the face of the steel as in Figure 5. There may be occasional "tearing" of the steel using this method, because the jaws of most bench vises are serrated and will support the stock only intermittently, but these teeth are easily ground flat again during rough shaping. If tearing is not a problem, you may even omit the filed groove.

Methods not to try include any sawing done while the stock is still tempered. It may be done but it's very hard to do. The same also goes for filing through the stock. It is certainly possible, would make a good leisure time or retirement hobby, but is not very practical. If you want to file, grind with the bench wheel instead. Bending and breaking the steel like it was a coat hanger works, but is very time-consuming and the slight curvature it leaves can't be made flat again without a lot of hassle. Stick to the more professional methods of grinding, or cutting with a cold chisel. Abrasive cut-off wheels can be used to make these cuts, but they offer no real advantage over the bench grinding wheel, and generate enough heat to cause tempering problems.

When cutting the steel by shearing action, you may notice that even a partial cut in which the cutting edge of the cold chisel does not extend all the way across the width of the steel, is still sufficient to shear all the way across. This is because the steel has a set of definite crystal fracture lines due to its highly brittle state. It is possible to use this physical fact to advantage and chisel down the length of the stock as well as across it.

Once you have done any pick grinding you will realize that 70% of the production time is spent just grinding one-quarter of the steel blank down to a rough shape. If your workshop is equipped with efficiently built holding jigs, then this time can be passed over automatically. If you sit at the wheel and tend the grinding by hand, a lot of time is wasted. If you observe Figure 6 you will see that a very narrow-faced grinding wheel or jeweler's wheel is used to make the initial depth notch into the steel blank. This notch defines length of working pick shank and also working tip height, since the line starting at its extreme depth will be carried parallel out to the very end of the pick by using the cold chisel. Scoring the steel does seem to produce some definite cut guiding, but the chisel will often have to be moved along the cut and the scoring done pretty heavily. A good pop on the chisel at the first part past the notch sometimes works, sometimes not. It helps to angle the chisel so it cuts right at the notch first. Once the chisel cut to rough width is made, the final grinding is a lot easier. A good operator can become very skilled at using the cold chisel, and may even be able to make the wheel-done starting notch with some light and delicate chisel work instead.

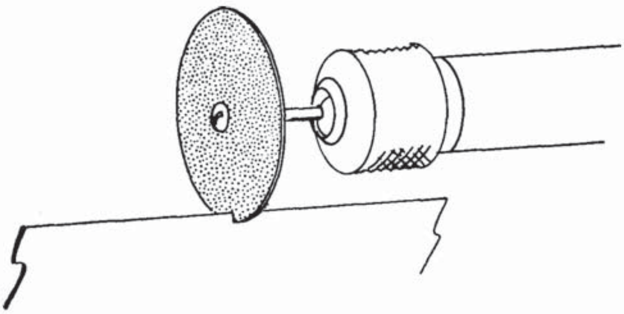


Figure 6
Cutting initial depth notch in pick stock with jeweler's wheel.

Figure 7 shows a mass production jig that can be made to cut shim stock to length and also cut tension wrench stock to length and bend it as well. When cutting shim stock it must be used with coolant spray. The swinging arm labeled B has a steel bushing inserted into the wood. The interior hole of the bushing matches the tension wrench stock diameter. To use the jig a long wire is inserted into the wrench hole and marked at the point it leaves the bushing. Put this wire on a bench and figure out how long you want the wrench handle to be. Make up the rest of the length (marked on the wire) by cutting a filler dowel to size. Now insert the dowel and then insert the wire again and mark it to see if the length is correct. This system allows you to make handles of different lengths just by inserting different length filler dowels. A set of dowels can be marked with pen to indicate the length they create. The dowel is easily removed by tipping the jig upside down.

Once the wrench blank is cut off using the grinding wheel the torch flame is applied to the bend juncture (where it leaves the bushing) and, when cherry red, the arm A is swung over to form the bend. The wrench end is flipped out of the jig, quenched in oil, and the next piece inserted to be cut. It is a mandatory safety ingredient that you have a secure holder for your torch since you will want to keep it lighted during the entire cutting session. It must be picked up and put down safely, so make a good stand. The Smith brand little torch comes with a wire loop that can be screwed into a wooden bench top. Don't attempt to fix the torch in place and swing the jig up to it. It may save time, but it is way too dangerous to work that close to a live flame.

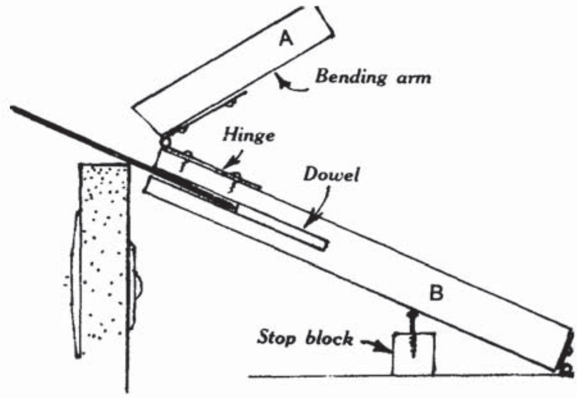


Figure 7
Tension wrench production jig.

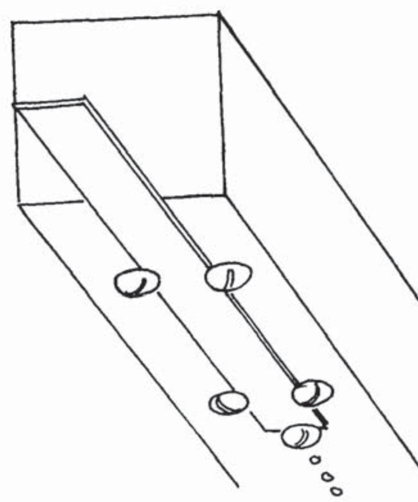


Figure 8
Tension wrench production jig modification to cut pick stock to initial length.

To cut shim stock using the same jig you will need to add a few wood screws in the bottom surface of the B part. Figure 8 shows the pattern of wood screws that will hold the shim stock in place on the B part. Different end screw holes may be drilled to make a variety of lengths. To use, just insert a screw into the desired length hole, and shove in a shim stock under the heads of the wood screws. They can be turned in for a tight shim fit or left as loose as needed, as long as the shim is held safely as it is cut by the grinding wheel. After insertion to the end screw, the A arm is swung down and the shim is cut off. A pointed tool like a screwdriver is needed to unload the cut piece from the embrace of the wood screws. Because of that time element, quenching is unnecessary. Heat from the wheel is not a problem if you use coolant. If you're not set up for coolant yet, just hold a piece of metal against the shim stock and it will act as a heat sink.

Chapter Four Layout Methods and Skills

In this chapter, eddie discourses on the perfect methods for putting Ye lines onto Ye steel blank, together with eddie's popular key-part tracing technique for quick and easy pick generation.

Layout is the process of making outlines on steel blanks for grinder cutting by eye, and points for drilling holes. It can be as simple as tracing a part of a key or a master template directly onto a blank, or more complicated, involving geometry and specialized tools. Although layout constructions can be made accurate to + or –.004″ if scribed and executed correctly, the lines are usually used only as rough cutting guides, since the final finishing to shape is done with hand files. The finish filing is guided according to dial vernier measurement or using simple hand methods. The process of layout can be done in two ways.

First of all, a layout can be done by strict measurement. Go one half inch from the edge of your measurement and make another line, then another line a quarter of an inch farther and so on.

Layout can also be unmeasured and still constructive. In other words the layout process itself can produce a line, center, or a set of lines whose position you didn't calculate or measure at all, but which the layout process says are geometrically correct, like the middle of a piece of stock, a right angle line set, and so on. This construction is a function of the properties of right angles, arcs, parallels, and so on, and involves the use of a pair of toolmaker's dividers and a 6″ engraved rule. If you paid attention in your geometry class this is old stuff. If not, it will become real familiar and valuable to you after reading this chapter, and make your geometry professor right when he said you'd be sorry someday if you didn't pay attention.

For straight measure layout the scribers are set using engraved steel rules and dial calipers. Then the measurements are transferred to the blank surface of the dye coated steel pick with dividers and squares.

In order to make the layout lines that you will scribe on the highly polished surface stand out, the steel must be treated with a non-reflective dark chemical coating called layout dye. It comes in either a brush-top can or in a handy spray can, the spray being better for lots of lock pick blanks done at once. Any substitutes like ordinary enamel paint or gun blue will not allow a fine line, and will flake or tear off the steel. Stick to formula layout dye. In addition to the layout dye you need a good scriber. A steel scriber with a very slender point is best for this type of work. A fat prick-awl point is a poor substitute for a machinist's scriber. The usual combination square often has a thin scriber tucked away inside it, with only the knurled brass knob handle showing. In a pinch even a sharp sewing needle works. A carbide tip makes a deep line but remember that it has a fat, chunky point that's hard to align with the ruler. The carbide is preferable for complicated layouts because it actually incises into the steel surface, and the intersection of two scribed lines can be felt by the sharp-pointed prick punch used to start a drill center. Not only felt, the trough formed will guide the punch point very accurately. The prick punch is very sharply pointed, and the center punch has a blunt, 45-degree angle point. Other than that, they are identical in appearance, so make sure you have a matching set, and use them in the correct sequence: prick first, center last.

A protective film is put on all shim stock to prevent corrosion, so to degrease the surface prior to spraying on layout dye, use lighter fluid, lacquer thinner, or naptha with a paper wipe. The layout dye dries almost instantly, especially if you put on a light coat, so don't overspray. As stated, the reason I recommend a spray layout dye — twenty or more pieces can be laid in order on a sheet of newspaper or on their respective paper sleeves and simultaneously marked. The dye keeps well and dries hard slowly, so extras may be stored for later processing. When I cut from different thicknesses of steel for experimental work, I remove each piece of steel from its skinny paper envelope, degrease it and place it back on top of the envelope so it masks the printed data. Then I spray the steel and when dry I resleeve it. At a glance, the dye marked envelope with pre-marked stock inside can be identified. If you are not storing them back in the envelope, wrap tissue around each one after drying. I will also mention that some people prefer to work with no layout dye at all. Instead they rely on the etched lines that the carbide scriber produces on the polished surface of the shim stock, remembering that a carbide point must be angled to align since it is so fat. The lines require correct lighting to see well, and I prefer instead layout dye, since a sharp-eyed operator can actually see a glimmering white line appear precisely at the point when the grinding wheel face begins to contact a scribed layout line on dye. With a second or two of grinding this white-appearing line disappears, which signals that the layout line has been ground away. By watching for the white line, great initial accuracy and speed can be had. This is not as easy as it sounds, though, and a little practice will be in order.

For regular layout tasks you will need a depth gauge, a small machinist's rule, and an angle protractor. Clamp the steel blank into the vise edgewise, and scribe the first line in Figure 9. Notice the inset. If the carbide point is held away from the ruler's edge, the line will be displaced from the real straightedge and inaccurate. If the ruler skids away from the surface being marked, the same thing will happen. To give the best accuracy, angle the scriber point into the ruler blade, and go so far as to clamp the ruler or protractor blade to the workpiece for critical layout jobs. The steel you are using is also very slippery to the scriber point, so be careful. A common machinist's trick for making two polished pieces of steel bind to each other is to insert some newspaper between them and tear or cut off the excess after clamping. The paper fibers are just abrasive enough to grip to the steel. To set the angle protractor for the correct depth easily, I've made a step gauge from some scrap ground flat stock. The tongue end of the ruler blade goes into the step and the baseplate of the protractor stays on the surface. This gauge can set the protractor to + or – .001 inches. Make sure all mating surfaces are flat and

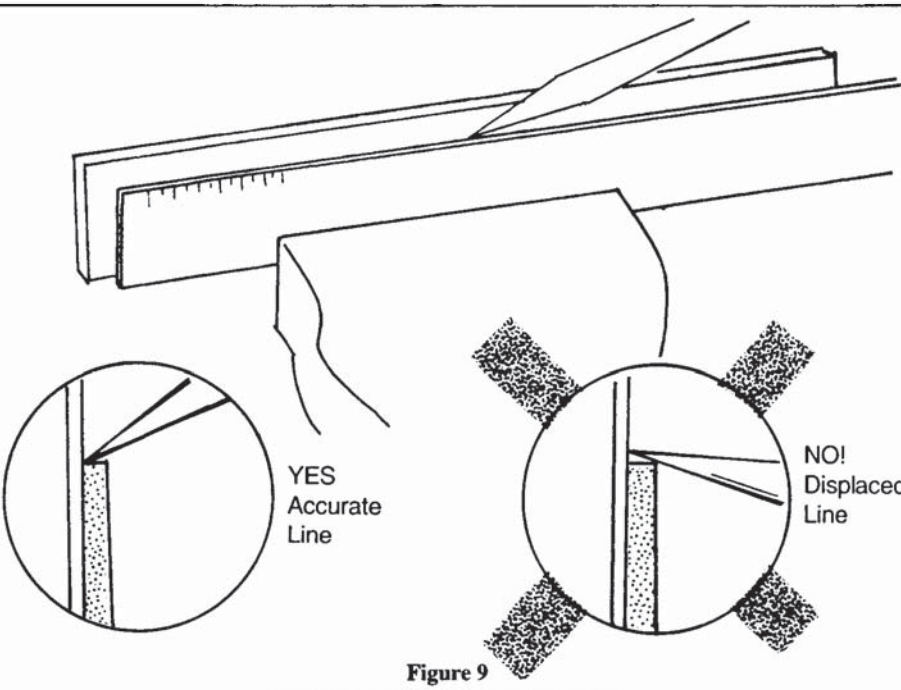


Figure 9
Marking scriber point must hug ruler.

parallel when using this gauge to set the protractor, because even a slight tilt will seriously affect accuracy. Even though the operator can't grind to layout lines with the same accuracy the gauge can be set to, it's still good practice to layout as accurately as possible. The step gauge is labeled with the micrometer depth using a set of stamp letters and numbers and a hammer, or your carbide scriber. If other depths are needed, make a whole new gauge. For very small adjustments on these gauges that you will sneak up to one-thousandth at a time, use a mill file. If you become a convert to this system and agree that a gauge to set up every one of your pick-making operations is a good idea, pick up a couple of pounds of light aluminum in various flats and angles to make gauges with. It has excellent dimensional stability, and it is a snap to work with. Pick shank width is one such measurement it pays to set by gauge. If you have access to a drill press, a better jig can be made from a block of aluminum that is drilled and tapped for five or six holes. Each hole admits the narrow ruler tongue, and the slug threaded into the hole is a hex-head tap screw treated with Loctite to prevent creeping movement. The ruler can be set at different depths depending on where the screw is left in the hole. A slight change either way is easy to adjust. You might think the same jig executed in wood is as accurate, but it's not nearly as good. Only metal retains any sort of dimensional integrity. Wood is not an acceptable substitute, and although plastic is possible to work, I still prefer aluminum.

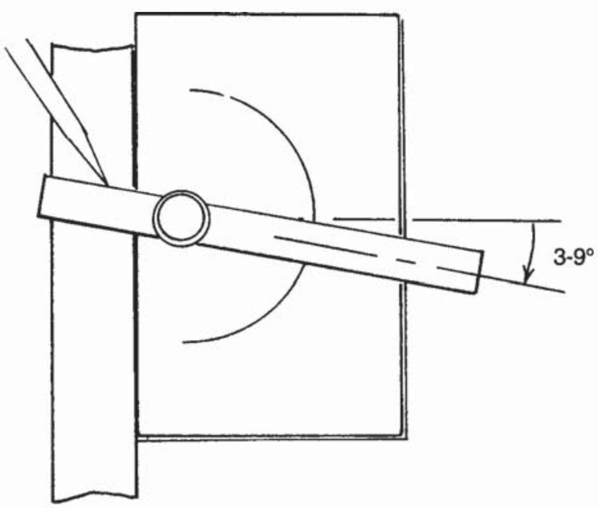


Figure 10
Using protractor gauge to scribe tension wrench cut lines to different angles.

The flat ground style of tension wrench can be easily laid out on a piece of steel using the protractor-type depth gauge. This is also covered in the chapter on tension wrenches. The tongue is set to anywhere between 3 & 9 degrees, as per Figure 10 and the side of the gauge is aligned with the stock. Scribe one line, then slide the gauge down and scribe the next line. Now keep the setting and rotate the gauge 90 degrees so the end is aligned with the stock. Now the two wrench end lines can be scribed, making them match the side lines already done, and the width of wrench tip can be scribed last of all. Laying out the wrench in this fashion allows the maximum use of the stock, with minimum grinding time. In addition, the flat shank this configuration of wrench presents to the lock cylinder face permits it to be used on a lock that is set flush with its mounting surface. This is a good example of calculative layout since you don't know any of the dimensions exactly, you can only say that they are exactly 90 degrees in orientation. If you would like to calibrate the amount that you slide the protractor body over on the pick stock to scribe the second line that determines the width of the tension wrench body, set up as shown in Figure 11. The protractor body is slid over and butted up against the toolmaker's clamp, and then clamped in turn. Once the first line is scribed, loosen the clamp holding the protractor, and insert a gauge block between the protractor and the initial indexing clamp, then reclamp to scribe the second line.

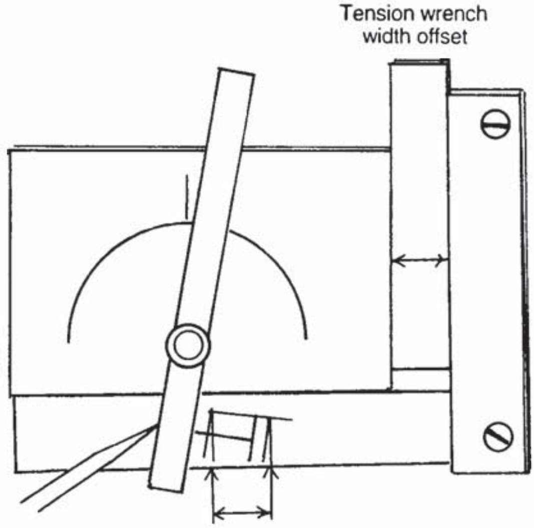


Figure 11
Layout of splayed-leg tension wrench using protractor and offset spacer.

What, you may ask, is a gauge block? Let's look at this valuable technique. Gauge blocks are pieces of metal that are very precisely finished in right angle, squareness and size. They are so perfect, in fact, that they can be made to cling together with almost molecular accuracy merely by hard pressure. This is called "wringing" a set of blocks together. This accuracy comes at a big price, so don't go out and get a set of gauge blocks, unless you buy a set of Chinese origin. You can use the next best thing, either a set of good quality shim feeler gauges, or a few odd sizes of ground flat stock. It is easy to see that a .010″ shim blade held next to a piece of flat ground stock that is .250″ will produce a gauge block offset of .260″. Various combinations of other pieces of metal will make up any size you desire, and with good repeatability. In the protractor set-off example at hand, a good initial try is for a .125″ dimension. There are formulas to tell you what that will translate out to in tension wrench shank width, but you get the idea. A known set-over produces layout lines that can be ground up to for a good approximation. Final finishing in conjunction with other measuring techniques will produce an accurate tool. Again, always try to work to greater precision than is required, if practical, since errors will inevitably affect the final tool.

I should mention that classical layout methods call for using dividers with needle sharp points that can be inserted into etched graduations on the 6″ rule. Once set they are used to scribe lines parallel to the long axis of the pick, one edge of the divider riding on the blank edge, the other divider leg doing the scribing. On slippery shim steel this is not at all easy to do accurately and requires a bit of practice, although it is very quick. The best approach is the use of gauge blocks acting on layout tools or against the working edges of the pick itself.

The term "working edge" also bears defining. On some classes of pick one edge is never touched, but is left smooth and straight as it comes from the factory. This is called the working edge and on our rake style lock pick tools it is usually the bottom.

For scribing angles, there is a tool produced from two pieces of shim stock. With a pop rivet or machine screw, secure the two pieces together by their drilled ends, and then slightly misalign the blades. The resulting angle can be measured if you wish, but all that is necessary to know is that an angle that produces the proper length of tension wrench and the proper width of shank is created. This angle can be preserved by clamping the set and then drilling another hole for another pop rivet. Both fasteners should obviously permit no movement in the two blades. If you have access to an acetylene torch the two pieces of steel can be brazed together permanently.

To use this jig, align the edge of the steel with one of the leg's edges, and scribe using the other leg as a straightedge. It will always be perfect from piece to piece. The small right-angled ends can be laid out almost by eye and checked with a small machinist's square as grinding progresses. In fact, in Figure 12, a design for a splayed-leg tension wrench shows that a right angle is not always a good design for a multi-end tool. This design allows the necessary clearance between tension wrench shank and lock cylinder/door face, yet it uses the steel to good economy.

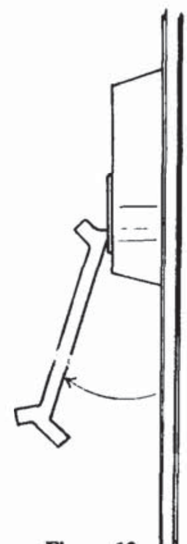


Figure 12
Note splayed-leg puts working end of wrench away from lock mount surface.

Let me go on record as saying that I cannot stand those double-ended picks personally. The typical tool has a lifter on one end and a diamond on the other end. It makes the shank much smaller and is difficult to shift end-for-end while holding the tension wrench on. Furthermore, it usually spells trouble big time when you have to shift from raking to lifting and back again a couple of times. My instructions to apprentices are to start over again if one stint of raking during a lifting attack won't turn the trick. The double-ended lock pick is an example in frustration but they look real "CIA" so they crop up a lot. They are undeniably cool, if impractical, tools.

On the other side of the coin I am strongly in favor of double-, triple-, quadruple-ended tension wrenches. Consider this. Make a wrench that has four identical ends with varying widths. Start with the narrowest and go to the next up and so on until one wedges tightly. This is very easy with a multiple-ended tool. One grab will get you four tools, and it also saves a lot of bulk. It's harder to juggle four separate tools in and out of your case.

Eddie will now set the wayback machine and talk about his early exploits making lock picks. The first lock pick book I got had a few fuzzy pictures of several lock picks with various ends. Here was knowledge and power waiting within my grasp if only I could duplicate those angles and shapes. After going nowhere with the magnifying glass I finally drew lots of complicated lines and stuff right on the book in an attempt to duplicate the pick tips on actual steel. All that got me was a bunch of numbers I was not tooled up to use then. I was disturbed to find out that water will quickly trash a paper pattern glued to a lock pick being ground and quenched repeatedly.

As eddie's technique matured lock pick pictures in books became unimportant. In the end eddie started to decide how the pick should be shaped. Let me ask you some questions: who decides exactly how a lock pick will be laid out? Who says how much of a curve it will have at the end (if a lifter) and how high the diamond will be? The answer is the lock, if you can learn how to make it talk to you. You can, by actually measuring and figuring, design which will be the most perfect shape for opening a given lock. Eddie will teach you how to do the two types, lifter and diamond.

The classical diamond pick shape is meant to be used to rake the lock. It relies on its ability to "billiard ball" the tumblers. To make a diamond ideal for a given lock, you need only measure a key that fits a lock of that type. If you don't have a key or lock of that type, other approaches will be discussed later, but now back to the key.

You will need a measuring tool; ideally the dial calipers, or at least an engraved ruler. First examine the key to locate the shoulder. Every key has a right angle shoulder that hits part of the lock keyway and regulates precisely how far the key can be inserted, so that the key bitting lines up exactly with the tumblers. Locate any such discernible shoulder or key to the lock stop located at the bow end of the key. Measure from there to the exact middle of the bottom of the furthest key bitting cut. This measurement is the working length the pick shank and tip needs to be to penetrate far enough into the lock keyway to reach all the tumblers. Next measure the distance between any two consecutive key bitting cuts. This will be the pin-to-pin spacing. The distance two pins are apart is very important since it indicates the point at which the pick shank can safely rise to become the pick nose or tip. If the shank raises too soon it will also act on the adjacent pin, which is very bad if you don't want to move two pins at the same time. Finally, grab that pencil you used to write down this lock's vital statistics. While holding it normally, measure how much of the pencil is in the hand. This will be a guide for how much pick handle you will be comfortable with initially. You may modify this number up or down as your technique progresses. Your measurements are: a) length in lock pick; b) pin spacing; c) length of handle. You can make an extreme fuss over measuring the angle of the key bitting cuts. The official number is 50 degrees, but eddie uses 45 degrees and it works just fine. It also means that any diamond you cut has equal force on it in and out. From these measurements it is easy to lay out your first actual pick. Use a foot long piece of ½″ wide .031″ shim stock covered in layout blue. Scribe a line using a square at the approximate center of the steel. This is the lock face parting line. Set your dividers to the "a" figure plus an 1/8″ (for fudging). Use the dividers to scribe a line as in Figure 13, and scribe a line 45 degrees away facing out from that point. Now at this point normally you would flip the protractor and scribe one more 45 degree line facing in, to complete the diamond shape. The problem is, how high to make the diamond? How far away does the second 45 degree line go? To answer that question we must go back to the lock again.

At this point examine the key from your sample lock. It may have cuts that are the same height as the next or adjacent cut. It may have some slightly lower or higher than the adjacent cut. What you are looking for is the biggest difference in height between adjacent bitting cuts. There is a maximum allowable height variation between two adjacent cuts. This restriction is necessary to maintain the bottoms or "vees" of the cuts in line with the tumblers. An excessively deep or high cut would intrude into the space reserved for the adjacent cut, and leave the

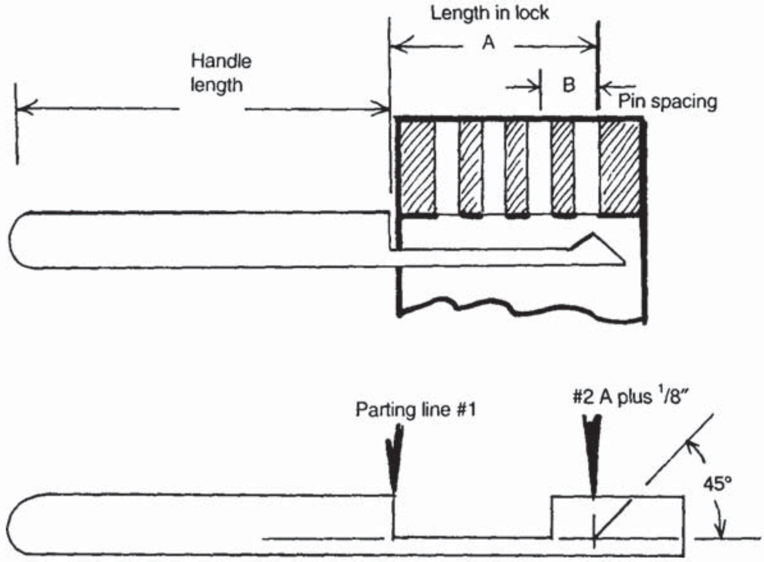


Figure 13
Initial layout for diamond pick.

adjacent tumbler end riding on the too deep/high cut's slope. See Figure 14. This maximum allowable cut height is also the most that your diamond height should be. It may of course be a lot less, but the higher the diamond the more energy imparted to the pins during a rake opening. The same principle applies to the classical lifter layout. If you want to avoid measuring the maximum allowed cut, just find it (if it exists on the key) and trace it directly into the layout dye on the pick blank. Orient the key shank parallel to the pick axis when doing this. The same "trace directly from key technique" works for quick and dirty snake or profile pick layout creation, since the heights and spacing are already cut machine correct. Finally, remember we said the maximum allowable. If you want your diamonds cut down in height, merely continue to grind PAST the layout point to adjust diamond height. This can be done any time after the pick is in use as well. The only rule is to keep the angle the same. Within about 2-3 degrees is close enough. Having discussed the diamond, eddie will now move on to the lifter. Here is where your tool really begins to differ from the commercial jobs. I have no idea who initially designed that clunky lifter profile, but like the boss told the strip-bar applicant, "Way too fat for pro work."

The classical lifter pick layout ideally has two curves in it, the end of the lifter and the shank. The curve is a quarter or less part of a circle, and the diameter of the circle is such that the point of the tumbler adjacent to the tumbler being manipulated will rest on the exact spot on the pick shank where the curve begins to sweep up from the width of the pick shank. This will ensure that the adjacent picked tumblers will not be affected or overlifted by the tool's working tip as it moves around in the lock. In theory, the maximum height difference allowed between two drivers should also enter into the calculation, but it is always less important than the previous dimension. To calculate the diameter of the pick tip upsweep radius, measure the outside of two adjacent pin wells as in Figure 15. From this dimension subtract one pin tumbler diameter (usually .115" or .120") and the result will be the center-to-center distance between adjacent drivers. That figure is also the diameter of hole that you want to layout on the pick stock. My data tallies have over twenty different makes of lock to distill, and the average seems to be .160" which is very close to 5/32" drill size, or can be bracketed by a drill size #20 or #21.

There are radius gauges available in different sizes that can be used to trace with, but there is a more precise method. Once the number is calculated, select whatever number drill comes closest to the micrometer number, and, using this drill, shoot a hole into a piece of .015" brass stock. This negative hole created from a positive drill rod now becomes the tracing template to use for the radius. Clamp this template down, and insert the tip of your carbide scriber into the hole, pushing it outward till it contacts the edge of the circle. The selection of very thin sheet brass for the template makes holding an accurate scribing angle much easier. Place a straightedge alongside the hole and nudge it inward until it contacts the scriber point. The straightedge will then be perfectly tangential to the hole. Scribe a layout line as shown in Figure 16 and grind along this to cut out the template required. This template may then be aligned either to another layout line on the blank or physically aligned with a semi-finished pick. Scribe the remaining layout lines and grind as close to them as possible. If you are seduced by all those double-half and full-ball and diamond shape picks used for raking a lock open, this same layout method will make their templates also, and with great accuracy. The procedure is to scribe a line on the aluminum stock, and, using a center punch and hammer, make a center prick mark exactly on it. From this center (not *in* the center of the stock at all) prick draw a circle with dividers set to the pin well center-to-center distance. Do another center prick where the circle crosses the line. Two holes will be drilled in these centers; the diameter of the hole is up to you.

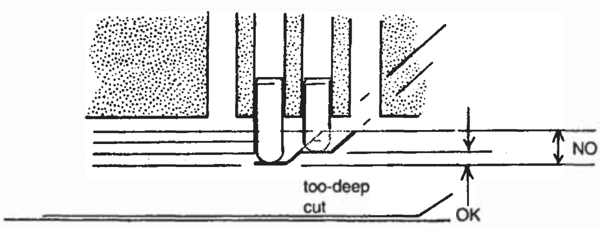


Figure 14
Notice that key cuts that are so deep they remove material from adjacent pin key areas are forbidden!

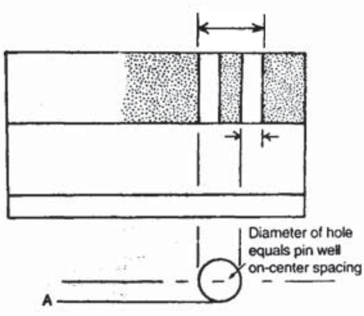


Figure 15
Shows line "A" scribed tangential to hole to form lifter hook profile.

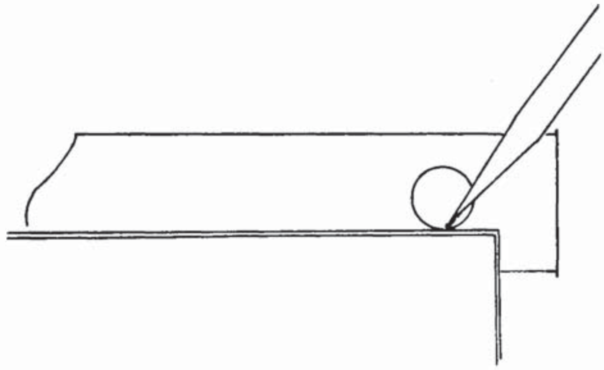


Figure 16
Method of scribing line tangentially to drilled hole.

The largest diameter is of course the maximum difference in height between two adjacent drivers. Usually this figure is .030″, but it may be looked up in a code book or measured and calculated from the right key bitting combination. One very common practice is to make the first ball (which will be cut from lines traced from the hole drilled) the maximum height difference, and the second ball the minimum step. The position of the balls (holes) may be switched, and even three, four, or five holes can be drilled. By the way, this layout method is also the easiest way by far to generate the complex wiggly pick outlines some pick artists still swear by. Once the wiggly outline has been generated, it may be further modified before the actual cutting commences. To return to the ball pick, after the holes are drilled, the template is finished by grinding away half the template to the initial line. The template may then be lined up flush with either an existing layout line or another semi-finished pick shank. It is crucial to remember that to produce a double-balled pick the grind must be modified to put the shank UP from the usual base of the tool. If this is not done, there will be no steel to make the lower set of half balls from, yes? With multiple sets of ball templates, one can be used for upper and one for lower tracing. The template can be flipped to exchange the order of the balls on the shank. A diamond on the bottom, a ball on top; the combinations involved are many. Let me also go on record here as saying that I have a low opinion of the wiggly pick, the vaunted "king and queen" pick, and the rake pick with tip modified from a diamond shape. The theory of raking is, of course, to impart the billiard ball transfer of shock from the lower pin to the upper pin, but rounding the point of the diamond will also reduce the reverse shock and/or acceleration of the driver to less than that maximum. It may be great fun to have all those geometric shapes, but it won't open locks any faster or better than raking skill with a single diamond. The wiggly or multiple profile pick has a different principle of operation. It is intended to align multiple drivers simultaneously, which is supposedly useful if tolerances are very tight and picking is especially difficult. The wiggly pick pretends to be the right key in essence. The real problem is that the higher tolerance the lock, the larger the number of possible combinations of key that will NOT fit.

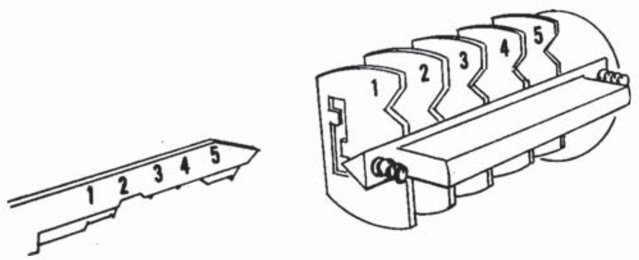


Figure 17
Automotive disc lock showing sidebar system.

Let me explain this in detail. You can figure out how many steps in the key system, how many drivers or tumblers, and use that data to computer generate a list of all possible combinations like 1111, 1112, 1113, 1121, 1131, and so forth. Then, like trying to "box" THE LOTTERY NUMBER, you can attempt to come up with several pick combinations or profiles that match probable ones on your listing. The commercially available models claim to have done just that. Just consider the tolerance of the lock. If the steps/increments of key bitting are .007″, but the driver will catch if the key is .003″ off either high or low, then there is in effect a set of "half" numbers or combinations that if picked to, will do absolutely nothing. This is why I say the number of WRONG combinations is a lot larger than just the code possibilities.

The wiggly pick got its start from the automotive lock industry. An automotive lock with a sidebar set into the plug and shell will prevent applying pressure on the wafers, or discs of the lock until ALL of them are almost in line. The wiggly pick was supposed to act like a surrogate key and ALMOST line up all the wafers simultaneously because of sloppy tolerances, and the sidebar would begin to snap in. Even better (or worse depending on your viewpoint), the sidebar has to be spring loaded to snap IN to the shell, and it actually helps line up tumblers that are almost in position. See the accompanying Figure 17.

Sets of automotive try-out keys that were available in the 1950-1963 period relied on this same fact. The difference there was that the tolerance of the locks then being produced closely approached the bitting depths, and keys cut to a half depth could thereby bridge the gap and work two combinations simultaneously. The number of combinations went down so dramatically that by using 50 keys and wiggling each one around, one would effect an opening. The wiggly or wiggly pick comes from that same period in locksmithing history. The wiggly pick still is valuable for automotive locksmithing today, but I believe that any opening on a pin tumbler residential lockset effected with such a tool could have been just as easily done with a single lifter pick. Remember that the single lifter perfectly duplicates the action of the key, as far as each single dumb driver knows, so the lifter comes closest to masquerading as the actual key.

The layout procedures eddie teaches here may seem to be way too fussy for you, but consider two points. First, each layout only needs to be done well once, because second generation picks may be directly traced from the first tool onto a new blank. Secondly, the time will come when you'll need to make a pick that is EXACTLY such-and-such high with so-and-so clearance, and when that day comes, having secure layout and measuring technique under your fingertips will save the day.

For other comments on rough layout technique, also see the chapter on rough grinding, and the chapter on tension wrenches.

Chapter Five
Initial Layout

This chapter deals with the first steps of whittling away metal to get to a finished pick. Your completed rough-ground pick should look like Figure 18. Notice that the working length of the shank will remain nearly the same after finish grinding, while the height and contours of the working tip will be much altered after finishing. To lay out the cutting guide lines for this first step use a surface gauge, or a preset scribing gauge to produce the parallel lines. A surface gauge is a block of metal with a lapped flat bottom and sides, and a double-jointed arm that terminates with a pointed scriber. Most surface gauges have a set screw for fine adjustment as well. To set it initially put an engraved 6″ ruler end-up on a sheet of glass, and set the pointer so it precisely "clicks" into whatever engraved mark you are using for approximate pick shank width.

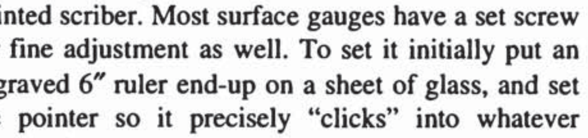


Figure 18
All-purpose pick blank.

When selecting a 6″ ruler make sure the graduations are engraved (cut by machine into the steel) and not just printed or etched on. For precise setting of small pick widths, the ruler is available in graduations of 100 per inch. This is called a 16R scale in the trade. Once the height gauge is accurately set, place it and the pick stock on edge upon a piece of glass and move the tip of the scriber along the pick at an angle. It will describe a perfectly parallel line on the layout dye sprayed on the pick stock. To keep the pick stock at 90 degrees you can back it up with a small machinist's square or anything reasonably cube-like. The same square will produce the right angle layout lines (end lines) also needed on the pick blank.

If you don't feel the need to get this accurate, the pick stock or blank covered with layout dye can be dropped in the slot you cut into your bench pin, and the line scribed along the surface of the pin. Not as good, but serviceable. It will just require a little more care in rough grinding, since you shouldn't go right up to the line.

As I said, a square or surface gauge will produce the end line, or you can make a one-step tracing jig as outlined below. Be sure to scribe a set of arrowheads whose points stop or cross on the length line once you put cut lines in. These arrows are scribed in the area of the pick that will be ground away. This prevents cutting the opposite side by mistake, and allows the eye to pick up the length line easier, since it will not show up well in light angled to show up the width line instead.

For one-step scribing of rough layout lines, I will show you the aluminum jig used for years at my shop. To make this jig, procure a piece of aluminum angle 1″ x 1″ x $^1/_8$″ and 6″ long. Aluminum is very easy to work and therefore ideal for jigs that only involve tracing or marking. Hold a finished rough-ground pick into the bottom of this angle as in Figure 19 and secure it with a couple of machinist's clamps. Now scribe the outline of the ground steel pick onto the aluminum inner face of the angle. Remove the pick and take the aluminum to the bandsaw/bench wheel and cut or grind out the profile you traced, paying strict attention to accuracy. Saw a little short of the line and finish up by filing or belt grinding. Filing will be very slow and tedious since the file will have to be cleaned of the numerous aluminum chips frequently. That's why the jig should be band-sawn. A belt grinder will be a lot faster than filing for the final working.

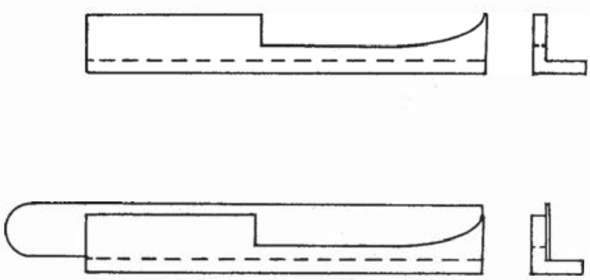


Figure 19
Blank pick inserted in marking jig to scribe final cut lines.

Once this master tracing jig is made, any number of chisel-cut half, third, or coil blanks can be quickly scribed with the profile required and then taken to the grinding wheel immediately. I omit the use of layout dye if the tracing procedure is followed, since with a carbide-tipped tool, the lines can be scribed deep enough to discern under the light easily. One pass is deep enough, even with a light touch. When marking with this method beginners have a tendency to re-scribe over the same line to make a deeper impression, but any repeat scribing rarely follows the exact same path each time, and only makes the layout line fatter. A really fat layout line seriously decreases accuracy of the grind since it increases the "correct" or "safe" area the grinder is trying to grind to. A heavy touch may cause the scriber to skip or slip away out of control, so go lightly. As an exercise see how light a line you can scribe, and then grind to it.

This aluminum jig may also be later modified incrementally by filing or belt grinding if it is decided that more material should be customarily removed during the rough grinding. When removing more metal from this marking jig, take care that it will still always produce a rough pick that is truly universal in that its contours can be made into any type of pick without being "short" some steel. If you remove too much material the jig will always mark "short" and must then be replaced or make-do modified to something else like a final profile marking jig. If in doubt, before you start any cutting on the original, use a rough blank made from the starting master jig to make a second generation jig and use it for experiment.

Once the blank is lined you go right to the wheel, check it for cracks or flaws, turn on the mist, dress the wheel, and go. The speed of the grind is of some importance here. By speed, I don't mean the wheel's rpm's but rather the rate at which the steel is fed into the wheel. Since it is technically a roughing-in operation you should go as fast as possible, but it is possible to feed so fast that even the mist coolant bath will not stay ahead of the heat generated. By close observation of the pattern of coolant flow on the face of the steel you can detect any areas of steel that become heated enough to vaporize the coolant. These hot spots will be potential danger areas if grinding speed and temp increase any further. For your first few tries start out slowly, then gradually increase the feed speed. The coolant will start to avoid areas of the pick in contact with the wheel, but this is still okay. At some faster feed point you may notice the sudden "blooming" of the tell-tale blue oxidation color. It will be seen to bleed away from the grind line into the main steel body. When this occurs, immediately lower pressure on the wheel and the temperature will cool below the danger point. Now, by slow and careful grinding, that small bloom of untempered steel can be removed and grinding then resumed at a new rate reasonably below danger levels. Remember to adjust the coolant spray direction so it will be exactly on the region where steel meets wheel, not on the wheel itself. A little experience will let you know how fast to rough-grind a piece. The real quick guy can push a line of blue discoloration almost all the way to the scribed line, and then back off the feed speed at just the proper moment and end up with a perfectly good expanse of steel. The even faster guy knows that the steel that will be ground off later in final profiling can also be left burnt and it won't matter. I prefer to leave no such blue in the rough grind, because in very small picks there seems to be a subtle alteration of the steel chemistry in the zone surrounding the tell-tale blue discoloration. I grind a little slower and have better results. The difference in pushing the line and staying conservative is negligible in most cases anyway, especially if the wheel is frequently dressed so it runs cooler.

Notice that when you grind off those little tabs of steel before going to the next cut, they heat up much quicker? That is because of their small mass. The rule is the smaller the piece, the slower it should be ground, even with that nifty mist coolant set-up!

As a rule of thumb, a ¾″ full cut in .028-.035″ shim stock to a depth of ¼″ should take no more than 45 seconds with no overheating. If you find that you are taking a lot longer than this, even as much as six minutes, something is very wrong and you should check on a couple of factors. Make sure the coolant spray pattern is centered on the steel, not the face of the grinding wheel. Check that the amount of coolant being sprayed is adequate and that the atomization is complete. If you are uncertain about either of these, try both to increase the air pressure and open the flow needle valve more. Since coolant is cheap, use as much as you want!

The most common factor to look for in excessive heat buildup is a glazed surface on the grinding wheel face. In nine times out of ten the wheel needs to be dressed. Between a dressed and a glazed wheel we are talking 45 seconds versus 3 minutes, and mucho added heat. The more glaze, the more heat and the less cut. Glazing will happen to you as you use the wheel normally. The glaze is composed of worn stone and particles of stones and steel, and even binder from the wheel. A telltale sign of this glaze is the volume of sparks given off during the grinding, and the amount of heat transferred through into the handle of the lock pick. If the amount of sparks is very low and the handle heat is very high, then the wheel surface is badly glazed and should be redressed immediately. Another indicator of a glazed wheel is an untrue or wavy grind. A further good indicator of glaze is a darker line on the wheel that produces a persistent "hot spot" on the pick steel. If in doubt, always try redressing the wheel since this will frequently work wonders!

It is smart practice to monitor constantly the speed of rough grinding and redress when any falloff in performance is detected. Without a fresh wheel surface, the coolant set-up is really inadequate to the potential heat buildup. Redressing the wheel takes only ten seconds or so, and is never the wrong thing to do. Wheels should be treated as a perishable item.

One or at most two wheel face width bites will get you over to the relief line. Once it is reached, reverse the pick end-for-end (if you are working on the left–hand wheel as I customarily do) and angle the pick 45 degrees to do the relief cut. Cut in until the radius of the wheel edge just matches the bottom of the straight cut, and then stop. Have a thick rag or wooden dowel handy to wipe off the splinters. Large amounts of free steel splinters await you on the down side (now the top side) of the pick. The ones still attached can be ground off with a very light touch as in Figure 20 as long as you don't dig into polished areas. They can also be filed off later, if you are timid about using the wheel. I myself strike off the bulk of these splinters with the wooden stick I use to feed and control the pick steel. I will explain about the stick.

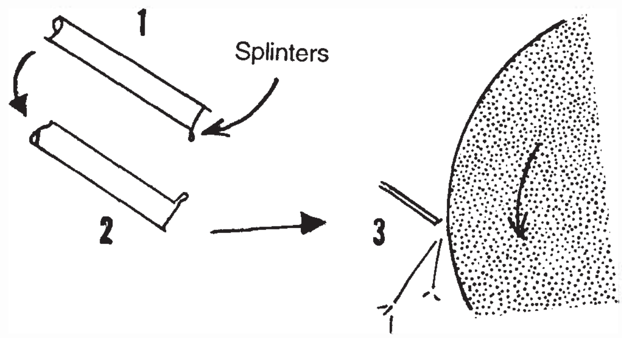


Figure 20
Lightly cutting off surplus splinters left from rough grinding.

Some extra aid in holding is really essential for anyone who plans to grind more than just one or two tools. It may not seem like too much trouble to hold the steel in your bare hands, but the many slivers and burrs created by the grinding process and left on the tool will eventually leave your hands with dozens of small cuts. Those freshly created wire edges are very sharp and will cut deeply if impelled by a slip at the wheel. Some form of holding is also safe practice in avoiding "kickbacks" and plain accidents of all types. The grinding coolant mist will also make your hold very slippery, and long exposure to coolant is hard on the hands.

The best type of protection is a piece of wood dowel that you hold in your left hand and which the lefthand edge of the tool digs into. This is more secure for holding than it sounds, and this is the method I habitually use for hand grinding to perimeter lines. The right hand holds the bare steel, and the left holds the short length of dowel angling up into the corner of the tool from below. The dowel has a hole ¼″ diameter drilled an inch deep into its end to hold and trap the pick tip. This wood dowel both damps vibrations, holds, and also pushes the tool into the wheel. It works especially well for me since I always grind with the tool handle at the left and the working tip at the right, with the lefthand wheel set up for grinding.

That's all there is to the roughing out. If you are trying to put blanks ahead and will store them for several days or longer, either drop them into a light oil bath to prevent rust, or heat them well and then apply a little WD-40 or Starrett M-1 spray, again for rust. The mist coolant must be neutralized since it is mostly water.

Chapter Six
Grinding at The Wheel

Grinding is the easiest technique available to work thin pieces of hardened lock pick steel as is, meaning without annealing or softening. If you grind right to the layout line, the wheel leaves a surface finish that will require only a little file work for completion. If any attempt was made to cut shim stock using a saw, for example, the cut would be very tedious due to the hardness of the metal, with frequent breakage of the blade as well. By comparison, grinding takes but a few minutes.

It will help you to explore briefly the cutting action of a grinding wheel. The wheel is composed mostly of abrasive minerals. The grain size and hardness are matched to the material the wheel is designed to cut. The abrasive grains are formed into a hard wheel by mixing them with substances that solidify under very high heat. The wheel is actually baked in a kiln.

The abrasive grains in the wheel are not round in shape, they are really square-, diamond-, or otherwise angularly shaped. As a result of the natural crystal-like shape, each grain has a sharp cutting edge. Taken together, these millions of tiny cutting edges are able to bite into whatever is being ground, even the hardest high-carbon steel. As their edges cut or chisel the metal away, they also blunt and fracture, eventually flaking away from the binder. A grinding wheel will therefore groove and use itself up as it is worked. It must be frequently re-formed or dressed to produce a straight cut again. The dressing process also removes leftover pieces of whatever material is being ground, and blunts packed-in grains. A wheel clogged with this junk cuts poorly and also heats up rapidly from the excessive friction generated. The term for this clogging is a "glazed" wheel.

Dressing restores the surface by removing the glaze and also retruing the surface to flat. Two main types of dressing tools are a toothed star wheel, which is mounted in a special holder, and an industrial diamond pointing tool. The diamond is intended for precision applications, and is valuable only for precise profiling of a wheel, like a precise radius on the corner for lifters. The more common tool is the star wheel. This has a pack of five or six wheels with multiple points of hardened steel. These star points can break off grains without being excessively ground down while doing so. The stars avoid wear because they wheel around rapidly, and because solid discs in the wheel pack prevent the dresser from digging in too deeply.

Dressing a wheel with a star is classified as a hazardous operation, requiring precautions. Always read and follow the grinding wheel manufacturer's instructions relating to wheel dressing. Wear eye protection at all times. The dressing star MUST be firmly seated on the grinding wheel's rest. If the rest is missing, do not attempt to dress the wheel, as dangerous kickback will result. Kickback may result in serious personal injury or even death. This is because dressing may cause a wheel to fracture. A fractured wheel turning at high speeds will literally explode, so work safely. You ain't NEVER been stoned like that!

To dress a wheel, apply the star pack very lightly against the stone at the point you normally grind, until the wheel face is true again. It will chatter and buzz as it whirls, and give off the occasional spark, and this is all normal. Some grains, grit and dust will be whirled off, and this is normal also.

Some minor profiling can also be done with a star by rounding a corner of the wheel to match the radius needed for a tool like the lifter pick. Eventually the teeth of the star will disappear and can be replaced. When you replace the star wheel pack, remember that one side of the nut assembly holding the steel axle pin in the cast holder is a lefthand thread.

Safety in using and mounting grinding wheels is nothing to laugh at. Getting brained with a small brick traveling at motor-driven velocity is one of the more serious-type accidents. There are some rules to follow:

1. If the motor shaft and the wheel hole don't match, make sure to use an approved arbor or bushing. Some wheels come with a variety of these included.
2. To prevent over-tightening and stressing the wheel, make and use a pair of cardboard washers between both sides of the wheel and the steel holding washers, as in Figure 21.
3. When starting a new wheel, plug the grinder in from a remote location and let the new wheel run unattended for an entire 15 minute espresso (eddie don't do coffee) break. Any hidden flaws will show up by then, and a wheel that may put on a deadly missile show will do so for an empty house.
4. After running a new wheel for 1 to 5 minutes, dismount it from the grinder and suspend it by a string through the hole. A very light tap on the wheel with a screwdriver handle may indicate if any hidden flaws and cracks exist. A good wheel usually gives a high-pitched sound and a bad wheel sounds dull or dead. This test should be applied at periodic intervals to monitor the health of the wheel. If in doubt about a particular wheel, discard it. They are not expensive compared to teeth.
5. Always follow the manufacturer's recommendations for care, mounting, nut tightening, and use of any specific abrasive wheel.

What kind of wheel to use? Avoid the dime-store shaft-mounted stones. Buy only a wheel that has a hole for arbor mounting. As you may know, the industrial supply houses carry specialty wheels for exotic steels or other materials, but frequently they require a large arbor and/or large machine to run. The standard bench grinder arbor shaft size is $^1/_2$″ or $^5/_8$″.

If you can get a soft stone that will mount on your bench grinder assembly, that is good. The softer stone will wear a lot faster because the abrasive grains are flaking away rapidly. This has the effect of making the grind go a lot quicker and a little cooler as well. Nothing happens for nothing however, but the trade-off in the wearing and more frequent redressing and wheel replacement is well worth it.

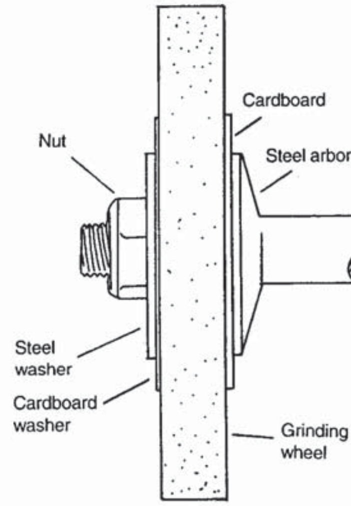


Figure 21
Recommended grinding wheel mounting using cardboard washers.

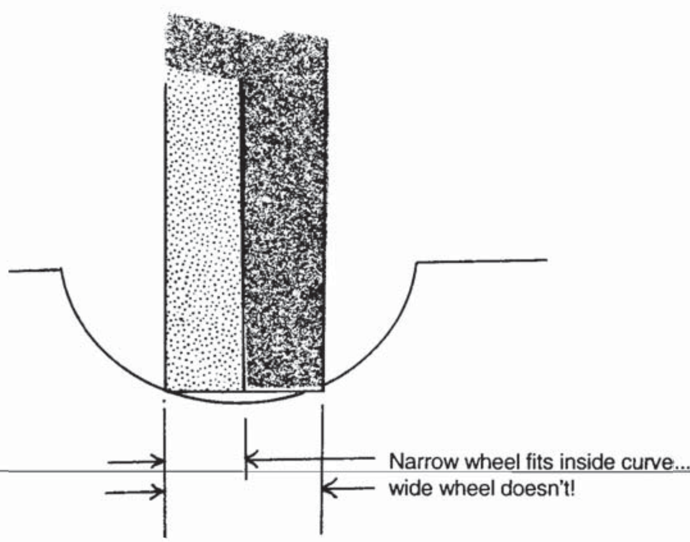


Figure 22
To grind inside curves, thinner width is better.

The much-quoted rule is hard wheels for soft materials and soft wheels for hard materials. The common aluminum oxide wheel is fine for your pick tool grinding. The larger the face width, the fewer grinding passes will have to be done while roughing out a tool, so try for a ¾″ width. With a very long arbor, multiple wheels can be side-to-side mounted for even greater face width, if the wheel manufacturer expressly states this can be done. For grinding the insides of curves, the smaller the width the better. Look at Figure 22 for an example of this curve-fitting rule. If you mount any wheel or combination of wheel surfaces wider than ¾″, you should add a second coolant nozzle to cover the extra width. Not only will more wheel in contact with the steel produce much more heat, but the spray pattern will be insufficient to cover all areas of the pick. Most spray coolant units have a two-nozzle system available for a few dollars more than a single unit. Truth is, a ¾″ wheel will handle most pick grind jobs.

The important aspect of the cooling mist is not only that water is applied to the steel, but also that the mist is constantly replacing the heated water with cooler water, and at a faster rate than even a stream of water could do. While we look at spray patterns, a little experimentation while seated at the wheel will show you that a pattern directed too much at the wheel surface and not more directly at the steel will cause large quantities of the coolant to be hurled into the air at a right angle to the wheel. This deluge of mist will soon wet down the guy doing the grinding. Aiming a little more directly at the steel will reduce this mist thrown off to almost zero. Once the proper position is found, mark it for future reference. This will also help you to keep the stock in the spray pattern. Stock that is held too close or far from the spray pattern will overheat and burn, so monitor this closely.

Do not grind in the same room where you do any bench and assembly work, because the grains given off will lodge in any greased working surface on a lock and cause excessive accuracy-destroying wear! If you must, put a tarp over the bench and lay down some wet newspaper on the floor to catch the abrasive dust/mist. Don't slip or trip on the wet newspaper and fall against the grinder. I wear sneakers while grinding.

Once the layout lines have been completed, grinding may begin according to your set sequence. The first roughing cut should be even with the end of the tool, and should be carried down almost to the layout lines that delineate the height of the tip. By contrast, if you decided to make the first cut where the handle begins, the heat built up by the grinding would have two places to go, to the handle and to the tip. Now, heat flowing into the handle is good for a cool grind, because the handle has lots of mass and surface area and therefore can absorb a lot of heat before it will begin to lose temper. In practice I have never seen a handle untemper. The problems would begin to start when the first roughing grind had been completed. The extremely small cross-section of the tool shank would prevent any more heat from rapidly flowing into the handle, and on the next cut practically all the heat would concentrate in the tip area, where the mass is less than the handle, and would only get much lesser as the grind progresses. The result is more heat build-up. That is why the desired approach is a grind progressing from the extreme tip back to the handle, allowing more heat to escape through fewer "bottlenecks."

We were doing a grind at the tip straight down to the layout lines. Once this first cut is completed you can jump over one wheel width and start over. Notice that at some point the grinding wheel will have metal on both sides bumping or striking against the sides of the wheel. It is crucial to realize the potential for disaster here. If the wheel catches its side against the tool and draws the tool down, the cut's width clearance will narrow until the opposite side of the wheel will catch also and wedge or tighten! Once that happens the wheel will whip the tool from your grasp, and turn it into a sharp-edged missile. To prevent this it is tempting to push the steel against the *side* of the wheel and grind some additional clearance, but avoid this. The side of the wheel is like a block wall. Straight up and down the wall is very strong in compression, but side to side it's very weak in tension. Grinding wheels can shear and break if repeatedly stressed on the sides. Instead of this, just shift the cut when the amount of cut penetration amounts to over $^1/_{16}$″. Go to the next cut position, cut $^1/_{16}$″ deep, then shift back for another bite. It's maybe slower going but it is much safer. It is advisable to leave a tiny tab between these cuts which will help "center" the cut and prevent the steel walking over sideways and making an angle cut. The small tab can be quickly ground off before the next cut sequence. Also try to avoid a "knocking" cut that just catches the corner of the wheel and walks down it. The sharp edge of the wheel is excellent for this because it breaks down so rapidly. The problem is that a that a severely rounded edge has to be dressed true again by losing a lot of good face that is relatively untouched, so use the full cutting face of the wheel evenly and it will last longer. The only advantage of a severely rounded wheel edge is that the catching effect is reduced a little, but don't count on this.

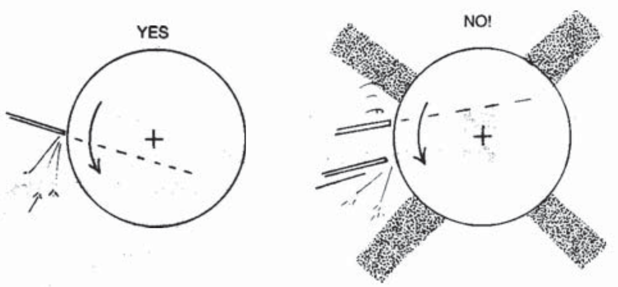


Figure 23
The work piece should always point below the center of the wheel.

The "whipping" or catching effect that a wheel has on a tight plunge roughing cut will also occur in a pushing out direction if the steel is held at an UP angle to the face of the grinding wheel as in Figure 23. There should always be a greater than 90-degree angle between the face of the wheel leaving the cut steel, and the width of the steel shim, and a less than 90-degree angle between the surface of the wheel approaching the cut area, and the width of the steel shim. As the steel approaches the wheel it can become caught, and will whip away at great speed and inertia. The force comes from the motor itself and its torque. Study Figure 23 carefully so you understand which is the right way and which is the wrong way!

Remember to mount and break in your grinding wheels according to manufacturer's recommendations, plan your cut sequences carefully to avoid dangerous heat build-up, and observe safe cutting angles when holding or setting up work to be ground.

Chapter Seven
Grinding Coolant Methods

In this chapter eddie discourses on mist coolant, an idea which will save you tens of hours by producing cooler, faster pick grinding. The professional lock pick builder will never be able to experiment with new designs if each new pick takes an hour to rough out. Eddie does it in six minutes with mist or drip coolants.

Tell the truth now, how many picks can you cut on the wheel in an hour without burning one or two? Grinding a pick to its perimeter shape requires the removing of very little actual metal, only about twenty percent or so of the total tool blank. The catch is in the tempered hardness of the metal. Don't get me wrong, because this hardness, created by carefully controlled heat-treating, creates a tool that is quite resistant to bending in very small cross-sections. The more bend resistance there is, the smaller the tool can be while still remaining capable of transferring enough necessary pressure from the tool user's hand to the lock tumblers. I will take all the toughness I can get and be happy for it, but it does mean that grinding this same metal produces friction, and friction makes heat.

So much heat is produced by the process of the grind that it can travel along the metal and untemper or anneal the pick you are trying to work on. It will anneal faster than the grind can proceed. That's sure not good, because the pick cannot be easily restored to its former precision degree of temper. Only a whole benchload of heat-treat equipment and the know-how to use them can bring the temper back with precision. It also takes time to re-temper, and may alter the chemical alloy makeup.

The practical way is to avoid annealing the pick in the first place, and you will do this by preventing that excess heat from building up enough in temperature to ruin your pick.

The quick and easy way is to just dip the steel into a can full of water very frequently. This is so common a method that many pedestal grinders are provided with a plastic or cast metal cup to hold water at the grinder. Since this method means lots of trips between the grinder wheel and the water tub, it pays to position the tub no further than 6″ from the wheel, preferably below the wheel. A wide-mouthed shallow tub will help too, since both the hand holding the pick and the pick itself are allowed quick in and out access. The initial rough cuts will be full wheel-face ones, and will generate the most amount of heat. Since they must chew up the most steel real estate, they will take a lot of time too. For this first step then, a rhythm of grind, dip, swirl-in-the-water, and back-to-the-wheel helps to speed the process. A favorite eddie trick is to find a good R & B radio station and nail a tune that matches your work pace. Get a copy of that tune. The more time spent on the wheel and the less in the air or the water, the quicker you get done, so get a system.

For just a few tools a water tub will work fine, but a practicing lock pick artist will design over five tools a week initially, and at three to five variations of each pick this adds up to a lot of drudgery at the wheel. The heat build up from grinding is so very rapid, in relation to the mass of steel available to absorb that heat, that most of the time spent standing at the grinding wheel will be taken up in removing, cooling, and carefully re-dressing the steel to the grinding wheel. The ultimate easy answer is coolant grinding. Don't take my word for it, just try making one pick using the water pot and you will wind up thinking there has to be an easier way. There is and the old-time peddler has already done it.

Adding a simple coolant system to the lowly tabletop grinding wheel setup is really quite easy. In times gone by that streetcart knife sharpener used an empty tomato can of water with a hole punched in the bottom for a steady drip-drip-drip. The can was hung over the large foot driven grinding wheel so that it deposited water right where the blade was applied to the wheel. The water also lubricated and carried away particles of steel that would have clogged the grinding stone's pores. The old tin can dodge still works today. A couple of holes nail–punched at the top rim will hold a wire loop. The wire loop is hung on a hanger wire (the good stiff kind, not today's cheap variety) for easy removal. The can's drip hole is sized according to your needs. The can is dip-filled from a large basin placed nearby the workbench. The free length of wire trailing from the loop in one side can be inserted down in the water and through the drip hole. It's still attached so it won't fall through. This wire can be bent so that it's positioned just above where the drip should go, and it will lead the water down with precision.

For a lot of water, one of those institutional size cans can easily be adapted to your bench grinder. Haul one out of the trash during the next restaurant call you make, and have it washed. You will also need a two-foot length of ¼″ outside diameter copper tubing, and some plumbing solder and flux. Back at the shop, drill a ¼″ hole in the side of the can about one-half inch above the bottom. Insert one end of the copper tubing into the middle of the can and put this assembly on a fire brick or fireproof surface on your bench. Apply flux and then solder. Check for leaks at the solder joint after a little cooling. This can filled with water is HEAVY so it must be placed on a shelf or other strong support above the grinder. Its large capacity makes filling a sometime affair. To regulate the flow, just crimp the open end. I put a needle valve in the line, because this keeps all the water from flowing out after grinding. A wooden plug would work too.

A telephone shower attachment can be used to deliver a stream or a flood of regular tap water to your hands at the wheel. Just buy one at the local drug store chain, and also pick up a couple of terrycloth towels and rubber bands. Hook up the telephone shower attachment to the faucet and snip the shower end off leaving an open hose. Use the rubber bands to attach terrycloth towel rolls around both arms at the wrists. This will prevent water from walking down your arms into your shoes. The hose end can also be rubber band secured to your wrist and arranged to point out over the pick in hand. Alternatively, the hose can be grasped by one or two fingers and merely held in contact with the pick. The only rule is that the water must actually flood the pick cutting-field and remove the heat before it spoils the temper. The waterbed retailers offer plumbing adapters that will fit to most faucets, and which will deliver water to you at the wheel.

The machinist's solution to the coolant problems is more elegant than a tomato can. There are two types of machine coolant system, the mist sprayer and the flood type. Big-shot experts tell me that research into cooling shows that a fine spray or mist of droplets is most efficient at carrying away heat buildup, so most modern systems use mist-type sprayers and not flood types. The mist cooler is also better suited for the tiny lock pick. The system involved is much less complicated, since it consists of only a small block with an air venturi in to suck the coolant up to the misting nozzle. The block is connected to a shop air supply. The catch is you need a steady supply of compressed air.

The venturi block feeds from the tank via a vinyl tube. Several companies offer a mist coolant system with various capacities. I use the Mist-Coolant brand. The volume per minute of compressed air needed to operate effectively the coolant pump is small, as are the pounds per square inch.

The venturi block works on the same principle that the car carburetor does. Air traveling through the constricted throat of the block creates an area of low pressure, and the coolant is drawn up through a tube and into this area by that vacuum. When the coolant hits that air stream it is atomized and accelerated out through the nozzle. An attached needle screw valve controls the amount of air for a given viscosity of coolant. Plain water feeds fine at almost all pressures, volumes, and knob settings. The Mist-Coolant brand manufacturers also package a coolant concentrate to mix with water and I feel this mixture cools much better than plain water. Of the three families of coolant additives: oils, emulsions, and synthetics, the emulsion is best for this type of work. A mix of 5% oil in water is usual. The industrial supplier who handles the mist units should have a large selection of these coolant mixes to choose from. When mixing up a batch, use only soft or preferably distilled water. Hard water may cause the emulsion to separate during the grinding. If no soft water is available, try a little trisodium phosphate (TSP) in the water before mixing to condition. In the actual mixing, put the correct amount of water in the bucket first and add the oil on top of it or into it. The finished mix should have a uniformly creamy texture. When mixing a new batch of coolant, run some plain water through the system to flush out all the old coolant. It is possible to have coolant spoil and grow bacteria when not in use. A month is the usual shelf life at my shop. Actually, I don't even measure the coolant concentrate closely, since it costs so little per gallon. I usually dump in a sizable gob and grind.

In use, the water coolant is directed to spray onto the steel at all points where it contacts the wheel. A generous flow of coolant will absorb enormous amounts of heat build up and allow continuous grinding, which translates to great time savings.

A pan to catch coolant as it condenses is a must. The amount of coolant you use per unit of time is determined by the amount of air pressure and the amount of throat given the needle valve, but it can add up to a lot over a five minute grinding session. The coolant is gritty and messy with steel particles, and will corrode and stain lots of things in the vicinity.

Any large size metal or plastic container will do if the grinder can fit comfortably inside it. To adapt a plastic dish or storage pan to the grinder, put a wooden plank in the bottom, with a pattern of holes drilled into it to accommodate the rubber feet on the grinder. Mark the positions for these rubber feet by putting layout ink or Magic Marker on the feet and then stamping it onto the wood. Once the grinder is in place, check it for comfortable working clearance, remembering that the wheel will get smaller in time, and also that the steel piece you grind may be as long as a foot. Once you have a position you like, provide cutouts in the metal pan for access to the areas where the hands get close to the grinding wheel face. To guard these edges install a wooden exterior board over the holes, pencil in the location of the pan cutouts, and cut the wood an eighth of an inch INSIDE these lines to provide a comfortable buffer for the wrists. I have a bulk drain hole in the bottom fitted with a rubber stopper. I used a liberal application of silicone RTV caulk to bed the board when mounting the grinder motor in a metal pan.

I do not advise directly recycling the coolant that will collect in the drip pan by laying the mist feed hose directly in the bottom of the pan. Even though the feed hose has a coarse sieve in its end, and a finer mesh could be added, nothing traps all of the particles. In addition, the water component of the coolant will decrease as it is steam-flashed away by the hot metal, while the oil will remain. Eventually an invert emulsion will be formed (see above) which is very bad, so the larger capacity defers the time when this problem crops up. I have a three-gallon plastic tub of coolant mixed up each time and it lasts for about one month of heavy machine time. The first of every month the coolant is replaced with a fresh batch. A teaspoon of dish soap in the pan serves to make the clean up a little easier. When cleaning out the pan use a rag, not paper towels or even cellulose wipers. The small particles of steel can slice right through mere paper and into your hand which is mere flesh and blood. You get enough small cuts from daily operations that you don't need to risk adding to the list. There will be hardened globs of iron oxide particles immediately below the wheel and these can be chipped with a putty knife for removal when they get too mountainous. While I am warming up on free advice here, let me also tell you that I have a regular schedule of tetanus booster shots set up. Pesky metal splinters will cause both minor and serious infections, and they can do even worse. Considering the locksmith's usual working conditions in some of the "ritzier" apartment flats, you could catch anything. Better to inquire with your Doc on any recommendations for keeping up to date on protection. Of course, any cut or "sticker" should be cleaned and dressed with some antiseptic ointment and a Band-Aid. Let me also repeat that the fine mist in the air around the grinder presents a significant health hazard. If inhaled in any quantity, it can lead to shortness of breath and sickness. The coolant additive carries no warning label regarding this, so I have no idea why it is so hazardous, but take it from one who knows from first-hand experience: use a regular respirator when doing any grinding.

Should your mist block get clogged from intake of any foreign material into the feed hose, it shall be disassembled and cleared, using a toothpick, not a metal implement.

Before you put the grinder system into operation for the first time, go over all of the metal surfaces of the grinder with a good grade of moly grease to retard corrosion. This especially applies to the area immediately below and behind the grinding wheel. Large lumps of metal particles that oxidize will form here, and the grease makes them easier to chip out and remove. With moderate use the "mountain" of oxide needs removal once a month, and I usually replace the grinding wheel then also. It is false economy to grind on a wheel even slightly worn down, and can be dangerous as well. When preparing a piece of steel to grind, cut a couple of doughnuts from a cellulose sponge by making circles about two inches in diameter with a slit through the center. These can be slipped onto the steel, and act as drip collars to prevent coolant run-off from trickling down your arm and over the pan sides. The doughnut is jockeyed around in position as the grind progresses. Also, in the less messy department, it's good to have a vinyl or waterproof apron to wear over your usual shop clothes. The mist clouds will wet down everything in the immediate area after a grinding session. Even more crucial, I can't seem to tolerate the mist in the air, and if I breathe just a little in, I suffer for days, so wear a respirator mask.

You may balk at buying an air compressor just to operate a coolant pump. However, I strongly recommend the air system with pump since mist does a far better job of cooling with far less excess runoff. The average locksmith's shop can always use a source of compressed air for cleaning the myriad of metal chips, dusty mortise and cylinder lock cases, drying solvents, and so on.

If you are like me the Reagan-era left old habits. We learned to make do with less then and went to the junkyard. If you would like to cobble together a make-do mist type system, go out and find an old fashioned garden plant sprayer. Look for the trombone-type with the long cylinder, the can at one end, and the push handle. Remove the push handle, cylinder end, and piston. Connect your shop vacuum backwards so it blows out air from the pickup hose, and duct-tape that hose end to the open cylinder. This will provide a continuous, automatic flow of air to atomize whatever coolant you put into the spray bottle. This makeshift version works okay, but is still no substitute for the air compressor driven one. Likewise, using a paint sprayer, air brush, or other atomizer is possible but not as efficient, and probably more hassle in the long haul.

Another possibility is an artist's mouth sprayer. These gizmos are used by artists to spray paint onto canvas. They consist of only a mouth tube to blow through, and a pickup tube to dip into the paint. They can be attached to a couple of vinyl tubes, one going to the vacuum cleaner backblast and the other going to the coolant tank. For large vertical lifts from the coolant tank, or extended grinding sessions, only air pressure from a backward-tubed vacuum cleaner or shop vac will cut it.

For my money there really is no acceptable substitute for a commercial mist coolant attachment. In everyday shop usage you can simply open a supply valve, turn on the grinder motor, and start grinding immediately and continuously. The time savings are well worth the initial cost of setup. If you machine other small metal parts in your shop operations, these can be shaped in a twinkle with such a handy setup! I find that I use a coolant-enhanced grinder just as frequently as a belt-type grinder once it is one-turn-easy to start the flow of coolant.

A couple of paragraphs back, I mentioned the shop belt grinder. Baldor, Kiwi, and other specialty suppliers make these handy machines for abrasive finishing. They take a variety of grit belts, sized anywhere from one to eight inches wide. There is one major advantage to the belt abrasive: it runs much cooler when cutting shim stock into lock picks. I don't know whether this is due to the accelerated wear caused by the sharp edges of the steel "stripping" off grains of abrasive, or to the fact that each square inch of the belt must travel along a 70+" path and be air-cooled before having to make another pass along the hardened steel.

Whatever the reason, it is almost possible to run off a few picks on an abrasive belt with only occasional cooling by immersion in water, if you have such a finisher. I have used both a Baldor and a Kiwi, and I prefer the Baldor. Their machines are closer to the tools produced for jewelers and seem to be more precise for small-parts grinding. Take note that some abrasives belts are made with water soluble binders and are not suitable for any wet grinding at all. Just about all belt finishers also seem to have low-mounted wheel bearings that can be attacked by corrosives like water-only coolant, so experiment on these machines with extreme care. By contrast I have been doing wet/mist grinding on a bench set-up (motor on wood pedestal) for many years and have never had a corrosive bearing failure or even a problem. If you specify resin-bonded belts, they will be waterproof.

Take a tip from eddie and be cool; mist cool that is. If you want to free up lots of time to file finish picks with great brilliance and skill at the bench, tool up with mist coolant and eliminate the biggest time waster in the chain.

Chapter Eight
Finish Filing

Although the rough grind can proceed to within .010″ of the desired contour, finish filing is still necessary to smooth the grind, refine the shape, and tune the flex of the shank. In this chapter eddie talks about the proper use of the file on your lock pick creations.

The pick quickly takes shape at the wheel and it becomes exciting. Standing hunched over the grinding wheel and getting sprayed damp while squinting to see layout lines is like honeymooning at Niagara Falls. It makes a body want to hurry up, dry out, and get on with the good stuff. Because of this impatience factor it is better to rough grind to the layout line and stop there, then clean up and take a coffee break. When you are rested and dried out the pick can be taken to the bench pin and filed the rest of the way. I usually have five or six picks laid out to grind all at once. Then I finish file them hours or days later.

The metal file is actually the best tool for this job, since files offer good control and flexibility at the bench. The file became prevalent in France first, about 1750, and coincidentally the lock began to be more of a high-tech device then as well. Which came first? Files are nothing more than soft metal blanks that have grooves raised on their faces, and are then hardened. The hard teeth are further carbonized (carbon added to the steel) for yet more hardness. So much for the short tour.

As for what type of file to keep and use, you will need three very different types to finish the job. For general rough filing, a single-cut, triangular six- or eight-inch is good. For filing to shoulders you need a pillar profile, double- (sometimes called second-) cut mill with two safe edges, and for finishing off the rough spots left by those files a smooth cut mill file of warding pattern is the best, again in the six- to eight-inch size. The terms "cut type" and "safe face" need some explanation. A safe edge on a file is a smooth face. Notice in Figure 24 the file will cut on face A but face B is a safe (smooth) edge so it does not cut or distort surface C. When files are diagrammed in a catalog they are shown in end-on view and safe edges are noted. File cuts are classified by how many sets of grooves are cut and to what degree of fineness. They are classified by jewelers as follows:

file cuts	teeth per inch
coarse	14–22
bastard	22–32
second	30–42
smooth	50–68
dead smooth	70–120

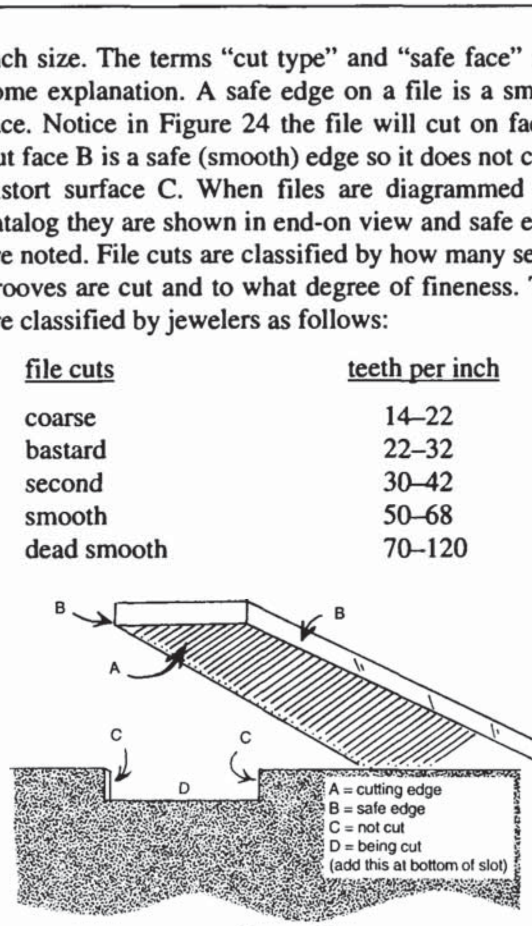


Figure 24
Safe-edge file cutting slot.

The more teeth per inch, the smoother the cut the file makes, and the slower it cuts. The more teeth per inch, the more cleaning is necessary, and boy does that price jump up on those smooth and dead-smooth files. Despite these pain in the ass factors a smooth cut file is a valuable weapon in your arsenal and is really worth hunting up. Its cut does not require any further finishing. The corner hardware is highly unlikely to stock these specialized files, so your best bet is a jewelry makers' or gunsmiths' supply.

Since you'll shell out many bucks for that smooth-cut mill the proper care of a file becomes important. The two rules of file care are that it be kept absolutely oil- and grease-free and that it never be used while clogged with metal particles. This is called pinning and is harmful to both file and work. When I get a new file I put it in a bath of lacquer thinner to remove all traces of shipping preservative. That is the same procedure you can follow for shim steel just before spraying it with layout dye. Anyway, once the file is pulled out of the thinner, swing it around to dry it and then apply a liberal amount of chalk to the teeth. Yes, that's right, chalk. The kind teachers and kids use is just fine, but avoid the really soft stuff. You should fill up the gullets right to the top. Gullets are the troughs between the teeth of the file.

The chalk is what keeps the file from clogging with the metal particles sheared off during use. The metal removed from the pick must go somewhere, and if it gets packed down in the file gullets it reduces the cutting ability of the file. Eventually the file will dull. The chalk sort of immobilizes those particles and holds them until you can brush them out with a file card. The chalk also absorbs any grease left on the work.

Any industrial house will sell you a stiff wire brush with a paddle handle: the file card. In use, the card sweeps the contents of the gullets sideways from the file. The single pointed wire some cards have stored in a sheath on back is a toothpick for tenacious metal particles. Once the file is brushed clean, the chalk is reapplied every time. So buy and use chalk and a file card. If you store all this stuff together it becomes second nature to clean the file frequently. In a half-hour session at the lock pick maker's bench it is wise to card and chalk the file at least ten or fifteen times. How many times do you see someone who never once cleans a file, and wears it out in thirty minutes? If well kept, a file lasts a year or better. One trick to save muscle strain is to hold the file down on the bench pin, not in the air, when carding it. If you grasp both card and chalk in your right hand it will also save time.

The files may have come in plastic or paper sleeves. Either retain these or make sturdy ones out of heavy cardboard wrapped with tape. On no account allow your files to touch or scrape each other while in the tool drawer or elsewhere, because they will then dull and chip quickly.

As for handles, the supplier carries a variety of plain wood types, and also a plastic one with a hardened screw insert that cuts into the tang of the file as it is screwed on. Some kind of handle is necessary or you will end up with a nasty puncture wound in the wrist from that tang when you slip up. For handles I was taught to cut a five-inch long piece of ¾″ wood dowel, and then burn the file tang literally into the end of the dowel by heating the metal bright cherry red with the torch. It may take a couple of heats to do the job, but it makes a good handle. Take care not to hammer the file in AT ALL since banging on the file's working end will easily chip it. Use only hand pressure and heat to seat it. A dollop of shellac poured in the charred handle recess will seal the wood and make the file stick better. Felt-tip marker on the handle identifies the file if it's sleeved.

Let's proceed to the filing now. To hold the pick for filing you will need a specialized arrangement. My personal filing jig for finishing picks of all types is modified from a stock-pattern jeweler's bench pin. This ingenious device has been used by watchmakers and jewelers for hundreds of years for working small parts, and is close to ideal for lock pick manufacture as well. Over the years I have made three modifications to my pin to suit it better for holding the pick during filing. I will describe the stock pin and then my modifications to it.

The jeweler's bench pin comes in two parts: a metal casting that is slotted at the front to take a wooden piece called a bird's mouth, and a series of wood inserts. This small wooden protrusion is used as a mini-workbench surface when filing, hammering, riveting or sawing jewelry parts. It is very useful because it allows easy access from three sides and lots of angles. The metal casting will have screw holes or a "C" clamp-type screw to fix it to the bench, and also a small metal anvil surface usually used to set rod rivets on. To adapt the wooden pin to lock pick work make the three alterations detailed in Figure 25.

The first alteration is a series of slots that serve two different functions. One is just to hold the pick tightly on edge so it can be filed down. The other function uses both a slot and the top surface of the bench pin. One slot is cut exactly as deep as the desired final width of pick shank. When using this slot during the final width filing, the file will cut down until it begins to bottom on the bench pin. Eventually the file will glide over the wood surface and not cut the shank at all. This gliding action over the smooth straight wooden bench pin will produce a matching smooth cut on the pick shank top surface. These slots are all cut with a jeweler's frame saw of .028″ thickness, so that .031″ pick steel will be a tight fit. If you cannot locate such a thickness saw, try a thin hacksaw blade.

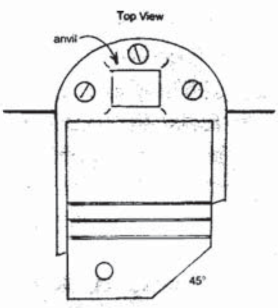


Figure 25
Modified bench pin for a lock pick maker.

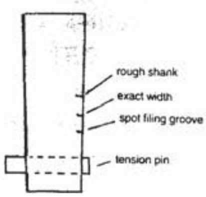


Figure 25a
Side view of pin showing grooves & pins.

Take some time to make these groove cuts and avoid any see-saw effect which will produce a curved bottom cut. Make the final finishing saw strokes absolutely parallel and slow with a tightly strung blade. They should range in depth to take the pick from rough grind to final shank width, and one slot should be very shallow, just enough to permit a toehold for spot filing on the pick shank, and NOT filing flush with the bench pin. This last slot is little more than a groove. If later working shows one slot is not deep enough (see end of chapter) then carefully cut it deeper. If the fit becomes progressively looser with age and use, try soaking the wooden pin in a mixture of mucilage glue and water to swell the wood. The slots also hold the pick for tip and handle finishing.

The second modification is a 45-degree cut on the corner of the bench pin. This serves as a guide for filing the outside tip and diamond surfaces to the correct angle. A series of shallow cuts into the top right or left edge of the bench pin, or into the front face as well, will be useful in holding the pick for offhand cuts.

The third modification is a tension pin inserted in a hole drilled in the bench pin. It is a friction fit and so can be moved up and down repeatedly and set at different precise heights with a hammer tap. It acts as an all purpose stop and is particularly useful for holding the tension wrench wire when filing flats on same. The wooden surface of the bench pin can also be used to hold the extreme tip of a pick for difficult angle filing jobs. To do this, just press the sharp tip of the lock pick into the surface of the wood and it will lodge there. Once all of the alterations on the bench pin are complete, spray it with a mist of WD-40 and let dry.

To begin finish filing, let's start with a single lifter pick. Initially, you begin with the pick shank top. Use the jig and insert the pick shank top up in the slot and hold the handle with your left hand. A slight away angle keeps the pick bottomed in the slot. There are two critical junctures to avoid filing too deep into. They are the shank-to-handle intersection, and the shank-to-tip intersection.

To safeguard against a slip in those areas, start the file cut short of the pick end by using your thumbnail placed alongside the pick as an initial guide. Go very slowly and make a starting cut deep enough so the file will not jump out past it on the next few strokes. If done properly, it will look like a small diamond or peak on the shank top located just where shank and tip meet. File at a 45-degree angle from the tip at the right to the handle at the left. The critical juncture between shank and handle is only critical if you cut it so deep it weakens. Personally, I like to leave a tiny radius there, and it will not affect the pick performance at all. The only time the pick fails at that point, is when no radius is left there, and the cut strays too far in.

Periodically switching from deeper to shallower slots, the filing should continue cutting the pick shank width until (in the finishing slot) the file slides along the wooden surface of the pin and can't cut the pick steel anymore.

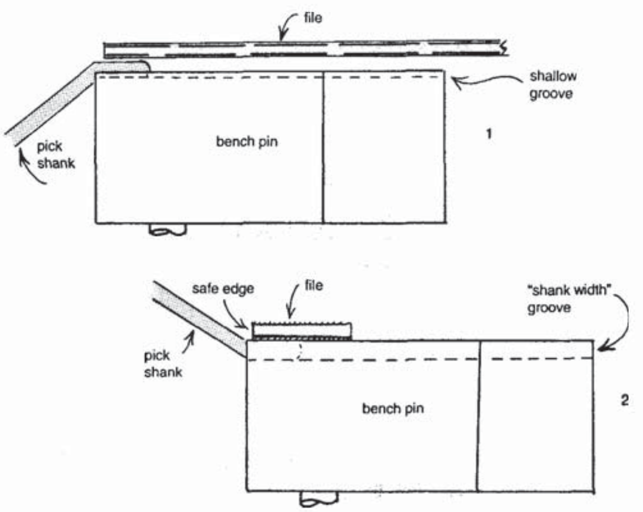


Figure 26
Using groove to file out and inside of pick tip.

The next surface to finish is the outside edge of the pick tip. Place the pick as shown in Figure 26 and hold the file parallel to the side of the bench pin, gauging it by eye. Cut until the surface is fully flat and there is an angle where the tip meets the pick bottom. Now check the angle with your protractor and re-file if necessary. The next surface to file is the inside of the pick tip. There is a trick to make the alignment perfect here. If you place the newly filed flat angle into the shank groove and press the pick tip down into the groove bottom with the file itself, it will pop up and perfectly align. Then you can reapply holding pressure on your left hand. Did you get that all? You hold the pick very lightly in the left hand, press it down into the groove with the file surface gripped in the right hand, just as if you were filing, and then re-grab with the left hand at the correct angle. This procedure can be repeated, even for every file stroke, to ensure proper alignment.

The safe edge of the file is now placed away from where the tip meets the shank, and the tip's inner angle is filed. Filing progresses until the file will no longer cut, making the lifter tip the same width as the pick shank. Now the juncture between the tip inner angle and the shank is worked up. In doing this, always face the file's safe edge into the angle. First cut a little bit on the shank, holding the file over and filing straight down, then shift to the tip and do the same. Eventually, the two surfaces will meet almost in the middle, and form two perfect planes connected by a small radius. Since the tumbler end or tip may find its way into this exact juncture, it must be very clean, with as small a radius as possible. This height-filing jig is not limited to a straight line either. By cutting a slanted or tapered groove in the pin a duplicate taper is produced on the pick. The slant can be very subtle like .005″, or as much as .020-.030″. It appears or rather feels to some operators that a tapered cut on the pick shank works easier in the lock because of the greater solidity afforded. Since the slant matches the type of end-only strain the pick is required to resist, the terminal width can be thus further reduced. In a very confined keyway area, however, where .004″ can be the remaining pin travel required to get to shear line, a taper can cause problems. There is an easy way to test a lock pick that is being filed down to its absolute least workable width. This kink was shown to me by the proverbial old master craftsman.

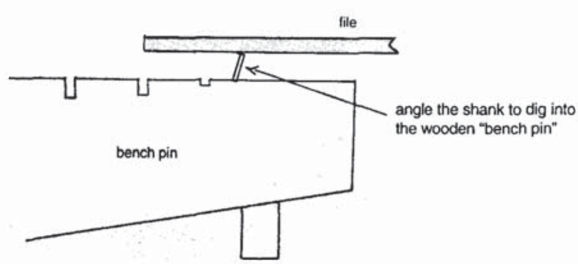


Figure 27
Angle the shank to dig into the wooden "bench pin."

After filing the pick shank down to width in your wooden bench pin filing jig, hold the tool up in one hand and gently flex the shank by pushing down on the working tip against the bench pin. Simulate the normal direction of stress the tumbler would give it. You will probably notice that the shank does not bend in a perfectly smooth curve, but instead seems to take a dogleg down or "break" at some point along its length. Mark that break point with a piece of tape or a china-marking pencil, and replace the pick onto the filing jig. You will have to angle the shank to get it to dig into the surface of the benchpin, as in Figure 27. Start filing the pick shank from your mark down to the working end. Frequently remove and bend test the tool. You will find the point at which the pick seems to start bending will advance steadily along towards the tip as the shank is thinned progressively into a smaller width or taper. Eventually, the shank will describe a fairly smooth curve as it bends. This means you MUST now cut no further or the pick will deform and react poorly in use. You may also find that the difference in width from the widest point to the narrowest is very slight, so little is gained in actual shank-to-pin-end clearance. If the clearance is absolutely critical for your needs, attend to the problem this way. For rammin' around type daily openings leave the tool a consistent width.

To finish-file diamond picks follow the same sequence of cut, but don't tune the shank to minimal width, since that is not critical for that type of pick.

Occasionally the lock pick maker will have a problem like... "the squealer." Not the Jimmy Cagney Bighouse variety, but rather a pick that does not cut smoothly while filing. You remember that pointing the lock pick up into the radius of the grinding wheel will cause it to chatter and catch violently. The squealer is that same principle. If the amount of stock free above the slot exceeds about three times the finished width, roughly speaking, the flex of that free end of metal will cause the pick to squeal as the file alternately grabs and then loses this metal surface. It is actually moving back and forth rapidly. This chattering under the cut reduces the efficiency and is hard on tool, file and nerves. The cure is a more solid hold, obtained by using a deeper cut slot in the bench pin. If you cut four sets of slots in the pin initially, and the deepest is not deep enough, cut it deeper until the job you are doing will not squeal. Then, later, if you need that slot back again, cut a new one. Eventually your tools will be adaptable enough to meet all sorts of tool-finishing problems.

One last point. The jeweler will suspend a cloth or leather bag immediately below the bench pin. This is to catch any precious metal shavings and scrap, which are then recycled. Eddie finds that the bag is just darn useful anyway. Any dropped tool is safely caught (especially chip-prone files) and it is easy to rig up such a bag using some denim jeans material and a coat-hanger wire frame with a formed eye screwed to the bench. In the next chapter eddie will put a handle on that newly filed lock pick.

Previous eddie material talks about "stoning" the pick after rough grinding, so where does this fit in? Do you grind, then stone, and then file, or stone last of all? Do you stone at all?

Stoning a pick with a fine grain stone produces the same smoothness of finish on pick steel as a smooth-cut file. In other words, if you are using a smooth-cut file for finishing, the stone is unnecessary. The smooth-cut file can be *reeeaall* expensive, so I will also talk about stoning.

The stone referred to is the same as a knife-sharpening stone: a natural-cut or synthetically furnace-made equivalent. Stones, like files, come in different grades, sizes, and shapes. Only the smoothest India and Arkansas types work for lock picks. They are sometimes referred to as die stones by industrial suppliers. The Gesswein Co. carries an incredible variety of stones.

Stones should always be used with some form of lubricant oil; either light machine oil (three-in-one) or the equivalent. Eddie recommends Marvel Mystery, if available in your area. Avoid using boiled linseed oil or mineral spirits for lubricant, as they will both cause their own unique problems. Another good lubricant is WD-40, applied frequently. The lubricant floats away steel particles and acts like the chalk does for the file. A new thirsty stone may have to be soaked in oil to break it in.

The actual stoning is simple and done similarly to filing. To find minute imperfections, chatter marks, or waves, use the film director's landscape-shot trick. The three hours just before sunset are called the "golden time" by film photographers because the light comes in almost parallel to the ground, and bounces off the land directly into the eye. The result is that every little wrinkle and depression in the landscape is strongly outlined in shadow and makes a nice visual effect. Ironically eddie's favorite movie is *Wrestling Women vs. the Aztec Mummy*, where this art lighting is a real non-issue.

The grazing light trick (see Figure 28) also locates rough areas on the pick to stone. The same lighting trick is used extensively to read key marks during the impressioning process, so it is worth learning.

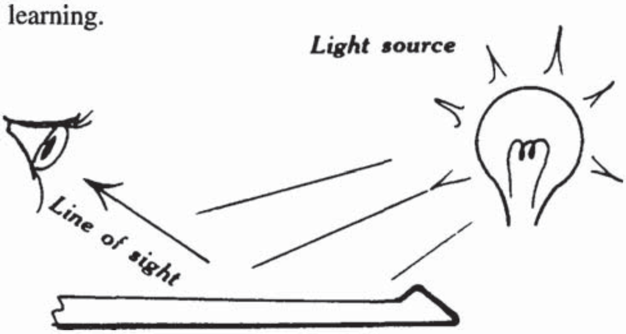


Figure 28
Using grazing light source to examine pick for roughness.

Excessive pressure will make a poor cut, so go slow and press medium firm. From time to time add more oil. Do NOT use your bare finger to check progress or you will get a finger full of tiny sharp-ended steel splinters laced with oil. Use a rag to wipe the pick clean and examine by eye. If you want to do a good job, a magnifying loupe is perfect for this work. They come in all types, mounts and powers. Eddie has used both the eyeglass mount 1.6X power (objects are 1.6 times normal size) and the 3X triplet hand lens. He prefers the latter. To use it, don't hunch over. Sit erect, hold the lens close to your eye, and move the pick in or out to focus. Don't move the lens, move the pick only.

The stone cuts fine and so very slowly, but excessive stoning can still spoil precise contours and sharp points, so take care to avoid this. One area the stone excels at is smoothing contours. Just like dressing the grinding wheel edge to cut a radius on the steel, a stone can be cut with a very hard steel tool like an old worn-out file. This is really good for getting that small radius between pick shank and pick tip just right. Stones may also be purchased in rounds or half-rounds, and these are good for lifter radius smoothing. Treat your stones like sandpaper, or any other replenishable material. If you need a short piece of stone, just go ahead and snap off a piece to use.

Attention must be given to all of the pick surfaces that were ground and filed. All of the surfaces must be accurately deburred in a specific sequence. First, polish the outside diamond, the inside diamond, the shank top, the shank taper, and finally the sides. All of this polishing should be done according to the rule of keeping as much of the stone's surface in contact with the pick as possible. When stoning the sides of the pick don't then go at right angles to the shank, but lay the stone the entire length of the pick's working shank and stone. The more surface area in contact per unit of time, the flatter and smoother the final surface will be. The shank top can be polished towards the tip using sideways strokes and just a few parallel strokes to finish up with. The bottom of the shank is not usually ground at all, so it should need no polishing.

All polishing need not be strictly parallel with the projected travel of the pick in the lock, since the scratches made by this point are so small they will not seriously impede the process.

As to potential problems, the diamond tip outside and inside is the toughest to do. The first problem is chatter, just like holding the pick higher than perpendicular to the axis of wheel rotation. Always file the diamonds at the proper angle. Secondly, owing to the fineness of the grit it will be impossible to affect any big dimensional change in the steel, but remember the polish can soften some of the hard point on the diamond. As in all things there are two viewpoints on this. One group holds that the hard edge of the angle will produce a greater shocking power as it travels over the tips of the tumblers, and therefore impart more "billiard ball" action to the top tumbler. The other school holds that a rounding there makes the pick run smoother and therefore faster in the lock. You should make a test of your ability to feel minute differences in the performance of a pick in a given lock, so try the tool with a sharp edge first of all, then cut that edge off and see if you notice any difference. I personally favor a sharp diamond. Under no circumstances should the extreme front to bottom edge of the pick be left sharp. This is the part that first enters the lock keyway. It must remain almost sharp so as to lever itself easily under the pin tumbler ends, but you should cut a small radius on it to avoid drag. While it is true that there is an angle cut on the bottom end of the bottom tumbler to facilitate ease of key entry, the sharper the pick (meaning the less flat at the end), the better the pick will enter in a lock with badly worn tumblers. By the way, while I like a sharp diamond, it is partially because of the difficulty I like to feel in jerking the lock; I think that more energy goes into the pins that way, but that may be just my personal fist-action.

After thoroughly polishing the four or six surfaces of the pick, take a minute and cut a 45-degree angle on all of the right angles that border on surfaces you have just polished. This will ensure that no wire edges remain.

The cutting action of the stone will be negligible to nil, but it can slip and you may puncture your hand on the pick, so be cautious and use moderate pressure to stone the pick surfaces. As you use your finely polished lock picks in day-to-day operation, some scratches may develop in their surfaces, and the India stone applied at infrequent intervals will remove these small wear scratches.

Remember to use oil and NEVER stone dry. The light machine oil keeps the stone's surface pores unclogged from steel particles, and lubricates the stone as well. As you polish, it is possible to both see and feel the surface become smoother. By working the pick with oil the cleanest cut possible is guaranteed. If you use oil, leave the stone in the tray for the next cutting session, and cover it with tinfoil or another tray, since it is a fire hazard.

If your picks have been thickness-ground to a smaller clearance at the tip, then stoning of this side-ground surface is essential to good lock picking with that tool.

One exception to normal stoning practice is using the stone to develop a series of cross-hatching scratches on the sides of the pick shank for the purpose of holding oil lubricant. This makes a raking pick work real nice in an older dry-mechanism lock. A final dip and rinse in the oil, drying on a rag, and then degreasing with naphtha or lacquer thinner, and your stoned pick is ready for bob polishing.

Chapter Nine
Polishing Picks

This chapter deals with the last important steps of finishing up your lock pick. There are still some hairline scratches marring the pick even after final filing with a #4 double cut file for those fine outline adjustments. These remaining scratches will not impair the performance of the pick, but in bollixing super-smooth action against the tumblers and in the keyway, they can make the pick relay "false" feedback about the movement of the lock tumblers. This is because the hardened steel edges of the pick cut into the soft brass alloys that the lock tumblers are composed of, and will also "dig" into the keyway surface as well. This abrading action will create some dragging and sticking friction and causes the lock parts to behave as you DON'T want them to: catching on the tool.

This dig-and-hold effect is useful in one place only. The ability to cut selectively into the bottom of a tumbler is a big asset for all types of lifter pick. To exploit this sticky tip effect, the top edge of all lifter picks may be designed especially with a knife-sharp working edge to cause an anchoring of pick tip into tumbler surface.

In all other cases, though, absolute smoothness of action against the tumbler/keyway is desired, especially in a rake or diamond pick and a snake or wiggly/bent riffler. It is also true that I polish a pick (called coloring it in the trade) for looks and beauty. A mirror-shine tool looks so good it gives you an ego boost when you think "I made that." One other point is that a tool carried on your person will be subject to spot rusting as assorted crud sticks to the tool. If it's polished, the tendency to spot up is much reduced.

Here at the shop we use a product called Fabulustre. It is manufactured by the Formax company and it's a stick abrasive formulated for final polishing jobs on a wide variety of metals. It is absolutely the best product I have ever used for that difficult job of steel polishing. Normally eddie doesn't get all mushy over a specific brand-name product, but only Fabulustre seems to work well for pick steels, so ask for it by name. It is usually available from jewelry tool trade suppliers, and a few are listed below.

Allcraft Tool and Supply Company, Inc.
22 West 48th Street
New York, NY 10036

Paul H. Gesswein and Company, Inc.
255 Hancock Avenue
Bridgeport, CT 06605

American Metalcraft, Inc.
4100 Belmont Avenue
Chicago, IL 60641

New Orlean's Jeweler's Supply
206 Charters Street
New Orleans, LA 70130

Ohio Jewelers Supply
1030 Euclid Avenue
Cleveland, OH 44115

Norvell Marcum Company
1609 South Boston
PO Box 2887
Tulsa, OK 74119

Nicholson File Company
667 Waterman Avenue
Providence, RI 02914

Skil-Crafts
305 Virginia Avenue
Joplin, MO 64801

To apply it, use a hard felt bob mounted in a rotary hand tool like your Foredom or Vigor machine, or a bench motor or drill press chuck. The bob should be circular and approximately 1″ diameter with a ¼″ face. A hard felt bob is almost as hard as a soft wood like pine, and in the dimensions you need it should be readily available. Once the cardboard tube is opened up a little, the compound bar end is dipped in kerosene briefly to lubricate the bob face and prevent excessive compound melting. The bar should be applied lightly to the bob while teasing the throttle to keep the speed as low as possible. In this way a good deposit can be built up quickly on a new bob. Once the bob is fully charged, begin polishing on the sides of the pick. The shim steel you have cut your picks from will be matte finish, but the bob will make them reflect soon enough. Starting on the side will also help to break in a new bob easier than attacking the wire thin shank first. The wire shank would just strip off compound. Work from the middle of the pick handle out to the end, moving the tool towards you in short sweeps. The pick is held either on the bench pin or in the air like for grinding. After one half is polished, turn the pick over and do the same half on the other side. Then switch the pick end-for-end and repeat the process. The felt bob will quickly become black from the polishing action against the steel. Charge the bob with more compound at frequent intervals, and remove the excess crud and used felt by raking the bob with a screwdriver blade while running. Notice how the felt bob can even cut the screwdriver. The screwdriver end will even be worn slightly by this raking. Use the same caution and rules when raking as you do when grinding at the bench grinder to prevent the bob from catching and whipping the screwdriver. The possibility of getting badly cut is still just as real at this final stage. Come to think of it, a lock pick is a dangerous tool for its owner all through its working life. The working end (shank and tip) of the pick is polished last, in whatever sequence you find comfortable. The rule is to always polish towards the free end, never into it, just as in grinding. Once you finish polishing, clean the excess compound and steel off with a lacquer thinner rag, and immediately follow it with some fine tool and instrument oil. I prefer the Starrett brand in the yellow bottle. Congratulations are in order, maybe even a celebration: you have just hand-fabricated your first professional class lock pick.

For your information, Fabulustre also does a nice job of coloring brass and nickel silver as well, so if you have fabricated handles, pocket toys, or other tools with these metals, have a go at them with the bob also. The bob should be used from time to time on lock picks in daily use to keep the shine up, and to recolor nickel silver that is carried on the body, since it will develop a tarnish. Remember whenever you clean the pick to reapply a thin film of instrument oil. In particular, don't — repeat — *don't* handle your tools after eating any fruits like apples, oranges, etc. The natural acids in fruit juice will make short work of your polished surface. This can be a neat trick, though. First, lacquer thinner-clean a pick. Then roll a fingerprint onto a fresh apple bite, then onto the exposed steel of the pick, and set it aside on the shelf. In no time at all you will have the ultimate personalized mark, your fingerprint etched onto the tool, and looking kind of pretty! Of course, who would be so bent as to want to steal another man's lock picks? Quite a few. A lock pick set on the side-walk would be snapped up faster than the proverbial wallet with a crisp twenty inside. Most everybody treats the lock pick with a kind of awe. In Chapter Sixteen, eddie will talk about that some more.

Chapter Ten
Lock Pick Handles

Here's a quote you hear from quasi-experts in the lock pick field from time to time: "Real professionals prefer lock pick tools without handles." In fact, if I hear that line just once more...! Supposedly, that lack of handle enhances the "feel" one receives transmitted from the tumblers to the tool. Contrast this with what the working locksmiths say: most think this is just plain wrong. Not to say that the top-flight locksmith isn't concerned with feel or touch. It's just that the right kind of handle is what's needed. A commercial pick has at least a thin aluminum slab handle, and you get used to it, but it's not the best. Handles are usually lacking altogether on shop-made picks. This isn't usually by choice, but is dictated instead by the difficulties in creating and installing workable handles on the shopmade pick.

The benchmade lock pick cut from .025-.031″ shim stock provides feel all right, altogether too much feel. The near-knife edge of the steel digs uncomfortably into the tips of thumb and index finger during a lock opening, and I believe it really dulls feeling more than enhances it. The common myth for all the youth of my day was the "Jimmy Valentine" safe cracker who could infallibly open combination locks on money vaults or chests simply by feeling when each tumbler clicked into its respective gate. In the popular stories of the day this feel was enhanced by rubbing one's fingertips on some fine sandpaper just prior to an opening. It was a great idea, but I prefer feeling with the skin attached.

That wire edge of the ultra-thin pick handle causes pain, not greater skill at opening. A lock pick that's cut from a jackknife is also just as bad. The problem there is the extreme overweight of the handle in relation to the delicacy of the task at hand. It is impossible to cultivate a niceness of touch when the total weight of the lock pick is so heavy. Far better too light than too heavy any day, and too fat an edge is preferable to one that's too thin. Serviceable, yet not quite there, is a wrap of electrician's tape. It just does not seem to fill the bill. Both handleless and overweight jackknife lock pick handles have one thing in common; they are make do only.

If you have just finished your pick and are anxious to try it for proper function, that's fine. Go ahead and use it on a couple of locks, but then remember to set aside the time to install a handle and see how much easier it is to use. I will be starting with the easiest types of handle installations, and progressing to the hardest or most complex. (Good plan, eh?) The least difficult handle is called the twist or doubled handle. Normally I do not use this type of handle, but making it will give you some experience in annealing and rehardening the steel, so I include it here. The ability to shape and harden the steel to suit your design aims is a valuable skill. Putting a couple of 20- or 30-degree bends in the handle does much towards aiding leverage feel while making the tool more pleasant to hold.

Before applying any annealing heat to the lock pick tool, remember that the steel has been industrially tempered to its best possible state, and heating the steel will destroy this temper. Of course the temper can be redone, but it is very difficult to match the superior factory heat treatment. That refrain is getting to be like the old "the secretary will disavow any knowledge, Mr. Phelps," I know, but it is important. Making allowances for a heat sink at the working end of the tool will prevent the heat applied for handle bending from traveling down and adversely affecting the working end of the pick.

A heat sink is merely a large mass of metal in good contact with the part of the tool you want to keep cool, or at least cooler than the temperature at which softening occurs. Unfortunately, if you use the largest mass of metal you have (the bench vise), and only use a propane torch for heating, the steel handle will not get very hot, because the heat sink will actually be far too efficient in relation to the amount of heat delivered per unit of time. A more balanced heat sink for a propane torch is the small machinist's clamp, applied about 1/8″ away from the point you have decided to bend at.

This small machinist's clamp may be in turn mounted in a bench vise with no appreciable added "sinking" effect because the heat is traveling through a bottleneck, namely the small cross-sectioned clamp. A strip of newspaper between the vise and clamp will further enhance this insulation effect, and prevent slippage as well. The trick of inserting newspaper between steel and a clamp works well in other areas of lock pick-making like layout, so try it sometime and you will appreciate it.

Once the clamp is firmly applied the torch can be lit and played on the spot where the twist is to go. The thin shim stock will quickly heat up to a dull red heat and easily bend. To minimize heat loss in bending, I use a piece of wet hardwood with a narrow slit cut into it to bend the steel in the desired direction. A crescent wrench with jaws set to a slit will also work, but grabs heat off rapidly. A bending fork of 1/16″ steel strip with a hacksawed slit in one end is good for a long-term bench accessory. Mine is screwed to the bench.

Notice that as the heat increases, the familiar "band" of tempering colors appears and travels down the tool handle. This narrow spectrum of colors shows where the heat has untempered the steel. If this band ever shows to have advanced into the working area of the lock pick tool and bypassed your heat sink, then that pick should be discarded. So make darn sure the heat sink is firmly applied and is working effectively so you won't ruin any good tool. If unsure, try your heat sink on a scrap piece of shim steel. It is possible to make a bend too close to the working end of the pick, where the heat will naturally "leak" through to, if the sink is faulty.

The bends shown in Figure 29 are all used on working picks. You should experiment with several degrees of bend and lengths of handle segment between bends, to get the kind that feels comfortable to you.

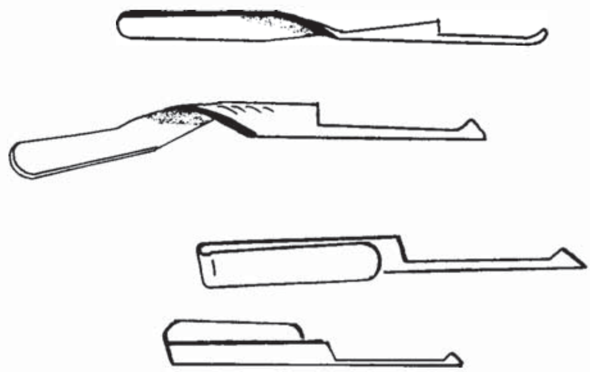


Figure 29
Two styles of twisted steel-only handles.

As you strive to NOT bend the lock pick forward of the handle, it may occur to you suddenly that that may be a good thing. If you hold the lock pick in your hand, it tends to point at a right angle to the arm if you are right handed. This indicates that it is a strain to hold the lock pick so that the end points right at you if you are standing in front of the keyway. It is difficult to assume this posture, which is probably why it is far easier to pick a lock cylinder while held in the hand as you are sitting at the bench. The obvious answer is to bend the handle of the pick at an angle to the pick shank, but this creates new problems.

The big drawback with such a bent pick is that the hand is no longer in a straight line with the pick tip, and if lifting, the lever function has been converted into a twisting, pulling action that is very difficult to control and get feedback from. If the pick begins to resemble your favorite bent slim shim for car knob openings, there will be little relationship between any handle movement and pick tip movement.

It is better if you keep the pencil grip type feel by keeping the pick tip in a straight line with the handle. I recommend that instead of bending the pick, you attach an auxiliary handle to it that will make grasping easier, while still retaining control. The control remains because of the counterweight effect exerted by the handle left in place in line with the pick tip. Later on in this chapter eddie details a foldable clip that doubles as just such a handle.

It is also possible to put a twist or 90-degree axial bend in the handle, and this is very comfortable for certain styles of lock picking. To apply very angular bends like a 90-degree bend, the heat sink is applied as usual, and another clamp is also applied, placed twice as far away from the first one as the shim stock is wide, usually 1″ total. Then the steel is heated to temperature while a twisting motion is simultaneously applied.

There are two points to consider when bending an extreme handle form. One, the bend should be overdone by some few degrees because springback may occur if the working temperature is very low. Two, the radius bends more gradually when worked while the temperature is relatively low. To produce a sharper-angled bend, heat sink the working end, and heat the entire handle very quickly. Then start the bend abruptly, reapplying the torch at frequent intervals. If you apply bending pressure before the steel is very soft, the bend may be more gradual than you want.

If you use a little torch (oxyacetylene) for the bending, the heat sink may almost be dispensed with since it heats so rapidly that the heat has no time to disperse down the handle. It must be quenched rapidly, so keep the bucket at your elbow. The higher heat also allows much sharper bends, almost perfectly compact. I prefer the Smith brand little torch any day, even though it is much more expensive, because it allows infinite control compared to even a #60 tip on a regular torch. Radio Shack also sells a gas brazing torch with both oxygen and flammable gas cylinders (catalog number 64-2165), and this is a good alternative to the expensive Smith brand torch and tanks.

As an alternative to twisting the handle, you can put in fingercuts on your tool, like the handle scallops on a knife blade, but you will probably find they don't make the tool any more comfortable, and are usually in the wrong place for your hand no matter how hard you try to position them accurately. If you want to experiment with these, use a grinding wheel that has been shaped to a small radius with the wheel dressing tool, or cut the scallops in square form and smooth out with a hand file. My number three apprentice's style of work benefits from two half-rounds cut exactly opposite each other about ¾″ away from the beginning of the shank. The small neck left can be as little as 3/16″ in width and still perform well.

If you carry your flat-ended tension wrenches in a pack graded according to size (width) of wrench end, you can start at the narrow end and move up until it catches in the keyway nicely. The added weight is nice also for a tension wrench. A handle pack for these is easily made from a doubled-over aluminum handle strip.

Speaking of aluminum handles, let's talk about those nifty wallet set picks you so coveted when you got a look at your first locksmith's tool catalog. My first set of tools had a handle made out of light aluminum stock in two pieces riveted to both sides of a pick. To duplicate this style of handle you need to layout the hole locations on the pick steel, anneal and drill holes, then transfer hole locations to aluminum or brass handle scales and drill these, finally riveting the assembly together. It is also easier to do spot annealing if the places are clearly marked.

If you are using a carbide scriber to make the layout lines, annealing the steel prior to layout is not necessary, but annealing IS necessary prior to punching and drilling a hole in the steel. So, if you can accurately spot anneal, then construct the layout and drill, so much the better.

We will now spot anneal the handle, but don't get out your torch just yet. It is also possible to heat up just a tiny spot where you want the hole to go, using a technique called spin annealing. A spin anneal involves minimal heat bleed and therefore is much more accurate. The tool to do that with is a heat-treated (and it absolutely must be heat-treated) prick punch. Carefully grind off the point and finish a flat spot on the end instead. Chuck this tool into the drill press and set the belt for the highest rpm possible. The spot for annealing can be marked with a light carbide scriber mark, or a couple of fences set up on the press table will align the handle properly. The handle must also be firmly clamped onto a block of wood to prevent disaster if the punch catches and holds the handle. It could whip around and end up as a flying sharp-pointed missile. A simple jig with a pin set into the wood on each of three sides of the pick handle will both position and hold. Bring the heat-treated flattened point of the punch down onto the handle and begin to bear down on the drill press handle. The pressure exerted will produce a lot of friction, and that friction in turn produces heat.

Enough heat will be generated to run the temper colors on the steel handle. This means the temper on the pick steel has been removed at that spot, while the heat-treated punch remains unharmed. The handle can now be left to slowly cool off, or lightly water-spritzed to cool it quickly.

Inspection of the spot will show the familiar blue/peacock temper colors. This area can now be subjected to a layout, prick-punched and drilled for the insertion of a rivet. It will still be hard but drillable. If you have trouble with this technique, it's usually because the spin speed isn't high enough. If your drill won't do this, stick with a torch anneal.

Use a light coat of layout dye on the correct side of the pick and a small patch on the backside. The object is to scribe a line exactly midway on the pick. To do that, use a pair of dividers set by trial and error on the wrong side patch until they scribe down the exact middle of the pick stock. The first try will leave a little space between the two lines as you scribe from both sides. Set the dividers to scribe a line halfway through this small space and try again. Observe closely that you don't overlap the dividers and start scribing lines past center. Once set perfectly, you can mark the layout line on the good side. If the pick stock is exactly ½" you can set the divider to ¼" by "clicking" the two tines or legs. Seat one point of the divider into the etched line on a machinist's rule, and then adjust the divider until the second point falls precisely into the other etched line at the length you desire. By alternately rocking the points of the divider in and out of the two etched lines, the feel will tell you how precisely the divider is set. Next, reset the gauge to the first hole dimension from the end of the pick, and by holding the gauge on the end of the stock the first hole can be located as in Figure 30. Now prick-punch the line intersections and set your dividers for the distance between two rivets. I usually make this dimension 2½" by habit, but any reasonable spacing is just fine. The only pitfall is putting the second hole too near the front and allowing the spot anneal to creep into the working shank area of the pick. This would be fatal, so avoid it. Using the center as a pivot, arc the divider over the centerline and prick-punch this for the second hole. The advantage to layout sequencing like this is that you now know exactly how far apart the two rivet or other fastener holes are. Once these holes are drilled, both handle blanks can be clamped to the underside of the steel and drilled as one. To make the aluminum or brass handle blanks, just use the finished pick as a tracing template and scribe the handle shape onto the raw material, or alternatively use layout dye on the handle blank. The stopping place for the handle should be carried no farther forward than where the pick starts to taper from a full handle width. For a nice radius, reverse the handle and trace the round back at the front also. If an aluminum handle is applied it can be marked. I use a die stamp set for this, and they are inexpensive at the industrial tool outlet type places. Assemble your code like "2 X 35" and clamp the stamps together very loosely, then stamp along the line. You may also clamp a toolmaker's clamp to the handle material and align the first stamp to it. Then keep the first stamp in the impression it just made and align the second stamp to it and the clamp. Lightly stamp, remove the first stamp and heavily stamp the second, then continue on down the line.

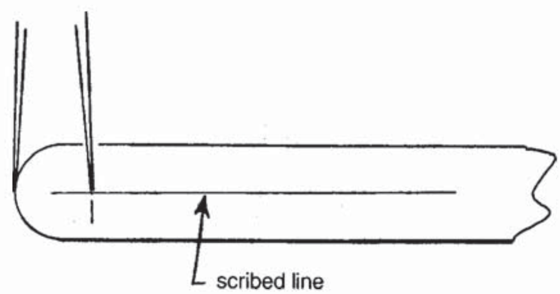


Figure 30
Scribing handle rivet holes equal distance from sides & end.

Aluminum is certainly not as pretty nor as heavy as brass. The added weight of the latter is a big advantage for the lock pick artist "fist." The disadvantage of brass is that it tarnishes easily, especially if carried in your pocket-pick wallet. A good alternative is nickel silver, a common jeweler's alloy which cuts easily. I recommend thickness of 8-10 gauge. The nickel silver handle material in 8 or 10 gauge will come in a large sheet from the rolling mill, and as such it is too heavy to easily rough grind to shape on a wheel. The proper way to do it is with a jeweler's saw.

The venerable jeweler's saw has been around for hundreds of years. It's still the quickest way to produce tiny intricate shapes in thin sheet metals. Jewelers, watch makers, instrument makers, and even lock pick specialists rely on it. The better made jeweler's saw comes with an adjustable end piece with a clamp screw, and a fixed clamp with the handle attached as well. The variety of saw blades available goes from 4/0 up to 10. Different manufacturers have their own numbering systems, so check with your supplier, or even better, buy right at the supplier. The tighter the turning radius of the blade required by the pattern, the smaller the blade that should be selected. For straight cuts, the largest available blade size is fine, and makes the work easier. Most handle-pattern designs will have a lot of straight cuts, so get the larger sizes for sure. They can be found in dozen lots, and even in gross lots as well. Notice that the blade has no attachment points. It is merely clamped into the screw anvils. The teeth can be very tiny, so use your touch to orient the blade correctly. Pinch both blade sides and run your two fingers over the blade, and in one direction one finger will catch on the teeth. This is how to determine which is the outside, and which is the correct cutting direction. The teeth are put in to cut facing out, and to cut on the down stroke, which is against the "V" mouth you will be cutting on. The moveable half of the saw frame should be adjusted so that the blade clamped in the handle end comes up to only one-half of the width of the moveable clamp. To tension and clamp the blade, rest the moveable end against the edge of the workbench, and push the flexible frame in with your stomach. Push in until the blade bottoms in the clamp, then tighten it. The blade should make a singing sound when it is plucked with the finger. A loose blade breaks too easily, and an overly tight one breaks also, but you will learn to judge this by feel. To save a lot of sawing time and ensure that both handle halves are of exactly the same contour, the two blanks can be tack soldered together and sawed as one piece. If you do this, first make the two or three solder joints at the edges where the waste pieces will probably come. After picking the handle assembly, do the layout on one piece only. The saw is held with the handle down, and the blade perpendicular to the piece of work. Excessive side bending of the blade, or twisting in the kerf, will only break the blade, which is brittle to begin with, and only gets more brittle with use. You can use some spit or beeswax on the blade to act as a lubricant, if you make a mental note to degrease the wax from the sawed-out work before any final soldering operations. To make the initial entry with the blade, hold your fingernail close to the work layout line, and using it as a guide pull the blade up (non-cutting direction) several times lightly against the work, rubbing in a small slot. Once the slot is established, begin sawing in earnest, perpendicular with the work. Very little pressure is required to hold the work against sawing pressure, and any clamp will have to be moved frequently for curves. A clamp may also mar the work if not padded. Despite this, I do use a machinist's clamp with a single layer of newspaper rubber cemented to the jaws. This is very useful for the long straight-edge cuts made so frequently. Curves in the design are negotiated by moving the work piece, and keeping the blade's motion forward and straight. The initial curve is done by moving the blade in the same spot and rotating the work. This cuts a starting "hole." If you are doing handle designs that call for a lot of curves, it will pay you in time saved to have two saw frames, one loaded with a saw blade just for the curves. The price of a good saw frame is negligible, compared to the continual hassle of mounting and remounting blades. Be advised that your first sawing will be jerky and uncertain, and you may break quite a few blades before you get the hang of it. It is best to start on straight lines for that reason, and to saw the more difficult curves later on. With very long lines you may exceed the width of your frame. Some frames allow you to turn the blade 90 degrees, but anyone can duplicate this same action, just by twisting the blade at both ends. Apply a quick firm twist with a pair of small needle nose pliers to both ends. This blade revolving allows you to cut to any length.

For a nice finish leave the handle blanks slightly oversize and file or belt-grind them to fit after rivets have been installed in them. A grinding wheel will pick up aluminum/brass particles and clog up, so use a crummy mill file for final finish and chalk it before use. Clean it with a file card after use. Alternative handle materials also include coin silver, hard red vulcanized fiber sheet, and wood at least $^1/_{16}$″ thick. Of special note are the countertop laminates. They have various trade names: Wilson Art and Formica are the best-known. They come in a virtually unlimited variety of colors and patterns. One company has recently re-released the cool countertop patterns of the 50s. Cut-offs or special order sheets come in any size you would need for pick handles. To cut and shape it any power or hand saw with lots of teeth per inch or lots of speed will work. It may even be formed with abrasive belt sanders. To do a lot of handles at one sitting is more economical of your set-up time. One particular advantage of the plastic laminate is its strength. That strength makes it possible to form the handle much larger than the steel pick handle, because it will hold up to strong gripping pressure without any deformation. If you design handles from plastic laminate, remember that the laminate may protrude different amounts of each side beyond where the metal handle leaves off. A wider handle with asymmetrical sides like in Figure 31 actually feels quite nice, and allows finger pockets in the right places to exert some torsional stress on the pick if needed.

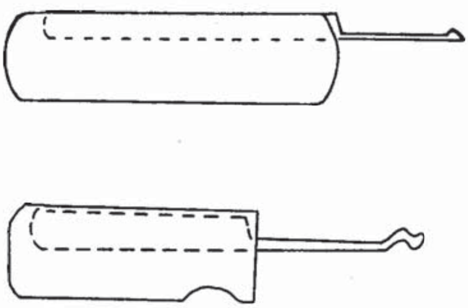


Figure 31
Oversized plastic laminate handles with phantom view of pick steel.

Before you cut a handle, make a cardboard pattern to experiment with. The custom knifemakers use this trick to good advantage and it works well. A piece of thick cardboard should be folded in half and then folded around a pick handle, taped in place, and cut to the approximate size and shape you are looking for. If the feel is not good, cut a little or try another handle until your design settles into a groove. Once you have a working cardboard pattern, the handle may be traced onto paper pattern sheets or directly onto the Formica if it is light colored. If you find one or two types of handle work well for you, it is worth producing a router master mask. Cut out exact size templates of the handle in ¼″ plywood, and attach these to a larger baseplate of plywood using glue and light nails. Note that you must leave room for the router bit to work. See Figure 32. This piece can be clamped or permanently secured to the workbench. To use this mask, lay a sheet of the desired Formica cut large enough to cover the mask to it's perimeter, and clamp at the extreme edges, where cutting will not occur and the router base will not jam in. Find a hollow spot by doing the hidden passageway tap, and plunge the router in. Alternatively, you can drill a starting hole and position it accordingly. The hole is also necessary if your router has a roller pilot and is not designed for any plunge cutting.

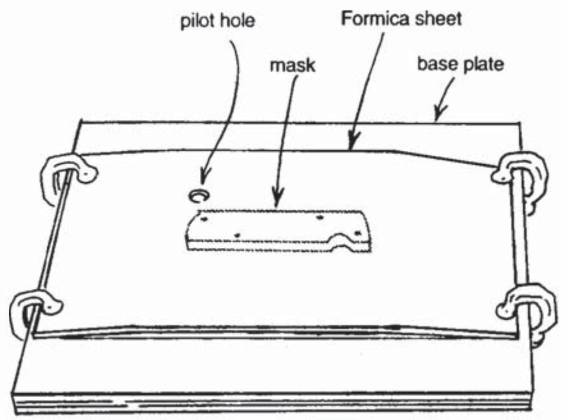


Figure 32
Handle cutting jig.

Plastics can of course be applied with the contact cement formulated to hold them to wood countertops, but riveting will stay forever, even with extreme pick handle flexing. If you use glue, remember to remove all traces of grease and oil from the pick.

If you color-code pick noses so all green handle picks are lifters, all red handles are diamond rifflers, all yellow are ball rifflers, and so on, it will look very professional on the job. To attract less attention, matte black is also available. Coding can also be done by cutting a series of grooves in the pick, with a triangular file, or drilling dimples in. This Braille-type system is not only for night use, but anytime you do not want to glance away from the job at hand.

Another useful plastic material is the stuff they router-cut those custom signage plates out of. You see 'em just about everywhere in corporate America today. This can be had in sizes to match most usual pick handle sizes, and it can be cut with a jeweler's saw, or shaped on the belt sander. As an added feature, any kind of marking code you designate can be inscribed into the handle prior to its being worked into shape. After all, that's what the signage people do. Not just names and numbers but any code you devise, and it will be decipherable in total darkness with a little practice, since it is cut into the surface. This plastic is difficult to glue and absolutely must be riveted. Ask the company if they have trashed signs with misspelled names or extras for guys like Edsel or Milkin. The price could be right. They also come in an assortment of colors.

You can even make handles quickly out of such easy material as duct or electrician's tape. As you wrap this, spacers like wood matchsticks or a split dowel can be inserted to bulk up the handle. The truth is they will slip and turn soggy after hard use, and should be avoided on a professional tool. It is not the hallmark of a patient locksmith to take any easy or quick way out when building a tool to last a lifetime. A very handsome-appearing handle can be made by putting two .020″ brass or fiber scales or blanks on, and two pieces of an exotic hardwood over these, just like a custom-produced folding knife. Nickel silver rivets will look better on a tool treated like this as well. The wood can be tapered towards all sides with sandpaper after riveting. Finish a handle like this by soaking it in linseed oil for ten minutes, then wiping dry. As an alternative finish, fill a jar deeper than the pick handle is long with a quick-drying varnish or wood lacquer, and suspend the handle in the liquid. Now very slowly draw out the handle, either by hand or by wrapping thread around a paperclip windlass or some other jury rig. The slow remove will evenly coat the handle with no drips or sags. Very beautiful. Any wood you use can be colored with felt-tip marker. Some types leave a beautiful color that will not be greatly affected by a lacquer finish. It is also possible to soak the wood in colors made up from Rit cloth dye.

Rit brand (and others) cloth dye is available at most fabric stores, even grocery stores. It is meant to be diluted in water, but you can use wood alcohol instead to dissolve it. There will be some solid residue if you do this, and it can be filtered off. The strong color dye this makes will quickly saturate wood, especially the lighter colored varieties such as oak and maple, and will also dry rapidly. Remember: wood alcohol is flammable and toxic. DO NOT HEAT THIS MIXTURE, and don't breathe the fumes. Do this outdoors. Soak for about ten minutes, remove and dry, and then finish with lacquer or varnish. Some types of finish may attack the dye, so experiment.

Any handle material you choose should not be expected to remain on the steel if it is only epoxy glued to the pick. The fault is not with the glue, but with the steel. Since it flexes easily, the bond between any handle material and the steel will eventually weaken and give way. In all cases a rivet of some kind should be used instead. The riveting technique using nickel silver wire bits is very easy and forms the most secure bond. Spot anneal the steel handle to allow drilling. Mark the wire you choose for the rivet stock and make the hole same size or larger by no more than .003″. If you have a set of number drills, you can often match exactly the diameter of commonly available sizes of nickel silver rod or wire. Scribe a centerline on the pick and space your holes as required on it. It is my custom to retain the divider setting used for the center line, and, holding it on the finished end of the pick, scribe the first hole location. That hole can then be center punched. The divider can now be reset for any other desired rivet spacing, and the second hole location scribed, registering the divider in the first center punched hole. The rivet wire should protrude about $^{1}/_{32}$″, and no more, above the finished surface on both sides. Insert the wire to check for height, and use a jeweler's saw to mark for the cut line. Remove the wire and complete the cut with saw on the bench pin. The rivet is inserted into the hole or handle pack and oiled slightly. The pin must be a close fit. If it is very sloppy, the situation may be saved by removing the pin and laying it on an anvil surface. By striking the rivet pin on the side softly with a hammer to form a flat, it will fit better. This deformation of round theoretically makes it wedge into the larger hole. If not, repeat until it is acceptably tight. A cross-peen hammer is used to lightly impress a series of cross-cuts into each rivet end. The rivet is turned 180 degrees for another set of hammer strokes until the crosses are both secure enough to retain the rivet and handle parts. Once the cross-peening is done, the rivet is mushroomed against a flat anvil or steel block surface, domed with a doming punch and hammer, or simply planished down flat with the other end of the cross-peen hammer. Do NOT use either face of your cross-peen hammer to drive a doming punch; use a regular bench hammer instead. If the rivet was too long and the end protruded too much above the surface of the handle, the end will mushroom and then crack along its edge margin. You may possibly even lose part of the head. If you crack a rivet, replace it altogether. If you sense a sudden increase in resistance or rebound from the riveting hammer, a crack is imminent. If so, stop with the hammer and file a little metal off the rivet top, and no crack will develop. It only takes a slight amount of flare in the rivet to hold the tool handle on dependably for years of hard use. Half the battle is knowing when to STOP. If you have done a fair amount of cross peening or hammering on the rivet, it may work-harden. When the metal work hardens it becomes difficult to cut it with the file. It behaves as if it was hardened by heating and quenching. In fact, it is hard, and the way to resoften it so the file will dress it down easily is to anneal it with the torch. Try to do this quickly or you will risk damaging the pick steel by overheating. Once cooled it can again be filed easily.

I have been asked if manufactured (called mechanical) rivets aren't better, but I have just never tried them. To me, the nickel silver rivets are preferable, since they can be produced to match the exact thickness of handle pack required. Also, an inexpensive stick of wire will last a long time, and they take an excellent polish when the pick is finished on the wheel. Most importantly, if the handle hole is beveled the plain rivet can be pulled down flush with the handle and polished to almost disappear. Any sharp edge on the handle only distracts me from the delicate job of using the pick, and handles are supposed to help, not annoy.

For all of the single picks I carry I make a riveted pocket clip, as shown in Figure 33. This clip can be extended straight back for use, giving you the unique advantage of a pick handle almost a foot long. This extra length translates into more inertial mass, and makes lifter crowbar picking just that much easier. If you feel the tool is over-balanced this way, set the clip to the "O" clock position of your choice, or modify clip length to make the handle feel comfortable. That's the unique advantage of making your own tools.

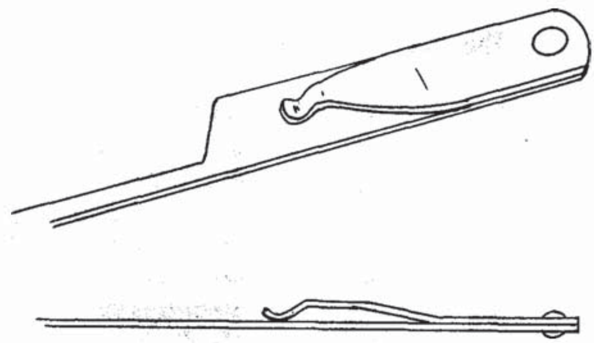


Figure 33
Lock pick handle with riveted pocket clip.

Let me pause here and make a point. Do you know one of the REAL advantages to being able to make your own picks and tools? I produced an absolutely beautiful pick a couple of years ago. It had a high polish, smooth contour lines, worked very well in my toughest test locks, and had a graceful feel as well. I carried it for ten months or so, but one day I plain, stone, lost it. Now, if it had been purchased it would have been expensive, difficult, maybe even impossible to replace, if the supplier was out of business. Instead, I pulled a tracing template and working drawings from the files and got busy again. In less than six hours I had a near duplicate of that missing lock pick. The missing lock pick, by the way, turned up later in a folded grocery bag, and I still have no clue how it came to be there, but I do have a matched set now. A buddy of mine used to have a vibrating-type lock aid tool with a matching belt-mount battery pack. He broke a part and couldn't use the tool again because the manufacturer was long gone. The moral is: tools you make can be replaced or, even better, made better.

Back to the lock pick with attached pocket clip. The clip itself is a smaller piece of steel shim stock. Thickness can be from .020 to .031″ for best results. After cutting it to a rough length, anneal the entire piece of clip with the torch, then coat the entire piece with layout dye and draw a profile on it like the one in Figure 33 or one more to your tastes. At the soft (annealed) end of the lock pick center a rivet hole punch mark and drill it for the size of wire used to rivet. For this rivet, which will also act as a swivel, use 1/8″ nickel silver wire for the necessary strength. Now clamp the clip over the pick and drill through the first hole into the clip. The clip must be curved to act as a pocket clip. Grip the rivet end with a machinist's clamp and make a 10-degree downward bend in the steel. Notice that the steel is still very difficult to bend even though it is soft. Steel does not get like paper during annealing, just a little softer. Now work the clip over a rod held in a bench vise or over the bench edge to get a curve in the clip. At the very end of the clip make a reverse bend to allow cloth to slide under. Now remove the layout dye and emery polish the clip along its entire length. Place the clip on a pumice pan or preferably a pair of firebricks, set at right angles, set out the motor oil, and spark the torch. Heat the clip until it is non-magnetic, and quench it in the motor oil. Repolish the clip with emery cloth, and do the final temper to peacock or blue. It MUST be done very slowly, and the critical area is the major curve and flat spot where the rivet comes, since stress is greatest in these areas. After tempering, polish on the wheel, and keep the heat down. It is possible to untemper the pick just from the friction heat created by the polishing wheel. Use a can of water to cool the tool.

I have even done a couple of handles in fiberglass, and I think it shows great promise, so I will explain the technique. Fiberglass spa or shower shells are composed of a sandwich. First is a layer of epoxy plastic or hardened resin, then a layer of resin impregnating glass fiber cloth or matting, and finally a final coat of clear resin again. The glass adds bulk and tensile strength, and the resin adds compressive strength and smoothness, as well as tying the whole pack together. The commercial kits put out by auto-body companies to do fiberglass repairs on metal car bodies can provide you with an inexpensive one-shot supply for fiberglass and resins. Since there is a mix or pot life factor, it pays to do a few handles at the same time. Once the initial coat is mixed and the steel degreased, it can be troweled on, popsicle-sticked on, or even dipped and the excess scraped back into the can. The initial resin dip should be wrapped with fiberglass matting about a minute after, and then saturated another minute later. The resin must be worked into all the nooks and crevices of the fiberglass matte for the proper strength. The final coat is applied like the base coat, and the whole pack is wrapped in sandwich wrap or heavy polyethylene sheeting. This holds the shape of the free-form unmolded fiberglass, and provides a fairly smooth finish as well. The cure time of the resin can be significantly decreased by heating the metal end of the pick with a candle or alcohol lamp. Not enough to glitch the temper or even make the resin bubble, but it will lower cure times. The fiberglass resin actually cures by exposure to heat, and the heat comes from a chemical reaction triggered by adding the catalyst (hardener) to the resin. The candle just helps things along a bit, and even prevents the reaction from going slower than normal because of the heat conducting properties of the steel pick AWAY from the resin. Once the resin is cured, the handle may be shaped on a disc sander wheel or belt sander. If you sand at all, be sure to take the precaution of wearing adequate breathing protection. It is said that inhaling fiberglass dust is VERY hazardous to your lungs.

If you wish to attempt to make a form-fitting handle, just grabbing the plastic-sheet envelope in your mitt and letting the epoxy cure like that will do the trick. A perfect form-fitting handle never seems to be really comfortable except in one precise position, and the real problem is that it is very difficult to attempt lock picking with a single hand position. It is kind of like the finger-scallop cuts thing. You should try the form fit thing though, because a little post-processing will even up the problems. Once the fiberglass has cured and you have used the pick for a few openings, make a note of the handle parts that seem to be in the way. These can easily be altered, smoothed down further, or even removed outright with a belt sander. Don't waste a fine metal file on the gummy resin. It seems as if, all things being equal, an amorphous blob handle is better.

Annealing the steel blanks to make them softer allows you to drill the handle later for a wire rivet, or screw and nut. This will allow you to make a combination pack of pick tools, or just corral single tools by hanging them together. If your working style involves changing tools frequently, this isn't for you. The advantage a pack offers is the increased handle weight and levering action you can exert when the picks are spread out at right angles. Like most picking techniques, some love it and some hate it. I suspect the pack-of-picks craze started with people cutting lock picks out of those little automobile spark plug gap sets. They have the minimum kind of steel in them, although the quality is low-carbon, but they are too short for a good working tool. If you want a secret agent set, use your own steel and make such a set.

If you want both tools to have flush edges when riveted together, clamp the next tool in a vise with the drilled first one, the drilled one on top, and anneal the next handle using the hole as a guide, or use the wood with pins for fences. Once the second handle is heated up, the hole can immediately be drilled through it without waiting for it to cool. Alternatively, a stack of three tools can be annealed and drilled in one operation. The proper drill press setup to use is shown in Figure 34. The toolmakers clamp keeps the handles aligned throughout the process.

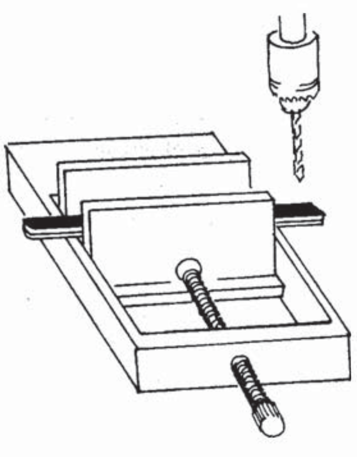


Figure 34
Vise used to safely drill rivet holes in pick handle.

Just because you have a hole in the handle doesn't mean all picks will have an identical contour. It is easy to build a grinding jig to true up the radius of the tool. Drill a hole two- or three-thousandths smaller than the hole size into a scrap of steel, and insert a pin the same size as the pick-handle hole into the steel. You may have to heat up the steel piece to get a good fit. This jig can now be used by putting the pick hole over this pin, and rotating it in contact with the grinding wheel. The radius resulting will be very uniform.

The jewelers' trade suppliers sell an oxygen/-propane torch under the trade name "Little Torch," and I find it is just great for this kind of spot annealing. In operation, you open one valve and light the propane first, adjusting for a fairly large brush-type flame, then slowly feed oxygen from the second valve, and the flame narrows to a small, intensely hot pinprick of light. This little flame will heat and anneal a tiny spot on your picks anywhere you want, and right bang now. Since the flame is so hot, it flows a lot of heat in rapidly and does the job before the metal conduction spread even starts. Cool this with an air blast. It really is a nifty tool.

There's always a catch: they cost over $130 at major city suppliers, less from mail-order. The small tanks they come with don't last at all. For a serious locksmith, the only way is to invest in a complete oxyacetylene welding outfit: tanks, cart, regulators, torch and tips. The small female pipe thread fittings that come with the little torch may be attached to quick-change couplers. The other half of the coupler is in turn attached to the regular torch hose. This allows you to shift from small to large torch safely and quickly. The standard size tanks will last a good, long time just driving the little torch, and the money saved will soon pay back the outlay costs. A further advantage to owning a torch like this is you can also do silver soldering on broken lock parts that are unobtainable.

This covers most of the handle-forming techniques eddie uses. It is very important that all of your working tools have some type of handle, because this will mark you as a professional lock pick tool maker. If you use handleless picks you will never get top efficiency in picking skills.

Chapter Eleven
Tension Wrenches

Tension wrench design theory is covered in the chapter on the theory of lock pick design, so I will deal only with the actual making of these wrenches here.

There are some easy (meaning quick) approaches to making these tools, and also more time-consuming methods. Eddie once saw a guy make a tension wrench from a piece of brass tube and a hunk of music wire in about two minutes. Here's how. Find the approximate middle of the wire, and bend it into a sharp "V" shape. Shove the bent middle into the brass tube and leave two inches sticking out. Swedge (slam) the tube around the wire with a hammer tap. Now grab both ends of the wire with a pair of pliers and bend them 90 degrees. Finally cut the free wire ends to the same length, about $^{1}/_{8}''$ from the bend. This is a double-ended wrench whose ends are inserted into a keyway top and bottom. Bend the wire to give them a slight outward spread. This works like a charm in double-bitted disc or wafer locks where a regular wrench would be pulled out by the pick action. You may also try it in regular pin openings as well. As my good friend Dave says, "Who's going to stop you?" By the way, for a professional version of this same double end tension wrench, read on.

On to the in-depth methods. The standard steel shim stock you cut your picks out from can also be cut into tension wrenches. Figure 35 shows a roughed-out lock pick in the process of being converted into an "L"-shaped tension wrench. The width of the end can be adjusted as shown to match a keyway very closely, as long as you don't cut too much off.

The handle on such a tool may occasionally cause trouble if used on a near-flush mounted lock. In such cases, the fat handle will drag on the door surface. There are a number of ways to get around that. The easiest is to cut the working tip at a slight angle to the handle as shown in Figure 36. This usually provides the needed clearance. If the shank of the tension wrench is long enough and the steel is thin enough, it can be cold-bent in a slight upward twist which will also serve to offset the wrench handle from its right-angle orientation to the tip.

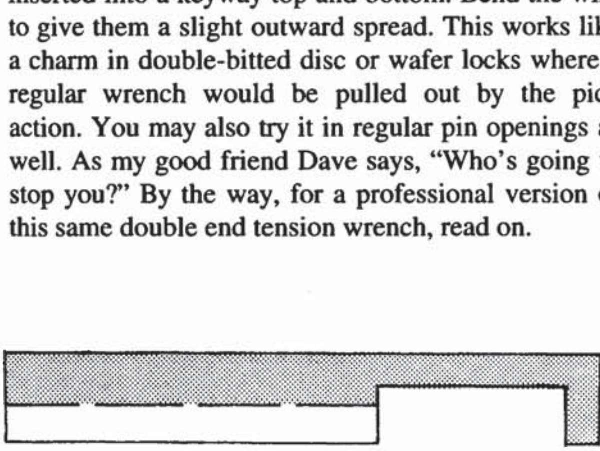


Figure 35
Rough pick blank converted to flat style tension wrench.

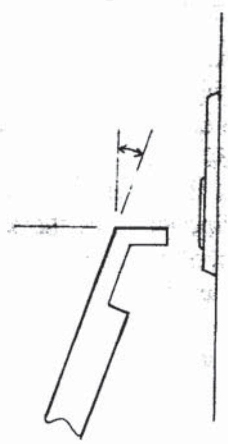


Figure 36
Note splayed tension wrench provides handle clearance.

The width of the working handle should not be left at a full ½″. It is much better to cut it down further to a ¼″ or even less. In fact, you should make an experiment to determine the style of wrench grip that you customarily use. This information will help you in tool design.

Simply put, you are going to mark a tension-wrench shank with Vaseline jelly and then use it to do a few openings. The printed area will indicate how far up or down you hold the wrench and how much area is actually in contact with your fingers. ATM and other keypad codes are often read using the same dodge. It's something a security pro should know about. Close observation also tells the story. Based on this information, length of wrench (for instance) can be determined.

Sequence for scribing lines for layout.
Scribe #1 first, and so on.

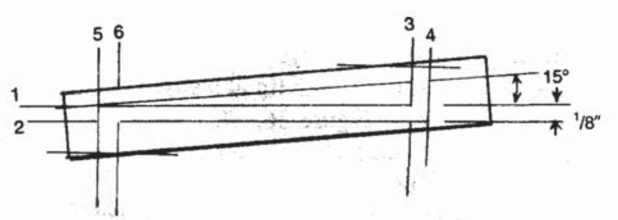


Figure 37
Layout for double-end wrench in ½ stock.

The logical extension of such a wrench is the double-ended whirligig wrench. This type is cut from a layout scribed in layout dye sprayed on the wrench blank. In Figure 37 you will see the usual type of layout. Notice that the wrench lines are actually at angles to the existing edges of the steel. The easiest sequence of line scribing is indicated in Figure 37. The long angle lines are executed first, at a shank width that you are comfortable with. The wider the width the more rigidity this wrench has. For a starting point try a width of 1/8″. If you find this too loose for your style, then expand it accordingly. To vary the spacing of the first two lines, and hence the shank width, execute one first and then set your divider points using an engraved rule to the inch fraction you want. Use the scriber to locate a starting point for the second line, and then align the protractor and execute the second line. The angle protractor is set to an angle of 15 degrees. For a longer wrench use less angle.

To scribe the nose layout lines shift the protractor 90 degrees (keep the setting locked in and twist the entire protractor so a different side contacts the steel shim stock edge), and scribe away. Once all the lines are done, grind and finish in the usual way.

To pack more punch than the double "ell," a tee, a fat H, or whatever other contour seems useful to you, can be laid out. However, with a grinding wheel that is sharp and unglazed and mist coolant flowing freely it will not take long to rough out a couple of double-end wrenches from stock of .025″ or better thickness.

Because of that same limited thickness this wrench style will not have tightly fitting tips, but will instead combine springy shanks with loose-fitting tips that rotationally cam or wedge in at an angle to the keyway. This is, of course, one position of wrench type, and it asks the question: "Which came first, the stock available or the wrench design?" You are aware that traditionally tight-nose wrenches have round shanks and loose wedgie-nose kinds have the flat .010-.040″ shank. Let's move on to the second wrench and stock type.

The second possibility for stock steel is blank drill rod. This is also from the industrial supplier of shim stock. As you know, drills themselves come in fractional sizes ranging from 1/32″ to ½″ in 64th-inch increments. You may not be aware that drills also come in a progression of other sizes termed letter and number drills. The numbers sizes run from 1-60, the decimal on this series is from .009 to .230. The number series drills run A-Z and the decimal sizes there are .234 to .413. These additional series of drills are valuable to the lock pick technician because they allow you to size holes very closely to pins and rivets due to the smaller steps between sizes. Number and letter drill sets come from the industrial suppliers. Drill rod blanks come in the very same decimal increments, usually in three foot lengths. For most wrenches the number sizes from # 25 to # 45 will serve very well.

The rod comes in two steel types, water-hardening and oil-hardening. The water-hardening is the easier to work with and temper, although both are high-carbon steel. The actual wrench is ground with opposing flats that are either parallel or taper gradually thinner to the nose tip. With correctly tapered flats this design is very tight fitting, and the initial diameter of the rod ensures that it will be very rigid at the shank as well, despite the degree of temper.

Notice again that these two types of steel each produce a tool that conforms to each of the two schools of thought. The shim stock makes a loose fit springy wrench, and the drill rod makes a wedge fit rigid shank. Further, each tool corresponds to a selection of pick and a type of lock opening technique. Since the 20s or so, this matching of plug wrench and pick type has prevailed.

What would happen, you ask, if a tight tip were matched with a springy shank? As you know, a tight-fit wrench is not commercially available and so must be shop-made. The tools which are made are very rigid, so the tight-nose springy-shank plug wrench hardly ever comes up. I tried thinning a rod shank by face-grinding, and I will tell you the results are very interesting. I thought initially that a springy shank response would cancel out any feedback feeling that the tight-fitting tip wrench usually produces in operation. A tight tip with a shank that is somewhat flexible is quite nice. The key here is the "somewhat." Too limp a spring is no good at all, too rigid gives no better feel or fist. In between I find that for my style it is the IDEAL wrench. Later in this chapter I give instructions on building this wrench type. I also show how to adjust it to its peak performance.

A further redeeming value is that it prevents accidental total loss of twist because of its built-in reserve of twist so to speak. Even if the hand slips, there is still some twist built-in, where with a rigid shank this is fatal.

One other point worth mentioning before we dismiss, is that moderately tight-fitting wrench noses will never slip around or, even worse, kick out during a long period of picking. The big advantage to a wedge-nose plug wrench is that you don't need to be so painfully careful about accidentally knocking the plug wrench free and causing a pin "zipper." If you have spent ten difficult minutes lining up four tumblers, only to lose them all when the wrench skids, you may find yourself fitting and even hammering a taper nose wrench in on the next job.

Keyways with extremely limited access or low cross-section also benefit from a plug wrench that is slightly taper-cut to "bite" into the cylinder core.

The other category of wrench that crosses these two sets is the loose tip with rigid shank. It is usually produced by sloppy grinding of the tip and/or taper. Perhaps you will produce some by default. What will not fit your intended lock may still fit another smaller keyway, so don't deep six it in a fit of pique. As to the working quality of such a wrench, I can't even get started with it, but it may be worth a try for someone with a totally different style, kind of like an orthopedic wrench. Always give any tool system a trial before discarding it as unusable for your "fist," since once discredited in your mind you will probably never try it again. Experimentation produces failure, but it is also father to new tool design.

As you tool up on tight-fitting wrenches, you will soon find that the tight-fitting nose of one size of keyway is the sloppy fit of another keyway, with as little as .004″ of thickness difference. To deal with this problem, which is unique to tight-fit wrenches, a fair number of sizes of plug wrench in smoothly increasing increments and arranged in order will be necessary to work most types of lock with the same touch or fist that you prefer. The more gradual the taper, the larger number of sizes needed. A very steep taper tends to see-saw in the keyway, since it only bites at the very edge, and is to be strictly avoided. If you see-saw at a critical moment, you will zipper tumblers.

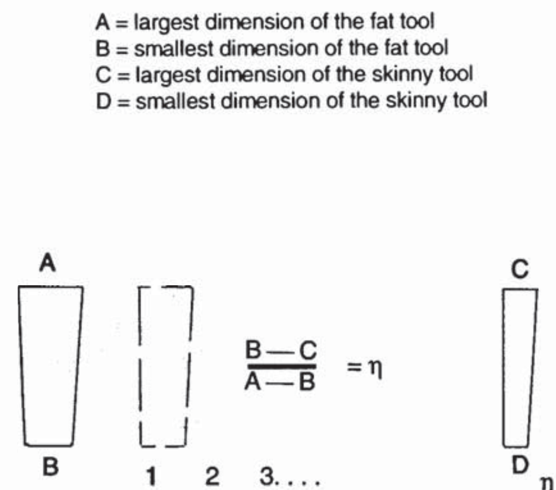


Figure 38

Note that a very shallow taper means a slightly tighter keyway fit, but means many more wrenches to make a full set.

For starters you can follow Figure 38 and produce a set of tools to dimensions that match most of the locks that will come under your hand. But even when entering a keyway system blind, (that is, starting from scratch with no patterns and dimensions), it is still easy to produce quickly a working set that can then be used as a baseline for future tool producing. You have the customary sets of code listings which will give keyway data, bitting increments and tumbler spacings, but not all locks are listed. Sometimes the books are just wrong, and some books are way too expensive to buy. Because of these reasons, starting from scratch is not all that bad.

Start with the fattest keyway you have in your plug collection, and produce a wrench that will wedge well in it. Measure the least and most dimensions of this tip, and also the least/most of a tool that fits the smallest keyway you could find. Now take the least of the fat tool (smallest portion of wedge) and the most (largest wedge) of the skinny tool and do the subtraction math. Take this figure and circle it, it is the theoretical full span of keyway widths you have seen to date. Now do subtraction between the two figures of each wrench (least/most) and notice this difference. This is the figure an average wrench wedge spans. Divide your circled figure by this average wrench span, and you will have a good idea of the number of steps or wrenches that will need to be created to fit most of the locks you would commonly encounter, assuming the taper angles on the wrenches remain fairly constant.

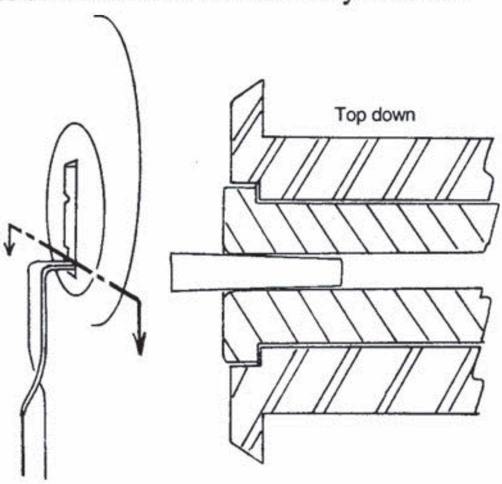


Figure 39
Showing taper fitting tight only *at front.*

Figure 39 shows you a top-down view of a tapered side wrench in a keyway and jammed tight. Since most keyways have some measurable wear, there will be a slight taper at the extreme outer mouth and the taper usually seats well here. Consider, though, that any tapered tool will never contact anything more than the first .015″ of any parallel slot, which is what a keyway really is, and a truly parallel and tight fit is nearly impossible in anybody's daily work.

Given this tenuous hold, the smaller the angle of taper the better. Not that it will contact a much greater area of the keyway, because it won't. It will instead wedge much harder into the keyway and increase the feel feedback you look for in a tight-taper plug wrench. With approximately a two- to three-degree taper, one wrench will serve five to eight keyway sizes, and will even have to be removed forcibly at times. Remember that this raises burrs on the keyway that may accelerate key wear and tip someone to a picking attack.

Polished ground drill-rod blank stock is usually shipped soft, but sometimes it is supplied in a fairly hardened state and must be annealed or heated to cherry and slowly cooled before it can be bent at an angle. To test for this, try to cut a small bite with the triangle file somewhere in the middle of the rod. If it cannot be cut, it must be annealed. Once it is bent and cooled it is filed with two flats as usual, and then rehardened and tempered.

For a hard approach (not the best idea, just one idea) to the plug wrench problem, have you considered making some out of brass bar stock? In the .020″-and-up thicknesses there is no appreciable strength in it, but that is an advantage for us as it can be easily formed, and is naturally more springy. You can either cut your tight-fitting wrenches from brass rod stock with opposing flats just like a steel wrench, or you can grind a flat style wrench from the thin or thick variety of flat stock. If the stock thickness is less than .025″, the tongue of the wrench can be produced by folding over a long tab. It is even possible to make wrenches from brass angle stock (hobby store). The great advantage of the brass rod style wrench is its ability to not mar the keyway during rough insertion of the wedge-type wrench nose. Brass grinding, especially the alloy that is trade named "free-cutting brass," will load up the wheel a lot and requires frequent dressing.

To cut a few pieces of drill-rod stock easily in quick succession, you may go to the grinding wheel and do the same edge grind you do for shim stock. The method we use involves the oxyacetylene torch. If you play an intense, oxygen rich flame at the wire, it will quickly cherry up, and in another five seconds sparks will begin to fly from the surface. This indicates the steel is literally burning up as it begins to melt. In another second the steel drops from its own weight and, *Presto!*, one piece cut off with minimal effort. If the heating is slow enough to heat the wire past where bare hands can hold it, it is too slow. I arrange the torch in a clamp so both hands are free, and I use a wax pencil (china marker) to strike off lengths quickly on the rod surface. There will be a little cratering and burn around the melted area, but this is unimportant for a plug wrench tip, and can be ground off during final finish.

The steel pieces cut off should be arranged to NOT drop into the olive oil quench bath, since the advantage of this method is that it anneals the steel at the same time. Allow the pieces to collect on your fire brick or pumice pan. Once all the needed pieces are processed, heat them all to cherry red so as to complete the annealing.

To make the 85-degree bend in the wrench shank from these pieces you'll need a bending jig. Drill a hole $^1/_8$" diameter and $^3/_8$" deep into a piece of steel which is about 4-6" on a side. The torch flame should be focused just parallel with this jig so the wire shank can be inserted into the hole, and quickly bent, then reversed, and double-bent. The wrench end points away from the direction of bending for the double bend. Notice that the torch heat is just an aid to easy bending and smooth radiusing. Heating has nothing to do at this point with hard or soft at all. If you are also offsetting each wrench tip size to make left- and right-hand wrenches, then the small offset bend should be put in each tip now, using the same bending jig. A skilled worker can make both bends using residual heat from one to facilitate the other. Allow cooling to continue in areas you don't desire to bend by re-reversing the wrench. The preferred sequence is insert, push away to 85, remove, reverse ends and insert, push away to 85. Re-reverse ends and insert, heat and 60-degree bend offset to left, again reverse ends, insert and 60-degree bend to right. Wear gloves.

Examine all the wrenches to see if both legs are in the same plane. If they are not, now is the time to straighten them. Apply a little heat to the middle of the wrench and give a slight twist in the required direction. Once straight, quench in the oil. The legs must lie in the same plane for the filing to be accurate. Now place all of the wrenches in line on the soldering block, and anneal all of their working ends up past the bend by heating to cherry red, then allowing to cool slowly to room temp. Customarily, one goes to lunch while they are cooling. The annealing is necessary because the next process is filing flats on the wrench.

If your wrenches are to be carried in a wallet, you may find it is useful to make a single-ended wrench with an eye at the end. This eye is bent into the rod using a pair of round-nose pliers on it while heated cherry red. The pliers will sink a lot of heat away from the rod, but the bend can still be accomplished in one or two stages with some dexterity. The diameter of the eye will depend on how far up or down on the round nose the wire is formed. A soapstone mark on the pliers helps to gauge this.

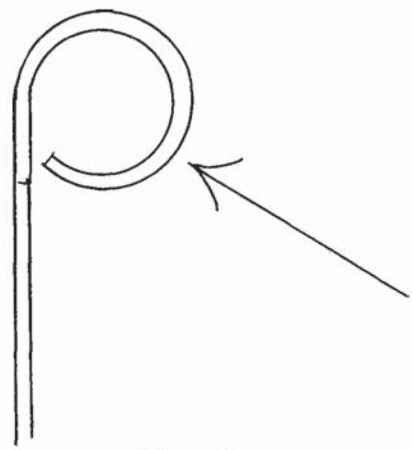


Figure 40
Hot-forming eye in wire end of wrench for chain/cord carry.

Once the eye is formed, it is heated cherry red again, and placed on its side on the bench pin anvil. It is then flattened with a mushroom or riveting hammer, alternating blows on either flat of the eye, while periodically reheating in the torch flame. The final step in eye forming is to heat and then hold the eye as in Figure 40 and close down the eye. It is wise to have a sample gauge rod of the wire you intend to string the wrench eye on, to verify it will still go on easily after this closing. If not, reform the eye. This blacksmithing technique can be made more handsome in appearance by filing the eye flat on both sides. Most tooling dents left by the hammer strikes are removed. This also allows the wrenches to register well on each other in a pack, or register on washers separating them in the pack. If you make a large pack, the washers may be stamped with numbers or points to indicate which size wrench is coming up. If you are thinking about trying it, this eye-flattening technique will also work on the tip of the plug wrench, but in practice little work is saved as opposed to straight filing, and the tip is pretty fairly deformed by such hammering. It is best to file only. I find that apprentices are unwilling to file anything major simply because they don't just dive in and start counting strokes. The sooner eighty strokes are started, the sooner it's done. A sure sign of an impatient file worker is the short stroke using only the middle of the file. If proper filing technique is used, even the hardest job is manageable.

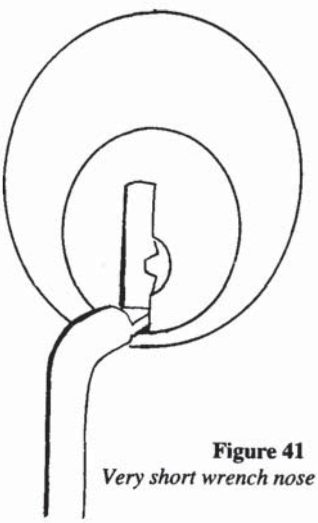


Figure 41
Very short wrench nose in keyway.

Notice in Figure 41 a wrench with a very short leg is shown inserted into a keyway. In most keyways milled into plugs, the bottom is left open to the inner wall of the cylinder. This is a natural result of the milling process. If a short wrench wedges only at the very front of the keyway, it can pivot on that bearing, and the end may either extend up into the keyway until it hits a ward, or it may pivot downward. If it pivots downward it can, if short, dig into the wall of the cylinder and cause considerable drag between plug and cylinder. It creates a mechanical connection between the two that inhibits free rotation. This drag will fatally short circuit the picking feel and the result is usually a non-opening. This drag problem is ruinous to good picking technique. The solution is to ensure that the leg of the plug wrench is long enough to only touch at a slight glancing angle to the cylinder wall. In addition, the end of the wrench should be carefully radiused, almost angled, as shown in Figure 42, to prevent any cutting contact. As you do an opening, check occasionally to see if the plug wrench is hitting the cylinder wall. If it does, try making the bend in the wrench less by five degrees at a time. This makes the vector of force you apply to the wrench tend to push the wrench tip up into the keyway. It also forces the plug down in the cylinder (if the lock is mounted correctly with tumbler ends down), but really doesn't seem to help the tolerance any.

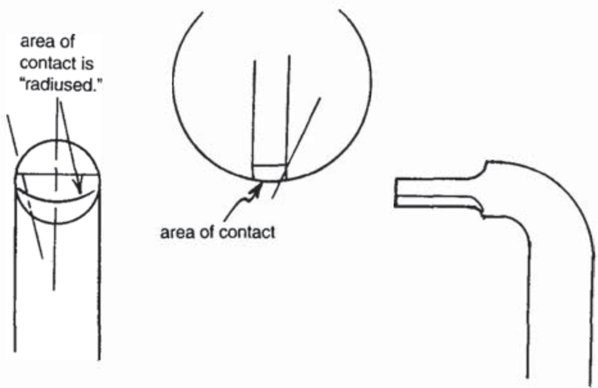


Figure 42
Cutting away wrench nose to prevent plug wall "drag."

Before starting to file flats on the wrench to complete it, some projected target should be written down and provisions made so it can be measured for as filing moves along. If you have a particular lock keyway in mind, use a set of modified feeler gauge leaves to measure the width of the slot. A regular automotive or machinist's set of feeler gauges in a jackknife-type pack can be used for this crucially important measurement. I say "crucially" because the jam fit of the wrench tip can be materially altered in feel either way by variations of as little as a .005″.

To modify the pack for these measurements do this. Hold the entire pack closed and cut all of the leaves narrower in width until they are $^{3}/_{32}$″ wide. Do this on the wet grinder. Once this is done, make a couple of passes on the cut with the #4 mill file to even up the grind, and disassemble the pack. Now clean up every leaf individually with the India stone and oil to remove burrs. This pack can now be reassembled and inserted singly or in combination into a keyway to get a direct reading as to thickness of a plug wrench tip desired. The smaller width prevents keyway warding from blocking insertion of the feelers.

As noted in the lock pick-lifter height discussion, once a few sizes have been established to work, the rest of the system can be extrapolated and filled in, then tested in the field to see what is common and what is not.

Now that a target size has been decided, let's learn the technique of file-fitting a plug wrench. This procedure is done on the bench pin with the tension pin extended up.

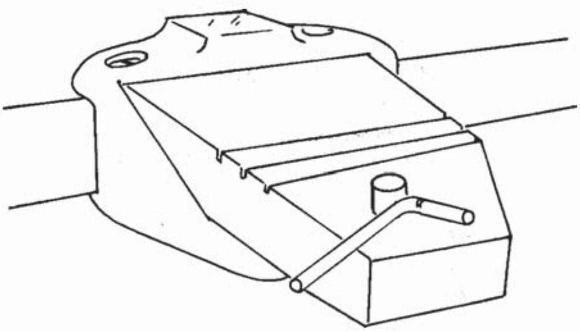


Figure 43
Using bench pin tension to hold wrench for filing.

Place a wrench blank on the bench pin, butted up against the tension pin as in Figure 43. The pin may be hammered down low as needed as long as it supports the wrench shank. Begin by choosing a narrow-edge, double-cut file and filing two notches in the wrench just past the bend. Look at Figure 44. These relief cuts should be only as deep as the projected final width. To gauge them easily, use the 4-way dial caliper. Their purpose is to allow the flat-cutting file to run parallel to the bench pin. If it were cutting against the wrench close to the bend, the cut would be angled and the tip would be much thinner, even though you try to control the file. By making relief cuts the file rides evenly on the steel, and the cuts also alert you when you are almost to the target width and should slow down the process. The first flat cut is made with your #4 file with the safe edge riding on the bench pin. When the cut is completed, insert a trial-size or multiple sizes of thickness gauge in the space formed by the newly cut flat and the bench pin surface. To make the measurement, push down firmly on the uncut shank, floating the cut nose portion above the bench pin surface. When the exact thickness to match the amount of metal removed is reached, use this pack to block up under the wrench for the second flat cut. It will make the cut nearly parallel by eliminating rocking. Now make the second cut, stopping again as the relief groove is reached and obliterated. It will be impossible to make the wrench flats parallel with each other on a repeatable basis, but the taper must always go from fat outside the lock to thin inside. The small taper actually works to your advantage because it makes the fit-up much tighter.

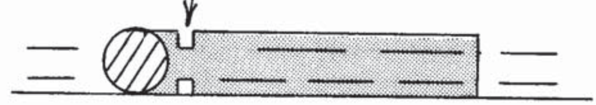


Figure 44
Location of initial cuts for finish-fitting-wedge-type tension wrench nose.

After filing as many wrenches as you require, they should be emery-papered or stoned well to remove all tooling marks. This is just as important with the wrench as it is with a lock pick because a rough wrench will sometimes stick when wedged tightly in a keyway, and removal sometimes breaks off a very brittle wrench in the plug. If this happens you get to use that key extractor you carry, if it works. After stoning, dip the wrench in olive oil, light the torch, then hold each wrench tip and bend in the flame, shank parallel to flame axis. By skipping the flame in a small arc on and off the tool, it will slowly and evenly heat to a dull red. The olive oil will act as an indicator, flaring to fire just before dull red heat is reached, or you may also use a small magnet to verify when tempering heat has been reached as the steel will lose its magnetic attraction at that precise point. When evenly heated, drop the wrench back in the oil bath. The bath should be checked periodically for temperature. If it is bathwater warm it will not quench properly and must be cooled before continuing. You can use two baths, both in metal containers, and keep one in the fridge at all times. As with picks after quenching, do not flex the wrench even gingerly, because most all of them will promptly snap off. Wait until after the draw tempering to see how strong they are. It seems that many of my students have roving fingers and idly or absently flex a freshly quenched tool; perhaps to see just how hard it really is. That slip can cost a half-hour of wasted tool time. I keep all such breaks in a glass jar on the bench just as a reminder to use kid gloves.

After the quench, the wrenches need to be tempered by heating to a light straw color. To accurately assess this, paper-polish an area the length of the pick. Set your torch for a very light, brushy neutral flame, or use just an alcohol lamp. Begin by heating the wrench NOT at the very tip, but at the mid-point of the mass that comprises the bend. It is okay for the very tip to be hard, but if the bend is brittle, it will fracture. The heating must initially be done very, very slowly, since the full spectrum of colors can suddenly bloom and fade in a hot spot, and that wrench must then be rehardened and retempered. I'd advise you to take at least a full two minutes in the beginning, slowly flicking the wrench in and out of the flame, trying to get thin and thick cross-sections to the same temperature at the same time.

The first color you will see will be a ghostly light straw. If heated further the colors will go to dark straw, peacock, then blue, and finally soft gray. I like to use my wrenches at that peacock color, and I have only lost one by stress fracture in twenty years. After some experience you can tell when the parade of colors is going to begin and you can slow down the heat even more. It does no harm to wait on a temper. Go fast and you must begin over again. Once the desired color/hardness combination has been reached, quench the wrench in water. That quench will not reharden it, it just retards further softening.

Once tempered, the tool should be cleaned of firescale with a fine emery or a cotton buff, and the wrench is done.

To produce the new-style, tight-nose spring shank wrench you must make a composite tool. A composite consists of two or more pieces joined with a wire rivet, usually nickel silver. Each piece is selected because it is close to the final size wanted, so no heavy cutting is required.

Learning to rivet is a skill you will find useful for adding handles and doing picks with pocket clips. If you can afford to learn ONE new skill this year, make it riveting. Joining two pieces of metal with a rivet allows for a lot of style variation and makes for more workable tools. In some cases a rivet is the only reasonable answer to a problem. Here is a good example. Suppose you wanted that composite wrench with a really tight wedging nose, and a springy shank. Here's how.

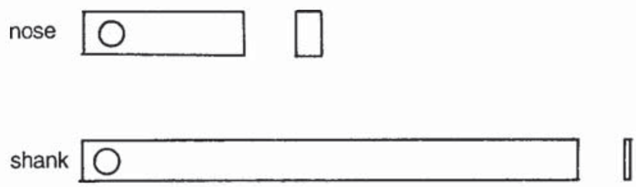


Figure 45
Composite (folding) tension wrench pieces comparative thickness.

The nose piece of a composite wrench is either precision ground flat stock or drill rod. Both are available from the usual industrial suppliers, and the flat stock comes in a variety of sizes and a few alloy types. I prefer 0-1 alloy, and the rough piece size is $^3/_{32}$″ thickness and saw/file as needed from the bar. Notice the hole drilled for the rivet in Figure 45. Flat-round stock comes soft, so annealing is usually not necessary. Drill the hole first and then file the nose to its desired size. A machinist's clamp will be a great holding aid for this small piece. If you are only doing three or four, you can make the holding easier by working the end of the bar into a nose shape, drilling the rivet hole, then hacksawing off the piece. The hacksaw cut can be cleaned up easily on the wet grinder or by bench filing. The nose should also be stoned for the nicest feel in the keyway.

The shank is cut from .030″ shim stock as per Figure 45.

The end will, of course, have to be annealed to allow drilling for the matching rivet hole. Once this piece is finished to size it must be rehardened all over and then drawn to a peacock or blue temper. The rivet is cut and inserted as per instructions in Chapter Ten.

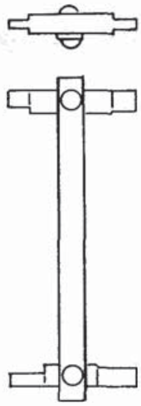


Figure 46
Four nose double-ended folding tension wrench.

To use drill rod instead, follow these instructions. Select a piece of drill rod with a diameter equal to the top to bottom distance of the keyway slot area you are trying to fill. First cut the parallel opposing flats with the vise grip jig or other alternative. Now get out your torch and small-faced hammer, and a bench anvil. Heat the area one inch back from the flats to bright cherry and flatten it down with the hammer. Remove from the quench bath and use a mill file to dress off any hammer mars and dents, and cut one whole face flat. Into the middle of this face, drill a rivet hole of appropriate diameter. Now resmooth that face and file a radius on the rivet end of the small rod nose piece you have just created. Finally, reheat to cherry and quench. Temper to peacock. The flexible shank is cut from shim stock, the end of which is annealed and drilled prior to any layout. Drill to match the rivet hole in the nose, of course. After layout and grinding, the shank is heated to cherry, quenched and tempered to blue. Finally the rivet is fabricated to length, oiled, assembled, riveted, de-greased and dressed down.

This tension wrench offers the best of both worlds, and the shank response is very even. As a bonus this wrench may be folded up flat and carried easily in the watch pocket. For the dedicated tinkerer this same wrench may be made in a double-nosed version shown in Figure 46. Also pictured is a double-ended, double-nosed type. While this may look like a gimmicky little pocket piece, it is actually very handy. The protruding nose gives the locksmith something to grab hold of in order to release a tightly wedged nose.

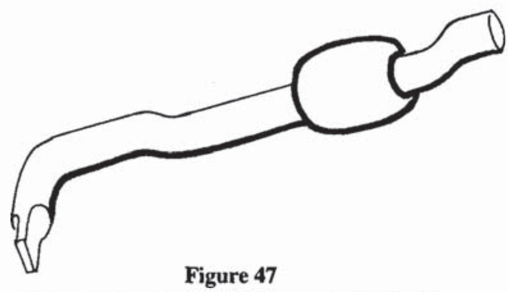


Figure 47
Wrench with captive weight secured by bends.

Once assembled, this wrench must be adjusted to your own unique fist. This is done slowly at first. Attempt a few openings on locks at the shop or ones you are already familiar with at your established accounts. I have a friend who works mostly downtown in the garment district, and he knows the pin order, feel and quirks of a lock on the security gate of the money vault of an established account. Whenever he is called there for a lost key box service, he picks the lock on the grill to gain access. He could easily ask for the key, but he gains practice and uses it to try out new tools. Most importantly, it enhances his reputation at the bank immensely by the off-handed way he says, "Don't bother hunting up the key. I'll just open this lock right up!"

Anyway, to develop your fist measurement, start by opening with the plug wrench as is. If it feels too stiff, take a light grinding cut off the outside edge of the shank and restone it down to remove the burrs. Continue this process until you feel you may have gone too far. At that point you can either unrivet the shank and replace with a new shank pre-cut to the last width you liked, or keep the wrench shank as is and recut the nose for a different keyway.

Once you have established some sense of where your fist is and what tool produces that feel, you can make as wide a variety of plug wrenches with different nose sizes as you need, and pre-cut them to your personal taste.

The subject of weighted tension wrench handles is last to be looked at. The weight is most frequently a lead fishing sinker with the wire eye removed and the core hole redrilled to a little over the drill-rod diameter. The weight may be fixed at one spot on the wrench handle or moveable within a region. There are lock pick technicians who swear by a weighted wrench, and others who leave them strictly alone. It is just another example of tools having to give way to technique. If it helps you, good; if not, don't force liking it.

Those who use a weighted wrench say it offers more sensitive feel on a rigid shank wrench, a sensitivity they don't get with a slimmer, more springy wrench shank. This is again an individual thing. But weight is definitely good in one respect for applying perfectly consistent tension on a lock. Two situations that cause no end of trouble are the non-automotive sidebar locks and brand spanking new high-tolerance, pin-tumbler locks. The sidebar wants the least tension possible, and the new lock needs it unvarying. To attack a sidebar, try a weight that only just causes a tumbler to hang at the shear, and increase it just a touch (this is a sliding type). The advantage here is that you can do it in the field. Even better, if the wrench is calibrated you can note the level and use it again on that same or similar locks.

To weight a drill rod wrench, bend and flat grind onto one end only, and leave the shank straight. After marking the rod, drilling the sinker and threading it on, the little torch can be used to run quick bends in the rod effectively trapping the sinker on. A bend pair can be spaced in different ways and on different parts of the shank to suit the maker. See Figure 47 for details.

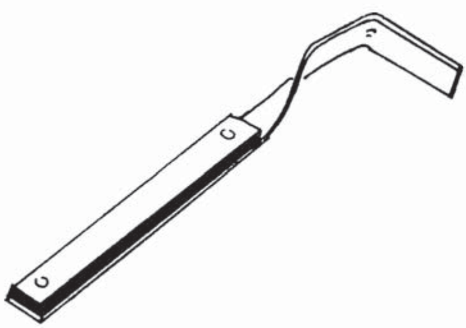


Figure 48
Added handle material to weight flat-style wrench.

For a friction fit with no bends, just swedge the ends of the weight down with a hammer and pin-punch. The sliding weight may be matched to a much-longer-than-usual wrench, if you can verify the wrench won't butt into any adjoining door jamb. But, if this is found to be the case, some judicious bending may save the day. Put the shank end at, say, 1:30 o'clock instead of 3:00 o'clock. For long slides, a series of small nicks should be marked off with layout dye and dividers set by rule, and successively filed in the BOTTOM of the shank with a three-corner file. This allows reference to be made.

If you want to do some research into which weight might be better for a certain lock (probably those sidebars again), the notches can be filed on the TOP of the shank and different-weight sinkers with wire loops attached can be rested in those notches for graduation of turning force. If you get a weight combo you really like, take the torch and bend an eye at that "sweet" spot, effectively trapping the weight there. This allows you to use the wrench for both left and right openings.

Even if you do not like weighted wrenches, you should consider carrying a single weight with a large wire loop still attached. If you have to move around, loosen a cramped-up shoulder, or even leave the lock for a few minutes altogether, the weight slung on the wrench will keep tension on the core and keep your two pins picked without having to start all over.

As to weighting a flat-style, loose nose tension wrench, the only practical approach seems to be riveting on a $^{1}/_{16}''$–$^{1}/_{8}''$ piece of flat stock as in Figure 48. Any other approach may likely unbalance the wrench's center of gravity and make it hard to maintain a good camming fit in the keyway.

One bonus to the use of a weighted tension wrench is that you can leave it hanging in the door instead of leaving yourself hanging in case things get hot. You know the problem — you get tired, the hand slips, you hear the night watchman, you have to go... and you have four out of five pins gimmicked; what frustration to have to "zipper" that lock and start over!

Previous books and such talk about weights and thumbtacks with rubber bands, but there is a better way. Another related problem is the extremely narrow keyway that only a severely cut-down wrench will work in. To counter this you can try tweezers or straddle wrenches, but many slip out at times, usually the worst of times. There is a better way.

Get thee to the local bearing shop. Ball/roller/needle bearing suppliers are in the yellows. Electric-motor repair shops junk noisy but perfectly good bearings. The local auto graveyard also is good if you are a mechanic of sorts. The target is a small, thin assembly, unshielded, about 2" outside diameter and as large as possible inside (shaft) diameter. Figure 49 shows you the idea. The two posts or teeth are small Allen wrenches set into drilled holes in the inner race. It is usually necessary to soften (anneal) this very hard alloy steel. The retaining screws are set into holes drilled perpendicular to the Allen wrench holes. The second set of holes is tapped for a 4/40 screw. This allows the teeth to be set in many different attitudes, and other teeth to be inserted as well for varying lock styles and keyways. The third hole (outer race) accommodates the tension spring. The fourth and fifth holes are just through holes to fit the nails and such that will affix the tension ring to the door in question.

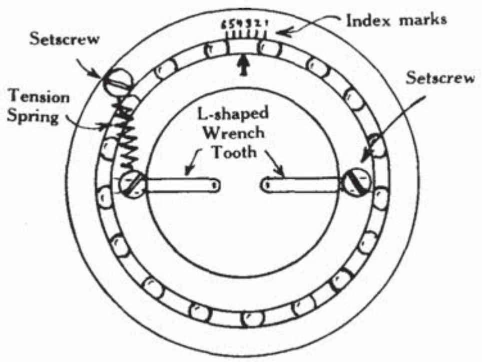


Figure 49
Ball-bearing tension wrench.

Ever wonder what good those burglar etching tools were? Well, get one (actually use your carbide-layout scriber) and engrave a scale of 1-7 or whatever on the outer race and a register mark (called a witness) on the inner race. This is done after the tool is completed.

I carry several types of tooth and tooth tips that have been useful over the years, and a blank set left soft to file on the job for new locks. Each set of tips must be bent to mostly the same contour, so use the Allen wrench as supplied, or modify it by torch-bending and match the teeth side-by-side for corrections. In fact, try to bend both tips as one unit using pliers or toolmaker's clamp.

By contrast, the different tips on the teeth are almost never the same in contour. Most keyways are different in bottom and top contours, and the tips must be a jam fit. Remember to allow maximum clearance for the pick, which is the whole idea. Ideally, you should position the teeth so the center of rotation of the plug is also the center of rotation of the wrench. If one tooth is very long and one is very short AND the tips fit real tight, there will be trouble as the plug turns (isn't that a soap?).

The engraved scale is used, of course, to track what tensions are good for what types of locks and what types of picks. Track the numbers by lock type and try to tell if the lock was lubricated lately. This will throw off the numbers a lot. Coil springs must be occasionally changed to match the type of lock as well. Hobby shops carry some, and coils may be clipped off to make the spring tighter. If you have two springs and don't know which is looser, hook them together and pull. The looser one springs out first and farther. Stretching the spring will make it respond differently over a wider pull area.

To make the scale show up in low light, try pick-nail polish rubbed in and wiped when dry. A gun sight ramp can be so treated to help you pick it up faster in low-light conditions, too. This idea even extends to any of your blued picks. Touch coding for night use was covered in Chapter Ten; here we are talking about a white dot or series of stripes to find the tool if you drop it in the black grass.

Aha, you are saying, how does this whole thing attach to the door? Well, a couple of grinder-sharpened light nails with large heads will go through the two holes in the outer race nicely if the door is made of wood. For a steel door, make a corral or fence around the bearing with a few magnets, or epoxy a magnet right to the ring. For some other doors neither dodge works well. Some decorator doors have irregular trim or plates. To get the ring to stick here a sub mount is necessary. Drill a hole in a piece of ¼"-thick paneling exactly the size of the outer race, and insert same into said wood hole. Use epoxy to make the bond. The wood will now hold by friction if you keep it in place, or it may be nailed or even taped.

The larger well-to-do homes sport these difficult doors, and this reminds me of a strategy you should know.

Two things happen as a luxury home or subdivision is built. Number one, the spec sheet on hardware is specific on brand only. This is often an industry standard like Schlage or Yale. The actual type and model of lock is left to the builder and his spec sheet will be the cheapest that complies. I know one entire subdivision where the contractor put in

Schlage wafer-tumblers. The Schlage spec was met, but the security was delightfully low, low, low. Even die-cast pin-tumblers would have been better.

The second thing is related to the first. In any subdivision you can bet that all of the locksets initially will be the same type and model. Builders employ semi-skilled tradesmen to install locking hardware, and rarely keep track of key codes. This means one set of lock tools will be sized for the entire area. The only exception is the do-it-yourself nut who puts on high-security deadlocks, pry-resistant, electronics and so on. This is rare. The busy rising professional does not have time to do lock work, and this means the busy mechanic can more efficiently do his job. The younger in age the subdivision, the less likely alterations have taken place, or that locksets have corroded or jammed. A call to the builder will disclose the hardware jobber who supplied the locksets, and you may then get one "to match my front door, please."

This also holds true for garage and window locks. This is important to you because you remembered to attack the weakest link in the security chain, right? Finally, scope out subdivisions with large numbers of music/intercom systems installed during construction. Such houses may also have security systems made by the intercom supplier. Such packages are often done hand-in-hand, and even share some components. Builders who offer these are still using the same tradesmen to install, and they will follow a set, learned pattern. The sensors, panel locations, and wiring conventions will be very similar. Why should the guy change a good thing that works for him? If you can chart just one or two of these installations, you will have a better working knowledge for other locations. The locking systems will also be standard and the jobber easily located. If it turns out not to be a jack-of-all-trades-type jobber but someone who ONLY deals security, obviously you should proceed with more caution. You are relying, however, on the builder being unwilling to go to many different suppliers, and the least common denominator is what he usually chooses.

Chapter Twelve
Jeweler's Grinding Tools

The designs of lock-opening tools may occasionally call for a very narrow slot to be cut into the middle of the steel blank, like the tool in Figure 50. This figure shows a double-pronged tool to be used as a tension wrench on a wafer-tumbler lock with double-key bitting. This width of slot could be cut from the side using a corner of the grinding wheel and cleaning up with a file, but that's very time consuming. For an even *more* extreme tool problem, examine this next figure also. Figure 51 shows a double-bitted profile pick with an even narrower slot cut down the middle. The function of the slot is to impart a small amount of "give" or flex to both sides of the tool. Many locksmiths rely on this design because it works so well on the types of double-bitted, disc-tumbler lock in which each side of the bitting is coded independently of the other side. Such a lock cannot be raked by holding two tools loosely in one hand and using them together. To duplicate this tool is thus desirable, but what about that tiny slit? Very thin slit-cutting on the edge of the grinding wheel is not practical, so a different approach is required. It is also difficult to find a file cut to this narrow width, and remember that hardened steel can be only ground or filed, not cut with any jeweler's or similar saw. The answer is the jeweler's sprue or cut-off wheel.

The average locksmith will be unfamiliar with them, but people in the jeweler's trade routinely use these abrasive wheels composed of rubber with embedded abrasive grains, usually closely graded silicon carbide. "Brightboy" is a trade name. In addition to these soft wheels, there are a variety of other semi- to hard wheels like the "Mizzy" brands and others. All of these are in the ½″ to 1½″ diameter range, and they are designed to be mounted on a set of minuscule arbors that are chucked into flexible shaft handpiece machines. This tool is mounted in the handpiece or drill and is designed to sever the sprue or "flash" attached to a finished item of cast metal jewelry after its removal from the plaster mold. The small stub left on the piece by the wheel is artfully removed by filing. Jeweler's cutoff wheels are capable of cutting high-carbon steel, yet the cut-off wheels are $^{1}/_{32}$″ thick at the face. They are also used to execute jewelry designs in three dimensions by carving. The catch in using these wonderful abrasives is that they work best at 5,000 + r.p.m.'s, so a flexible shaft handpiece or handheld grinder is necessary for their efficient use. These shaft grinders are not cheap. You are welcome to try using the abrasives in a regular drill, but the results will be very disappointing. There are two respected names for those flexible shaft machines: "Vigor" and "Foredom." There are also air-driven die grinders but I found them either unsuitably heavy and uncontrollable for this delicate work, or light but ver-r-ry expensive.

The large price tag to purchase one of these highly specialized tools may not immediately be appealing to someone looking to execute only a dozen tools per month, but our Foredom has been in use over six years and it is highly useful in many other delicate locksmithing operations. It has the necessary flexibility and high r.p.m.'s to do a lot of jobs that are customarily done with other tools. We have used it for polishing key burrs, light rust removal, surface finishing, slot-machining in tight spots, and even precision hole-drilling in the #60-80 range. It is unexcelled for polishing brass padlock cases to conceal a set of newly plugged pin wells. I am confident that many locksmiths will find many more uses for such a tool in their shops also, so consider adding one to the bench.

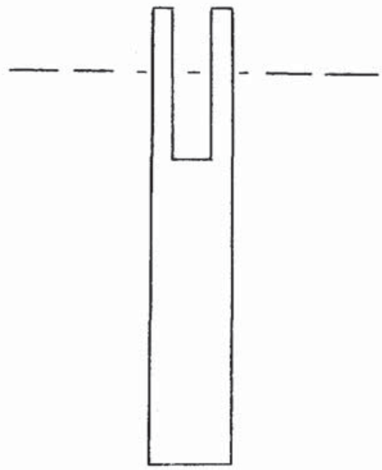


Figure 50
Bend site of slotted steel to make 2-pronged wrench.

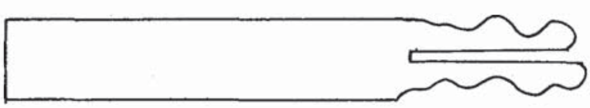


Figure 51
Slot to make pick bitting sides "flex" independently.

Another handpiece type tool is used for grinding. It is called the Cratex-type wheel. It is like a miniature grinding wheel, and its use is the technique of choice for rough grinding to very complex layout lines. Lock picks like the rocker and the snake pick executed in shim steel benefit from the use of a Cratex-type wheel. For this work the handpiece can be clamped to the bench top or held in a device designed for just such a purpose.

For all-around pick finishing, slotting and dimensioning there is no better tool than a Foredom and a set of Cratex or cutoff wheels. These abrasives allow almost infinite control over the small amount of material to be removed, so that blueprint standards of thousandths of an inch can be repeatably machined to. The grinding wheel will customarily rough out to within ten or twenty thousandths, and the Cratex will finish the job.

These soft rubber abrasives (Cratex) come in a wide variety of shapes, grits, and face widths. I prefer to stock and use a 1/8″ face straight wheel of 2″ diameter in fine grit, and a tapered edge, fine grit 5/8″ wheel for finishing into the tight corners of Diamond picks. You will need a ¼″ and 1/16″ mandrel or arbor to mount both of these wheels. They have an occasionally unfortunate tendency to catch on the hard wire edge left by the rough grinding wheel, and strip or spiral their little guts out. Given the very low price of the wheels, it isn't worth worrying about. There is not enough torque to catch and hurl a pick when this happens, but I usually have my picks clamped in a bench vise by their handles anyway. I do this so that I may quickly switch from finishing to mikeing and back again, almost a left-to-right-back-to-left-handed operation. You can also clamp the grinder handpiece in a vise or bench clamp and secure your micrometer in a padded jaw bench mount, switching the pick between the two. This works especially well if your mike has a spindle lock so it can be converted into a temporary go-no-go gauge. Most dial calipers also have a grub-screw slide lock, and may be better for this operation.

I have done some experimentation with executing the rough grinding outlines by cutting the steel from the side (the face) with a small cut-off wheel or a "Mizzy" wheel. This is to save time as compared to overgrinding away the edge. The results are so-so. It is certainly easier to clamp a pick into a grinding jig and edge grind as usual down to the finished form, since this can be done without holding the steel. It is also true that any pet projects or extra-special outlines you may wish to experiment with seem to be easier cut from the side. Try it once or twice and see what you think. It is possible to hold the pick down onto a large steel bench block using a couple of rare earth magnets while grinding from the side. It is also possible to use mist coolant on this arrangement as well. Remember that excessive heat will weaken or destroy the magnetism, so don't try this unless you cool also. Coolant seeping into the precision bearings of your Foredom handpiece will destroy it. To dry it out after such grinding, run it at full speed for ten minutes to get it hot and the water usually evaporates. All things considered, I prefer to rough-grind outlines on the bench wheel.

Note also that while fine-finishing to the layout line can be executed with a plain ol' finishing file, the motorized abrasive has two advantages: less chatter and fatigue on large jobs, and the ability to follow difficult and convoluted layouts, like snake or wiggly picks.

Now let's return to the first tool: the double-nosed plug wrench. The initial step in making this tool is making the 90-degree bend at one end. The steel may be clamped in a bench vise, toolmaker's clamp, or spring clamp to insulate the hand. A narrow band of steel is heated cherry red one inch from the end, and the bend quickly executed by grabbing the end with pliers and simultaneously bending and pulling, as if you wanted to stretch the steel on the long piece of steel. This pulling helps to make the bend's radius smaller by forming it more tightly along the clamp edge. If you can very quickly heat a very narrow band of steel to cherry, then the bend can be done by bopping the short end down on a workbench top, but this is hard to do. As the heat conducts away from the bend site it also softens the steel, and the result is a bend with a wider radius. The bend can be adjusted for angle by slightly reheating and nudging either way with the pliers' nose or jaws, and then the bend is heated cherry once more and plunged into an oil bath to leave it in the hardened state. It would be necessary to cherry-heat the entire tool to get it all hard uniformly again, but the only critical area of strength will be the tip and the bend, so it is easy to harden and temper these, and leave an area or band of soft steel down into the handle. The outside radius of the bend is immediately polished with emery cloth or felt buff to remove the scale, and the bend then gradually and fleetingly reheated until that shiny spot turns straw or peacock blue in color. When that color emerges it has been tempered. Now comes the part where a Cratex or flexible grinding wheel is vital: cutting a slot down the middle. The slot could be cut prior to bending, but the tines will align better this way, and the bend produces some rigidity to the piece which will make it easier to cut. The slot could also be cut when the steel is still annealed, but the grinding is not much different on hardened steel, and the hardening process applied to both prongs simultaneously would risk warping them out of their alignment. The slot you will cut allows working clearance for the pick manipulating the wafer or disc tumblers, and the degree to which you cut internally will define the approximate width of the tines to be inserted into the keyway. The final tine filing to fit occurs on the outside edges. A file would take a long time to cut such a wide and long slot, but the rubberized abrasive wheel makes short work of it.

Chapter Thirteen
Leather Cases

The choice of what type of case to carry your lock picks in should be based on one question: Will the picks be carried in a pocket or carried anywhere else? In a pocket means anywhere on or very near your person or clothing, and anywhere else means inside tool boxes, drawers, car glove compartments, etc. The downfall of a body- or person-carry is pick corrosion, and I will explain this.

The lock picks and related tools you can create after mastering the skills outlined in this manual will come only at a considerable investment in bench time and craftsmanship. They really should be well-protected, from the bending and possible breakage that may occur when you carry those tools on a daily basis. If well-protected, your personal lock picks will last your working lifetime. High-carbon steel should also be insulated from the high humidity that carrying them on your person will expose them to, or they will rust and pit. Just as an off-duty officer will carry his gun in a leather holster, the locksmith should consider nothing less than a top-quality, leather pick wallet as the home for personal precision tools.

Before covering personal cases, then, let's discuss the tool box and so on case. How would you like the ultimate high-tech pick cases; zippered all around for no tool fallout, padded sides, classy vinyl? Sounds good? Just take a drive down to the local Bible/Sunday School gift store and you will find Bible cases that easily will convert to pick-carrying cases. Take a pick or two (longer lengths) to test and you may find that certain brands will exactly fit two "racks" of picks placed side by side. While you are there pick up a generous assortment of tracts and pamphlets to bolster your "cover." Maybe even add a lapel button or pin; a neck chain is too obvious.

If you want to add a third leaf to the Bible case, or just need to reconfigure it, you must add to it with compatible material. The vinyl/foam dinner placemats with those cute pictures of duckies and horsies on them that are available everywhere will provide excellent material. The plastic is semi-rigid and easily cut, yet has a tough vinyl outer skin. When adding a leaf, sew it on with heavy carpet thread. Try to keep the duckies and horsies pictures imprinted on the placemat on the inside of the pick case. It pays to maintain a professional image, after all. Individual pick pockets may be outlined by sewing, or SOME types of glues will also work. Test to make sure the glue you choose will stand up to moderately heavy use without unsticking. If you have trouble with this, the vinyl can be cut: two slits both just $^1/_8''$ longer than the pick handle width, and spaced anywhere from ½″ to 3″ apart will make nifty loops for the picks to be bayonetted into. If your handle is coded you can make one a smaller slit for the pick tip and insert away from the open face of the case, avoiding the dreaded protruding pick-tip puncturing your anatomy. The tip then will not show, so coded handles alone will tell which is which.

The classic zippered case that you get with standard pick sets will be familiar to any working locksmith. They come in four flavors, up to one with two fold-out "wing" flaps. While this zipper design is good for keeping picks from straying, it can make it uncomfortable to carry, and a case that is bulky often gets left behind. A case of tools has not yet been invented that will get up, walk out the door and down to where you are waiting to use it. Nothing is more frustrating than to have built up solid lock picking skills and hand-crafted beautiful tools, and have them home in a drawer when you REALLY NEED to pop a lock.

After scouring numerous retail offerings of wallets, card cases, and small clutch purses for days, I came to the conclusion that the best way to get a case of the proper dimensions is either to make one for yourself, or find a leather craftsman who will sew one up. If you go the latter route it will materially reduce your craftsman's bill if you can provide a set of cutting templates made of frosted mylar material. Before I outline the procedure of template making, I will say that a standard credit card long wallet can be customized by adding a few pockets and slits here and there to make a passable substitute. You can choose this easy way out or get one sewn to specification, but at least read this chapter.

The outside dimensions of the case are easily worked out. Measure out a convenient pocket size for width; about 3½″ to 4″ is good. For length, remember that a foldover when open will be double the average pick or tension wrench length, both of which are 4–6″, plus ¼″. Since I prefer the longest tool I can comfortably carry, my case is sewn accordingly. Let me emphasize comfort. It is easy to make a case to carry lots and lots of tools and wrenches for locks you probably will only encounter once or twice in a year. To be sure of your dimensions, you can lay your picks out in any convenient order on the actual leather. If you are unsure of the process, the initial pick layout can be on heavy paper, cardboard or soft vinyl. A dining-table placemat is an excellent quickie source for foam sandwich vinyl. Experiment with pick layout until you come up with one that is workable. Remember that the smaller wire-tension wrenches can ride two in a recess cut. Also remember to leave sufficient margin all around the edges where stitches will be placed when the leather case is assembled. The number of flaps to add, pockets and so on is variable, and Figure 52 will give you an idea of the possibilities.

Once the layout is finalized either outline the tools with a marker pen on the leather or other pattern, or spray a single pass of layout dye over the pick array, which will accurately mark their layout. A notation in marker ink will remind you of what tool went where. I find it's also a good idea to make a high-quality photocopy of the finished pattern before cutting it out.

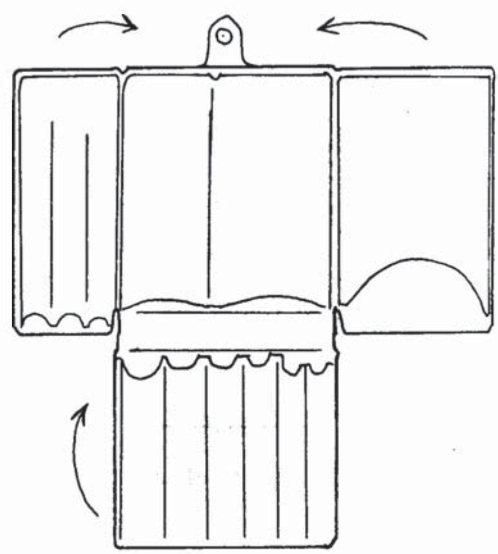


Figure 52
Case with foldable leafs.

If you have a paper pattern, cut with scissors and assemble with tape, then insert the tools and try to assess how well this layout works for you. If it's good, go on to the next step. If not, retry a new design.

Once the design is proved, cut it out and use it as a pattern to draw lines on the leather. You can move the pattern around to avoid rough spots, holes, rangemarks, and whatever. Now it's time to pick a leather to use for your case.

A leather craftsman's supply store should carry the following hides. Garment pigskin is easy to cut and sew, comes pre-dyed in a multitude of shades, and is inexpensive. It does have very little stiffness, and cases made from it will "flop" open just from the weight of four or five picks, but that is a matter of taste. The stiffness of pigskin can be increased by a combination process of dying with alcohol-based dye and then coating with a nitrocellulose lacquer. If you prefer to carry lots of different picks around, the thinner leather will keep total bulk down.

Morocco cowskin is much stiffer and so more difficult to sew and trace-cut. It comes only in a few colors, usually dark, and does not crease easily either, but it can be grooved to accept stitches. The trade-off is that this leather makes a case that holds its shape even without a pick inside. If you carry just a few picks, this is a good choice. Just try to thread a pick into a floppy pigskin case once and you will appreciate stiffness as a virtue.

Garment cowskin, sometimes called biker leather, combines qualities of the two other leathers. It is between the two in softness, creases well, sews easily with a glover's needle, and comes in a few colors. For my taste, it's the perfect choice for a cool CIA-type black bag.

If you carry picks with fairly thick handles, you may want a thick spacer. The spacer is cut from 8 oz. or thicker carving leather. It will stiffen ANY case, and its thickness gives an ample pocket for a big handled pick. A good combination is black garment outer case with a carving leather spacer.

Once you have decided on and purchased leather hides, the cutting process comes next. They sell a lot of specialty knives for the leather trade, some that will do intricate curves and bevels, but these are unneeded for most pick wallet designs. A razor blade is all you'll need for straight cutting leather on a board. If you want to lay out the pattern using fine-point pen on light leather or white art pencil on dark, a bandage or EMT emergency shear can be used to cut the leather in hand. Invest in a leather shear only if you have bucks to burn. After cutting out the pieces of the case, cut the spacer out as well.

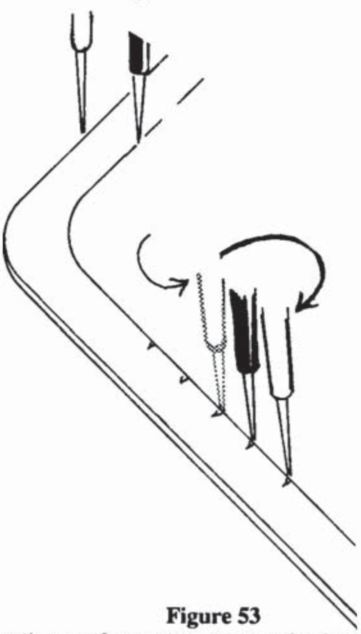


Figure 53
Compass points set for sewing seam set-back and stitch spacing.

Using the marker lines, cut away from the leather spacer where the tools will be housed. A couple of new, sharp Exacto knifes will do well here, as the leather is very tough. Once the pockets or slots (if any) for the accommodation of the tool handles have all been cut, the top and bottom sides of the case are applied with glue or just held in place with paper clips used as clamps, until all of the holes for the stitching can be punched or awled into the top leather piece. A compass set to the correct seam inset, and the desired hole spacing as well, is an invaluable tool here. As shown in Figure 53, the sharp point of the compass will scribe a parallel line, and the same compass, set to whatever stitch spacing, can be also "spider-walked" along that line to mark hole locations.

A stitching spacer wheel in seven stitches per inch is nice to have. After the leather is cut, instead of using the dividers you can run this wheel along the lines to be stitched, and it will produce a series of perfectly spaced prick marks to guide your sewing. This can be done freehand for both straight lines and curves if your pattern requires it. An eight- or nine-stitch per inch wheel gives an even more finished appearance, but is hard to locate. The ones produced for fabric sewing don't leave a clear enough impression. The drawback to using the wheel is that it produces many more stitches that have to be done, where the divider is set usually to fewer stitches per inch, like four or five. If you get the really fine wheel you can just stitch every other hole if you wish.

Traditionally, the holes are either tube-punched or pierced with a mallet-driven awl, but with thinner leather and the proper stitching-awl as well, the leather may be directly sewn. Direct sewing is a tremendous time saver.

Needles to sew leather are either smooth or triangular. The smooth ones are numerous in name. Tapestry, crewel, and sharps are just a few of the labels, and all of these require a lot of force to pierce even the thinnest leather. The triangular needles are called glover's needles, and are designed to sew leathers for gloves. The triangle shape creates edges that cut like an awl, so the needle penetrates easily. With a thimble and a glover's needle leather, up to 2-2.5 oz. weights may be easily sewn. They are well worth running down to purchase.

Don't confuse sewing needles with thonging or lacing needles, both of which are much larger and useless for this finer caliber leather work.

Leather stitchers use a very heavy linen-based, twisted thread. For this neater case work, a carpet thread singled or doubled is better. Buy it at a sewing outlet, and if in doubt take your needle along to verify it will fit the thread.

A cake of beeswax can be had at either a leather or sewing supplier, and is used to lubricate, stiffen, and strengthen the thread before sewing. If you purchased a jeweler's saw and frame you will need the beeswax to lubricate the saw, so buy two cakes. By the way, Uncle Sam (you) pays a subsidy to beeswax growers every year, so do your patriotic duty: buy more beeswax and sweep the Axis from the waves.

A thimble is essential, even with a smooth-pushing glover's needle. The amount of force required to sew is still formidable, and sore fingers are no fun when picking locks or drinking shots. Make sure the thimble fits your index finger loosely, but will stay on when inverted. Another option is the sewing palm, a leather or plastic appliance with a metal insert which is fitted to the heel of your right hand, with a strap attached around your wrist. The metal insert is used to push the needle's butt through the leather once it is inserted. If you use a #3 glover's, it will be long enough to sew comfortably with a palm; the smaller ones are too short to do this well. Leather finger stalls (tubes) may also be useful, IF the stall leather is heavy enough. Buy a very stiff cowhide leather stall, not a limp one.

If you prefer, small needle–nosed pliers can also be used to sew with. This will both grip and push the needle through the leather and pull the needle and thread out the other side. You will either love it, or be unable to feel comfortable with it. Most of those who sew leather by hand for profit say they prefer the pliers.

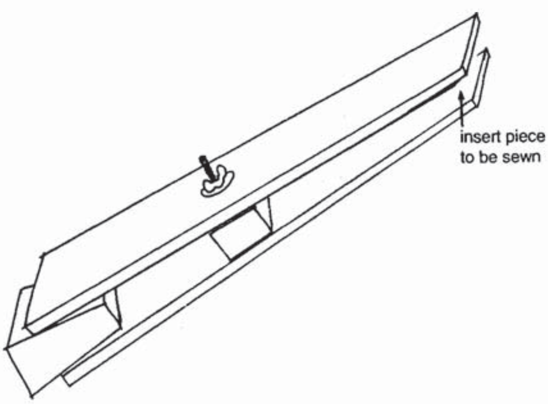


Figure 54
Leather workers' sewing "pony" to hold work while stitching.

A sewing pony is a clamp that holds the leather case so you don't have to. If you want to make one quickly, see Figure 54. The two boards are 1x4′ pine, the spacer is a block of 2x4′ and the bolt is anything with washers on the ends. The wedge that goes in the bottom pony mouth must be worked out until it fits correctly, but it is not difficult. The pony will make work easier if you do three or more cases.

The interior of the case where the pockets are cut should also be sewed, at least with a couple of tack stitches to prevent the case from becoming a large pocket with a piece of Swiss-cheesed leather that does not prevent the tools from mixing all together. To keep the pockets separated, sew their boundaries as well.

Chapter Fourteen
Pick Hilt Soldering

Pick handles are often altered by their owners from the as-supplied condition to something a little more comfortable or for heavier heft, or both. Enlarged or heavier handles are placed on the pick to give sufficient weight to counterbalance the pick comfortably for lifting. The counterbalancing is against the resistance of the tumblers being lifted. This weight must be considerable to balance against some tumblers.

The force of the tumbler springs is just a minor one compared to the resistance to tumbler lifting due to core and shell friction that the misalignment caused by the tension wrench creates.

Providing sufficient area for finger grips that can transmit feel and control in the directions most helpful to lock picking is another handle priority. While slab side or bent self-handles offer lots of possibilities, the best control is created by appliances affixed to the pick. These add-ons, such as finger rings, double handles, clips, or whatever, work so well because they extend well into the third dimension. Since they exert considerable leverage and have odd contours, they must be tightly secured to the lock pick handle, and the two best methods are silver-soldering and riveting. Riveting technique is covered in the chapter on handles, and here eddie discusses silver solder.

For a quick fix aimed more at better feel and not so much for weight, your first try will be to silver-solder a small piece of brass or nickel silver strip-stock to one or both sides of the pick handle. The brass may be crosswise similar to where a knife has its hilt or guard, or extend at any angle to the steel handle. Either type of brass add-on will be invaluable to you as a hand grip to control the movement of the pick in the lock, after having suffered with the plain old ¼"- to ½"-wide handle. The new process of silver solder is more accurately called silver brazing but nobody says brazing. Of the three hot join methods there is soft solder, hard solder or braze, and welding. The most notable thing about silver solder to remember is its very high melting/working temp. The melting temperature of the silver solder will vary according to which grade is chosen, and the chart below shows the five commonly available grades and their matching temps. There is a loose relationship between hardness of the solder and melting temperature, but the harder/hotter the working temperature, the more difficult it is to use for a beginner. The first few joints you make should be with so-called EZ or repair solder. If you can only go shopping for this at a hardware store, remember that silver solder is not to be confused with soft solder like the plumbers use on copper pipes. Soft solder has a lead base, and it will in no way adhere well to the shim steel. A jeweler's supply is the better place to get commercial silver solder. By the way, silver solder gets its name from its customary use by jewelers, to solder coin or sterling silver alloys. It actually will wet or merge with the molecular surface of the two pieces being joined, hence the superior joint strength it offers. It is one step below actual welding or fusion of the base metal.

Solder flow	degrees F
IT	1490
hard	1450
medium	1360
easy	1325
easy flow	1270
ready flow	1200

Silver solder made for the jeweler's trade comes in wire, piece, powder, and the kind we use: sheet form. Small pieces of this sheet are cut by making a series of parallel or fringing cuts into the sheet with snips, and then cutting crosswise to produce rectangles or squares. It is very important to label the type/temperature of solder when doing this. If two different temperatures of solder are used in the wrong sequence on one project, a previous colder solder joint may suddenly collapse when you are working on another area of the pick using a hotter solder. Put pre-cut pieces of solder in a pill bottle and label the bottle as to grade, and also label the uncut full sheet of solder with a felt tip pen.

Whichever solder temp. you choose and use, its melting point will be well above the soft annealing temperature range for the pick steel, so the steel pick must be protected by a heat sink, or large steel area between the joint and the critical handle-to-pick shank transition area, or both. The hilt handle will do the most good if placed closer to the front of the pick, so a heat sink is a necessary precaution. You can do the solder joint after the pick has been rough- or even-finish ground, but it is harder to hold and control the steel during rough grinding with a protruding hilt. On the other hand, there is more steel to absorb the heat and prevent problems if you solder before any grinding is done on the pick. That's assuming the handle does not project into the grinding wheel path, or hit any other obstructions.

Carbide-scribe the projected pick outline onto the steel, and then layout or measure where you want the guard to be and scribe its location as well. Do not use layout dye, as it will mask the joint. The mating surfaces of steel and brass or nickel and silver should be cleaned of oxide and grease by a light emery cloth buffing, followed by a swipe with a naphtha soaked rag. Unless the joint is perfectly clean, the solder will not flow well, and the joint may be flawed. After cleaning, apply flux to both surfaces and also to the small pieces of solder used in the joint. There are two types, paste and liquid flux mixtures, available. I prefer the solid borax and alcohol pastes because they retain their fluxing capacity a little longer than liquids. The common problem beginners have is in heating the joint overlong and losing the window of fluxing action. The resulting joint will be weak or non-binding. The paste form is more forgiving of this common problem. As you gain skill in the selection of flame size, the resultant heating time will become minimal. Jewelers call the small pieces of solder "paillons," and each paillon should be bent in a slightly twisted or "u" shape and placed on the pick body between. This will elevate the brass above the surface, and when the solder melts, it will let the brass slam down onto the pick for a firmer joint, which also lets you know when the solder has melted, since you cannot see it flow except at the very edge. It is possible to feed the solder in, as soft solderers are familiar with, but this is not as workmanlike as the paillon-placement method. Make sure the brass and the steel contact at all points on their faces. If the brass is bent away at all, the joint will not be very secure. The thickness of the solder film is less than .002″, and the solder will not bridge large gaps or flow well. This is why the surfaces must match so well.

Once the joint is prepared, flux both surfaces and the paillons, then insert the solder paillons and place the brass over them, aligning it with the scribed lines. Do not handle the paillons with bare fingers after fluxing, as that replaces grease the flux is supposed to remove. Use a pointed tool to place the paillons. Remember, the joint must also be heated quickly to prevent the flux from spending its chemical action before the solder melts. If this happens, the flux will not protect the metal and oxides will re-form, preventing solder flow. Also, the joint must not be overheated, or warping and even actual melting of the pick metal will result. A neutral or reducing flame is best for soldering. Now, I had a lot of trouble deciding which flame was neutral, reducing or oxidizing, until I read that the white-hot luminous cone you will see as you begin to add oxygen is the result of carbon particles that have insufficient air to burn. That made it clear to me. It is also stated that a tinge of yellowish blue indicates a neutral flame, best for all-around soldering. A common technique is to establish flame size with the fuel and just a touch of oxygen, then reduce the fuel until the flame begins to roar. This will be well past oxidizing into reducing, so back off the oxygen a touch and go to it. If you are insecure about your soldering technique you can use a twist of iron binding wire to help in the alignment of the parts. The preheat serves to activate the flux and equalize the heat content of both pieces being silver-soldered. Since the hilt/handle will have more mass than the pick handle, the torch flame must linger a lot longer on the hilt until it is heated to the same temp as the pick. The heat should be applied very slowly until the alcohol in the paste flux ignites and burns away. Sometimes small steam explosions from any small water content of the flux paste might even displace a free-standing paillon or the brass itself. If this happens, nudge both back into position with a soldering needle or tweezers. A soldering needle is a non-stick alloy needle set in a wooden handle. It can be used to press parts together, align objects in the flame field, and even help in drawing the line of melted silver solder down to the proper joint areas. Once the borax fuses into a glass, the heating can then be accelerated, applying the flame from the back-side, then the front-side of the pick until the brass moves as the solder melts. Do not continue to heat the joint once the solder flows. If you do, the zinc in the solder formulation will cook off and break down the strength of the join. The heat should linger for a fraction of a second only to ensure the joint, then divert the torch flame. Don't quench the handle, let it cool slowly at first.

While not impossible, it is very difficult to make a full length handle-to-pick silver solder joint with integrity, so start with just a hilt or short handle at first, and proceed as your technique improves. The larger the pick handle mass to be silver-soldered to a pick, the larger flame size needed, so gauge the heating time accurately as you work, and if it appears that the flame will take too long to heat a large handle, or may even have insufficient heat to bring the entire handle up to temperature or hold it there despite natural cool-down, then change to a larger tip size. It always pays to use the tip adequate for the job, but excessive flame splash is difficult to clean up from nickel silver, and over heat is hard to control. Over-cooked nickel silver may develop a SUB-surface fire stain that is very difficult to remove. If you have a design that is difficult to heat-sink adequately, or you generally have trouble with silver-soldering heat-annealing the pick, consider placing an intermediate piece of metal between the pick and the hilt. This intermediate piece can be silver-soldered as hot as needed, then quenched, drilled and cold-riveted directly to the pick itself, avoiding any problems. The intermediate piece may be fairly short or even longer than the original pick steel itself, but obviously it must have sufficient free surface for the riveting. It should also be of a thickness sufficient to withstand the torsional stress put on the hilt.

Make it a point to learn to silver-solder well, and your pick designs will have no practical limits.

Chapter Fifteen
Tempering Pick Steels

I've repeated often that it is MUCH better to maintain the factory-produced temper of the shim steel; that's why you always go to great lengths to wet-grind, heat-sink, and similarly prevent over-heating. Not that you can't temper; it's just much easier to avoid it unless you need or want to.

The time to learn the mysteries and way of hot steel is now. Having progressed this far, it now becomes useful to adjust the steel hardness to suit your designs. VERY experienced professionals may alter hardness to suit some specialized intended use of each of their tools, and the ability to do this dependably is a valuable technique in the locksmith's arsenal.

While the factory-supplied temper is still best for all-around pick designs, very hard tools have uses. These special-purpose tools, usually a very tiny cross-section tool that must then be harder than the average to resist bending, are prone to a short life, and ticklish to use. There is an equation for this. The harder the pick, the easier to break; the easier to break, the less lifting force that should be used; the less lifting force used, the smaller the wrench tension to be applied; the smaller the wrench tension, the harder to dope out which pin binds. The ultimate in tools demands the ultimate in technique. If you occasionally snap a brittle pick, don't be surprised. It is the true price of success.

Hardness can also be manipulated within a given tool, making some areas tough and others springy.

How is it possible to manipulate steel so that the same piece will be either hard and soft or both? It is actually quite easy to explain: the molecular makeup of steel can exist in several different phases just like water can be gaseous steam, liquid water or solid ice. Steel that has been heated to the critical cherry red heat at which the steel becomes non-magnetic and is then quenched or instantaneously cooled, undergoes a transformation that leaves the steel not only very hard, but also as brittle as glass. It is quite easy to test this. Heat a ½″ section of a length of music wire to cherry red and plunge it into ice water. Now exert some bending tension on that heated site and it should snap right off. Heat that same part but let it cool slowly, and it is soft.

The quicker the cool, the more complete the transformation and the more brittle the steel. Picks and other tools that have just been quenched preparatory to being tempered should therefore be handled with extreme care. Even a little innocently done experimental bending can snap them and right now. In fact, if the cool is too quick the steel may even snap of its own accord from internal stresses as different parts of the steel structure cool and contract at different rates. The internal stress is what causes the tendency to fracture, either at the quench or later as the steel is stressed or bent.

An old toolmaker's trick for hardening screw thread-cutting taps was to quench the red-hot tool in mercury, and in this state it was so hard the merest scratch was enough stress to turn the tap into shards. Motor oil, brine, diesel oil, water, wet sawdust, molten salt, hot sand; the kinds of quench baths are endless. The trick is to pick a bath that will not cool too fast and make unbearable stress, or too slow and not harden by causing the phase change.

The medium choice also depends very much on the cross-section or the amount of mass in the metal being quenched. A thick piece will take quicker cooling before developing stress because the mass of the metal slows down the cooling rate. A very thin lock pick is a real challenge to quench without causing too-rapid cooling rates. Remember that fast cooling may lead to spontaneous fracturing, and too slow cooling will not produce the tempering effect. For a thin lock pick you usually cool it too quickly, so a slow bath is better.

Now that you're learning to temper your steels, it's easy to fix a too-soft pick by reheating and requenching, but a stressed pick will break and it's back to the layout process. While on this subject, let me also say that even a short period between the cherry-red heat and the quench, like for a walk across the shop or to answer a question, may spoil the quench by lowering the critical temperature below where phase change occurs, thus producing inferior results. If steel is heated to critical, but allowed to cool slowly, it stays as soft as ever. Commercial furnaces for heat-treating (tempering) often have an actual trap door to allow rapid transition from the furnace to the cooling bath beneath. The locksmith can emulate this by keeping torch, quench bath and magnet all in a 4″ radius, and shoving the correctly heated tool into the bath with all the speed of a swooping investment banker.

Of the many different cooling mediums that are used, again dependent on the cross-section or mass of the steel being quenched, plain old motor oil seems to work well for picks. For a faster, surer quench try brine water, and just live with the occasional fractured tool. Some of the tempering will be on tension wrenches, as well as picks. For the occasional pick-shank work, stick to brine. Olive oil as used in cooking also will work in place of the motor oil.

Let's assume you have just bent a pick-clothing spring to its desired contour, and now you need to reharden and temper it. A handy set up for tempering on the workbench is a steel pan filled with pea stone size pieces of pumice or a bath of clean beach sand, a stacked-up niche of firebricks, or a non-asbestos-type soldering block. All of these will reflect torch heat back up to whatever tool is placed on them for heating, and a very even temperature results. A can filled with oil or brine is placed right next to the reflecting bed, and BETWEEN the torch operator and the bed. You will also need pliers to hold the clip, and a large magnet, something with a lot of weight.

Grab a cake of high quality soap and smear it all over the clip. This will protect the surface from excessive scale formation. The scale I am referring to is a surface oxidation that develops on the steel when it is heated. The steel will chemically unite with oxygen in the air, and the soap film retards this reaction. Light the torch and adjust it for a neutral flame, and hold the clip in the flame. As the clip becomes progressively hotter, test its attraction to the magnet. At the exact temperature when phase transformation takes place, the magnet will no longer react to the clip. Magnets do not attract steel when it is in that phase. This is called variously the critical heat and the point of decalesence. With a swift motion plunge the clip perpendicularly into the water and swirl it around a little under the water. Remove and lightly dry the clip, then carefully polish the underside of it to a brightness, using a piece torn from the roll of emery cloth. This bright spot will allow the oxidation colors to show clearly while tempering proceeds, which should be immediately after polishing. The sooner the temper is done, the more accurate the tempering will be.

Tempering is where you destroy most of the hardness you just put into your tool. A very brittle tool will snap at the slightest stressing, so you want it to be just a little bit less hard. You do that by slowly heating the tool. This is called tempering. You can gauge very accurately how the temperature is increasing by observing the colors that will bloom into the polished area of the steel. Each color indicates a level of heat, and it is usual to speak of metal being tempered (also called drawn) to a blue color or a light straw color. This tells how much of the hardness was left, and how much brittleness was removed.

Tempering is matching the brittle/soft ration of the tool to the job it's intended for. Screwdriver tips, for example, are tempered to a different color than steel cold-chisels or hacksaw blades. Experience will teach you how brittle you may leave your lock picks and still have them work dependably for your lock-opening technique.

With the same torch flame (neutral), very slowly and very evenly heat the clip until a straw color appears at the rivet end. You may frequently remove the flame from the clip to allow the heat to soak in and distribute evenly. Dip this end slightly in water now to arrest further tempering (further softening). Return the clip to the brick and reapply the flame, concentrating more on the curved area, and temper it to a blue color, then re-plunge in the water. This water quench does NOT reharden the steel, because it is not occurring from that different phase. It merely stops the heat from bleeding into areas where it is not wanted. It also halts the steel from proceeding to a softer state when the hardness required has been reached.

To recap, once the steel has been quench-hardened what this further heat-treating does is to begin to reverse the transformation back to the softer steel. The progress you allow along the road from dead brittle to dead soft determines the final degree of toughness of the steel.

Now that you have learned to temper on easy parts, you can try for the slightly tricky pick-shank procedure. Suppose you have a tool that has been heat-splashed in the critical shank region, and the dreaded bloom of blue has developed. A pick like this is unusable since it will easily bend in the region where the blue oxidation spectrum is, and must be re-hardened to be of any future use. Place the tool on the block and dim the shop lights. The subdued light allows you to gauge more accurately the energy of the glow from the heated steel. Bright room light will distort and alter the actual steel temperature colors.

Light the torch, and adjust to a neutral flame. Begin the preheat by moving the flame in a walking figure eight over the pick shank. The heat can build up excessively at the tip of the tool, much in the same way it does during a water grind, so cut the torch pattern shorter at that end. Experience will soon teach you what area will produce the desired results. After the preheat, which may take a minute or more, it's only 20–30 seconds until the steel develops the oxidation bloom. Continued heating will make the steel a dusky red, then blood red, then a color described as worm red. Testing with the magnet will show that the steel has lost its magnetic qualities where the heat is hottest at the shank. Be careful that the body of the pick, still cool enough to be magnetically attractive, does not prejudice this test. Once the critical heat has been reached, quench the pick shank perpendicularly down into the brine water. This angle of penetration ensures that no excessive warping develops, since the cooling occurs in concentric rings around the shank cross-section. If the shank breaks spontaneously, it was unavoidable. Oils are safer, but not as good. If the shank comes out intact, ver-r-ry carefully polish it with emery cloth as before and start the critical tempering process. I lay a pick flat on a rubber mat laid on the workbench to polish a brittle piece. The color to temper to is a light peacock, just barely visible as a color between violet-red and blue. Due to the extremely small cross section of the shank, the temper must be as slow as possible, since it heats up fast. I find a very small spritzer filled with water is an excellent tool to quench slightly a critical area. With this temperature control it is possible to "sculpt" the heating pattern very accurately and put the temper exactly where it is needed. Recall also that difficult heating problems may be overcome by the judicious use of a heat-sink clamp, or even touching an area desired to be cooled with a piece of steel.

Once the easier skills of pick crafting are mastered, try this demanding work of selective tempering. Some time, it may be the only technique that saves your day.

Chapter Sixteen
Lock Picks, Inc.

Eddie the wire has been all across this great land, and the lock pick seems to be close to the ultimate trade good. Everybody will show at least some interest in a set of lock pick tools, especially if they look professionally done, and not a few people are willing to spend a few dollars just to possess a set. That's reason one for having a few sets on hand to sell.

The professional lock-opener quickly finds out that having one set is just not enough. You'll need a good set for the service van, an equally good set for the shop, a starter set for your apprentice, a set to keep at home, and a set to carry with you at all times. John Bianci, the famous leather holster maker, publishes a great pair of photos in his book. The first shows him in suit and tie, absolutely normal appearing, but in the next photo his jacket is gone, pants legs up, and you can easily count over twenty guns scattered in various hideout holsters on his person.

Paradoxically, his point (called Bianci's Law) is "one gun, one carry." That means find the one combination of holster and pistol you are most suited to physically, and which most meets your needs, and learn to function with this gun and this carry. It is more efficient than changing off and never developing an instinctive "feel" for your armament.

The flip side of this is Wire's Law, which states, "you can never have too many lock picks stashed away." As I sit here writing this chapter, I have twelve tools in my wallet, my tool case, and my keychain combined. Should one break or get misplaced, I have a backup. This is reason too why you should have extra sets.

The title of this chapter, however, is Lock Picks, Inc. Always carry a simple set to sell to the average guy. You and I both know just buying the tools will not make him a lock ace overnight. In fact I hope whoever buys them will go right out and buy eddie's *Complete Guide to Lock Picking* and really learn the correct way to use the tools, but at least you can make some coin on the deal up front.

Let's get a repeat of some helpful hints here: *Possession of lock picking or other related burglary tools is a felony in many legal jurisdictions.* A case of intent can easily be built up unless you can cough up an ALOA or similar professional organization document really quickly. If you like to get attention by flashing lock picking tools in the local bar, you may get your wish. On the other hand, a one-to-one deal for a small set is worth about thirty or forty extra dollars in hand. The supply houses offer smaller sets of poorer quality steel for more money. Beating this is called enterprise. A sales formula that never fails is to demonstrate how easy it is to pop a low tolerance disc lock, and then get the potential buyer to try the same. Most anyone can rake open such a lock with a little help on the tension wrench. Once your mark has that first successful B&E under the belt, they are only too eager to buy a set of tools. In fact, you will find it's almost impossible to get someone to let go of the lock pick once they experience the almost inexpressible feeling of a lock magically opening without the key. Your customer will be shy about revealing his contact too, so you will have a loyal following.

Part of the mystique behind such a sale is indeed that admonition: "Don't tell anyone where you got these special lock picks." I can't begin to count the number of sets floating around that started on my workbench. By the way, if eddie takes a liking to you he usually gives you a set at no charge. Maybe he'll see you some where, some day. It could happen!

To be in the business in a big way, you must learn to work quickly and a little cheaply, and a set of helper tools called jigs will increase your pick per hour rate lots. Here's how.

Material selection is critical. Regular ½″ shim stock is of course best for the serious tool, but amateurs could get by with the steel used in the do-it-yourself sewer snakes found at Wal-Mart and similar emporiums. This steel is only ¼″ wide and, of course, comes on a reel. It is also blued to begin with. The first step is cutting off lengths.

Figure 55 shows the jig used for length cutting from the reel. Blanks should be 5-6″. Push the steel in until it bottoms, then hold the clamp arm down and begin to cut on the wheel edge. When the cut is a little more than halfway through in thickness, a quick jerk of the bending arm will snap it off. Experience will soon tell you when. Since you're wearing gloves it is easy to pluck out the cut piece and throw it in a tub of water. Always wear the usual eye and ear protection for such marathon work.

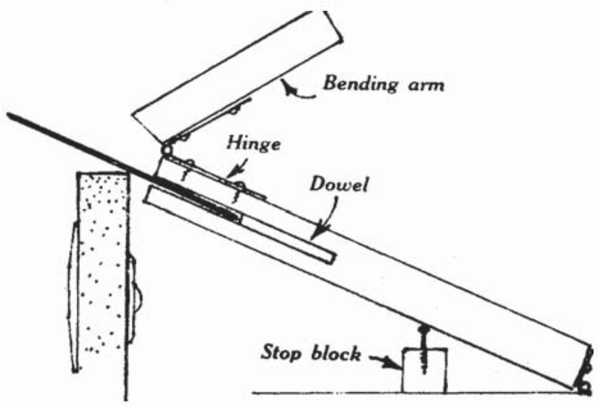


Figure 55
Mass production of wrenches.

All the pieces will have two rough-ground ends, so it won't matter which end you pick to grind the relief cut and rough tool contour on. A master pick and a scribe will make short work of generating the cut lines. If you are pack-grinding freehand, only the top pick need be marked at all. To spray all the blanks, lay them out like floor tiles on the bench, or rely on the stock blue to make layout lines appear. The object here is to save time and money.

It used to be that special gang jigs with several grinding wheels mounted side-by-side were necessary to eliminate the enormous amount of time to rough grind, and the heat build-up was so intense that cooling was a real chore. With the advent of the mist coolant system, however, pack-grinding (one marked pick on top and two or three blanks below) can now be done freehand and in record time. You can use a machinist's clamp or filament tape to bind the pack together at first, but as experience grows you will learn just to grip them tightly, and frequently slam the entire pack bottom edge down on a flat surface. This action throws all of the blanks in the pack down straight with each other if they have slipped out of line, and gives your hand time to relax.

Okay, if you are really good with the wheel the picks are rough ground to profile and need only a little polishing to sell. For production picks you must omit the nice steps of filing and/or stoning and polishing because of the hand work involved. The easy answer is to tumble the picks. Rock hounds are familiar with the rubber-lined canisters mounted on rollers motorized to turn at about 1 r.p.m. every 2-3 seconds. The barrels are usually filled with a mix of rocks and polishing media. Media can be anything from sand to corncobs and rouge to ceramic bits and pieces. Sometimes water, oil or other exotics are added as well. To use this system one merely charges the barrel, turns it on, and goes to several movies. In fact, polishing can take 2-3 days, but who cares? Eddie uses an industry media concoction called "stones and oil mod three." The oil is 20-weight motor oil, and the stones can be anything from pea gravel to sharp silica sand used by sandblasters. If you are frequenting a jewelers' supply it will have many types of media to choose from and a different type may suit you better. The key is never to tumble roughed-out picks dry, always use oil of some sort. Kerosene works, but it's a fire hazard and will swell the rubber in the barrel. Water will rust out the stock in no time. Motor oil is a good compromise. Scratching of the picks may result with this tumbling process, but it's easy and hands-off fun. Reloaders will also be familiar with the vibratory bowl method, but eddie has never tried it, so he can't say if it works.

If you don't want to invest in a commercial barrel rig, an empty one-gallon paint can works just as well (by the way, only fill the barrel ½ to ⅔ full), and a rotating cradle can easily be devised. Figure 56 shows a cradle capable of processing four cans at once, each barrel containing a different grit size charge. This is real high production. To sieve out the tools once polished, try a kitchen colander and a plastic pail. A fry basket also works. If you transfer tools from one grit to the next, wash them in between with soapy water that is VERY hot to prevent rusting.

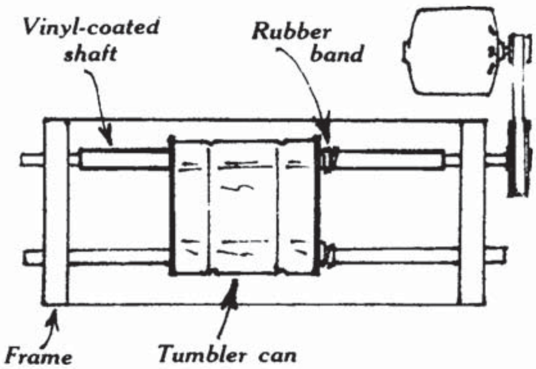


Figure 56
Polishing tumbler to finish pick steel.

This same tumble finishing works well with Formica handle blanks, which is the recommended handle material for production picks. The media here must be run dry, and be very fine to begin with. I use fine silica.

Lock pick cases present a problem, but I recommend a bank bag case with a Formica insert. The bank bags are vinyl with a coil zipper and usually available for a dollar or so from your bank. They are for big cash deposits, kind of like the establishment adult's version of the old plastic pencil case. Hilariously, although they weigh a few ounces and are 4x10 inches, they come with locks on the zippers. It is even possible to get them custom screened for a small set-up fee. Overruns are available inexpensively from the same bag companies, or right from the bank. Stress up front that you want them supplied empty, and are willing to pay for them. It saves embarrassment.

The lettering may come off with a soft scrub dipped in methylene chloride (real nasty stuff, take all precautions necessary), or it may not. The Formica insert holds the tools inserted in elastic cord loops laced through a pattern of holes in the Formica. The Formica blanks can be gang drilled for holes in large stacks.

For those of you making lock picks inside pen sets (a fountain pen with the insides gutted out and a tiny lock pick inserted), the epoxy resins are just the thing to set the pick into the pen top. These sell pretty well and eliminate finishing and... er... handling charges.

Figure 57
A professional lock tool set with a "wallet-type" carrying case.

Simple instruction sheets are a nice professional touch, and any high-powered copy shop will let you rent computer time to make laser copies of same. Consult a local users' group in your flavor of computer for lots of friendly advice about which software to get for writing and so on. If you can obtain access to a high-resolution flatbed scanner, you can keep a running file of all your pick designs. Just lay them all out on the scanner's glass and make the scan at the highest resolution possible. The resulting image may then be reprinted, altered in a variety of ways to make the edges more distinct, or the edges themselves may even be altered very precisely using a graphics program that is "zoomed-in" very tightly. At 1200 DPI, subtle changes in the contour of any lock pick are a snap. Once the pick is altered, a laser printout can be saturated with rubber cement and applied directly to a steel blank for grinding. Eddie uses a Microtek scanner wired to a Macintosh Quadra 610 with Photoshop and Canvas for software. All images are bit-mapped. Once the picks have been digitized they can also be filed and cross filed in a simple flat-file database and sorted out by category, tip height, any criteria you desire. The actual high (and high-meg) file need not be filed, just a low-resolution stand-in for bookmark purposes. Most of this is foreign to you, but a user group will explain it all. In eddie's neck of the woods, Kinko's copies has all the equipment, software and expertise needed on line.

As the Coneheads would say, "This technical discourse on subject matter of mass quantities of lock manipulation devices is completed."

Chapter Seventeen
Wafer Tumbler Tools

Having progressed this far, you certainly know the main lock mechanism types: lever tumbler, plain warded, pin tumbler, disc tumbler, cylinder (ACE) tumbler, and sidebar tumbler. There are also a few oddball types like the Bell lock (1920s vintage), and one curiosity that is commonly seen, although not currently in production: the Schlage wafer tumbler lock system. Schlage had some specific design recommendations in mind when evolving the wafer tumbler; it had to be easily mass produced, yet long wearing. It had to be easily masterkeyed, while still providing enough of a security leap over the common disc tumbler, since it was slated to be used primarily for the residential duty exterior lockset market. They achieved this added security (so they thought) by using eight wafer positions in each lockset instead of the usual four or five per disc tumbler locks. This lock system is further unusual in that both keycuts and a lack of keycuts cooperate to align tumblers at the shear line. The key is two-sided and each side is independent in its bitting of the other side. Furthermore, there are only two depths of cut: either cut .060″ deep or not cut at all. Such systems exist in some European locks as well. All of the eight tumbler positions can have combination tumblers inserted right side up or upside down so that tumblers have two possible orientations in the lock, to which the key bitting must match. We are not talking about two different tumblers per position. Only one fits, but it can be inserted either regular or flipped over.

We will not concentrate on the specific mechanics of the lock here. First of all, the tool you will use to open these locks requires no skill in manipulation, so it's not necessary to know precisely how it works. If you want more detailed knowledge, if you're curious about how this tool works, just pick up a lock of this type and play around with it. The operation is easily understood with the lock actually in hand.

There are three variations of keyway profile, but one is a master-key type seldom seen. The two common keyways each require a tool that is fitted to them, and each of the keyways has an "A" or a "B" flavor that is really not keyway-related but due to an item called the master wafer. The master wafer is the furthest tumbler inside the lock, and at rest it protrudes out from the cylinder. It is pushed in to align at shear by the absence of a cut on the far end of the key. The master wafer may also be reversed or flipped in the lock, and the lack of cut will then have to be on the reverse side of the key, hence the "A" or "B" flavor of the lock. The side opposite this uncut portion of the key must, however, be cut to allow the key to be fully inserted in the lock. Carefully note that the key can only be inserted one way, and cannot be turned and inserted 180 degrees. This is due to the keyway warding (really, the keyway shape). Consequently, you cannot flip your tool over if the master wafer cut is on the wrong side. You will need two tools, an "A" and a "B," for each of the two keyway variations, or four tools in all.

The master wafer (the farthest from the keyway opening) is followed by a random selection of two other wafer types: series wafers and combination wafers. These fill up all the rest of the slots available. The series wafers function just like the master wafer; they require an uncut portion of key to push or retract them into the cylinder and align them at shear, but they cannot be flipped. The combination wafers are normally inside the cylinder, and any uncut portion of key will cause them to protrude and misalign with the shear line. Consequently, the combination wafers require key cuts to keep from being forced out of shear, and the series wafers require no cuts since a cut will unalign shear. When a lock is set up to a given keycode, the locksmith proceeds by putting a combination wafer into each of the fourteen position/orientation slots remaining which are designated in the coding system, and then filling the remainder of the slots with series wafers. All together there are eight slots with tumblers either inserted up or down, so there are 16 possibles. A combination tumbler may protrude from either side of the cylinder, a series only from one side. It sounds confusing, but I told you that no theory is really required to do these locks. The only real quirk of this lock is the combination wafer, which will lock if you touch or disturb it. Other than that, this is a lock that will unlock if you fully lift all the series and master wafers. It's really simple.

If you follow this discussion it is easy to see that the security of this locking system is zip except for the series wafers which keep the cylinder locked while at rest. All that is required to fox this lock is to identify mechanically which are the combination wafers and leave them alone, while raising all the series and master wafers to shear while exerting torque on the cylinder to create the usual "lip." When all the series and the correct master wafer are at shear the lock snaps open.

To bypass these locks easily, it is possible to cut a very special set of four keys that will do most of the work for you. This key set is produced by cutting down a regular key set from a wafer lock so you will need to have one each of the two KEYWAY types in hand.

After disassembling this lock down to the core, insert the matching key and observe the reaction of each tumbler as the bitting slides by it. Eventually all the tumblers will line up to shear. The object here is to identify whether your particular key is a type one or type two. If the hollowed-out side of the key is away from you and the extreme tip cut is on the bottom half of the key, it is a type one. If on top, it's a type two. Now align a keyblank onto your key (get a keyblank for this lock at any five-and-dime), and trace all the cut troughs on the blank. Connect these troughs (full cuts) on the side of the key with the tip cut out with a straight line that runs from key tip all the way through the bow. Even the bow will be cut flush to allow room for an additional tool. The troughs that are on the NON-cut tip side are also connected, but these are only cut as shown in Figure 58. The end result is a key that has no guts except at the tip. In other words, this key will retract only the master tumbler. Remember, the master comes in the far end position (deepest in the lock) only, and always protrudes into the lock case, locking the lock unless it is retracted by a non-cut on an inserted key. When you insert this key, then, it will retract the master and not advance or retract any other tumblers. This key must have a twin that will retract the master tumbler if it is inserted upside down, as it is designed to be. There are two tools, then: one for master up, and one for master inverted. There are two types of keyway, so those are your four key tools in all. Once produced, they should be riveted together in matching pairs in such an orientation that the probe will have unobstructed access to the flush-cut top of the key tool.

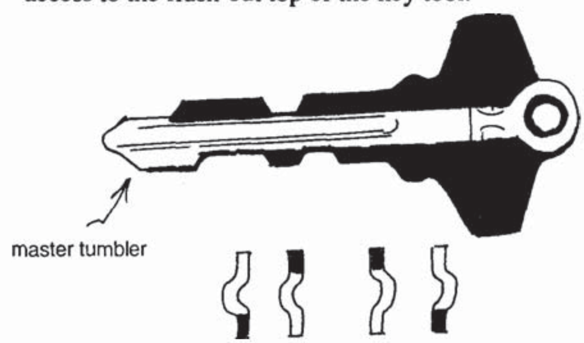


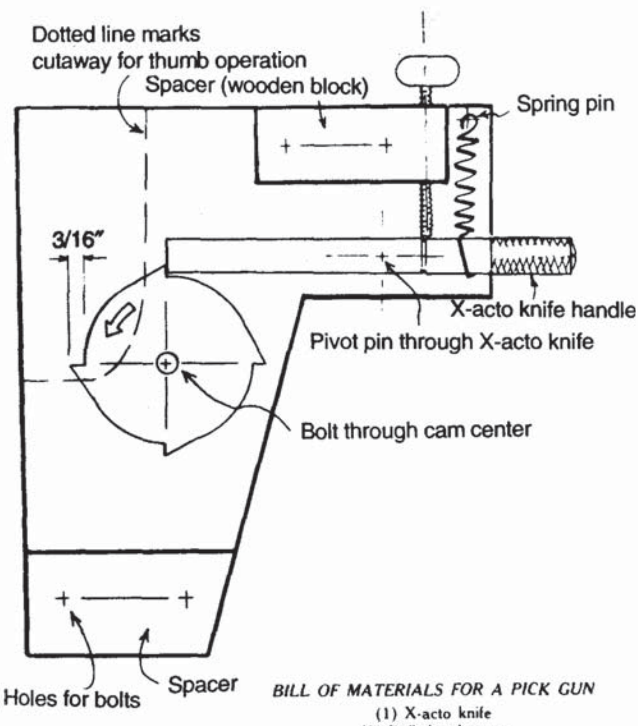
Figure 58
Shaded areas cut away to make master wafer pick-key.

Okay, you go to the lock, figure out which keyway it is, select the correct pair of key tools, select one and insert it. If you don't feel any contact with the master tumbler, it's the wrong tool, so insert the right one. The right one will retract the master. To complete the lock picking process, you must now retract all the series wafers to shear, and the lock will snap open. To manipulate the series wafers, insert the second tool, a slim handle-mounted probe, and use it to lift all the series wafers by pushing to the outside of the keyway (away from the keyway center). While holding all these wafers at shear, apply tension to the core using the handy fold-down other half of the key tool. After applying hard tension, withdraw the probe, and slightly relax turning tension on the core. The lock will snap.

The assumption is that a key tool is an automatic thing like a set of tryout keys. The truth is, the key tool is just a convenient way to make a tool, and some skill is still involved. It is possible to fail an opening using this system. A second try usually succeeds. With all tools, a little practice yields rich rewards. Since the Schlage is still very prevalent, it is worthwhile to make and carry a set of bypass tools as described.

Chapter Eighteen
Pick Guns

The mail order suppliers often tack on a 120% increase on prices of lock pick guns. The average guy doesn't have access to locksmith suppliers, so how do you get a pick gun? Figure 59 shows the side view of a manually operated model.



BILL OF MATERIALS FOR A PICK GUN

(1) X-acto knife
(1) 1½" thumbscrew
(1) Expansion spring
(7) ⅛" x 1" machine bolts with nuts & washers
(1) ¼" x 2" machine bolt with nut & 5 washers
(1) Plexiglass piece ¼" x 6" x 12"
(1) Wood block ¼" x 1⅞" x ¾"
(1) Music wire 1/16" diameter x 10"
(1) Tube Loctite

Figure 59
Pick gun side phantom view.

Cut the two side pieces by tracing onto a piece of Masonite, heavy sheet metal, or plastic — you need two pieces. You can also photocopy the figure twice, and glue the copies onto the stock. Make sure to center-punch for all holes to be drilled. Once you have two gun halves with holes drilled, purchase the rest of the materials listed, and drill the holes in the X-acto knife handle. If you have a "V" block, that will help in getting them perfectly aligned. The next step is to cut the cam, which can be made from ¼" thick Plexiglas or plywood or Masonite. I prefer the plastic. The needles that chuck into the knife can be cut from extra length blades that fit the knife — just grind the blade down to a straight tool like your feeler pick.

The next step is to begin assembly by threading a washer on the cam bolt, putting this assembly through one gun half, then a nut locked on with Loctite (a compound that permanently "freezes" threads in position). Now coat both cam and nut with contact cement and install the cam, then a washer, then the other gun half, then a washer and a nut with more Loctite. Into this assembly, install the X-acto knife, the blocks for the spring and stop mechanisms, the spring and stop screw, and finally the crank handle.

The crank handle is bent from the music wire and is inserted into a hole drilled through the end of the cam bolt, just like the holes drilled in the X-acto handle.

Notice that the thickness of the spring and stop blocks must be adjusted with the addition of washers and paper spacers to their holding bolts to ensure no warping strain is put on the gun. Once all the other bolts are installed and Loctited, regulation is next. (Note: Loctite and its releasing compound are available in most cycle supply shops. Because of the vibration of both cycles and lock pick guns, it is necessary for all bolts that may work loose.)

Regulation is accomplished by inserting a small strip of paper between the cam and knife handle where it bears on the cam. Turn the stop screw until the paper is just free. This ensures that the screw, not the cam face, takes all of the jar of the knife handle as it snaps up. This adjustment should be periodically repeated as the gun "settles."

Now adjust the spring to provide slight tension with the knife in the rest position (on the stop screw). You may want to vary the spring tension as you work the gun to provide different results. It all depends on your style and the lock in question. Generally, more tension is more controllable, though.

In use, the needle is clamped in the chuck, and then a moderate-weight tension wrench is inserted in the keyway. (See Chapter Eleven for weighted tension wrenches.) Then the needle is pushed in straight under all the pins, and the operator turns the crank with a steady speed. The cam alternately pushes and releases the knife, and the spring tension is transmitted via the knife and needle to the bottom pins, which in turn slam the top pins up. At some point, there is a gap between both sets of pins, and the tension weight turns the core, opening the lock. Varying cranking speed may help. Another possible variation is to turn the stop screw in even more, which will reduce the travel of the needle, but more travel is usually better. Heavy tension on the core is definitely to be avoided.

If you feel that you must have hand control of the tension wrench, your gun can be modified by cutting away the rear portion, exposing the outer perimeter of the cam for a least 120° sector of travel. Then you can use the holding hand thumb to actuate the cam surface with one hand free for the tension wrench. A real enthusiast could convert this gun to clockwork or electrical operation, allowing you to be elsewhere if necessary while the gun operates — but that is a little too much "James Bond" for me.

Chapter Nineteen
A Tool for Picking Tubular Locks

Eddie does it again! Lock tools to pick tubular locks are always expensive and hardly ever mentioned. Let's build one for five dollars.

First, are you up on elementary tubular lock theory? These locks are the kind with circular keyholes that show up on vending machines. Close examination shows that the pin tumbler principle is used, but the pins are placed end-forward in a circle. The outer portion is fixed, and holds the top pins in the bottom. The inner portion is movable, rotates around a center fastened to the outer portion (at the bottom), and holds the bottom pins whose ends you see in the keyway.

In operation, the tubular key is inserted to fit over the inner post (inner portion), and a lug protruding from the key fits into a slot cut in both inner and outer portions of the lock.

The key is then pressed in, and while the outer lug clears the slot, the inner one stays bearing on the groove cut for it in the movable portion. Simultaneously, different depth cuts on the edge of the key (corresponding to bitting on a regular key) push in the bottom pins to their respective shearlines. Once shear is reached, the inner portion can be turned, and it is the inner lug of the key riding on the slot that does the turning. If this is a little unclear, it is because I am trying to condense. Get a tubular lock and study it to be sure you understand this theory.

The most important thing to remember in all this is that unlike a pin tumbler lock where the bottom pins are trapped and perform no further function as the core is rotated, in the tubular lock the bottom pins must be held at shear line continually, or when the lock inner portion rotates over exactly one pin hole, the top pin will snap into the hole and relock the tubular lock. Therefore, even if you were to pick each pin stack individually and begin rotation of the core (inner portion), the entire set of pin stacks would relock as the next pin hole came up. Theoretically, you would need to repick each pin stack eight times to get one complete rotation. Furthermore, since many of the locks are in applications where nine or ten turns are needed to unscrew the locking mechanism fully, the individual pick artist can be in real trouble. That is why tubular lock picks are configured as shown in Figure 60.

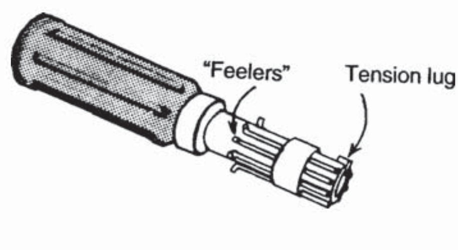


Figure 60
Commercially produced tubular lock pick, showing "feeler" picks.

In practice, the operator puts tension on the core via the lug protruding from the inner face of the tube. Once tension is applied, the operator begins to exert a wiggling downward push on the tool, and its eight fingers begin to push each pin end simultaneously, driving them all to the shear line. The amount of pressure each feeler exerts on the pin stacks is adjusted by adding or removing turns from the rubber band around the feelers and rod. It must be enough to counteract the opposite push of the pin springs, but not so much that it pushes the pins past shear. This pressure is the analog to lifting pressure with the regular lock pick.

To begin producing the pick, purchase a tubular lock — regular eight pin with center keyway (the most common) — to use as a gauge for buying brass tubing. You need one piece that snugly fits over the inner portion just like the key, and the next telescoping size smaller. You also need a length of music wire one-sixteenth inch in diameter and 36 inches long, and a 20 inch piece of brass tubing that the wire telescope fits into.

These materials with telescope fit can be purchased at hobby stores that sell to model airplane hobbyists. Begin by cutting a piece of the music wire, bending it double, and using epoxy or super-glue to attach it to the edge of the tube fitting over the lock's inner portion (called a nose). Make sure that the wire extends the full depth of the lock on the inside tube edge, and only half that outside.

This will be the lug that engages the groove to put tension on the nose. When the glue is dry, cut the tube exactly double the length that it bottoms in the lock. It should protrude the same amount outside of the lock as it goes in. Also cut the other, smaller tube to a four inch length. Cutting both tubes requires finesse and a fine-toothed hacksaw. Go slowly and try to avoid bending the tube. When finished, carefully de-burr the end and file square if you goofed and cut it on an angle. The tubes *must* be flat and square. Leave yourself a little over-length if necessary.

Now slip the two tubes together, insert this assembly into the lock, bottom both tubes, and mark the point where the larger tube and the smaller tube meet by scribing a line on the smaller tube. Remove the assembly, spread superglue or epoxy on the join and re-join the tubes, using the scribed line to position the two properly. Tape them together in this relationship and let dry.

Now comes the hard part. You need to cut eight lengths of the smallest brass tube, and eight lengths of the music wire that telescope into the tube. Each tube should be 1½ inches long. The music wire segments should be 2¼ inches long. Be very careful when cutting the tubing, as the wire must later slide freely inside it.

When the tubes and wires are all cut and deburred, insert the dry, glued tube assembly (large tubes) into the lock and run tape from the end of the tube to the sides of the lock, effectively pushing it into the lock. Now spread some very thick epoxy glue onto the first inch and a half of the large tube assembly above the lock face. Only apply the glue to the area where one of the small tubes will stick.

Now apply one of the tubes pointing exactly in line with the pin tumbler axis. If necessary, slide a piece of music wire inside the tube and down to the pin to precisely align the tube. Once it is roughly aligned, put tape around the assembly to hold the small tube in place. Let dry. Do this entire procedure for each of the other seven tubes, and be sure to align each one in turn precisely. If even one is canted and not parallel with the pin tumbler axis, excessive friction will result as the pick is operated.

Once all eight are mounted and dry, insert one of the music wire rods into the tube and see if it will clear the inside rim of the lock and contact the pin end. If it will, fine. If not (this may vary with different locks), grind a flat on each rod until they will all clear to contact the pin end and not touch the rim. The flat must extend up far enough on the rod to allow the rod to bottom the pin. Remember to touch up the grind a little with a file to prevent metal slivers from jamming the lock.

The final step is to insert all the rods into their respective tubes, and put a doubled and tripled rubber band around the whole assembly to hold the rods.

Chapter Twenty
The Plug Spinner

The next professional lock tool is something every pick expert should carry. Occasionally you will succeed in picking a lock only to find that you are on the locked side of turning, and if you reverse the turning towards unlocking, the pins will fall back into the holes, and you must start over. However, a plug spinner applies a sudden forceful rotation to the plug and, by applying a centrifugal force to the pins, bypasses the locked position and unlocks the plug.

You need the following materials:

One piece ¼″ diameter music wire *(for shank)*
One piece .030″ diameter music wire, 18 inches long *(for spring)*
One piece of tubing that slips over the above music wire (the fit should be precise)
One flat stock, brass or aluminum, 1½″ x 10 inches x one-thirty-second inch (these dimensions are approximate)
One machine screw ¼″ x ¾″, with two washers and a nut
One flat stock 1½″ x 4 inches x one-thirty-second inch

Start by grinding two parallel flats 1″ long on one end of the ten inch piece of ¼″ o.d. music wire. This is the same cut that you make for tension wrenches. Cut until a thin blade is formed that will fit in a keyway. Now drill a one-sixteenth inch diameter hole in the middle of the blade as shown in Figure 61. Finally, bend one inch of the other end into a right angle and then another one inch section back again, forming a crank. A vise and hammer may be necessary for the bending. That wire is tough! Next cut a piece of tubing as long as the flat stock is wide, and set it aside. The next step is to form the flat stock around the music wire. Try to follow the curve of the wire as much as possible — a pair of pliers may help to do this. After the stock has been formed, remove the wire, thread the tubing section onto the end and form the flat stock over the tubing/wire combination. Now place one of the washers on the flat stock so that the top edge just touches where the stock starts to curve. Hold the washer in this position, and mark the center for drilling a hole. Now remove the washer and drill the hole, then put a washer on the bolt, and finally the nut. Tighten this assembly, but check for rotation of the music wire. Do not crush the tube.

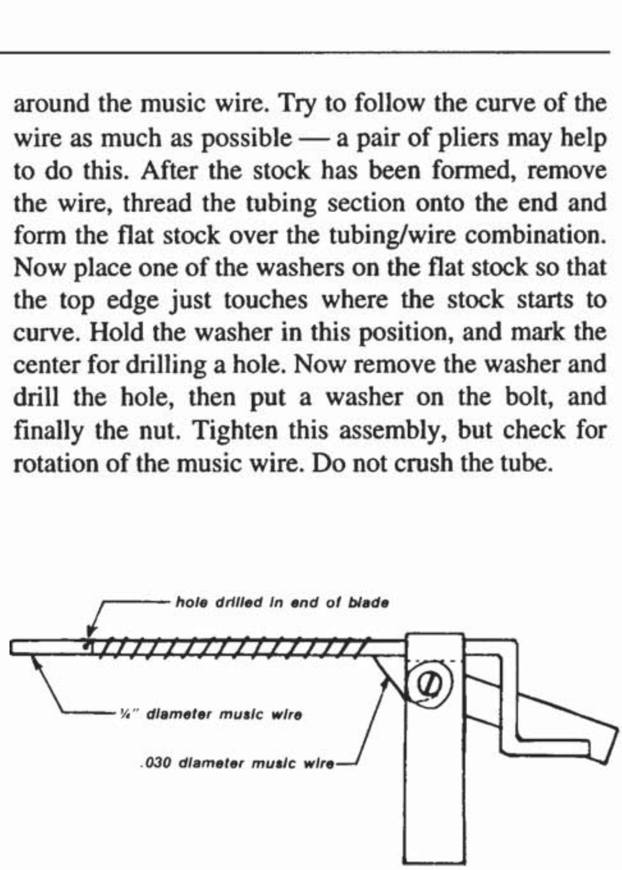


Figure 61
Shop-built plug spinner.

The next step is to insert one end of the .030″ music wire in the hole drilled in the ¼″ music wire, and bend it back around the .030″ wire, locking the end. Now use your fingers to guide the wire about the ¼″ shaft, while you turn the crank end. You are in effect winding a spiral spring up to the flat stock handle. Leave about two inches of wire and wrap a loop or two around the machine bolt under the washer on the head side on the handle to anchor the other end. Finally drill a hole in the 1½" x 4" x one-thirty-second inch stock piece and put it on under the washer on the nut side to act as a trigger.

To use, first wind the crank in the opposite direction of what you want the plug to turn. When tight enough, lift up the trigger to block the crank from turning, then insert the blade in the keyway of the wrong-picked plug. Hold the tool by the handle and, watching your fingers, release the trigger. Presto! If you have trouble, try winding the spring tighter. You may also find that two tools, a lefthand and a righthand wound spring, will allow you to tighten the spring rather than winding the spring in some cases. An unwound spring does not spin as forcefully.

Chapter Twenty One
Car Opening Tools

Next, we will discuss car-opening tools. First, let me say that all of the professional lock tool/key outline tracing techniques are applicable to tools that will work non-GM locks. GM locks can only be opened by a snake pick capable of literally lining up all the tumblers simultaneously. Once the shutter over the keyway is bypassed, picking can proceed as usual. It may be useful to secure a couple of junk auto locks and grind off the front of the lock, exposing the keyway to allow for easy tool sizing. However, there is a tool that bypasses door locks only. Grind the tool shown in Figure 62 from one-sixteenth inch tempered or spring steel stock. Possible sources are hardware store stock bins, elevator bands, discarded large bandsaw blades, or metal house wind bracing. Please note: this tool is inserted between the outside weather stripping and the glass, directly above the door lock.

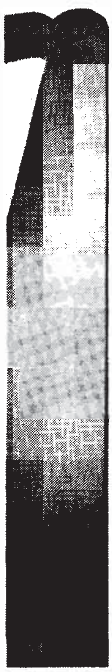


Figure 62
Good old slim jim

It works by hooking some of the locking mechanism inside the door, either by pulling up or pushing down. Also remember occasionally to try to open the door to see if it has been unlocked yet. This tool works on all cars, all years, except those which have metal boxes protecting the locking mechanism.

The Slim Jim

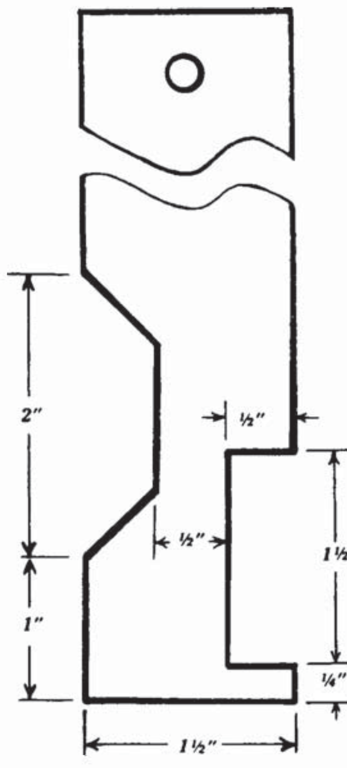


Figure 63
Slim Jim end detail.

The next subject to cover is the slim jim. Instructions (brief) on manufacture and use of a slim-jim were given in the first edition of *How To Make Your Own Professional Lock Tools, Volume Two* but a new and better model is currently in use. In fact, a recent publication lists six versions of this tool, plus a Corvette-opening tool. My tool is cut from an aluminum shop ruler, available at most hardware stores. The ruler I use is three feet long and one and one half inches wide. Cut a twenty-three inch long piece with a hacksaw, and grind the end as shown in Figure 63.

The measurements are given so that you can spray with toolmaker's ink and scribe the pattern on the ruler directly. With the right lighting, you can even omit the toolmaker's ink. These rulers are all tempered aluminum, so watch for heat build-up as usual, and quench frequently. If your first stop is an art store, look for a flexible tempered steel ruler in a length that is close to twenty three inches, and use it instead.

Now that the end has been cut to profile, the thickness of the working end must be specially sharpened to avoid catching on the weather stripping on all car windows.

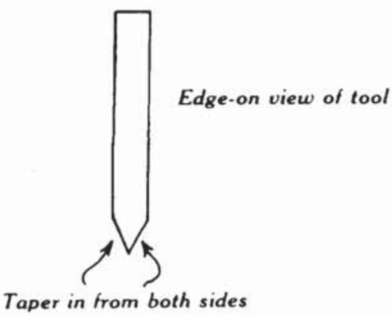


Figure 64
Edge-on view of slim jim.

Figure 64 shows the profile for sharpening. It allows two-way tool insertion and no hang-ups. A hole should also be drilled in the handle end of the tool, one-eighth inch in diameter and located a quarter of an inch from the edge. Finally, get a large heavy rubber band and double it around the shank of the tool. Working the tool is fairly simple. Simply insert the working end between the weather stripping and the glass at the driver's or passenger's side, straight down from where the lock cylinder is. Disregard where the inside button is. The object is to hook either the camming mechanism or linkage that is attached to the back of the lock cylinder, or hook the rocker shaped latch assembly located at the back edge of the door. Once hooked, a simple pull, or alternately, a push down, will unlock the door.

There are finer points, though. One is to lubricate the weather stripping with a spray silicone or hand cream for easier insertion. Some cars, notably Fords, have two layers of stripping — in this case, go through the middle. A fifteen to twenty five degree bend in the tool end may be very helpful in contacting the lock mechanism — once you get it right, keep it bent. Occasionally, while working the tool, the door unlocks but does not open, so try the button on the handle once or twice while working, and watch the inside button.

Another point is that smaller cars, especially of foreign manufacture, will have bolts that obstruct the straight down maneuver, but an angling movement will avoid these. Some cars even open with a sideways push on the tool shank.

Now to the rubber band. Before insertion in the door, hold the tool with the hook on the cylinder and slide the rubber band until it is level with the top of the door. This will provide an accurate measure of how far down to insert the tool. In fact, if the inch markings are intact on the ruler, you can go by those and save the extra time involved in rubber banding. After all, time is of the essence while opening.

I strongly advise that you keep records of each attempted opening so that you can duplicate it next time. Some people keep a notebook listing make, model and comments.

Some makes and models of cars from 1979 on have metal shields or framing members that impede this slim jim. For those tricky situations, I recommend a length of three thirty-seconds of an inch diameter music wire with a handle looped in one end and a right angle bend on the other end.

The right-angle member should be an inch and a quarter long, and the whole tool should be twenty three inches. This tool is inserted by putting the end of the bend straight down through the weather stripping (a little sharpening may be helpful here in avoiding metal retainer clips — but not too sharp) then bringing the shank of the tool up ninety degrees to normal working position. This puts the right angle bend inside the door with a minimum of forcing. From there the tool can be used as normal, although it will have a tendency to hang up easily. When that occurs, don't panic, just work the tool back and forth slowly and it will free up.

A rubber band on the shank of this tool is very helpful in locating the locking mechanism depth properly. The hole on the other end can be used as a lasso to open mushroom style inside knobs, the threaded wire that remains when the knob is removed, and some types of anti-theft smooth knobs. Just bend at an angle and insert; as the tool is pulled over the knob it will cant and dig into the surface, pulling up the knob.

Another well-known (to most people I know, anyway) dodge is tying some fishing line to the hole, then leading the end back through, up the tool shank, and out the car. The noose that results can be looped over a button and tightened by a pull on the line, then the whole tool pulled to lift the bottom. Oh, by the way, avoid all of the other car opening tools on the market. Most of them are designed to operate the inside button, and only the slim jim is truly reliable.

Chapter Twenty Two
The Pin Tumbler Simulator

This tool alone is worth more than the price of this book. The pin tumbler simulator gives instant and visual feedback as to the exact position of the pick tip and shank while in the lock. It is invaluable for practice.

If you don't already have a cheap five-pin tumbler lock in your collection, get one. Try to get one that has a spring retainer that can be easily removed, like a clip. (Note: if you don't know what I'm talking about, please refer to *The Complete Guide to Lock Picking*.)

To prepare the lock, have five letter envelopes ready. Insert the key and turn the plug 90°. Hold the lock upright and remove the spring well retainer, allowing the springs to release tension gradually. With fingers or tweezers, remove the five springs and place in one envelope. Now hold your finger over the spring well holes, invert the lock, and uncover one hole at a time, dropping each top pin into a different envelope. Label the envelopes. Now tape the plug in its 90° position and set aside.

The diameter of the pins should be .115 inches, but there are variations. You need five pieces of rod as close to the pin diameter as possible, and at least four inches long. Possible sources include:

- Drill rod (at industrial supply or machine shop supply stores)
- Regular drills (wood or metal twist)
- Music wire (the old standby, but hard to get exact diameters)
- Nails (usually 16 d)
- Welding rod
- Any metal rod that will fit with *precision.* (A sloppy fit will greatly degrade the simulator's performance.)

If you don't have measuring equipment (a micrometer is best) take along the taped lock casing and use it as a fit gauge. Drill rod and drills will probably be the easiest choice. With the drill rod you may buy a long piece and grind off appropriate lengths. In fact, once you have the rod, grind one end (the non-spiral end on a drill) perfectly flat, to mate with the bottom pins in the lock.

Next, the lock must be mounted. It can be clamped in a vise, or a "C" clamp. If it is a rim cylinder, the mounting hardware it came with can be used. Just get a board 4″ x 4″ x ½″ (dimensions not critical) and drill two holes through it to screw the lock end first to the board. See Figure 65.

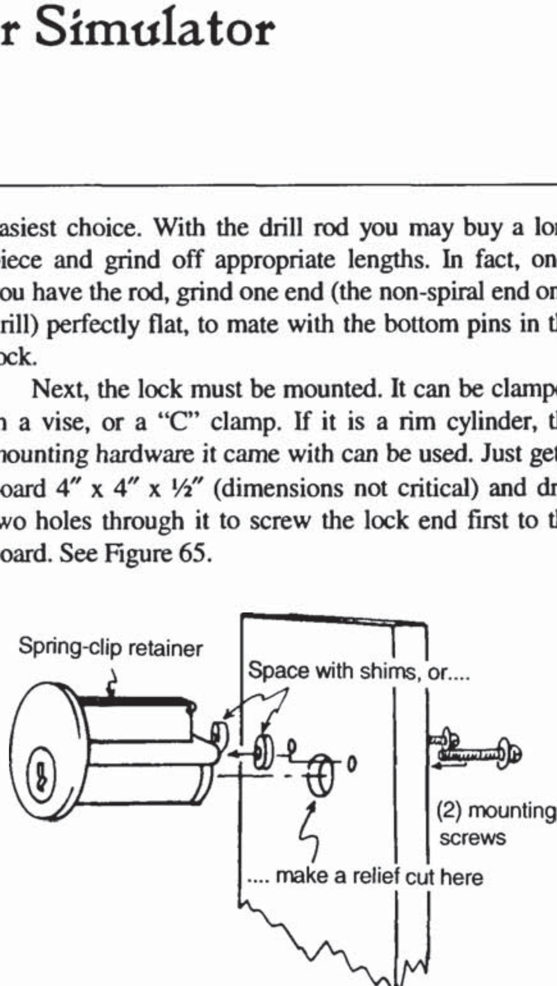


Figure 65

If needed, the board can be cut away slightly to allow the plug end to rotate freely, or the lock can be spaced from the board with washers or paper shims. This board can in turn be vise-clamped, or screwed to any vertical surface, even your regular practice board (see *The Complete Guide To Lock Picking).*

If the lock is a mortise type, get a board 4″ x 8″ x ½″ and cut or drill in the exact center a hole the same diameter as the lock. Next, saw the board at the middle of the hole and get two pieces 4″ x 4″ with a half-circle in the top. Glue and nail these together and glue the lock in the half-circle with contact cement. See Figure 66.

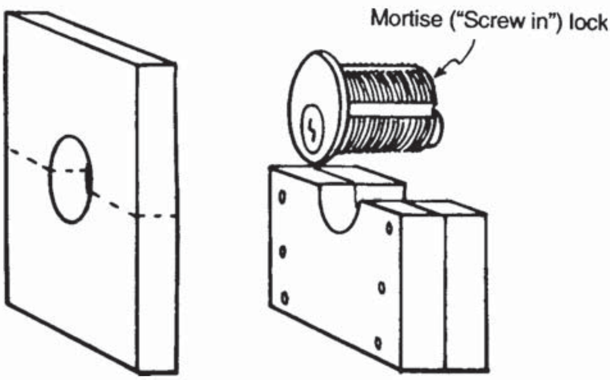


Figure 66

Mount as before. After mounting is completed, untape and return the plug to full-up position. Note that five bottom pins are now laying in the pin wells, held in by gravity. Place one prepared rod in each of the five holes, making sure that they bottom. Wiggling the plug may help, and be sure the rod has no burrs or grinding sprue to impede fit or jam the lock.

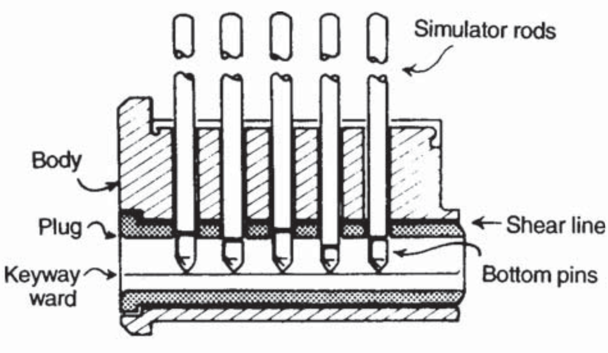


Figure 67
Practice simulator.

Once the rods are seated, put a drop of oil in each pin hole. The simulator is now complete — how does it operate? Insert the individually-lifting pick in the keyway and attempt to lift each rod in turn from front to back. Notice that the weight of the top rod simulates the spring tension as normal. If the weight of the rod seems excessive, cut or grind off a little from the *top* of the rod. Also notice that if the shank of the pick contacts a pin stack (a real no-no) the simulator will show it. This lock can be picked as usual (concentrate on individually lifting techniques). When working the lock, keep your eye on all the rods. Remember that gravity alone holds the lock together. For transport, tape all the rods down securely. See Figure 67.

The concept can also be applied to the lever lock. Obtain a lever lock with three or four levers and a small case. Carefully grind off the top of the case, allowing top access to the levers. Now get some clear celluloid, plastic, or paper. It should be as rigid, and as thin, as possible. Fit a flag cut from the stock so that it is glued to the *face* of one of the lever tumblers, and protrudes from the top of the case (ground off).

Cut this flag until it fits properly and then use it as a pattern for the others. It may be necessary to cut tiny washers from the same material to thread over the pivot post that the tumblers are on, in order to "space" tumblers. If this is done it will prevent the levers from binding against each other due to the increased thickness caused by the flags. Experimentation will determine where to put the washers. See Figure 68.

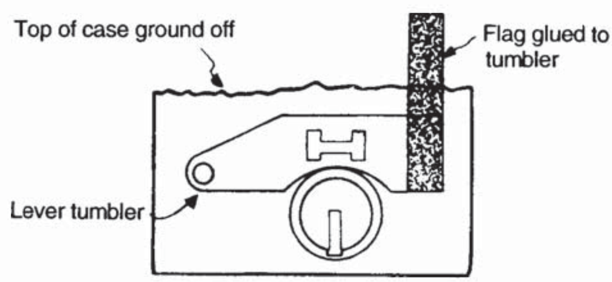


Figure 68
Front view of lever lock simulator.

Once all of the flags have been cut and applied (use contact cement), the lock should be reassembled (with washers, if necessary) and then the flags should be cut off flush with each other about a half inch above the case. Trim them to the same height *only* with the proper key inserted and turned to the top dead center position. This means that when the tumblers are next aligned so as to unlock the bolt, their tops will all be at the same height. Obviously, if a tumbler has been over-lifted (a real problem) it will also show up. This system can be further improved by color-coding the flags, and also by providing a "standard" flag attached to the case that never varies in height. With paper flags this is especially important. See Figure 69.

Professional lock experts will greatly appreciate this simulator because lever locks are the hardest to practice individually lifting techniques on, yet their use is widespread in high-security applications, such as mail and security boxes.

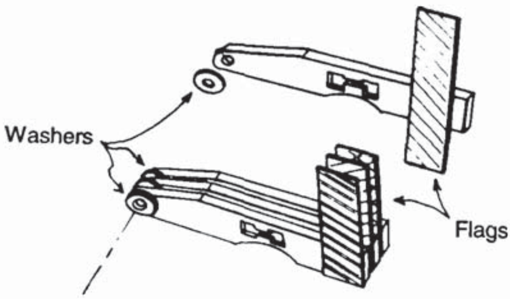


Figure 69
Spacing washers for simulator levers (thickness of flags/washers exaggerated).

Chapter Twenty Three
Making a Tool for Impressioning a Lock Cylinder

The next discussion is not strictly about lock picking tools but is vitally important. Impressioning a lock cylinder will be treated it in detail here, and I will show you a tool for same. Only impressioning a pin-tumbler cylinder will be covered, because other types of locks can be easily bypassed by other techniques in less time and with less inventory. Inventory is the key work here — none of the impressioning books tell you that a set of fifty or sixty blanks is required to impression an unknown lock effectively. Some keyways (notably hotels, grand master systems, and government installations) are unavailable in blank form. Nevertheless, let's look into the technique.

When you insert the proper key in a pin-tumbler lock and turn it, what prevents the key from being withdrawn during rotation? A little thought will show you that during insertion, the bottom pins were pushed up past the shearline of the plug and into the top pin wells by the various height key cuts. However, when the plug is rotating, there are no top pin key wells to provide a space for the bottom pins to go if the key were pulled out. So what happens is that as the attempt is made to withdraw the key, the bottom pins are wedged up by the sloping key cuts, and rise until they contact the shearline and the inner surface of the outer shell that the plug or cylinder moves in. When they contact this outer shell, they press against it and stop lifting, thereby preventing further key withdrawal. The item to note here is that they press against the top shell.

Now remember that during the usual picking process, the pin stack can be upside-down picked. That means that the pin stack is totally lifted into the top pin well, and then the stack is racked while the tension is relaxed. At some point, the pin stack will slide down until the shearline of the pin stack meets the shearline of the plug and outer shell. At that point, the bottom of the top pin hangs up on the lip created by attempting to rotate the plug, and that stack is said to be picked.

Impressioning works both ways, taking advantage of both principles. A keyblank is inserted into the keyway and the blank is turned to bind all of the pinstacks. While still applying turning tension, the bow or head of the key is rapped lightly with a hammer, first straight up, then straight down. See Figure 70.

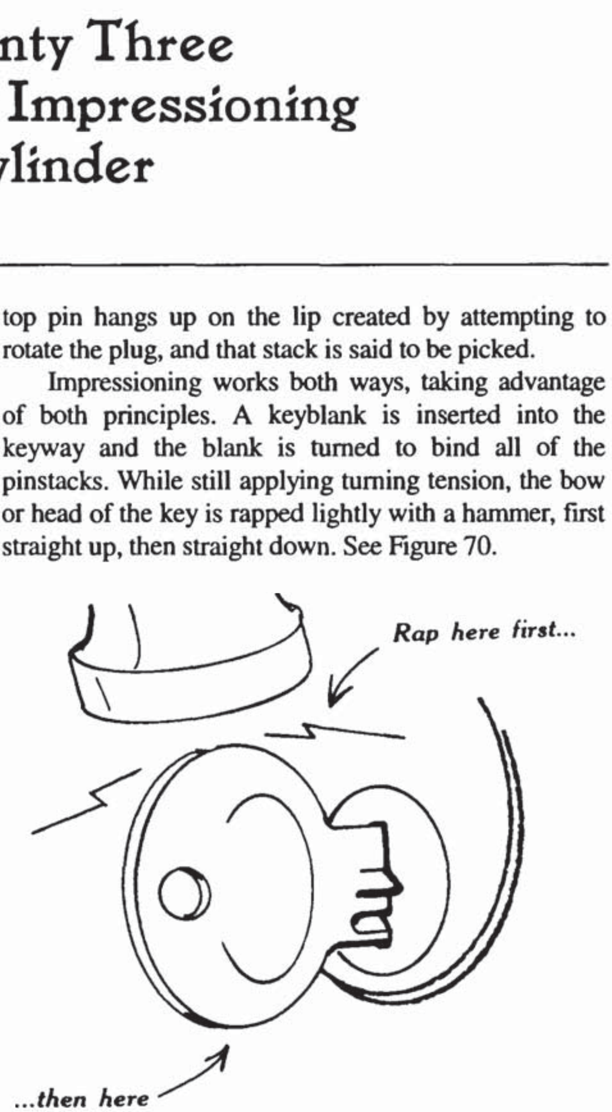


Figure 70

This rapping produces marks on the keyblank top as the bound pin ends dig into the key surface. Think — they have nowhere to go when the keyblank surface comes up to meet them, so they make marks in the keyblank.

The next step is to remove the keyblank and examine it for marks. With a half-*round* file, start a keycut at each mark location. Now re-insert the key and repeat the process. A point is reached finally at which one pin stack is lifted up only to the shearline. At that point, when you insert, turn, and tap the keyblank, the top pin is held at shear and only the bottom pin riding the blank. This bottom pin alone does not make marks on the keyblank surface, so you know not to file any deeper at that spot. Eventually, all the filing will be done for each pin stack, and the cylinder will turn. Congratulations, you just made a key for that lock!

It's usually not that easy, though, but a little extra knowledge and some practice will make it that easy. First of all, selecting a key blank is important. The proliferation of key blanks on the market of various brands today makes it difficult but there are not nearly as many keyways, so stacking a set of blanks is possible. The easiest way to get a set is to make a package deal with a small key duplicator, like a dime or drug store. You many even be able to pick up an entire stock and key duplicating machine to boot. In any event, look for quality keyblanks, and try to avoid light metal alloys and aluminum blanks.

Next, be sure that the keyway is well filled, because some master key systems and some keyways vary only slightly in dimension, so avoid a lot of play in the keyblank/keyway fit. A tool that can help you a lot in impressioning is a cast metal turnbuckle fitted with a thumbscrew.

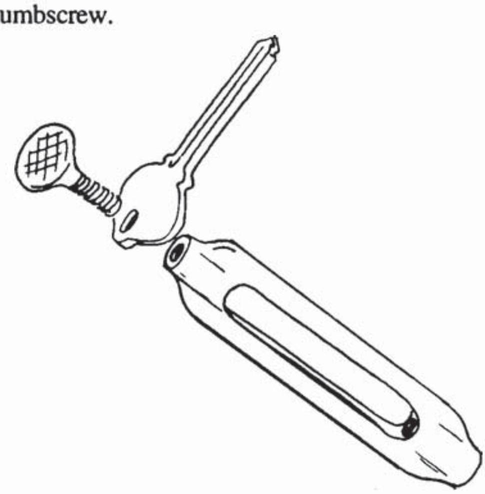


Figure 71

Any well-stocked hardware store carries turnbuckles(not the aluminum extrusion type, but cast) and a machine screw thumbscrew to match the threads of the right-hand side. Be sure not to get a thumbscrew so large in diameter that it will not fit through the smallest hole in the bow of each keyblank you stock. If so, the tool obviously cannot be used. In fact, it may be better to try for two sizes. Also, get two fender washers that are a tight fit on the thumbscrew. The selected keyblank is threaded onto the thumbscrew, using the fender washers if they will not obstruct the keyway insertion, and then firmly screwed into the turnbuckle. The left-hand threaded piece is removed. This combination provides an effective handle to apply turning tension to the keyblank, and also a filing holder. If you are improvising, a metal rod that will fit the hole is also good, but not as firm. See Figure 71

Remember when buying the turnbuckle to pick up a half-round mill file to do the key cuts with. If you wish, you can even buy a vise at some stores that is small enough to carry, or clamp to the top of your toolbox. In a field situation a "C" clamp can be used to hold the keyblank while filing — or just use any level surface. Onto the next step.

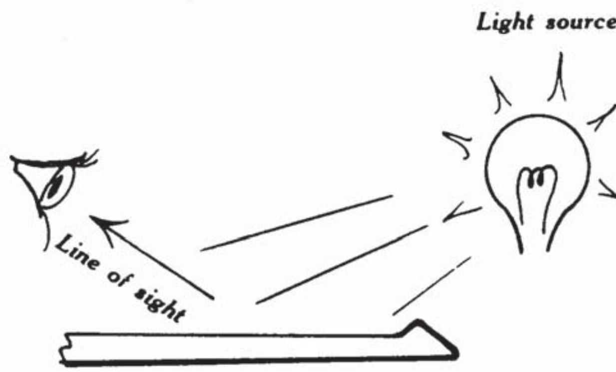


Figure 72

Before inserting the keyblank for the first impression, it is usually wise to take a flat mill file and clean off the top .002" of an inch from the keyblank. This is necessary because the manufacturing process produces a hard skin that does not take impressions as well as the softer metal underneath. After this filing (keep the blade top square with the keyblank sides), polish the filed surface with emery cloth to remove scratches. Scratch removal is necessary because the impression the pin ends make are usually very, very faint. In fact, they are not "marks" so much as changes in the glossiness of the key finish. A number of methods all make the marks show up better — breathing on the key to deposit a thin film of moisture, using a magnifying glass, and the traditional shining a light obliquely onto the key blade. Oblique lighting (like the light of the setting sun) makes small changes in the key surface throw shadows much larger than the marks themselves, so try to master this important technique. See Figure 72. It may be essential if you work in low light conditions.

Once the initial marks have been made (you have to twist hard and also rap hard sometimes to produce a mark), some specialists like to scribe light lines on the sides of the keyblade, perpendicular to the key, that show how the cut is supposed to proceed, namely straight down. See Figure 73.

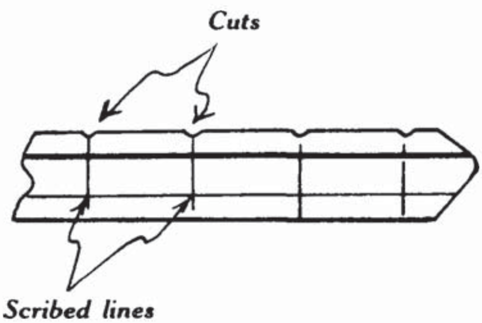


Figure 73

This has become popular, because if the cut starts to vary (and what hand filing doesn't?) from straight down, the pin will mark the side of the cut and not the bottom, making reading impossible. A small machinist's square or a depth gauge will produce the required marks. If you mark the key, remember to follow those marks strictly.

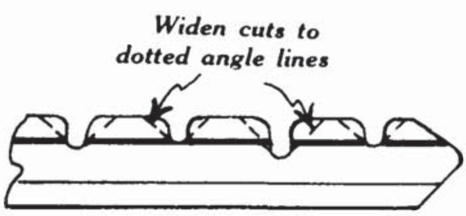


Figure 74

The next tough point is to stop when you don't see a mark anymore. Now the key may not have impressioned well, and the pin stack is not really at shearline yet, but you don't know that, so immediately stop when no more marks are seen. If you get all done (no marks at all) and the key still will not fit the lock, make a little harder impression and look very closely for marks, and one or two may become visible. If you are having trouble seeing the marks, it may be advisable to polish to the depth of a sixteenth of an inch or more. It will become necessary to provide angles leading down into the key cut bottoms. See Figure 74.

If these are not provided, the pins will catch at the cut bottoms and the key is forever frozen in the lock, requiring dissassembly. The angles should be 45 degrees or more — examine a couple of house keys and duplicate that angle. The actual cutting can be done with a small triangular mill file. Be very careful not to increase the cut depth, though.

Okay, let's assume you just impressioned the key and the lock opened. Touch up and straighten any crooked cuts in the key (but don't alter cut depths), and polish the entire keyblade with emery cloth, especially if guide lines are scribed on the key. Now, as a precaution, blow the keyway out with air to prevent key filings or chips from getting in the pin wells.

Now, let's suppose that you cut too deep — what next? Well, never fear. The easy way to build back the key surface is to rap the side of the blank carefully with a "ball," as in ball-peen hammer. This will flatten the metal (you did hit it on the side, didn't you?) and effectively make the cut shallower. If the damage cannot be repaired by this method, you must start over.

The final word on impressioning is practice, practice, practice. This skill requires good mark reading ability, but it is the opening skill that most locksmiths use to effect a lock-out or keyless entry, because when completed, the customer has a key that will work. It is also the preferred method of truly professional lock specialists, because once the opening is effected, it can be duplicated in a fraction of the time for subsequent visits. Also, the lock may be impressioned with a rest period between sessions, impossible with other lock bypass techniques, because of the necessity of keeping tension on the lock core.

Just briefly, there is another impressioning system out in which the key is turned as usual, but then pulled out of the lock about a sixteenth of an inch with great force and slowly (special tool needed for this). This system is not superior, but is easier on the lock. Although disc tumbler locks can be impressioned successfully with up and down impressioning, the pull system will not damage these locks, where up and down usually does. A resourceful person could probably improvise a slammer from a length of rod with a threaded end with two lock nuts on it, a large weight like a roll of washers taped together, and a hook to fit in the keyblank on the other end, but I have not experimented with this idea fully. I prefer the up and down system because of the ease of mark reading. A final caution: use a soft faced hammer when tapping the keyblank or the bow may suffer a lot of damage.

Chapter Twenty Four
Miscellaneous Other Tools

The Snapper

Another tool that is very useful is the snapper. For this tool from one-sixteenth inch o.d. music wire 18 inches long, start bending with the hook end and proceed back. See Figures 75 and 76.

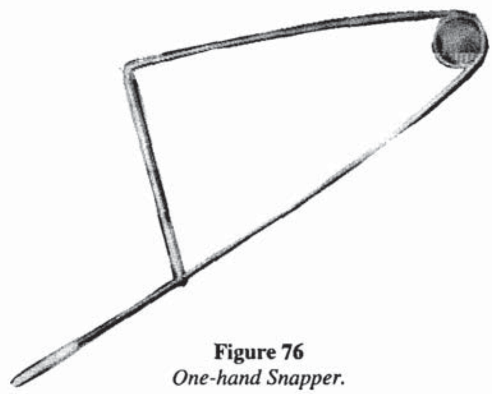


Figure 76
One-hand Snapper.

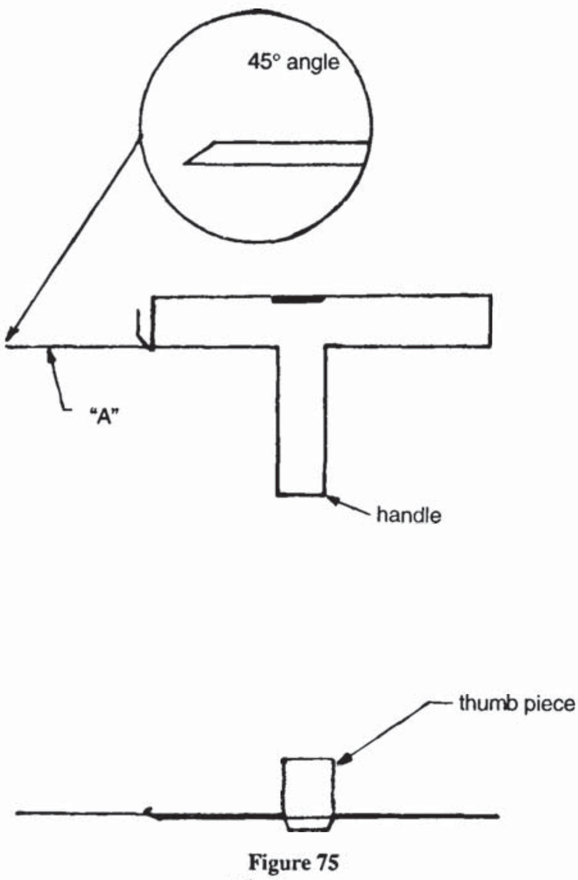


Figure 75
The Snapper.

When you get to the "A" end, hook it in and cut it so that there is 1½ inches sticking past the loop. Grind flats as before on the sides of the wire so that it will fit in under the pins like a pick does. Be sure to grind at least one inch of the rod. Then grind a 45° taper on the end to enable it to slip under the pin ends. You may also want to taper the handle and the thumbpiece. This tool is a vibration pick. The ground end is inserted to contact the bottoms of all of the pins in the lock. Then a tension tool is inserted in the keyway. Hold the tool by the handle and push down the thumbpiece, then suddenly release, allowing the loop to hit the shank, transmitting vibration to the pins via the shank. By varying the tempo of snapping, and the level of tension exerted, a point will come when all of the top pins in the lock will be in the air. At this point, the lock plug will suddenly turn. A good operator can often open a lock with one snap.

A Tool For Opening Office Equipment

A tool useful for opening office equipment locks can be made merely by bending a .030″ music wire in a "J" shape as shown in Figure 77.

Figure 77
"J" Tool

Wrap tape around the loop to form a handle. This tool is inserted in the bottom of the keyway, ending with the "J" end pointing down at the rear of the lock. On many locks this end will engage the same slot that the cam on the tail of the lock plug engages. Then you can twist the handle and bypass the lock entirely. Manufacturers lately have wised up, though, and put a blocking pin in to prevent this. Even then, this technique is sometimes still useable — and for older equipment, it's great!

Tools For Spring Latches

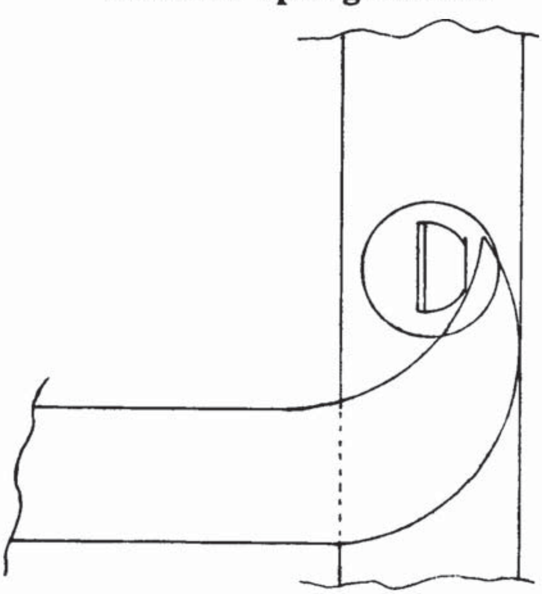


Figure 78
Spring latch shim tool.

Now let's take a look at the tools that act on the spring latch common on most exterior and interior lock sets. This is the wedge-shaped latch that locks automatically, not the bolt that must be locked by key. Those latches that are exposed, i.e., the latch can be seen, are a snap to open. A half-moon shim cut from one-sixteenth inch thick stock as shown in Figure 78, can be inserted behind the latch and levered against the bevel to open.

Tools For The Dead-Locking Latch

A dead-locking latch, consisting of an extra bar of metal parallel to the latch that does not enter the latch strike, but instead blocks on the strike plate, will prevent you from doing the half-moon bit, but I have seen doors fit so loosely that by forcing the door more tightly closed, the dead-locking bar suddenly snaps into the strike pocket. This releases the dead-lock and the latch can then be shimmed as usual. If the latch is not exposed (is covered by the stop), then you know it bevels the opposite way. The traditional plastic strip or credit card works fine, unless the traditional homeowner has installed nails, plates, cut a saw slot, or otherwise made it impossible for the card end to round the corner. In cases like this, the "Z" wire can save the day. As Figure 79 shows, the "Z" wire is only a .060″ or one-sixteenth inch o.d. music wire with two right angle bends, inserted and pivoted as shown.

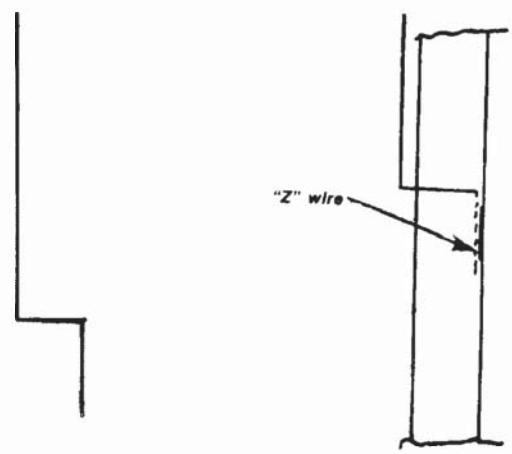
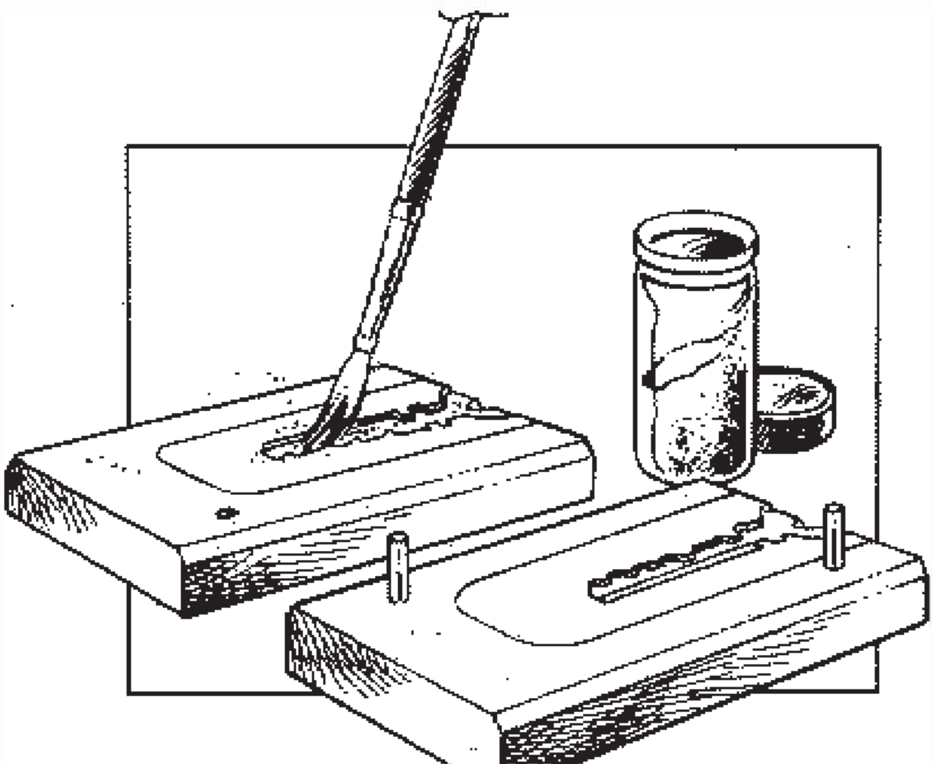


Figure 79
"Z" wire and "Z" wire engaging latch.

You will probably have to push on the door to gain clearance for inserting, and pull on the doorknob while working the tool. If a dead-locking latch is encountered in the non-exposed latch, attack the lock with your professional lock tool and forget the latch, because it won't budge.

CIA FIELD-EXPEDIENT KEY CASTING MANUAL



Key Casting

Have you ever wondered how the CIA agent gets behind locked doors when he is in the field, far from the locksmith shop? This manual, a revised reprint of the classic *CIA Key Casting Instruction Manual*, will teach you how to make a duplicate key when you can keep the original only a very short time. This step-by-step, self-checking manual guides you through the process of preparing the casting mold, making an accurate key impression, and casting the key model, using a standard issue or improvised casting mold and other readily available materials. The finished key can then be duplicated out of brass or steel on a regular key machine.

The straightforward text and clear illustrations of this updated manual give you the tools you need to create accurate duplicate keys to gain access to off-limits areas without special equipment.

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CONTENTS

HOW TO USE THE KEY CASTING KIT

This manual is a reprint of the CIA Key Casting Instruction Manual. The text is straightforward, and the instructions are self-testing and step-by-step. New illustrations and a few items of explanation have been added to clarify the process of using the kit.

The casting medium recommended is Cerrosafe, which is used as a chamber casting medium and is available from distributors of firearms supplies such as Brownells, Inc. It shrinks about one percent after cooling so that it will slip from the chamber of a rifle, and makes an excellent cast. The slicer used here is a common cheese slicer, which can be found at any housewares store. The candles are common party or camping candles. A thimble with a twisted wire handle can be used as a casting cup. The rest of the items are standard stock items.

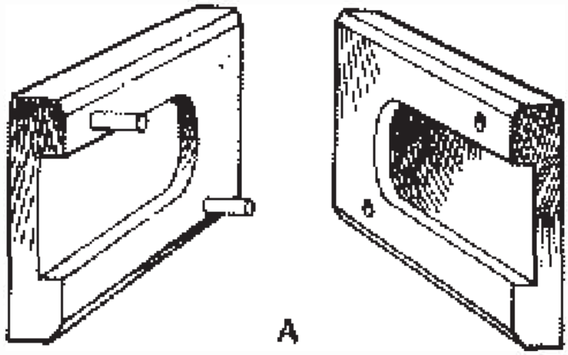
The mold illustrated here is issued in aluminum, but it can be handmade from hardwood or plastic or built in layers of aluminum sheet metal and pinned to final size. The mold illustrated measures 4" x 2 1/2" x 1"; the cavity for the clay is 3" x 1 1/4" x 1/4". The mold will cast all keys, including the modern Medeco and high-security type. The finished key can then be duplicated on a regular machine or hand filed. The cast key may be used in a lock if it is assisted with a turning wrench lock-picking tool. Flash or metal ooze must be scraped or filed away to the correct tolerance and key dimensions. The kit will cast anything it can physically hold and, as an adjunct, is useful in making impressions of high-tech components, script, bullets, and the like.

THE KEY CASTING KIT

The KEY CASTING KIT will enable you to make a duplicate key when you can keep the original key only a very short time.

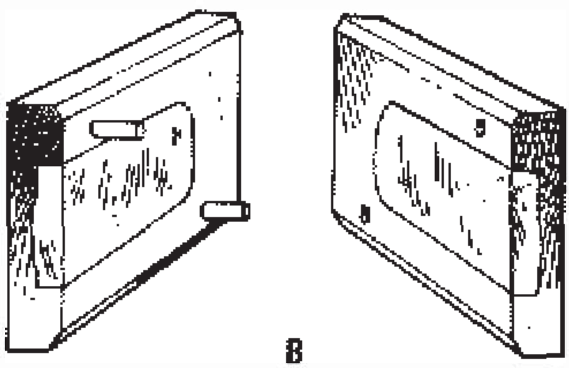
In using the kit, you first make an impression of the key by pressing it in a mold between two layers of clay. Then you make a casting of the key by pouring low-melting-point metal into the impression. The low-melting-point metal, when cooled, is quite soft, so that ordinarily you have to make a hard metal (brass or steel) key from the casting before attempting to open a lock.

This book is carefully designed to teach you how to cast a key. It takes you, step-by-step, through the process of (1) preparing the mold for the key impression; (2) impressing the key on the clay of the mold; and (3) casting a model of the key in soft metal. The kit will not enable you to make a brass (or steel) key; that must be done with other equipment.



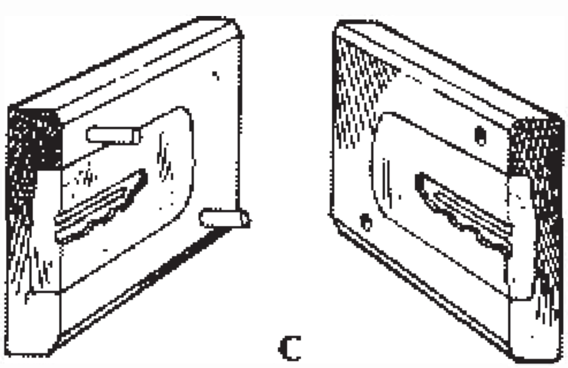
A

If your mold is not filled with clay (as in A), and you wish to learn how to prepare the mold, turn to the next page.



B

If your mold is prepared for use (as in B), and you wish to learn how to make a key impression, turn to page 11.

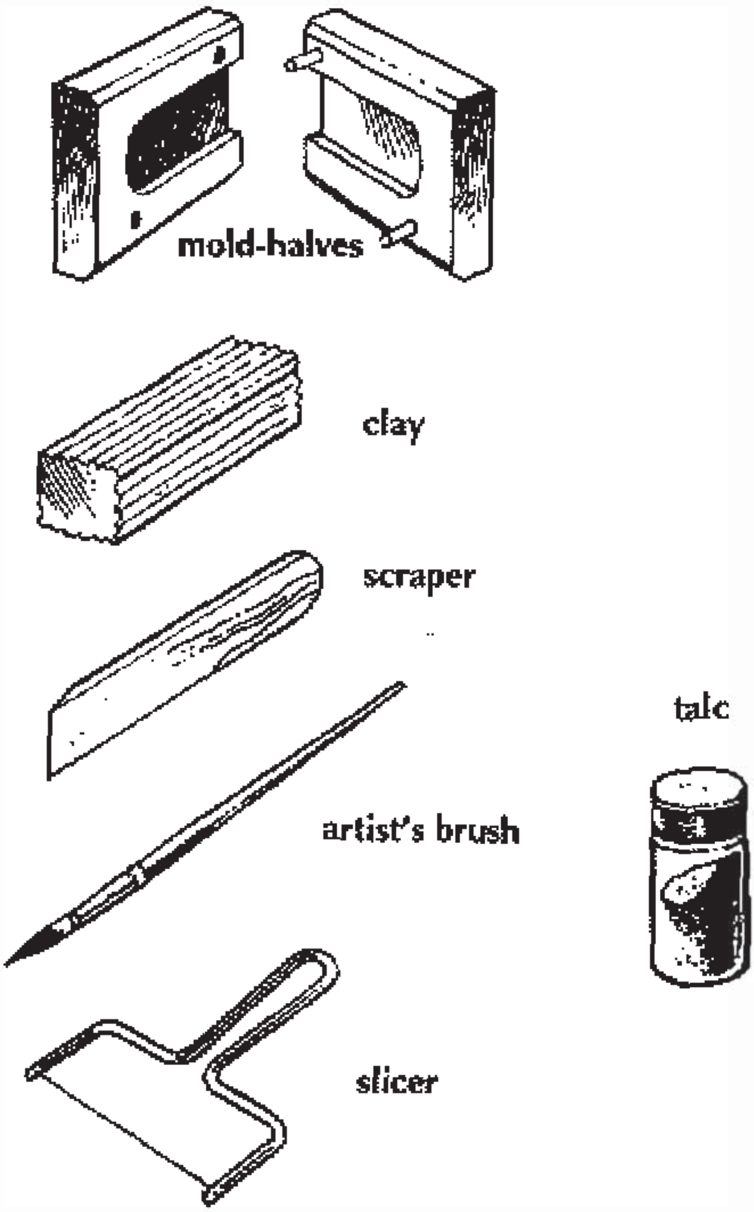


C

If you have a key impression (as in C), and you wish to learn how to cast the key, turn to page 21.

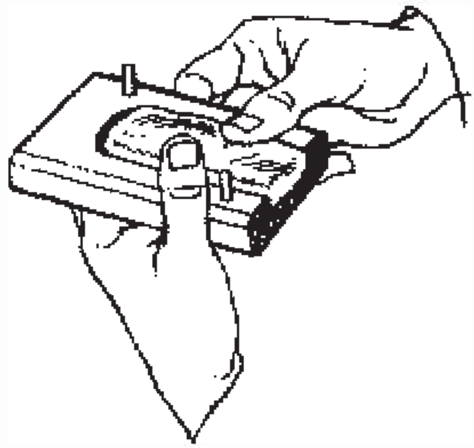
PREPARING THE MOLD

What you need:



Do you have all of these? Then turn the page.

What you do:



Cut the clay in half lengthwise.

Warm one of the clay halves in your hands.

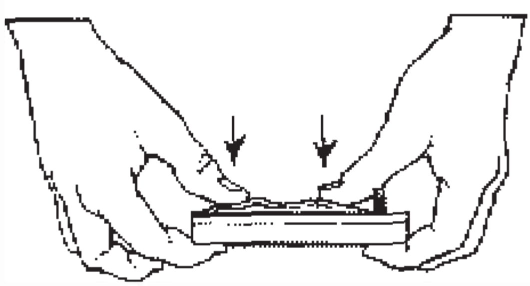
Place the warmed clay in the mold-half with pins.

Press down with your thumbs.

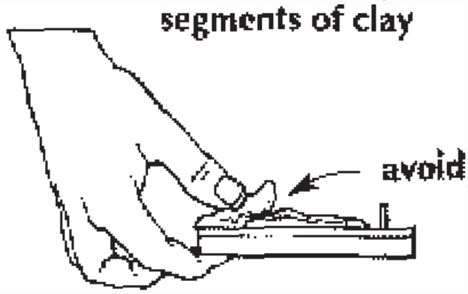
Work the clay into all parts of the mold-half.

Avoid overlapping segments of clay.

DO press *down*



DON'T overlap segments of clay

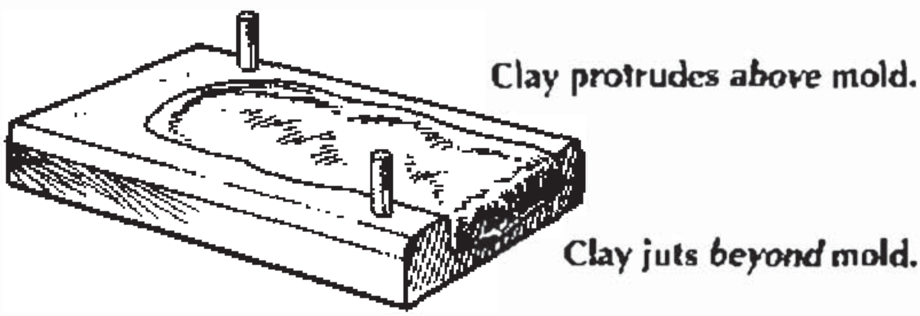


The purpose in avoiding overlap is to avoid forming cracks in the clay. The clay should be crack-free, so it will not flake or chunk apart.

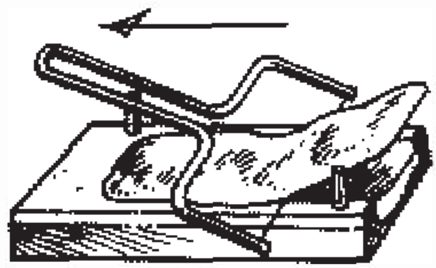
If you do overlap segments of clay, just keep pressing down with your thumbs and the crack you made will eventually blend away.

When ready, turn page.

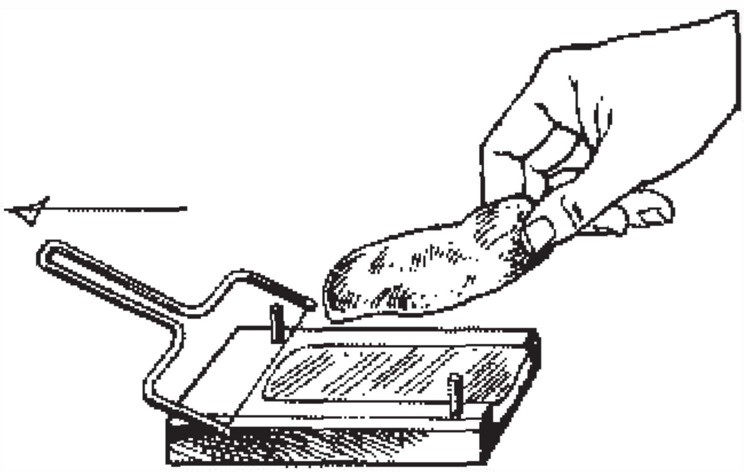
Your mold-half should look like this:



Next, take the slicer and slice off the excess clay (top surface only).

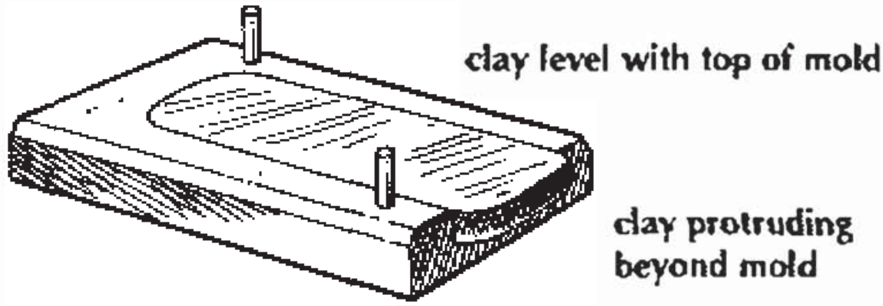


Slicing around the pin is a problem. Be careful not to gouge out clay below the level of the mold-half face.

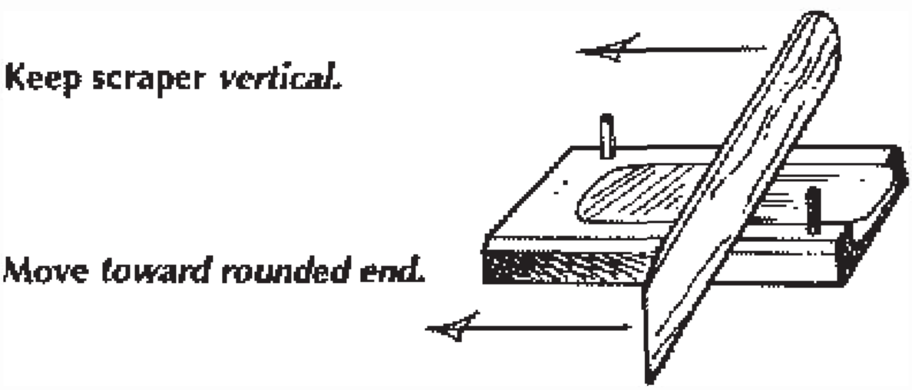


When you have sliced off the excess clay from the top surface of the mold-half, turn the page.

Your mold-half should now look like this:



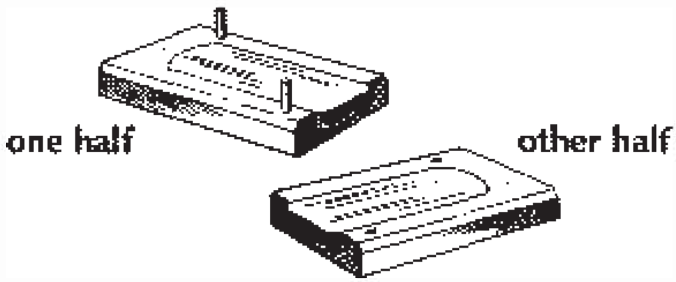
Next, scrape several times with the scraper, to remove excess clay.



Now fill, slice, and scrape the *other* half of the mold. Then, turn the page.

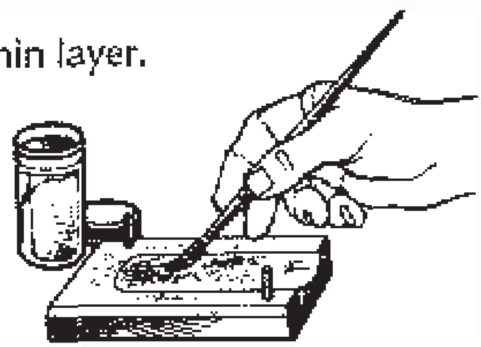
NOTE: If the scraped surface flakes off, develops holes, or otherwise is not perfectly smooth, you should not add lumps of clay directly to the surface itself. If you do, you will have to work hard with your thumbs to avoid future flaking. Instead, add a lump to the open end of the mold. By working this in, you will raise the general level of the clay surface and can quickly scrape again.

Your mold-halves should look like these:



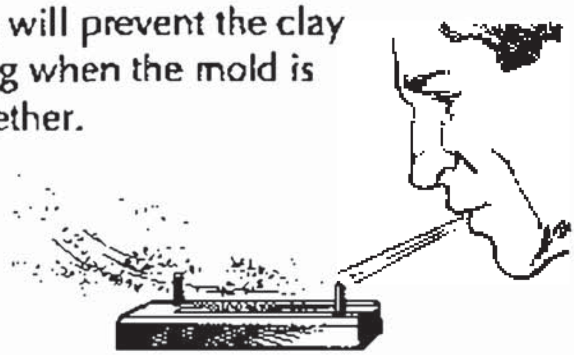
Now dust the clay of both halves with talc.

Brush on a thin layer.



Blow off any excess.

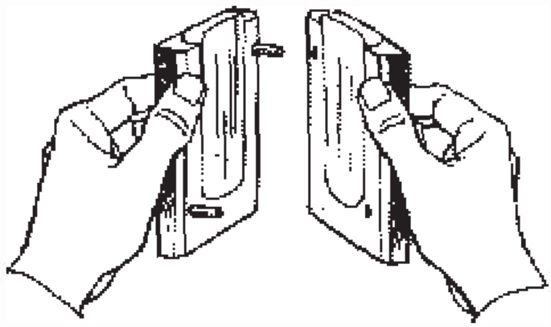
The dusting will prevent the clay from sticking when the mold is pressed together.



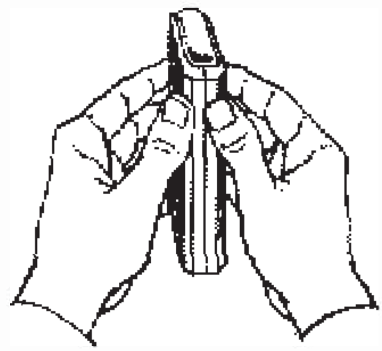
When you have finished dusting both mold-halves, turn the page.

Have you dusted *both* halves?

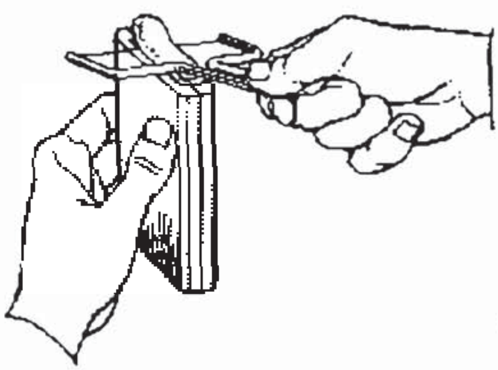
Next, put the mold together.



Caution: Be sure no traces of clay are on the metal surfaces of the mold that will be touching each other when the mold is put together. Otherwise the mold will not close tightly.



Slice off the excess clay.



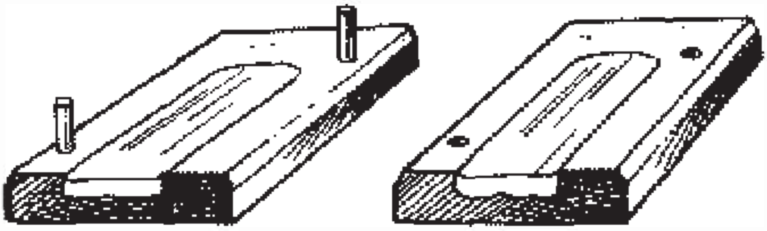
Dusting with talc isn't necessary this time.

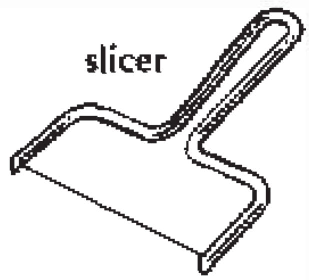
You have now finished *preparing the mold* for the key impression. The next step is *making the key impression.*

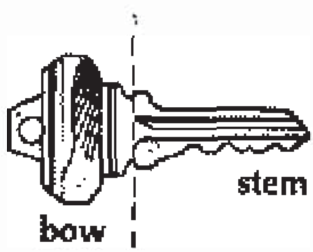
Now, turn the page.

MAKING THE KEY IMPRESSION

What you need:

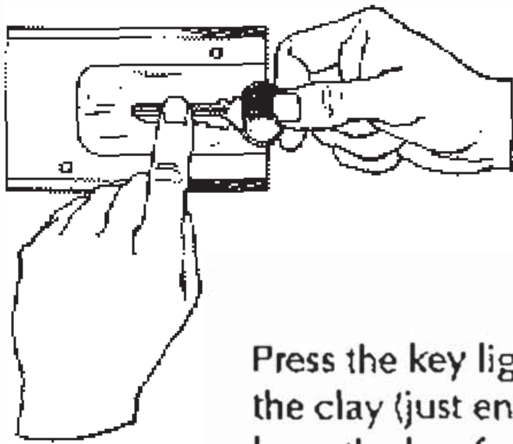




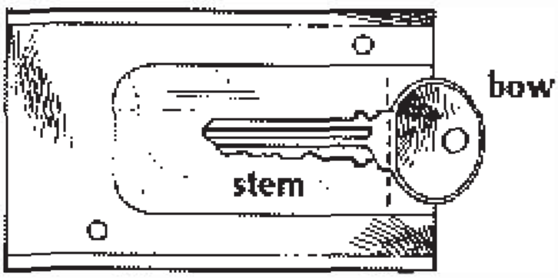


Do you have all of these? Then turn the page.

What you do:



Press the key lightly onto the clay (just enough to keep the key from sliding off).



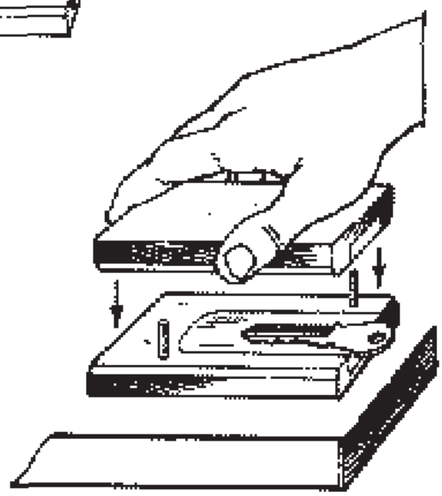
Allow about half of the bow to rest on the clay.

NOTE: If you are casting a lever-lock key, it may be too long for you to put half of the bow in the mold. In this case, cast what you can.

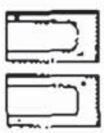
The purpose of putting just half of the bow of the key on the half-mold surface is to allow enough of the key to extend beyond the mold so that there will be something to hold on to when it comes time to lift the key from the half-mold. Why not leave the whole bow outside? Because the more of the key you cast, the more information about the key you will be recording in the casting, and the easier the key will be to duplicate.

Your mold-half and key should look like this:

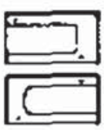
Now place the other half of the mold down over the guide pins . . .



CAUTION:

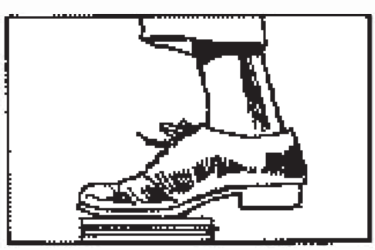


right



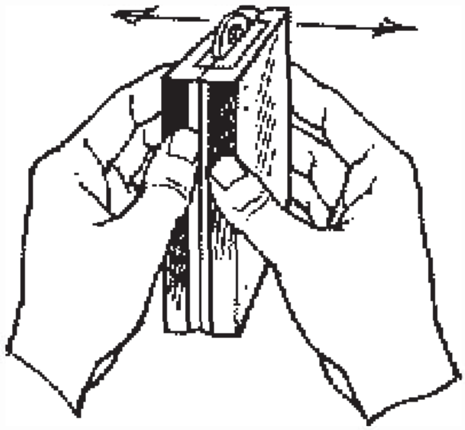
wrong

. . . and press the two halves firmly together. Press tightly for several seconds, so the clay will be less likely to spring back toward the center of the mold.

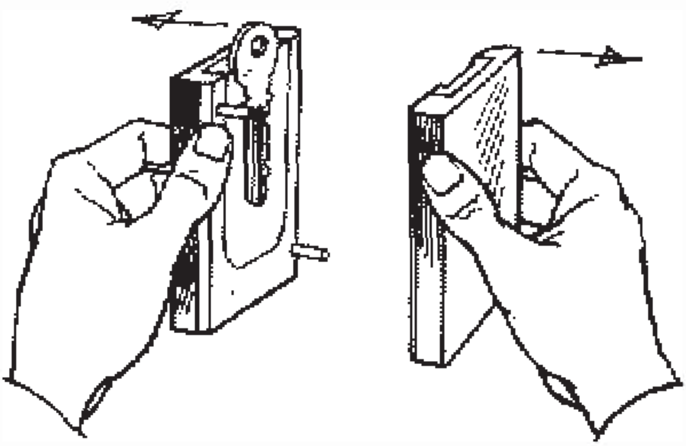


Standing on the mold works nicely.

Place the mold upright on a table, and *carefully* pull the halves apart.



NOTE: If the mold does not come apart easily, loosen the halves by gently working your thumbs and fingers alternately in the grooves between the mold halves.



Then put the halves down, clay side up.

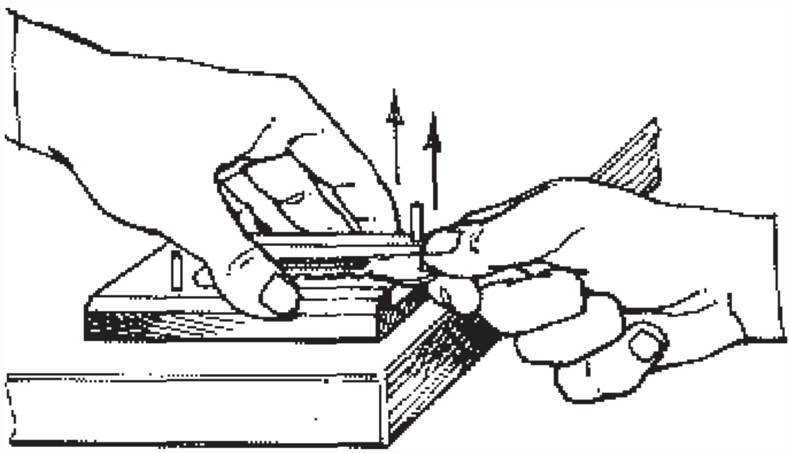
The purpose in being so careful is to avoid damaging the impression.

The next step is to lift the key from the mold.

What you do:

Gently loosen the key by *slightly* twisting it.

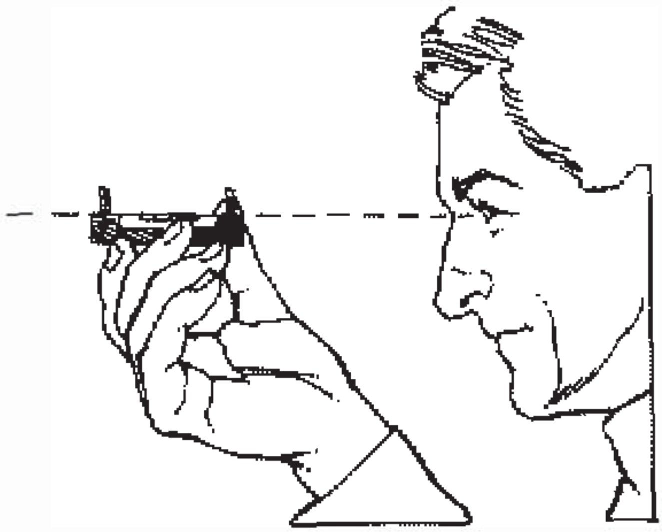
Then lift it *straight up.*



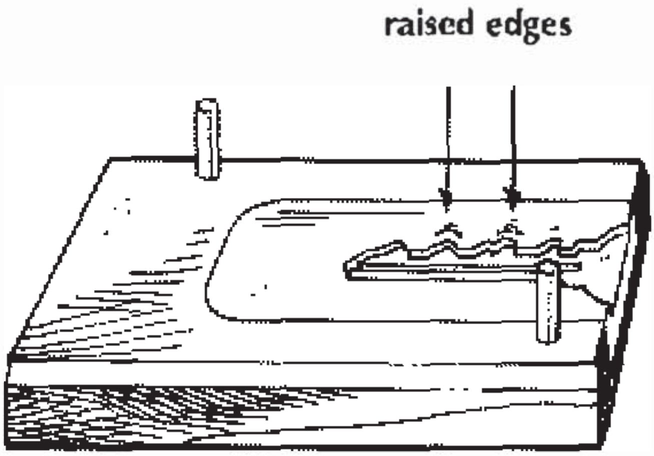
The purpose in twisting the key only *slightly* and then lifting the key *straight up* is to avoid damaging the impression.

Practice will help.

Examine both halves of the key impression.



Can you find raised edges in either half of the impression?



If so, what probably caused them?

After you have decided on your answer, turn the page.

Among the causes of a raised edge are:

1) Twisting the key too much while loosening it;

2) Pushing or pulling the key while loosening it;

3) Not lifting straight up.

Perhaps yours, however, was caused in some other way.

If you could find no raised edge, you are doing well.

Why is it important to avoid causing raised edges?

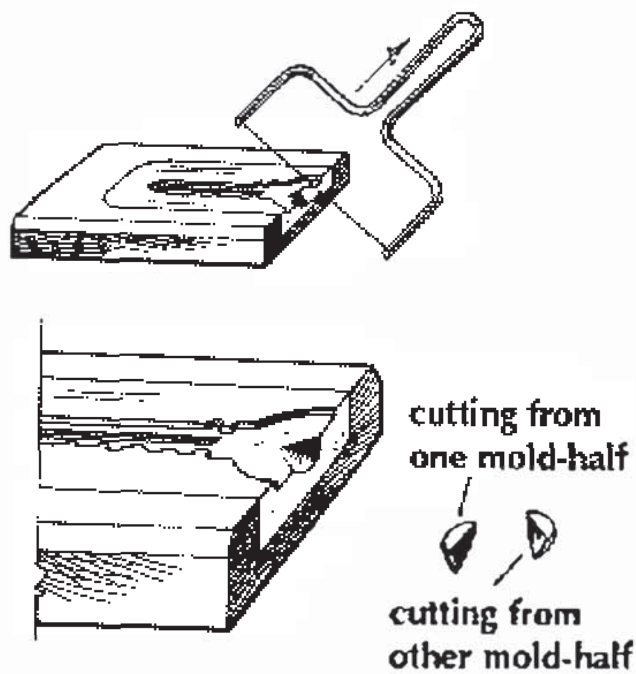
After you have decided on your answer, turn the page.

Why avoid raised edges? Because a raised edge means that the duplicate key may not be exactly like the original key.

If a duplicate key is off by only the thickness of this piece of paper, it may not open the lock.

After lifting the key from the mold, the next step is to make a funnel in the clay through which the molten metal can flow.

Using the slicer, cut away a bit of clay from each half of the mold. When put together, the two pieces should make a funnel, shaped like a cone.



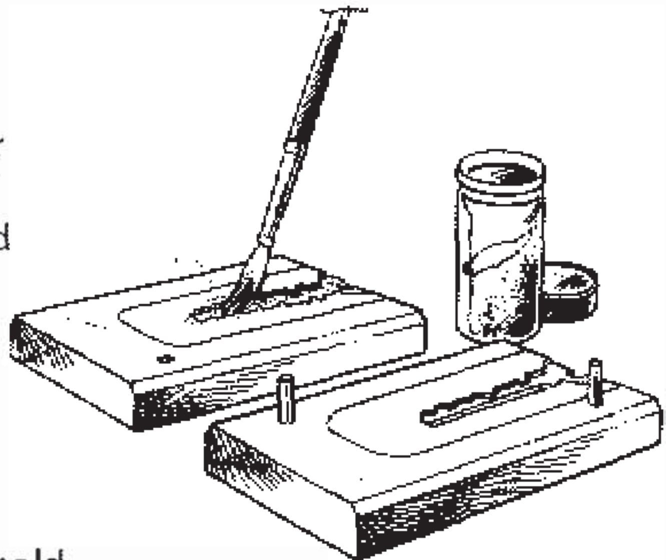
NOTE: The cuttings should be at least as large as shown above (1/4" in diameter).

The purpose of the funnel is to allow the metal to flow quickly into the mold.

You may prefer using a penknife or other implement.

Did you cut away clay from *both* halves of the mold?

The last step in making a key impression is to dust the impression and put the mold together.

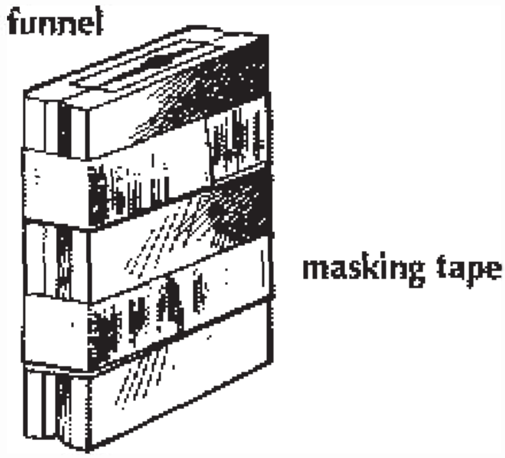


Brush talc over *both* halves of impression and funnel.

Blow off any excess talc.

Then put the mold carefully together.

CAUTION:
Match funnel ends!



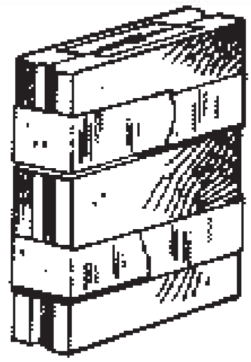
Now bind the halves together with masking tape (or strong rubber bands).

You have *prepared the mold;* you have *made a key impression.* The next step is to *cast a soft-metal model of the key.*

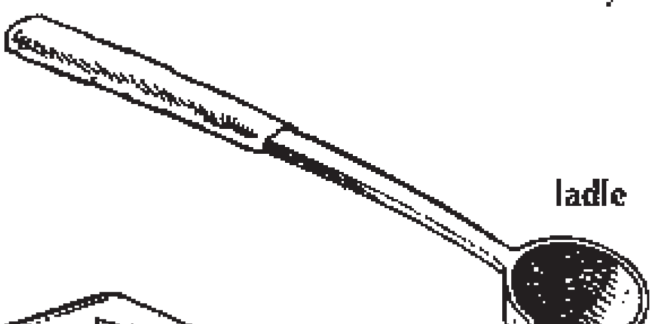
CASTING THE KEY

What you need:

alloy slug



mold with key impression



ladle

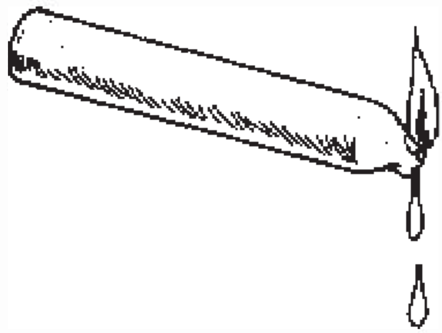
matches

candle

NOTE: A stove, hot plate, torch, or other such heat-generating item, may be used in place of the candle and matches.

Do you have all five items? Then you are ready to . . .

Prepare the candle.



Allow a drop of hot wax to drip onto the spot where you wish to mount the candle.

Then immediately place the candle on the drop of wax and hold it there firmly for three or four seconds to allow the melted wax to harden.

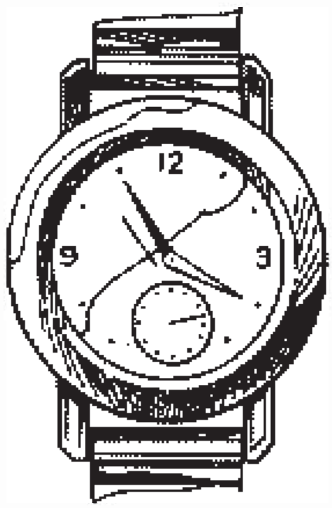
A candlestick would, of course, hold the candle in place equally well.

When your candle is firmly mounted, turn the page.

Now get set to time the heating of the metal.

If you have a watch, put it where you can see the small seconds dial.

If you do not have a watch, you can count the seconds aloud, speaking at a moderately fast pace ("One thousand and one, one thousand and two," etc.)



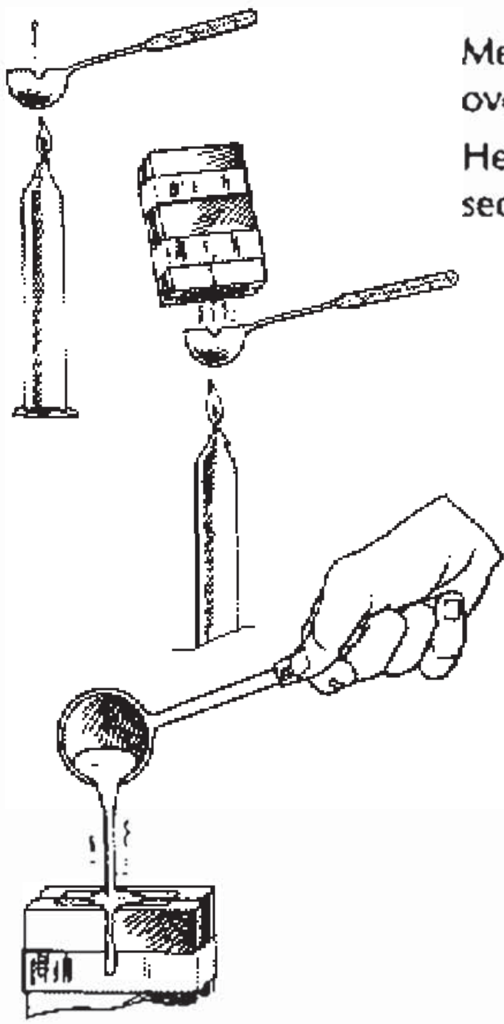
The purpose of timing the heating of the metal is to avoid 1) having the metal insufficiently hot so that it cools too rapidly in the mold (and so leaves unfilled portions) and 2) having the metal so hot that it softens the clay and blurs the impression. You can make mistakes either by *underheating* or *overheating* the metal.

If you are ready to time the heating of the metal, turn the page.

Now you are about to melt the alloy slug and pour a casting—the payoff for all your careful preparation.

But before you actually do it, let's go over the steps involved because, once you've started, one step follows another in quick sequence.

What you are to do (but not yet):



Melt the metal in the ladle over the candle flame.

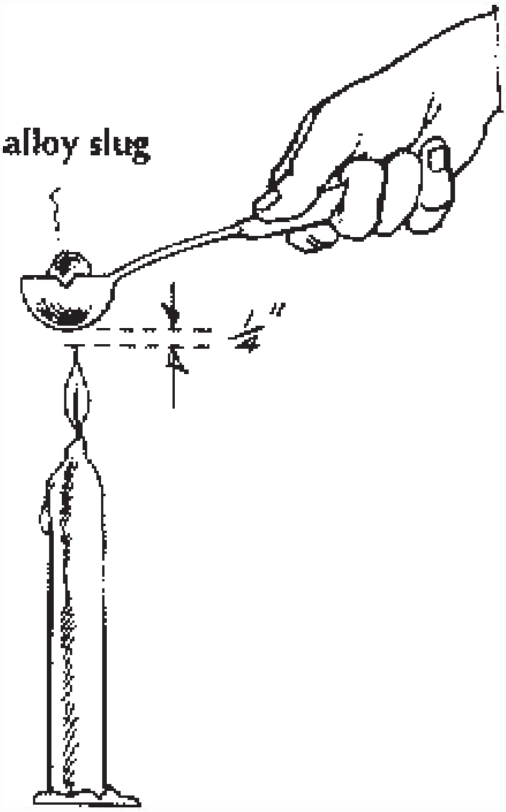
Heat it for about 30 seconds after it is melted.

During the last 5-10 seconds of the heating, hold the mold upside down over the ladle. (This warms the inside of the mold enough to delay solidification until the metal can flow into the tiniest crevices.)

And, finally, pour the casting. NOTE: Keep your fingers away from spilling metal!

Now, turn the page.

Now you are ready to make your casting.



Begin by heating the alloy slug.

Light the candle.

Check to see that the flame is steady (if not, stand an open book near to prevent drafts).

Hold the ladle about 1/4" above the tip of the flame.

NOTE: A common mistake is to hold the ladle *in* the flame rather than *above* it. If you hold it in the flame, not only will the heating take longer (it is cooler in the flame than above it), but you will get soot on the ladle —and probably on your clothes, hands, etc., as well.

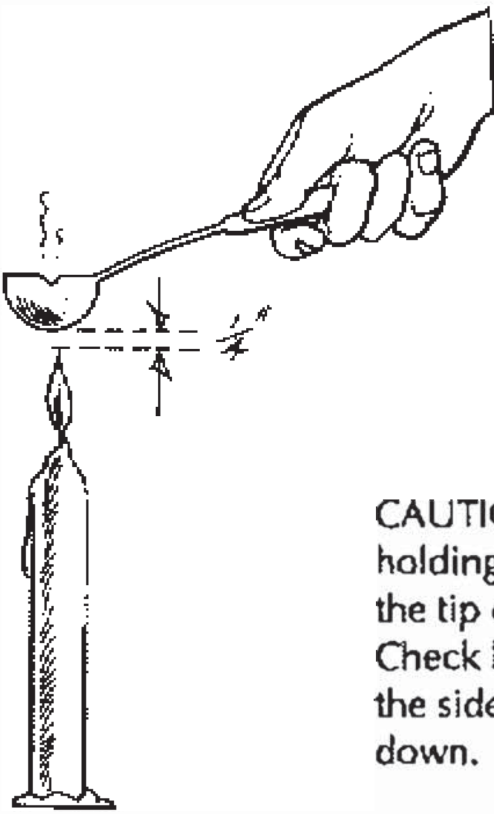
As soon as you have begun to heat the metal, think through your answer to this question:

What am I to begin to do as soon as all of the metal is melted?

After you have your answer, turn the page.

A good answer: After the metal is all melted, I'll begin counting seconds.

OK. Wait till the metal is *all* melted, then watch your time.



CAUTION: Are you holding the ladle *above* the tip of the flame? Check by looking from the side, not simply down.

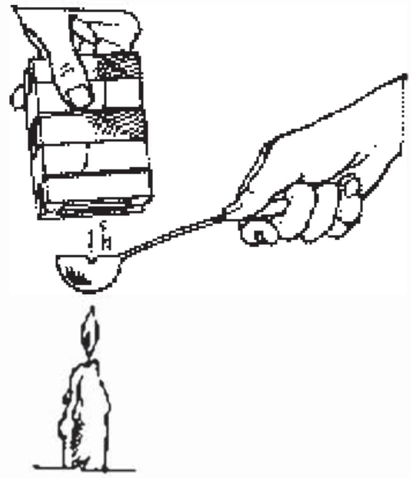
What are you going to do after about 20-25 seconds?

After you have thought through your answer, turn the page.

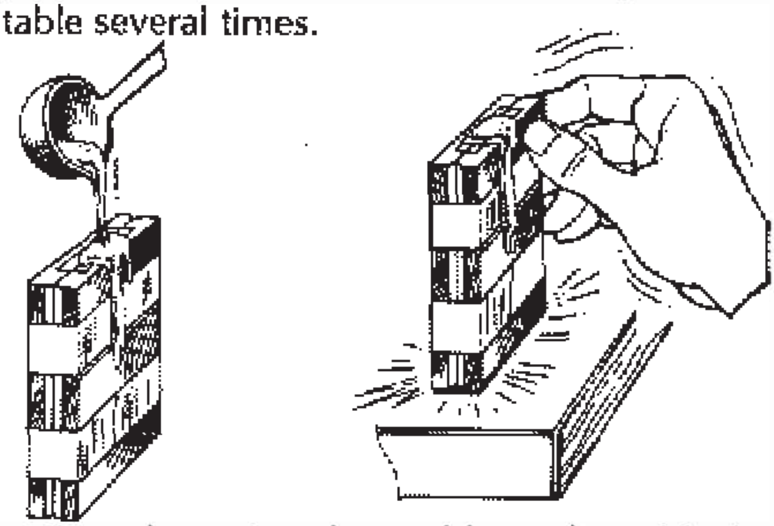
A good answer: After 20-25 seconds, I'm going to hold the mold upside down over the ladle to warm it up for casting.

OK. When your 20-25 seconds are up, hold the mold as shown.

Hold for another 5-10 seconds.



Then, *pour* the metal into the mold and *tap* the mold on the table several times.



The purpose of tapping the mold on the table is to release any air bubbles and to help the metal flow into small crevices.

NOTE: Don't be surprised if not much metal seems to go into the mold. You may have a small key.

Congratulations! You have now cast the key.

If you poured hot metal on your fingers, you probably discovered that you were more startled than hurt. The metal cools so fast that it is very unlikely to burn.

Now all that remains is:

1. Waiting for the cast to solidify;
2. Removing the cast from the mold; and
3. Inspecting the cast for defects.

Now turn to the next page.

Usually the cast can be expected to solidify within a minute of pouring, but it is good to wait about two minutes before opening the mold.

Imagine you have just cast a rather large key. How long would it be safe to wait before separating the mold-halves?

A. One minute
B. Two minutes

After you have decided on your answer, turn the page.

"B" is correct. It would be unsafe to separate the mold after only one minute when casting a large or thick key.

Why?

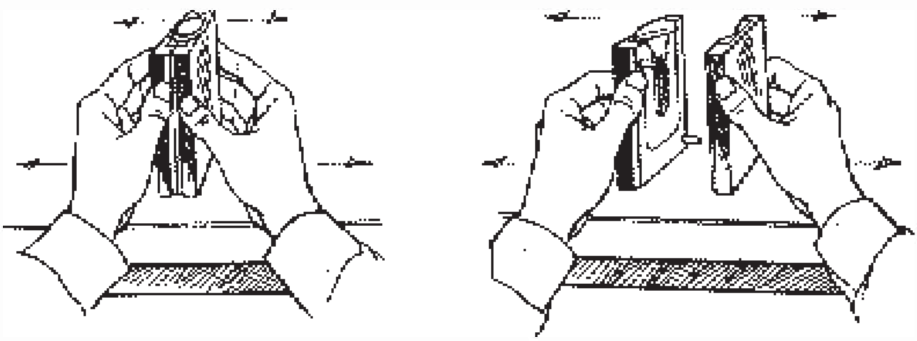
When you have your answer, turn the page.

A good answer: The large key, having more hot metal, would take longer to cool and therefore longer to solidify.

Once again, two minutes is a reasonably safe time to wait before opening the mold.

The next step is to remove the cast from the mold.

What you do:



With the mold held vertically, pull the halves apart *carefully.*

You should then put the mold-halves on the table, clay-side up.

Why be careful with the mold *after* the cast has solidified?

When you have your answer, turn the page.

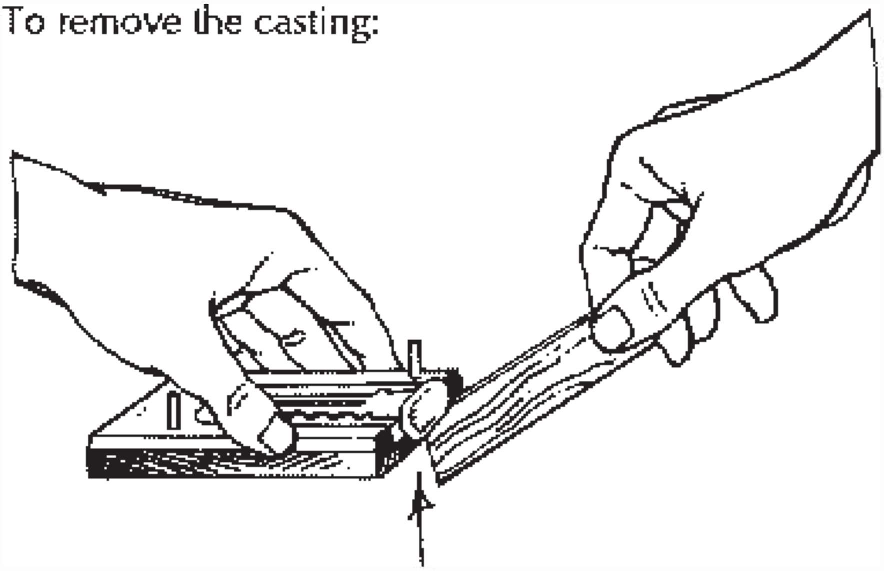
The "right" answer: If you are careful with the mold, then you can use it again to make another good casting.

Why does removing the casting pose more of a problem than removing the key itself?

After you have your answer in mind, turn the page.

A good answer: Removing the casting from the mold poses more of a problem than removing the key itself because the casting, unlike the key, offers nothing to hold on to, nothing to lift with.

To remove the casting:



Insert a corner of the scraper under the casting.
Loosen gently.
Remove carefully.

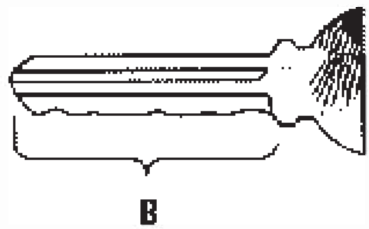
NOTE: If you are *careful* in removing the key casting, you will be able to use the same impression again.

Casting removed? Turn to the next page.

The last step is to inspect the casting for defects. Defects can be divided into two sorts:

1. Absence of bitting;
2. Blurring of bitting.

Which drawing shows "bitting"?



When you have chosen "A" or "B," turn the page.

NOTE: Frequently, the bitting is webbed with *thin sheets of metal*. These sheets result when the clay of the two mold-halves does not close tightly about the key while it is being impressed in the mold. Slight air spaces remain, into which the metal runs during casting. These presence of these thin sheets is *not a defect,* because they can be removed by filing.

CAUTION: Leave the filing to a properly trained technician.

The bitting is shown in drawing A.

Defects can be classified into those involving:

1. Absence of bitting; or
2. Blurring of bitting.

Does this drawing illustrate a defect in casting due to

A. Absence of bitting, or
B. Blurring of bitting?

Choose A or B.

Dotted line shows outline of original key.

Got your answer? Turn the page.

"A" is correct. The defect shown is due to *absence* of bitting.

Blurring has to do with slight inaccuracies in the bitting due to air bubbles or damage to the impression.

Which do these drawings illustrate, defects due to absence of bitting, or defects due to blurring of bitting? Both illustrate the same defect.

A. Absence of bitting   B. Blurring of bitting

When you've chosen A or B, turn the page.

"B" for blurring of bitting is correct. The two drawings illustrate small defects of the bitting due to tiny air bubbles and carelessness in removing the key after making the impression.

You may remember that such carelessness may be the result of:

1. Twisting the key too much while loosening it;
2. Pushing or pulling the key while loosening it; or
3. Not lifting straight up.

Inspect your own casting by comparing it with the original.

Can you find any defects?

If so, what kind are they?
If so, can you explain them?

Take your time. When you've done a careful inspection, turn the page.

If you could find no defects, you are doing unusually well. It is the rare person whose first casting has no noticeable imperfection.

Let's pretend that your casting had a defect due to absence of bitting.

What should you do?

When ready with your answer, turn the page.

If your defect is due to absence of bitting, chances are that your mold is OK, and you only need to recast the key, using the same mold. Absence of bitting usually results from a bubble of entrapped air or too rapid cooling of the metal, rather than from damage to the mold itself.

NOTE: If you suspect that the defect is due to entrapped air, you may draw a fine line in the clay with the scraper, perhaps 1/2" or more long, leading away from the point in the mold where the defect occurred. This will allow the air to escape and metal to flow into that part of the mold.

NOTE: If you suspect that the defect is due to too rapid cooling of the metal, maybe you're counting seconds too fast and not heating the metal enough. Or maybe you're not holding the ladle the proper distance above the tip of the candle flame. The flame is much hotter at its tip than in the middle.

Let's pretend this time that your casting had a defect due to blurring of bitting. In comparing the casting with the original key, you notice some slight irregularities due, you believe, from damage to the impression while you were removing the key.

What should you do in this case?

When ready with your answer, turn the page.

If a defect is due to damage to the impression, you should start all over again—preparing the mold, taking another impression, and recasting.

NOTE: To reprepare the mold, you may either rework the clay already in the mold, or you may remove the old clay and start over with fresh clay.

If you rework the old clay, you should add to it the clay you scraped off and keep pressing *down* with your thumbs until the two chunks are smoothly blended.

If you remove the old clay, you will find the scraper convenient for getting the clay out of the mold-halves. You needn't bother to remove all traces of the old clay before adding the new.

Now that you have cast a key, you are all set to open the lock with what you have produced so lovingly.

Right?

When ready, turn the page.

Answer: No! You are not in a good position yet to open the lock!

Why not?

Ready with your answer? Then turn the page.

Good answers:

The metal is too soft.
There's no bow with which to hold and turn the key.

What must be done before you have a true "duplicate key"?

Thought out your answer? Then turn the page.

Answer: Before you have a true "duplicate key," you must make one of regular key metal (commonly brass). Usually this is done on a standard key duplicating machine.

Congratulations!

You now should be able to use the Key Casting Kit with at least a beginner's skill.

Practice will make you more nearly perfect.

Good luck to you!

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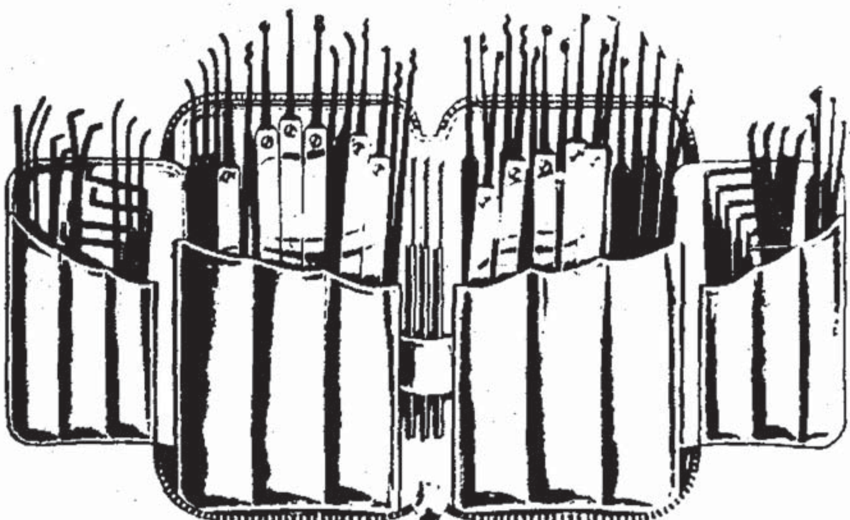

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GENERAL

Lock picking, like all facets of locksmithing, requires knowledge of the lock itself, a certain amount of manual dexterity, and a lot of practice. In this manual, you will learn about the construction of a pin tumbler lock and gain practical experience by following through on actual picking practice. You will progress from an easy to pick setup to more difficult ones as you gain more experience.

To practice picking, you will need the following tools and supplies:

1. A pin cylinder lock as illustrated in Figure 1 & 2. This type of cylinder is found in most common night latches. All locksmithing suppliers and many large hardware stores carry them for about $3.00 each. Try to get one as near like the ones illustrated as possible with the plug retained by a round plate and 2 screws. You will be removing and replacing the plug many times, and its ease of removal and installation is important.

2. A plug follower as illustrated in Figure 5. This can be either purchased from a locksmith supply house, or simply made from a short length of 1/2 inch diameter wooden dowel.

3. A pair of large tweezers for removing and inserting the tumbler pins. These can be purchased at most hardware suppliers. You may wish to file the tips as shown in Figure 7 to further aid holding the small pins.

4. A small set of lock picks and torsion wrench. These can be purchased from a locksmith supply house or made yourself. In Figure 10, 11, & 12 you will find full size templets for two of the most popular picks, and a standard shape torsion wrench. Any source of steel that is approximately .025 inch thick may be

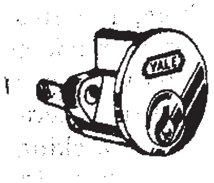


Fig 1

Fig 2

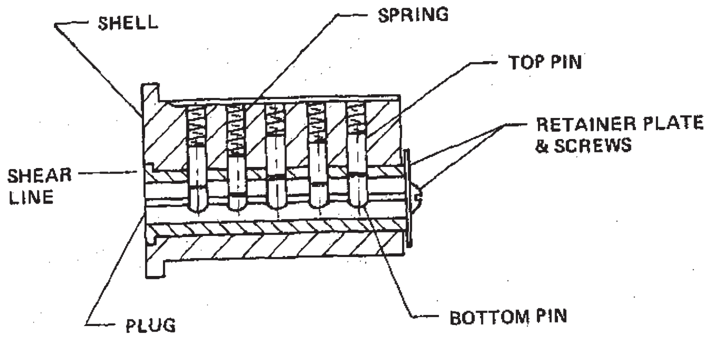


Fig 3

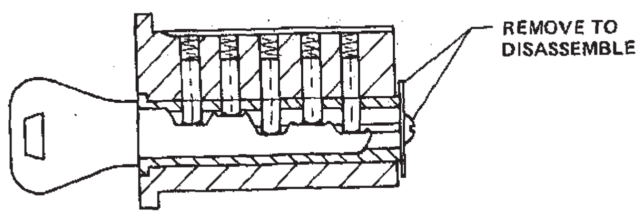


Fig 4

- fôrmas de gesso
- cadinho de porcelana
- maçarico
- Chumbo + Estanho — igual a tinta de ferro de solda.
- palito de sorvete + estilete

used. Just transfer the templet shape onto the steel and grind or file to shape. The torsion wrench is made from .025 x .125 flat stock steel. Again, you may use any available source. Your flat piece should not be so hard that it breaks when bending to shape. As you gain experience, you will soon be designing picks that fit your style best. A look at Figures 15, 16, & 17 will give you a good idea as to the many types of picks that are available from locksmithing supply houses.

5. You should also have a small vice to hold the cylinder as you practice on it.

Needless to say, a small, well-lighted work area will be of great help. Also, a small tray to hold pins, springs, etc. is a necessity.

In Figure 3, you will find a cut away view of a pin tumbler lock with the names of its various parts given. Throughout this manual we will refer to the parts by name. Study this illustration until you have memorized each part.

Take the cylinder apart by removing the two retaining screws and retaining plate. If the cylinder has a key, insert it into the keyway, thus raising all the pins to their shear line. See the illustration in Figure 4. The plug may now be turned. With the retainer removed, the plug can also be pulled out of the shell. Here is where your plug follower is used. Without it you would have pins and springs flying in all directions. As you pull the plug out from the front, follow it with the plug follower from the rear as illustrated in Figure 5. You will note that the bottom pins have remained with the plug while the top pins and springs remain in the shell, retained by the plug follower. By carefully removing the plug follower, you can remove the top pins and springs one at a time from the shell. Go slowly here, for this is the perfect time to have a spring go flying into space, never to be seen again. If some of the top pins are preceded by a rather short pin, then your cylinder was master keyed. These master pins, if present, can be discarded at this time.

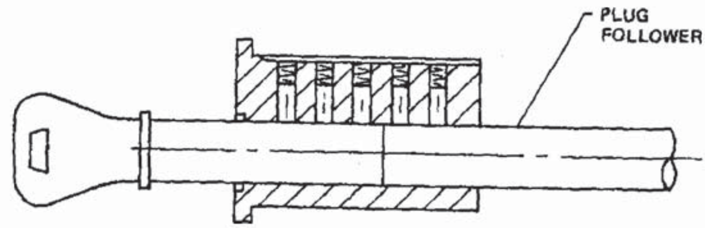


Fig 5

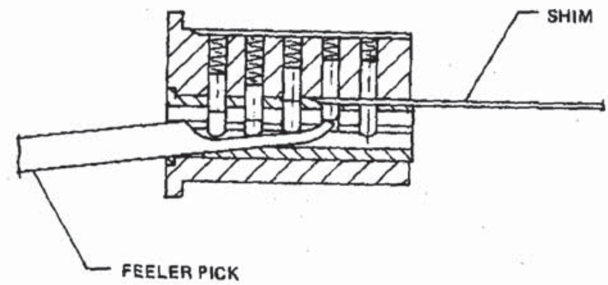
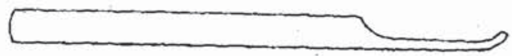


Fig 6



Should you have a cylinder without a key, you can disassemble it by shimming it open. See the illustration in Fig. 6. You will need a narrow piece of thin steel shim stock or an automotive type feeler gauge may be used. Locksmith supply houses carry curved shims just for this purpose. After the retaining screws and plate have been removed, the shim is inserted between the plug and shell from the rear. Starting from the rear pin, use a feeler pick to raise each pin until you can feel the shim go between the top and bottom pin. Procede forward until the shim is between the shear line of all the pins. The plug may now be removed as described in the preceding paragraph.

When reassembling your cylinder, the above procedures are practically reversed. The springs and top pins are loaded into the shell one at a time and retained by inserting the plug follower. The bottom pins are loaded into the plug and it is inserted from the front while the follower is forced out the rear.

PICKING PRACTICE — You are now ready to set up your cylinder for some simple picking practice. Remove the plug from the shell. Remove all the pins and springs except one or two as illustrated in Figure 8. You might wish to start with only one set to get a better feel for what is going on.

Insert your torsion wrench into the keyway in such a manner as not to block the keyway for inserting a pick. See the illustration in Figure 9. Begin your practice by using a feeler pick. While exerting a slight turning force with the torsion wrench, gently lift the bottom pin with the feeler pick. When the shear line is reached, the lock should open. If you should lift the pins past the shear line, then relax the force on the torsion wrench allowing the spring to return the pins to their original position and start over.

Note that this lock will open with the plug turning in either direction. If you were opening a lock as a locksmith, you would naturally apply torsion wrench force in the direction that the lock normally opens, usually clockwise.

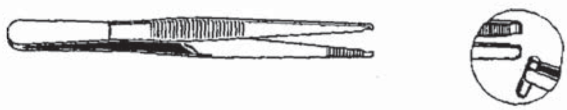


Fig 7

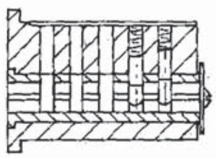
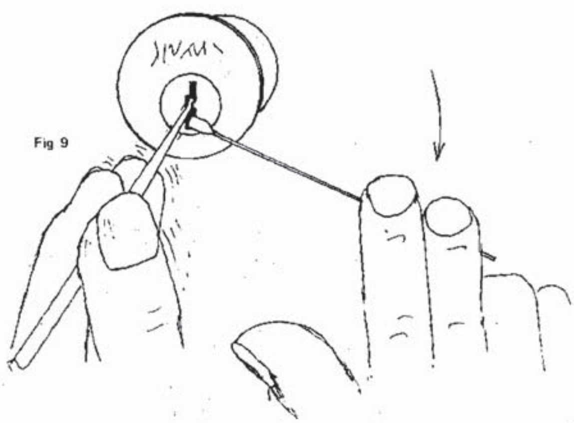


Fig 8

Fig 9



6

With your cylinder still set up with one pin, try using your rake pick. This pick can be used similar to a feeler pick, and also by inserting it past the pins and quickly raking it out toward you. This type of picking requires less torsion wrench force than while using your feeler pick. The most common mistake is to use too much force.

Another picking technique is to move the rake pick in and out really fast rather than just raking it out. The wavy end of your rake pick is well suited for this technique.

While practicing the above techniques, try using various amounts of torsion wrench force until you have a good feel for the best amount to use with each different method of picking.

When you feel ready, add one or two more sets of pins and springs to your cylinder, and again practice all of the picking techniques previously practiced with one set of pins.

While using your feeler pick this time, you will notice an important short coming of pin tumbler locks that aid their being picked: *ONE OF THE PINS WILL CATCH ON THE SHEAR LINE BEFORE THE OTHERS.* You will feel the plug turn ever so slightly. If using two sets of pins, when the last pin is raised to the shear line, the lock will open.

This "short coming" of locks is due to the tolerance inherent in their manufacture. It would be both difficult and expensive to manufacture a lock with all of the holes drilled the same diameter and in a perfect line. They may look so to the naked eye, but using precision measuring equipment, you would discover that such was not the case.

Therefore, when picking a cylinder lock having say five tumblers, one of the five will catch first, allowing the plug to turn a small amount. This will be true with each of the remaining pins until the last one reaches the shear line. Then the lock will open.

Fig 10

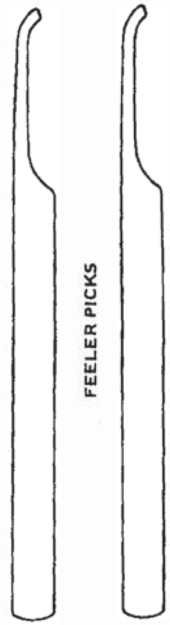


Fig 11

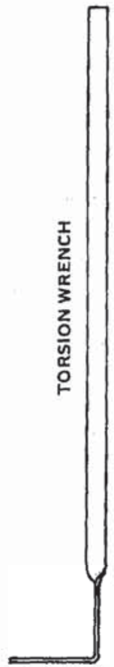


Fig 12

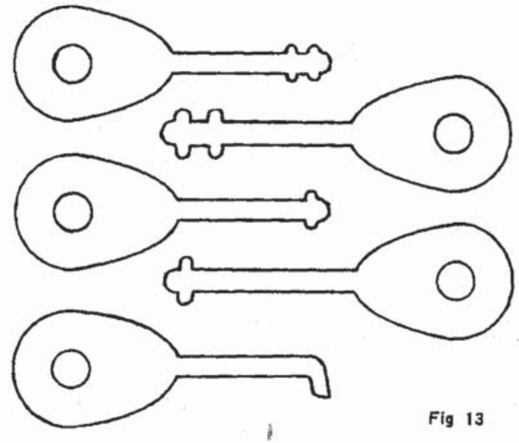


Fig 13

Fig 14

APPROX 1/2 SIZE

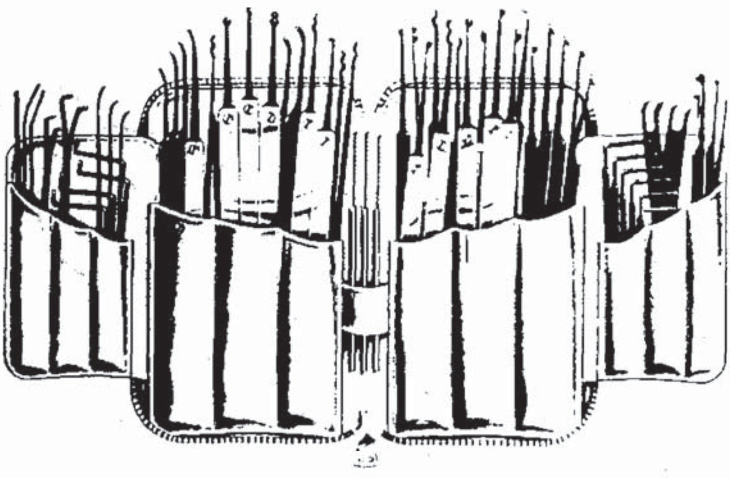


Fig 15

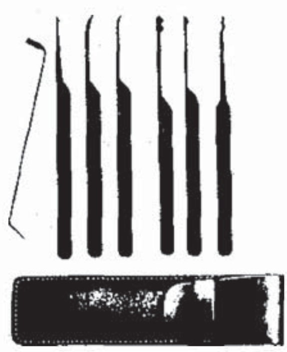


Fig 16

Fig 17

Usually, the cheaper the lock the easier it is to pick. There are some exceptions however. The pin tumbler padlock made by Master Lock Co. is a good example of a cheap lock that is hard to pick, due to the precision of their cylinder. The key-in-knob locks in most homes are very easy to pick due to their cheap construction and also due to the fact that most of them are master keyed, which simply creates more shear lines.

Continue practicing with two sets of pins until you feel proficient, then add another set and continue practicing with a total of three tumblers in your cylinder. Continue with four sets and then finally replace all five sets. If you have progressed well with the preceding setups, uou will have little trouble picking it open. You will now feel confident to try to open other locks. You will find some easier than others for reasons previously discussed.

Our study and practice in this manual has been centered around the pin tumbler. If you understand opening procedures with this lock, you will have little difficulty with other types. In the illustration in Figure 13, several pick keys for simple warded locks are shown full size. Cut them out of .032 thick steel, and you will have a set that will open most of the simple padlocks that you will encounter as a locksmith.

Another type of lock that you will find is the tubular key type, as found on most vending machines. This is a pin tumbler lock with all the pins radially located around the axis of the plug. Special picks are available from locksmith supply houses for these locks. See the illustration in Figure 19. These tools provide a turning force and also allow you to work each tumbler until the shear line is reached.

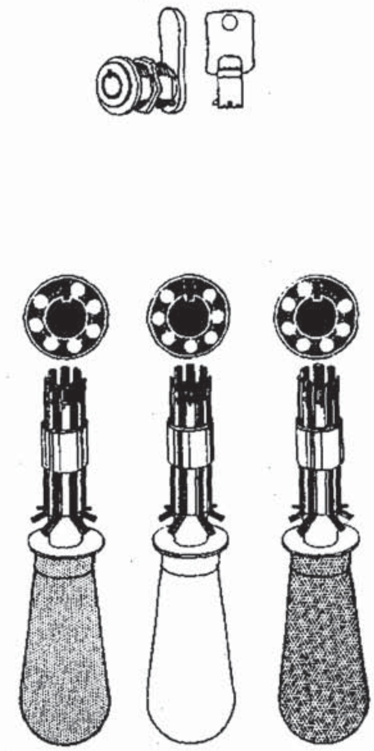


Fig 19

PICK GUNS

Pick guns are a generally misunderstood locksmithing tool. Most people, who are not familiar with them, think that there is something magic about them. They imagine little steel fingers that caress the lock mechanism into opening. The private eye shows on TV have aided this false thinking.

Mechanical pick guns, or lock opening aids as some call them, simply use the same basic principles as used when picking by hand. The gun shown in Figure 18 is known as a rake type gun. When the trigger is squeezed, the pick extends slowly forward. Being spring loaded, when it reaches its full forward travel, it snaps back out of the lock, raking all the pins on the way out.

The gun shown in Figures 20 and 22 is a snapping type gun. When the trigger of this gun is squeezed, the pick will travel down, then snap up very fast and hard. The amount of force is adjustable. When the snapping pick hits the bottom pin, the force is transferred to the top pin, causing it to travel up away from the bottom pin. This principle of physics applies when playing billiards. You apply force to the cue ball, which hits another ball. The cue ball stops while the other ball travels on.

In the lock, there is an instant of time when the top and bottom pins are separated at the same time. At this time, if a small turning force can be applied with a torsion wrench, the lock will open. See Figure 23.

As with any picking, it takes practice with these tools to become proficient in their use. These guns are sold by locksmithing supply houses for about $35.00 each.

Electric pick guns, as illustrated in Figure 21, are used in much the same manner as the mechanical snapping gun. They vibrate from the 60 cycle AC voltage that they require. This limits their usage to where they can be plugged in.

Some locksmiths have made their own by using an electrical toothbrush and adapting a pick holder to it, instead of the brush. Some of these have built in rechargeable batteries which make them excellent for using away from the shop.

Hand vibrators usually vibrate too strongly for effective use. Some of the vibrating types of electrical scissors could be adapted very nicely. The best would be the small childrens' type, with the 110 Volt 60 cycle vibrating motor. A pick could be easily attached to the moving blade. Door bell buzzers have also been adapted.

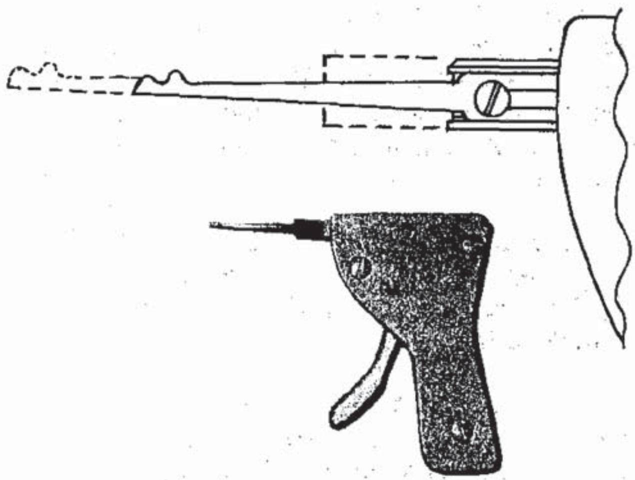


Fig 18

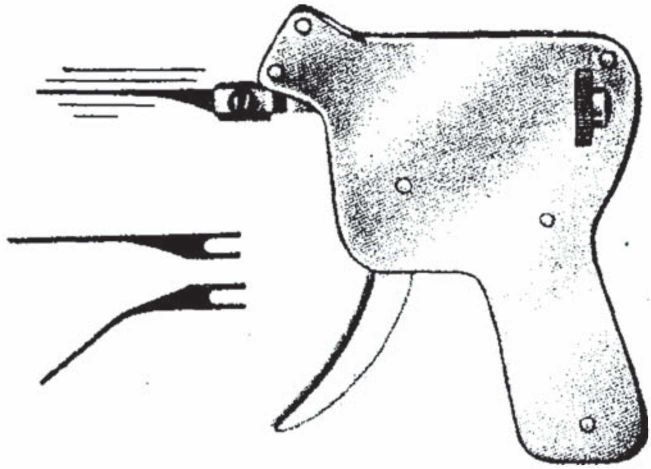


Fig 20

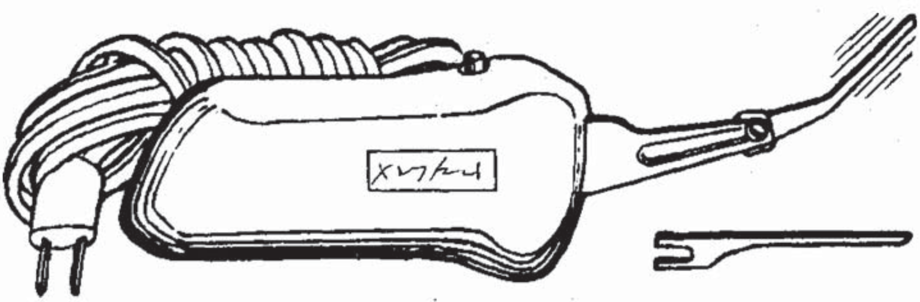


Fig 21

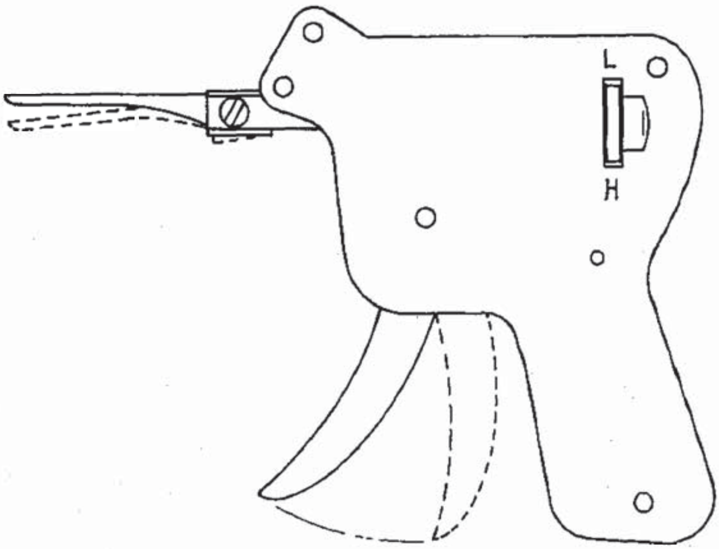


Fig 22

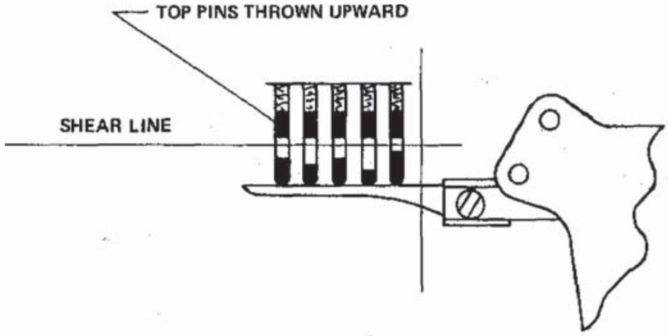
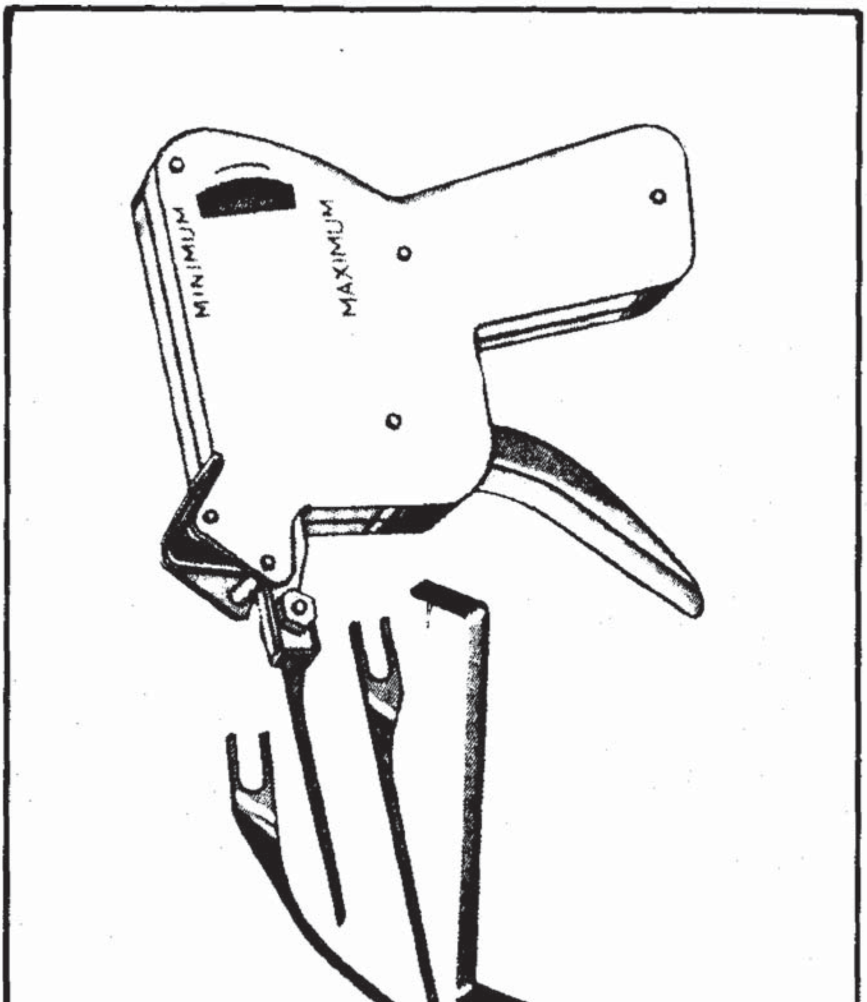


Fig 23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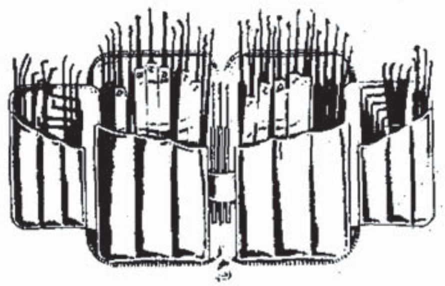


SNAP PICKS

Figure 24 shows a picking device known as a snap pick. They can be purchased from a supplier or one can be made from a piece of .025 x .125 steel strip.

Form the strip approximately as shown, and grind the pick end to fit a keyway. You could also make one from a piece of steel wire and grind the pick end flat. The exact shape is not important, and after some experience, you may find a design you like better.

It is operated by inserting the pick end into a keyway in the same way that a pick gun is used. Hold it parallel to the axis of the lock plug, and just touching the bottom pins. With the spring bail compressed as shown in Figure 25, slowly let the bail slip from under your thumb. The bail springs upward imparting a sharp rap to the pick end, similar to a pick gun. A torsion wrench is used to provide a small amount of turning force. When this picking operation is correctly done, the top pins will be thrown upward, leaving the shear line free to turn as in Figure 23.

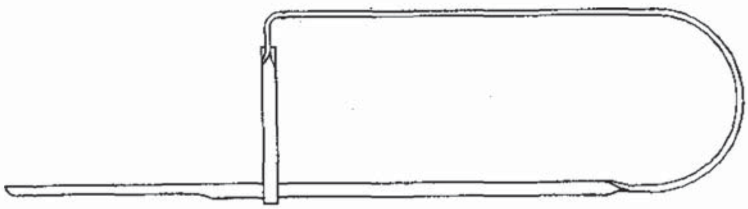


Fig 24

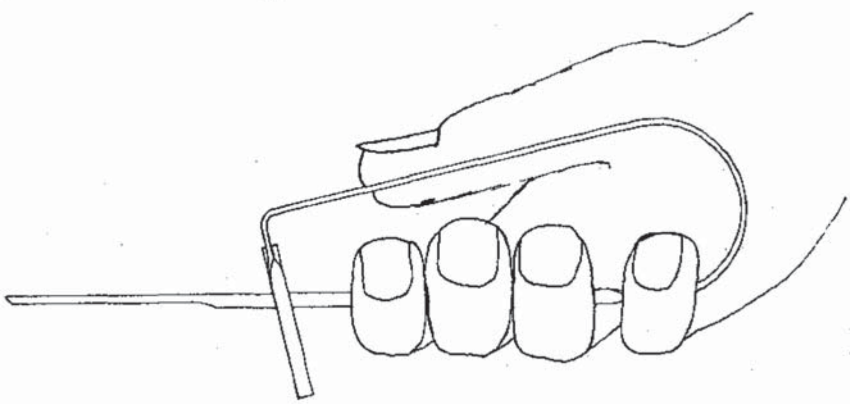


Fig 25

HOW TO PICK A SCHLAGE DISC TUMBLER LOCK

Before studying how to pick these locks, you should be familiar with the mechanism. You will find that there are two types of keyway units or plugs: a type 1 and a type 2. Each type requires a different tip cut. Figure 27 shows a tip cut for a type 1, and Figure 26 shows one for a type 2. Both are cut from the same basic blank.

If you examine the tumblers, you will find that there are three different types in the keyway unit: 1 master (always the farthest tumbler in the plug); 3 series tumblers; and 4 combination tumblers.

The master tumbler is spring loaded so as to extend from the plug, preventing its turning. When the proper key blank is inserted, the master tumbler is withdrawn into the plug.

The series tumblers are also spring loaded so as to extend from the plug. When an uncut key blank is inserted into the keyway, they are all four withdrawn into the plug.

The combination tumblers are spring loaded so as to be normally withdrawn into the plug. If an uncut key blank is inserted into the keyway, these tumblers extend from the plug.

These explanations may at first seem confusing, however, if you will disassemble and study the mechanism, it should be quite clear. This knowledge will now enable you to better understand how to pick these locks.

SCHLAGE PICKING PROCESS — You must first make yourself a set of picking keys. This is accomplished by altering a No. 1 and 2 key blank as shown in Figures 28 & 29. These key blanks both receive a .060 deep cut on both sides. On the side of the tip cut, the entire key is removed to the same level as the tip cut. On the opposite side, a .060 deep cut is made to the dimensions given.

A 2 to 3 inch length of material is soldered to the remaining portion of the bow. In the picking operation, this lever provides a means of imparting a turning force to the plug.

You will also need a pick as shown in Figure 30. This is made from a .060 diameter wire with the tip beveled as shown.

From the outside appearance of a lock, you cannot tell whether it is a type 1 or a type 2. Insert one of your pick keys into the keyway. The correct pick key withdraws the master tumbler and also the combination tumblers. Hold the pick key in place, and slide the wire pick into a position as shown in Figure 31. The resistance you feel while inserting the pick is the series tumblers being withdrawn into the plug. If you feel a resistance near the end of the rearward travel of the pick, it is the master tumbler indicating that you have chosen the wrong pick key. Using the other pick key, repeat the above procedure.

Inserting the .060 diameter wire pick withdraws the series tumblers into the plug. The plug would now turn if it were not for the fact that while the wire pick withdraws the series tumblers, it also forces the combination tumblers out of the plug. This is overcome by the following procedure: Apply a small amount of clockwise turning force to the lever soldered to your pick key. While holding this force, withdraw the wire pick and lay it aside. Slowly reduce the turning force until you hear the combination tumblers click back into the plug. The plug is now picked and can be turned clockwise to open the lock.

As with other picking techniques, picking a Schlage disc tumbler lock requires practice for proficiency.

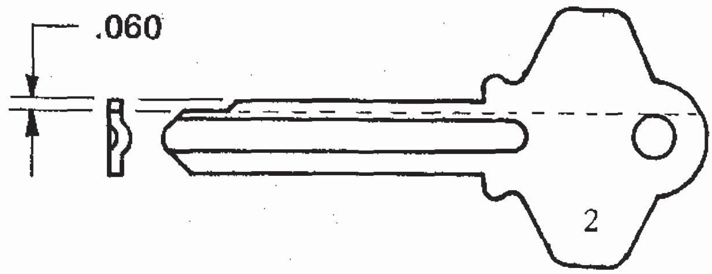


Fig 26

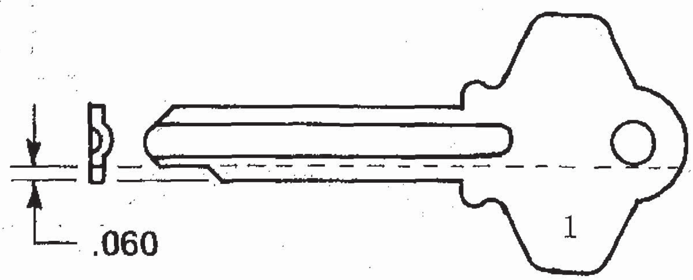


Fig 27

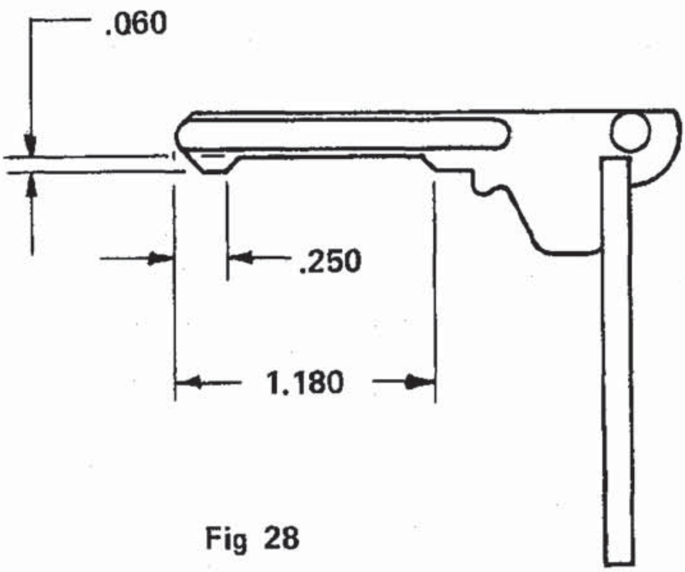


Fig 28

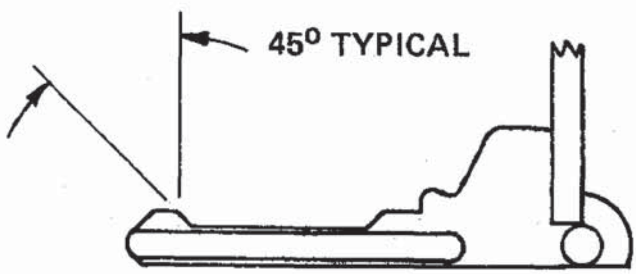


Fig 29

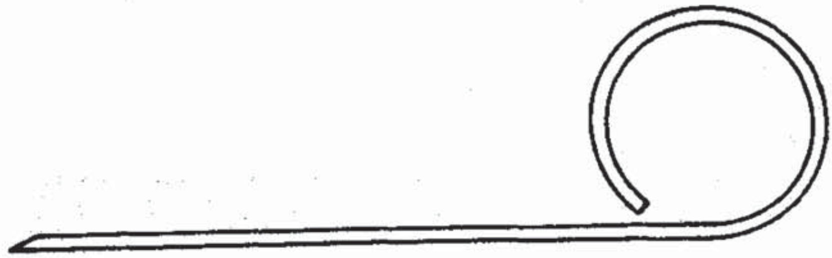


Fig 30

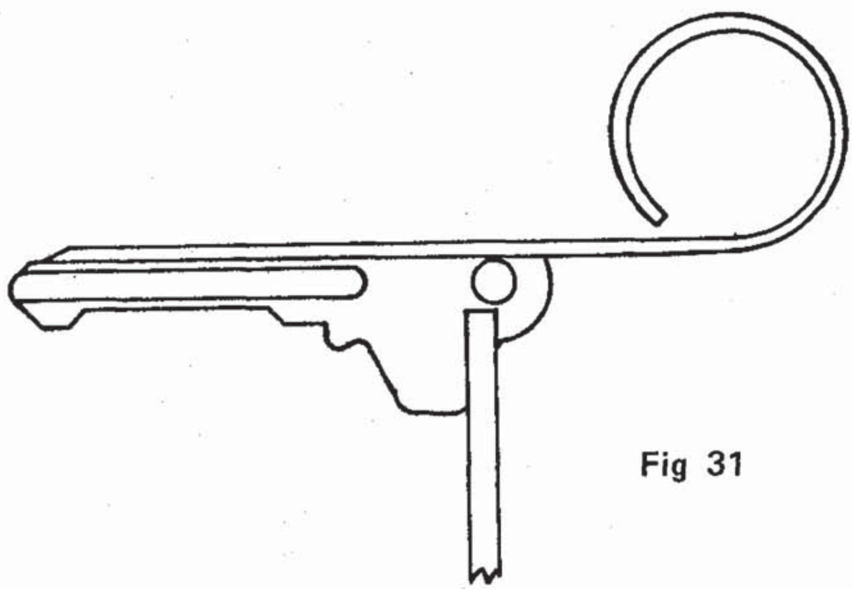
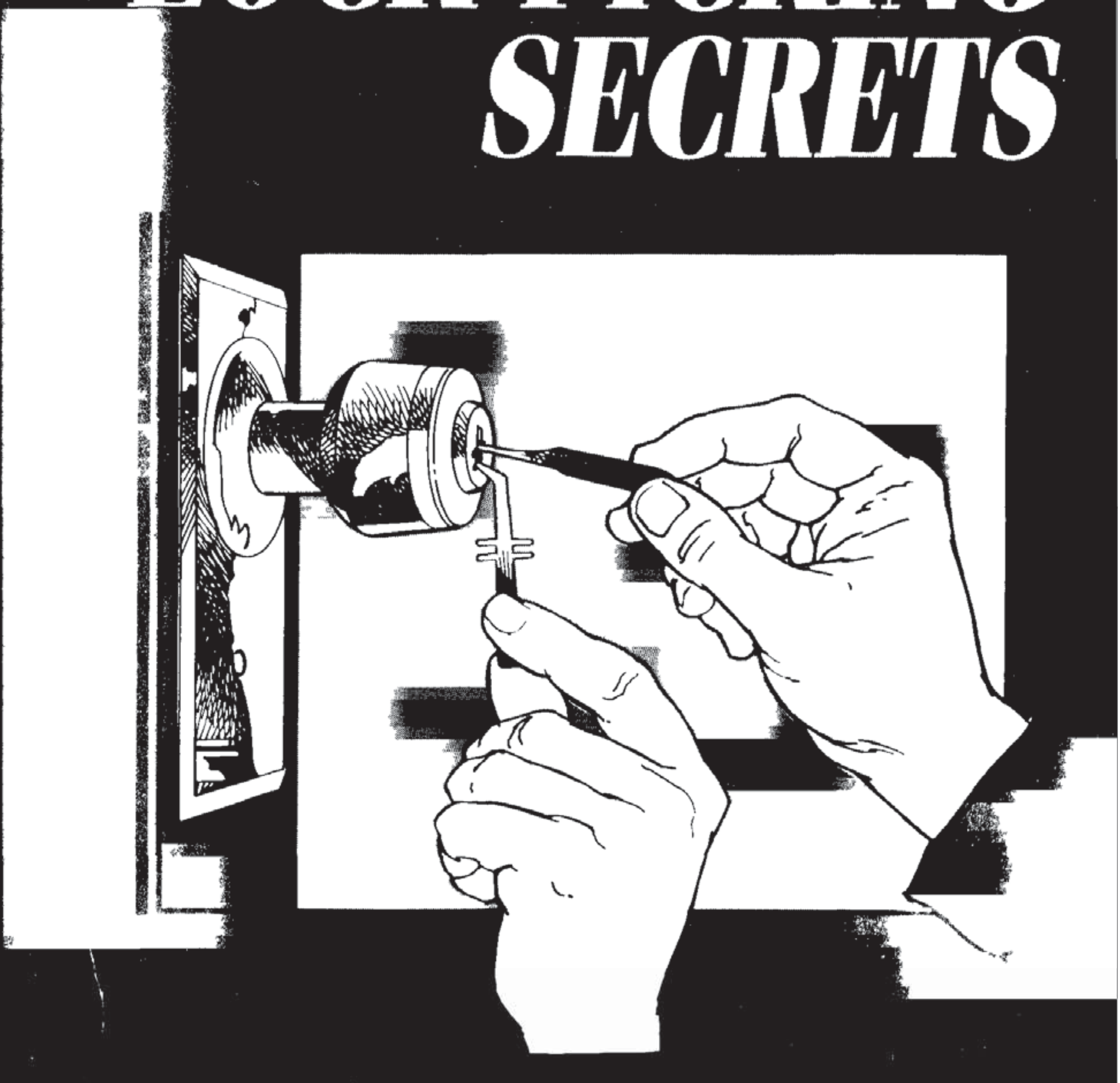


Fig 31

ADVANCED LOCK PICKING SECRETS



Steven Hampton

Contents

Acknowledgments

I would like to give special thanks to several people for their assistance with the research and development of this book. Mr. Steven Hillius, EE, provided the portable magnetic lock pick circuit design. I would like to thank Mr. Craig Herrington and Mr. Jack Folkerth for their help in creating and testing the new lock pick designs. Finally, I would like to thank a very good friend and kung-fu Master, Mr. Lucjan Shila, and Sensei John Angelos, for their contribution of the "Energizing Hands" exercise.

you must now have or you wouldn't be reading this book. There should be no doubt in your mind that you have the right stuff. And you do.

The second quality of a master lock picker is the ability to improvise when you are without lock picks—to be able to use such things as paper clips, small screw-drivers, pieces of wire, and hacksaw blades as tools. In other words, tools are always available to the master lock picker. And after finishing this book, you'll know, in greater detail, how to make your own professional tools.

Third, you have the understanding that if you break into a locked premise illegally, you could go to jail and not collect $200. I really did not want to write about such a negative subject, but it is important that we, as master lock pickers, have some integrity. With our knowledge and skills, we need to maintain some kind of code. For instance, I only pick locks for fun and emer-gencies. Being broke is not an emergency. If it comes down to it, you can probably get a job as a locksmith apprentice. If you encounter someone locked out of his house or car, and you are going to help him get in, be sure he can prove the property belongs to him. At least, ask to see his driver's license, just in case the police get involved.

So, those three qualities—confidence, skillful means of applying tools for the purpose, and caution when it comes to breaching the security of unknown situations—will keep you out of trouble and let you enjoy your skills as a master lock picker.

Another important factor to realize is that practice does make perfect. You not only project yourself into the lock you are picking, but the process of mere repetition will accumulate to make your fingers very skillful. By projection, I am referring to the intense concentration that leads to visualization of all the inner workings *of the lock you are picking.

As I also mentioned in my previous book, a firm yet gentle touch on the tension wrench is needed along with a sense of *heightened sensitivity,* which is basically developed through practice and mind*full*ness—being fully aware of what one is experiencing while picking a lock. One of my favorite scenes from a popular private investigator show on television is where the star is trying to break into his house while the "lads" (two Doberman pinscher dogs) are madly racing toward him. He repeats over and over to himself, "Concentrate on the lock, don't look at the dogs, concentrate on the lock." Of course, he gets in, just in the nick of time. So, success is simply based on concentration, which develops into heightened sensitivity through practice and remembering to focus: concentration is the key.

Making the Tools

The fundamentals of lock picking were covered in my first book, *Secrets of Lock Picking*. In this volume, we will expand on tool design and manufacture, and look at the development of further skills needed to successfully pick open most locks on the market today.

Security is an uncertain endeavor at best. Since there is an infinite variety of ways to secure property and valuables with locking mechanisms, it is natural that the even greater variety of ways to open locks would spawn new tools. Having the right tools is very important: good tools make difficult locks open faster and easier. The ideal tools should be durable, portable, easy to use, and effectively designed to open a lock quickly. In this book, I would like to introduce some new tools my research company has designed and tested, and also show you how to make your own. This is not as difficult as you may think since these tools are made from easily obtainable metal stock. You should be aware that these tools are not on the market; they were developed solely for myself and my advanced students.

All you need to start a lock pick factory is an inexpensive 5-inch bench grinder with cutoff wheel on one side, a pair of needle-nose vise grips, spray paint and stick glue for making the patterns, and a burnishing or Scotch-Brite wheel attachment for smoothing up rough edges.

With this simple setup and a little practice, you can create virtually any kind of lock picking tool you will ever need. You can even create your own style if you so desire. Your first few tools may not turn out as you planned, but don't be discouraged: by the second or third try, your picks will look professional. Also, you'll never be without good lock picks since you will be able to whip up a set in minutes.

The bench grinder I use is a 5-inch Black and Decker, Model 7901 with a 1/2-inch arbor and 3600 RPM. This little plastic-cased grinder costs about $30 at discount stores, and I have made hundreds of lock picks with it. If you can find a reasonably priced 6-inch grinder, go for it.

Be very sure that you read and understand all of the safety rules involved with bench grinders and wear goggles or eyeglasses with safety lenses. If you have glasses made with safety glass, they may protect your eyes, but they could be damaged by burn spots. I wear high temperature plastic safety lenses, mostly because of their light weight and their resistance to burn spots. Also, don't wear polyester shirts or pants, as you could burn tiny holes in them; wear old cotton work clothes instead.

When buying a cutoff wheel and burnisher, be sure that they are rated at or over the RPM limit of your grinder. Since I am right-handed, I mounted the cutoff wheel on the right side of the grinder for easier maneuverability. Make sure that the arbor nuts are tight. The tool rest must also be level and tight. You will have to mount it on your workbench or an old table for good stability. Mine is mounted on a 2-foot by 3-foot, 1-inch thick board with 8-inch legs. With this setup, I can put it on a tabletop and stand while grinding. I also bored a 4-inch hole in front of the grinder for a water cup for quenching the metal to cool it down.

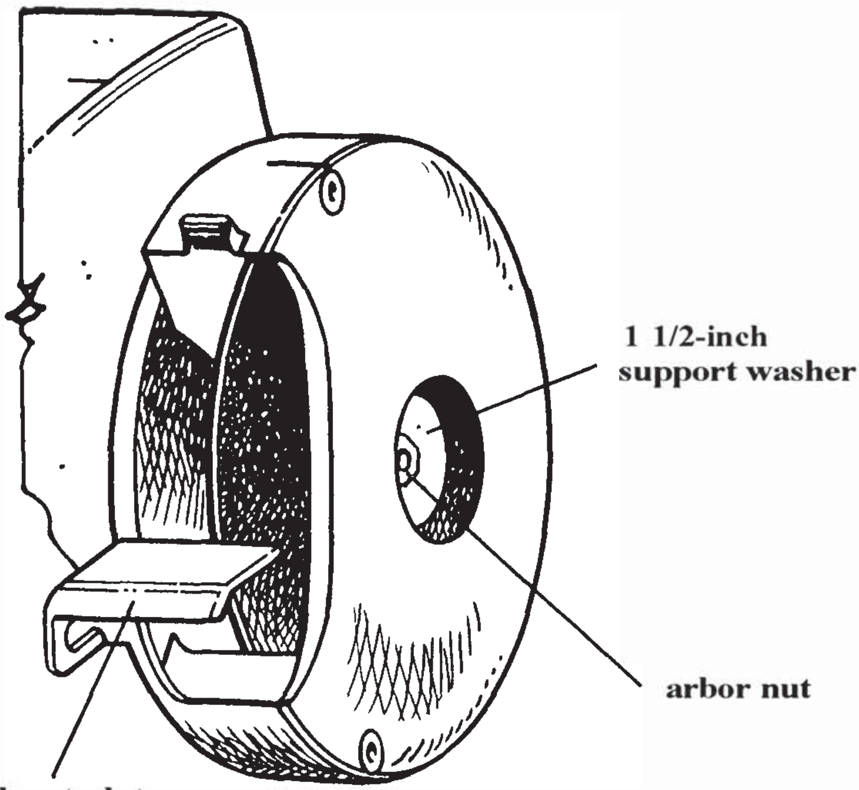


Figure 1. Cutoff wheel.

The Basic Lock Pick Set

After years of research and practice, I have designed a set of picks that will let you into about 80 percent of the cylinder locks that you might encounter in an average day. The pick illustrated in Figure 2 is made from a flat stainless steel steak knife. Steak knives are generally .032 inch to .035 inch thick and are already hardened; used as stock, they make durable and long-lasting picks. When properly cut out with a cutoff wheel and touched up with a grinding stone, they will outlast any commercial picks. Tension wrenches are about .040 inch to .045 inch thick, and I get that stock from pancake turners, spatulas, or large bread knives.

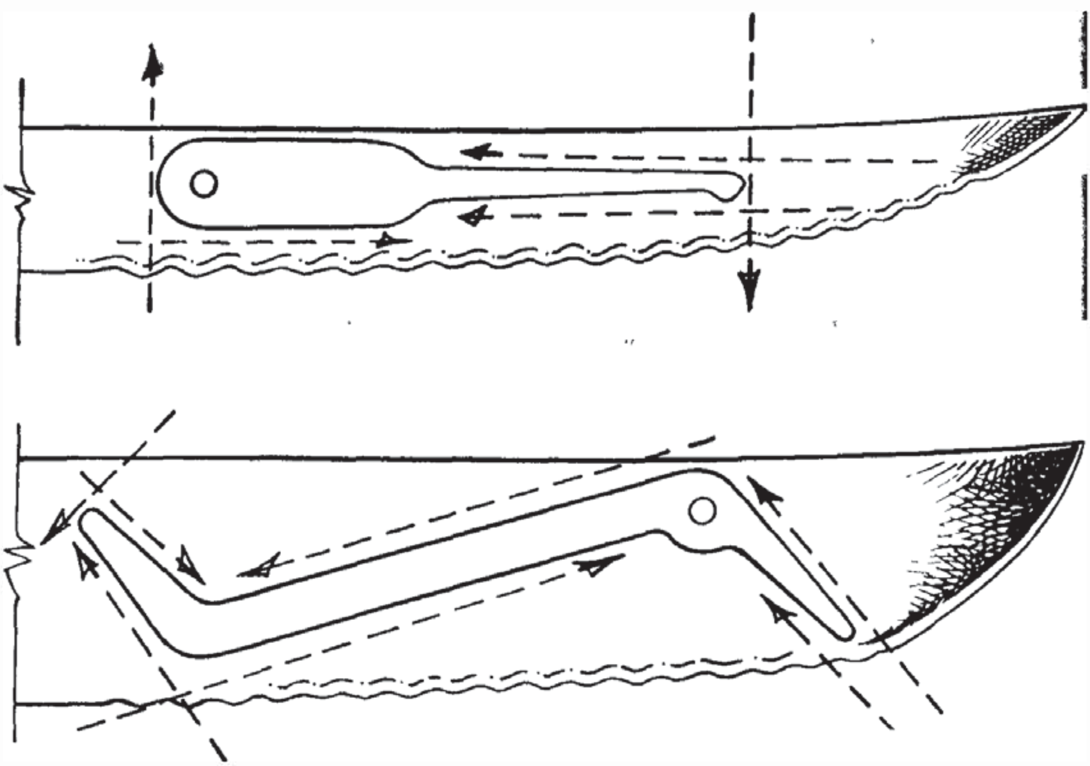


Figure 2. Lock pick tools made from steak-knife stock.

This tension wrench design allows you to open virtually all keyed tumbler locks with its long, narrow end. Automobile locks and other large tumbler locks demand the use of a wider and stiffer wrench which is on the other end of this design. The pick design is a diamond type that is medium sized to accommodate tight keyways and still have enough strength to prevent bending under normal lock-picking conditions.

All tool patterns illustrated in this book are the exact size of the tools. Make two photocopies of them to avoid destroying your book. Cut out one copy carefully, inside the line, with an X-ACTO knife. Clean the stainless steel stock with rubbing alcohol and wipe dry with a paper towel. Now, glue your pattern onto the steel, making sure that you place it exactly where you want it, without sliding it around on the stock. I use stick glue and apply it to the paper pattern only. Gently press down, without squishing glue out over the edges of the pattern. Let it dry for about ten minutes and spray paint over it with a high-temperature paint. I like a flat black paint, simply because of the greater contrast against the shiny steel, allowing one to see the pattern better. After another ten minutes, bake the painted steak knife for another twenty minutes in a warm oven at 200 degrees. When you take the painted pattern out of the oven, put it in a place where it won't be disturbed and let dry overnight.

The next day, carefully remove the painted paper pattern from your stock. You are ready to cut and grind. You can use this paper-to-steel technique with almost any lock-opening tool you want to make. If you want to duplicate a tool you have already made, just place it on your steel stock and spray paint directly over it. Let it set for sixty seconds and remove the tool from your

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When you have completed cutting and grinding your new tool, use the second photocopy to make final touch-ups and sizing. A finished tool should fit within the lines of the drawing.

Before you start grinding, here are a few helpful tips to make the job easier and more successful. The dashed lines with the arrows in the illustrations are the paths your cutoff wheel takes. This helps to eliminate excessive grinding. Use your vice grips to hold the stock. When that is completed, the rough form is ready to grind in smooth, even strokes. After final touch-ups are made, use a burnishing wheel to smooth out any sharp edges and corners. The burnishing wheel I use looks and feels like very hard rubber. It is impregnated with Carborundum.

If you have trouble getting the pick smoothly into a keyway of a standard pin tumbler house lock, you may have to lower the diamond point slightly by using the burnishing wheel on the bottom side of the pick's shaft only.

Also remember to quench the steel with water every three or four seconds when cutting and grinding. You don't want to void the steel's temper by getting it hot to the point of dark blue discoloration. If you can avoid the straw-yellow discoloration, do so as much as you can, but this is often not completely possible.

The holes are optional. I do this part of the job last. The holes must be drilled by a drill press with a sharp, high speed carbon drill bit about 1/8 inch in diameter. Stainless steel is very hard and dulls bits quickly. If you don't have a drill bit sharpener, plan on one drill bit per tool. They are about one dollar apiece, so this is not a major expense. Center-punch the holes before drilling, and avoid hitting the punch any harder than if you were starting a nail into wood.

Angular Pin Tumbler Locks

The Medeco Lock Company has designed a sophisticated lock which I refer to as an angular pin tumbler. Not only do the pins have to be raised to their proper shear point, they must also twist or turn in order to clear the cylinder-shell line. The pins are cut at an angle rather than on a horizontal plane. The keyway is also tightly corrugated to restrict foreign objects such as picks. Figure 3 shows a Medeco key with its angled cuts. This type of lock is considered by most locksmiths to be a high security device, and keying one up requires special tools.

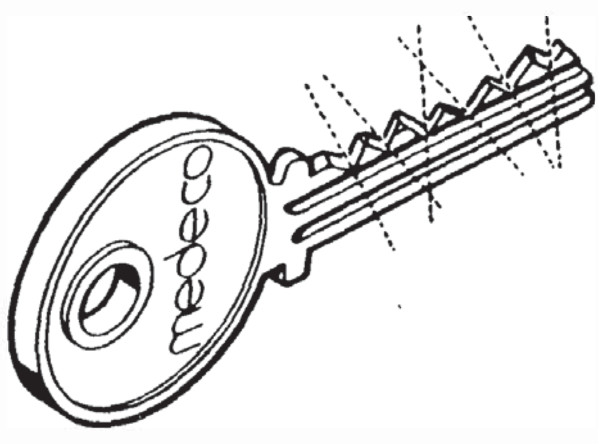

Figure 3. Medeco key.

One of the newest developments in pick design is my twisted-wedge point lock pick. It is very effective on these locks. To make this pick, take a standard diamond pick and put it in a vise with only the last 1/32 inch of the tip exposed. Heat gently with a propane torch for thirty seconds. Using a pair of pliers, gently twist the tip 15 degrees as shown in Figure 4. The vise will absorb most of the heat to keep the shaft of the pick from losing its temper. Remember to heat the tip until it turns blue, then twist. The tip will lose its temper, but it is not involved with much stress when picking so it will be all right. It is still harder than brass and will hardly wear. After it has cooled, carefully file it to a wedge-like shape, keeping the angle even. Burnish to remove any discoloration and file marks. If you have trouble getting this pick into the Medeco keyway, carefully grind off the bottom of the pick's shaft along its whole length until it slides in with little effort.

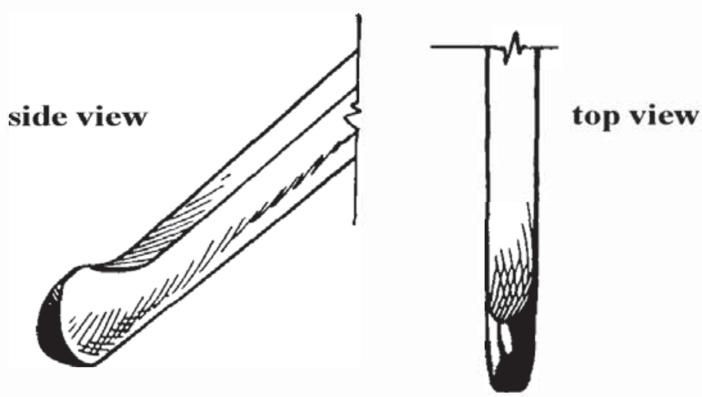

Figure 4. Twisted-wedge point pick.

One should practice with an old Medeco lock before attempting to open one in an emergency. The lock must be picked as if you were "raking" the tumblers so as to allow the pins to rotate as they are raised. A feather-touch tension wrench must be used. These locks require a lot of play with the tension wrench because the pins must be free to rotate. I have had much success picking these locks with the twisted-wedge point pick and a feather-touch wrench. The feather-touch wrench is used until the pins have reached their shear point and the cylinder has been freed. At that point, a standard tension wrench or small screwdriver is needed to turn the cylinder to unlock the lock.

A major drawback to these locks (along with most other pin tumbler locks), which is to your advantage, is that they are made with relatively soft brass and can be easily drilled. The cylinder can then be turned with a medium screwdriver, shearing the tumbler springs and unlocking the lock. Drill 1/16 inch above the top of the keyway about 7/8 inch into the lock. This obviously destroys the lock, which runs about $125 at 1988 prices.

Rim Cylinder Locks

There are two major manufacturers of rim cylinder locks; the two different cylinder sizes are typically classified as large and small. These locks are basically pin tumbler-type locks that have their shear lines arranged on a circular plane rather than on a horizontal one. There are usually seven pins, and each one has to be depressed a predetermined distance to its individual shear line. When all of them are at shear point, the cylinder, located at the center of the lock, can be turned, thus unlocking the lock.

The major security factor of these locks is that the pins lock up again when the cylinder has turned only 51 degrees and must be picked two to three more times in order to accomplish the desired 180 degrees to unlock the lock. This takes a lot of time and patience, which discourages illegal entry. Another factor that makes the rim cylinder lock a good security device is that it is very difficult to get a firm grip on the cylinder. Needle-nose pliers just get in the way of the pick and tumblers. Even L-shaped tension wrenches have a tendency to slip out just when the cylinder feels ready to turn.

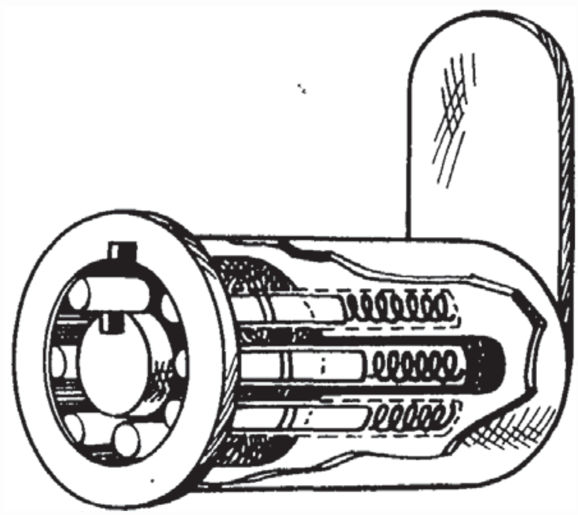

Figure 5. Rim cylinder lock.

One day while working on my plumbing, I got an idea. By designing a U-shaped tool to be used like a pipe wrench, one can grab hold of the cylinder with it and still have plenty of room for the pick to do its thing. When placed across the cylinder and used with a straight pick, this type of wrench would really speed up the process of picking these locks. The prongs of the wrench must not be burnished but left with sharp right angles for better gripping. Needless to say, it worked great. We will discuss how to make a tool that has this feature in three different sizes later in this chapter.

In an emergency, there is also the "make my day" method in which you cut the pins out of the lock with a hole saw (without the centering drill bit). The cylinder is then turned with electrician's pliers or needle-nose vise grips.

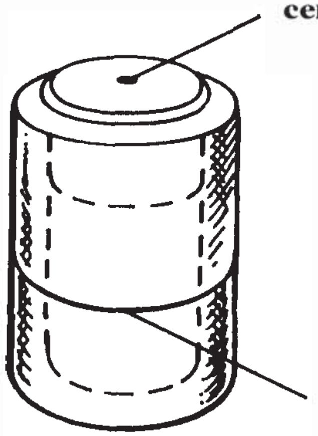

Figure 6. Lock cylinder.

Another new development in lock technology that you should be aware of are the tube pins used on the higher security rim cylinder locks. They are tube-like structures with shear lines and usually surround four of the seven pins, making for a total of eleven pins. The lock is picked the same way as a regular rim cylinder, but takes even more time to open. Once the solid pins have been set with your pick, you must go back and depress the tube pins to their shear lines.

Mushroom and Spool Pin Tumbler Locks

Spool refers to the top pins and *mushroom* refers to the bottom pin, the one that gets picked. These pins are machined down to resemble spools and mushrooms so as to foil any picking attempts. They are installed in

Figure 7. Spool pin (left) and mushroom pin (right).

pin tumbler locks that are used in relatively high security situations. The indication that one has encountered a lock with these pins is that the cylinder seems to want to turn while picking, but stops short at about 10 or 15 degrees of its turning radius. They give a false sense of

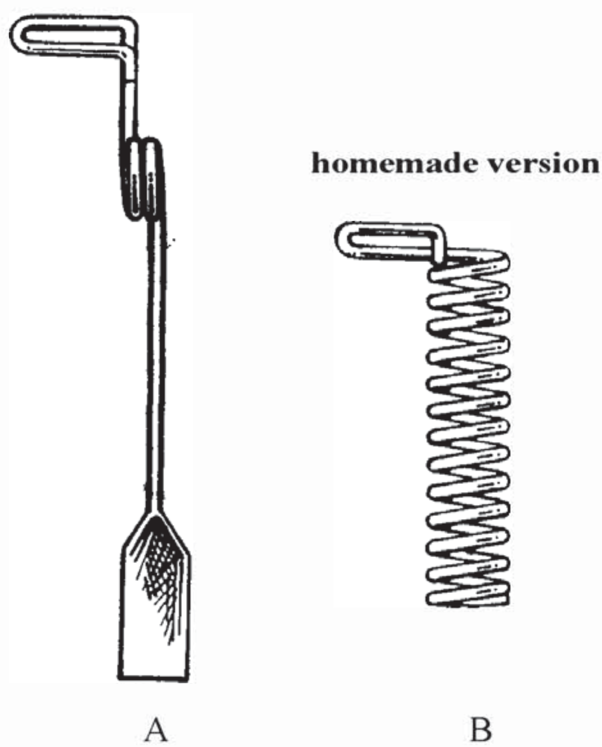

Figure 8. Feather-touch tension wrenches.

success by giving an audible and physical sensation that the lock cylinder has been released. In reality, the cylinder has been caught in the middle of one of these pins.

This problem can be overcome by using a feather-touch tension wrench (see Figure 8A). A feather-touch wrench is a spring-loaded tension wrench that regulates a slight pressure on the cylinder, which allows you to "bounce" these pins into place at their shear points with your pick. This may appear to be a sloppy way of picking a pin tumbler lock, but it is the only way one can overcome the tendency of these pins to snag on the shear line. This is a case where being sloppy requires more skill than being skillful.

Once the cylinder has been freed, a standard tension wrench or small screwdriver must be used to turn the cylinder and operate the unlocking action of the cam. Figure 8B shows a homemade version of the feather-touch wrench made from a medium-light duty spring. A pair of needle-nose pliers is needed to bend the loop that slides into the cylinder's keyway.

These pins are used in bank door locks and in other areas that are usually backed up with burglar alarm systems. Some padlocks have these pins. The American Lock Company uses them in its stainless steel-cased padlocks, which are machined to close tolerances and can be quite a challenge to pick open. But like most other locks, they can be picked open by an experienced lock picker with the right tools.

Another mushroom pin tumbler lock is the West German-made **Diskus** padlock from the Abus Lock Company. It has a stainless steel case with only four tumblers and a small corrugated keyway. It sounds simple, but I've seen this little padlock put locksmiths

Figure 9. Mushroom and spool pin padlock.

into contortions to pick it open. It's hard to hang onto, even though it's over 2 1/2 inches in diameter. The cylinder is mounted upside down and the tight keyway has those four tiny pins with a mushroom cut, which makes this lock one of the hardest to pick. Part of the problem is that most conventional diamond picks are too large for the keyway. Figure 10 is a smaller version of the diamond and should only be used with locks like this one, since the pick's shank is narrower and could bend on conventional locks.

One of my lock picking successes was picking one of these open (without ever seeing one before) in front of two master locksmiths who said it couldn't be done. If you have practiced the skills covered in my first book and have read thus far into this book, chances are you would be able to open an Abus Diskus padlock. To feel the round bolt slide open on this lock is a real feeling of success, and I hope you have a chance to open one. They cost about $12. Not only can you use it for practice, it is a very good padlock for personal use.

Figure 10 shows a pattern for a small diamond pick, which is required to open locks with small, tight keyways.

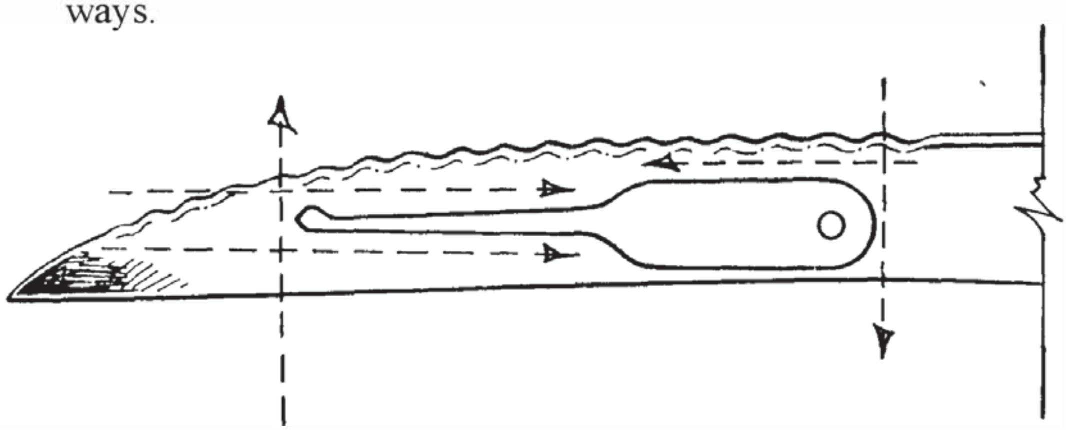

Figure 10. Small diamond pick.

Universal Tension Wrench

Since a simplistic approach to lock picking is so successful, creativity can find its outlet in the area of lock pick design. The idea would be to develop simple, yet multifunctional and easy-to-carry lock picks. Also, designing new tools is fun.

Figure 11 illustrates a tension wrench I designed and made that is very handy to have around. It is called the "Dragon." It is a universal or multiple-use wrench that is like having six different wrenches in one wallet-size tool. It features three different types of rim cylinder tension wrenches, a double wafer lock wrench, an auto lock wrench, and a long, narrow snout for virtually all types of pin and wafer tumbler locks. The "legs" of the Dragon have a pipe wrench-like gripping action on rim cylinder locks. The "wings" are used for double wafer locks to place the pick between them while picking. You may bend these wings slightly if you wish for better accessibility to the tumblers. If you do so, you must place the body of the Dragon in a vise and heat the wings for three minutes with a 1500-watt hair dryer. Slowly and carefully, bend both prongs at the same time with a pair of pliers. Remember to bend only to about 15 or 20 degrees; if you bend them any further, you might break off a prong.

Figure 11. Universal tension wrench called the "Dragon."

In order to make this tool, you will need .035-inch stainless steel stock. The piece should be 3 1/2 inches by 1 1/4 inches. Make your pattern as described on pages 9 and 10. When you have a painted pattern on your stock, rough cut it out with your cutoff wheel. You will have to use the cutoff wheel to get between the Dragon's legs and wings, so cut carefully in these places. The only way you will be able to finish these places is with the cutoff. The rest of the areas can be cut so that you have just a little metal to grind. Now replace your cutoff wheel with the burnishing wheel and smooth all sharp edges. Be sure to leave relatively sharp right angles on the Dragon's feet since they have to be able to grab rim

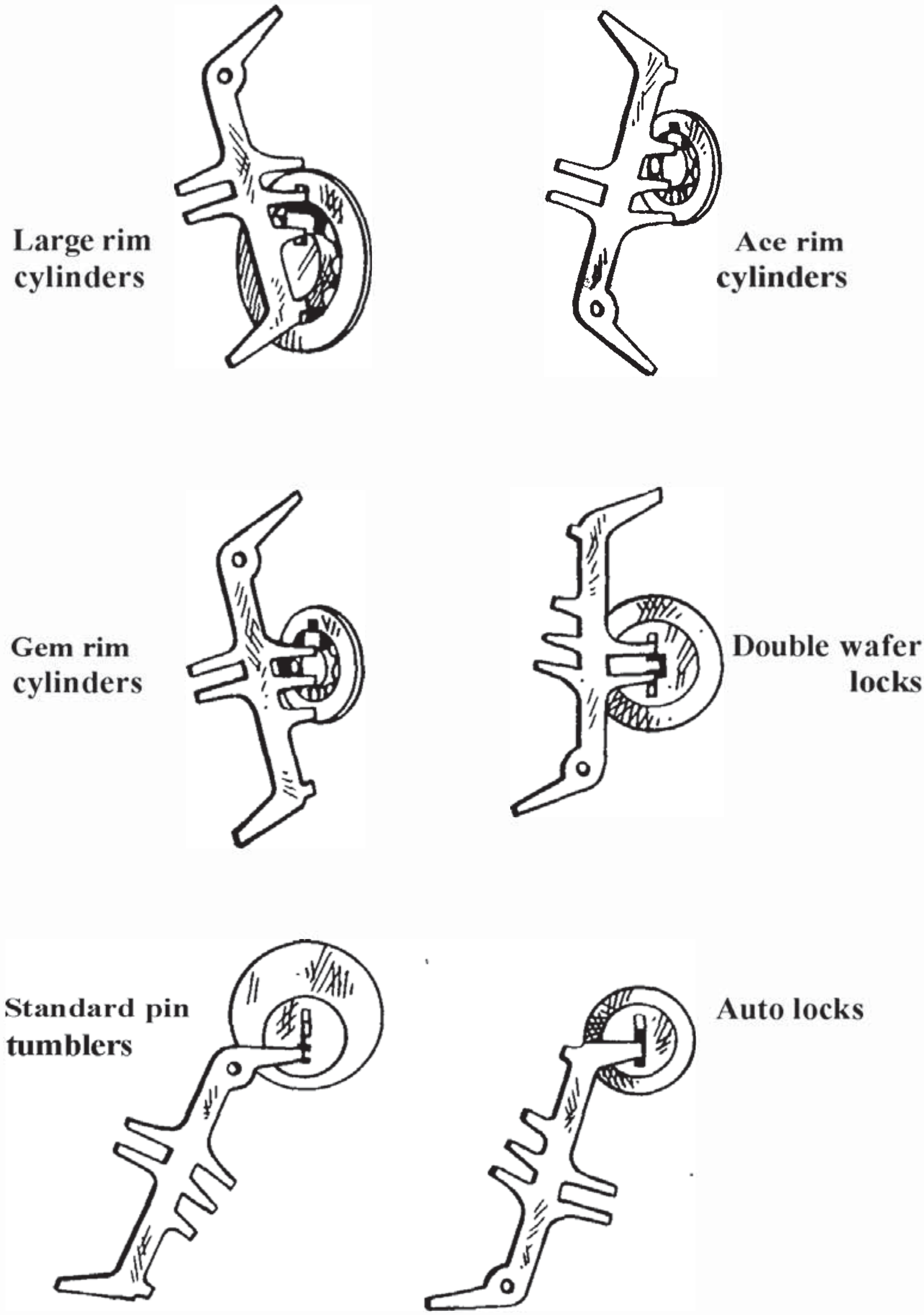

Figure 12. Using the Dragon universal tension wrench.

cylinders. The front of the first leg and the back of the last leg can be smoothed with your burnisher to keep the tool user-friendly; otherwise, it could snag clothing or your wallet.

The key chain hole is optional but may be drilled on a drill press since stainless is so hard. Start with a small drill bit to make a pilot hole, than finish it with a 1/8-inch bit. You may also want to chamfer the hole by hand with a 1/4-inch drill bit when you are done.

Making this tool is not as difficult as it may first appear. The hardest part is cutting out the paper pattern. The time it takes to make is well worth it, since nothing like it exists on the market. I am the sole patent owner and have given you permission to make it for your own use.

Figure 13 illustrates a pattern for a pick I call the "Serpent," which has a diamond tip pick on one end and a ball pick on the other. The diamond tip is obviously useful for pin and wafer tumbler locks, and the ball end is used exclusively on double wafer locks. If you wish, you can make the central 3/4 inch of the shank wider for easier handling. My hands are large, yet I find the size illustrated suits me fine. If you learned to pick tumbler locks with a safety pin, as I did, you'll find that this size will work well—you'll have less metal to carry.

Figure 13. Serpent pick.

With the Serpent and the Dragon, one can open a wide variety oflocks. With practice on each aspect ofthe tools, one basically becomes a walking key.

Warded-Lever Locks

Figure 14 shows a few warded-lever lock pick keys. Examples A and B are skeleton keys made from .045-inch stock. They are used on the old-style door locks of years past and, surprisingly, are still in use in isolated cases. Some old office buildings and homes still have them on the doors. These two tools are designed with maximum clearance while maintaining enough metal to keep them strong.

The pick key in example C is made from .025-inch stock and is used on old desks and cabinets. It is made thin so it will bypass the center restricting post on these types of locks. Examples D and E are pick keys made from about .035-inch stock. They are used on simple courtesy dispensing devices in public places, such as the paper towel box in bathrooms, and so on.

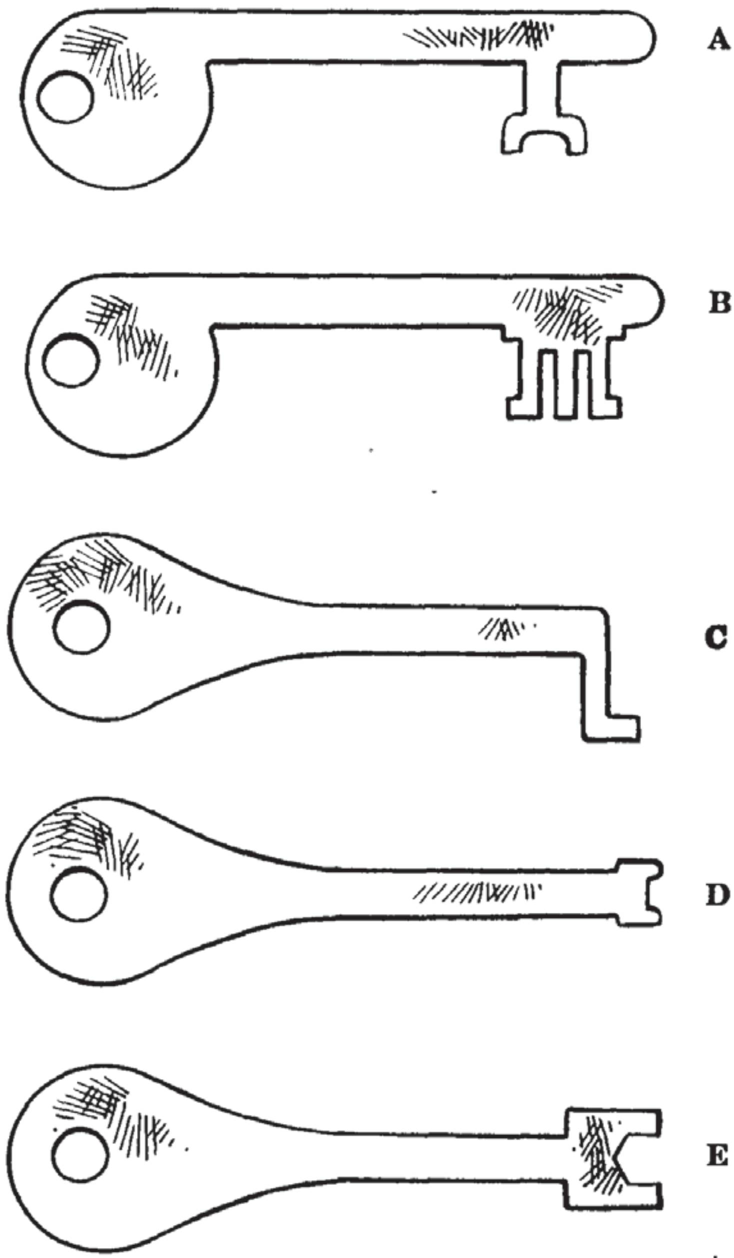

Figure 14. Five keys for warded-lever locks.

Magnetic Locks

Magnetic locks are usually divided into two groups. The purely magnetic ones are basically mechanical in nature. These operate on the principle that like poles repel. The other group of magnetic locks uses electronic sensors to read the small magnetic fields embedded into plastic cards. These fields are detected and decoded to determine whether or not to allow entry.

The mechanical-type magnetic lock has magnets super-glued onto a spring-loaded cam network. These magnets are arranged in such a way that the key's magnets will repel the magnet-operated cam through the bolt, thus opening the lock.

Although magnetic locks were discussed in my previous book, there seemed to be some questions from my readers about the magnetic pick. Most of you were wondering if it could be made portable, and in this chapter we will discuss three portable magnetic lock picks. The first one is rather simple and works 75 percent of the time. The second one is much more complex, and you may need a friend who is an electronics technician to build it for you. Since locks are going the way of electronic technology these days, a knowledge of electronics is useful to the master lock picker.

These picks are used in a stroking fashion, either in and out through the key slot of a magnetic card lock or across the side of a magnetic padlock. The basic principle is to get the magnetic domains in the lock to vibrate, allowing you to catch the bolt at the right moment to open it (see Figure 15).

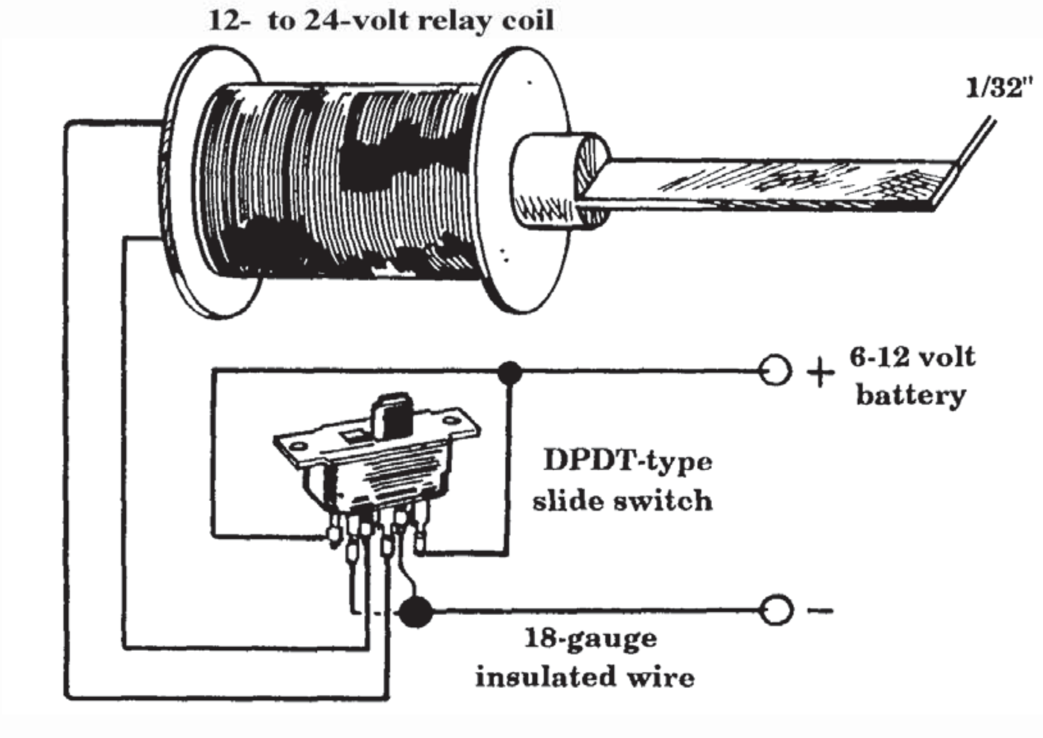

Figure 15. Magnetic "key" mechanism.

In order to do this, a quickly changing magnetic field is generated by a coil of insulated magnet wire and a source of electrical power. In Figure 15, a battery pack (four to eight D cells) is the power source. The switch is rapidly flipped back and forth to cause the current through the coil to flow one way, then the other. This causes the magnetic field to first go north, then south, then north, and so on. The coil can be salvaged from an old 12- to 24-volt solenoid, or you may choose to buy a new one. The important thing is that you need to remove the core (iron slug) from the solenoid, find its diameter, and get a steel rod the same diameter—about 4 inches long. Carefully grind down 2 inches (half the rod length) until it is about 1/32 inch thick so that it will fit into most magnetic card locks. After that, epoxy the unground side of the slug into the coil. This is your portable electromagnetic pick.

Be sure to add an on/off switch from the battery pack since the DPDT slide switch acts only as an oscillator switch and doesn't turn the unit off. This unit may cause television and radio interference.

Figure 16 is a more sophisticated version that oscillates the electromagnetic field for you. It is quiet and can be made small enough to fit in your shirt pocket. You will still be using a battery pack (two 9-volt transistor batteries, to be exact), but the unit frees up one of your hands while in operation. It is basically a multivibrator circuit, generating a square wave pulse, like a low voltage AC source. DC current comes from the batteries and this circuit converts it to AC for the pick. If you know some basic electronics, you'll find that it is easy to build. If not, have a friend who is familiar with the subject build it for you. You can use the same solenoid coil-type pick with this circuit and both picks are safe to operate. Make sure you use electrical tape to insulate all exposed connections. Also, don't leave the units on when not in use or you'll run your batteries down.

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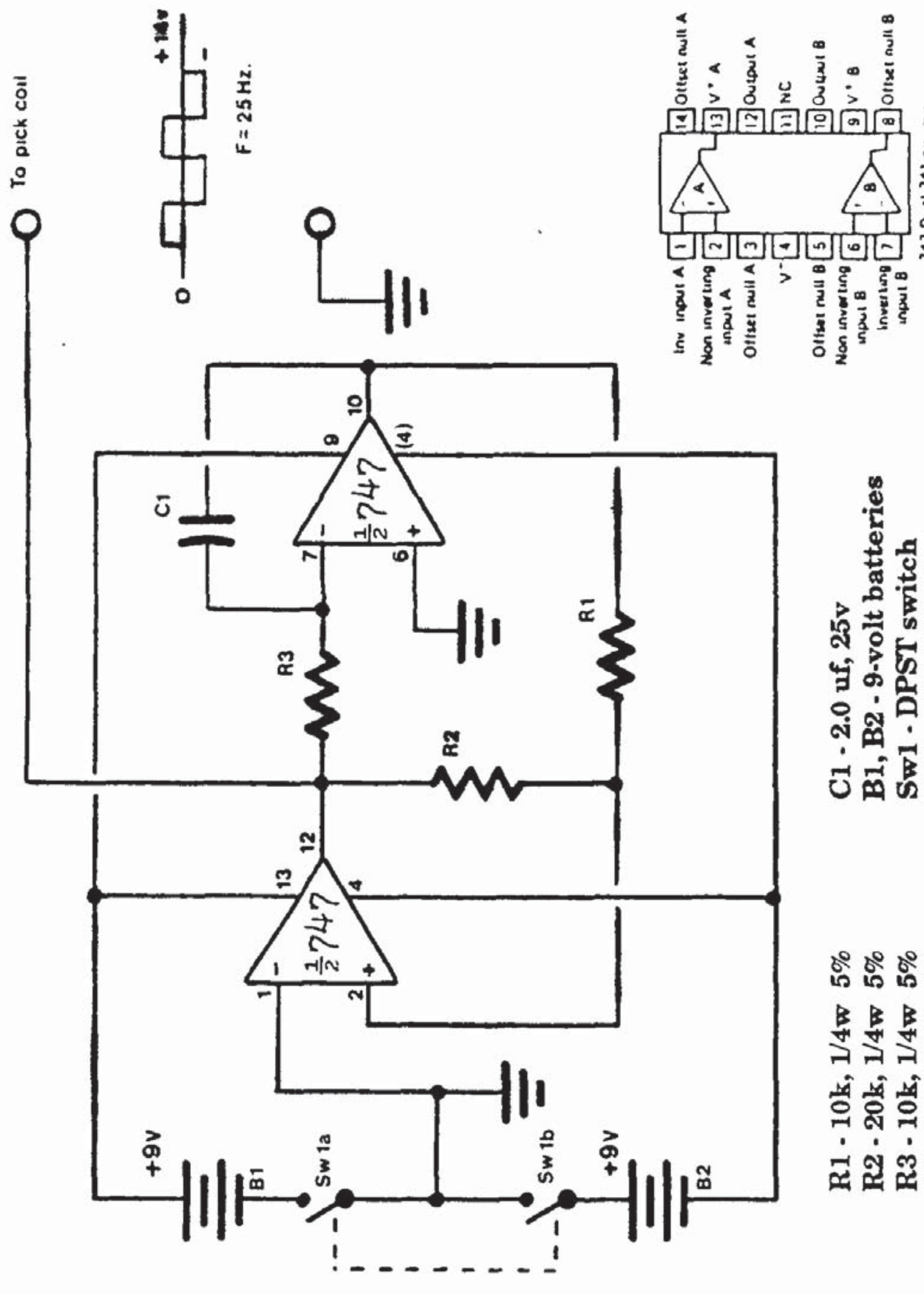


Figure 16. Magnetic lock pick schematic.

Magnetic Card Locks

Some magnetic locks use microprocessing electronic circuits to control entry. They are in current use on hotel doors and at the workplace. Though formidable in appearance, they have inherent weaknesses. Before we discuss "picking" these types of locks, let's see how they work.

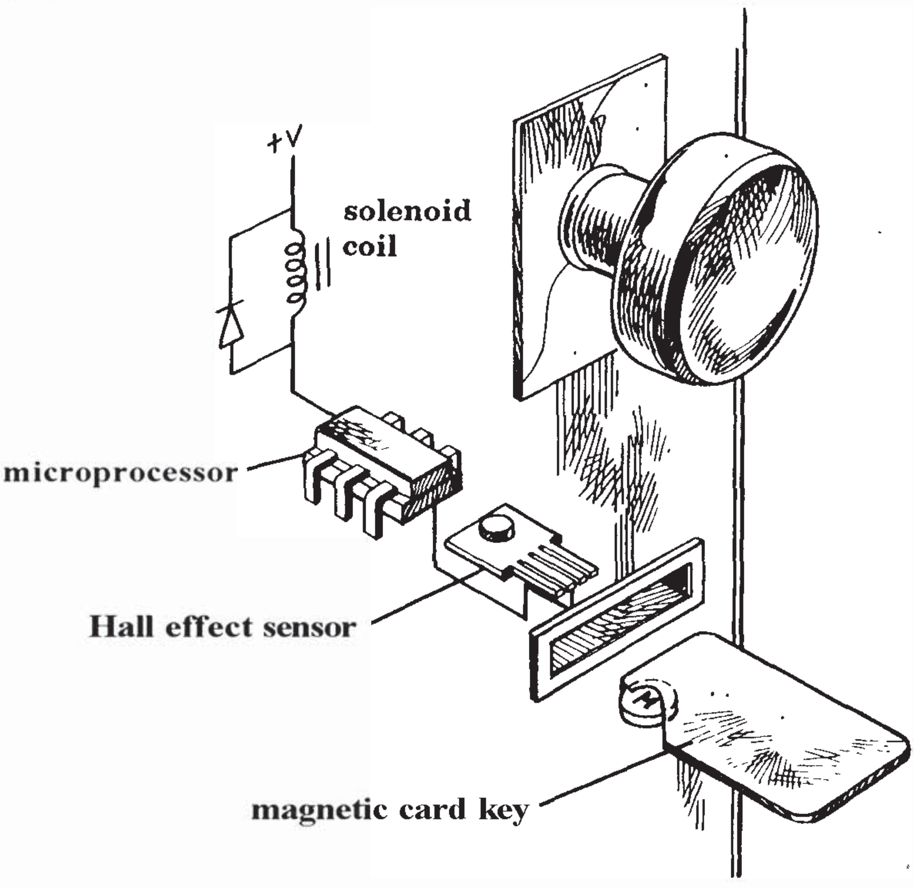


Figure 17. Magnetic card lock.

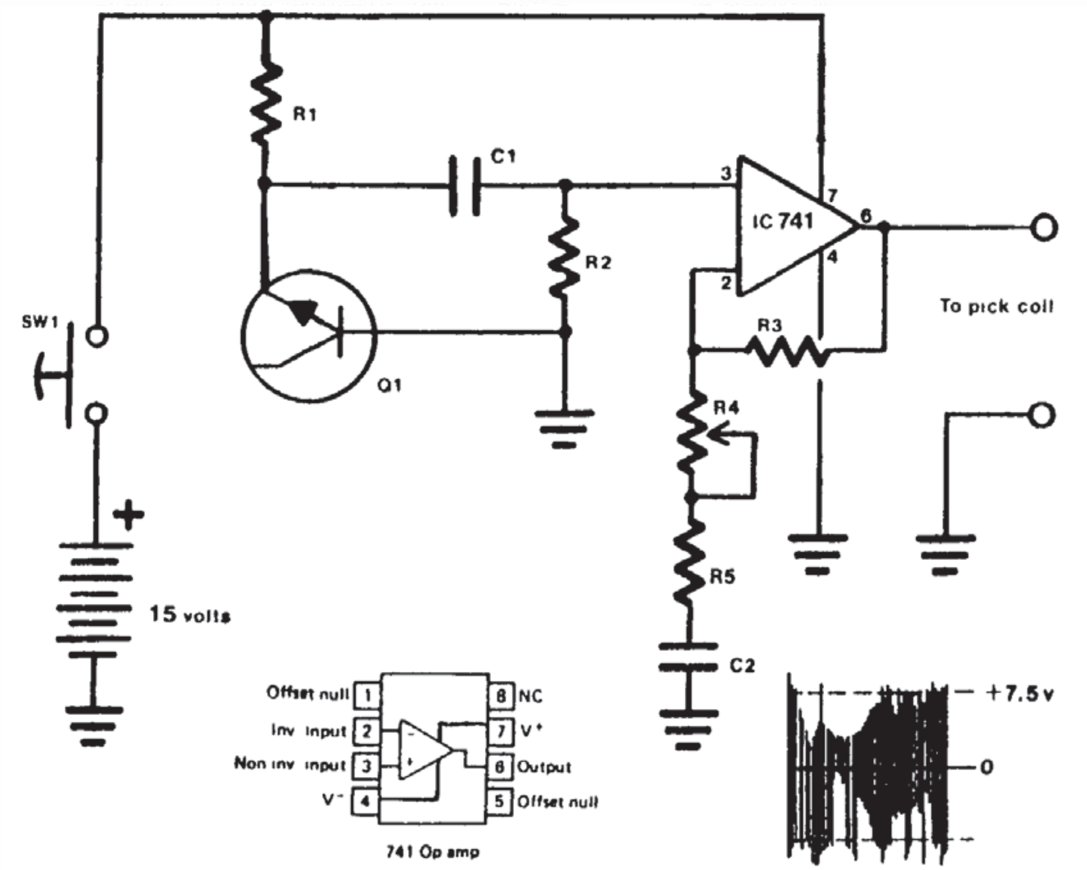
A linear output transducer (a Hall effect sensor) picks up a magnetic field from the card. There are dozens of sensors in the cardway and each one responds to a magnetic field from the magnets molded into the card. When the Hall effect sensor determines the polarity (north or south) of a particular field, it sends a signal to the microprocessor. This information is either go or no-go. When all of the sensors are sending go signals, the microprocessor determines whether or not they are all go and if they are at the right frequency. On some locks, the sensors are "gated" to allow only one narrow band of oscillating signals at so many cycles per second. These cards have their own power supply (battery) and actually pulse their magnetic fields. With all signals at go status, the microprocessor sends a pulse to the electromagnetic solenoid latch, thus allowing the door to be opened.

Some systems use a constant speed motor-driven tray to slide the multicoded card past the sensors to read it, and then spit it back out to you. In order to effectively open this type of magnetic card lock, we'll need to use strong magnetic fields so as to not get the magnetic pick too deeply into the cardway. We will also need to generate a continually changing magnetic field with multiple frequencies.

Magnetic Card Pick

If you have already built the portable magnetic pick, you have the electromagnetic pick assembly on hand. This will be the device that will put out the kind of electromagnetic fields we will need. To generate these fields, we will have to use a circuit that is a little more complex than the previous magnetic pick.

The circuit illustrated in Figure 18 is a schematic of a random noise generator. When completed, it can fit into a matchbox (approximately 1 inch by 1 1/2 inches by 1/2 inch). It is basically a noisy amplifier that has high gain and a low impedance output which produces a large signal noise, enough so that it will drive a 24-volt solenoid coil and produce a continual oscillating magnetic field with random frequencies rich in harmonics.



R1 - 220k, 1/4w 5%	**R5 - 10k, 1/4w 5%**
R2 - 1.0M, 1/4w 5%	**C1 - .01 uf**
R3 - 1.0M, 1/4w 5%	**C2 - .1 uf**
R4 - 100k, linear taper	**Q1 • any NPN transistor**

Figure 18. Magnetic card pick schematic.

This type of signal is caused by the zener breakdown of the transistor junction in Ql. The signal is then amplified by the operational amplifier IC 741, generating electromagnetic fields in the pick coil. The battery pack is simply ten size AA, 1.5-volt batteries taped and soldered in series, with short pieces of insulated wire, positive to negative. SW 1 is a momentary push-button switch designed to pulse the fields into the Hall effect sensors if stroking them won't work. Potentiometer R4 controls the intensity of the fields. On locks that do not have a motor-driven tray, set the intensity at one-half to three-quarters of full power to avoid overtaxing the sensors. On motor-driven tray-type magnetic card locks, go full blast to keep from getting your pick stuck in the cardway; just place it about 1/4 inch into the entrance of the cardway, and it should open.

When you use this device, the continually changing magnetic fields stimulate the Hall effect sensors with a flurry of information. In turn, the sensors determine that somewhere in that message was its coded frequency with its proper polarity. This in turn signals the microprocessor that something is happening, which finds the proper code out of all that noise and activates the solenoid latch. The latch can be heard as a loud clack when its driving solenoid fires.

If you are not familiar with building electronic circuits, have a friend build it for you. The total cost of the parts is around five dollars. The batteries are the major expense, but they should last for about twenty-four hours of continual use and longer with intermittent use. Be sure to use an eight-pin, dual inline socket for IC 741 for easy replacement. The other components should never go bad.

Disc Tumbler and Puzzle Locks

Some residential and business doors use puzzle locks that have five numbers that must be pressed in sequence to open the door. These are sometimes referred to as push-button locks. Simplex Security Company makes a good mechanism, and since it is typical of most of these types of locks, we will use one as an example.

One technique used to open such a lock is to apply rotational pressure on the knob and push each button, seeing which one offers the most resistance. This is usually the first combination number. Release the knob, push the first number you found, and apply rotational pressure again. Now search for the second number like you did the first one. Release the knob again, and apply rotational pressure again. Find the third number the same way, and continue on until the lock opens. You must release the knob each time you find a likely number and start the process over to find the next one.

You should be able to open the lock within five minutes. If not, I have had limited success in randomly,

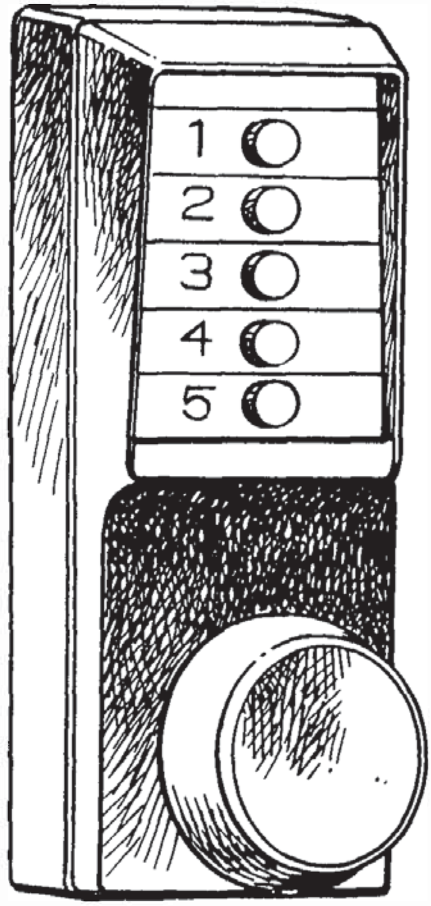


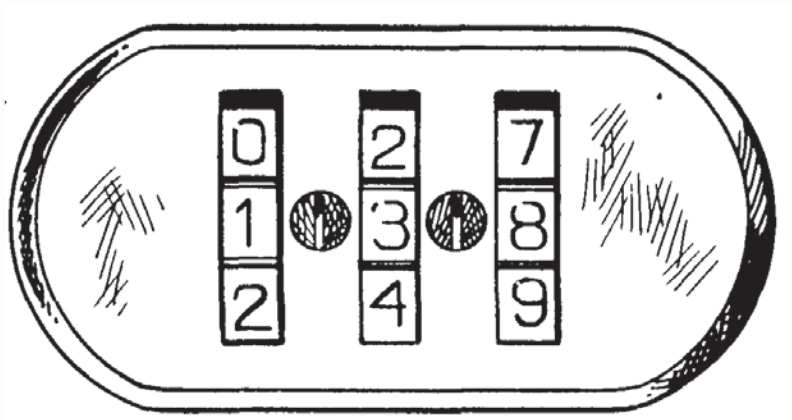
Figure 19. Push-button puzzle lock.

and very quickly, pushing out the numbers until you find the proper combination. The trouble with this method is that you seldom catch what the combination was and have to go through the whole process again in order to gain access a second time. As usual, practice will shorten the time it takes you to open these locks.

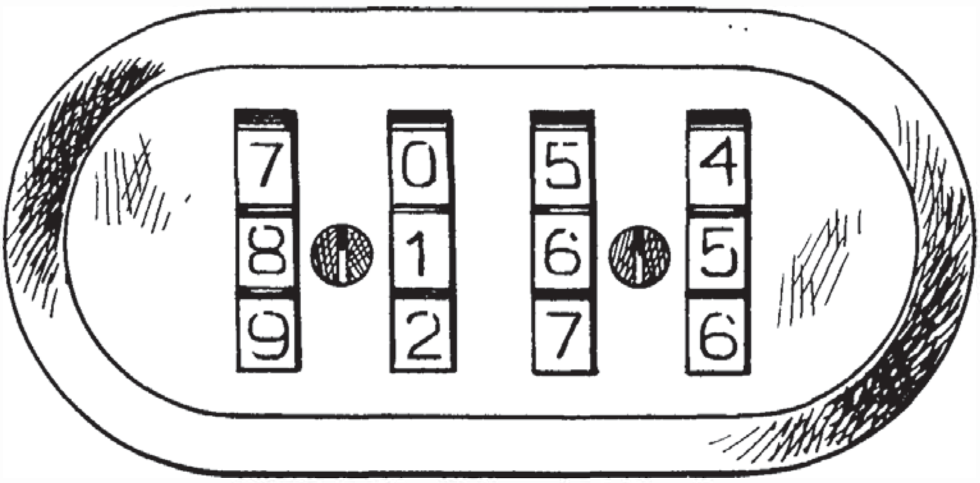
Some of my readers have been having trouble opening Sesame-type padlocks. These locks have isolated bolts; that is, they cannot be manipulated open by touch and listen exclusively. If you ever have to open one in a hurry, I suggest the following method.

Figure 20 shows three-wheel and four-wheel model Sesame locks that have been drilled. For illustration purposes, I have drilled the holes larger than necessary. Through the holes you can see the cams rotate as you turn the wheels. Simply rotate each wheel to line up the flat spot on the cams so that they are straight across as you look into the holes.

The numbers at which the wheels are now set do not comprise the actual combinations. However, adding seven to each number on the dials will give you the right combination. For example, after all of the cams are lined up straight across and the wheels are set at 1-3-8, as shown in the top illustration on the following page, simply add seven to each one to get the combination of 8-0-5.



1-3-8=8-0-5 to open



8-1-6-5 = 5-8-3-2 to open

Figure 20. Three- and four-wheel Sesame locks.

Energizing Your Hands

I would like to introduce an old kung-fu method used to strengthen and add flexibility to your fingers and hands. In kung-fu, the hands are regarded as terminal points for *chi*, or life force. I don't want to sound mystical, but there is great power of spirit in most schools of kung-fu. Your fingers and hands can become clear open channels for your mind's intentions. I do this exercise to open these channels and you can do it too.

The first part of this exercise is called Energizing Hands. The hands are energy gateways to and from your body. They allow energy to flow because they are termination points from your heart *chakra*, or center, where life force resides. In other words, your fingers are the receptors and transmitters of energy. The forearms are the storehouse for this energy and by stretching your forearms in a certain way, you can induce large amounts of chi energy into your hands and fingertips.

First, sit on the floor cross-legged on a thin cushion. Try to get comfortable while keeping your back relaxed and straight. Cross-legged is best because the back is straighter and excess energy that might otherwise escape from your feet goes back into your body. Indian style is OK. If you can get into a half- or full-lotus position, that's even better. The main point is to be erect and relaxed with your eyes open.

Drop your shoulders, and let your arms hang to your sides with your palms flat to the floor. Loosen up your arms; try to imagine them being pulled down because of the tremendous weight of your hands. Keep your shoulders back and down.

Now, lift your hands up from the floor about half an inch without moving your shoulders up. Your hands should be parallel to the floor but not touching it. With your hands in this position, you can reap huge amounts of energy from Mother Earth. S t r e t c h the arms down—make it almost hurt. Stay in this position five to ten minutes, or as long as possible. You will start to shake all over after a few minutes. Don't be concerned. You are collecting power from the Earth. The longer you hold this position, the more energy your hands and forearms will accumulate.

At some point you will feel the energy entering your heart chakra to store itself there. This energy will stay there until you need to use it for "fight or flight" situations (or for picking locks). In fact, you could charge yourself up in this manner whenever you encounter a stressful or otherwise difficult situation. This is a very powerful technique. It is used in Tibetan kung-fu to subdue the opponent.

You can locate missing or lost people after you have practiced this for a while by holding your hand (left if you are right-handed, right if you are left-handed) up to the general direction of their disappearance. When you feel a warm buzzing sensation in your fingertips, chances are they will be in that area. You can also detect intruders in this way. Your hands can be powerful guides when you need them.

Remember to keep the palms flat and fingers together when doing this exercise. Make sure that your thumbs are not hanging out and keep your shoulders *down.* Make it hurt. Don't hurt yourself by being overly zealous, but make the arms and shoulders *stretch.*

Your palms should be hot by now—they will be charged with chi. If you were to look at them, you would see that they are red with white specks in them. The white specks are areas of intense energy radiation. A Kirlian photograph made with special equipment would detect this as brilliant lights shooting out from your hands. The hand that you are now looking at can shatter a brick! That is how much energy you can muster in such a short time. *But please,* don't try shattering bricks because other techniques are involved to do that safely; you could hurt yourself.

Practice this exercise five minutes a day for a few weeks and you will definitely notice an improvement in your lock picking abilities.

The second part of this exercise can be practiced anywhere and as many times as you like. It is called "Disbursement," or the outward flow of accumulated energy. This is done by popping your finger joints in an extended stretching motion. After you have energized your hands, slowly lift your arms up in front of you and really stretch your fingers as if each one were extending out and out. This is a safe and proven way to pop your knuckles to make your hands and fingers strong and flexible. Kung-fu students and teachers have been doing it for centuries and none of them ended up with arthritis or anything like it. Your fingers may not pop at first, but with practice, more and more of your finger joints will loosen up.

While doing this you should try to imagine that beams of light are shooting out from the tips of your fingers. You can do this exercise standing, sitting, or lying down, although I recommend you do it in conjunction with the energizing exercise for a few weeks until your hands have loosened up.

Now, slowly close your hands in a clawlike manner, closing one set of joints at a time. It should take you about ten seconds to get them closed. Keep your fingers stiff to cause tension in them while closing. Your joints will really start to pop, and when you are done, they will feel quite pliable and strong. At this point the exercise is over and you may find picking locks a little easier and faster.

Tips for Success

Due to limited time and space, as well as individual styles of learning, I am unable to cover all of the locks used today. Therefore, I encourage the sincere novice to purchase locks of interest and disassemble them to learn how they operate. Then you will be able to figure out a way to open them. The biggest deterrent to lock picking is the lack of knowledge of a lock's inner functions. With this in mind, you will find that opening locks is just a matter of discovery.

In the art of lock picking, as with any fine art, nothing compares with experience through practice. A simple way for you to get that experience is to practice with tumbler padlocks. They are small, portable sources of working material for your experience. Start a collection and pick them while you are watching television or just loafing around the house. The greater the variety of locks you have, the wider your range of experience will become and locks will not become obstacles to your goals.

One of the most amazing things I have discovered in past years is that many people I have taught to pick locks are not what you would call very mechanically inclined. Yet, curiosity on their part has led them to become virtually master lock pickers. This tickles me to no end.

It is also important to remember that making your own tools will let you have access to a much larger range of locks, mostly because your tools are *yours*. You made them and they work. There is a powerful psychological factor involved here. Your first few sets may not be exactly what you want, but you will probably wear them out anyway through practice. By the time you make your third set, they will be perfect because you will know how you want them to work.

Practice picking with thin cotton or wool gloves. I wear thin wool gloves in winter bejcause they are durable and keep your hands warm even when wet. Some locks require more time to pick in cold weather because they have a tendency to stick from moisture frozen inside the lock. You must keep your fingers and hands warm in order to successfully open them. I have never been able to pick open a lock with cold hands.

I first learned how to pick locks by taking them apart to see how they worked. At some point in my young career, I had made a "Lock Box"—a wooden box covered with mounted locks. It looked ridiculous—seventy locks on a box with cheap hinges. There were padlocks dangling off the sides, safe locks protruding out the back, and almost every kind of lock imaginable on the top. The inside contained spare lock parts and various tools. I would practice every night picking all of them. My friends thought I was nuts—until they saw me in action. Then, of course, they wanted to learn too.

Most locksmith shops will sell you old discarded locks of all kinds for the price of brass by weight. You can probably pick up a hundred locks with all the associated hardware (trimmings) for about $10 to $15. If you are at the right place at the right time, you can get some old safe locks, which are great fun to play with. The only tools you will really need are a pair of pliers, vise grips, a crescent wrench, various screwdrivers (both standard and Phillips), some files (round, flat, and square), and a drill with a set of bits and hole saws.

You can make the box out of pine or oak if you wish. With a varnished finish and polished brass locks, it can be a rather attractive novelty in your home. Don't use brass polish on the locks, as the residue will get into the tumblers and cylinders and cause problems. Use an old toothbrush and toothpaste to clean up the face of the locks. Rinse with hot water and dry them by a furnace duct or in the sun.

Building yourself a Lock Box will make the art of lock picking more fun and give you a lot of experience.

TRICKS OF THE BURGLAR ALARM TRADE

MIKE KESSLER

PALADIN PRESS
BOULDER, COLORADO

Tricks of the Burglar Alarm Trade
by Mike Kessler

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FOREWORD

Anything worth learning is worth learning well, and learning something well calls for some degree of effort. The objective of this book is to minimize that effort by avoiding the use of technical jargon, cryptic diagrams and references to electrical theory. However, this doesn't mean the information contained in this book will jump off the pages and burrow itself into the casual reader's brain.

The "simplified" instructions packed with most do-it-yourself burgar alarm *kits* are usually quite easy to follow, leading one blindly through the haphazard installation of a mediocre system; explaining "how to do it," without a word about what one is doing, or why. As a result there are thousands of so-called burglar alarms in current use, many of which can be defeated by the least sophisticated methods-- and most of which will malfunction within a few months, often leaving the do-it-yourselfer with a collection of useless hardware fastened to the walls.

Most burglars can easily recognize an improperly installed, simple to defeat, do-it-yourself *kit* burglar alarm just by glancing at its components: the often flimsy control box, drooping wires, cheap shunt locks and improperly applied window foil with sloppy connections. Many of these packaged kits are relatively inexpensive (cheap), therefore increasingly commonplace. Most contain essentially the **same** type of parts-- with instructions to install them in essentially the **same** way, therefore they are relatively easy to recognize and defeat by a number of simple methods. The most common of these methods is called "jumpering." This is a technique used effectively by burglars to "by-pass" cheap or improperly installed alarm systems. There is a very simple countermeasure to the jumpering technique, but it is never explained in "simplified" instruction manuals, and rarely mentioned in books. In order to apply this countermeasure one must understand the jumpering technique, which calls for thorough familiarity with the nature of **closed-circuit burglar alarm systems.**

This book explores closed-circuit ("supervised") wiring in detail, concentrating on the basic principles that govern all closed circuit burglar alarms, ranging from those found in tenement apartments and candy stores to those used in mansions and bank vaults. Once these principles are understood, they may be applied to any type of closed-circuit burglar alarm system. The best way to learn from this book is to read it through from cover to cover, passing over any word or segment that seems vague, or a bit too *technical.* Very often the answer to a question that arises in one section will be found in a following section, or in the next paragraph. None of the diagrams are *schematic*: some are self-explanatory pictorials, while others are simple line drawings. Each drawing is thoroughly supported by accompanying text.

It is true that "one picture is worth a thousand words;" and it's also true that one hands-on experiment is worth more than a thousand pictures: The serious reader is well advised to obtain a sampling of the components described throughout this book and assemble a "bench system" (on a workbench or kitchen table), and follow each separate section of the book with an actual experiment. This is precisely the teaching method used in all classroom and correspondence courses on security electronics-- and it works! Every student of a burglar alarm course is given a control panel, a coil of wire, one each of a variety of sensors, a power supply and some miscellaneous parts; and is guided through a number of "bench experiments." After the course is completed, the same components are used in an actual installation or they remain part of a permanent bench system. (To be used in conjunction with the testing of new components and devices.)

It is recommended to readers who intend to install a burglar alarm system to set up a "bench system" first. After becoming thoroughly familiar with each component and its particular function in the bench system, stretch out a few yards of wire, apply a foil pattern to a pane of glass (even a mirror), and practice troubleshooting with a test meter. To most novices, a bench system is like a set of electric trains-- with a serious purpose.

Security electronics is a fascinating world of ultimate gadgetry, a field that presently offers golden opportunities to any competent, motivated individual. Burglar alarms are definitely *in*, and the profit potential in this business is impressive. A burglar alarm *sideline* can be operated out of a closet, using an ordinary car. And the initial investment is nominal.

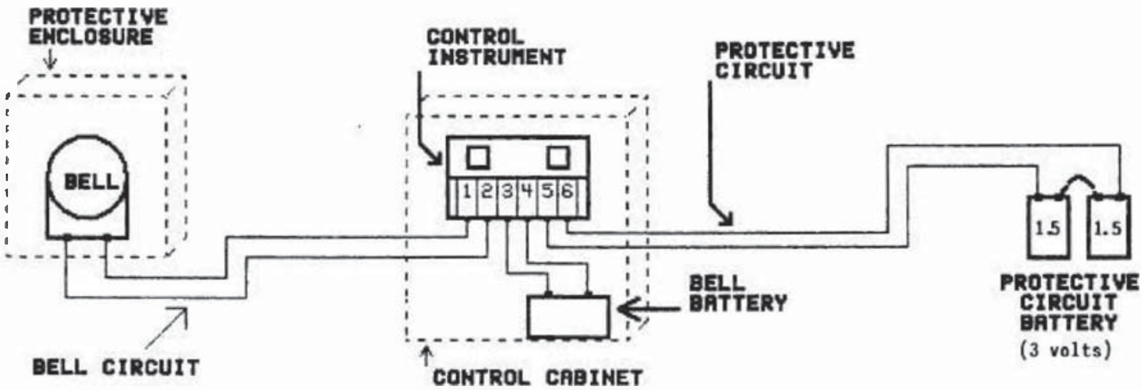
For example, one way to start up is install a system in your own home, then do the same for a friend or neighbor-- at a fair price. The price should at least recover the cost of both sets of components, enabling the purchase of more equipment, thus an inventory is established with practically no cash investment. Each subsequent job generates a profit while providing valuable experience. As your proficiency grows, so will your income. Thousands of profitable installation companies have started up in exactly this way; many of them are highly successful today-- and there's plenty of room for more.

The techniques and equipment described in this book are not restricted to residential installations, but apply to commercial premises as well. In fact, commercial premises are usually easier to wire and offer exceptionally high profits to the *leasing* installer: In a leasing arrangement, the initial (installation) charge should absorb the cost of equipment; the system remains the property of the installer, who agrees to provide service and maintenance under contract (payable monthly.) Service contracts should not provide for free service when damage or tampering is the cause of a problem. Leased burglar alarm service contracts range from 15.00 to 500.00 per month, depending on the size and sophistication of the individual system.

Whether the reader intends to install only his (or her) own burglar alarm system or to strike out on a new career, this book is a good place to begin. The next step is to assemble a bench system and get some hands-on experience. Each step thereafter will be rewarding; in personal satisfaction, and cash savings-- or handsome profits.

THE BASIC BURGLAR ALARM

A basic burglar alarm system consists of three separate segments, the **bell circuit**, the **control panel**, and the **protective circuit**. The separate segments are wired together as shown in Fig. 1-1.



<u>Figure 1-1</u>

The bell, an 8" circular gong with a motorized hammer on its underside, is normally enclosed in a protective steel cabinet, which should be securely mounted to an exterior wall, high enough to be inaccessible to tampering. A pair of 16 to 14 gauge wires are attached to the bell motor's terminals, drawn through a wiring hole in the back of the housing, drawn through a hole bored through the mounting surface and into the premises, where they are routed to the **control panel**.

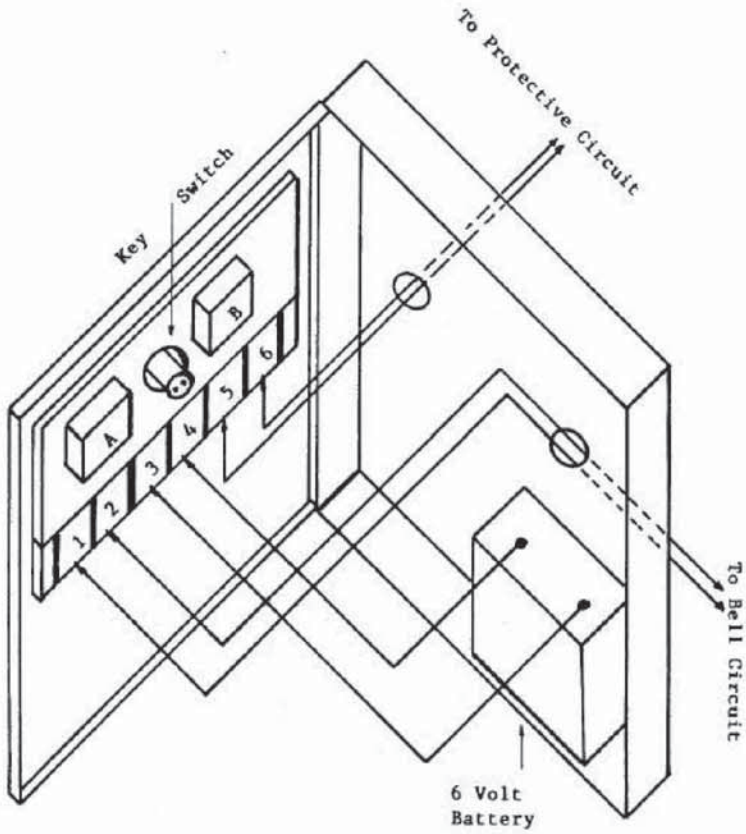
The **control panel** is a square, steel electrical cabinet with a key-operated ON/OFF switch mounted on its face. This cabinet is securely fastened to an interior wall, somewhere in a convenient, preferably <u>concealed</u> location within the premises. Inside this cabinet are the *control instrument*, which is the "brain" of the system, and a 6 volt battery to energize the bell.

The **protective circuit** is a pair of 22 to 20 gauge wires, which are routed through the interior of the premises. Although none are shown in this diagram, the various *sensors* (switches, detectors, *trap* circuits, etc.) used to monitor anticipated points of entry, (windows, doors, etc.), will be wired into the protective circuit. The protective circuit must be routed so it passes directly across, or close to each point to be protected by a sensor.

One end of the protective circuit is connected to the control panel. At the other end is an <u>independent</u> power supply, consisting of a pair of 1.5 volt ignition cells, wired together to form a 3 volt battery.

As mentioned above, there is a separate power supply, (a 6 volt, heavy-duty lantern battery), inside the control cabinet for ringing the bell. **The protective circuit power supply does not serve the bell circuit in any way!**

Fig. 1-2 is a closer look at the inside of a wired control panel: Fastened to the inside of the cabinet door is the *control instrument,* a circuit board upon which are mounted two electro-mechanical relays, shown as A & B.



<u>Figure 1-2</u>

Situated between these two relays is a hole through which the rear section (body) of the ON/OFF key-switch protrudes. A pair of wires (not shown) is pulled through this hole from behind the board and connected to the key-switch.

Situated below the relays and key-switch is a connecting strip with six, separated terminals, numbered 1 thru 6. Terminals 1 & 2 are addressed to Relay A, which is the **bell relay.** Terminals 3 & 4 are also addressed to Relay A. Terminals 5 & 6 are addressed to Relay B, which is the protective circuit relay. Note the connections to these terminals: The bell circuit wiring is connected to Terminals 1 & 2. A six volt battery, (for the bell), is connected to Terminals 3 & 4. The protective circuit is connected to Terminals 5 & 6. The wiring for the bell and protective circuits is drawn through "knockout" holes in the rear of the cabinet. The 6 volt battery is attached to Terminals 3 & 4 by a short pair of 16 to 14 gauge wires.

Imagine that the components we've covered thus far are set up on a test bench, arranged as shown in Fig. 1-1: Rotating the key-switch to the ON position will arm the system, meaning it is "set up" to function as a burglar alarm. The way to activate the alarm is to somehow interrupt the flow of current through the protective circuit, which may be done either by disconnecting the battery-- or cutting a wire. The following is a detailed explanation of how the control instrument governs the separate functions of the bell and protective circuits.

Relay A is the bell relay. When the properly rated power source is applied to it, (6 volts in this example), its contacts are pulled together, "latching" in place and providing a conductive path between the power source (at terminals 3 & 4) and the bell. There are two *opens* in the path between the power supply attached to Terminals 3 & 4: one is controlled by the key switch, the other is controlled by the protective circuit, (Relay B.) In order for the bell to ring, the key switch must be turned ON and the flow of protective circuit current must be interrupted.

Relay B is the protective circuit relay. It is **totally independent** of the key-switch. The protective circuit is constantly energized by the 3 volt battery, and will remain energized as long as this "supervisory" current flow is not interrupted. The flow of 3 volt energy throughout the protective circuit is called "supervisory" current because it monitors the status of the circuit.

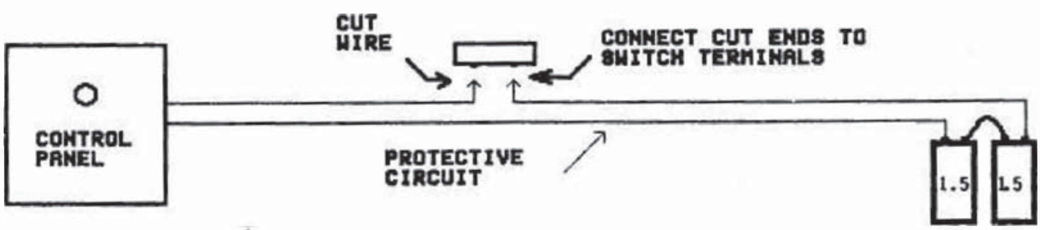


Figure 1-3

Burglars are not so accomodating as to deliberately disconnect the protective circuit battery or cut a wire to de-energize the protective circuit relay and cause an alarm, so some form of switching device (sensor) must be applied to each point of potential entry and wired into the protective circuit. Fig. 1-3 shows how to wire any sensor.

One "leg" of the protective circuit pair is cut, the severed ends are stripped and attached to the terminals of the switching device. The device serves as a means to *make* or *break* electrical continuity through the protective circuit, as in the example of an ordinary light switch.

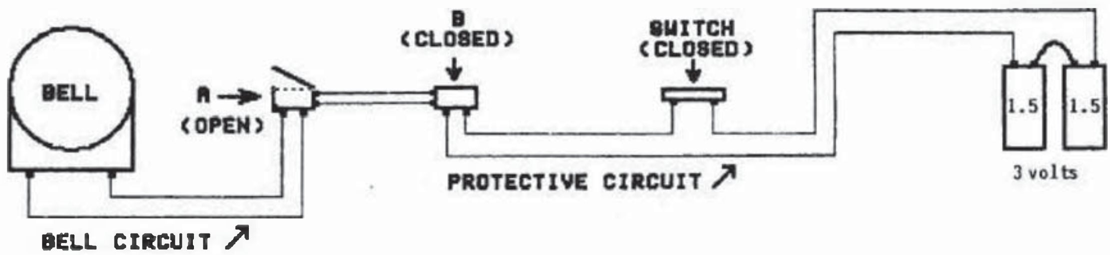


Figure 1-4

In Fig. 1-4, the closed switch provides continuity through the protective circuit. Relay B is held closed by the flow of current from the protective circuit battery. Note that when relay B is closed, relay A remains open-- therefore the bell cannot ring.

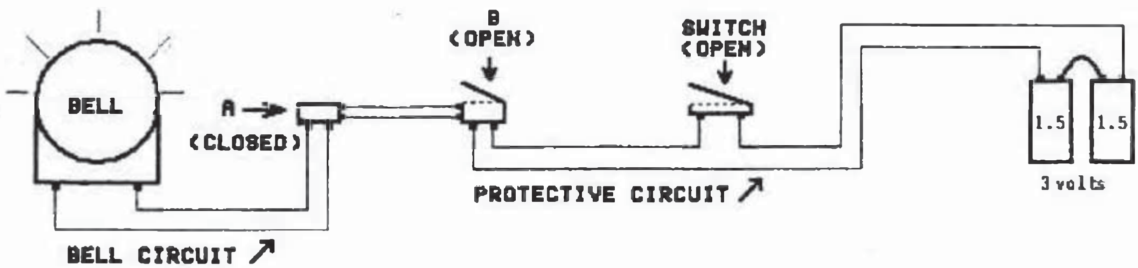


Figure 1-5

In Fig. 1-5 the switch (pictured) is open, which de-energizes Relay B, causing it to open. Whenever the key-switch is turned ON (system operational) and relay B snaps open, relay A will simultaneously snap closed, activating the alarm. The only way to disengage the bell is to turn the key-switch to the OFF position.

The drop-out action of Relay B is extremely fast, therefore an interruption of current flow through the protective circuit need only occur for a fraction of a second to activate the bell circuit. Restoring the protective circuit will not release the bell relay once it has *latched* in.

THE PROTECTIVE CIRCUIT

To present this concept in its simplest form, the protective circuit described in the foregoing section is depicted in a short, straight-line configuration, containing only one sensor. While there are situations that call for such a short run of wire and just one sensor, they are rare. In most cases a protective circuit will be routed through several rooms of a premises, on different levels, and will contain about a dozen, separate sensors. Regardless of a protective circuit's area of coverage, or how many sensors it contains, the basic principle remains the same: The protective circuit should always be perceived as a pair of wires with a power supply and a number of switches connected in *series*. The open ends of the pair are attached to a pair of screw terminals in the control panel, (5 & 6.)

In electrical terminology the word *series* means a continuous *string*, like a group of people holding hands in a circle. To further clarify this analogy, remember that the words **circle** and **circuit** derive from a common root:

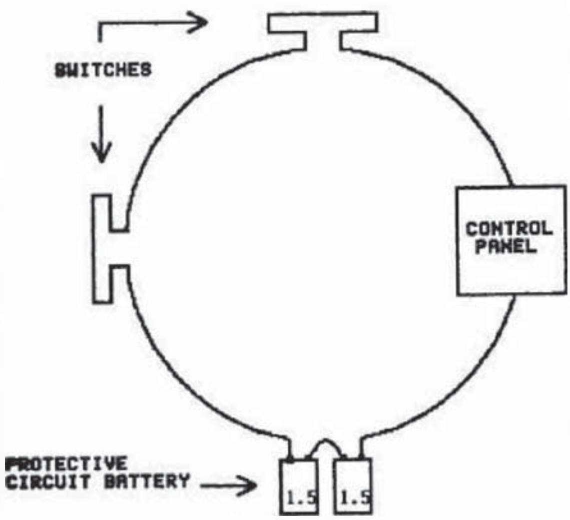


Figure 2-1

Compare Fig. 2-1 with the diagram in Fig. 2-2 (next page.) Study both diagrams and you will find the only difference is that the protective circuit in Fig. 2-2 has four sensors wired in series, while the one in Fig. 2-1 has only two, and the battery is situated on the other side of the control panel. Otherwise, both diagrams depict exactly the same thing, a continuous, series circuit, consisting of a single string of wire connecting a number of components together. Fig. 2-1 is a series circuit, so is Fig. 2-2. If this simple principle is clearly understood, the following sections will present no problems.

Fig. 2-2 is a protective circuit: a control panel, a pair of wires extending out to a battery and four sensors wired in series.

In Fig. 2-1 we see that a "pair" of wires is just a convenient way of producing a circle of connected components.

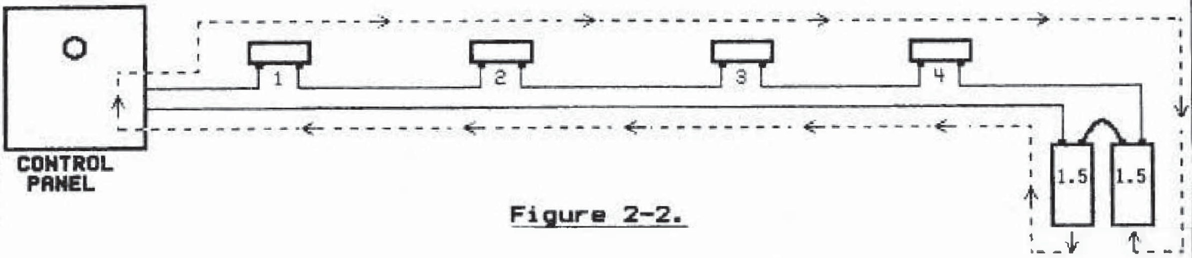


Figure 2-2.

The phantom line of arrows in Fig 2-2 depicts the flow of current from the battery, through the entire protective circuit (including the protective circuit relay in the control panel), through each of the sensors, and back to the battery. This diagram is representative of a simple, straightforward installation, such as a row of four windows on the same wall.

As previously mentioned, most installations call for about a dozen protected points, which are situated in different rooms and on more than one level of a premises. To begin a protective circuit at one given point and carry a continuous pair of wires to each consecutive point would be doing things the hard way. A much easier way to distribute a protective circuit throughout a premises is shown in Fig. 2-3 (next page.)

Study this diagram and you'll find that the "main circuit" (running from the control panel to the battery) is an exact duplicate of the protective circuit in Fig. 2-2, with a few additions:

The layout of this hypothetical installation makes it convenient to situate the control panel at one end of a row of four windows (on one wall) and put the battery in a closet at the other end of the wall. This is the "main circuit" and it contains four sensors. (Count them.)

A second, separate circuit is started at another location of the premises, covering five windows and two doors, (seven sensors-- count them.) This circuit is tied into the main circuit at A, in the same way as a sensor would be connected. This circuit is now known as "loop" A of the protective circuit.

Another loop is seen at B. Loop B contains only one sensor, (protecting a roof-hatch, cellar door, etc.), and it is tied into loop A.

A third loop, also containing one sensor, is seen tied into the main circuit, at C.

Follow the arrows around this circuit (from the battery and back again) and you'll see that no matter how many loops are added, and no matter where they are connected, the final effect will be the same. As complicated as it might seem in diagram form, in principle we are dealing with a huge circle-- produced by interconnecting several, separate pairs of wires, (loops.)

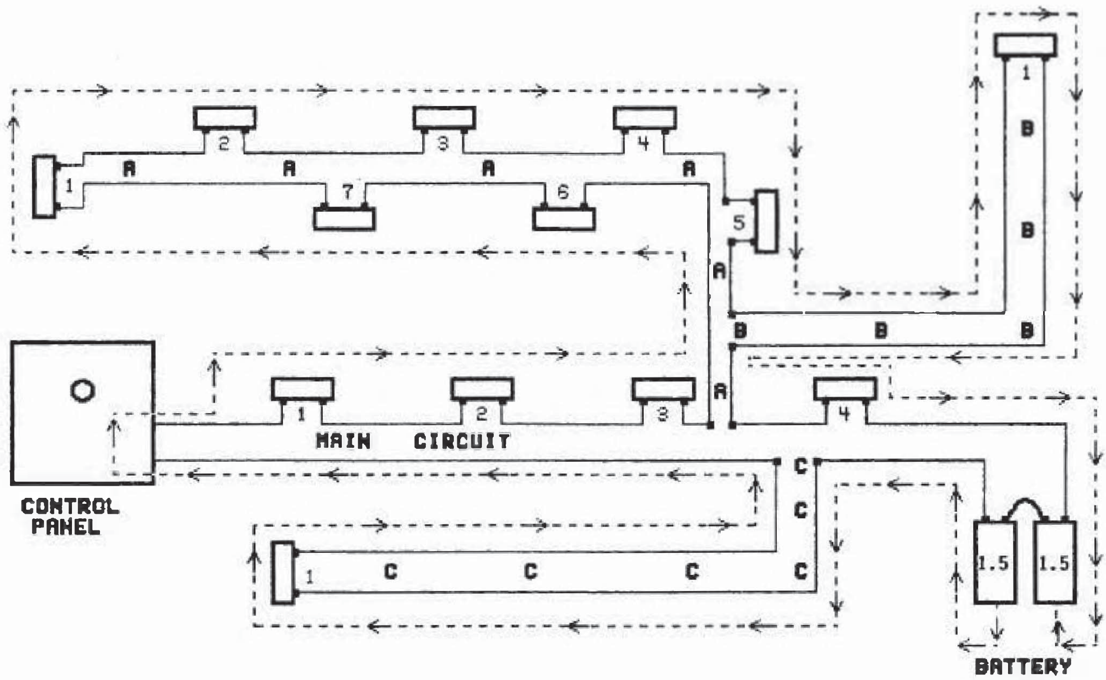


Figure 2-3.

It is important to mention that, technically, it makes no difference where the battery is situated in the protective circuit. The battery in Fig. 2-3 could be removed from its present location and (after the vacated wire ends are spliced together), connected anywhere else-- in the main circuit or in loops **A**, **B** or **C**.

The protective circuit battery may be wired in a different way and placed inside the control cabinet along with the bell battery, which is sometimes done. However, there is a good reason why this practice should not be followed in some situations. For reasons which will be explained in the section on SHORT CIRCUITS, the protective circuit battery should be situated a good distance away from the control panel and concealed whenever the protective circuit parts are accessible to tampering by visitors to the premises, customers, employees, etc.

SHORT CIRCUITS

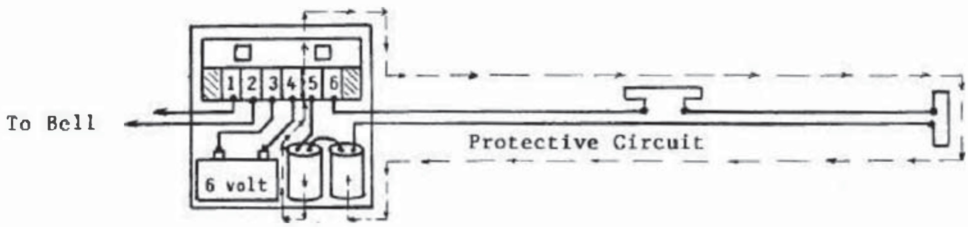


Figure 3-1

Fig. 3-1 shows a protective circuit wired to a control panel. Note that the protective circuit battery is situated inside the control cabinet, next to the bell battery. Examine the wiring of this protective circuit: One terminal of the two-cell battery is attached directly to Terminal 5 of the control instrument, leaving one vacant battery terminal and one vacant terminal, (6), on the control instrument. The protective circuit is wired directly to these vacant terminals. The path of the arrows shows that the *supervisory* current from the battery flows through the protective circuit, (and the protective circuit relay), just as it would if the battery were situated outside the cabinet. However, wiring a protective circuit in this manner offers the potential for compromise, making it easy for a knowledgeable burglar to *bypass* the entire circuit by imposing a "short," (short circuit), at some point close to the control cabinet.

In the same way that water will always seek the lowest level, electricity will always seek the ***short***est path to follow:

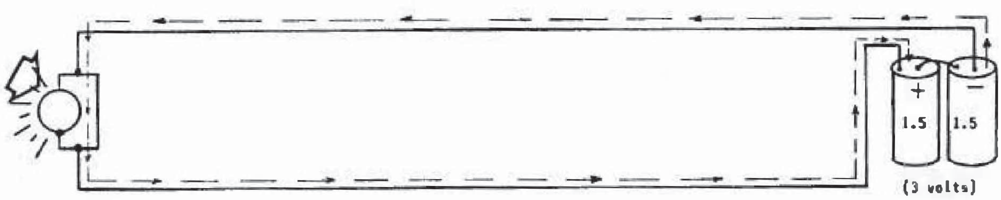


Figure 3-2

Fig. 3-2 depicts a simple circuit, a two-cell battery connected to a lamp by a pair of wires. Note the unimpeded flow of current through the entire circuit, causing the lamp to light.

In Fig. 3-3, (which is identical to Fig. 3-1), we see that a short has been imposed across the pair, (by attaching a "jumper" wire.)

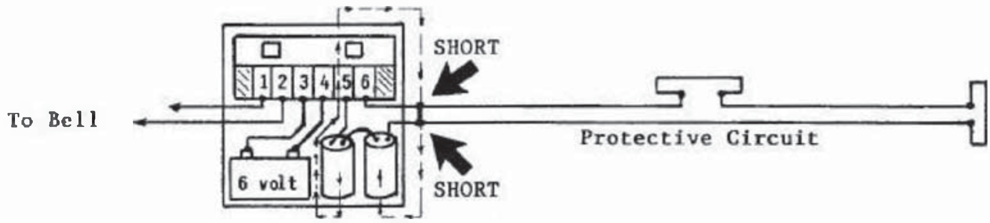


Figure 3-3

Note that the current flow has been diverted by the short, returning by the shortest possible path back to the battery. Electricity flows with incredible speed, from negative (-) to positive (+), and will always follow the **shortest possible route.**

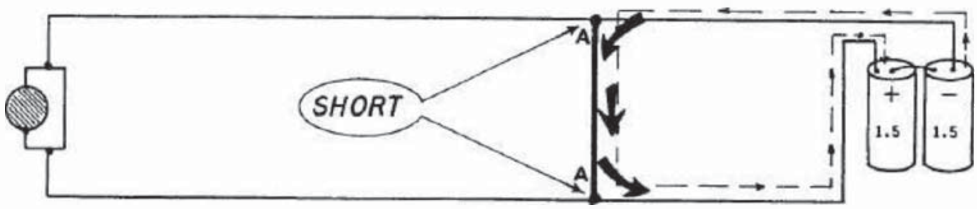


Figure 3-4

Fig. 3-4 is identical to Fig. 3-2, with one important exception. A short appears at A. Note that the supervisory current is diverted by the short and returns directly to the battery. Also note (in Fig. 3-3) that even though the entire protective circuit has been *by-passed,* the protective circuit relay doesn't "know" this. The current still flows through the relay, energizing it, thus the sensors in the protective circuit are unsupervised.

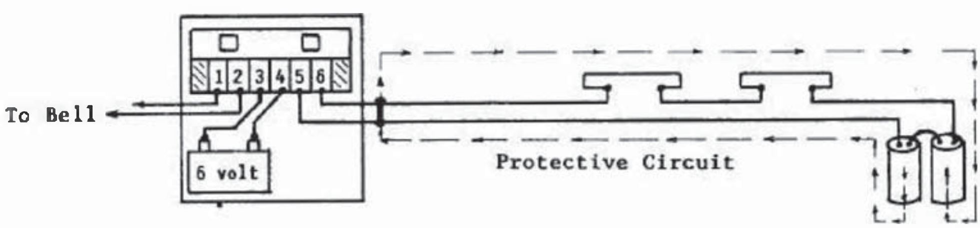


Figure 3-5

Fig. 3-5 is identical to Fig. 3-1, with one exception. This is a properly "supervised" protective circuit, with the battery situated outside the cabinet. Note the effect of imposing a short at the same point as in Fig. 3-3: The flow of supervisory current is diverted by the short-- but in this case the protective circuit relay is deprived of energy, and will drop out, activating the bell circuit.

Some shorts are accidental, caused by worn or damaged insulation that causes both conductors of a pair to make contact. But imposing a deliberate short is called "by-passing," and is the favorite technique of sophisticated burglars. In one example, a commercial premises was burglarized and the alarm system failed to function. An inspection disclosed that the installer had wired the protective circuit with the battery inside the control cabinet. Because the public had access to the protective circuit during normal business hours, someone had pushed an ordinary straight-pin through both legs of the protective circuit pair just a few feet away from the control panel, shorting out the entire protective circuit.

To summarize the foregoing in simpler terms: When the protective circuit battery is situated outside the control panel and at a remote distance from it, an attempt to "short out" any part of the protective circuit between the battery and the control panel will instantly cause an alarm.

It is often more convenient to place the protective circuit battery in the control cabinet (as shown in Fig. 3-1) and when the possibility of a compromise attempt does not exist there is nothing wrong with doing it this way. In fact, when a control panel with a built-in power supply is used, there is little alternative. However, unless an "end-of-the-line resistor" type control panel is used, this wiring method leaves the protective circuit vulnerable to a simple by-pass.

The "end-of-the-line resistor" panel will seem somewhat confusing to the novice at this stage, but it is a relatively simple principle to understand: All electrically conductive materials present a measurable amount of *specific resistance* to the flow of electrical current. The amount of resistance (which is measured in "Ohms") depends on the type of material and its mass, (*gauge*, in the case of wires.) For example, a 20 yard length of 22 ga. copper wire will show a specific level of resistance when measured with a precision meter; naturally the amount will be less than 21 yards and more than 19 yards.

The protective circuit relay of an end-of-the-line resistor control panel is sensitive to an abrupt change in the specific resistance of a protective circuit. When the protective circuit's overall resistance is measured, which will include the sum of the specific resistance levels of every sensor in the circuit, this type of control panel adjusts to the specific resistance of the protective circuit, with a very narrow margin of tolerance. The slightest fluctuation, such as a by-pass attempt, will cause it to drop out.

This method is not new, it is borrowed from the principle of the *central station* connection, by which bank alarms, etc., are wired by leased telephone lines to a monitoring station.

CONTROLS

Most of the components used in burglar alarm systems, such as bells, wire, batteries and sensors are designed to perform a single, specific function, therefore the only factor to consider when selecting these items from the wide variety of available brands is quality. For example, a bell is a bell and is expected to do nothing more than make a noise. There are many bells available on the equipment market, most of which are very well made and priced within the same range. If a bell bears the U.L. label and is sold by a regular alarm equipment dealer, this is adequate assurance of reliable quality.

The same can be said for wire, batteries, power supplies and sensors, from the simplest switch to the most sophisticated motion detector. However, the same cannot be said for control panels because there simply are too many different brands and models available, some of which provide numerous accessory functions in addition to the primary function of activating a signal when the protective circuit is disturbed.

The control panel described in this material is known in the burglar alarm trade as the "100 control" and it has been the standard of the industry for many years. The 100 control consists of a plain, sturdy enclosure, (cabinet), with a Model 100 control instrument mounted on the inside and a two-position ON/OFF switch showing on the outside, nothing more. In spite of the many high-tech alternatives available on the market, the 100 is presently in use in millions of commercial and residential installations. These panels are preferred by many commercial alarm contractors for use in leased alarm systems, which is a significant testimonial because leased burglar alarms are profitable <u>only</u> if they are trouble-free and the equipment is cost-efficient.

The 100 is an inexpensive, reliable burglar alarm control which may be expanded upon by adding any number of optional accessories such as a permanent power supply ("power pack"), entry/exit delay timer, bell cut-off timer, AC switching relay, and more. These accessory modules are quite easy to add to a basic control panel at any time after the system is installed and operational. The alternative to using separate modules is to purchase a control panel with all of the desired accessories built in. While this is a suitable alternative for the experienced installer, a novice is likely to find a sophisticated, multi-function control panel to be baffling. This is why the format of this material is structured around a simple, basic control panel, which the novice installer is well advised to start out with.

Listed below are a number of useful accessory control features. If preferred, there are many control panels available that offer any combination of these features, and more, as built-in options.

POWER PACKS:

A popular alternative to operating a burglar alarm system on temporary batteries is to use an AC-dependent transformer, called a *permanent power supply*, or *power pack*. But a permanent power supply should never be used without attaching a trickle-charging, stand-by battery to it for maintaining power in the event of an AC failure or deliberate, preburglary tampering with the house wiring from outside the premises.

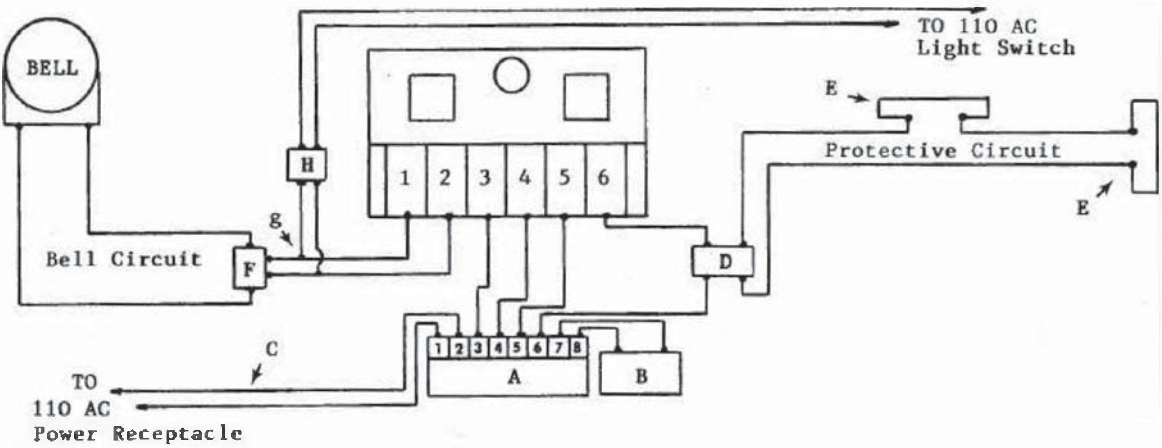


Figure 5-1.

Fig. 5-1 shows the layout of a Model 100 control instrument, wired up with a number of accessory control-function modules.

A is the power supply with a stand-by storage battery attached at B.

Terminals 1 & 2 of the power pack are connected (C) to 110 AC, either directly, (using 18 - 16 gauge wire), or via a plug-in transformer, (which will be included with the unit when purchased.)

Terminals 3 & 4 of the power supply are wired to Terminals 3 & 4 of the control panel, providing a permanent source of 6 volt energy for the bell. These power pack terminals replace the bell battery shown in previous diagrams.

Terminals 5 & 6 of the power pack provide a permanent source of 3 volt energy for the protective circuit and are wired in the same manner as described in Fig. 3-1. These power pack terminals replace the protective circuit battery shown in previous diagrams.

STAND-BY BATTERY:

Terminals 7 & 8 of the power pack are wired to the stand-by battery, (B.) If the AC power fails, the power pack will simultaneously switch to battery support. Because the standby battery is under continuous charge, it remains permanently energized to peak capacity and does not require periodic replacement.

ENTRY/EXIT DELAY TIMER:

The item shown at D represents an entry/exit delay timer module. Note that it is wired directly into the protective circuit. This device has two separate timing circuits, (ENTRY and EXIT), both of which are adjustable to provide a delay period from 0 to 60 seconds.

The EXIT delay enables the user to switch the system on and leave the premises without activating the alarm. Likewise, the ENTRY delay provides sufficient time to re-enter and switch the system off before the alarm activates. An ENTRY delay timer should always be adjusted to the shortest possible delay period, for obvious reasons: An excessive pre-activation delay might afford a burglar sufficient time to locate and forcibly disable the control panel before the system activates.

TIMED BELL CUT-OFF:

F represents a timed bell cut-off device, which is wired into the bell circuit. This device automatically cuts off power to the bell after it has rung for a pre-selected time. Twenty to thirty minutes is plenty of time for a burglar alarm to sound, whether the cause is an entry attempt or a malfunction. (Many localities have ordinances that mandate a 20 - 30 minute maximum *ring-off* period for burglar alarms.)

AC SWITCHING RELAY:

H is an AC switching relay. It is connected (g) in *parallel* to the bell circuit pair. When the alarm is activated, **the same current that rings the bell also energizes this relay,** causing its high-voltage rated contacts to close. These contacts are wired directly to the terminals of a light-switch. Closure of this relay's contacts will thus turn on whatever lights the switch normally controls, which might be a single table-lamp or a string of exterior floodlights. The combined effect of a loud bell or siren, (or both), and bright light will usually drive off the most brazen burglar.

Note that the AC switching relay is connected to the bell circuit wiring between the control panel terminals and the bell cut-off device at F. If it were connected anywhere beyond the bell cut-off, it would be de-energized along with the bell when the timer's contacts opened. This would turn off the lights, too, which is not desirable.

MULTIPLE ZONES:

It is often desirable to wire more than one protective circuit into the same burglar alarm system. The reason for doing this is to divide the system into separate "zones," each of which may be temporarily "shunted" (removed, or "by-passed") from the system without affecting the remaining zones. This capability is valuable in situations where a problem in a protective circuit is discovered prior to closing the premises and cannot be serviced until the following day. With a single zone system this would require that the entire system be switched off, leaving the premises totally unprotected.

A trick which is used successfully by many burglars is that of inconspicuously passing a razor blade through a strip of protective foil on the interior glass of a business premises during normal business hours, knowing that this inconspicuous damage to the protective circuit will force the owner to either remain overnight in the premises or leave it unprotected, which is usually the choice of a tired, unsuspecting shopkeeper who doesn't want to wait several hours for a serviceman.

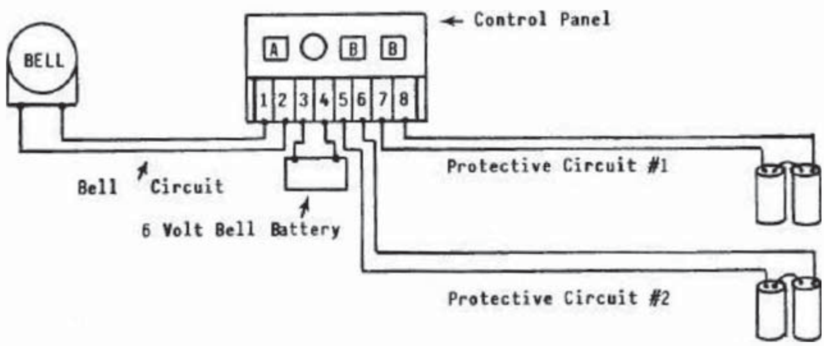


Figure 5-2.

The use of a two-zone control panel is a good way to counter this trick. Fig. 5-2 depicts the layout of a two-zone system. Note the differences between this layout and those seen in previous, single-zone diagrams: This control instrument has a second protective circuit relay (B) and another pair of terminals on the connecting strip, (7 & 8) which accomodates the additional protective circuit. Everything else is the same.

Assume that Protective Circuit #1 is dedicated exclusively to supervising the premises window foil and nothing else, while Protective Circuit #2 is dedicated to the remaining sensors used in the system--which includes a motion detector device: Several possibilities exist in such an arrangement. One possibility is the burglar(s) who sabotage the foil pattern, believing that the entire system has been disabled, will attempt to break in via a back-door, etc., which (unknown to them) is protected by a sensor in Protective Circuit #2, (Zone 2.)

Another possibility is that the burglar(s) will break and enter right through a glass pane, which is left unprotected because of the disabled zone. Once inside, however, they will enter the energized field of the motion detector device, which is wired into the active circuit, (Zone 2.)

The third possibility expresses the principle of the *day/night* control technique: The day/night control is a two-zone system which is used in the manner explained above: Zone One is dedicated to window foil, skylight *lacing*, wall foil and any other sensor which is not subject to operation or disturbance by routine daily movement. All of the other sensors, door and window switches, motion detectors, etc., those devices which are constantly being operated or otherwise disturbed by routine movement, are wired into Zone Two.

During normal business hours the alarm system is left switched on, but Zone Two is shunted. (Multiple zone panels have individual switches to shunt any zone.) Door and window switches may then be freely operated, and motion detectors disturbed without activating the alarm, because their circuit (zone) has been shunted out. But the instant that any kind of damage occurs in Zone One, (like a deliberate slit in a foil pattern, broken lacing, etc.), the alarm will activate. This enables the premises owner to call for service immediately and to possibly observe the cause of damage the moment it happens.

"DAY/NIGHT" control panels are commonly used for commercial premises which are freely visited by the general public. These are simply a "two-zone box" with a switching provision that temporarily shifts the bell circuit to a buzzer and light on the face of the control panel cabinet. this is a convenient alternative to having loud bells and sirens go off if Zone One is activated during business hours. When Zone Two is restored prior to closing, the normal bell circuit is re-engaged.

Control panels are available with built-in provisions for two, four or six separate zones, or more. The use of multiple zones, particularly in systems that utilize multiple loops, provides a valuable advantage in terms of "trouble-shooting," which is locating the cause of a protective circuit problem: Referring to the foregoing example of a two-zone system, a break in a foil pattern would immediately isolate the problem to Zone One.

Suppose that a burglar alarm system utilizes a dozen separate loops, covering three different levels (floors) of a premises: If all twelve loops are tied into the same protective circuit, a problem in any individual loop will require trouble-shooting the entire twelve loop protective circuit. And if the problem is discovered when the system is switched on just prior to securing the premises, (which is usually the case), when it is not convenient to trouble-shoot and repair it, the entire system must be disabled overnight.

If a multiple-zone control panel is used in the same situation, and the system is divided into four, (or more), separate zones, the zone in which the problem exists will be immediately identified by an indicator lamp when the system is switched on. If the specific cause of the problem, (a malfunctioning or damaged sensor, broken wire, etc.), cannot be quickly located and repaired, the indicating zone may be shunted out by moving a panel switch, leaving the remainder of the system operational.

The cost of a multiple-zone panel is greater than that of a basic, single-zone model and there is much more work involved in running a number of separate protective circuits directly to the control panel, instead of just one. But in view of the foregoing advantages it makes sense to go the extra mile. The advantages of a multiple-zone system are obvious and well worth the extra effort in the long run.

In comparison with the simple, straightforward design and appearance of a basic, single-circuit control panel, a multiple-zone, multi-feature control panel might be an intimidating prospect for a beginner. It should be kept in mind, however, that regardless of how many separate zones a given control panel will accomodate, the basic principles outlined in this material will apply to each of them.

Due to the large number of different control panels available from the various manufacturers it would be impractical to attempt a description of each of them in one book, because by the time this book is published there undoubtedly would be more. (Few of which will offer any really useful, new features.)

There is no question that some (or all) of the accessory functions described above are necessary for certain situations, but a good rule to follow when selecting a control panel is to avoid those which seem to promote gadgetry as opposed to sensible technology and are not truly useful or practical. While seductive lights, buzzers, whistles and bells serve an acceptably frivolous purpose in luxury automobiles, such redundant features in a burglar alarm control are often more confusing than convenient.

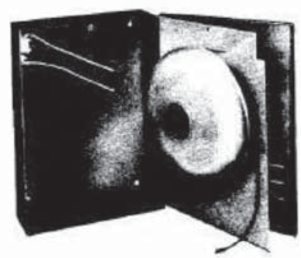
A listing of price averages for burglar alarm equipment is found at the end of this book. The prices given are the typical retail cost of reliable, professional-grade equipment. The reader who plans to install more than a few burglar alarms will save considerably when purchasing equipment directly from a wholesale distributor, but the beginner is well advised to patronize an experienced retailer who is not opposed to answering basic, "stupid" questions.

Wholesale distributors discount up to 40% off retail and thus depend on brisk, high-volume sales, which is why they have little patience with "gimme one of those and where do the wires go?" customers. A wholesaler's counter is usually busy with large quantity orders from working installers who know exactly what they need, and how many dozen, so the novice who's looking to save a few percent on the cost of a control panel stands an excellent chance of having a "white elephant" unloaded on him by a wholesaler who's been looking for an inexperienced amateur to dump it on.

It is alright for a beginner to buy a control panel with a few, necessary control features built in, provided the dealer is willing to explain the various wiring connections and any special requirements at the time of sale-- and provide additional information afterward, if needed. After the first installation has been completed, the novice will have sufficient experience to evaluate the more sophisticated control panels. Until then, the simpler the better.

BELLS & SIRENS

Because a burglar alarm bell will be permanently exposed to a variety of weather extremes, one should not consider using a bell which is not "UL Listed," meaning that its overall quality has been tested and found acceptable by the Underwriters' Laboratories. (The UL label is a generally reliable indication of quality where alarm components are concerned.) A burglar alarm bell should be contained in a heavy-gauge, weather-resistant , louvred cabinet, which should be equipped with tamper-detecting switches, or "tamper switches."



The inset above shows a burglar alarm bell in a heavy-duty cabinet. Note that the gong is mounted on a removable plate, (called a suspension plate.) The plate isolates the gong from the mounting surface which otherwise would absorb the gong's resonance. The suspension plate is secured to internal brackets by machine screws, then the outer door is sealed by more screws. Removing fine-threaded machine screws is a time-consuming procedure which, in combination with the measures outlined below, provide an adequate level of protection for the mounted bell. Even when a bell cabinet is mounted high above street level, some burglars won't hesitate to climb a ladder to get at it, provided they can do so without being seen. The following describes how a properly wired bell will frustrate such a compromise attempt:

Fig. 5-1 (next page) shows a bell cabinet with the suspension plate and gong removed. Note the two tamper switches mounted on the inner side of the cabinet, with their plungers facing to the front and to the back. The plunger of the front switch protrudes through a hole in the suspension plate, (when it is in place), and the plunger of the rear switch protrudes through a hole in the back of the cabinet. When the cabinet is mounted and sealed, the plungers of both switches are compressed by both the mounting surface and the closed cabinet door.

Fig. 5-2 is a close-up view of the tamper switches (only) and how they are wired. (The three holes on each switch are for the mounting screws.) Note that a short, 22 gauge *jumper* wire (A) extends from a screw terminal of one switch to a terminal of the other switch, conjoining both switches by a *series* connection. B is a 22 gauge pair, which is brought into the premises and connected to any loop of the protective circuit.

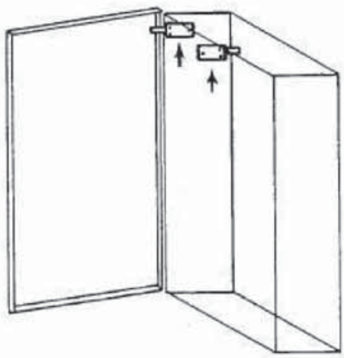


Figure 5-1

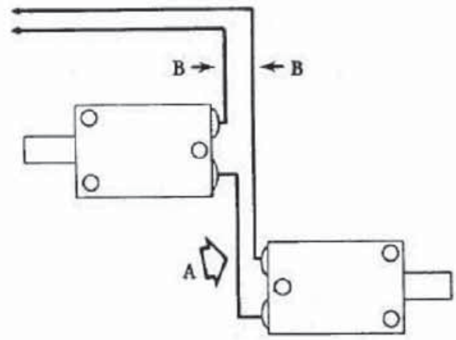


Figure 5-2

(If convenient, this connection may be made inside the control panel.) In effect, these switches represent a separate loop in the protective circuit and they serve the same purpose as any of the switches used inside the premises to protect windows and doors, etc.

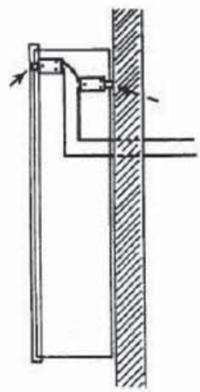


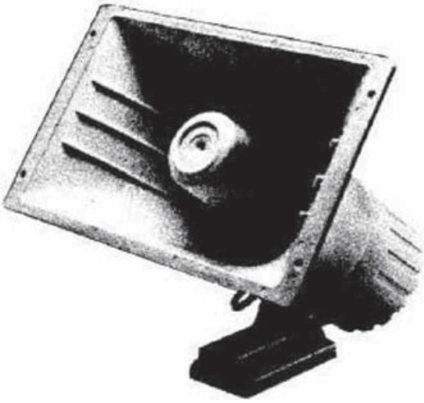
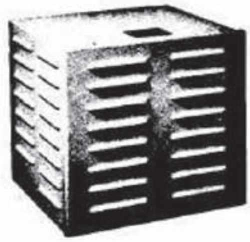
Figure 5-3

Fig. 5-3 is a side-view of a bell cabinet, mounted and sealed. Even if a burglar removed the three screws that seal the cover, the moment the cover is opened the plunger of the front switch will release, opening the circuit and activating the bell. The burglar still would not be able to reach the bell wiring without first removing three more screws that secure the suspension plate. Not an easy task while standing on a ladder with a 108 decibel bell pounding away in one's face, wondering if the police are on the way.

Likewise, if an attempt is made to pry the cabinet away from its mounting surface, the bell will be activated the moment the cabinet is pried enough to release the rear tamper. For this reason, the cabinet should be mounted as securely as possible.

An increasingly popular alternative to the traditional burglar alarm bell is the electronic siren, which is similar in its oscillating tone to the sirens used in police cars and other emergency vehicles.

The electronic sirens used for burglar alarms consist of a PA speaker contained in a protective cabinet, much like that of a bell cabinet. If an electronic siren is used in place of a bell, it is recommended that a 12 volt model be used because of the relatively weak noise level of the 6 volt versions.

A typical electronic siren speaker is shown above. The cabinet on the right is tamper-protected in the same manner as a bell cabinet.

Most of these sirens employ a remote driver/amplifier, a separate module which is contained in the control panel. The module is wired to the bell terminals of the control instrument, and the wires leading to the siren are connected to the module. (Some control panels have built-in siren drivers.) Most siren drivers can accomodate up to four separate speakers, which enables the use of **multiple annunciators.** (An "annunciator" is any type of noisemaker, a bell or a siren.)

One technique which will greatly enhance the overall effect of a burglar alarm is to use an electronic siren <u>inside</u> the premises, in addition to the exterior bell or siren. The noise generated by an indoor siren is deafening and will deprive a burglar of the ability to listen for approaching danger. A convenient way to do this is by wiring a siren driver directly to any type of indoor PA speakers, <u>or</u> to a pair of existing stereo speakers.

Another useful accessory is a strobe. The effect of a strobe burst in a darkened area is virtually blinding, causing general disorientation and loss of balance. For outdoor application, weatherproof strobes are available for mounting directly onto bell or siren cabinets. These are powered by the bell circuit and serve as a beacon for responding police.

Thus far it has been shown how adding modular accessories to a basic burglar alarm control can ring a bell outside and a siren inside, switch on outdoor or indoor lighting, temporarily blind a burglar with a strobe burst, 'visually guide responding police to the sound of an active alarm annunciator, and automatically silence the annunciator(s) after a fixed period of time. The following sections are devoted to the many sensors, (detectors and switches), which may be wired into the protective circuit to initiate the foregoing effects. It is assumed that the reader is sufficiently acquainted with the operation of a burglar alarm system that no further discussion of control functions will be necessary. If not, a review of the foregoing sections is recommended before proceeding further.

TESTING WITH A METER

Working with burglar alarms calls for the performance of certain tests to determine the factors of *polarity, continuity* and *voltage.* Fortunately, these tests are quite simple and each may be performed with an easy-to-use instrument called a *multimeter*, or "meter" in the language of the trade.

There are hundreds of different types of multimeters available, ranging in price from twenty dollars to several hundred dollars. The more expensive models are extremely accurate and are designed for sophisticated applications. (Such precision is not required for testing burglar alarm circuits.) Small, lightweight multimeters, which are ideal for burglar alarm work, are available from alarm equipment suppliers for around thirty or forty dollars.

Because of its highly technical appearance, a multimeter can be intimidating to the novice who has never used one. The face of the meter is graduated into hundreds of fine increments and there are many numbered settings to select from. However, the device is extremely simple to use:

A typical multi-meter is a rectangular device, with a pair of wire *probes* extending from its body. It may be set to test either AC or DC voltage or electrical continuity through a "dead" conductor. Because burglar alarms operate on DC, the only AC test will be that of determining whether a wall receptacle is live prior to plugging in a power supply transformer. This is done by selecting the AC function and inserting the probe tips into the receptacle. If the meter moves, the outlet is live. If it doesn't move, the outlet is dead. Aside from this, the meter will be used exclusively for DC and continuity testing:

<u>POLARITY:</u>

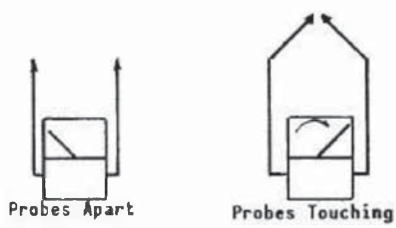
Polarity means the difference between the Positive (+) and the Negative (-) "sides" of a DC power source. It is important to know which is which because DC components require that polarity be *observed* during wiring, that is + to +, - to -. The terminals of most components are clearly marked with a + or - symbol, or by color. Red is Positive, black is Negative. Connecting a component the wrong way (*cross-polarizing*), will cause damage, malfunction or non-function.

It is simple to determine the polarity of a DC power source: The probe wires of a multimeter are color-coded red and black. These probes are applied to the terminals of the power source, (such as those of an unmarked battery or transformer.) If the needle of the meter swings to the right, (which is the normal direction), the terminal to which the RED probe is applied is the POSITIVE side. If the needle moves <u>backward</u>, this means the RED probe is applied to the NEGATIVE side. A simple way to acquaint oneself with this test is to alternately apply the probes of a multimeter to the terminals of any type of battery and note the direction in which the needle moves.

Proper polarity must be observed when connecting the ends of a protective circuit to the terminals of a control panel. Imagine that the protective circuit battery is located a considerable distance away from the control panel to which you are about to connect the protective circuit pair. The polarity of the pair may be determined instantly by applying the meter's probes to the wire ends. If the needle swings to the right, then the conductor to which the RED probe is applied is POSITIVE. If the needle moves backward, the RED probe is applied to the NEGATIVE conductor. (The control panel terminals will always be marked, either with the + and - symbols or the colors red and black.)

<u>CONTINUITY:</u>

Continuity means the ability of a conductor, (a wire, etc.), to accomodate the flow of an electrical current. To perform this test, the meter is set to the position marked OHMS, (meaning *resistance.*)



<u>Figure 6-1</u>

When the meter's probes are brought together the needle will swing all the way to the right, indicating unimpeded continuity. By bringing the probes together a <u>circuit</u> is completed, consisting of the probe wires, the meter's battery, and an electromagnetic coil inside the meter that moves the needle.

If the meter's probes are applied to any conductive medium, whether the shaft of a screwdriver or a 1,000 ft. protective circuit, the effect will be the same. So long as there is unbroken continuity throughout the conductor, the needle will indicate by swinging to the right.

If the needle doesn't move, there is a break somewhere in the conductor.

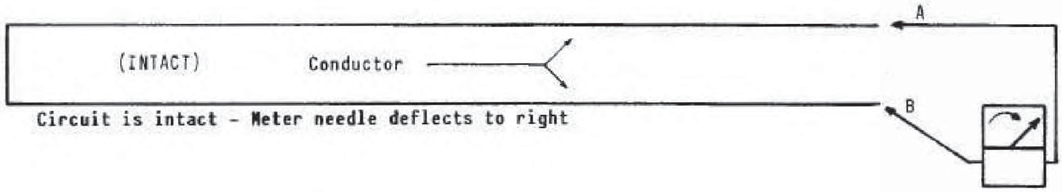


Figure 6-2

Fig. 6-2 shows a conductor, (a pair of wires open at one end.) The probes of a meter, (A & B), are applied to the open ends. Because the conductor is intact, (no breaks), the meter is indicating full continuity, (no resistance to the flow of electrical energy.)

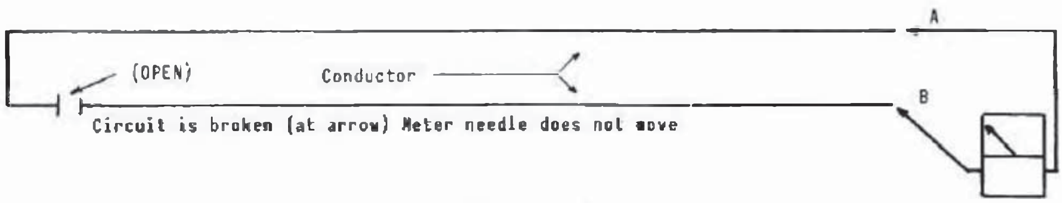


Figure 6-3

In Fig. 6-3 there is a break (open) in the lower leg of the conductor. Note that the needle hasn't moved from its extreme left position, showing that energy cannot flow through the circuit.

Breaks in continuity are rarely visible. One example of a situation in which a concealed break would be impossible to locate without the aid of a meter is an open occurring beneath the insulation of a conductor. This can be the result of a manufacturing defect, excessive strain when pulling wire through a tight space or careless use of a staple-gun while fastening the pair. The example seen in Fig. 6-3 shows such a break, it could be precisely located by advancing the probes of the meter along the length of the conductor a few feet at a time. Contact with the wire under the insulation is made by pushing map pins through the insulation and applying the meter probes to the pins. Ideally, the tips of the meter's probes will be alligator clips into which pins may be clamped.

Burglar alarm wire is usually packaged on 500' spools. The wire is wound on the spool so that both ends of the 500' pair are exposed and accessible. By twisting the open conductors at one end of the spool together and applying a meter's probes to the other ends, the entire 500' pair may be tested for a defect while still on the spool. It is recommended that this test be performed on every spool of wire prior to using it. Each spool is factory tested right after it's wound, but damage could occur during shipping. It is rare that a broken conductor will be found in a fresh spool of wire but, if one exists, it's best to find it before the wire is installed-- especially inside a wall!

SENSORS

By now it should be clear that a burglar alarm is activated by some action which causes an *open* (break) to occur at **any** point in the protective circuit. The open may be produced by disconnecting an external protective circuit battery, removing either of the protective circuit connections from Terminals 5 & 6 of the control panel, **cutting** a conductor or **otherwise producing an open** **anywhere** **along the length of the protective circuit wiring.**

As explained in the section on PROTECTIVE CIRCUITS, a wide variety of special devices are situated at strategic locations within a protected premises and wired into the protective circuit. This variety of devices ranges from simple mechanical switches and fragile conductors ("lacing" wire and window "foil") to sophisticated electronic motion detectors such as passive infra-red, photoelectric, micro-wave, ultrasonic, capacitance and audio-discriminator devices. Regardless of how simple or complicated any of these devices might be they all serve the same purpose, that of producing an open in the protective circuit when disturbed by **movement**, or *excited* by the **presence** of something approximate to a human form.

Any device that is wired into a protective circuit to detect **movement** or **presence** when it is **operated** (as in the case of a switch) or ***excited***, (as in the case of a motion detector), is called a *sensor*. All sensors are connected into the protective circuit in the same manner, by cutting one leg of the protective circuit wiring, stripping the severed ends and attaching them to a pair of screw terminals on the device.

The novice installer should not be intimidated by the complex nature of any type of motion detector apparatus. Like radios and tv sets, one needn't know what makes them tick in order to use them efficiently. All that the installer needs to know about an individual detector is its operational nature, its capabilities and limitations, how to apply it and test it for proper operation. These procedures are covered in the following segments.

It is neither necessary nor practical for the installer to repair a motion detector device in the field, or otherwise. When it is determined that a detector is malfunctioning, the accepted practice is to remove it and return it to the supplier for repair. The malfunctioning device is then replaced with another of the same type. If a replacement is not immediately available, the wire ends from which the device is removed are spliced together to restore the circuit until the device is returned. Excluding a detector from a protective circuit, even for one day, is not a desirable practice. Professional installers avoid this by making sure they have an adequate stock of replacement components on hand.

PLUNGER SWITCH

Operationally, a plunger switch is no different from the spring-loaded button used to ring a doorbell. Pressing the button closes a pair of internal contacts, completing a circuit, causing the bell to ring. When pressure is released, the contacts release.

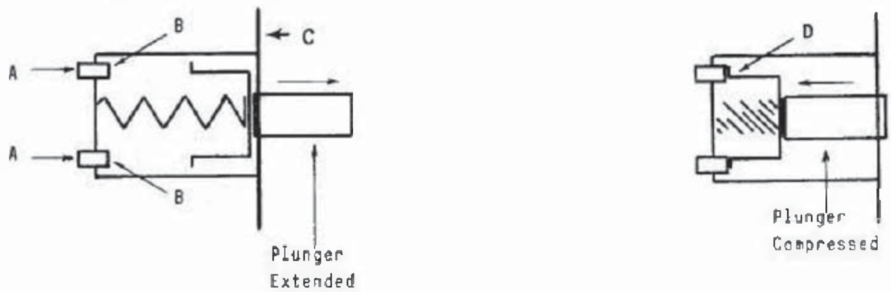


Fig. 8-1 **Fig. 8-2**

The major difference between a plunger switch and a doorbell button is shape and internal construction. As seen in Fig. 8-1, the push-button is a plunger that protrudes about 3/4" from the face (C) of the switch. A relaxed spring is seen inside the body of the switch forcing the plunger outward, leaving the contacts open at B.

Fig. 8-2 shows the plunger compressed into the body of the switch, collapsing the spring, causing a U-shaped, bronze jumper strip (D) to complete a circuit across the internal contacts. A pair of screw terminals at A are seen as physical extensions of the internal contacts, (B).

The reader who is experienced in electrical wiring will probably consider the foregoing description of a simple device to be somewhat tiresome, but this exhaustive explanation will be helpful to the novice in understanding how switches work and how they are used in a protective circuit.

So long as pressure is maintained against the plunger of this switch the jumper strip remains compressed against the contacts, providing electrical continuity through the switch via the external terminals. When pressure is relaxed the jumper strip withdraws, producing an open in the protective circuit. This will activate the alarm.

Although a plunger switch is one of the simplest and least expensive of all sensors, there are many ways to use it.

Fig. 8-3 shows the most common application: The plunger switch is mounted in a 3/4" hole bored into a door-frame. The edge of the door will compress the plunger when the door is closed. When the door is opened the plunger will release.

A pair of wires is seen attached to the terminals of the switch and drawn through a small hole drilled through a baseboard. This pair will be connected into the protective circuit at the closest junction.

This wiring route presumes an exposed wiring job. If concealed wiring is preferred, (which is optional), the wiring may be snaked through the wall or tucked behind the baseboard.

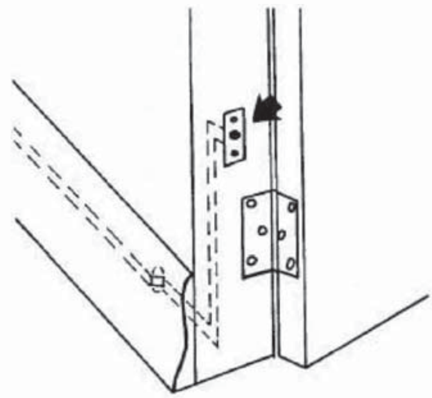
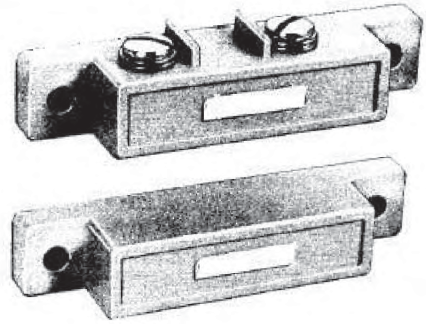


Fig. 8-3

Another way to use a plunger switch is to mount it in the bottom channel of a double-hung window frame (and another in the top channel, if desired) and snake the wiring through the wall. While this technique provides absolute concealment, a special, weatherproof plunger switch must be used because of the direct exposure to moisture. The weatherproof plunger is enclosed in a flexible rubber boot and the housing of the switch is moisture-resistant.

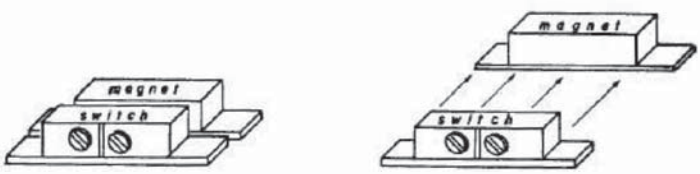
These are just two of many possible applications of this versatile switch, other possibilities are limited only by the installer's imagination: For example, a plunger switch may be mounted in the surface of a table or cabinet and the plunger compressed by the weight of a valuable item of property. Removal of the item will release the plunger. This type of application is called a "trap" and is useful to ensure that an alarm will be activated even if a burglar manages to bypass the *perimeter* sensors and gets inside. Such a "trap" may be rigged and wired into the active "zone" of a *day/night system* to guard against removal of certain items from a premises during normal business hours.

The "tamper" switch described in the section on BELLS & SIRENS is simply a plunger switch that is specifically designed for surface mounting inside a bell or siren cabinet. This type of plunger switch may also be mounted on the sill of an outward-opening casement window so the sash of the window will compress the plunger when the window is closed.



MAGNETIC SWITCH

A magnetic switch consists of two separate parts, the **switch** and the **magnet**. Except for a pair of screw terminals on the switch, both parts are physically identical. One part is a short rod of permanent **magnet** sealed in a plastic enclosure. The other part contains a clever **switching** mechanism.



Inside the switch housing are a pair of contact arms. One arm is stationary, the other is pivotal. The pivoting contact is held apart from the stationary contact by the light pulling force of a tiny, bronze, coil spring. The arm of the pivoting contact is made of ferrous metal, which is receptive to magnetic influence. When the magnet is brought into close proximity with the switch, its force outweighs that of the coil spring and the pivoting arm is drawn sharply into contact with the stationary arm.

The screw terminals on the switch housing are extensions of the internal contact arms. When the two arms are drawn together by the magnet's influence, continuity is established between the screw terminals. When the dominating magnet is withdrawn, the force of the coil spring is restored and the pivoting contact is pulled away from the stationary contact.

The operation of a magnetic switch may be observed by applying the probes of a meter, (set to read continuity), to the screw terminals of the switch and observing the behavior of the needle: (See Fig. 9-1, next page.) When the switch is separated from the magnet, (1/4" or more), its internal contacts remain open and there is no continuity, thus the needle will not move. When the magnet is brought close to the switch its internal contacts snap together and the needle swings sharply to the right, indicating continuity between the screw terminals.

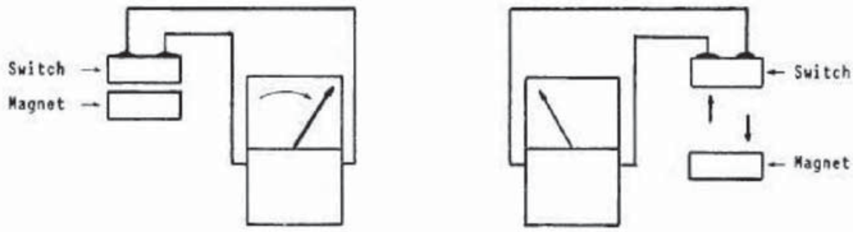


Fig. 9-1

Because of its clever, two-part design, the magnetic switch is compatible with a wide variety of applications, the most typical of which are depicted in Fig. 9-2, below.

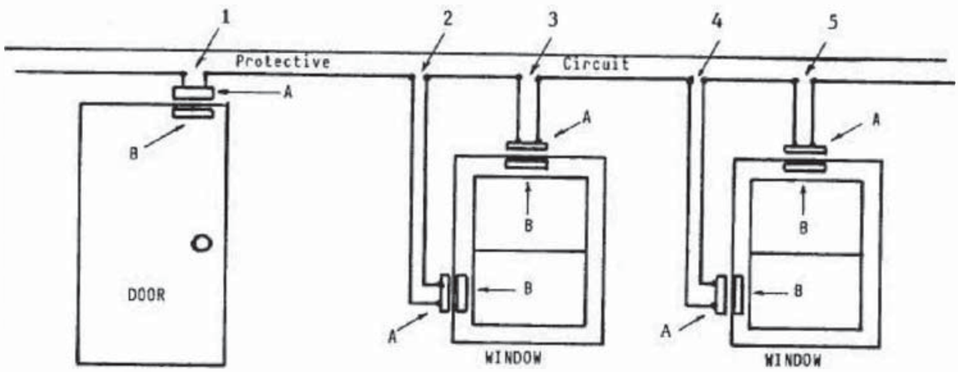


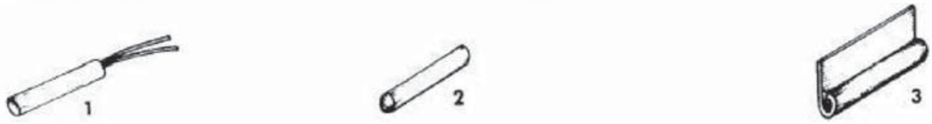
Fig. 9-2

In Fig. 9-2, a series of five magnetic switches are seen applied to a door and two windows. The switches are shown as A, the magnets are B. The door switch is mounted on the door frame immediately over the upper edge of the door. A magnet is mounted on the door directly beneath the switch, holding the internal contacts closed and maintaining continuity through the switch.

The windows represented in this diagram are the standard, double-hung type. The switches are mounted on the window frames, the magnets are mounted on the sashes. With the window switches and magnets arranged as shown, normal movement of the upper and lower sashes is unobstructed.

The magnetic switch described above is the surface-mounted type. It may be fastened to either a wood or metal surface with a pair of 1/2" (#6) screws. The ideal spacing between magnet and switch is 1/8". When the mounting surfaces for the magnet and switch are offset, making it difficult to align the two segments, plastic spacers (and specially designed brackets) are available to compensate for the offset distance. The plastic spacers, (or "shims"), are 1/8" thick and conform to the mounting base shape of the magnet or switch. Whenever a magnetic switch is used on a ferrous metal surface, at least two spacers should be used to move the magnet and switch farther away from the mounting surface. Otherwise the metallic mass will absorb energy from the magnet and weaken its effect on the switch.

Other types of magnetic switches are available for special applications. The shape and construction of these devices are different but the same operating principle applies to each of them.

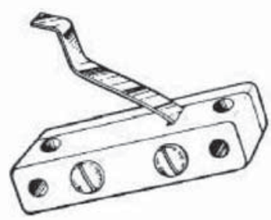


Item 1 is a sealed, cylindrical magnetic switch, which is 1/4" wide X 1-1/2" long. Instead of screw terminals for connecting it into a protective circuit, a pair of wire *tails* is provided for soldering to the protective circuit wiring. 2 is a bare (not sealed in plastic) rod of permanent magnet, which is the same size as the switch. 3 is a plastic mounting tab, curled at one end into a loop which accomodates the magnet or switch perfectly. On the back of the tab is an adhesive pad for convenient, stick-on mounting. This type of switch is commonly used on horizontal sliding, aluminum-frame windows, (on which the rectangular type described above cannot be used because of their shape and size.) A cylindrical switch and a magnet are slipped into separate mounting tabs. The switch is stuck to the frame above or alongside the sliding window. A magnet is stuck to the edge of the window glass in alignment with the switch. The mounting surfaces should be cleaned with alochol before applying the tabs or the adhesive is likely to fail.

This type of magnetic switch is also appropriate for concealed applications. One common example is that of boring a 1/4" hole up through a door-frame, and another 1/4" hole down 1-1/2" into the upper edge of the door. Both holes must be carefully aligned. The switch is fitted into the hole in the frame, with the wire tails extending upward into the hollow above the frame for connection to the protective circuit. The magnet is fitted into the hole in the door edge. When the door is closed the magnet is aligned end-to-end with the switch. The foregoing arrangement also applies to wood-frame, double-hung windows, (both top & bottom), when a totally concealed installation is desirable.

A large, heavy-duty magnetic switch set, both parts encased in cast aluminum, is available for protecting roll-up garage and warehouse doors. This switch has a long pair of connecting wires extending from one end, protected.within a 24" length of flexible, 1/4" aluminum tubing. The switch may be surface-mounted or set in poured concrete on the floor just inside the door and alongside the frame, where the tube is bent around the frame and upward along the inner wall. The wire tails are connected into the protective circuit. The magnet is attached to the lower edge of the door immediately above the switch. When the door is rolled down, the magnet engages the switch. This type of switch should <u>not</u> be used on roll-up doors which are loosely hung and subject to movement, (from wind, vibration, bumping, etc.)

LEAF SWITCH

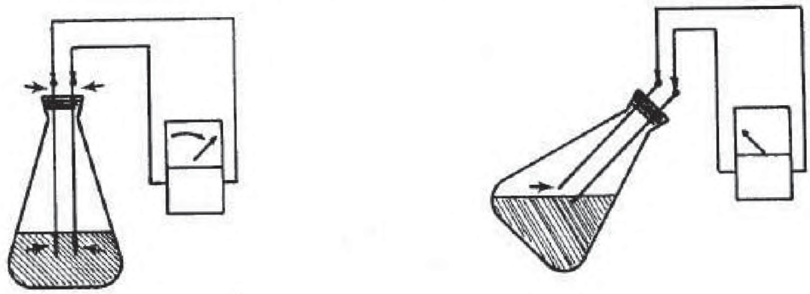


The *leaf* switch is named for the flexible strip (leaf spring) that extends from one side. This device is operationally similar to the plunger switch. It is equally inexpensive and very simple to use.

The major difference between the leaf and the plunger switches is that the leaf switch is surface mounted. Note that there are two pairs of mounting holes on the body which enable the (1" / #6) mounting screws to be inserted either from the top or side of the device. Connection to the protective circuit is made via the pair of screw terminals seen on the front side of the device.

The leaf switch is a quick, handy, inexpensive way to protect any type of opening which is covered by a movable barrier, such as a roof hatch, trap-door, etc. The device is mounted close to the barrier so that the leaf is compressed by the barrier when it is closed. Compression of the leaf engages a pair of internal contacts. Relaxing pressure against the leaf separates the internal contacts, triggering the alarm.

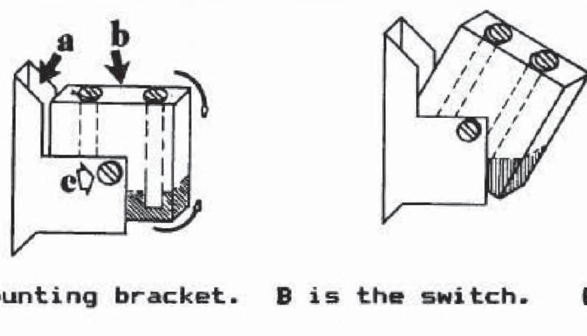
MERCURY SWITCH



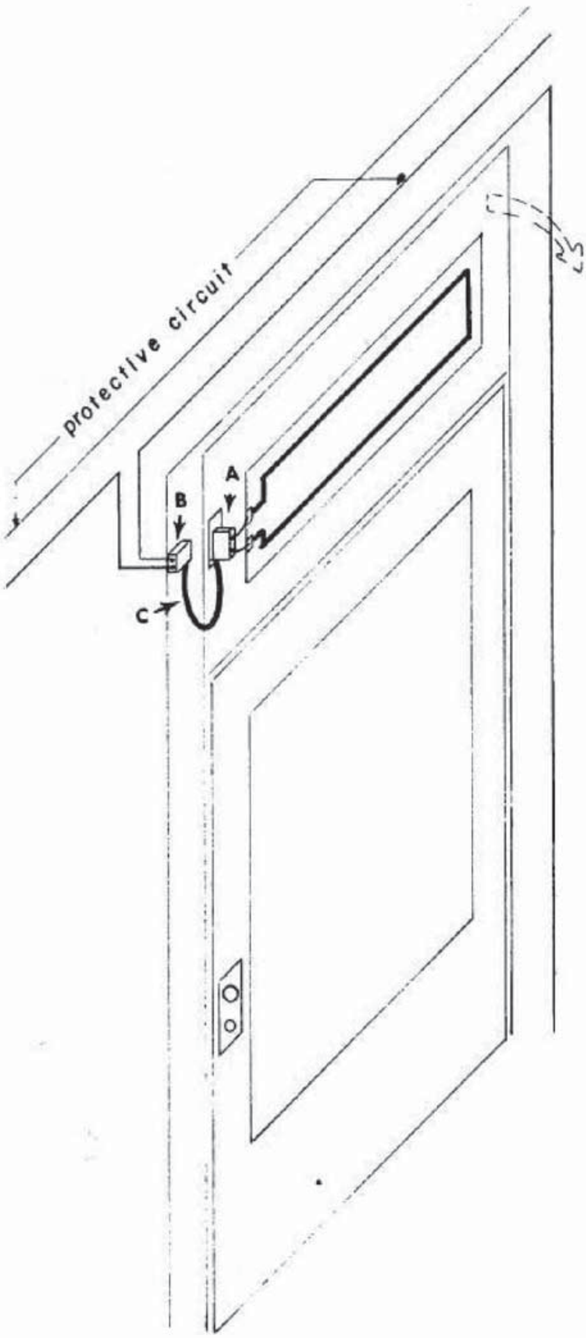
The principle of a mercury switch is expressed in the above diagram: Seen on the left is a laboratory flask which is partially filled with mercury, a highly conductive, heavy liquid substance. Two rigid wires are passed through the cork in the flask and extend downward into the mercury. The probes of a meter (set to read continuity) are attached to the external ends of the two wires, indicating that the mercury is conducting an electrical current between the two wires. On the right the flask is shown tilted to one side, withdrawing one of the wires from the conductive mercury. As indicated by the *zero continuity* reading on the meter face, the effect is identical to opening the contacts of a switch.

The portion of the wires inside the flask are regarded as internal *contacts*, the tips of the wires extending outside through the cork are the exterior *terminals*. Thus there is no functional difference between this ingenious device and any other switch. Mechanically, the mercury switch is operated by simply tilting it.

Mercury switches come in many shapes and sizes and are used in a wide variety of applications, such as switching on the light in an automobile trunk when the hatch is raised. Regardless of the shape of its housing, inside every mercury switch is a sealed glass vessel with a pair of contacts and a pair of terminals arranged essentially the same as in the flask example seen above. In order to adjust the *sensitivity*, or *angle of activation* of a mercury switch, the vessel itself is suspended on some type of mounting bracket. The type of mercury switch used in burglar alarms is represented below:



A is the mounting bracket. B is the switch. C is the adjustment screw.



After the bracket is fastened to the mounting surface, the probes of a meter are attached to the terminals of the switch. The angle of the switch is then adjusted to partially tilt the vessel. The objective is to cause activation when the mounting surface is tilted two or three inches in its opening direction.

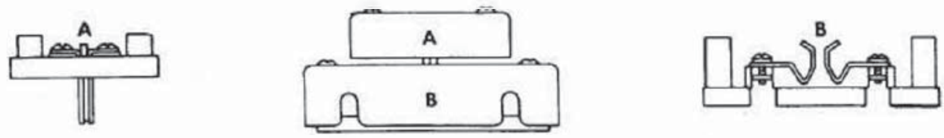
A mercury switch may be used to monitor a hinged skylight cover, transom, cellar door, trap doors, or whatever application calls for this type of sensor. A special-purpose door cord (C) is available with a flexible connecting cable and a terminal block attached, for applications like the one seen on the left:

This version enables the attachment of a foil pattern to the terminals of the switch (A) which is mounted on a transom. The terminal block (B) is fastened to the adjoining frame. The flexible cable, (called a *door cord*), enables free movement of the transom when the alarm is not in use.

When the alarm is switched on, disturbance of the foil pattern or movement of the transom will activate it.

No sensors are shown on the door below the transom because it is not relevant to this discussion. However, if a magnetic switch were used, it could be connected in series with the protective circuit connection to the terminal block of the mercury switch, (at B.)

Although the *clip trap* goes back to the stone age of burglar alarm technology, it continues to afford a simple, inexpensive means of monitoring a variety of situations, such as ventilator openings, window-mounted air conditioners, garage doors, etc.



The clip trap shown above consists of two parts: A is the *plug*, B is the *jack*. Both parts are seen in the center diagram with their covers on, engaged as they would be in actual service. There are two different ways to use a clip trap, one is called a "live trap," the other is a "dead trap."

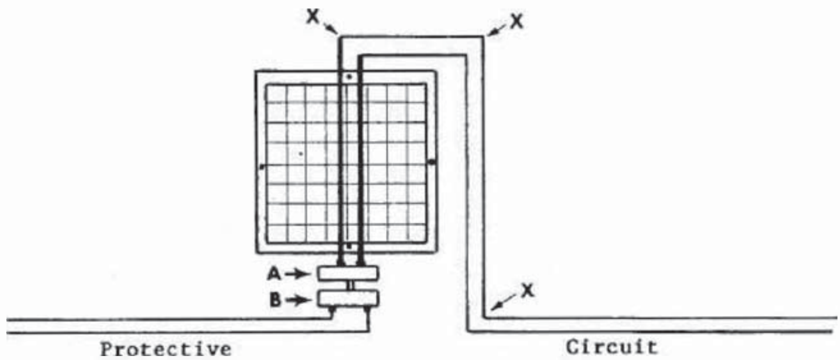


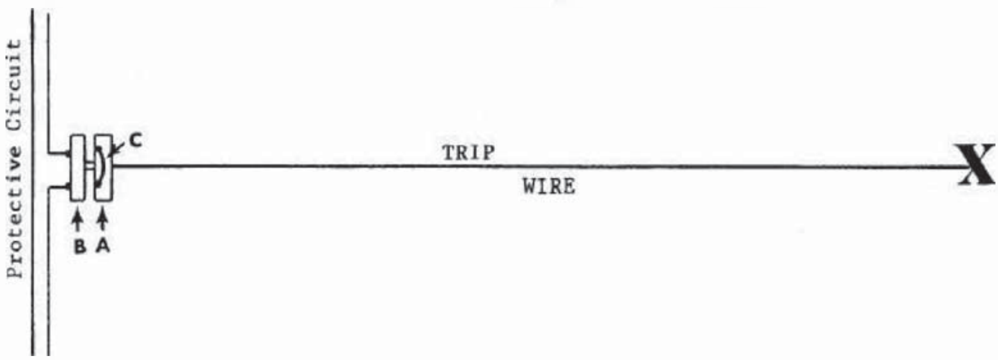
Figure 12-1

An example of a *live trap* is shown above, applied to the grille of a ventilator duct: Note that both legs of the protective circuit wiring are connected to the screw terminals of the jack (B), which is fastened to the wall just below the duct. The continuation of the protective circuit is connected to the screw terminals of the plug, (A). The protective circuit wiring is securely fastened to the wall at the points marked X.

When A is plugged into B, the path of electrical continuity may be seen by examining the diagrams of both parts: The blades seen protruding downward from the plastic base of the clip are metallic extensions of the terminal screws visible on top. The hooked posts in the center of the jack are shaped strips of spring steel, spaced to hold the clip's blade firmly when it is inserted.

It is not uncommon for a burglar to wriggle through a ventilator duct and cut through or kick out the interior grille. As seen in Fig. 12-1, if the grille is kicked out the clip will be dislodged from the jack. If the burglar reached through with a tool to cut the wire the effect would be the same, thus the name *live trap*. This clip trap arrangement enables removal of the grille for cleaning and maintenance without need to disassemble a more permanent type of wiring.

A typical use for the *dead trap* is that of a floor-level trip wire, which is useful in simple, "low risk" applications such as a tool shed, or the trip wire may be passed through a hole in a wall and stretched across an exterior driveway or path, enabling the outside of a premises to be monitored by an interior alarm system. The same type of clip trap may be used for a dead trap, with two major differences in the wiring:



In the above example, the jack (B) is wired in series into one leg of the protective circuit (in the usual manner.) The plug (A) is not used as a *live* continuation of the protective circuit. Instead, a short jumper wire (C) is connected across its terminals to affect continuity when it is plugged into the jack. (Review the drawings of the two parts if this is not clear.)

A length of fine, black fishing line, (at least 20# test), is attached to A and stretched at baseboard height, where it is fastened at an anchor point shown as X. Trip wires of this type, strategically situated within a darkened premises are a simple, efficient, economical way to protect a low-risk premises.

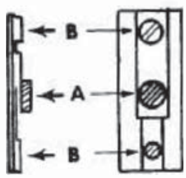
The floor-level trip wire is but one way to use a dead trap. Another technique is to stretch the wire across a closed door, tack it to the lower sash of a window, or use it in any manner dictated by common sense and imagination. Its range of applications is limitless.

Any action which causes the plug of a *dead* trap to be withdrawn from its jack will initiate an alarm.

Any action which causes the plug of a *live* trap to be withdrawn from its jack-- or severs the *supervised* trip wire (as shown in Fig. 12-1)-- will initiate an alarm.

VIBRATION DETECTOR

The vibration detector used in contemporary burglar alarms is an adaptation of the "tremolo" switch, which was devised by the British cloak & dagger service (during WW-II) for detonating vehicle bombs in sabotage operations. While the tremolo was designed to close a circuit upon sensing vibration, the burglar alarm version opens a circuit.



The device is approx. the size of pack of chewing gum. On the left are side and front views of a typical vibration detector, (with its cover removed.) A is the *pendulum*, a small, cylindrical brass weight fastened to a thin strip of spring bronze. B is a pair of terminal screws. The base of the device is non-conductive plastic. Note that another thin strip of bronze extends from the lower terminal screw, upward and under the pendulum. Not shown in this diagram is a sensitivity adjustment screw, which adjusts the spacing between the pendulum and the bronze strip beneath it.

The device is fastened to a solid, vibration-free surface, (e.g. a brick wall), which might be penetrated by extremely forceful means, such as hammer-blows, drilling, etc. (Breaking through cellar walls of adjoining commercial premises is not an uncommon entry method when the stakes are high enough.) It may be fastened with screws but epoxy cement provides a better union with the mounting surface.

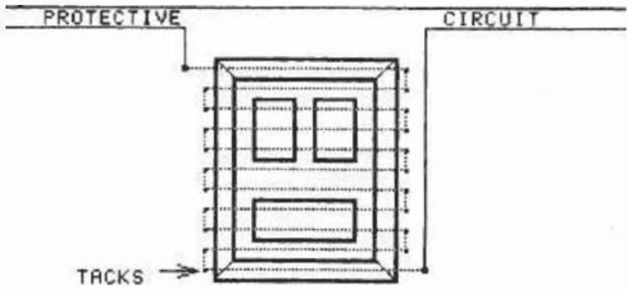
After the device is fastened, the probes of a meter are applied to its terminal screws and the sensitivity adjustment screw is slowly rotated clockwise until the meter indicates closed contact between the pendulum and the conductive strip beneath it, by swinging fully to the right. The adjustment screw is then backed off until the meter needle drops back, indicating loss of contact. Then, by alternately pounding on the mounting surface and re-adjusting the sensitivity screw, the device is "tuned" to detect a forceful attack on the protected wall.

When using a meter (set to read continuity) the proper indication will occur as a slight *bounce* of the needle, not a fixed, wide movement to the right as occurs with a solidly closed circuit. A sharp blow against the mounting surface (within a 12' radius) should cause the needle to move slightly and fall back. Keep in mind that a protective circuit relay is extremely "fast" and sensitive, and will react to the slightest disturbance in the flow of supervisory current through it; therefore the slightest fluctuation of the meter needle represents a sufficient disturbance to trigger the alarm.

Consider that a blow struck while testing the device will not be as severe as would be those struck in an actual attack on the wall, so the difference must be experimentally projected. Be careful not to adjust the sensitivity too high, or false alarms will result from such routine events as thunderstorms, passing trucks, etc. When the sensitivity is properly adjusted, connect the protective circuit to the terminals and screw the cover on the device. (Not too tightly, or the sensitivity adjustment might be altered.)

LACING

Wire *lacing* is a very simple way to monitor a door or window that is never used, a weak section of wall, a workshop skylight and situations where the use of switching sensors, (magnetics, etc.), is neither necessary nor practical.



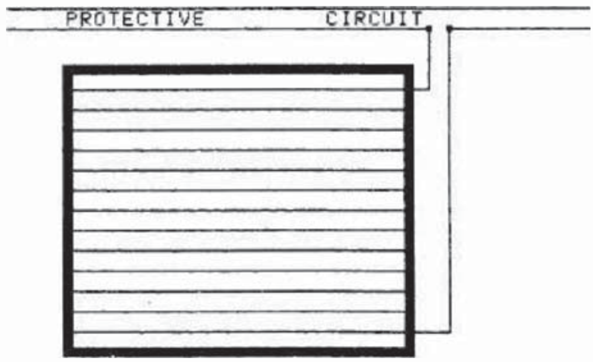
Lacing is simply a continuous pattern of fine, brittle wire, (either bare or insulated), which is fastened in an even pattern across the opening or barrier to be monitored. The door shown above opens inward and is fitted with three panels, any of which could easily be kicked in by a burglar. It is situated in an area where appearances are not an important concern, so lacing is the ideal sensor for it.

The pattern was created by driving ordinary carpet tacks into the door-frame on both sides of the door at 2" vertical intervals. The tacks are driven in only partially, leaving about 1/8" extended to wrap the lacing wire around the heads. Begin forming the pattern by wrapping about four turns around the first tack, leaving a short tail hanging to splice into the protective circuit. Then stretch the lacing wire across to the corresponding tack and wind four turns around it. Move the wire down to the tack below the one just wound, wind another four turns and stretch across the door again. Repeat the process until the pattern is completed, leaving another tail hanging at the last tack, then gently drive the tacks <u>almost</u> flush with the wall. (A hard hammer blow will easily break the wire.) Splice the pattern into the protective circuit as shown and the job is finished.

While a lacing pattern is easy to by-pass, (by attaching a jumper to the strands at the top and bottom), access to the pattern would be necessary. To penetrate this pattern without breaking any strands would require careful, skillful cutting of the door, which only a sophisticated thief is capable of. This type of sensor is <u>not</u> recommended for any type of high-risk application, however it is adequate for protecting against the average, unsophisticated, "crowbar" burglar.

Lacing patterns are useful for monitoring potential points of forceful entry onto low or average-risk premises such as flimsy, adjoining walls, unused doors, windows and skylights, etc.

Ventilator ducts are commonly protected by fastening a *laced frame* (next page) over the interior grille.



A laced frame is easily constructed from two sections of wood frame (of optional shape and size) which are made from 1" x 1/2" strips. Thumb tacks are used to stretch the lacing onto one of the frame sections. When the pattern is completed, the second section is applied over the first (leaving the two connecting tails hanging out), a hole is drilled through each corner of the frame and it is fastened over the ventilator grille. Again, this type of sensor should be used only when the maximum level of attack sophistication is that of a burglar squeezing through the vent and kicking out the grille-- breaking the lacing strands at the same time. (This diagram shows the completed frame, not the unfinished sections.)

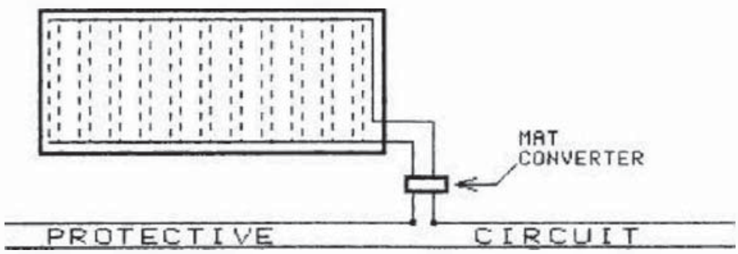
More sophisticated versions of laced screens are available, made to order according to size. One type is a finely-crafted window screen that looks no different from ordinary screen but has insulated lacing wire woven into the screen material. Because the cutting or removal of window screens is an extremely common practice in residential burglaries, screens of this type are uniquely efficient perimeter monitoring devices. They will activate the alarm if the screen is cut <u>or</u> removed.

Also available from commercial suppliers are pre-assembled screens which are made from basswood dowels that have the lacing wire imbedded in them. The wiring of these screens incorporates <u>both</u> legs of the protective circuit rather than just one, as a measure of protection against 'by-pass' by the jumper method mentioned above. This technique presents the burglar with a random arrangement of strands, some of which are extensions of the + (positive) leg of the protective circuit and some of which are extensions of the - (negative) leg. If a jumper is attached to a positive and a negative strand, the protective circuit will be shorted at that point and the alarm will be activated. (See the section on SHORT CIRCUITS if this principle is not clear.)

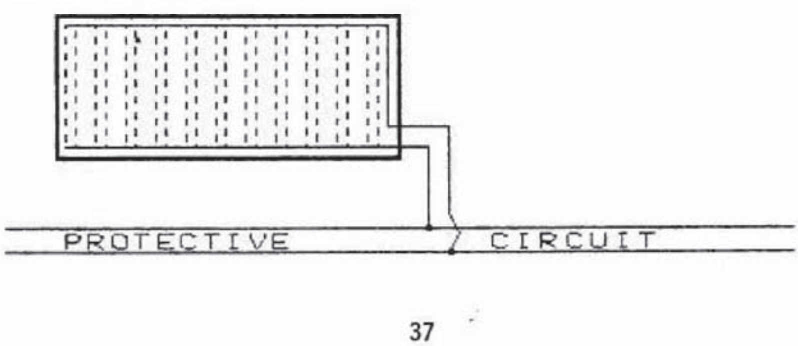
The wire used for lacing is available from specialized suppliers and is designated as *hard-drawn* copper wire. This type of wire is especially suitable for lacing because of its brittle, non-resilient nature. It will not stretch as will normal copper wire but will break easily if stress is applied to it.

SWITCH MAT

Switch mat is available in rolls of 10 to 25 ft. long x 30" wide and may be cut to any desired length for placement under carpeting. The mat is made up of individual strips, arranged one next to another and sealed within a thin, plastic cover. Each strip is an individual sensor, consisting of two metallic strips which are held apart by a resilient, insulative material. When the mat is compressed the two metallic strips are forced into contact, which closes a circuit. A wire tail extends from each metallic strip. When the mat is intact, the wire tails serve to conjoin the separate strip segments. The full-length mat may be placed beneath a carpet, or it may be cut up into individual segments (strips) which may be distributed over a wider area. Each section (individual strip) cut from a mat has it's own wire tails for attachment into a protective circuit, so a full size mat will yield several smaller sections or a large number of individual strips.



Because of the simple nature of switch mat construction, which amounts to several pairs of metal contacts (strips) held apart by thin springy material, it maintains an open circuit until compressed, (by a footstep, etc.) Because a sensor which maintains **open contacts** cannot be *series* connected into a protective circuit, a device called a **mat** *converter* must be used. A mat converter contains a simple circuit that reverses this status, presenting a **closed contact** status to the protective circuit until the mat is compressed-- at which point the converter shows open contact status. An alternative to using a mat converter is seen below: The mat is wired directly to the protective circuit in parallel (compare the connections in both diagrams) so that closure of the mat's contacts imposes a **short circuit.** When this wiring method is used, the protective circuit battery cannot be wired as shown in Fig. 3-1, in SHORT CIRCUITS. Review the section on SHORT CIRCUITS if this principle is not clear.



PROTECTING GLASS

A number of imaginative movie sequences have created the notion that plate glass is easily penetrated by scratching it with a glass-cutter and removing the scored section with a (suction-cup) glazier's handle. While this is a very good trick for the movies, it is virtually impossible to penetrate a mounted glass pane in this manner! The proper use of a glass cutter calls for an experienced hand and rigid support directly <u>behind</u> the section being scribed. Once the pane is scribed, it must be sharply tapped from the <u>opposite</u> side to effect a clean separation.

Burglars do not use cutters on glass. They either remove the entire pane by prying away the moldings that hold it in place, or they smash it out! Before smashing a glass pane, a sophisticated burglar will cover it with wide strips of *duct tape* to minimize shattering, and suppress the noise with several thicknesses of soaked newspaper. Therefore one should never be confident that the factor of noise will discourage a burglar from breaking glass, especially a smaller pane, to gain entry.

An efficient method of protecting glass is to apply a continuous strand of conductive **foil** ribbon around the edges of a pane on the **interior** side, and connect the ends of the strand into a protective circuit. If the pane is shattered, the foil conductor (which is the equivalent of a strand of fragile wire) will be torn, interrupting the flow of current through the protective circuit-- which triggers the alarm.

Applying foil to glass is a simple procedure but making a neat job of it requires some practice. By experimentally applying a foil pattern to a small pane of glass, then scraping it off and doing it over, the technique may be mastered in a few hours. The following is a list of the items required, along with a description of the technique for applying foil to window panes.

1> **Foil:** Comes packed on 1 lb. rolls of 3/8" wide ribbon. A roll contains several hundred feet, which is enough for dozens of large windows.

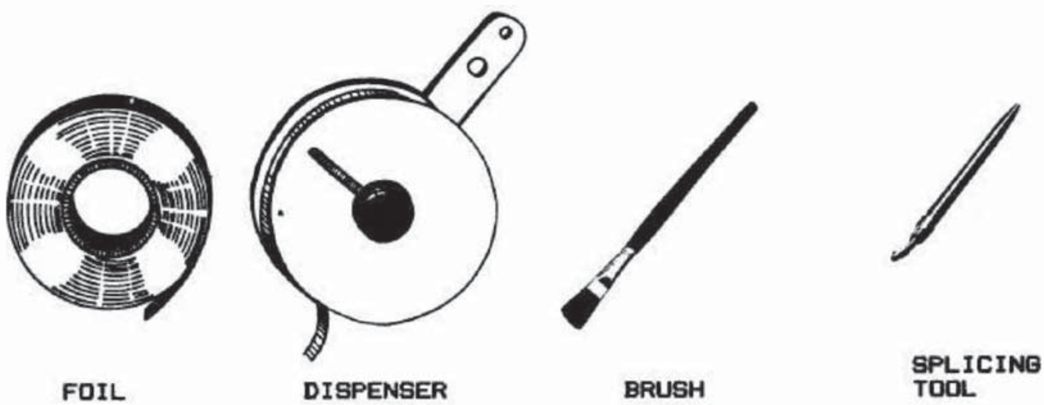
2> **Foil Dispenser:** The most convenient way to work with foil is to suspend the roll above the working surface so the ribbon may be drawn downward as it is applied. This keeps it out of the way and prevents tangling. A special dispenser is made for this purpose. It is simply a pair of flat discs that clamp onto the roll and are held in place by a screw-on knob. A bracket extends from the one disc for hanging the dispenser on a nail. (If a dispenser is not available the roll of foil may be hung on a loop wire or heavy string.)

3> **Varnish, Thinner and Brush:** Ordinary white varnish is used as both adhesive and sealer. (A small can is plenty.) Also, a can of benzene or a similar thinning agent will be needed, along with a short, wide-mouth jar. (A small, clean peanut-butter jar is ideal.) An ordinary, 3/8", flat-tip artist's brush is used to apply the varnish.

4> **Squeegee:** A very handy item to use as a squeegee for smoothing foil ribbon to a glass surface is a Rubbermaid dishwashing scraper, with the handle cut off. (One that's been used and softened by hot water won't work very well.) If this item is not available, the shoulder of a matchbook cover may be used.

5> **Tailor's Chalk and Marking Guide:** An ordinary piece of (white or yellow) tailor's chalk is perfect for marking a guide-line around the edges of a glass pane. The guide lines are marked on the outside of the glass and are used to align the pattern as the foil is applied on the inside. The guide-lines are marked by running one edge of a rigid, square guide alongside the edges of the window frame while holding the chalk against the opposite edge of the guide. An ideal marking guide is a 2-1/2" square block of wood for a small window, or a 3-1/2" block for a large window. In a pinch, a deck of playing cards or a cigarette box may be used.

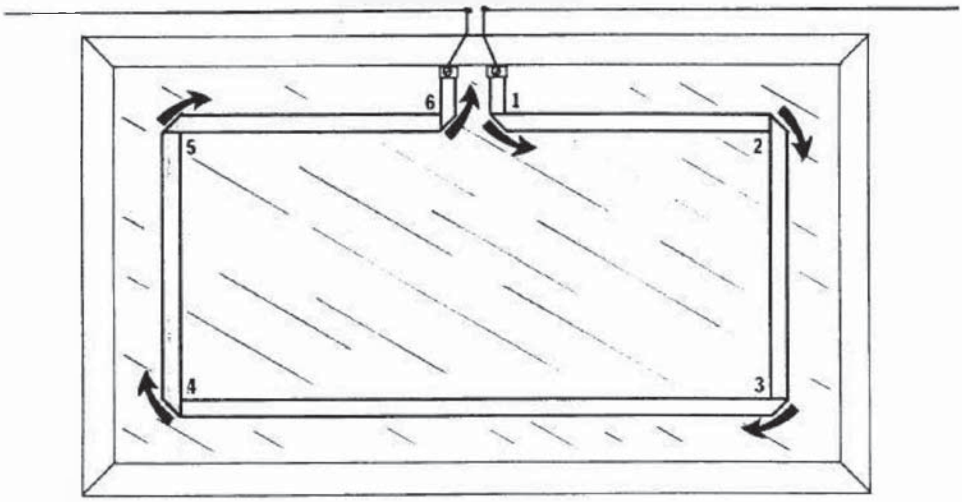
6> **Splicing Tool:** When an applied strip of foil is torn or scratched it is easily repaired by splicing, or applying a *patch* that overlaps the separated ends. When a splice or a patch is completed, it is necessary to puncture several holes through the overlapping ends of the patch or splice. A special tool is available for this purpose; it is a small, multi-toothed disc, mounted like a wheel on a pencil-size handle. This tool looks very much like a miniaturized version of the gadget used to cut a pizza into sections, but instead of a cutting edge the blade has pointed teeth: Instead of cutting, the wheel's teeth penetrate the over-lapped sections very neatly and efficiently. If this tool is not available any type of pin may be used. (No less than a dozen holes should be punched through each overlap.)



A short step-ladder is usually needed to provide a comfortable working position through the separate stages of the foiling procedure. If the roll of foil cannot be suspended and centered over the working surface, it should be hung either on the belt or on a hook screwed into the edge of the ladder shelf.

Before beginning, fill the wide-mouth jar halfway with thinner. The glass must be clean, and the areas to be foiled should be wiped with denatured alcohol or mineral spirits to remove any oily film.

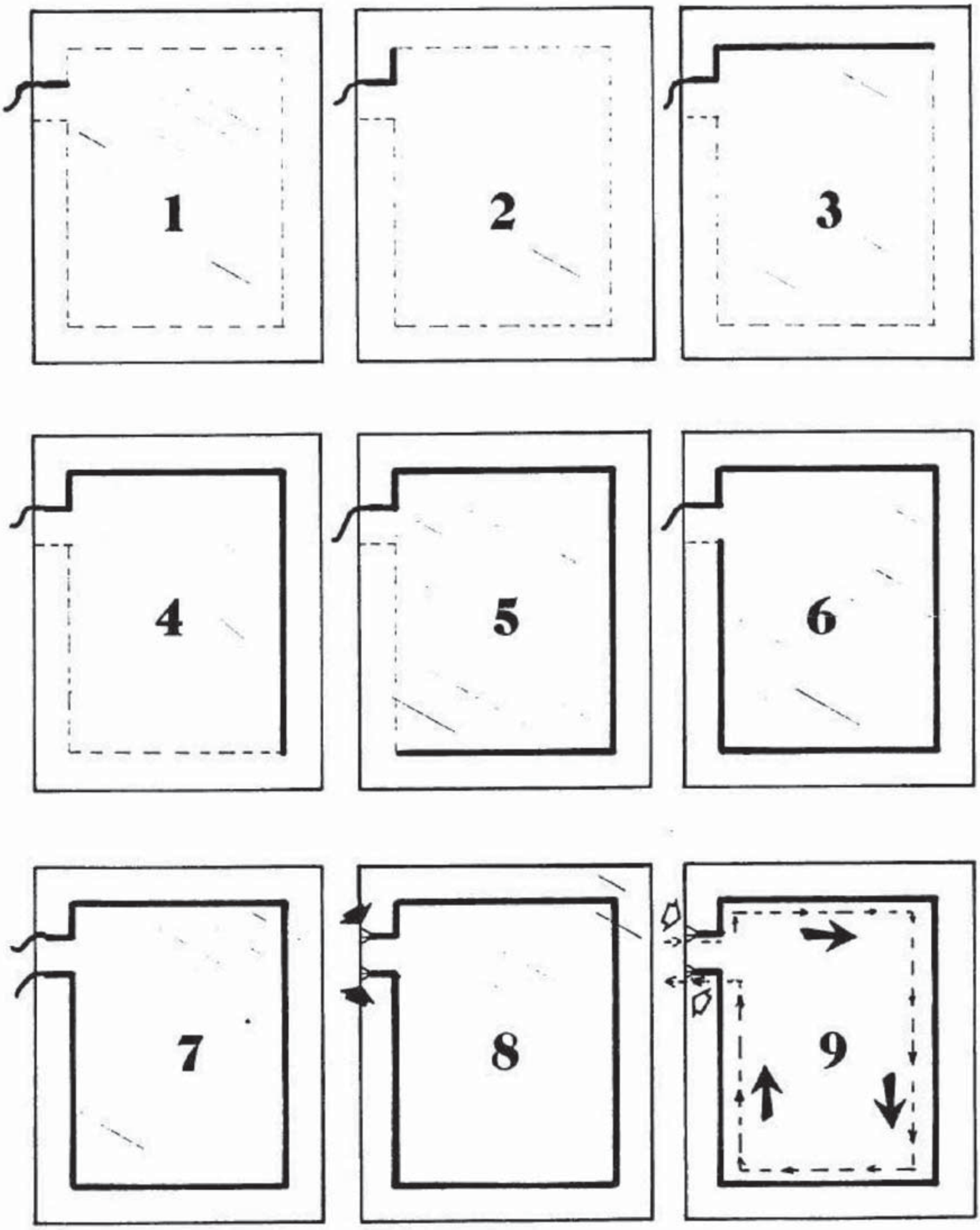
PROTECTIVE CIRCUIT



Above is an illustration of a finished foil pattern applied to a pane of glass which might be a picture window in a living room or a plate glass window in a commercial premises. Note that the pattern begins at 1 and progresses through a sequence of six, right-angle corner bends. In this example the pattern is terminated at the upper center of the window, which does not imply a standard or a rule: A foil pattern may be terminated **anywhere** on the window. The determining factors are appearance and wiring convenience.

The following page shows a numbered sequence of the steps involved in applying a foil pattern to a window pane. In this case the pattern terminates at the upper left edge of the frame. The faint, broken line represents the guide-line marked with tailor's chalk.

The first step in the procedure is applying the adhesive: If the varnish is not fresh, a few drops of thinner should be stirred in to avoid a thick, gummy consistency. A thin coat is applied along the guideline, leaving approximately 1/2" of dry space next to the frame for attaching a *take-off block*, to which the foil tails will be connected. Continue the varnish coat along the guide-line through the progression shown in Steps 2 & 3, and stop there.


1
2
3
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7
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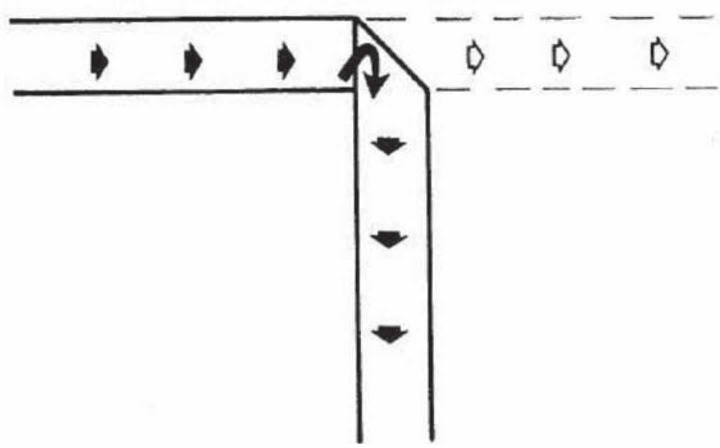
9

If the adhesive coat is continued around the entire pane before beginning to apply the foil ribbon, by the time the fourth or fifth sections are foiled the adhesive will have dried out on the remaining sections. While an experienced installer is usually able to apply the adhesive coat around the entire pane and follow it rapidly with straight, accurately positioned strips of foil, a beginner should follow the progression slowly and carefully. After three sections of adhesive coat are applied, wait a few minutes until the first section becomes *tacky*, (sticky and almost dry.) If the ribbon is applied over freshly laid (wet) adhesive, it will slide around and tend to fall away from the glass.

A short section of foil, (see Step 1), is held by the thumb and forefinger of both hands, with a 4 - 6 inch *leader* dangling from the left hand. This first section is aligned with the guide-line, pressed in place with the thumbs and smoothed with a fingertip. The corner bend is made by simply folding the foil over itself as shown in the diagram below.



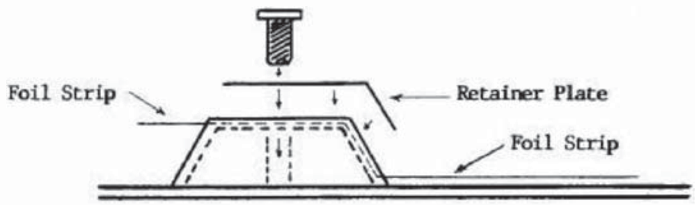
Fold the first bend upward as seen in Step 2, then fold the second bend and apply the third section, which is the upper, horizontal strip seen in Step 3. Pause at this point, dip the squeegee into the thinner to lubricate it, then use it to smooth the foil tightly to the glass.

Shake off the brush (which has been standing in the thinner jar to prevent the bristles from hardening) and apply a line of adhesive to two more sections, (4 & 5.) Then follow the same procedure through Steps 6 & 7, but leave another 1/2" of glass dry between the edge of the frame and the last line of adhesive applied. When the last strip of foil is applied, tear the ribbon from the roll, leaving another 4 to 6 inch *leader* hanging loosely as seen in Step 7.

The darkened arrows in Step 8 point to the terminal ends of the foil pattern. The ends of the ribbon are attached here to a pair of *foil take-off blocks.*

FOIL TAKE-OFF BLOCK

A take-off block is a small, plastic platform with sloping edges and a 3/8" recessed channel that accomodates the hanging ends (*leaders*) of the foil ribbon. A metal retainer plate (seen in the upper right diagram) is fitted into this channel and secured by a small screw.



The take-off block has an adhesive pad on its underside, by which it fastens to the glass surface. The reason why 1/2" spaces are left un-varnished at the edge of the frame near the terminal points of each pattern is to accomodate the take-off blocks. These 1/2" spaces should be wiped clean with denatured alcohol before applying the take-off blocks, or the adhesive might fail.

After the blocks are firmly mounted, apply a final dab of varnish at the foot of each block, squeegee the hanging tails of ribbon right up to the edges of the block, smooth the hanging tails of ribbon into the channel of the block, seat the retainer plates and tear off any excess foil. The retainer screws are used to connect the foil pattern into the protective circuit. To finish the job, apply a liberal (but neat) coat of varnish over the foil pattern to seal it.

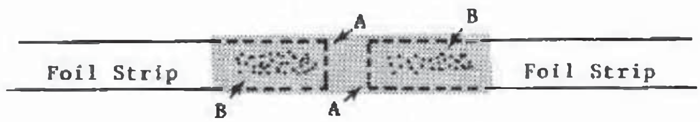
Step 9 depicts electrical continuity through the completed foil pattern. To test the pattern for continuity, apply the probes of a meter to the terminal screws of the take-off blocks.

The foregoing procedure describes the "old way" of applying foil, which is the best way. The *new way* is essentially the same, except that a time-saving, "self-adhesive" type foil is used, which requires no varnish coat. This type of foil is backed with a peel-off strip, much like a band-aid. It is much easier to apply: one just strips off the backing, sticks it on and applies the sealer coat. While everything *appears* to be the same, the problem with self-adhesive foil is that it's distinctly thicker, heavier and stronger than the fragile, non-adhesive variety. Because the objective of window foil is to separate (tear) easily when stress is applied, the stronger it is the less efficiently it will perform. This brings up a very important factor which was not covered above:

The "old-fashioned," non-adhesive foil is extremely soft and pliable. It stretches easily, so the first stage of a beginner's practice should be that of experimentally stretching a few lengths of foil ribbon to become familiar with its tolerance and breaking point. When applying the foil each section should be **stretched** as it is pressed onto the glass, rather than just laid on like adhesive tape. The purpose of this stretching is to produce a thin, tight *skin* on the glass that will easily separate when a crack opens beneath it.

When plate glass shatters, several generations of cracks are distributed downward and outward. Even though the typical foil pattern is applied just a few inches from the edges of the pane, it is extremely rare that the cracks will not extend down and out to pass underneath the foil pattern at the sides and bottom. A tightly stretched skin of non-adhesive foil is far more likely to separate from the stress of a fine crack than is the heavier, self-adhesive type. So the extra time and work involved in doing it the "old way" has paid off in many instances.

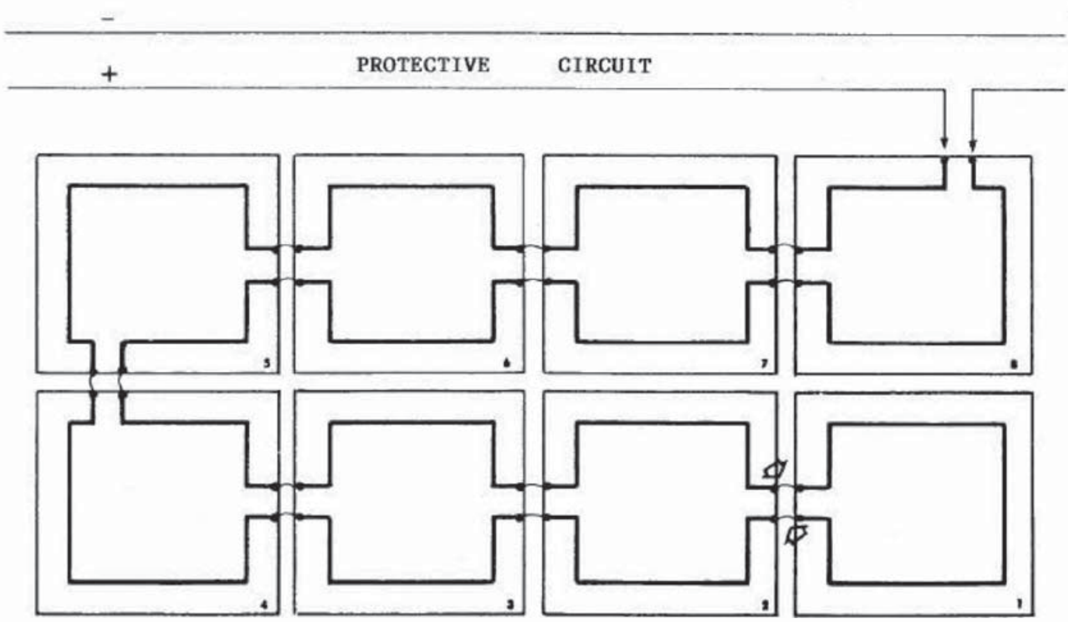
When a section of foil is scratched or torn it can easily be repaired by applying a patch: A razor blade is used to dress the scratched or torn ends, leaving a clean gap between them. A represents the dressed ends of the damaged foil section. B represents clusters of punctures through the patch, wedding it to the severed ends beneath.



Dip a pad of soft steel wool (000 grade) in thinner and use it to (gently) rub away the dried sealer coat of varnish from the trimmed ends. Then apply a thin coat of fresh varnish to the ends, span them with a 2" length of new foil (seen as the shaded area in the above diagram) and squeegee this patch firmly in place. Use either a splicing tool or a pin to puncture at least a dozen holes through the overlapped sections, as shown below.

Above is a <u>side</u> view of a broken strip of foil which has been spanned with a patch. The clusters of arrows denote punctures. Finish the patch by applying a sealer coat of varnish. Then apply the probes of meter to both sides of the patch to test for continuity. (Disconnect the foil pattern from the protective circuit before making this continuity test.)

It is sometimes necessary to apply foil to a grouping of multiple panes in which it is not practical to terminate each separate pane with a separate connection into the protective circuit. The following diagram depicts this kind of situation.



This diagram represents two horizontal rows of small glass panes. A separate foil pattern is applied to each pane. The dots seen at the termination points of each pattern represent take-off blocks. Note that there are only two termination points on pane #1. The arrows point to a pair of short jumper wires, (cut from ordinary 22 ga. protective circuit wire), which connect the pattern on pane #1 to the pattern on pane #2. Pane #2 is connected to pane #3, 3 to 4 and so on.

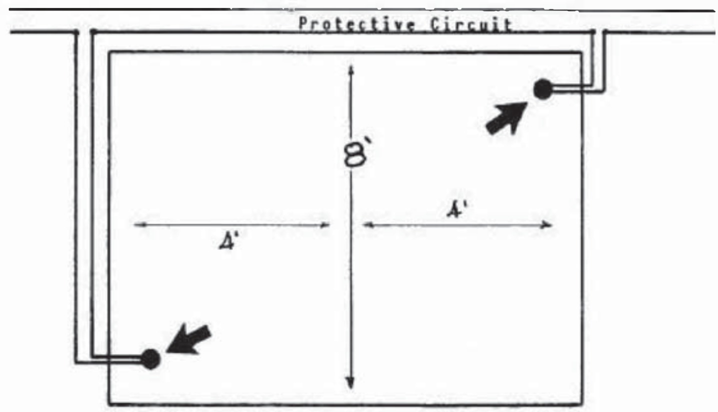
This arrangement of panes is not typical (except on garage doors.) The purpose of this diagram is to show that the basic configuration of a foil pattern should follow the contour of the pane it is applied to, and that the termination points are determined by the wiring requirements. Note that each separate pattern is a basic square, but the termination points vary according to the connection requirements. The patterns on each of the separate panes are connected in a way that affords <u>series continuity</u> throughout th entire sequence. The final termination points are seen at the top of pane #8, where the entire grouping is connected into the protective circuit.

Observe that the protective circuit wires are marked to indicate polarity (+ -). . In this example, the **positive** (+) wire is cut to accomodate the connection. Using a pen or pencil, follow the + leg of the protective circuit through the entire "maze" of connected patterns, from pane #8 to pane #1, and out again. This will graphically demonstrate the principle of a <u>continuous series circuit</u>, showing the path that the 3 volt *supervisory* current will follow.

The alternative to applying foil ribbon is to use a specially designed sensor called a **GLASS-BREAK DETECTOR**, a small, circular device that attaches to a glass surface by means of a self-adhesive backing.

The single advantage of glass-break detectors, as opposed to foil ribbon, is ease and simplicity of installation: All that is required is to peel away the protective coating from the adhesive backing on the device and press it in place on the glass, (after wiping the mounting surface clean with alcohol!) A pair of wire tails extend from the device for splicing directly into the protective circuit wiring. Before this connection is made the probes of a meter are attached to the leads so the <u>sensitivity level</u> of the device can be adjusted:

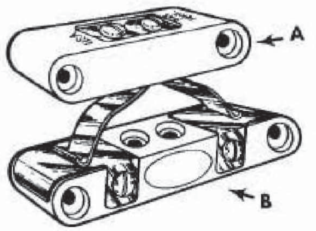
While a glass-break detector is not classified as a "vibration detector," it operates by sensing the high-frequency vibrations which are generated by the sharp crack of shattering glass.

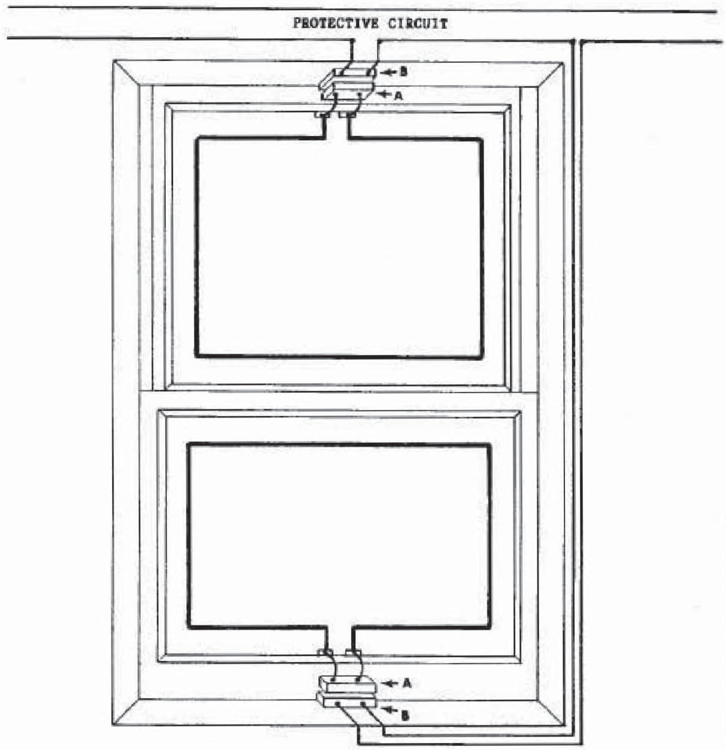


The device on the right (above) is rated to detect glass breakage within a 32 square ft. area, which works out approximately to a 4' x 8' section. The diagram on the left represents an 8' x 8' pane with two detectors applied to the glass and wired into a protective circuit.

The drawbacks of using glass-break detectors instead of foil are cost per device and a somewhat greater potential for false alarms. This does not imply that glass-break detectors are inherently false-alarm prone. But they are activated by sensing a high-frequency vibration-- which might be generated by events other than actual breakage, such as a flying pebble striking the protected pane, etc.

A high-quality glass-break detector is capable of providing years of stable, reliable protection, and is recommended for large, stationary panes such as residential picture windows and plate store-front windows. However, they are less practical for use on smaller, movable panes such as the average double-hung and sliding aluminum window. The problem here exists in the volume of individual detectors needed and the requirement to wire each of them with a flexible cord to enable unimpeded movement of the sash. (Remember that the detector is applied to the glass and its wiring must be carried onto the stationary, surrounding area.) The problem of carrying the protective circuit onto a movable window sash is solved in the following manner.





The device on the left is a simple but clever, two-part set of contacts that serves two purposes: It provides continuity from the protective circuit to the foil pattern and acts as a sensor to detect movement of the sash.

A is a plastic block with a pair of screw terminals on top. On the bottom of this block, (not visible in the drawing), are a pair of metal plates which are direct extensions of the screw terminals. This block is fastened by screws to the window sash shown on the right.

B is another block with a pair of screw terminals on its front. This block is fastened to the window frame with screws. Protruding from the top of this block is a pair of leaf springs which are aligned to contact the metal plates at the bottom of A when the window is closed. These leaf springs are direct extensions of the screw terminals on the front of the block.

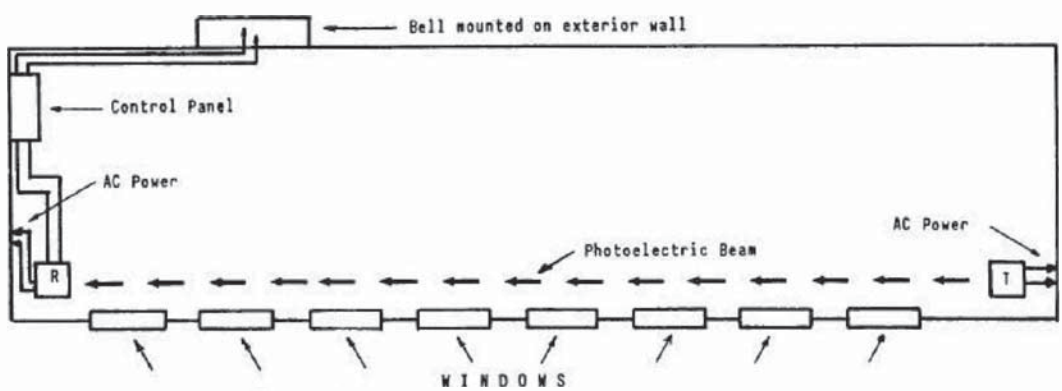
Note that the foil pattern is connected to the screw terminals on A, while the protective circuit is connected to the screw terminals on B. When the sash is closed, tight contact between A and B is effected by compression of the leaf springs of B against the metal plates of A.

PHOTOELECTRIC DETECTOR

The photoelectric detector is commonly referred to as an "electric eye." It consists of two separate parts, a transmitter and a receiver, each of which operates independently, served by its own power source. The receiver of a modern photoelectric contains a highly sophisticated receptor cell which is sensitive to a *pulsed,* infra-red beam. Its companion transmitter projects a beam which is invisible to the naked eye and cannot be defeated by superimposing a secondary, *bypass* beam. (Early photoelectrics emitted a highly consipcuous beam, and could easily be compromised by aiming the beam of an ordinary flashlight into the receiver to override the companion transmitter.)

The transmitter serves the single purpose of emitting a beam, which is aimed directly into the *eye* (lens) of its companion receiver. The beam *excites* a photocell within the receiver, causing a pair of internal contacts to switch closed. These contacts are continuous with an external pair of terminal screws, which in turn are wired into a protective circuit. When the transmitter's beam is momentarily interrupted, the internal contacts instantly switch open, activating the alarm.

Photoelectrics are available in a variety of distance capabilities, ranging from 50 to 1,000 feet and weatherproof versions are available for outdoor application. Modern photoelectrics are generally stable when properly aligned, but both transmitter and receiver must be securely fastened to a rigid, vibration-free mounting surface. The importance of this requirement increases in proportion to the <u>distance</u> between transmitter and receiver.



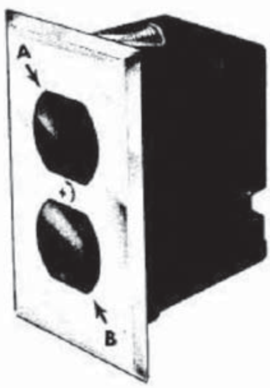
The layout shown above depicts a photoelectric applied to a very common industrial situation, a factory corridor with a number of windows along one wall, spanning a distance of approx. 250 feet: It is often difficult to protect such an area with foil patterns or individual window switches because of multiple panes, (often broken), and deteriorated stone and metal fittings.

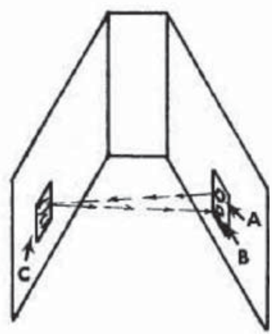
The diagram shows a photoelectric transmitter (T) mounted at one end of the wall and the companion receiver (R) at the other end. The beam is projected across each of the eight windows and positioned so that an entry through any window would unavoidably interrupt it.

Both transmitter and receiver are powered (via 12V DC transformer) by 110 AC, but both units must be equipped with an internal, trickle-charging standby power supply to maintain stability during momentary or prolonged power loss.

No other sensors are shown in this system. The receiver is wired directly to a protective circuit which is energized by a power supply within the control panel.

There is an endless variety of possible applications for the photoelectric detector, each of which must be evaluated on the basis of environment and other circumstances. Currently, the most popular type of photoelectric detector is the cleverly designed version shown below--which is disguised as an ordinary wall receptacle.





There are two parts to this device, one of which is simply a reflector. It, too, looks like a wall receptacle but its only purpose is to bounce the beam back from the transmitter (A) to the receiver (B), both of which are built into the same housing. The transmitter/receiver unit is flush mounted in the same manner as any normal wall receptacle, or it may be substituted for an existing receptacle and connected directly to the AC power. The reflector (C) is then situated on an opposing wall and aligned. (Alignment is performed by simple screw adjustments.) While the range of this device is a liberal 75' it is most commonly installed in a narrow entrance corridor, thereby assuring many years of stable, trouble-free service. The nature of this device calls for fully concealed, in-the-wall protective circuit wiring unless the protective circuit is brought in through a small hole drilled straight through from the rear of the mounting wall, (which might be a closet, etc.) In this case, the protective circuit wiring may be carried along baseboards and door moldings, as explained in the section on INSTALLATION NOTES.

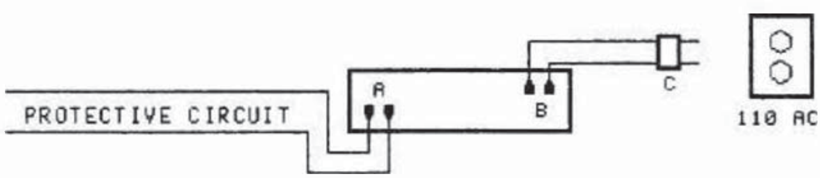
AREA PROTECTION DEVICES

The devices used to monitor doors, windows and walls (such as magnetic, plunger and leaf switches, foil patterns and vibration sensors, etc.) are classified as *perimeter* protection devices, for obvious reasons. When a device is employed to monitor a specific volume of space, such as the interior of a room or a part of a larger area, it is called an *area* protection device, or *space* protection device.

Before the photoelectric device (described in the foregoing section) came along, the only alternative to perimeter monitoring was the imaginative application of "traps," such as clip-traps, trip-wires and switch mats situated in strategic locations. The example given in the photoelectric description is but one of many possible applications of this very flexible device, its full range of possiblities being limited only by the installer's resourcefulness and the physical environment.

The photoelectric detector is an area protection device. It was described separately because of its relatively simple nature and limitations in comparison with the sophisticated devices to be covered in this section. Before proceeding it is important to mention that the **operational sophistication** of these motion detectors is of **no consequence to the installer.** This section will describe the individual devices, how they work and their respective limitations. Installing and "setting up" any motion detector is no more difficult than installing a simple switch-type sensor.

There presently are three separate types of motion detector devices available for burglar alarm application, these are MICRO-WAVE, ULTRASONIC and PASSIVE INFRA-RED. These device are made by numerous manufacturers, therefore they come in many shapes, sizes and degrees of relative quality. For the most part, however, the physical configuration of these devices is basically similar.



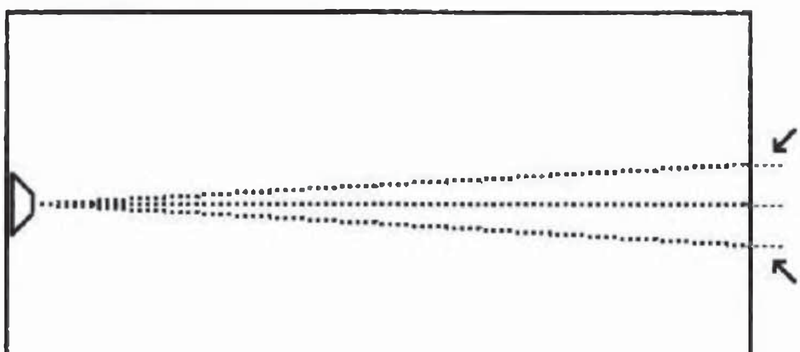
The figure above depicts the rear panel of a typical area protection device, showing its two wiring requirements: The device is connected into the protective circuit at A by means of a pair of screw terminals, in the same manner as would be a simple switch. The other connection (B) is the independent power requirement, which is usually facilitated by a plug-in transformer. (The transformer is included as a separate component and is connected to the device with 22/2 wire.) While most of these devices may be situated on a shelf, each is equipped with a bracket for mounting it on a wall (which is recommended for stability and protection from damage and tampering.)

The front panel of a typical motion detector is depicted above. In the center is a "screened emitter aperture," which is a hole through which a field of active energy is projected. To the right (in this figure) is a tiny LED called the "walk-test" light. This light flashes on whenever the device is activated, visually indicating its sensitivity and serving as an aid to adjustment.

Adjusting the device is usually a matter of rotating a small knob, wheel or screw, which is also located on the rear panel. Turning it clockwise increases the range, counter-clockwise decreases it. Another way to observe the sensitivity of a motion detector is to attach the probes of a meter (set to read continuity) to the protective circuit connecting terminals. When the device is activated by movement within its adjusted range, the meter needle will swing to the right. When the movement stops, the internal circuitry of the device will stabilize and the needle will then drop back to the left.

Installing a motion detector device in a burglar alarm protective circuit is similar to installing a receiver or a tape deck in a stereo component system, (and generally easier.) One needn't know anything about what makes the component "tick" electronically. It either works or it doesn't, which is immediately apparent. If it doesn't work, it is removed and returned for service.

MICRO-WAVE:



• MICRO-WAVE DETECTOR PATTERN

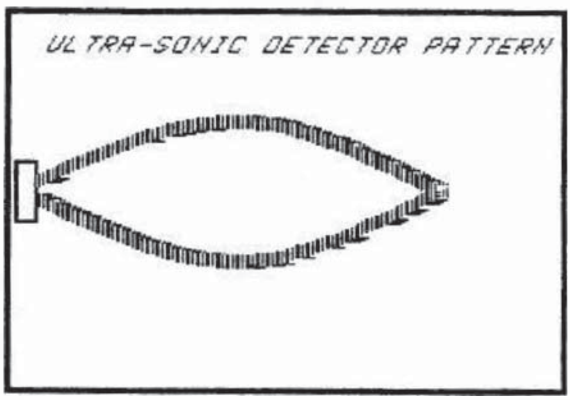
The MICRO-WAVE motion detector emits a focused beam of RF (radio frequency) energy, typically at 10.525 GHz, which is roughly the frequency of operational RADAR-- including highway speed detectors. When the device is switched on it projects an RF beam, which is reflected by any solid object within its range. Its internal sensory apparatus adjusts to the reflective *constant*, that is the absence of any changes. The movement, or appearance, of any solid object within the path of the beam alters the *constant*, causing a pair of internal contacts to open, which activates the alarm.

The primary advantage of MICRO-WAVE is its comparatively long range, which is typically 300' long by 15' wide at mid-range. Another advantage is its ability to **penetrate** most materials (except metal) enabling one device to monitor more than one room or area within the same premises. However, inherent in this capability is an outstanding false alarm hazard-- as seen in the MICRO-WAVE PATTERN diagram:

This diagram depicts a MICRO-WAVE device mounted on one wall of an enclosed area and projecting its beam forward. In this diagram the device is not properly adjusted (or has "drifted" out of adjustment) and is penetrating the perimeter walls at the points indicated by arrows. Any movement occurring within this unintentionally extended field of coverage will cause a false alarm! Therefore, the factor of **penetration** is the *Achilles heel* of the MICRO-WAVE motion detector.

Because MICRO-WAVE motion detectors operate in the same frequency range as highway speed RADAR guns, their radiations are detectable by the same devices used to avoid speeding tickets.

ULTRA-SONIC:



The ULTRA-SONIC motion detector emits an elliptically shaped field (see diagram) of sound waves which are well beyond the range of human hearing. The typical range of coverage is roughly 40' long by 20' wide at mid-range. (This range is considerably smaller than that available with a micro-wave device but there is no penetration hazard.) The transmitter section of this device generates ultra-sound, which is monitored by the receiver section. The receiver adjusts to the stable level of ultra-sound sent out by the transmitter and "listens" for any significant changes occurring in the "shape" of the sound waves, such as those which are caused by a solid object moving within the ULTRA-SONIC field. The effect of disturbing an ULTRA-SONIC field is similar to causing a ripple on a body of still water, but the sound waves move much faster. The receiver section of the device reacts to any disturbance by opening a pair of internal contacts.

A good quality ULTRA-SONIC unit, properly adjusted and operating in a **compatible** environment, is capable of providing years of efficient, reliable service with little or no attention. *Proper* adjustment means sacrificing a few square yards of range to significantly decrease the device's false alarm potential.

The typical range of an ULTRA-SONIC device is mentioned above. When the sensitivity is adjusted lower, (by rotating a thumbwheel), the elliptical pattern is proportionally reduced-- and so is the false-alarm potential. Even if maximum range is required it is best not to adjust the device to its absolute limit, but to back off a small degree. If a space does not call for maximum range sensitivity, the device should be adjusted to only the level required and not beyond.

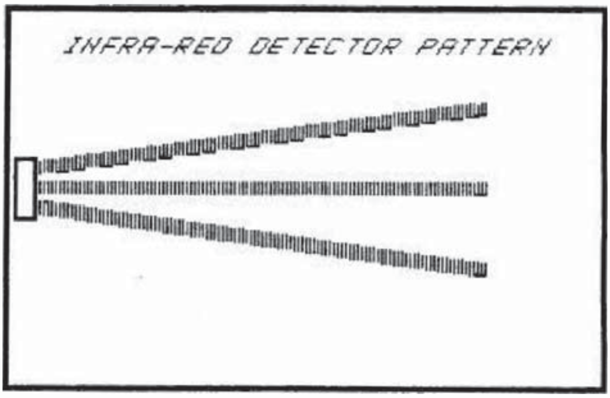
The ideal environment is quiet, clean and **free of any movement**, whatsoever. Moving drapes, falling cartons or shelves and any kind of unanticipated physical movement within the adjusted pattern will activate an ULTRA-SONIC, so a cluttered environment is risky. Drafts are a leading cause of false alarms, because drafts are perceived as motion by the ULTRA-SONIC. Forced air heating will definitely cause problems, as will many types of high-frequency sound waves.

Some ringing telephones will activate an ULTRA-SONIC device. The only way to know for sure is to **test and observe.** If a particular telephone seems to cause activation when it rings, the frequencies may be altered by applying a small strip of electrical tape to the inside of its bells. Before an ULTRA-SONIC is installed, the environment must be carefully surveyed for such things as whistling radiator valves, noisy heating and ventilating systems, hammering steam pipes and high frequency vibrations from passing traffic. The mounting surface must be absolutely free of vibration and movement.

Pets can be a problem if they cannot be appropriately isolated from an operating ULTRA-SONIC: Even a dog barking in an adjoining room could activate it. Most pets, especially the littler ones, are receptive to high-frequency sound waves which, in some cases, causes them great discomfort. On the positive side, it has been demonstrated that these motion detectors often serve the dual purpose of repelling rodents and certain insects from cellars, attics, etc. Ultra-sonic units are sold for that specific purpose-- with different names and significantly higher prices. High-efficiency ULTRA-SONIC motion detectors are available for less than $200.00.

ULTRA-SONIC motion detectors, operating in compatible environments, have an impressive track record and are widely used by professional installers. In spite of their early reputation for hypersensitivity, the major bugs have been removed and, at present, the major causes of false activation are improper adjustment, forced-air heating systems and such events as radiator valves that whistle when the heat comes on automatically at 4:30 am, etc.

PASSIVE INFRA-RED:



The most recent application of space-age technology to security electronics is the PASSIVE INFRA-RED motion detector, so called because it does not emit an active energy beam, such as the light beam of a photoelectric, the radio beam of a micro-wave or the sound waves of an ultra-sonic; instead it projects a number of sensitive *probes* of passive energy. A product of heat-seeking missile research, the "PIR" has risen quickly to popularity in the industry as an efficient detector of body heat and motion.

When switched on, the PIR adjusts quickly to the *ambient* temperature of its operating environment, which it monitors constantly via the emitted probes of passive energy. If an object is radiating a surface temperature that is higher or lower than that of the surrounding (ambient) temperature, the PIR will detect it and activate. Obviously, the efficiency of this type of device will be compromised if used in an environment where the ambient temperature (room temperature) is close to that of the human body, which is 98.6.

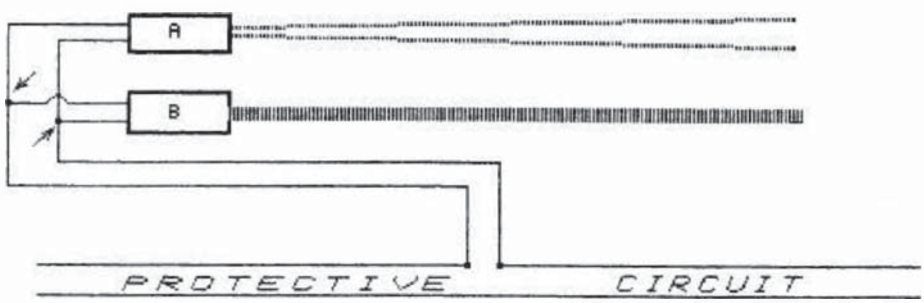
Since its introduction, the relatively new PIR technology has attained an excellent reputation for stability: Micro-wave can penetrate a brick wall and pick up the movement of passing traffic and it can be activated by spurious radio signals. Ultra-sonics can be triggered by ringing telephones, barking dogs, whistling radiator valves, etc. A PIR is not generally sensitive to these influences.

PIR is sensitive to a **rapidly** occurring change in temperature but not to gradual changes, such as weather changes or those occurring from thermostatically contolled heating. The exception is a forced air heating system where a duct is likely to deliver a rush of superheated air directly into the PIR field.

A PIR device should not be aimed toward a window, because bright sunlight striking a glass pane can cause a rapid elevation in the surface temperature of the pane. The operating environment should be surveyed in the area of PIR focus for "hot spots." These are steam pipes, (eithor exposed or inside a wall), radiators, lights that are switched on by an automatic timer, etc.

Because it is much easier to eliminate sources of rapid temperature variation than it is to eliminate sound, vibration, and stray radio signals, the wider range of applicability and relatively low false-alarm potential of PASSIVE INFRA-RED is a good reason to select it over alternative types of area protection.

With the exception of forced air heating, PIR is not sensitive to the things that will cause an ultra-sonic to activate, and vice-versa, nor will either device disturb or interfere with the other. Therefore, a good way to combine maximum area protection with minimal false-alarm potential is to employ both devices in the same area, connecting them as shown below so that each device serves as a **shunt** for the other. If one device is activated by an accidental event the other remains stable, acting as a by-pass for the protective circuit current. But the movement of a human form entering both fields at the same time will cause both devices to activate simultaneously, opening both sets of contacts.

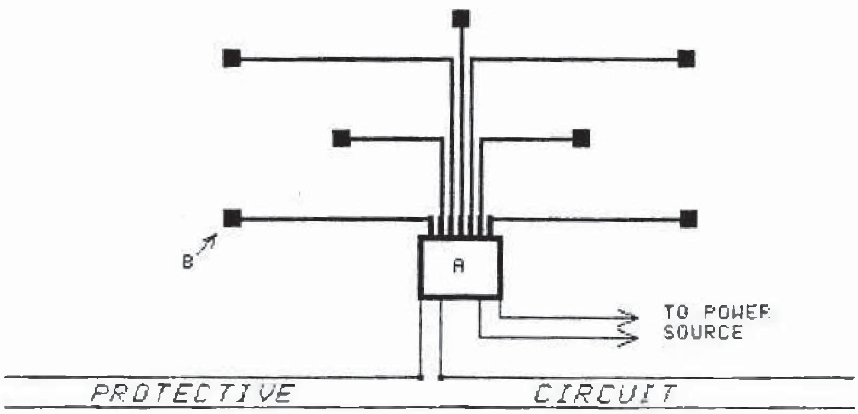


This diagram shows an ultra-sonic motion detector (A) situated above (or in close proximity to) a PIR motion detector (B), with both devices focused in the same general direction. Note that the connecting wires of the PIR are attached directly to the connecting wires of the ultra-sonic at the point indicated by arrows. This is a *parallel* connection and it functions in the same manner as a shunt lock (see the section on SHUNT LOCKS) with the PIR serving as the shunt in this example.

If the ultra-sonic activates but the PIR does not, the protective circuit current will simply conduct through the closed contacts of the PIR via the parallel connection. If the PIR activates but the ultra-sonic does not, it cannot affect the protective circuit because the PIR is not wired in series. (Review the diagram if this is not clear.) Only if both devices are activated at the same time will the alarm be triggered. It doesn't matter which device is wired as the shunt, the effect will be the same.

AUDIO DISCRIMINATOR:

As its name implies, the AUDIO DISCRIMINATOR sensor "listens," via one or more amplified microphones, for audio frequencies generated by the typical noises made during forcible entry; such as breaking glass, creaking wood, etc.



A professional-grade *sound discriminator* (as these devices are called) consists of an audio-processor(A), into which one or more separate sensors (microphones) are connected. The microphones (B) are quite sensitive and will pick up the slightest sound occurring within a given radius, (typically 40' x 40') and feed it to the amplifier/processor. The (sensitivity-adjustable) processor ingores all sound frequencies which are common to an unoccupied environment, but is stimulated by frequencies which are *common* to breaking glass, creaking wood, etc.

The principle of this highly-efficient technology presumes two things, that no other possible source of the activating frequencies will exist in the monitored environment and that a burglar will break a window or use a crowbar to gain entry. And there lies the weakness of the AUDIO DISCRIMINATOR device: Some burglars are extremely quiet in their methods.

With certain refinements, this technology is analagous to the "VOx" (voice-operated) tape recorder, which is commonly used in electronic surveillance operations. The VOx (Voice Operated switch) activates upon the **input of sound** into the tape recorders microphone. Its sensitivity is adjustable to the sound levels of normal conversation, but every surveillance tape made with a VOx operated tape recorder is interspersed with sounds of doors closing sharply, telephone bells, clinking noises from the kitchen, toilets flushing and, sometimes, squeaking beds. To adjust the sensitivity of a VOx above the level of those sounds would also take it above the frequencies of normal speech.

Obviously the VOx alone is not suitable for activating a burglar alarm system, but with the lower frequencies filtered out it would work well under certain conditions, those conditions being a normally quiet environment and no chance of a sophisticated, (quiet) attack. A good quality AUDIO DISCRIMINATOR is ideally suited to protecting the interior of a safe or vault. Tuned to the higher frequency levels it will *discriminate* against routine environmental sounds, such as floor-waxing machines outside, etc., but will activate if a drill or chisel were applied to its steel surfaces. They are also suitable for monitoring school corridors and other premises where the attentions of a sophisticated thief are not anticipated.

The second presumption is pretty close to accurate because most burglars are un-skilled: If all locks are secure against duplicate keys, simple picking or frame-spreading techniques, and all windows are locked, 99% of the nation's burglars will use relatively crude, forcible methods to enter. Another factor in favor of AUDIO DISCRIMINATORS is cost. When area protection is required in many separate rooms within the same premises, the use of other types of area protection systems would cost more: Ultra-sonic, photoelectric, infra-red or micro-wave detector systems are available with a central processor and any number of remote *heads*, but in large quantity it is less expensive to buy twenty microphones than twenty micro-wave or ultra-sonic *heads* for a *master/slave* system, as these set-ups are called.

AUDIO DISCRIMINATORS are classified as area protection devices because they are not dedicated to monitoring one specific point in a perimeter circuit, yet their primary purpose is that of detecting a forcible attack on a premises perimeter, (doors, windows, walls, etc.)

GENERAL NOTES:

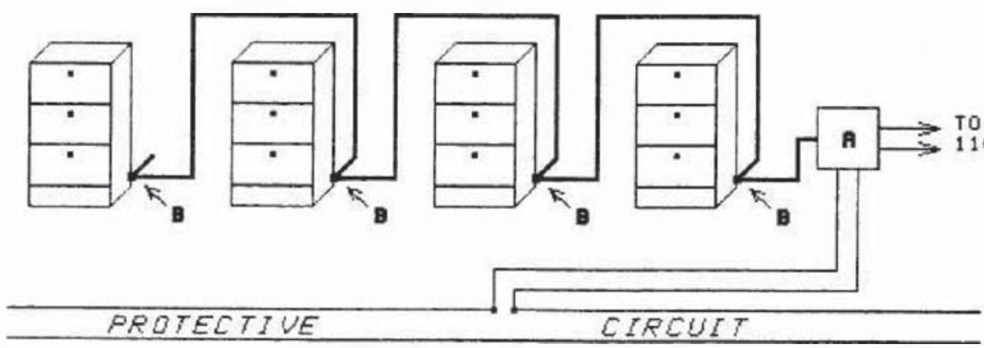
The principal value of perimeter monitoring devices (switches, foil patterns, etc.) is that a burglary attempt will be detected in the initial stages of entry. The material cost of monitoring a large number of individual points around a premises perimeter will be less than the cost of one area protection device. However, when a contractor is hired to install a system, the cost of labor to install the perimeter devices, particularly where a concealed installation is required, will far exceed the cost of several motion detectors.

As mentioned previously, the ideal situation is a perimeter system with one or more area protection devices strategically located and wired into the protective circuit as a back-up, in case a burglar gets past the perimeter circuit. This measure is particularly recommended in any situation where it is not possible or practical to monitor every individual point of potential entry, or in commercial premises where the possibility of a "stowaway" burglary exists. A *stowaway* is a thief who conceals himself on a premises until it closes for the day, a technique which is commonly used against large commercial or industrial premises where no late-shift personnel or watchmen are employed.

PROXIMITY SENSOR

Sometimes called a *capacitance* sensor, the principle of this device is demonstrated in many types of modern appliances and gadgets that use "touch sensitive" switching, in which the lightest touch of a fingertip to a solid, immovable surface is sufficient to operate the switch. No pressure is required-- only the close presence (proximity) of a finger. Simply stated, this action exploits the small electrical charge (capacitance) inherent in a living body. At present, this technology is applied to elevator call-buttons, economy microcomputer keyboards, light switches, tv and microwave oven controls, etc.

The PROXIMITY sensor used in burglar alarm systems is considerably more sensitive than those used in the applications mentioned above. In fact, when adusted to maximum sensitivity these devices will detect the presence of a human body up to 24" away. However, when adjusted to its maximum level the device is susceptible to disturbance (activation) by static electricity in the atmosphere.

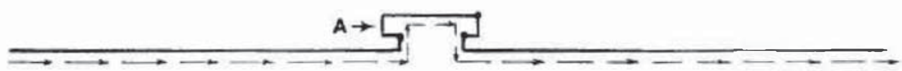


This diagram depicts a proximity sensor system monitoring a row of four (metal) filing cabinets. A is the sensor control, which is powered by a plug-in AC transformer and connected into a protective circuit. A single wire, attached to the input terminal on the device, serves as an extension to the sensor circuitry. Touching the bare wire at any point along its length will activate the control.

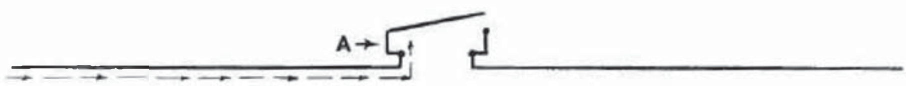
The wire is attached to each filing cabinet (at the points marked B) by using a sheet metal screw and a crimp-on terminal. Each of the cabinets thus becomes an integral part of the sensor, touching any part of any cabinet will activate the alarm. Any metal object may be attached to the sensor wire, such as shelving units, racks, doors, doorknobs, window frames, bars, fences, screens, etc. Each metal object attached to the sensor wire becomes an estension of the sensor wire. Touching any of them will activate the alarm.

THE SHUNT LOCK

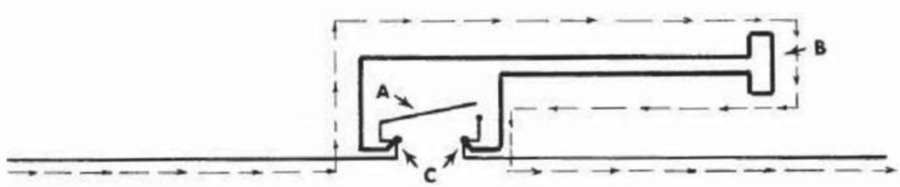
In the section on CONTROLS, the delay timer was described as one means of departing from and re-entering a premises when the alarm is switched on without triggering it. This section describes another popular method, called *shunting* the entrance door. The word shunt means *controlled by-pass*: A shunt lock is nothing more than a key operated switch that enables the door sensor to be by-passed from outside.



The figure above depicts a sensor (A) connected into one leg of a protective circuit. The arrows represent the flow of supervisory current through the closed switch. (A could be any type of sensor, plunger, magnetic, motion detector, etc.)



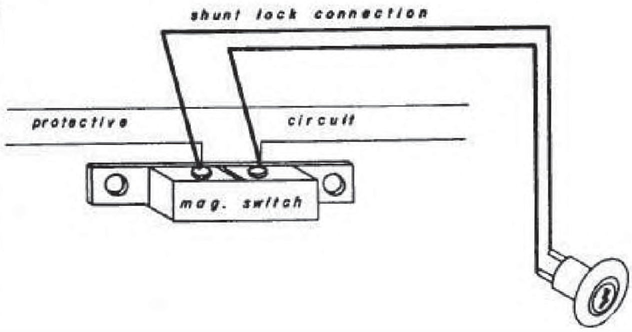
Above, the same sensor is shown in the open condition, interrupting continuity, so the current cannot flow through it.



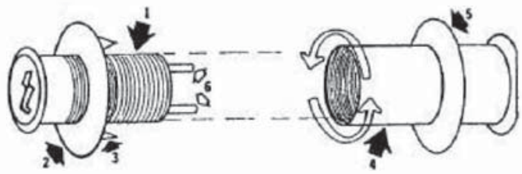
Examine the above diagram closely. It is the same as the previous diagrams, with an important addition: A is the open sensor, but a special type of switch (B) has been imposed at C. Note that the wires of switch B are attached directly to the same terminals that connect sensor A into the protective circuit. Also note that the supervisory current has followed the path of least resistance, by-passing A.

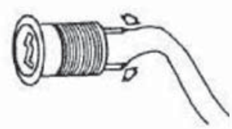
Before going to the next level of this explanation, think about the interaction of A and B: If A is closed and B is open, then B cannot serve as a secondary path for the protective circuit current.

B represents a *shunt lock*, which is a key-operated on/off switch, designed expressly for use with a burglar alarm system. When the concept outlined above is understood, the pictorial diagram on the following page should clarify the function of a shunt lock without further explanation.

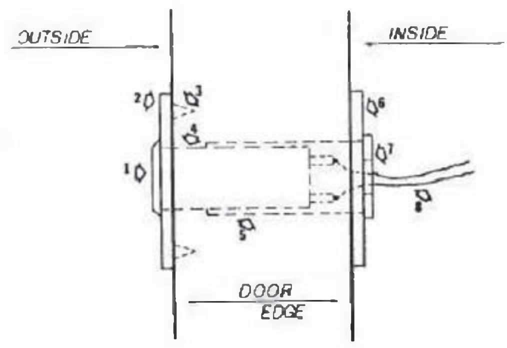


On the left is a magnetic switch wired into a protective circuit in the normal manner, with a shunt lock connected to the same terminal screws. Because a shunt lock is nothing but a key-operated **switch**, this magnetic switch may be by-passed at will by simply inserting the proper key and rotating it to the right-- which closes the contacts within the switch.

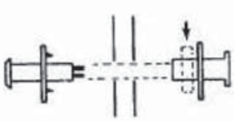




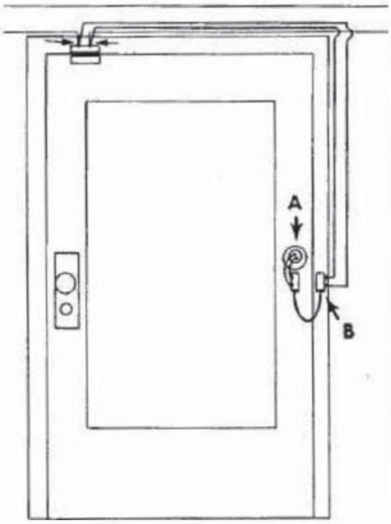
The first figure above is an assembled shunt lock. The second figure shows its parts: 1 is the externally threaded key-switch body, (cylinder.) 2 is the front washer; notice the spikes (3) which pierce the mounting surface to prevent movement. 4 is the internally threaded sleeve, which couples with the cylinder. 5 is the rear washer. 6 is a pair of terminals for attaching the connecting wires, as seen in the third figure.



On the right is a side-view cut-away showing a shunt lock assembled through a 7/8" hole bored through a door rail:
1 is the cylinder face. 2 is the front washer. 3 is the upper piercing spike. 4 is the cylinder body. 5 is the sleeve. 6 is the rear washer. 7 is the the rear lug of the sleeve, which is flat on two sides to accomodate the jaws of a wrench when tightening the two sections together. 8 is a pair of wires attached to the terminals of the cylinder. These wires are passed through a 1/4" hole in the rear lug of the sleeve.



NOTE: Most shunt lock sleeves are 2" long to accomodate heavy doors. The average residential door is 1-3/8" to 1-3/4" thick. One solution is to order a shunt lock with a special "short sleeve," or order five extra rear washers to *shim* up the difference. Be certain that the rear lug of the sleeve is never screwed on tight enough to make contact with the exposed terminals of the key-switch-- or they will be shorted, defeating the switch.



The figure on the left shows the most typical positioning of a shunt lock, (viewed from inside.) Logically the device must be installed on the hinge-side of the door, so a flexible cable (*door cord*) is used to carry the connection to the frame. This enables the door to be freely used with no strain on the connection.

A door cord is merely a flexible, two-conductor cable with a terminal block on each end. Each terminal block has two screw terminals and holes for mounting. One end of the door cord is fastened near the shunt lock (A) and the wires from the shunt lock are connected to it. The other end is fastened on the frame (B), a pair of wires are taken from it and connected directly to the terminals of the magnetic switch that monitors the door.

Reviewing the operation of a shunt lock:

A key is inserted into the shunt lock (outside the door), rotated to the right and removed. This closes a pair of internal contacts in the shunt lock, enabling the protective circuit current to **by-pass** the magnetic switch. The door may now be opened without triggering the alarm. In other words, the magnetic switch is *neutralized* by this action.

When departing from the premises-- after switching the system on-- the key is inserted in the shunt lock and rotated to the left. This opens the internal contacts, *disengaging* the by-pass. The magnetic switch is now fully active and will trigger the alarm if the door is opened.

The advantage of a shunt lock is that no delay is imposed on the system's reaction to an attempted break-in.

The disadvantage of a shunt lock is that it presents a skilled burglar with an opportunity for external tampering: If a shunt lock is to be used, do not purchase one that uses a flat, brass key with cuts on both sides. These are the least expensive types, but can be picked open very easily with a few strokes of a "rake" type pick and a simple tension tool!

A shunt lock that uses a "tubular" (round) key offers a much higher level of security. They cost a few dollars more but are well worth it. These locks are also susceptible to picking, but a special tool and a high level of skill is required to do it. This type of shunt lock is perfectly adequate for the average situation where a sophisticated attack is not anticipated. At the top of the line is the **highly pick resistant shunt lock**, which is recommended for any installation which might come under attack by a skilled, professional burglar. These are designated as **maximum security** devices and are UL approved for burglar alarm use. The MEDECO(tm) shunt lock is very secure.

TROUBLESHOOTING

Among the most common causes of "trouble" in a burglar alarm system are careless installation, no maintenance, damaged components, adverse environment, routine wear and defective components, in that order.

Careless installation includes poor wiring discipline, loose or sloppy terminal connections, poorly fastened switches and improper placement or adjustment of area protection devices, etc.

Defective, malfunctioning components are frequently the result of buying burglar alarm equipment from sources other than knowledgeable, specialized dealers; but even a professional-grade component can be damaged by unusual events, movement and traffic, or affected by its environment. Furniture movers and window-washers are the worst enemies of a burglar alarm system. Next on the list of troublemakers is a greasy environment, such as a busy kitchen, a gas station workshop, etc. Airborne grease accumulates on anything that isn't frequently cleaned, and it gets into the smallest cracks. If the grease contains salt, the film it deposits is corrosive.

Some components will just naturally wear out from routine use, such as the switch on a heavily-used door. Professional-grade sensors are test-rated at X operations before anticipated failure, (several million operations, typically.) By estimating the average daily traffic rate through a door and dividing that figure into the test-rating figure, the expected life span of the sensor may be projected. Most sensors will outlive their rated average-- but should not be expected to. A sensor attached to a door that is opened and closed 200 times a day (amounting to 400 separate operations) should last 6-1/2 years with a test rating of one million operations.

A switching sensor that isn't operated *enough* (at least once a day) will tend to get "lazy" from accumulations of corrosive film and stiffened springs. Using a switching sensor (a magnetic, for example) on a window that is rarely opened is not recommended. A more straightforward, non-mechanical type of sensor should be used, such as a wire lacing pattern, a laced frame, or a foil pattern with the protective circuit wired to take-off blocks. (Foil may be applied to walls as well as glass!) If carefully installed and protected from damage, these "fixed" sensors will serve reliably for many years without attention. Any type of mechanical, switching sensor must be periodically operated to keep its contacts "wiped" clean and to exercise its springs.

There are two common categories of burglar alarm malfunction: *operational* and *pre-operational*. An operational malfunction is a false activation (or failure to activate) while the system is armed. A pre-operational malfunction is one that is discovered when the user tries to switch the system on and it won't *set up*, indicating a problem either in the protective circuit or in the control panel.

The first step in troubleshooting a pre-operational malfunction is to make sure that all switching sensors are engaged (windows and doors are closed.) Next, set a test meter to read DC VOLTAGE (at the same voltage rating as the protective circuit battery) and apply the meter's probes to the protective circuit terminals inside the control panel. If the needle moves ("reading" the battery) this indicates that the protective circuit is intact and the problem is either a weak battery or it's somewhere in the control panel. Brisk, energetic motion of the needle is an indication that the battery is strong. Conversely, a lazy, sluggish motion of the needle indicates a weak or discharged battery.

A multimeter can test for the presence of electrical energy, and it can measure voltage levels, but it cannot accurately measure the amount of stored energy (amperage) remaining in a battery. Only a battery tester (ammeter) can do this. A fully discharged battery will often contain enough residual energy to excite the sensitive coil of a meter, but not enough to *pull in* the contacts of a protective circuit relay. So, when the system won't set up, but the protective circuit reads "live," apply a fresh battery directly to the protective circuit terminals (5 & 6 in the control panel.) If this doesn't force the system to set up, it proves that the problem is in the control panel. A simple, premium quality control panel (such as the "100") rarely malfunctions; if it does, the entire circuit board (control instrument) may be replaced by removing four screws. (This is one advantage of using a simple control panel.)

Returning to the initial step; if the meter needle doesn't move at all when applied to the terminal ends of the protective circuit, but moves briskly when applied directly to the terminals of the battery, it proves that the protective circuit is open at some point. Thus a simple, two-step procedure has isolated the problem to the protective circuit. Troubleshooting is a logical progression of stages, each of which further isolates the problem and eventually will pin-point it.

Fig.21-1 (next page) shows a top-view of the perimeter (outer walls) of a rectangular, single-story commercial premises, which is monitored by a 12 sensor system. (Count these sensors before proceeding.)

The control panel is shown fastened to an interior wall, with the bell wiring "snaked" through the wall to a bell mounted on the exterior. The dotted line represents a protective circuit pair, originating at the control panel and running in the direction of the arrows around all four walls of the premises. The two doors are designated D (for Door) 1 & 2, the windows are designated W (for Window) 1 thru 8. Each sensor in the protective circuit is designated S, (for Sensor) 1 thru 12. The protective circuit ends at the 3 volt battery which is shown as a pair of circles in the lower left corner, marked + -.

S1 is a magnetic switch monitoring the entrance door, which is D1. S2 is a foil-pattern on a window at W1. S3 is a laced screen fastened over a ventilator duct in a toilet. S4 & S5 are foil patterns on windows W2 & W3. S6 is a PIR (passive infra-red) motion detector, projecting its beams down the length of a center corridor. The remaining sensors monitor five more windows and the rear door.

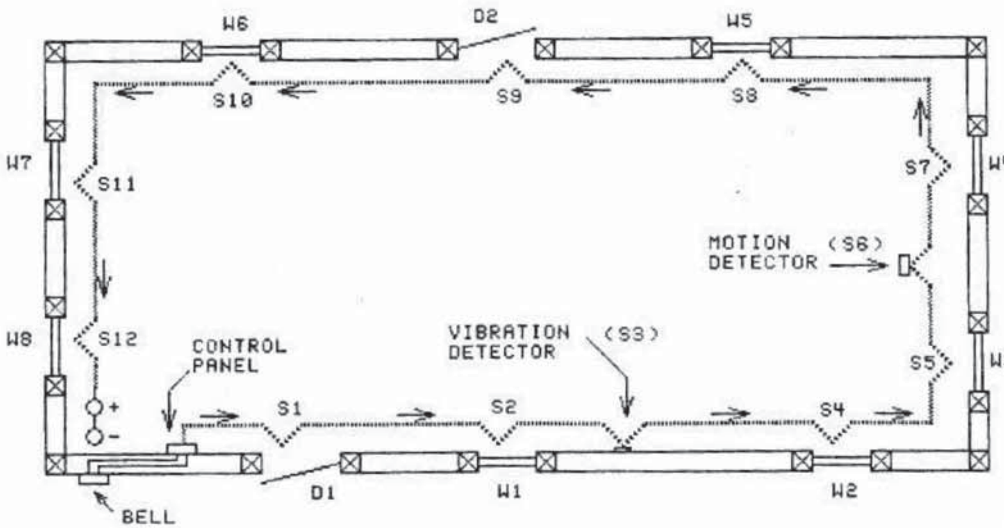


Fig. 21-1.

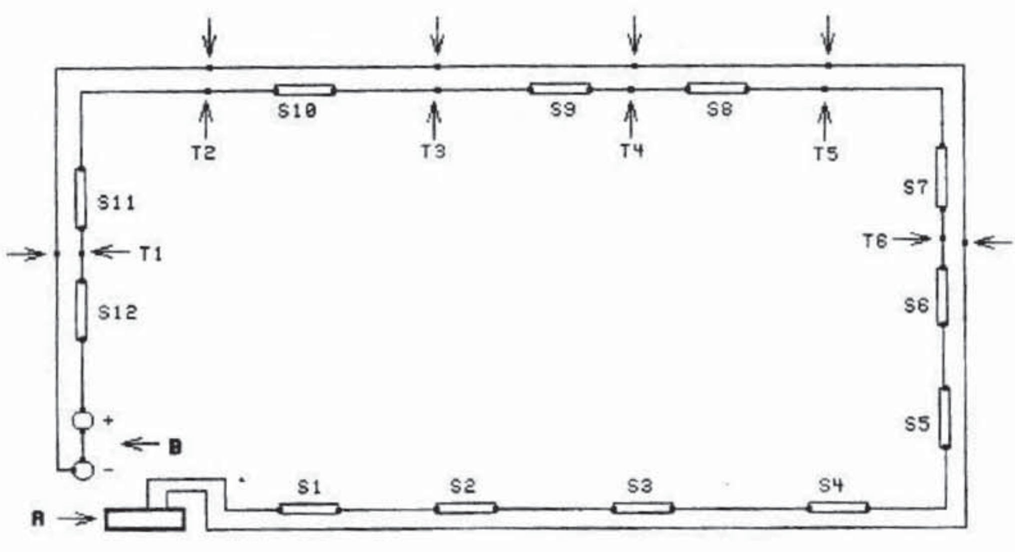


Fig. 21-2.

Fig. 21-2 is a simplification of Fig. 21-1, showing only the control panel at A and the protective circuit wiring, with twelve sensors connected in series and terminating at the battery, **B**.

In this hypothetical example, the bell rang when the system was switched on, (a pre-operational malfunction.) A visual inspection revealed no apparent cause, so a service technician was called.

The initial trouble-shooting step isolated the problem to the protective circuit. A direct reading at the battery terminals shows the battery to be fully charged. The next step is to test for a voltage reading further along the protective circuit wiring, beginning at T1 (for Test-point 1) in Fig. 21-2.

Fig. 21-3.

The way to perform a meter test when no exposed terminals are accessible is shown in Fig. 21-3. Map pins (which are better for this task than ordinary straight pins) are pushed through the insulation of the wires, making contact with the conductors beneath. The meter's probes are then applied to the pins.

When applied at T1 the meter indicates live voltage, which means the circuit is intact between that point and the battery. This step is repeated at T2 and again indicates voltage; likewise at T3, T4 and T5. When the meter is applied at T6, however, the meter needle doesn't budge, indicating that somewhere between that point and the last test-point (T5) there is an *open* in the circuit. Between T5 & T6 is Window 4, which is monitored by a foil pattern, the most probable location of the trouble.

W4 is a picture window, which is depicted in Fig. 21-4 (next page.) To test the pattern, the protective circuit connections are removed from the take-off blocks at A. The meter is set to read CONTINUITY and its probes are applied to the terminal screws of the take-off blocks. If the pattern is intact the needle will swing to the right.

In this example the meter showed that the foil pattern is open at some point. Foil damage is sometimes a clearly visible scratch but just as often it is an invisible, hairline crack that must be further isolated by probihg short spans with the meter. In order to penetrate the insulative varnish coat without having to gouge holes in the foil, the meter probes must be needle sharp. The ideal meter for burglar alarm work will have 36" leads with alligator clips at the ends (instead of pointed tips) for probes. Gripping map pins in the jaws of the alligator-clip probes, is the best way to test a foil strip.

The meter at position 1 is reading to the right, showing continuity between its probes. Likewise at positions 2 and 3. At position 4 the needle doesn't move, indicating that the break is somewhere between the probes.

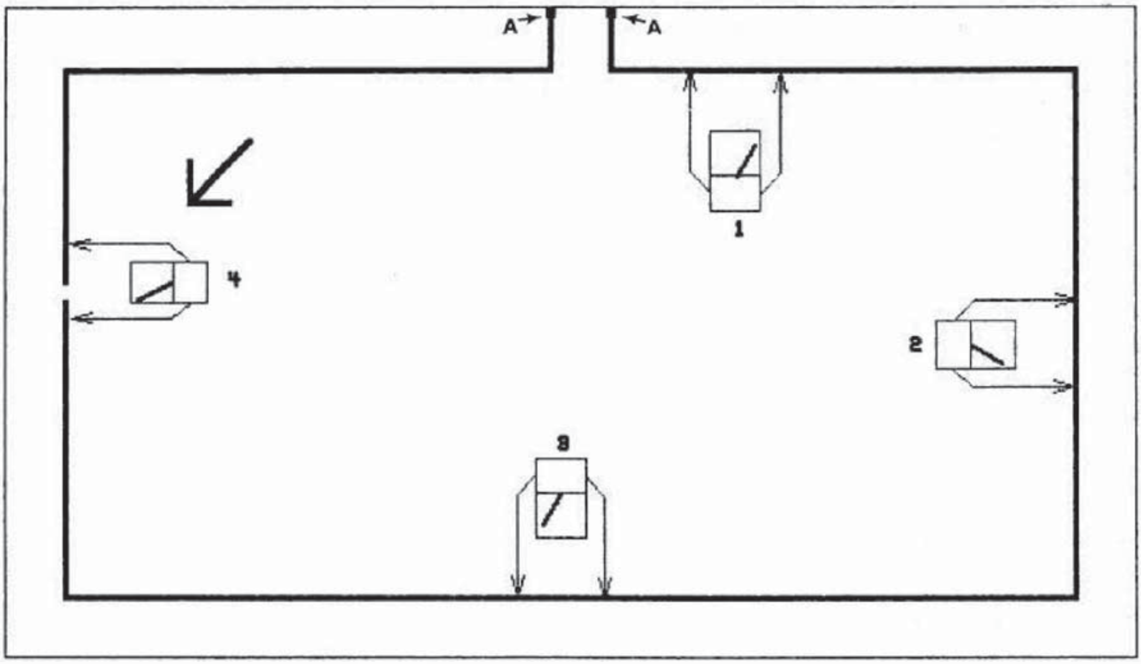


Fig. 21-4.

Now that the open has been isolated to a relatively short section, and it still cannot be seen, a sequence of probing steps at 1" increments will quickly locate it. Fig. 21-5 depicts a short strip of foil with a crack in it. One of the meter probes is applied at A and the other probe is applied at 1. Because the foil between these points is intact, the meter will show continuity. With one probe still fixed at A, the second probe is moved to point 2, then 3, then 4-- at which point the needle will not move! Thus an invisible, hairline crack in a 200 foot protective circuit, which contains numerous sensors (including a sophisticated motion detector) has been isolated to a 1" area. This problem is easily corrected by stripping away a 2" section of foil with a razor blade and applying a patch.

Fig. 21-5.

The same procedure will just as easily isolate a defective door switch, a torn conductor, a broken strand of lacing wire in the frame over the ventilator duct, or **any other problem** in the protective circuit. Although this explanation has been carried through exhaustive detail to illustrate the use of a meter, under actual circumstances the problem could be isolated and repaired within a few minutes. In fact, this example has taken the "long way home" to demonstrate the trouble-shooting procedure: Referring to Fig. 21-2, the following explains a much faster way to find the problem.

After determining that the protective circuit battery is good, instead of making the first test at T1, logic dictates that the best place to start would be at midpoint in the circuit, in the area of T6. For example, if the first test was made between S5 and S6, the **absence** of voltage would immediately show that the problem is somewhere between that point and the battery, thereby isolating the problem to one specific half of the protective circuit.

The next step is to move back **toward** the battery (instead of away from it), again dividing the remaining distance in half by testing between S9 and S10. This time the test would show live voltage, indicating that the problem is somewhere between that point and S5.

Again dividing, the next test would be between S7 and S8, where live voltage would show that the problem is between that point and S5.

Dividing the remaining distance would narrow the search to approximately the area of T6. Thus the problem has been isolated to S7 in only three steps instead of the six steps taken in the first explanation.

If the problem was the magnetic switch at S1, instead of the foil pattern at S7, eleven steps would be required to find it by taking the "long way home." By **dividing**, that is starting at T6 and reading live voltage there, one step would eliminate half the circuit; thus the problem would be located in just three or four steps. Live voltage at T6 would dictate that a test be made between S3 and S4, then between S1 and S2. Finally, a *dead reading* between S1 and the control panel would suggest that the problem is in the magnetic switch at S1. Dropping the protective circuit connections from this switch, applying the meter probes to its terminals and operating the switch would reveal the problem. Replacing the switch would solve it.

The foregoing has described the simple, logical procedure involved in troubleshooting a *constant* malfunction, that is a problem which appears and remains constant. Most pre-operational malfunctions are constant, deriving from physical damage to a protective circuit component while the system was switched off. As shown in the foregoing example, a constant malfunction (torn or scratched foil) is relatively easy to locate by moving a test meter along the protective circuit wiring in a logical progression of steps and observing the meter's needle.

An operational malfunction is one that occurs while the system is in service, usually producing a false alarm. Occasionally an operational malfunction will be the result of damage caused by an unusual event such as water leakage, rodents (who like to chew wires), falling boxes or shelves, etc. This kind of damage will produce a problem which is easily traced because it is constant, (a broken sensor, scratched foil, a broken conductor, etc.) Most frequently, however, an operational malfunction is caused by an *intermittent* problem, often referred to as a "swinger" or a "hider." Simply stated, an intermittent problem is one that appears spontaneously, often momentarily, causing the protective circuit relay to drop out-- and then restores itself.

The classic example of an intermittent problem is an imperceptible crack in a foil pattern (usually at the base of a take-off block) which occurs during a winter night, when the window-pane contracts from the cold and the foil is too brittle to flex with it. The crack is barely wide enough to interrupt the current flow through the protective circuit. When the temperature begins to rise (and the glass relaxes) the tiny crack closes, restoring the protective circuit. As previously explained, restoring the protective circuit will not stop the bell from ringing, so unless a cut-off timer is used it will ring until someone arrives with the proper key to turn it off.

One way to prevent this specific problem is to leave a little slack at the point where the foil strip meets the take-off block (don't stretch the foil tightly there) and apply a generous amount of varnish at this point for added support. This point, incidentally, is usually subjected to damage from a careless window washer's squeegee. So in situations where commercial window washers are used, foil patterns should be considered a prime suspect, especially if an intermittent problem arises shortly after the window-washer has been around.

Cheap or worn-out sensors can cause intermittent problems; so can loose or corroded splices, loose or corroded terminal connections and damaged protective circuit wiring. The fact that most false alarms occur in the middle of the night (most often in winter and during thunderstorms) directly implies the contributing factors of temperature change and vibration.

The most effective approach to locating an intermittent problem is a physical "shakedown" of the protective circuit: The system is switched on and, beginning at the control panel, the protective circuit wiring is tugged at and prodded, especially at corners and splices, and in the area of each staple. Sensors should be tapped with a screwdriver handle and the surrounding areas pounded with a fist or a rubber hammer. The type of foil crack described above can sometimes be found by poking around at the take-off block with a finger, but the best way to test foil for a "hiding" crack is by spraying a film of aerosol frost directly onto the foil-- concentrating on the base of each take-off block and on patches. (A carelessly applied patch has a high potential for causing intermittent problems.) Aerosol frost is available from electronics suppliers, it is commonly used to coax out invisible cracks on printed circuit boards.

Nine out of every ten swingers can be located by a good shakedown of the protective circuit, which includes a careful visual inspection of the circuit while tugging, tapping and pounding its components. Screw terminal connections should be loosened and re-tightened, especially in a damp or greasy environment, because grease and corrosion can accumulate under these screws and produce an insulating film.

When shaking down a protective circuit, remember that even a brand-new, mechanically perfect magnetic switch can be disturbed by a heavy blow. The *feel* of just how hard to tap a magnetic switch during a shakedown may be developed only through experiment and practice.

Obviously, vibration detectors cannot be tested by this "shakedown" procedure, so they must be jumpered out of circuit before proceeding. Whenever a vibration dectector is in use, it should be regarded as a probable cause of an intermittent problem. If a better "suspect" cannot be located, all vibration detectors should be temporarily removed--or their sensitivity adjusted to minimum to see if this solves the problem. The same reasoning applies to any type of motion detector: If a more apparent cause of an intermittent problem cannot be found, these devices should likewise be suspected and adjusted to low sensitivity, or temporarily jumpered out of circuit.

Just because a system false alarms once, after a long period of stable operation, does not mean there is a swinger in the circuit. The most stable, trouble-free system can be subjected to an uncommon event such as a severe, localized tremor, an unusually loud or high frequency noise, or the spontaneous discharge of atmospheric static. While an attempt should be made to locate the cause of any operational malfunction, an intermittent problem is one that recurs. Sometimes it will appear within a few hours after the system is switched on and sometimes the interval between appearances will be several days. In either case, there usually is some corresponding cause.

In one example, a system that contained a number of vibration detectors began to false alarm on Monday nights only. This system was thoroughly inspected (which included two vigorous shakedowns) but no cause was found. The fact that it happened only on Monday nights suggested an external, corresponding cause. A long-duration tape recorder (with a pre-amplified microphone) was situated on the premises and switched on at closing time. Playing back the tape after the fourth, consecutive occurrence revealed the cause: The Monday night (relief) barmaid in an adjoining tavern liked rock music and ran the juke-box up to full volume after the place began to empty, at about 1:00 AM. The juke-box speakers were mounted on a wall that was continuous with an adjoining wall in the protected premises, which was monitored by vibration detectors. The problem was solved by replacing the vibration detectors with a PIR motion detector.

Long-duration tape recorders are an efficient means of determining the cause of such problems. In this case, the sound of a throbbing bass guitar was heard on the tape immediately before the alarm bell started ringing.

The foregoing is an example of a common audio-surveillance technique applied to a very legitimate purpose. The same technique has been used to identify such trouble-causing villains as whistling radiator valves, timer-activated heating systems, banging steam pipes, ringing telephones and, in one instance, the noise of a garbage truck's hydraulic hopper at 5 AM. All of these things, and quite a few more, are capable of disturbing motion detectors and hypersensitive vibration detectors. The tape recorder trick is one way to discover such mysterious events. (Long-duration tape recorders and amplified microphones are available from security & surveillance equipment suppliers.)

When no amount of probing, prodding, tugging, pounding or Sherlock Holmes-type deduction succeeds in ferreting out the cause of a swinger, the process of elimination is the least desirable but most positive way to get rid of the problem. If a system consists of many sensors the elimination process can take several days, during which time the system must be shut down to avoid repeated false alarms until the problem is eliminated:

One way to proceed is to remove the bell connection from the control panel terminals and attach an indicator lamp (rated at 6 volts)in its place, then disconnect half of the sensors in the circuit, (remembering to clip or twist the vacated protective circuit wires together to close the circuit.) If the problem does not recur, which is determined by observing the indicator lamp upon opening the premises each day, begin replacing the components **one at a time** until it does. When the problem recurs, the last component replaced is probably the cause and should be changed.

If the intermittent **does** recur while half of the components are disconnected, begin removing the remaining components one at a time until the problem stops. When it stops, the last component removed should be changed. Then replace all components and return the system to service.

Rarely will a simple, professional grade control panel be the cause of an intermittent problem, but when the process of elimination doesn't work the panel must be tested. One way to do this (after the bell connection is replaced with an indicator lamp to avoid disturbing the neighbors) is to drop the protective circuit connections from the control panel, attach the battery directly to the protective circuit terminals and wait to see if the lamp lights. If it does, the panel is obviously defective. Another way to check out a suspect control panel is to just swap it for another and see what happens.

Batteries are sometimes the cause of an intermittent problem: Most batteries will discharge at an even, predictable rate with an average service life of one year, but a defective battery will sometimes discharge erratically, dropping well below the minimum service level then resurging to full power. Another potential battery problem is a broken carbon rod, which is an extension of the positive terminal on a carbon/zinc cell. This brittle rod extends through the center of the cell and is sometimes cracked by rough handling. Like a latent crack in a foil pattern, temperature changes will affect it. When the crack opens, the cell will become erratic. Moisture and temperature extremes will also affect batteries.

By following the principles outlined in the foregoing pages any type of problem in any burglar alarm system can be pinpointed and corrected. By now it should be clear that trouble-shooting is a logical process of elimination. The first step in learning the procedure is to obtain a suitable test meter and learn how to use it-- which takes about ten minutes. Once the meter, itself, is understood, applying it to a protective circuit is incredibly simple.

Special meters are available which are designed expressly for trouble-shooting a burglar alarm system. One such instrument ("Peter's Meter," described elsewhere) provides LED indicators and an audible tone in addition to a movable needle, thus it may be observed from a distance while shaking down a system to locate a swinger.

A set of clip-on test leads (jumpers), which are short lengths of insulated wire with alligator clips at each end, comes in handy for by-passing segments of a protective circuit, or individual sensors, when testing for an intermittent by eliminating components. The clips are simply attached to both terminals of the sensor to be by-passed.

Most intermittent problems are the result of careless installation practices and therefore are avoidable. When a staple is shot through a conductor (instead of around it), in time the fine copper strands within will become corroded and fail. Spliced joints, which were twisted with grimy fingers and wrapped loosely with tape, will eventually corrode and fail. One major cause of intermittents are spliced connections in a bell cabinet that are twisted and taped without first being soldered. Good wiring discipline calls for soldering all splices, but many installers are delinquent in this area. Failing to solder splices on interior wiring significantly increases the possibility of future problems, but failing to solder the splices in a bell cabinet, where they are exposed to moisture and temperature extremes, is asking for trouble. A portable soldering iron makes the job of soldering splices a very simple one, so there is no reason to ignore this important task.

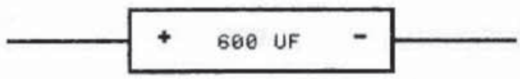
Experienced trouble-shooters know that the *little things*, like a loose terminal screw, an un-soldered splice, a little too much gap between the two parts of a magnetic switch, etc., are the things that cause the biggest headaches. The phrase *wiring discipline* is not loosely applied: Running wire, attaching sensors and applying foil can be tedious work, so it is often tempting to ignore a little detail here and there. By selecting top-quality components and installing them carefully it is possible to produce a system that will perform for many years without the slightest problem.

When an intermittent problem is traced to a motion detector, it is possible that the device is being triggered for a brief instant by some momentary disturbance such as static discharge, an unusual vibration, noise, or a gust of wind blowing under a door. Such events are capable of causing a motion detector to activate for a split second, which is more than enough time to "drop out" the protective circuit relay. This action may sometimes be observed by sitting quietly in a room where a motion detector is operating and observing the walk-test light:

Usually a slight movement of a hand or foot will cause the device to activate for a moment (causing the walk-test light to wink on and off very briefly. This is not the normal action of a motion detector when it is sensing the mass of a whole human body moving within its field. The difference may be seen by simply walking a few steps instead of just moving an arm or leg: The walk-test light will come on and **stay on** for at least three or four seconds, depending on the speed and distance covered. A motion detector which is activated by an actual bodily movement will activate and **maintain** its active state for several seconds.

The foregoing implies that a *slower* protective circuit would solve the problem-- and in most cases it will. By slightly "retarding" the normally instantaneous drop-out action of the protective circuit relay, so that it will ignore a momentary interruption in current flow, a false alarm-prone system may be stabilized.

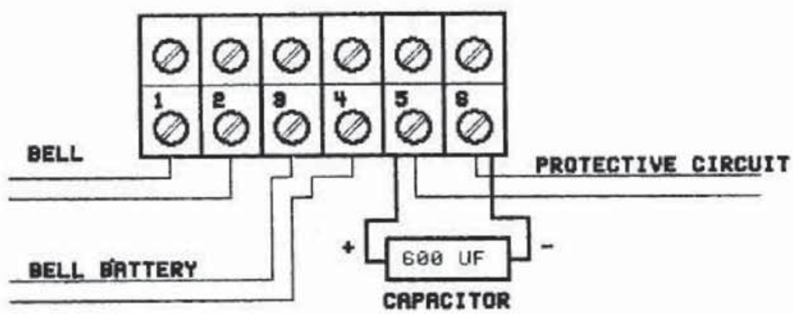
The drop-out speed of the protective circuit relay may be retarded by attaching a simple, semi-conductor component to the protective circuit terminals (5 & 6) inside the control panel as shown in the figures below.



TUBULAR ELECTROLYTIC CAPACITOR

The device is a *tubular, electrolytic capacitor* with *axial leads*, (a small, cylindrical object with a wire sticking out of each end.) The wires are bent as shown and simply fastened underneath the same terminal screws that hold the protective circuit. The function of a capacitor is to <u>store</u> a specific amount of energy, much like a battery, and discharge it slowly when the parent energy source is removed.

CONTROL PANEL TERMINAL STRIP - SHOWING NORMAL CONNECTIONS WITH 600 UF CAPACITOR ADDED TO IMPOSE A DELAY IN PROTECTIVE CIRCUIT RELAY DROP-OUT TIME.



The capacitor absorbs a tiny amount of energy from the protective circuit battery. When the protective circuit current is interrupted, instead of the relay dropping out instantly as it normally would, the tiny amount of energy stored in the capacitor will maintain the relay until that stored energy "bleeds off." The exact number of seconds this takes (the delay period) depends on the rating of the capacitor.

These capacitors are available at electronic supply stores in a wide variety of ratings. Capacitors are rated in fractions of a *farad* (a unit of measurement) called *micro-farads*, (one millionth of a farad.) The symbol for micro is the character u, the symbol for farad is f; thus the marking, 600uf, on the body of a capacitor means 600 micro-farads, which will provide approximately 2 seconds of delay.

Another marking on the capacitor indicates its **polarity**, and it is important that wire on the + side of the capacitor be attached to the same terminal as the + side of the protective circuit-- or it won't work. The polarity marking will either show as a + sign at one end of the device or an arrow pointing toward one end, indicating the Positive (+) end.

The objective of this section is to show that finding any type of problem in a burglar alarm system is simply a process of gradual elimination. For example, the bell may be tested by simply dropping the bell circuit connection at the control panel and directly applying these wires to a 6 volt battery. If the bell rings, this means the entire bell circuit is intact. But if it won't ring when the control panel is activated, the problem is obviously in the control panel-- probably the bell relay.

By dropping the protective circuit connections at the control panel and directly attaching a 3 volt battery to the vacated terminals, the control panel may be tested without a protective circuit.

Because 99.9% of all problems occur somewhere in the protective circuit, common sense dictates that this should be tested first. If the meter does not read voltage from the 3 volt battery when its probes are applied at the control panel end, go directly to the battery and apply the meter to the battery terminals. If the battery is okay, move further along the protective circuit and take another reading.

Keep moving until the meter stops reading voltage, then move back (in shorter steps) toward the point where the last live reading was taken. In this manner the problem will be isolated to within a few feet, (or inches.) Begin disconnecting every sensor (within the isolated area) from the protective circuit and test each one for continuity and proper operation. If all of the sensors seem to be okay, check all splices in the same area.

INSTALLATION NOTES

The first step in planning an installation is to evaluate the vulnerable points of a premises to determine which type of sensor is most appropriate for each point. If there are simply too many individual points to monitor in a given area, or the physical environment is somehow opposed to the wiring of a perimeter circuit, then consider an area protection device. Also consider the merits of using area protection devices in addition to a perimeter circuit.

The next step is to select the best locations for the control panel and annunciator(s). Before deciding these locations, all wiring routes must be carefully considered. Sometimes the most convenient or desirable locations for the control panel and annunciator(s) will impose special difficulties in bringing the bell and protective circuit wiring to them. Keep in mind that the bell circuit wiring must be totally concealed from view or securely armored to protect it from being cut.

The best location for exterior annunciators is anywhere that is not accessible without a ladder and affords a secure, concealed route for running the bell circuit wiring to the control panel. The best location for the control panel is somewhere that affords reasonably convenient access by the user and concealment from general view. If a power supply is to be used (instead of dry-cell batteries), access to AC power is important. Whether a single *zone* or a multiple-zone control panel is to be used, the control panel must be located where it is accessible to the protective circuit(s) wiring. After weighing the foregoing factors and requirements, the individual circumstances of each individual job should dictate the priorities.

Except for high-risk situations, where sophisticated tampering and bypass attempts are a real possibility, protective circuit wiring need not be concealed. So unless hidden wiring is absolutely necessary for protection from tampering, or simply for appearances, semi-concealed, *surface wiring* affords a significant trouble-shooting advantage. When a protective circuit is totally concealed, isolating and repairing a problem which is hidden inside a wall can be a tough job. That thought should prevail throughout any concealed wiring job and inspire close attention to proper wiring discipline.

While a fully concealed installation looks better, and affords protection from tampering and physical damage, it calls for a significantly greater amount of patient, careful work. Labor is the biggest factor in the final cost of a commercially installed burglar alarm: the cost of a concealed wire installation is usually triple the cost of the same installation with semi-concealed wiring.

Semi-concealed wiring is typified by ordinary telephone wiring, which is generally stapled along baseboards, up and over door-frames and moldings, etc., and passed from room-to-room through small holes drilled in corners. Whenever a closet can be exploited as a "tunnel" to another level, or a shortcut between rooms, it is. Whenever the wiring can be tucked behind a loosened baseboard, it is. Wherever wire can be concealed without major work and reconstruction, it is. Semi-concealed wiring is taken through small holes drilled in the side or bottom of kitchen cabinets, then through a wall or up through the ceiling, into an upstairs closet, etc.

Protective circuit wire, which is little different from telephone wire, can be hidden behind furniture and stapled into the edges alongside wall-to-wall carpeting. 3 volts is very low-voltage so there is little risk of a protective circuit starting a fire. High (hazardous) voltage is rated at 40 volts and above by most electrical standards, but a staple that pierces the insulation of a pair, causing a *dead short* across the protective circuit, will radiate a high temperature as it rapidly drains the battery. In a hot, dusty environment, such as an attic, special care must be taken when stapling wire.

Stapling wire is a simple procedure but a beginner should practice stapling a few 6 ft. lengths of 22/2 to a lumber scrap before starting a first job, because it takes a few minutes to get used to the proper *feel* of the staplegun. Regardless of how proficient one becomes with this tool, every staple should be closely observed in good light to be sure that the legs of the staple straddle both legs of the pair and haven't punctured either leg.

The first staple is the anchor, from there each successive, 18" length of wire is stretched tight before the next staple is shot. The nose of the Arrow T-18 staplegun (the standard of the trade) is grooved to accept a 22/2 twisted pair, so the gun is slid down the wire as it is worked into position, pressed down tightly and snapped. Before shooting the staple, look to make sure that the groove is straddling both wire legs. After shooting the staple, regardless of how good it felt to the hand, look again to make sure. This is good wiring discipline and prevents a great deal of future trouble. Staple punctures and poorly crafted splices are a major cause of intermittent problems. An unsoldered splice is alright for a temporary situation (a year or so, for example) but it cannot be depended on after that time. A staple puncture is <u>certain</u> to cause a problem in the future.

Baseboards and corner moldings can usually be pried away to accomodate a 22/2 pair but they must be replaced carefully, making sure the pair is not crushed in the corners. Never withdraw the finishing nails all the way because they must serve as guides for the wires as the molding or baseboard is being replaced.

Dropped ceilings and acoustical tile ceilings are ideal wiring conduits because they often are common to numerous rooms within the same premises. Attics and cellars are another way to move wiring from one area to another. By drilling up through closet ceilings or down through corners in a floor, wiring can easily be taken from one end of a premises to another.

When it is not practical or possible to hide wiring behind baseboards and moldings, in closets and cabinets, attics, cellars, etc., it may be stapled along the <u>top</u> of baseboards and <u>alongside</u> moldings. If it becomes necessary to run a length of wiring straight up a wall (with no concealment) and this looks unsightly, there are several types of decorative "raceway" available to make a neat job of it. Wiring "raceway" is usually sold in 6 ft. lengths of low-profile, plastic or metal conduits that attach to clips fastened to a wall surface. The raceway is easily cut to the right size and a variety of corner sections are available to create a finished appearance. Wiring raceway is available at most do-it-yourself centers, hardware, electrical and lighting suppliers. It is inexpensive, very easy to work with and imparts a very neat appearance to surface wiring.

Snaking wire inside walls is an intimidating prospect to anyone who has never done it, especially to one who has little experience at working with wiring tools. In some cases the procedure involves removing entire sections of wall paneling, punching holes in plaster, pulling out bunches of insulation and boring holes through the 2 x 4 "cross-cats" and "headers" in wood-frame construction. These methods require reconstruction and skilled finishing work after the wiring is in place, which must be considered when planning wiring routes.

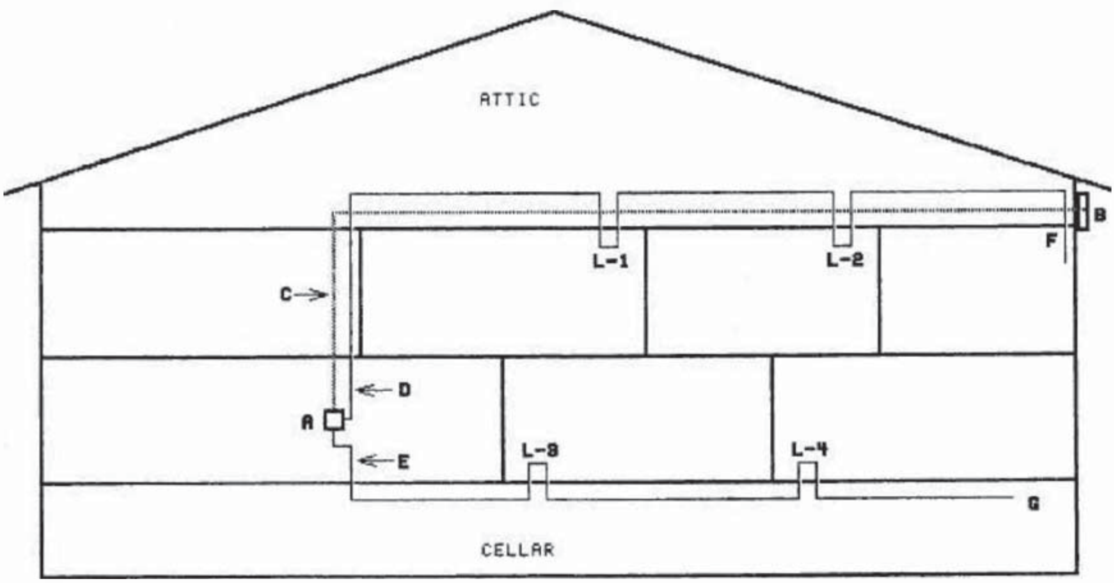


Fig. 22 -1 .

The figure above represents the wiring routes of a residential installation. The control panel (shown at A) is situated in the entrance corridor. The bell is mounted under the eaves at B. The dotted line (C) represents the bell circuit. A is mounted on a wall in the corridor closet. It is a two-zone control panel with a built-in power supply and entry/exit delay.

Directly over the closet where A is located is an upstairs bathroom. By removing the medicine cabinet and drilling a 1" hole down through a "cross cat" (a horizontal 2 x 4 used in framework), and drilling a larger hole in the closet wall, it is easy to *snake* the wires up from the closet to the medicine cabinet, which is located at C. By drilling up through another cross-cat, the wiring was passed up from there to the attic and taken directly to the bell location, at B.

An *electrician's snake* can be purchased at any well-stocked hardware store. This is a 24 ft. (or longer) coil of tempered steel wire, 3/16" wide by 1/16" thick. From this, several shorter lengths are cut, 2 ft., 3 ft., 4, 5 and 6 ft. These five lengths are usually adequate for most jobs, except where wiring must be pulled through an extremely long conduit. Using the jaws of the same *side-cutter* pliers that were used to cut the heavy wire, a narrow, 3/4" hook is bent into one end of the shorter snakes.

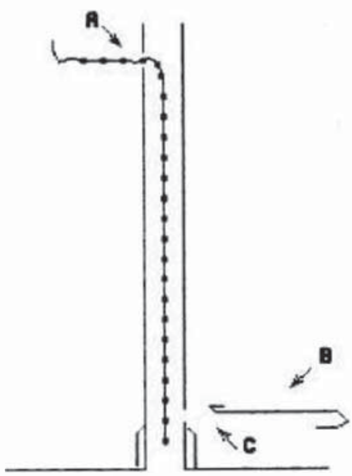


Fig. 22 -2 .

The figure on the left shows the typical use of a short snake, which is shown at B. Note the short hook at one end and a larger loop at the gripping end. In this diagram the snake will be pushed through a small hole drilled through a wall in a baseboard corner (C), and used to "fish" for the length of heavy bead chain which is shown lowered from a hole drilled through the opposite side, at A. A 20' length of bead chain (stored on an empty wire spool) comes in very handy for situations like this, because it's sometimes difficult to bend a snaking wire at a critical angle. After the bead-chain is hooked and pulled through at C, the wiring will be fastened to the end of the chain at A and will follow it when the chain is pullled through the wall.

Another handy wiring tool is an ordinary, tubular aluminum, .22 rifle-cleaning rod. A notch can be cut or ground out of one side of the patch loop (of the right size for snagging bead chain and 22 gauge wire.) These rods are sectional and an unlimited number of sections may be joined together for reaching through long, attic "crawl spaces," etc.

In Fig. 22 -1 , the fine, solid lines represent protective circuit *zones* 1 and 2. The wires of zone 1 are pulled up into the attic along with the bell circuit. At L-1 and L-2 (for Loop 1 and Loop 2), this circuit is pulled through a closet ceiling, where a separate loop is connected into it. Zone 1 is taken right to the bell connection, where the tamper switch loop is connected to it, (not shown.)

Zone 2, (E) is passed down from the closet at A into the cellar. In most cases the plumbing from the upstairs bathroom would be found in this path, which sometimes provides a ready-made conduit to follow. Care must be taken whenever drilling into a wall where plumbing pipes and high voltage wiring are likely to be hiding. To be on the safe side, use a 3/8" or 1/2" chuck, heavy-duty, variable speed, reversible drill because they are easier to control. Bore slowly until the tip breaks through to the hollow space behind the wall, then stop. Withdraw the bit, push the tip of a screwdriver in, tap and feel around with it. **Warning: Never drill into a wall with an un-grounded drill!**

Zone 2 is brought up through the floor inside a kitchen cabinet at L-1, where the kitchen loop is connected into it, at L-3. It then accomodates the living room loop at L-4 and finishes up at the cellar loop, (not shown.)

Note that one of these two zones makes an "appearance" in every room of the house and at all levels. In the same way that an unlimited number of sensors may be added to any separate loop, any number of loops may be added to these two zones if future expansion of the system is desired. These are the primary wiring routes mentioned in THE BASIC BURGLAR ALARM SYSTEM and they should impart a general idea of how to "lay out" a system.

This example does not imply any rules, it simply suggests some of the tricks of the trade useful to snaking wire. Sometimes the only way to run concealed wiring is to break through plaster, cut out panels of drywall, tear up wallpaper and, sometimes, remove door frames. These are radical methods and should be avoided whenever possible.

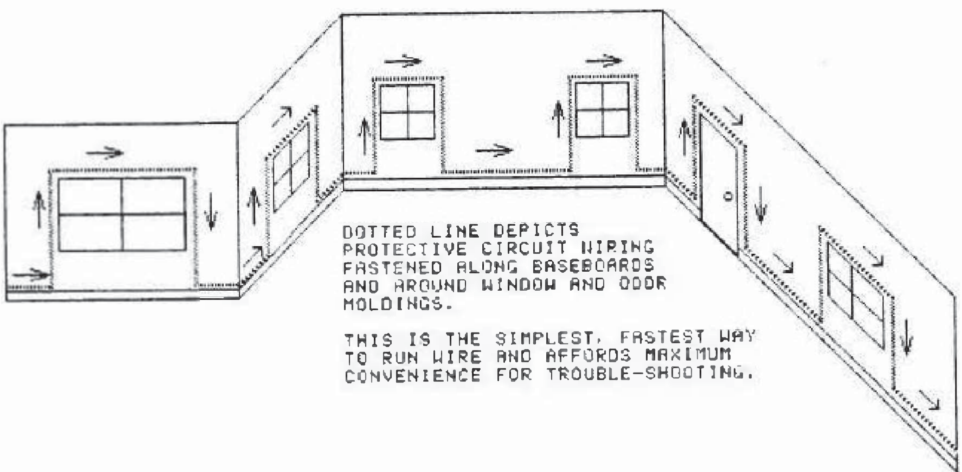


Fig. 22-3.

Fig. 22-3 shows an example of protective circuit wiring stapled along baseboards, up and over window and door moldings. In most situations the vertical lengths of wire seen running up a bare wall to a window frame would be concealed by drapes, along with the sensors and their connections into the protective circuit. 22/2 is available in either brown or ivory color so it usually blends well with the color of a baseboard, especially when it's been painted over. Furnishings normally hide a good percentage of the baseboard wiring, leaving only the wiring around the door frame conspicuously exposed.

The wiring shown in Fig. 22-3 may be totally concealed, but depending on the physical construction of the premises, the amount of additional work involved could be considerable. Sometimes the hollow space inside the walls is accessible from an attic or cellar, which makes the job of snaking wire much easier. If not, it might be necessary to pull out sections of paneling, punch holes in plaster walls, etc.

As mentioned previously, the average handyman-for-hire is extremely competent at this type of work and would charge considerably less than a professional electrician or alarm installer to do it. Assume that the cost of components for an alarm system is 350.00 and the cost of having a surface-wired or semi-concealed installation done by a contractor is 1,500.00, the job will cost 1,850.00. The same job with fully concealed wiring might cost two to three thousand dollars more! But if a local handyman is hired to do nothing more than snake the wiring through the walls, leaving an exposed "appearance" near every window and door, the cost of his labor might be 500.00 to 1,000.00. Many independent burglar alarm installers operate in exactly this manner, using local handymen as sub-contractors, finishing off the job themselves (which amounts to fastening and connecting the sensors to the exposed appearances) and walking away with a 1,500.00 to 2,500.00 profit!

Surprisingly, in spite of the fact that most local handymen are extremely skillful at carpentry, masonry, high-voltage wiring, etc., few of them have more than a general idea of how a burglar alarm system works. It isn't necessary to explain anything more than where to leave the exposed *appearances*. After the concealed wiring is in place, and the handyman is paid off and gone, the control panel, bell and sensors are installed. This completes the installation.

SPECIAL TOOLS, PARTS AND TECHNIQUES

The foregoing sections describe a variety of specialized components, explaining how they interact when connected together in an electronic system called a burglar alarm. While it is relatively easy to assemble a working system on a bench (as an aid to understanding how each separate component functions in the system), the physical task of installing these components will be greatly simplified with the help of the proper tools.

The following descriptions refer (by corresponding letter) to the tools shown on the next page:

A> FEELER BIT (or) ELECTRICIAN'S BIT (or) BELL HANGER BIT: These drill bits are available in 12", 18", 24" and 48" lengths; 1/4" and 3/8" diameters. They are excellent for drilling passage holes through hollow walls (plaster, plasterboard, sheet-rock), baseboards, floors and ceilings. The longer ones are useful for reaching into hollow walls to drill through 2 x 4 crosscats and headers.

B> MASONRY BIT: Available in a variety of lengths, from 4" to 24" and diameters from 3/16" to 1". These are the bits to use for drilling into any type of masonry, such as brick, concrete, cement, tile and plaster. Never use "twist" bits (those which are made for drilling metal), on any kind of masonry (including plaster) or they will be ruined instantly. When drilling through thick masonry, such as brick, cement or cement block walls, and the masonry bit begins to shriek and stall, withdraw it and dip it into a cup of water. Never use oil to lubricate or cool a masonry bit.

C> PLASTIC ANCHOR: These come in several sizes: # 6 - 8 (x 7/8" long) fits a 1/4" hole and will accomodate # 6 - 8 screws, which are used to fasten sensors and similarly small objects. # 10 - 12 (x 1") accomodates #10 - 12 screws, which are used to mount bells, sirens and control cabinets. These are used on solid (masonry) mounting surfaces.

D> TOGGLE BOLT: Available in several sizes: 1/8" (diameter) x 4" (length), 3/16" x 3", 3/16" x 4", 1/4" x 4". Used for mounting heavy objects on thin mounting surfaces, such as hollow plaster, plasterboard, sheet-rock, paneling, etc. The toggle slips through a drilled hole, snaps open and grips firmly when the bolt is tightened.

E> MOLLY ANCHORS: Available in a variety of sizes. An alternative to the toggle bolt. A ribbed sleeve that surrounds the bolt expands as the bolt is tightened.

F> HOLE SAW: Available in a variety of widths, from 3/4" to 2-1/2". Used to bore holes in wood, panel, wallboard, etc. Carbide version is available for boring metal. Used for shunt lock installation, etc.

G> SPADE TONGUE: Available in variety of sizes. The smallest size is 9/64", which accomodates 22 - 18 gauge wire. (Perfect size for burglar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B
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J
K
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M
BRIGHT STAR
HEAVY DUTY
LANTERN
battery
N
BRIGHT STAR
LONG LIFE
IGNITION
O
P
Q

alarm work.)

H> QUIK-WEDGE SCREWDRIVER: The split blade of this screwdriver expands to grip tightly inside a screw index, holding the screw firmly. This tool is particularly handy when working with window foil take-off blocks. Also useful for handling screws in tight working spaces, or when working from a ladder.

I> SCREW STARTER: Similar to a screwdriver, but the tip is a hardened, threaded screw, (instead of a screw-driving edge.) Very useful for starting screw-holes with one hand. An extremely handy tool.

J> SIDE-CUTTER PLIERS (or) LINEMAN'S PLIERS: Useful for cutting & forming snakes, cutting heavier wire (16 gauge zip cord, etc.), and such tasks as removing the "knockout" slugs from the back of bell and control panel cabinets, etc.

K> WIRE STRIPPER: The perfect tool for working with 22/2 wire. Easily adjusted to accomodate any size wire. Cuts and strips wire very quickly. The stripper groove is screw adjustable to any wire gauge.

L> CORDLESS SOLDERING IRON: Contains rechargable battery. Sold with charger stand. Charges up overnight. Full charge will accomodate about 50 solder joints. Extremely handy for soldering splices, especially the splices in a bell box.

M> ARROW T-18 STAPLE-GUN: The standard fastening tool for burglar alarm (and telephone) wire. The only alternatives to using this tool are wiring tacks and the type of wiring staples that must be pounded in with a tack-hammer.

N> 6 VOLT LANTERN BATTERY: (Heavy-duty.) Used for powering bells & sirens. Life-span is about one year (with no prolonged "ring-offs.")

O> 1.5 VOLT IGNITION CELL: Two of these, connected together by jumpering the Positive terminal of one to the Negative terminal of another, produces a 3 volt battery. Used to provide "supervisory" current for protective circuits. Life-span is one year.

P> MULTIMETER (or) V-O-M (or) METER: This is a standard electrical testing instrument and is <u>indispensable</u> when working with burglar alarms. Burglar alarm suppliers sell meters which are specially modified for the trade.

Q> "PETER's METER": (Named for its inventor, who designed it specifically for the burglar alarm trade.) Has several unique features that make the job of testing for an intermittent much easier. Two of these features are an audible tone and an indicator light, in addition to the meter face. Another feature is a special circuit that sets up and holds (just like a protective circuit relay), then indicates ("drops out") when the swinger "appears" during a shakedown. Recommended for anybody who intends to work with burglar alarms as a sideline, or a living.

To avoid several trips up and down a ladder when mounting a bell, trace the mounting holes on a sheet of stiff cardboard to use as a template. Tie a length of wire to the bell cabinet and climb the ladder with the template, a drill, and the hoisting wire end. Use the template to mark the mounting holes, drill the holes, then hoist the bell & cabinet up by the wire.

Set a small level on top of or inside a control panel when marking the mounting holes. It's hard to square off the box while holding it against a wall, and even a 1/4" tilt is unsightly.

When it's convenient to run protective circuit wiring under a wall-to-wall carpet, splice in a section of 22 gauge speaker wire for that purpose. This wire, called "22/2 *parallel*," is much thinner and won't show through as will 22/2 twisted.

When drilling through a hollow wall and you don't know where the bit will emerge on the other side, use a side-cutter pliers to cut a short section of wire coat-hanger, with a sharpl angle at one end. Chuck the other end in a high-speed drill (2,200 rpm) and apply moderate pressure to drill through with this improvised "bit." It bores a very small hole, which may easily be patched with a dab of filler (Spackle, Dap, Plastic Wood, etc.) if it breaks through in the wrong place.

After mounting a bell (or siren) and splicing the connections, apply a generous coating of RTV (Room Temperature Vulcanizing) cement to the tamper switch screw terminals. This stuff forms a rubbery skin overnight which will protect against corrosion for many years. RTV comes in a tube and is available at any hardware store.

When drilling a passage hole in a brick or stone wall for the bell circuit wiring, drill the hole at a slight angle (aiming upward from outside, or downward from inside) to prevent rain-water from seeping in through the hole. Also, block the hole with RTV.

Whenever wiring is to be concealed inside a wall, or anywhere that will be difficult to access and repair it after the wall is sealed, run an extra pair (spare) alongside it to be used as a substitute if a future problem develops. Four conductor cable, such as telephone wire, is recommended for this application. Conceal the tails of the spare pair in some convenient place, to be retrieved and used if ever needed.

Figure 23-1 (next page) shows one way to produce a strong splice:

A represents the ends of two 22 gauge wires. 3/4" of insulation has been stripped away and the exposed wire strands twisted into rigid posts.

B shows the two posts twisted together; (apply a film of solder to these joined posts before proceeding to the next step.)

C shows the soldered joint bent backward at its base and pressed tightly against one section of wire.

D shows the finished joint covered with about three turns of plastic electrical tape.

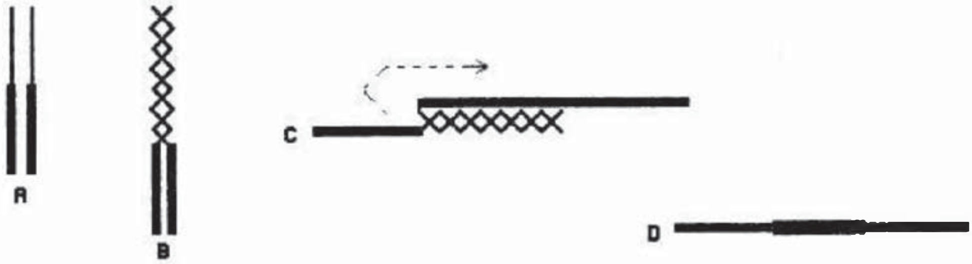


Figure 23-1

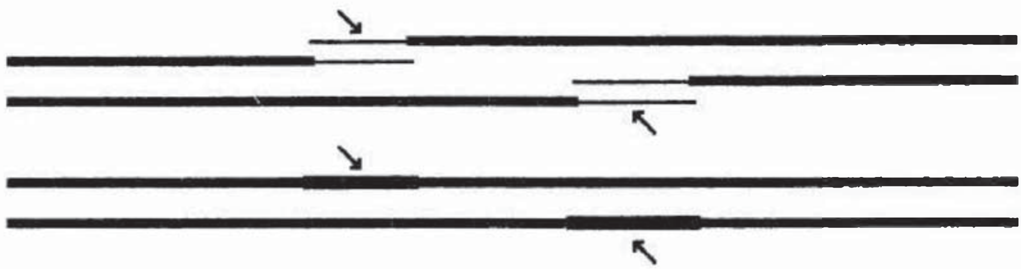


Figure 23-2

When splicing two pairs of wires together, prepare the ends as shown at E, in Fig 23-2: Note that the stripped ends of the legs to be joined are **offset** from each other. This is to eliminate the possibility of a loose strand of wire from one leg coming in contact with the other leg (and causing a short.) This also enables a much neater, finished wrap when the two legs are ready to be bound together, (see F.) If the individually wrapped joints are taped side by side, an unsightly bulge will result when the two legs are bound together.

Soldering is not difficult, but it takes a little practice to get used to: Use either a 30 Watt, plug-in iron (with an extension cord) or a portable, and "60/40 rosin-core" solder. Allow the iron to heat to maximum. Apply the iron to the twisted posts for a few seconds, until they become heated, then apply solder to the heated posts (near the iron.) After a second or two, the solder will abruptly puddle and run into all the cracks, at which time the iron should be quickly removed. A soldered joint hardens and cools in a few seconds.

For troubleshooting purposes, it is best to leave an exposed "test point" wherever a loop is connected into the protective circuit. An exposed test point is enormously helpful when isolating a loop to test it for continuity. Without a test point it is necessary to open and rewrap a splice, which is a troublesome job. The following are recommended methods of providing exposed test points.

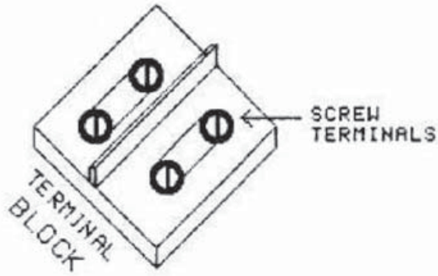


Figure 23-3

Figure 23-4

Figure 23-3 depicts a *2-post, barrier terminal block;* a small plastic block with two pairs of screw terminals, which are separated by an insulating barrier. The two pairs of screw terminals are isolated from each other, but a metal strip provides continuity between both screws of each pair. Figure 23-4 depicts a handy little item called a *spade tongue*, which is slipped onto a prepared wire post and tightly crimped in place (either with a special crimping tool or a corner of a side-cutter pliers' jaws.) The spade tongue fits perfectly under any type of screw terminal, producing a much more efficient connection and affording great convenience when the connection must be removed and replaced during troubleshooting.

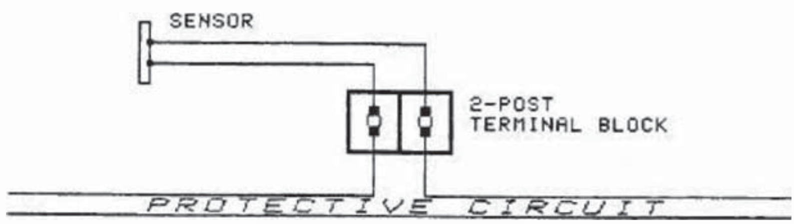


Figure 23-5

Figure 23-5 shows a one-sensor loop connected into a protective circuit, using a terminal block instead of a wrapped splice. Both legs of the loop are fitted with spade tongues and fastened under the upper screws of a terminal block, as shown. The ends of the severed protective circuit leg are likewise prepared and fastened under the lower screws on the terminal block. The continuity of this connection is the same as a spliced junction, but it provides conveniently exposed test points. To isolate the loop from the protective circuit (to test it for continuity), just loosen the upper screws of the terminal block.

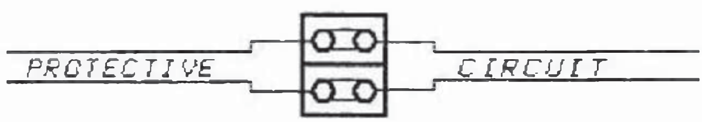


Figure 23-6

These terminal blocks may also be introduced at intervals in long wire runs to eliminate the need for penetrating wire insulation with pins when taking voltage readings along the protective circuit. As shown in Fig. 23-6, the protective circuit pair is cut in two (spade tongues are attached to each stripped end) and attached to a terminal block. (Note that the block in Fig. 23-5 is situated vertically for making a *series* connection; but horizontally in Fig. 23-6 for making a *parallel* connection.)

When attaching a wire to a screw terminal without using a spade tongue, strip the wire end, twist it tightly; bend the twisted post around the shaft of a screwdriver to form a hook, then solder the hook. This is the next best method to using a spade tongue and will prevent the wire strands from fraying and corroding under the screw terminal.

The use of exposed test points should be restricted to areas where they will not be accessible to tampering (i.e., in the public areas of a commercial premises.) All it would take is a jumper across the two upper screws in Fig. 23-5 to shunt the loop out of circuit. One way to provide a concealed test point is to use a covered telephone connecting block ("baseboard block") instead of a barrier terminal block.

Another handy technique makes use of a 3.5mm plug ("mini-plug") and jack set. A 3.5mm plug is the small plug usually found at the end of most tape recorder accessory wires, miniature headsets, etc. These plugs usually have a cylindrical, black plastic sleeve that screws off to accomodate the wiring connections, as seen in Fig. 23-7.

Figure 23-7

The "jack" is the female part of the set. Use the "in-line" type jack, which comes with a screw-off sleeve, as seen in Fig. 23-8.

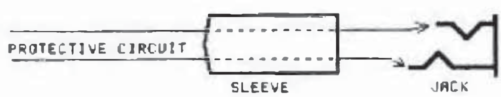


Figure 23-8

These plug & jack sets offer a convenient way to improvise a "trap" sensor, such as a "live trap" trip-wire, or to monitor a ventilator duct grille, etc; (see CLIP TRAPS.)

The way to wire a plug/jack set is seen in the above figures: 1/8" of insulation is stripped from the ends of a severed protective circuit pair. The separate ends are passed through the sleeves of both plug and jack and soldered to the terminals, then the sleeves are screwed in place to cover the connection.

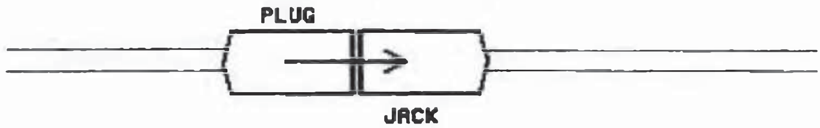


Figure 23-9

When the plug is inserted into the jack (as seen in Fig. 23-9), continuity is established. A slight tug at the wiring will separate the two parts, having precisely the same effect as separating a clip trap.

In addition to a trap function, this plug/jack set provides a convenient test point:

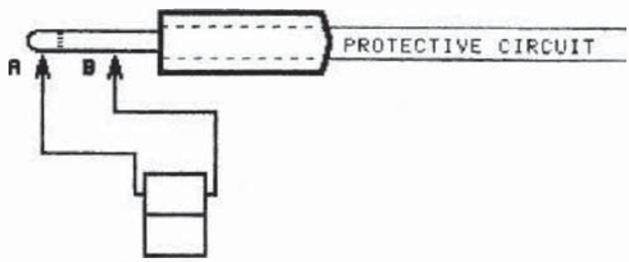


Figure 23-10

The tip of the plug is separated from the shaft by an insulative band. The tip is continuous with one of the terminals, the shaft is continuous with the other. Fig. 23-10 shows how to apply the probes of a meter to a plug for testing: One probe is applied to the tip (A), the other is applied to the shaft (B.) This is identical to applying the probes to screw terminals. The tip and shaft are continuous with the separate legs of wire.

To use a meter on the jack, an extra plug (without a sleeve) must be used: Slip this plug into the jack and apply the meter's probes to the plug's solder terminals as shown in Fig. 23-11.

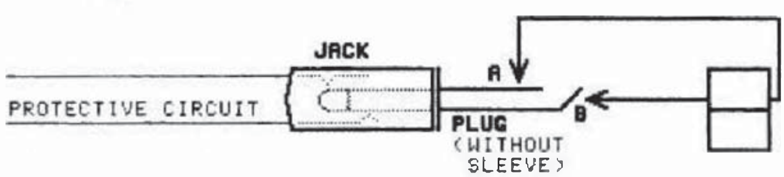


Figure 23-11

The previous paragraphs refer to using a plug/jack set to achieve the same effect as seen in Fig. 23-6, which is direct continuity of the protective circuit pair. A plug/jack set may also be used to connect a loop into the protective circuit, as shown in Fig. 23-5.

=+=

A good source of standard tools and hardware items is,

U.S. GENERAL TOOL CO.
100 General Place
Jericho, New York
11753

This is a mail-order supplier. All prices are discounted from the suggested retail. A large tool catalog is available for 2.00.

=+

An excellent source of supply for professional-grade burglar alarm components and special equipment is,

GARRISON PROTECTIVE ELECTRONICS
Box 128
Kew Gardens, New York
11415

This supplier has been around the burglar alarm business for many years and handles nothing but top-quality equipment. Their prices are reasonable and they provide informational support to their customers. We recommend this supplier to any reader who wishes to take the next step in the direction of learning this fascinating skill.

Garrison will supply special 'package' sets of equipment, including **supplementary instructions** that conform with the information in this book. They stock the "100" control panel (and others), and will make recommendations pertaining to a customer's individual requirements.

A catalog is 2.00, which may be applied to any equipment order.

EQUIPMENT COST REFERENCE

The following are typical retail prices of professional quality burglar alarm components, (list compiled in the Fall, 1984.) This listing is provided as a reference to calculate the approximate cost of installing a burglar alarm system. Wholesale suppliers (who depend on volume sales) generally do not invite small orders from beginners, and are too busy to provide informational support. To avoid making costly, troublesome mistakes, the beginner is advised to deal with a retail supplier who has installation experience.

CONTROLS>

Expect to pay about 75.00 for a "UL Listed," basic control panel, such as the one described in this material. If accessory features are required, an entry/exit-delay timer will cost about 60.00. A bell cut-off timer, about 40.00. An AC switching relay, about 20.00. A permanent power supply (with plug-in transformer, trickle charger and standby battery), about 80.00. Reliable control panels are available with built-in power supply, entry/exit delay timers, and two zones, for about 200.00. (Be sure that clear, supplementary wiring instructions are included with any multi-featured panel.)

BELLS & SIRENS>

A UL Listed bell, contained in a weatherproof cabinet with pre-wired tamper switches will cost about 75.00. A siren with speaker, remote driver and tamper protected cabinet will cost about 100.00. Remember that a 12 volt system is recommended if an exceptionally loud siren is required.

MAGNETIC SWITCH SET>

UL Listed, (rated at more than one million operations) will cost about 5.00 to 6.00 per set, with cover.

PLUNGER SWITCH>

Weatherproof type: 4.00.

LEAF SWITCH>

3.00.

CLIP TRAP>

UL Listed type: 4.00.

MERCURY SWITCH>

UL Listed type, with adjustable bracket: 10.00. With adjustable bracket & door cord, 12.00.

VIBRATION DETECTOR>

UL Listed type: 8.00.

SWITCH MAT>

10 ft. length x 30" width: 50.00 per roll.

SHUNT LOCK>
Round key type: 13.00. MEDECO: 30.00.

PHOTOELECTRIC SENSOR>
UL Listed type: Average 150.00.

PROXIMITY SENSOR>
About 350.00.

ULTRA-SONIC MOTION DETECTOR>
About 150.00.

PASSIVE INFRA-RED MOTION DETECTOR>
About 150.00.

MICRO-WAVE MOTION DETECTOR>
About 175.00.

WIRE>
22/2: 8.00 per 100 ft. coil. 35.00 per 500 ft. spool.
Lacing wire: (hard-drawn copper) 20.00 per 500 ft. spool.

FOIL>
8.00 per 500 ft. roll. Self-adhesive type: 12.00.

GLASS-BREAK DETECTOR>
UL Listed type: 7.00.

MULTI-METER>
Standard type: About 35.00.
Peters Meter (specialized for alarm work) 75.00.

ARROW T-18 STAPLE-GUN>
40.00. Staples, 2.00 per 1,000.

FEELER BITS>
Range from 10.00 to 20.00, depending on length and diameter.

In the way of miscellaneous hardware and fasteners, a box of 100 #6 screws costs about 2.50. Spade tongues: about 10.00 per 100.

Because retail equipment suppliers make a better profit on the components they sell to beginners, they generally will include such incidental item as fasteners with an order.

The burglar alarm kit you've installed will protect your property, family, and valuables, right? Not necessarily. A majority of the so-called burglar alarms currently in use can be defeated by amateur crooks using the least sophisticated methods. And many systems will malfunction within a matter of months, leaving the do-it-yourselfer with a collection of useless hardware fastened to the walls.

Tricks of the Burglar Alarm Trade will help you find and fix the weaknesses in your current system or show you how to select and install a new one that will make your home or business truly secure. And you won't have to wade through technical jargon, cryptic diagrams, or complicated references to electrical theory. Author Mike Kessler's straightforward, get-down-to-the-basics approach will familiarize you with the principles that govern all closed-circuit burglar alarms and then provide you with countermeasures that will defeat any attempt to bypass your system.

Whether you own an apartment, liquor store, or mansion, *Tricks of the Burglar Alarm Trade* will help you keep your property and loved ones safe from intruders.

A PALADIN PRESS BOOK
ISBN 0-87364-550-2

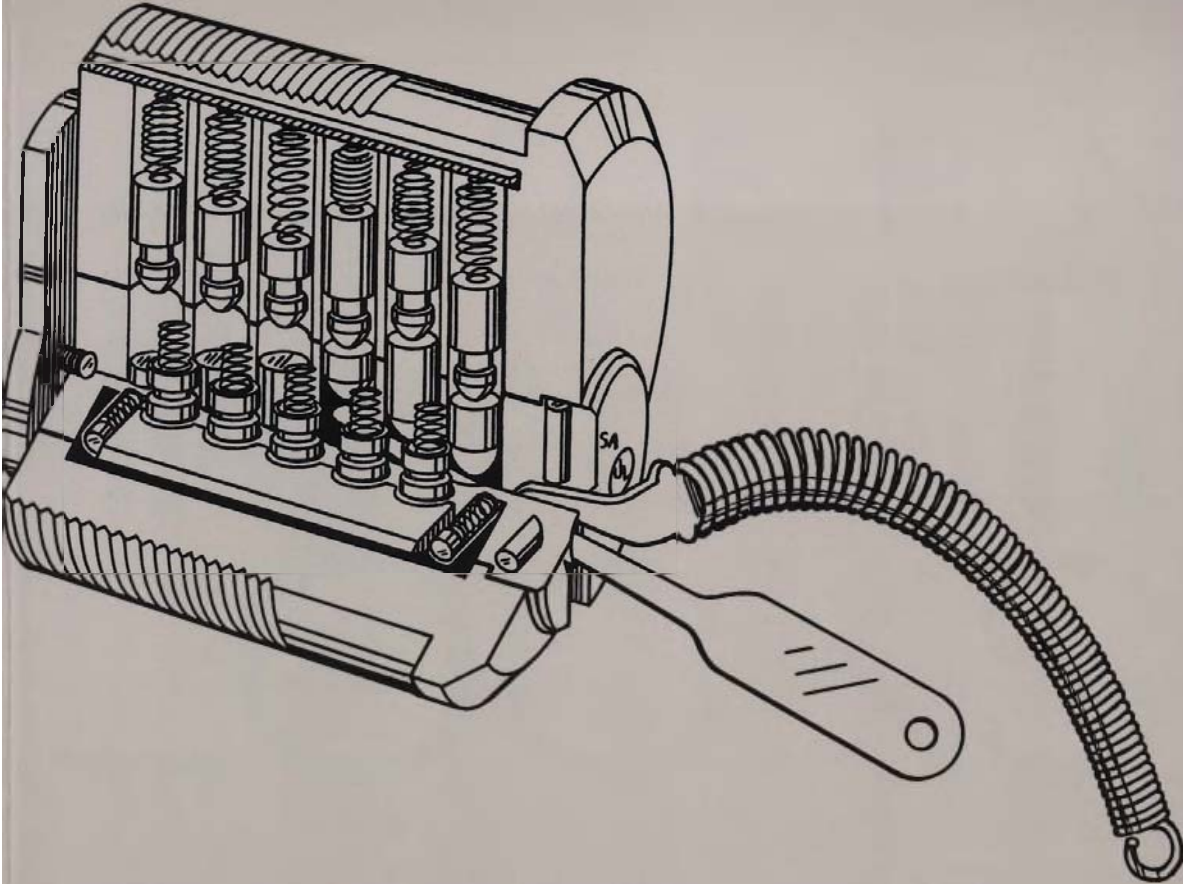
Master locksmith Steven Hampton, author of the best-selling *Secrets of Lock Picking*, takes the art of picking locks one step further with *Modern High-Security Locks*. Here, he collects some of today's most popular pick-resistant locks and sets out to see which ones hold up to their claims.

Generally speaking, the more complex a lock, the more secure it is. However complex the lock gets, though, it must be durable, dependable, and user-friendly. It has to be tough enough to endure physical attack, but it can't be machined too tight or it will jam up with just a breath of dust. It must be simple and easy to lock and unlock with its key, or the customer will not pay the higher price for it. It is this delicate balance between security and utility that allows the lock-smith to open this new generation of locks.

Hampton shows locksmiths how each lock is picked and how long it will take. He details the tools of the trade and includes patterns and instructions for making your own picks and tension wrenches. He even includes ancient Tibetan Buddhist tantric visualization exercises to help locksmiths learn to "see" the inner workings of the lock within the mind's eye.

Veteran locksmiths or those new to the trade will find Hampton's latest book an invaluable sourcebook. *For academic study only.*

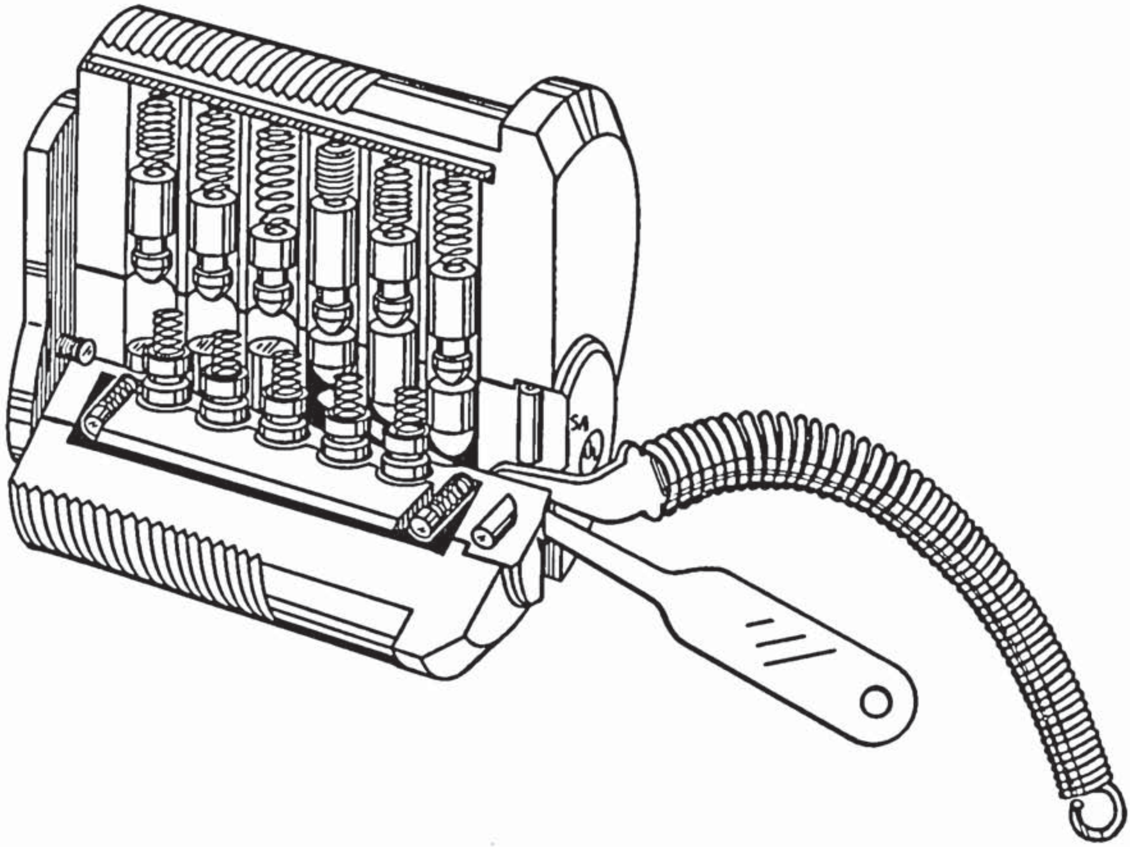
HAMPTON MODERN HIGH-SECURITY LOCKS



MODERN HIGH-SECURITY LOCKS

HOW TO OPEN THEM

Steven Hampton



MODERN HIGH-SECURITY LOCKS

HOW TO OPEN THEM

Steven Hampton

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Warning

The author, publisher, and distributors of this book in no way endorse or condone any potentially illegal activity or act and disclaim any liability for the use or misuse of the information contained herein. This book is *for information purposes only*.

Preface

When *Secrets of Lock Picking* first appeared in 1987, I felt somewhat concerned about the possibility of someone using my information for illegal purposes. But then I realized most criminals do not have the patience to pick open a lock or the skills needed to make the tools. Since the publication of *Secrets of Lock Picking*, the national burglary rate (as well as crime in general) has dropped per capita. Not because of the book, of course, but in spite of it.

This suggests that information alone is not the precursor to crime—it is poverty and poverty mentality that spark crime. In any society, crime is a political disease, not just an emotional one. Good government should not alienate its citizens with unfair taxes, regulations, and favoritism. And though our democracy has grown complex and is by no means perfect, so may be our own judgment should we suddenly find ourselves immersed in poverty—imagined or real.

But blaming our poverty on the system does not justify committing a theft. Ultimately, we are responsible for our own destinies. So we must use this kind of information wisely and rise above that first, sudden impulse to steal, because doing so would cause another's loss and suffering, accompanied by anger and perhaps even a sad loss of faith in man.

We all know empathetically what is right, and deep in our bones we know what feels wrong. As enlightened beings we can carefully weigh our choices and see what we are up against in the War on Crime. You do not want to enter that battlefield. You will lose. This information is for reference only—or to help someone in need. Knowledge is a double-edged sword that cuts both enemy and holder; only the hand of compassion can safely wield it.

Real wealth is found in the heart.

Introduction

I decided to write this follow-up to *Secrets of Lock Picking* at the request of many of my readers. Herein I have evaluated various new locks on the market and designed and made tools to test their security. In so doing, I have collected a series of some of the more popular pick-resistant locks and set out see which ones held up to their claims. This catalog is not intended to devalue the security of these locks, but rather to instill in the manufacturer the awareness that security is a never-ending battle and none of them can rest on their laurels.

It is also in the best interest of the locksmith to know how these locks are rated in pick resistance. Furthermore, my evaluation would be meaningless if I did not show the reader how they are picked. After all, the security of a lock is not rated just by knowing how to pick it, but by the time it takes to pick it.

AN EVOLUTIONARY BEGINNING—THE PIN TUMBLER LOCK

The modern pin tumbler lock was invented in the mid-1820s by Linus Yale, Sr.[1] All good, present-day mechanical locks are based on his invention: a cylinder that contains a series of spring-loaded pins (or wafers in subsequent inventions) that restrict its rotation. This type of security has worked well for almost two centuries, even though its beginnings can be traced back 5,000 years.[2] But with the new wave of electronic locks and multi-functional mechanisms, being locked out today may have a whole new meaning. And though this is good news for the world of security, when keys are lost or the circuit fails, the locksmith is faced with a daunting challenge—to open the expensive lock without destroying it. Also, in most cases, destroying the lock could make matters worst.

The ability to pick locks open is considered a magical feat, the reason being that the pin tumbler lock is supposedly invincible. But any lock with an access port can be picked if you have the skill and enough time.

With new lock designs being developed every year someplace on the planet, it becomes ever more difficult to keep up with all the different systems. When I first started working with locks as a pimply-faced teenager in the 1960s, I had no idea how far this would go. James Bond-type palm-reading locks, voice recognition, not to mention space-age retina scanners, were just fiction then. Now they are a reality. These are real, functioning systems not yet available to the general public. Some are being used in selected industrial and government facilities. The U.S. Army is perfecting this new field, called "biometrics." This complex system uses a video camera to scan people's eyes, the shapes of their ears, their voices, and even their movement. This information is then fed into microprocessing and is used to allow access to buildings and military bases. Some systems can even detect a particular person's body odor and are programmed to open a lock when that scent is detected. So how does one go about opening the locks in an emergency?

Today, there seem to be nine different classifications of keyed pin tumbler locks alone. Most of them are hybrids of past successful systems. The evolutionary path of hybrid locks has led to finely machined mechanisms that fit together with such precision that greater sensitivity and skill are required to pick them. As such, I have classified and arranged the various mechanisms into chapters by order of complexity.

Generally speaking, the more complex a lock, the more secure it is. However complex the lock gets, though, it must be durable, dependable, and user-friendly. It has to be tough enough to endure physical attack, but it can't be machined too tight or it will jam up with just a breath of dust. It must be simple and easy to lock and unlock with its key or the customer will not pay the higher price for it.

It is this delicate balance between security and utility that allows the lock picker to open this new generation of locks.

In this volume, I can only cover some of the more popular high-security locks—most of which evolved from the lowly pin tumbler cylinder lock. The real challenging systems are not yet available for study to the majority of us, though we might see them occasionally. I will try to keep the technical jargon to a minimum, when possible, and fill you in on the latest systems and how you might possibly open them.

Please note that most of the following lock illustrations are redrawn from patent copy, so there are a few subtle differences between some of the figures and the actual lock or key. Many times once an invention is patented, modifications are made to the finished product. Naturally these changes would have to be small or the patent would not apply to the end product. I have drawn in these various modifications to depict the actual lock where possible. In Chapter 3, the differences were great enough to warrant drawing the patent version (Figure 3J) and the actual lock (Figure 3I). In all other cases, any differences between lock and key and their illustrations are very minor and do not affect how the lock functions or how it is picked.

I have personally picked nearly all of these locks. Those that I had a good deal of trouble with and could not open, I gave the highest pick-resistance rating and included in the text anyway so that you may take a crack at them if you wish. Hopefully my advice will help you. At the very least, you'll discover which ones are best suited for your customer's application.

PICK-RESISTANCE RATING SYSTEM

We have devised a security rating scale of **1** to **15** in half-steps, based on the difficulty in picking the lock and the time it takes to open it. For example, the tiny, single-lever, riveted-case Master padlock model #44 (the first lock I ever picked and no longer in production) or a simple jewelry box lock rates at **1** for ease of picking, as only two simple actions are involved within a time frame of two seconds: sticking in the pick key and turning it.

An example of a pick-resistance 2-rated lock would be a double-lever warded, laminated Master padlock model #22D, as this requires a little searching for the two levers hidden within the laminate wards and intermittent tugging of the shackle to pop it open.[3] Average pick time, about 15 seconds.

A lock with a pick resistance rating of **3** would be a five-wafer cylinder desk lock such as a National or Welsh, either of which can be picked in about 30 seconds.

Standard five-pin tumbler cylinder locks such as a Quikset or Weslock, the tight keyway of a wafer tumbler Hurd lock, and the Chicago double-wafer desk lock are pick resistance rated at **4** and are usually picked within 45 seconds.

A five-pin tumbler Yale lock (no spools or mushroom pins[4]) that has its pins keyed to near-level shear plane is rated at **5**. This is because the slant and tightness of the keyway is the major security issue, not the number of tumblers and varied shear lines. A Schlage double-wafer knob lock would also fall into this category. Pick time: under 60 seconds.

With a rating of **6** the security starts to get pretty good. A few prime examples would be a Corbin, Russwin, or Yale spool and/or mushroom pin tumbler lock. Or a Dexter, Weiser, or Ilco with a high degree of varied pin tumbler shear lines. I can usually pick one of these in between 90 and 120 seconds on a good day with a White Crane Feather Touch tension wrench and a thin (.018" to .022") standard diamond pick.

Ratings of **6.5** and higher will be given to the locks we are about to encounter—so find a comfortable chair, we're off to explore the best security available on the market today. By the way, a **7.5** is typical of automotive side-bar locks. A pick-resistance value of **15** would be considered unpickable. These locks would include such mechanisms as digitally controlled, high-security safe locks or card readers, for instance. This is the range of the new high-security locks today.

A FEW WORDS OF CAUTION

As with my previous books, I must warn the reader that the information contained within these pages is for eyes only. If you are using this information for illegal reasons, you will eventually get caught. There is only one professional cat burglar that I know of who has retired out of prison—and he is a 78-year-old pauper.

Forensic science has evolved to a point where crime just does not pay. For example, in the near future, DNA from a few skin cells could convict you. Since everyone constantly sheds skin in the hundreds of thousands of cells per hour, getting away with a high-stakes theft will be very rare indeed (unless the thief is wearing a sealed body suit, which would make the job unbearable). If a reader is prosecuted, Paladin Press and I will naturally side with the authorities, because though I find stories and movies about cat burglars interesting and entertaining, I personally have no respect for thieves.

Also, with the popular (and often disturbing) uses of various types of miniature video cameras and recorders today, you can't get away with anything anyway. Along with silent helicopters and satellite cameras, this is one more infringement on our personal freedom. On a side note, though it reduces crime, I find this reduction of our privacy an expensive price to pay. It is a tough call to determine which is more important, but Big Brother seems to have decided for us.

On the brighter side, if you learn the techniques in this book, your skills could help someone who is locked out of his or her home, business, or car. Just be certain that the one you are helping is the proper owner of that property. Ask for I.D. or a neighbor's OK. To open a lock in such a dubious situation would be practicing "idiot" compassion. But in all other cases, picking locks can be a satisfying and often rewarding hobby. There is a sense of power and pride as well. Remember to use visualization while picking.

Visualization Techniques

Visualization within this context implies a deliberate, conscious effort to "see" the inner workings of a lock within the mind's eye. Below is an old, secret, Tibetan Buddhist tantric visualization exercise. Here I have modified it for the reader to use for lock picking, but the essence of the technique is the same.

Step One

First, remove your shoes and put on comfortable, loose-fitting clothing such as sweats or shorts and a T-shirt if it is warm. Remove all tight jewelry, such as rings (you may keep your wedding band on if you wish), chokers, and bracelets. Remove eyeglasses (contacts are OK) as well. Remove as much metal from your person as possible.

Step Two

You may begin the technique by sitting upright in a comfortable chair with your hands in you lap and feet flat on the floor. Don't slouch or recline, as this will make it too easy for you to fall asleep. Keep your spine straight, but not stiff. The chair should have a comfortable headrest. Most newer car seats are good examples of an ideal chair, as comfort and alertness are important. Also, a good office chair will work very nicely. Or you may choose to practice the traditional method by sitting cross-legged on the floor on a four- to six-inch cushion. The point is not to let your head tilt back. Your neck should align comfortably with your spine. Tuck your chin in slightly. Your tailbone should be tilted slightly forward, but with your hips at a comfortable angle. If your hips are properly aligned forward, you will not need a headrest, as your straight spine and neck will comfortably balance your head, which is in the ideal position.

Step Three

The room should be quiet, with no music, and dimly lit or dark, with no candles or incense. Sit down and settle in for a few minutes.

Step Four

Now close your eyes. Breathe in deeply, but not forcefully, through your nose. Feel the life flow into your lungs, filling you with vitality and lightness. Do not hold the breath, but let it flow out naturally, dissolving into the room, filling the space. Do this for several breaths.

Step Five

Now breathe normally, relaxing any tight muscles in your body. This can be accomplished by just focusing attention on various parts of the body and letting go of those parts. Just abandon them. If you feel an itch, abandon it—it will go away by itself.

Start by relaxing the jaw muscles. Let them go, but don't gape your mouth completely open. Just crack your lips and let the breath come and go gently, naturally through both lips and nose.

Relax your facial muscles. Relax the tiny muscles around the eyes and forehead. Then let go of the neck muscles. Now relax the shoulders, let them drop comfortably back and down, gently drawing the shoulder blades closer together. Relax the shoulder blades. Relax the rib cage and chest with each out-breath. Let go of the upper arms. Relax the forearms, letting the fingers open naturally in the lap.

Let the stomach muscles go—feel the warmth in the belly. Let go of the thigh muscles and calves. Then feel the feet dissolve away as well. Let the whole body dissolve away. Just sit there for a few minutes and enjoy this pleasant, tingling warmth vibrating through the whole being.

Step Six

Now, with eyes still closed, gently bring attention to the forehead—the focal point between the eyes—about where the eyebrows join. With eyelids closed, focus the eyes there without straining. Just let the breath come and go without strain, without clinging. After a few minutes or less, a series of images will flash into view. In this darkness these images will even take on the shapes of faces. This is natural; don't be alarmed or concerned with them. Gently concentrate on forming a simple, round white ball between the eyes and keep focused on it. Here, size doesn't matter much, but for reference, imagine the size of a softball at arm's length away. Don't let it become anything but a smooth, white ball.

The ball will want to rise. But gently bring it back down into view. If you let it rise above your head, you might lose consciousness and fall asleep. Gently hold it level between the eyes with the mind, casually viewing it as if you were an isolated, detached observer. You have no investment in this ball, but you will not let it stray from your empty gaze, either.

Practice this technique for 20 minutes. You may set a timer if you wish, as long as it is not loud. When you are finished, you will rise refreshed and alert.

After practicing the above technique for a week, you will be ready to color and texture the ball. You can make it any color or texture you want—a silver moon or a dimpled orange, for example. But it must have a *texture* of some sort, the more complex the texture the better. Hold that image for 10 or more minutes during your 20-minute practice. Each day find a different ball-shaped object in your daily routine with texture that you can use in your visualization.

For the third week, visualize a cube. See it from all sides by very slowly rotating it from various directions and angles. Make it solid the first day and hollow or transparent the second day. The third day give it a more dimensional quality, such as dividing it into eight cubic sections with white intersecting lines. The fourth day give it 27 sections or nine faces per side. Then each succeeding day divide the cube until there are too many smaller cubes to count. But don't count any of the cubes, just see them.

By the fourth week, you will be ready to "imprint." You can skip all of the above steps. In good light, gaze (with fixed intent) unblinking at the first detailed lock illustrations in this book. (If you wear glasses, leave them on.) Start with Figure 2A or 3E. Gaze for as long as you can—at least three to five minutes—or until your eyes water and obscure your view. Then, remove your glasses, close your eyes, and gently cover them with your palms, making a slight vacuum with your eye sockets. View the negative image against your closed eyelids. Hold it for as long as you can. The following day, imprint the next detailed lock in the series. Imprint no more than one lock per day until you have viewed all 20 keyhole locks detailed in this manual. This will help to commit each lock to memory.

Should you have to pick one of these locks, occasionally close your eyes and remember the above technique. Simultaneously relax all your muscles (except your fingers, of course) and "see" the lock before your closed eyes. Having imprinted the "X-ray" illustrations of this book, you will have a clear, almost mystical view of the inner workings of the lock that you are picking. You will "see" each tumbler move into place as you pick it. Generally, the more practiced you are at visualization, the better puzzle and problem solver you will become.

ALARM SWITCH LOCKS

Because of their high-security nature, a lot of these new locking systems are used as switch locks for various machinery and alarm circuits. Nowadays, with infrared motion detectors, perimeter switch systems, and a varying host of microprocessing and laser systems, one cannot just walk into secured premises without making a big noise. But behind all of these systems—and the kingpin to their effectiveness—is the switch lock. Each burglar alarm system has to be able to be turned on and off by the owner. This convenience has a price, though, as the switch lock can be picked like any other lock.

CARRYING LOCK PICKS

Many people have asked me about the legal right to carry lock picks on their person, and I wish that I could answer with a definitive yes or no. The problem is that each state in the union has its own laws. Some states are more rigid than others when it comes to the law, but in most states, one must be a qualified locksmith to have the right to carry picks. To have that right, one must take the state locksmith's test at the state capitol's office of licensing. But, there is more to locksmithing than just being good at picking locks.

If you are a lock distributor, law officer, or bona fide repossessor, you can try calling your county courthouse to speak with the county clerk. In some of the larger populated counties, they are better informed and are more willing to help you. After moving back to the state where he grew up, a friend of mine had to talk with one county clerk, three policemen, a police sergeant, and two locksmiths before he could get a straight answer. Hopefully you will not have to go through all that.

If you are not sure about your state, call your local locksmith right off the bat and ask him what it takes to legally carry your picks. You don't have to give him your name, just ask the innocent question. Tell him that you are interested in locksmithing and need to know the laws regarding carrying. Most will be happy to give you information on what you have to do to protect yourself should you be picked up by the local authorities under suspicion of burglary, or during a routine traffic stop.

By the way, it is your constitutional right to be served a search warrant before any cop can riffle through your wallet or personal belongings. But while the Fourth Amendment is supposed to protect us from search unless officers have "reasonable suspicion," that interpretation is broad—which is why there is a judicial system to sort the details out. So to avoid all that hassle, you are better off going through the hoops that your state requires.

IF ALL ELSE FAILS, PERFORM EXPLORATORY SURGERY

Another important point that should be made here is that not all locks of the same species are keyed alike. You may have success picking your practice lock, but the one out in the field may give you a conniption fit. In any case, you have a better chance of opening the one out there if you know the workings of the one in your shop.

If the lock sitting on your bench is not covered in this book, I suggest that you use your cut-off wheel and give it a good old-fashioned autopsy. Sometimes that's the best way to find out how the system works. I suggest that you carefully cut it length-wise above and below the cylinder for best viewing. Be careful not to dissect your finger or hand in the process—you already know how they work. Most locks though, come right apart with either a rear nut, a side-mounted set screw or a roll pin that can be punched out with the proper-sized pin punch.

There is nothing like a good challenge to keep the senses and one's lock-picking skills fresh and alive. That is another reason why I hope you will enjoy reading and using this book. But before we can learn how to pick these new high-security locks, we will need some shiny, brand spanking new tools—which just so happen to be covered in the first chapter of this book.

1. *Pick Guns*, John Minnery, Paladin Press.
2. The pin tumbler lock originated in ancient Egypt around 4.5 thousand years ago and was made of wood. The modern brass pin tumbler lock started its extensive use around the turn of the last century.
3. See example in *Secrets of Lock Picking*, p. 36, Paladin Press.
4. These pin types will be discussed in Chapter 2.

1 Tools of the Trade

A large percentage of the tools that we are about to discuss have been covered in my previous two lock-picking books,[1] and over the years they have served me well. Some of these tools have had to be slightly modified here and there, so it is important that we review them now as they will be needed to open some of the high-security locks we will be covering.

But some of these locks will require new tools—most of which I have designed as I needed them. These tools can be easily made from readily available materials. In the same way, you should also explore different and better tools to open these locks, as many household items can be employed. But first, let's dispel some myths about what is considered the best lock-picking tool around.

PICK GUNS

Many readers write me asking about pick guns. I have used a few pick guns, and some work better than others. But overall, they have three inherent problems: they may require an AC power source or batteries, they are too big and bulky to carry on your person, and in just seconds they can add decades of wear to the springs, pins, or wafers of a lock.

The principle on which they work is an age-old trick in the locksmith trade of opening cylinder locks by "rapping." It is done by applying light tension-wrench pressure on the cylinder while smacking the shell with a soft-faced hammer or on the workbench. This causes an inertial force upon the lower pins to drive the upper pins high into their spring-loaded cavities. This impact allows the pins to clear the cylinder/shell shear line and the cylinder turns, unlocking the lock. This technique will not work on a door-mounted pin tumbler lock, so it was reasoned that by impacting the individual pins (or wafers) the same effect would occur.

This inspired the invention of the pick gun, which was patented by Eli Epstein in 1922 (Patent #1,403,753), but the original concept had been around for some time.[2] Since then, the pick gun has evolved from a simple spring-loaded impact tool to an electromechanical vibrator. Then came a system that uses a rotary hammer driven by a small electric motor. The latest device uses a rotary cam mechanism, also driven by a small electric motor. Though some modern manufacturers claim that their pick guns are "electronic," there actually are no electronic components in them; they are simply electric pick guns. It *is* possible to build an electronic-type pick gun by using a transistor flip-flop oscillator, driving an SCR[3] circuit to drive an electromechanical vibrator, but why go to all that trouble and expense when an electric motor will do the same job?

In any case, the pick gun's shaft impacts the pins with enough force to cause the lock to rub shavings from the pins, making it easier to pick by hand afterwards, hence decreasing the security of the cylinder and causing key-jamming problems later on. You can tell if a pick gun was used on your lock by all the brass-filing dust in and around the keyway. You might just as well drill the cylinder with slightly more effort because it is going to need to be replaced soon anyway. Most responsible locksmiths will not use a pick gun for that reason alone unless it is an emergency, in which case the lock should be replaced.

Another disadvantage to pick guns is that they seldom work on pin tumbler locks that are mounted upside down. Since about 40 percent of these locks are mounted upside down in America and nearly 80 percent are mounted this way overseas, a pick gun becomes that much more inconvenient to have around. (Locks mounted upside-down wear out faster because tiny brass filings and dirt can fall down past the driver pins and into the springs, causing tumblers to gum up. This is a common cause of lock-outs as the bottom pins fall down past shear line. Water vapor can also condense and drip down into the springs causing lock freeze-up in cold weather.)

Pick guns can be made from modified electric jigsaws, electric scissors, and even personal vibrators. ("Ah hum . . . excuse me, I do say my good man, what are you doing there, givin' the lock a jolly good time?") However, for more specific information about pick guns I recommend *Pick Guns* by John Minnery. It is very informative and interesting reading. He also invented, and includes with illustrations, an effective line of pick guns made from wire coat hangers.

So in conclusion on this subject, a pick gun of any sort (as of present-day technology) will not work on the newer high-security tumbler locks that are in extensive use

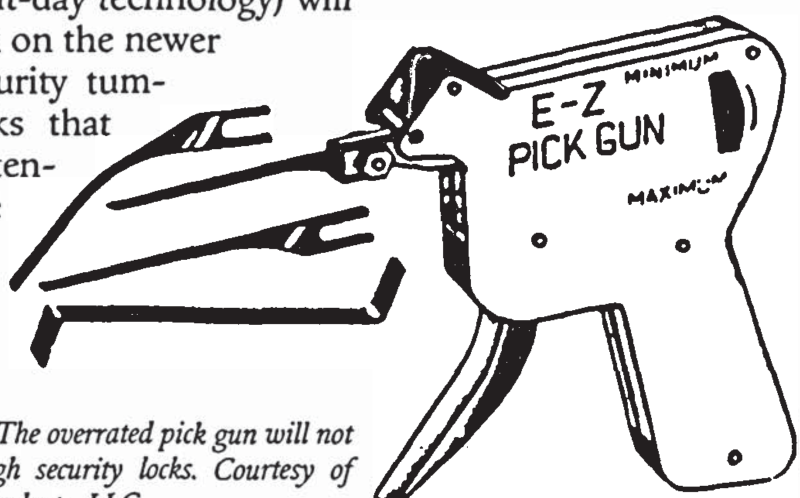


Figure 1A. The overrated pick gun will not work on high security locks. Courtesy of ESP Lock Products, LLC.

today. Only the original key or a highly skilled human hand can open them.

LOCK PICKS—THE ULTIMATE FINGER TOOLS

HPC in Chicago sells hardened steel picks stamped from stock at a pretty reasonable price. You can get them from Clark Security Products (Visit their Web site at <www.clark-security.com/sitemap.asp> for locations across the country.) Clark also carries pick guns. Please do not call them unless you are a bonded locksmith or with a law enforcement agency, as they will not send lock picks to just anybody. Some inquiries are also investigated, as I have discovered. Another good source is the ESP Lock Products Company. Write them at 375 Harvard Street, Leominster, MA 01453 for a free catalog. They make good quality picks as stamped-out ones go. They also will verify whether or not you are a bonded locksmith or cop before responding.

You can also get picks on the Internet: Try <www.lock-picks.com>. But you get what you pay for—stamped-out picks tend to break often, as they cannot be tempered like stainless steel. Also, they rust when carried on your person (from the natural moisture of the body) making a nasty reddish-brown stain in your wallet, pocket, or on the skin. So good

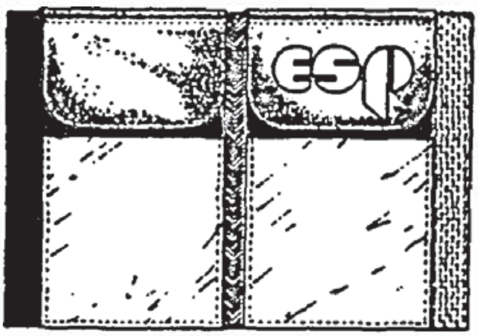


Figure 1B. Conventional lock pick sets are not adequate to handle the new high-security locking systems. Courtesy of ESP Lock Products, LLC.

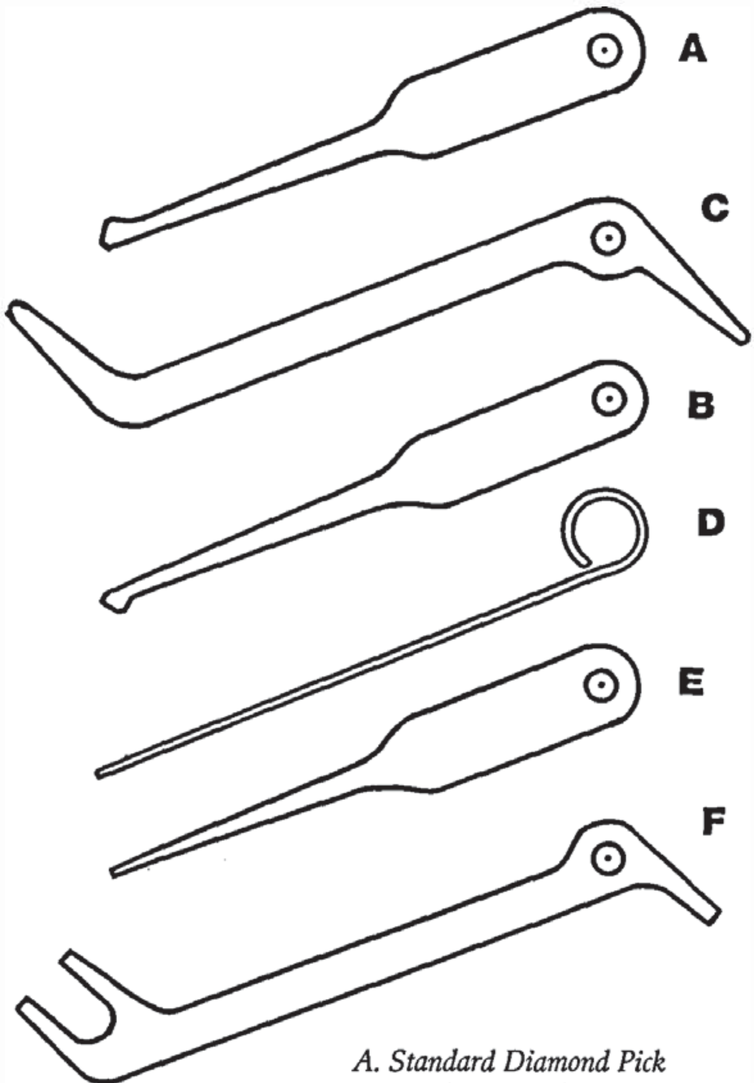
lock-pick tools are hard to find and wear out rapidly, break, rust, or are just not shaped for the newer high-security locks.

Personally, I prefer hand-ground, stainless-steel picks because though they may bend, they will not break under normal use and can be bent back into shape. Also, with this tapered shaft design, the likelihood of one bending is remote (lock picks are finger tools that require delicate manipulation for proper use and should never be used with excessive force). For comfort, I put cushioned, color-coded vinyl caps over the handle ends of picks when working with high-security locks, as these locks usually take time to pick open.

All the tools that I use here can be made at home and some are covered in my first two books. It is best that you make your own. If you have stainless-steel steak knives (flat, stainless butter knives will also work) and an inexpensive grinder with cut-off wheel, you can copy off the patterns. Cut them out (inside of the line) and lightly glue the patterns on the thoroughly cleaned knives, then spray paint two to three light coats (two minutes drying time between coats) with a high-temperature paint such as black woodstove paint. Let dry 20 minutes, then carefully peel off the paper patterns with a needle and bake the knives for one hour in a 275-degree oven. When cooled, you'll have a hard, durable pattern from which to cut and grind your own professional, lifetime picks. Follow the instructions in these books and remember to cut your patterns right on the inside of the line.

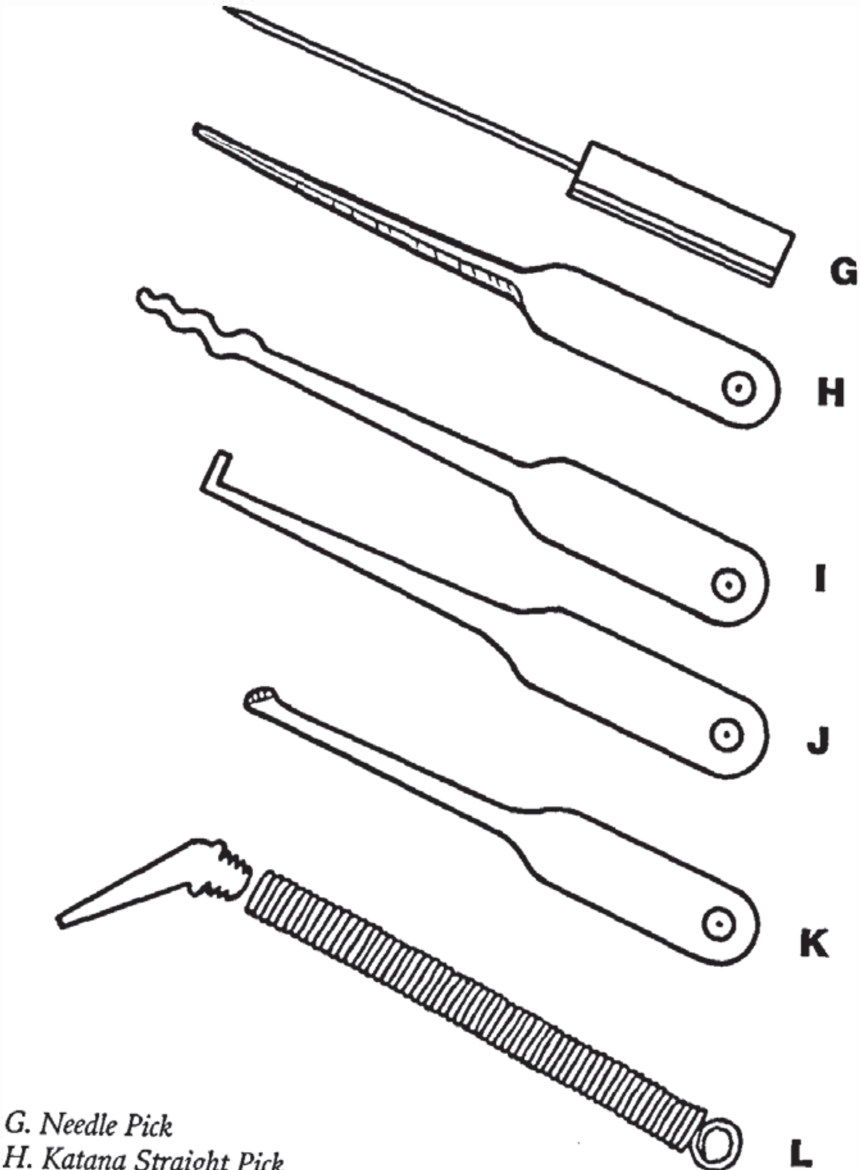
THE LATEST LOCK PICKS

I have had a chance to extensively test the tools that I showed you how to make in my previous books. I have made modifications on some and invented new ones for today's locks. (Also, all picks in the illustrations of this book are shown unburnished for detail. You *must* burnish your picks before using them or they will file shavings off the tumblers and keyway and hinder picking and the lock's performance.) But let's review some of the old reliable standards as well: If

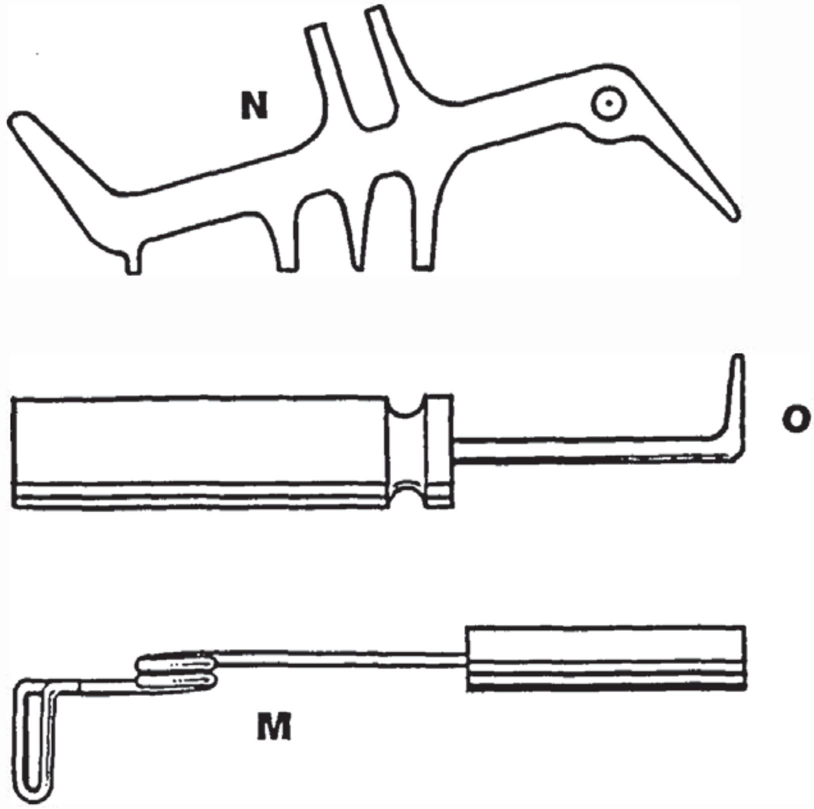


A. Standard Diamond Pick
B. Small Diamond Pick
C. Tiger Dual Tension Wrench
D. Piano Wire Pick
E. Rim Cylinder Pick
F. Road Runner Rim Tension Wrench

Figure 1C. On the next three pages are some state-of-the-art lock picks. Carefully note the inside lines as exact dimensions. We will refer back to these illustration often.



G. Needle Pick
H. Katana Straight Pick
I. Snake Rake Pick
J. Scorpion Hook Pick
K. Monkey Twisted-Wedge Diamond Pick
L. White Crane Feather Touch Tension Wrench



M. Looped Feather Touch Tension Wrench
N. Dragon Tension Wrench
O. TuBar Tension Wrench

you must carry lock picks, for practical reasons I recommend the CIA Special: the standard diamond pick ("A") and the Tiger dual tension wrench ("C"). These two tools are all I ever carry: They will get you into 70 percent of the keyhole locks used today. The standard diamond pick ("A") will work on virtually any pin or wafer tumbler lock. I have even used it to open a suitcase lever lock. In addition, the small diamond pick ("B") is used for small pin tumbler padlocks and some tight keyways—but should never be used on standard pin tumbler locks with stiff cylinders.

The Tiger dual tension wrench ("C") features a narrow tongue for all pin tumbler house and padlocks. It can center-fix on double wafer lock cylinders giving it a greater range of use. Because of its width, it can also wedge into the groove of most rim cylinder locks. The wide tongue is used for automotive and large tumbler locks. If you are a locksmith, you will appreciate the value and convenience of this set. Remember, all tools are shown exact size inside of the lines. Always wear safety glasses when making tools!

CIA SPECIAL

A. **Standard Diamond Pick:** This tool has been around for almost a century and is used on the popular pin tumbler lock to gently pry up the pins to their breaking point so that the cylinder may turn. Our modern version is simple; the unique design lends to easy movement within the lock while sporting a small, raised, flat surface to contact the individual pins. This tool is the primary pick for nearly all standard pin tumbler house locks. It can also be used on double wafer tumbler locks, but the pick must be withdrawn and reversed to work both sets of tumblers (see *Secrets of Lock Picking*). It is a direct pattern of the one that I carried and used for 17 years, which doesn't show a bit of wear and is as straight as the day I ground it.

B. **Small Diamond Pick:** A scaled-down version of the above for small pin tumbler locks such as padlocks (Master); file cabinets (Chicago, Curtis); gaming machines (Fort, Hudson); discus mushroom pin tumbler padlocks (Abus); and even wafer desk drawer locks (Eagle, Welch); and various other applications where good security is required within a small space.

C. **Tiger Dual Tension Wrench:** A good all-around wrench (American, all automotive, Chicago, Corbin, Illinois, Master, Quikset, Russwin, Schlage, Weiser, Yale, etc.—some high-security locks as well). This tool is also patterned from the one I carried for 17 years. But before I could copy it, I had to straighten the wide blade. I was amazed by how readily it straightened. It took some careful force in a small vise, but it came out strong and flat;

this stuff is tough. See above for earlier comments on this tool. Use .040" thick stock.

SERVICEMAN'S TOOL BOX

D. **Piano Wire Pick:** .030" to .035" diameter stainless steel wire (see conversion chart at end of chapter) with flat, very lightly burnished end for picking radial pin (rim cylinder) locks.
E. **Rim Cylinder Pick:** Used to depress the pins on radial pin tumbler locks (Ace, Gem, etc.) such as on vending and arcade machines. Its square-faced tip seats firmly on the surface of older pins. Even at an angle, however, this tends to leave scratch marks on the pins, so use this tool as squarely as possible.
F. **Road Runner Rim Tension Wrench** (with Double Wafer Wrench on the other end): The single prong is cut to fit nicely into most rim cylinder locks (Ace, Gem). The double end is used to get a grip on double wafer tumbler locks (Schlage, Chicago). This tool should be .043" to .045" thick. Burnish the prongs only slightly so that they grip the cylinder better.
G. **Needle Pick:** Detailed in Chapter 4.
H. **Katana Straight Pick:** This pick is used on multiple-row pin tumbler locks and made so that one-half of the tool is patterned on a steak-knife blade with the knife's edge running along the bottom edge of the pick. Or, you can lay it out and make the tool on flat stock of .030" to .035" thick stainless and grind an edge along its length. Note the slight upward curve of the blade. Be sure to burnish off any and all sharp edges on the tool and round off the tip. It should slip smoothly and comfortably through your fingers when you are finished making it. The tool must be able to slip in and out of a cylinder without snagging and with little effort.
I. **Snake Rake Pick:** Our special design was inspired by the dampened sine-wave form of matter-in-motion and glides across pin tumblers, causing them to virtually oscillate

into position with the right tension wrench pressure. For medium security house locks (Ilco, Quikset) and cylinders with larger keyways. Also used for the ultra-high security ASSA Desmo lock.

J. **Scorpion Hook Pick:** For probing larger pin tumbler locks used in old United States jails and prisons. Also, lever and warded locks. Here used as a tension wrench for the high security radial pin Van lock.

SPECIALTY PICKS

K. **Monkey Twisted-Wedge Diamond Pick:** A standard diamond pick with a new twist—the tip, that is. Its angle of approach is precision ground to cause pins to rotate. For high-security locks (such as those from Medeco) whose chiseled-tipped pins not only have to rise to break with the cylinder, but have to turn as well. It has been improved by grinding the leading edge of the tool at a 30-degree angle, then burnished to prevent pin scraping, facilitating a smoother rotating action on the pins as they are picked. (So-named because monkeys are the only animals that can manipulate objects within a tight, confined opening.)

L. **White Crane Feather Touch Tension Wrench:** "The yielding hand often opens the way." We find this to be true. Some cylinders (American, Corbin, Russwin, Sargent, and Yale) sport mushroom or spool-shaped pins that "break" too soon when being picked. This wrench allows you to apply only a light, constant pressure upon the cylinder so that these pins can be jostled into place to open the lock. You can pop spool and mushroom pin tumbler locks with ease using this tool as it drives the cylinder without jamming the pins while picking. Our design is made with a stainless steel point, anchored into a special stainless steel spring with the perfect force-to-distance tension ratio required to pop high-security locks made by Medeco and ASSA.

Cut insert (tip) from .035" stainless steel stock leaving threads for last. Mount tip securely in vise and carefully file the threads with a small triangular V-notching file. Note that threads are staggered between each side. (Do not de-burr threads.) Then screw the special spring onto the insert up to the stop collar. Once on, the spring cannot be removed unless you cut it, so be sure that the end of the spring is burnished and de-burred first to prevent snagging on clothing and self. Spring dynamics for the White Crane are as follows:

Type: Extension spring
Outside Diameter: 0.024"
Wire Diameter: .031"
Free length: 2.50"
Load @ 1.00": 5.30 pounds
Spring rate: 2.2

You can order your White Crane stainless steel spring(s) from one of the following companies:

- Associated Spring Raymond, 1705 Indian Wood Circle, Suite 210, Maumee, OH 43537, <www.asraymond.com>. (Part #EO240-031-2500S)
- Century Spring Corporation, P.O. Box 15287, Los Angeles, CA 90015, <www.centuryspring.com>. (Part #80310-S)

You may experiment with spring rates between 1.2 and 3.9, but I found 2.2 to be the best for me as I have large hands and tend to use too much pressure on side-bar locks. If you have smaller hands, try a slightly higher spring rate.

Both companies require a $25 minimum order, so you might first want to order their free catalog and choose from a variety of similar springs.

M. Looped Feather Touch Tension Wrench: This has been a standard high-security tool in the industry since the

1950s. Even today I find this tool very effective, though a little too difficult to carry on person as it is a three-dimensional device. The Crane is also three-dimensional, but in a comfortable, round sort of way; it is easy to carry close to the person. The looped wrench must not be crushed or otherwise bent by accident, as that would render it quite ineffective. Still, to this day, this tool is in my arsenal of high-security lock picks. It has proven itself time and again.

Mine is made of stainless steel piano wire with a diameter of .031″ and bent tightly into two full loops around a .250″ diameter steel rod held in a vise. The end loop that goes into the keyway is .500″ long with a .125″-wide tongue. You may wrap the end of the tongue wire back around the shaft and clip it off short. Burnish this end until there's no threat of snagging on fingers or clothing. My original looped Feather Touch was carefully brazed between the loop and shaft as is illustrated. However, since brazing can detemper stainless (and most other metals), it is best to wrap the end of the wire around the shaft. The handle end, you may finish as you wish. I flattened that end with hammer and anvil to keep it from spinning within its handle, then heated that end with a cigarette lighter and forced it into a round plastic rod about .250″ in diameter as a handle. Center-mark the plastic rod for a guide to wire placement. This will give you a well-centered handle for this tool. Remember to wear safety glasses when making this or any other tool.

N. **Dragon Tension Wrench:** I mention this tool again because it is so versatile. This design is improved with a Van Lock tension wrench tab for the Dragon's very hind leg. This tool though, will work on virtually any cylinder lock: The Dragon's "head" and "tail" are basically the Tiger dual tension wrench ("C") shown on p. 18. But this tool also has three built-in spanner wrenches that grip the cylinders of the three major radial pin lock types: Ace, Gem, Chicago, and all other large radial pin locks used on the older vending machines. The Dragon's snout can also hold the rim cylinders of various other brands. The "wings" are a fourth spanner set used to turn double wafer cylinders.

O. TuBar Tension Wrench: Detailed in Chapter 3.

AUXILIARY EQUIPMENT

Magnifier: When making tools (or inspecting locks) I use a headband Opti-Visor (Model DA-3 or newer) and an Optical Glass Binocular Magnifier so as to see the lines very clearly. It makes a world of difference when doing precise work. They fit comfortably over glasses, too. I find the best lens for me is the #3, as the focal length comes out to 14 inches. I often wear them when picking a new and difficult lock. Don't wear them while cutting a tool though, as one needs wider depth perception to work safely with power tools. Contact Donegan Optical Company by mail at P.O. Box 14308, Lenexa, KS 66285-4308 or visit their Web site at <www.doneganoptical.com> for pricing or free catalog.

Penlight: A good penlight is also very important. For just a few dollars, Radio Shack sells a very convenient penlight that uses a fiber-optic rod for looking into tight places.

The best affordable penlight system for looking into keyholes is the Nite Ize fiber-optic adapter. It fits over the end of the 7" and 20" (AA size) Mini-Maglite. A smaller version is available for the 4.5" and 20" (AAA size) Mini-Maglites. Each unit is less than $6 and available at your local Wal-Mart. Or, you may visit their Web site at <www.niteize.com> for a catalog.

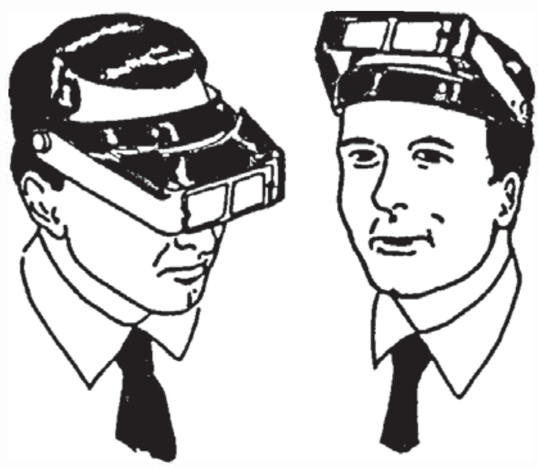


Figure 1D. The Opti-Visor helps the locksmith work with fine parts and to make specialized lock picks.

Fraction	Decimals	Millimeters	Fraction	Decimals	Millimeters
1/64	0.015625	0.397	33/64	0.515625	13.097
1/32	.03125	0.794	17/32	.53125	13.494
3/64	.046875	1.191	35/64	.546875	13.891
1/16	.0625	1.588	9/16	.5625	14.288
5/64	.078125	1.984	37/64	.578125	14.684
3/32	.09375	2.381	19/32	.59375	15.081
7/64	.109375	2.778	39/64	.609375	15.478
1/8	.1250	3.175	5/8	.6250	15.875
9/64	.140625	3.572	41/64	.640625	16.272
5/32	.15625	3.969	21/32	.65625	16.669
11/64	.171875	4.366	43/64	.671875	17.066
3/16	.1875	4.763	11/16	.6875	17.463
13/64	.203125	5.159	45/64	.703125	17.859
7/32	.21875	5.556	23/32	.71875	18.256
15/64	.234375	5.953	47/64	.734375	18.653
1/4	.2500	6.350	3/4	.7500	19.050
17/64	.265625	6.747	49/64	.765625	19.447
9/32	.28125	7.144	25/32	.78125	19.844
19/64	.296875	7.541	51/64	.796875	20.241
5/16	.3125	7.938	13/16	.8125	20.638
21/64	.328125	8.334	53/64	.828125	21.034
11/32	.34375	8.731	27/32	.84375	21.431
23/64	.359375	9.128	55/64	.859375	21.828
3/8	.3750	9.525	7/8	.8750	22.225
25/64	.390625	9.922	57/64	.890625	22.622
13/32	.40625	10.319	29/32	.90625	23.019
27/64	.421875	10.716	59/64	.921875	23.416
7/16	.4375	11.113	15/16	.9375	23.813
29/64	.453125	11.509	61/64	.953125	24.209
15/32	.46875	11.906	31/32	.96875	24.606
31/64	.484375	12.303	63/64	.984375	25.003
1/2	.5000	12.700	1	1.000	25.400

1 mm = .03937"   .001" = .0254 mm

MM	Inches	MM	Inches
.1	.0039	46	1.8110
.2	.0079	47	1.8504
.3	.0118	48	1.8898
.4	.0157	49	1.9291
.5	.0197	50	1.9685
.6	.0236	51	2.0079
.7	.0276	52	2.0472
.8	.0315	53	2.0866
.9	.0354	54	2.1260
1	.0394	55	2.1654
2	.0787	56	2.2047
3	.1181	57	2.2441
4	.1575	58	2.2835
5	.1969	59	2.3228
6	.2362	60	2.3622
7	.2756	61	2.4016
8	.3150	62	2.4409
9	.3543	63	2.4803
10	.3937	64	2.5197
11	.4331	65	2.5591
12	.4724	66	2.5984
13	.5118	67	2.6378
14	.5512	68	2.6772
15	.5906	69	2.7165
16	.6299	70	2.7559
17	.6693	71	2.7953
18	.7087	72	2.8346
19	.7480	73	2.8740
20	.7874	74	2.9134
21	.8268	75	2.9528
22	.8661	76	2.9921
23	.9055	77	3.0315
24	.9449	78	3.0709
25	.9843	79	3.1102
26	1.0236	80	3.1496
27	1.0630	81	3.1890
28	1.1024	82	3.2283
29	1.1417	83	3.2677
30	1.1811	84	3.3071
31	1.2205	85	3.3465
32	1.2598	86	3.3858
33	1.2992	87	3.4252
34	1.3386	88	3.4646
35	1.3780	89	3.5039
36	1.4173	90	3.5433
37	1.4567	91	3.5827
38	1.4961	92	3.6220
39	1.5354	93	3.6614
40	1.5748	94	3.7008
41	1.6142	95	3.7402
42	1.6535	96	3.7795
43	1.6929	97	3.8189
44	1.7323	98	3.8583
45	1.7717	99	3.8976
		100	3.9370

Figure 1E. Fraction to decimal conversion chart.

1. *Secrets of Lock Picking* and *Advanced Lock Picking Secrets*, both published by Paladin Press.
2. *Pick Guns*, John Minnery, Paladin Press.
3. Invented in 1957 at General Electric to control 30+ amperes of current, an SCR is a "silicon controlled rectifier" or, simply put, a solid-state (having no moving parts) power switch where a small electrical current can control a much larger current in either an "on" or "off" mode for inductive loads such as motors and relays. Some SCRs are brutes and can switch thousands of amps. (By comparison, a 100-watt light bulb draws just under 1 amp.) But for here, much smaller versions of this device are available.

2 Spooled/Mushroom Pin Tumbler Locks

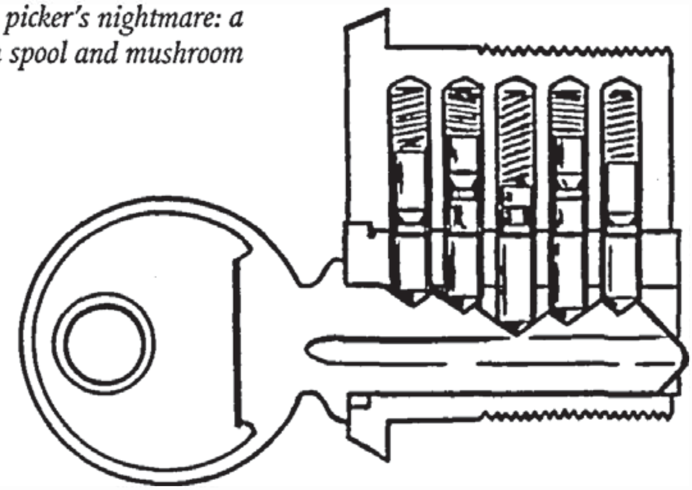
This chapter is a short review of the pin tumbler lock. The "high security" aspect of this chapter involves the pins that can make this lock a formidable challenge to even the most experienced lock picker.

Spool and mushroom driver pin tumblers have been around for a long time and have proven to be the best security features that a pin tumbler lock can possess. Invented by the Yale Lock Company, these pins can make picking pin tumbler locks a tiresome experience.

SPOOL PINS

Spool pins were the first to be utilized in pin tumbler cylinders and they are simple in design. When a pin is being picked (or raised by an improper key), the cylinder is forced by the tension wrench to align in the gap of the spool with the leading inner edge of the lock's shell, jamming any further attempts to turn the cylinder. Corbin and Russwin relied heavily on these pins for their security from the 1930s

Figure 2A. A lock picker's nightmare: a Yale lock with both spool and mushroom driver pins.



through '60s. These locks were used extensively on bank doors and other high-risk areas where sums of money or valuables were at stake. With the invention of the Feather Touch tension wrench in the 1940s, which required more skill to use, the mighty spool pin was brought down to being only a minor nuisance to the professional lock picker.

MUSHROOM PINS

These pins were designed and employed to foil pick gun attacks and manual picking in particular. Because of their

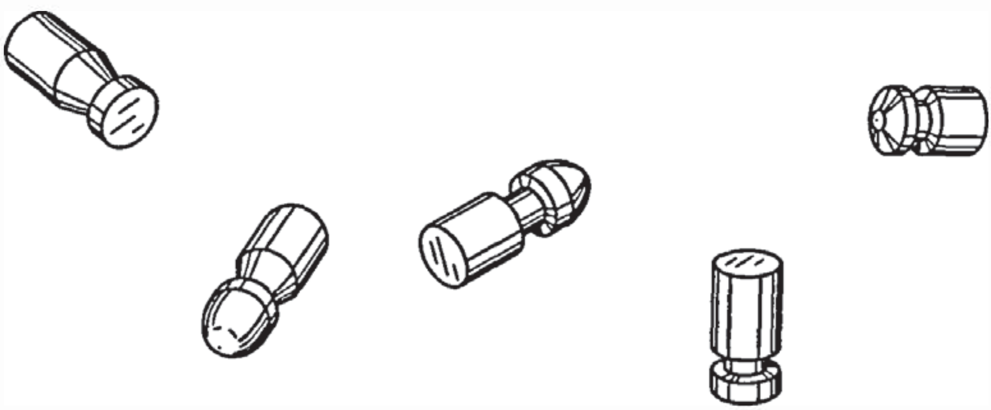


Figure 2B. High security top driver pins through the years (from left to right): The ever popular Yale mushroom pin; an early Sargent mushroom pin; an early Russwin mushroom pin; a modern, single-grooved spool pin; and the latest—an ASSA V-10 mushroom pin.

shape, mushroom pins are a devious ploy against the determined thief. This is why: As the bottom pins are raised, the force from the tension wrench causes the cylinder to turn at the first sign of relief against the raised, mushroom pin. There is no clear-cut distinction of a breaking point, as with spool pins. Rather, when the cylinder starts to give way to the wrench, one feels that he has actually picked the lock—until the cylinder stops dead about 15 to 20 degrees later. To the inexperienced lock picker this can be a very frustrating experience. But in fact, these pins cannot be picked one at a time as with a standard pin tumbler lock. In most cases, the sloppier the picking process (with a light, steady wrench torque), the better chance one has of popping a mushroom-pin lock.

Pick guns seldom work with mushroom driver pins as these pins must be free to rise under the gun's vibratory forces—which cannot happen even with the slightest of tension wrench torque.

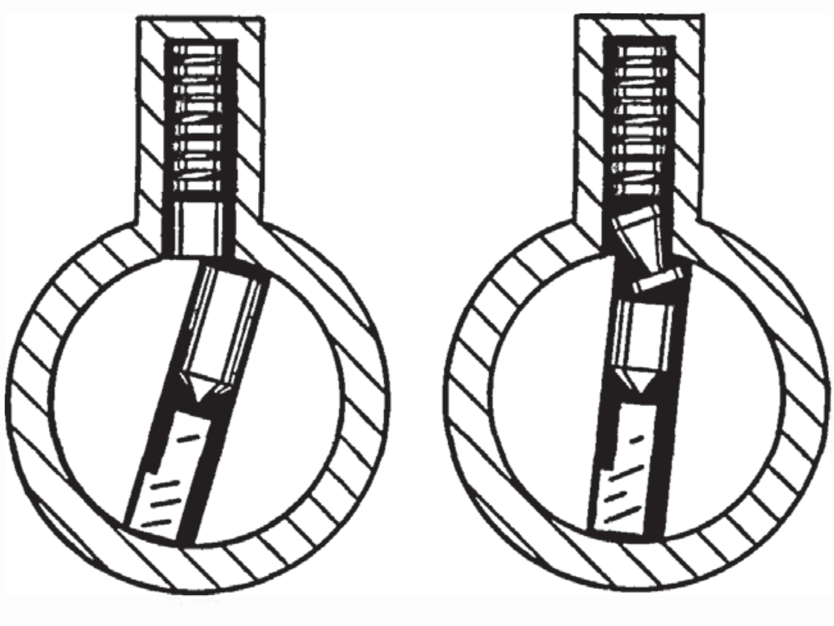


Figure 2C. Standard pin tumbler cylinder (left) and mushroom pin tumbler cylinder.

THE ABUS DISKUS PADLOCK

Because of its small keyway and tough nature, the ABUS Diskus padlock is generally considered a high-security lock. American-made Yale mushroom pins are the highlight of this German-made marvel, which has been distributed worldwide for more than 40 years and in the United States for at least 25 years.[1] I mentioned this lock briefly in *Advanced Lock Picking Secrets,* however, this German bomb has since evolved into one of the most pick-resistant padlocks on the market. (I must have pissed them off.)

Figure 2D. The ABUS Diskus Padlock shown closed and open.

This "Urban Tough" breed of lock has a stainless steel body and shackle. Note the upside-down keyway. Most European pin tumbler locks have their cylinders mounted upside down—I am not sure why (other than to foil pick-gun attacks). But this seems to me that it would cause more problems than not. However, with the ABUS padlock, this works to its advantage. Because of its enclosed shackle, you can't swing the lock around to pick it properly like most other padlocks. So you are forced to pick it upside down. The enclosed shackle rotates within the Diskus body when the lock is unlocked, so there is no shackle spring. This, however, is to the lock picker's advantage; less force is needed to pop the cylinder once you do get the mushroom pins in proper place.

But that is a minor advantage. The tight, corrugated keyway alone totally eliminates attacks by pick guns and all but the thinnest of diamond picks. A thin, small diamond pick is the only hope one has of opening the lock.

This lock now carries five pins (all mushroom-top pins) and a tighter keyway than 20 years ago. My standard diamond pick ("A") was too large to get into the tight keyway so I had to go to the smaller diamond pick ("B"). The Tiger wrench ("C") must mount further out on its narrow point to grip the cylinder. This told me right away that I was in trouble. I finally went to the White Crane Feather Touch wrench and settled down for a long haul. After 25 minutes of fiddling around, I managed to get my sample lock open. Most of my time was spent trying to get into a comfortable position to pick it.

ABUS makes a variety of other pin tumbler padlocks. The steel laminated 41 and 45 Series uses four mushroom pins; the brass 55 and 55M Series uses four standard pins; the brass 65 Series uses five mushroom pins; the 36 and 37 Series "Granit" uses "pick-proof" seven-disc tumblers. The 88 Series ABUS also use seven-disc tumblers using the same spacing as the Abloy disc tumbler lock. It is very similar to the Abloy in many other ways as well. We will discuss keyed disc tumbler locks in Chapter 9.

The ABUS "Convertible" 83/45 Z-bar (a retaining piece at the rear of the cylinder) will hold an IC (interchangeable core) that can be keyed to your house, so don't be surprised if you encounter an Arrow, Corbin, Kwikset, Russwin, Sargent, Schlage, Weiser-Falcon, or Yale keyway and pins inside this brass padlock.

Pick resistance: The ABUS Diskus padlock is the only lock we are concerned with here. For the money, it is one of the best padlocks on the market and I rate this pain-in-the-wazoo a **7.5**.

1. An American version of this lock is made by Federal Lock.

3 Radial Pin Tumbler Locks

The radial pin tumbler lock was covered in my first two books, previously referred to by the more common name of "tubular rim cylinder" or "tuberim" locks. However, with further experience on my part and new advances in this style of lock, I thought this would be a good opportunity to expand on these high-security locks. Let's review this venerable modified pin tumbler mechanism.

INTERNAL PLUG

The standard of the vending-machine era for the last 30+ years, these familiar seven-pin tube-key locks have been subject to assault from drills, hole saws, hammers, punches, and even sophisticated picking techniques.[1] However, it is still one of the best security devices available for its price.

THE GEMATIC RADIAL PIN TUMBLER

One of the latest versions of radial pin tumbler locks uses master keyed pin tumblers. This allows the person with the master control key to exclude a particular key (for example, to guard against the use of a key that's been lost or stolen). Fort Lock's Gematic has eight pins, but one master control key can set the cylinder so that it will only accept one out of eight different keys. This allows a supervisor to set up the lock so that one select employee can open it (boggles the brain). The customer can also change the key code up to eight times. Since there are extra dividing cuts on the pins, it makes picking these locks easier than the standard radial pin tumbler. Priced at around $13 each and $2 per key, this lock is rated at 7.0.

Though radial pin tumbler locks can be picked with skill and patience—qualities most burglars lack—they still require too much time, as every 45-degree turn of the cylinder means that the lock must be picked again. Some of the older vending machines use a T-handle, which takes several 360-degree turns to unscrew and release the vending machine's door. That's about 42 pickings of a seven-pin tumbler lock—with a spanner tension wrench that tends to fly off the plug (cylinder). We're talking major stress here. The new T-handles pop out once the lock is unlocked, and turn right just 180 degrees. But the locks tend to have higher security cylinders such as KABA, Medecos, or Abloy. We'll discuss these locks later in the book.

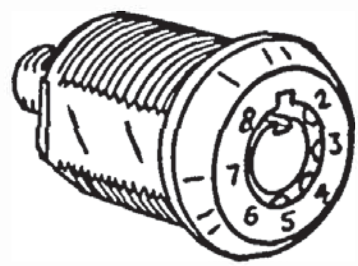


Figure 3A. Fort Lock's Gematic has up to eight key-code changes. Master keying the radial pin tumbler means more cuts in the pins, which increases the chances of picking the lock open.

Again, as explained in my previous work, a tension wrench must be affixed to the cylinder plug (the most difficult task in picking this lock, aside from the time involved) and secured so as to affect a slight torque upon it. Then, each pin must be

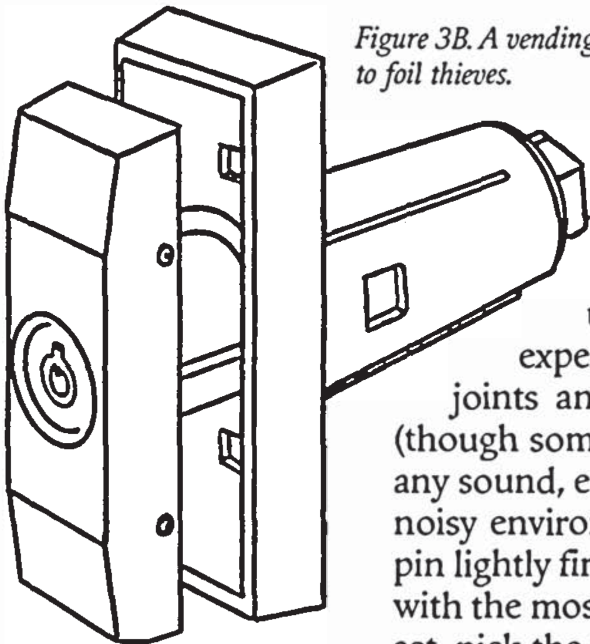


Figure 3B. A vending machine T-handle is designed to foil thieves.

depressed in turn until a subtle click is experienced in the finger joints and heard with the ear (though sometimes there is little if any sound, especially in a windy or noisy environment). Depress each pin lightly first, looking for the one with the most resistance. Once it is set, pick the next tight one, careful not to depress the pin too far past its shear line. In this way, the lock's machine tolerance, or "slop," can be taken advantage of.

In the newer T-handles, these cylinders need only to turn 90 to 120 degrees, which means that you must still pick them at least two or three times. This problem can be overcome with various locksmiths' rim cylinder pick tools (one of which I designed myself). But I cannot discuss these here as little skill is involved and such tools in the hands of an unscrupulous few would create much grief and condemn the radial pin tumbler lock into extinction.

The tension wrench direction depends on the set-up. There is a slot between the plug and shell that allows the key to be inserted into the lock. (See switch lock configuration chart on p. 38.)

Now, 90 to 120 degrees (usually to the right) there is another slot, but it is only in the outer shell. This is where the key is removed from the lock once it is turned to the unlocked position. Generally, if an exit slot is to the right, pick right. If left, go left. Typically, all Chicago Lock Company's Ace, Ace 2, and Ace Change-Matics radial pin tumbler locks

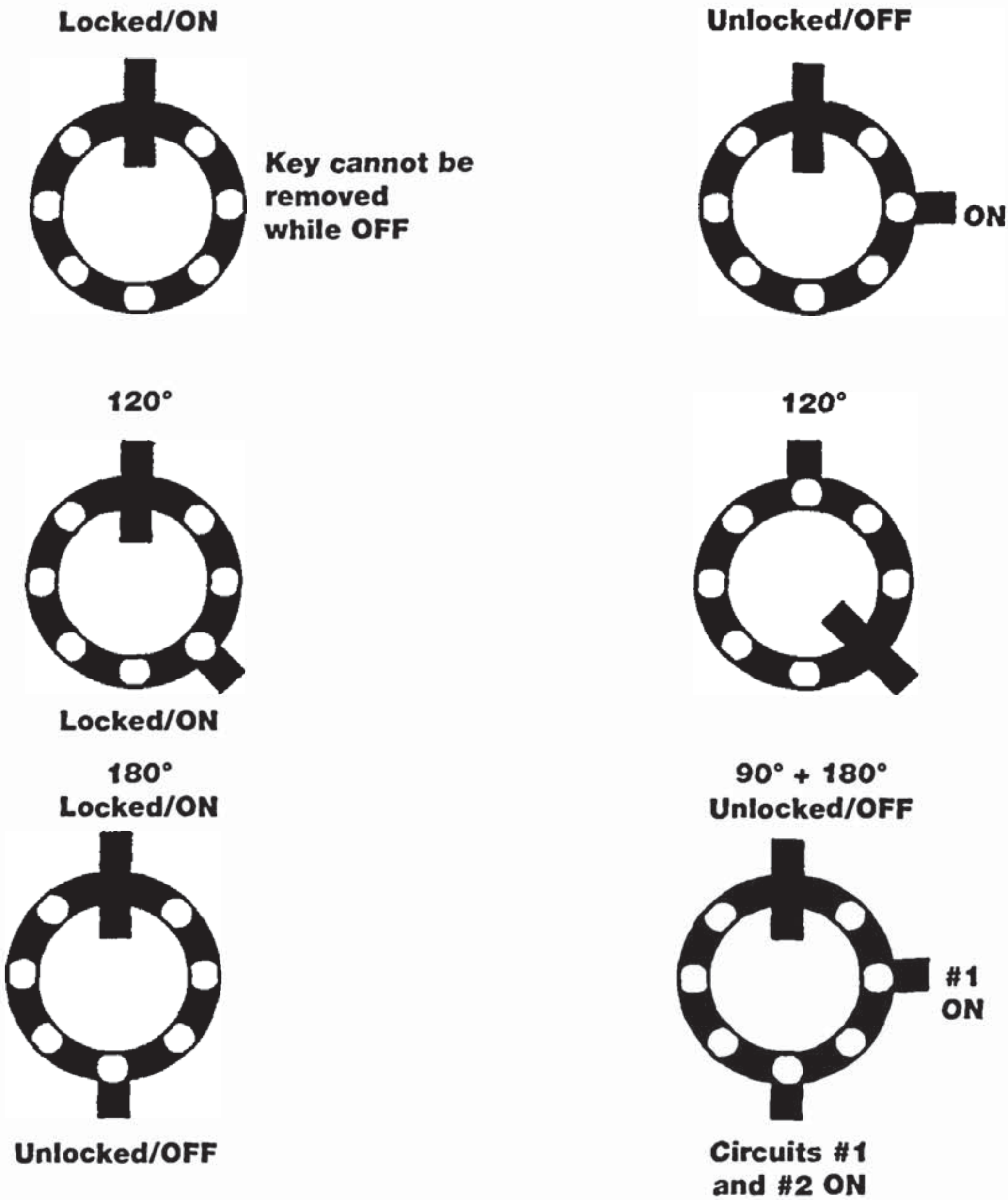


Figure 3C. The most common configurations of radial pin tumbler switch-locks.

unlock to the right, or clockwise. The Fort Lock Company's Gem, Gematic, and Apex also follow this rule. Some cheap foreign locks may not, but in every other way, those locks pick the same.

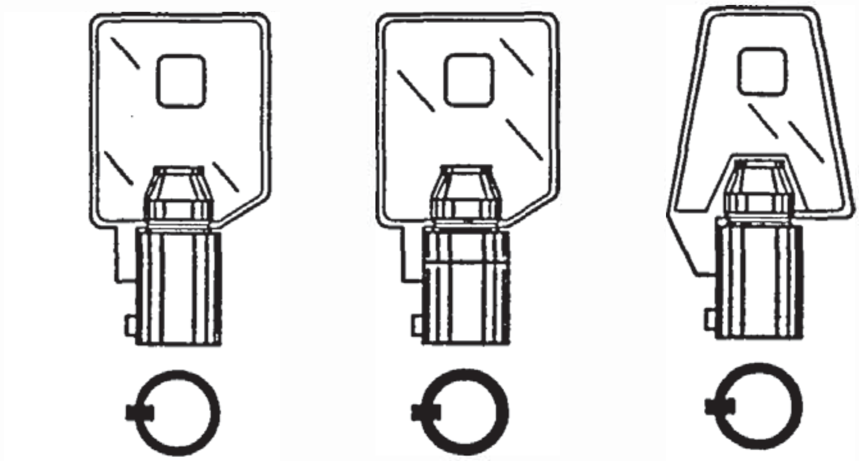


Figure 3D. Barrel or "tube" key blanks: Despite efforts to secure the keyway, they all have the same O.D. (outer diameter) plug dimension, making a standard tension wrench possible.

Pick resistance: Even though each pin is exposed to the lock picker and the cylinder is relatively easy to grab hold of, because of the time involved I rate these types of radial pin tumbler locks at 7.5. These locks typically run around $9.

But, if that's not enough, other companies have developed a higher degree of quality with lower machine tolerances—tighter locks—and so a different approach to the same principle.

INTERNAL PLUG—TUBE PIN

All radial pin tumbler locks can be used for alarm switches. But this next lock—the radial tube pin tumbler—brought lock picking to a higher level of tedium and is often used to thwart the turning off of burglar alarm systems by the intruder.

The first time I encountered this piece of work made by the Chicago Lock Co., I was very impressed—I still am. However, since there is more stuff in there, there's a little more room to get a pick onto both the seven pins and the four individual tubes. With 11 total pins, that's a whole lot of

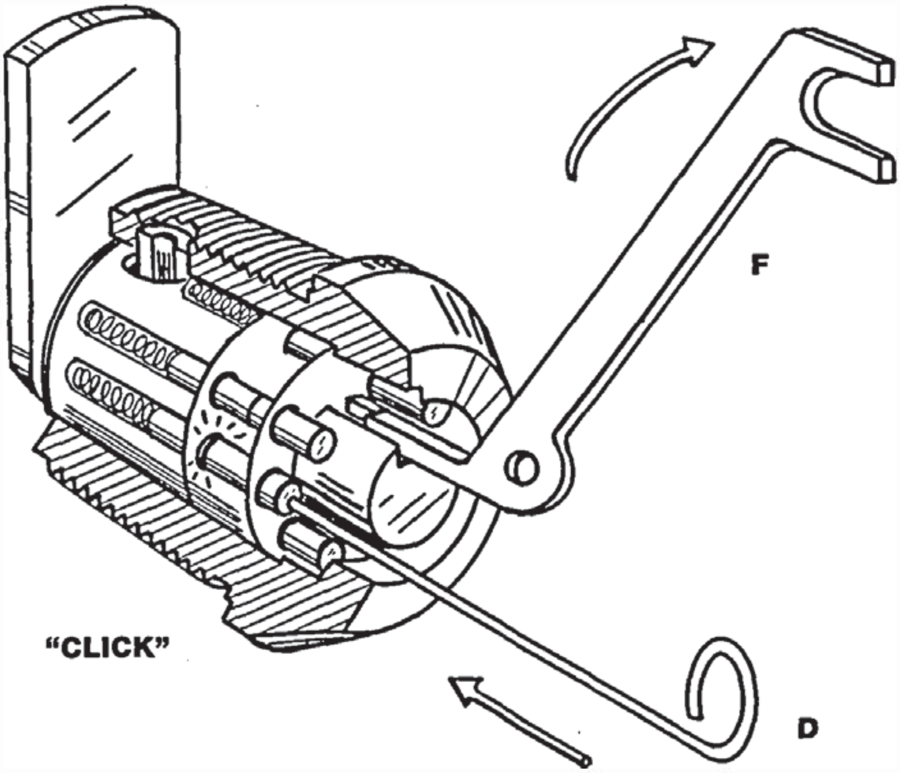
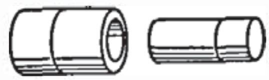


Figure 3E. The Roadrunner ("F") and the piano wire pick are shown opening a radial pin tumbler lock. First pick the pin that binds the most, then pick subsequent pins.

picking. Still, you have to pick the lock three or four times to shut off the switch at the back of the lock.

I must make a correction here: on page 15 of *Advanced Lock Picking Secrets* I stated that all the round (solid) pins had to be picked first. Somehow I got that backwards while writing it. The tube pins must be picked first, before any round pins can be set to their shear line as they are, obviously, the first pins to encounter the shear line of the cylinder and shell.

Pick resistance: These cylinders are just a little more hassle to open so I rated them, in general, at 8. This lock is no longer in production and has been replaced by the Chicago TuBar mentioned at the end of this chapter.



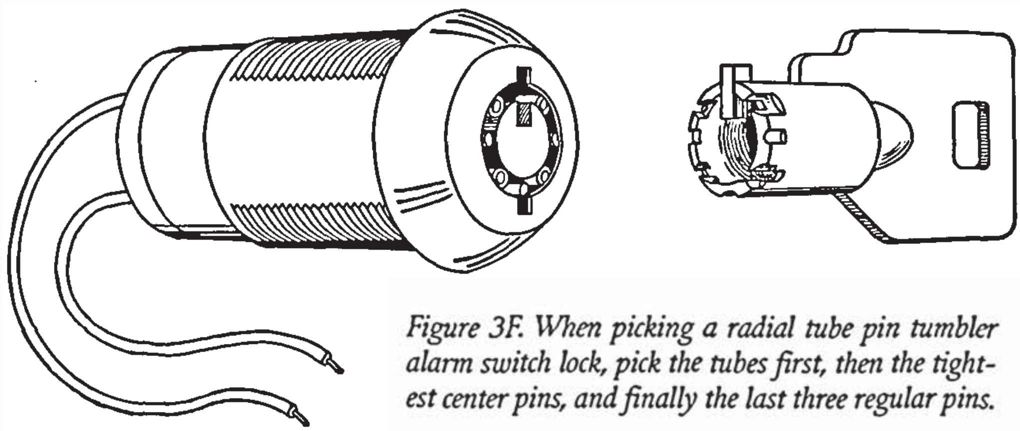


Figure 3F. When picking a radial tube pin tumbler alarm switch lock, pick the tubes first, then the tightest center pins, and finally the last three regular pins.

EXTERNAL PLUG

The Van Lock Company has a unique approach to modern security with its custom, handmade radial pin tumbler locks. They have stainless steel pins in flush-mounted faces designed to resist pipe wrenching, punching, and pulling from unguarded vending machines. These radial locks have their cylinder (plug) on the outside rim of the lock, as opposed to the inside like the older Gem, Ace, and other styles shown above. The manufacturer claims that they cannot be picked because ". . . pick tools cannot get to the pins." I find these locks are still vulnerable to the pick, maybe even more so than the standard radial pin lock. Let's see why:

First off, I call this an external plug radial pin tumbler not because the plug is exposed to the outside rim of the lock, but because the pins are inside the plug. The brass cylinder face rotates with the flush stainless steel pins. The plug itself is enclosed around its circumference by the edge of the shell. This edge is also machined to accept the key rim as if it were the single thread of a fruit jar. Once the key is engaged to the lock and turned a bit, it cannot be removed, even after unlocking the lock 120 degrees later. To do so without this

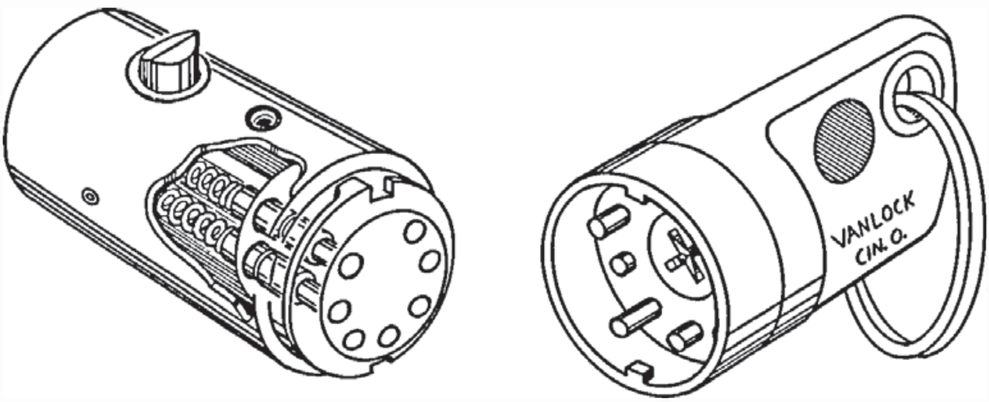


Figure 3G. The punch, pull, and drill resistant Van lock with its key: surrounding the pins with the plug. Special tools ("E" and "J") are needed to pick this high-security lock.

engagement would set the surface pins to the wrong back pins, meaning that the key would have to be re-engaged at that very position to continue to unlock the lock. (In fact, this principle is exploited by Fort Lock's Gematic re-keyable rim cylinder lock mentioned at the beginning of this chapter.)

The 120 degrees, by the way, means that the surface pins must cross the spring-loaded drivers beneath them three times, which means the lock would have to be picked three times to bring down the spring-loaded catch (called the "locking dog") sticking up at the back of the cylinder. This cylinder is interchangeable and fits within the T-handle. The T-handle could then be turned to open the door of the vending machine.

Though machined to very tight tolerances, these locks work under the same principle as all other tube key locks: five to nine (seven in this case) pins must be individually depressed until a click is heard and/or felt before the cylinder can be turned to unlock the lock. But in this case, the spanner tension wrench can go on the outside of the lock face instead of the inside. This brings the pins right out front making them easier to get to. In a way, the Van lock is almost easier to pick because of that feature alone. And because the wrench is not on the inside of the cylinder restricting the motion of the pick, it's a cakewalk: there is no inside edge of

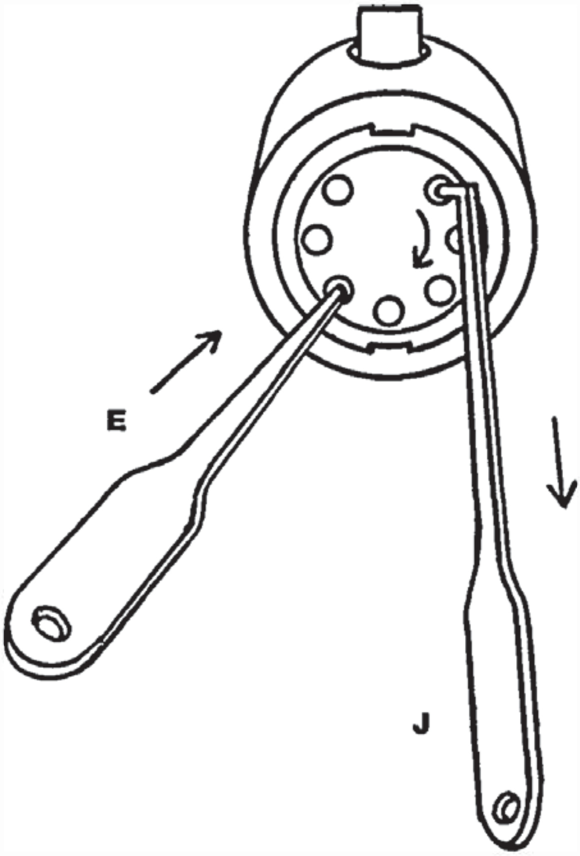


Figure 3H. Picking the Van lock: Pull or push down on the cylinder in a pinhole that breaks deep for rotary force while picking the rest of the pins.

the outer shell to scrape and drag against the wrench. It is easy to get a grip on this cylinder; apparently this was overlooked by Van.

Here's how it's done: First, you cannot really use a regular tubular rim spanner wrench; it just won't work because there is not enough room between the tight plug and shell. Instead, we use an L-shaped tension wrench ("J") designed for this job. (See exact-size template.) The L-wrench is also a right-angled straight pick used to depress one of the pins, after which it remains in that pin hole to hold the plug. Find the pin that breaks deep enough so that you can also use the L-wrench to *pull* down on the plug (you may use your left hand to gently *push* the plug in a downward motion). This means that you would be better off looking for that pin in either the 1, 3, or 5 o'clock position. While gently pulling down (clockwise) with your L-wrench, depress the other pins with a standard rim pick in your left hand as if you were picking an Ace or Gem radial pin tumbler. Search for the pin with the most resistance and depress it to breaking the shear line of the plug. Find the next stiff pin and depress it, being careful not to depress any pin too low. All the while, maintain a light torque on the plug with the L-wrench.

As the cylinder begins to bind further against the pins, you may have to lighten up on the tension just a hair, but not too much. Make sure the pin you are depressing with the L-wrench is not being pushed down too deep.

Just remember, like all other radial pin tumbler locks, you will have to pick it three or more times. Also, if you do not return the plug to the locked position, the key will not operate the cylinder. This lock sells for about $15 plus $5 a key.

Pick resistance: Picking the vending-machine mounted Van lock is another story as the cylinder face is set below the surface of the T-handle, putting the tension wrench at an awkward angle. I rate this lock at a respectable **8.5**.

THE TUBAR

Recently, I had the opportunity to pick a TuBar. Invented by Robert L. Steinbach (Patent #4,446,709, 1984) for the Chicago Lock Co., this lock is used on utility cabinets, as switch locks, and on vending machines. It is advertised as "... the ultimate in resistance to surreptitious entry." The wording alone was enough to worry me, so I just had to get this lock.

This dual side-bar eight-pin tumbler uses two rows of four pins with a side bar on each row. The pins are arranged with their ends facing the keyhole opening in two sets of four. At first glance, one would think that it is an odd version of a radial cylinder or tube rim lock, if not for the pin arrangement. It is anything but that. Though this lock is similar to a radial pin tumbler, the pins are not placed in a circular pattern. If you're a determined lock picker and know your locks, just looking down the keyhole will give rise to despair.

On the outer edge of the brass cylinder (9) (within the lock but above each row of pins) is a half-moon shaped plate (7) with a notch balancing a tapered side-bar (8) riding in a groove along the length of the cylinder. This is a double side-bar quasi-radial pin tumbler lock.

This lock sports hardened stainless steel spool pins (5).

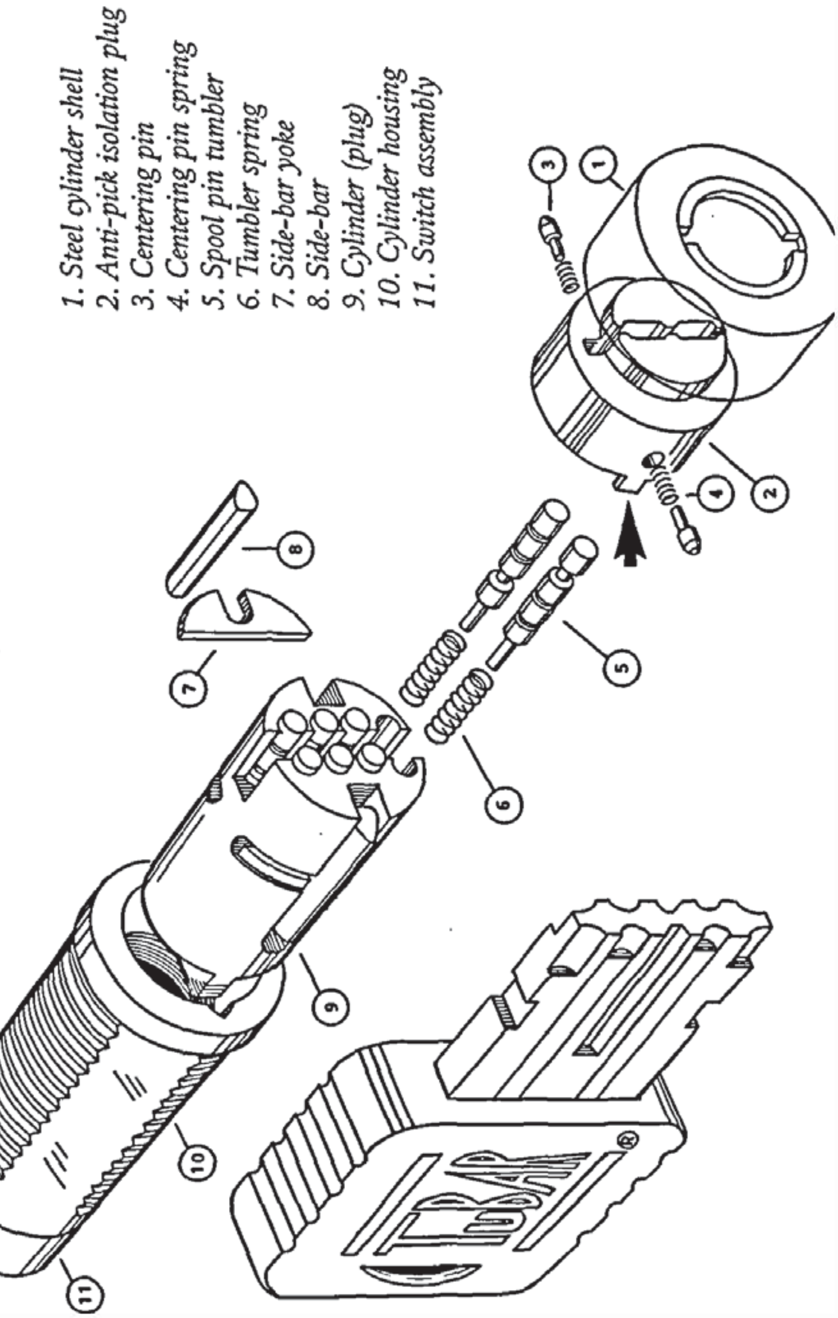


Figure 31. Chicago Lock's TuBar is in a class of its own with eight spooled pins and two side-bars—but its pins are radially exposed. Note the hefty key to overcome the "stiffness" of the lock.

My stainless steel pick didn't even leave a mark on them, so forget about drilling out the cylinder. Also, there is a circular stainless-steel drill-proof plate (not shown) with a keyhole opening in the center. (This plate also helps to prevent drilling.) The pins are one solid piece with a heavy groove girdling the middle so that the flat side of the half-moon side-bar "yoke" can fall into it. Furthermore, each pin has two shallow fake grooves and one deep real groove, reminiscent of the old Russwin spool pin. In Figure 3I, two of the eight pins shown have the fake grooves above and below the heavy, real groove. The dissected lock that I picked has the real groove in the middle on all eight pins—but this is not the norm. My other TuBar picked with deep and shallow breaking pins. There are three different positions on each pin, and two out of three of them are "fake." The "fake" grooves seem to have a lot less relief than the real grooves, so you can use a little more force on the tension wrench than you would a standard pin tumbler lock. However, having only three different pins in an eight-pin lock limits the possible key combinations to only 6,561 (3 to the 8th power). But that doesn't matter—this lock's a bitch to pick anyway.

Unlike regular side-bar locks, this cylinder requires a stiff tension wrench. But the keyway is full of pins, so the only way to get a grip on this cylinder is in the center of the keyway. However, when the narrow tip of my Tiger dual tension wrench was placed down into the center of the keyway, it blocked the four center pins. I finally gave up picking this lock because none of the pins would stick or hold to their shear lines.

Now, you may wonder why we don't use a Feather Touch tension wrench on the little monster. The front keyhole plug (2) holds two spring-loaded pins (3), one on each side. These "centering" pins do not need to be picked—they rest in a groove on the left and right inner sides of the lock housing wall (10) and act as an added resistance to the turning of the cylinder, rendering Feather Touch tension wrenches useless.

I noticed that the steel side bars to the lock I had taken apart were beveled along their outside length. Even though

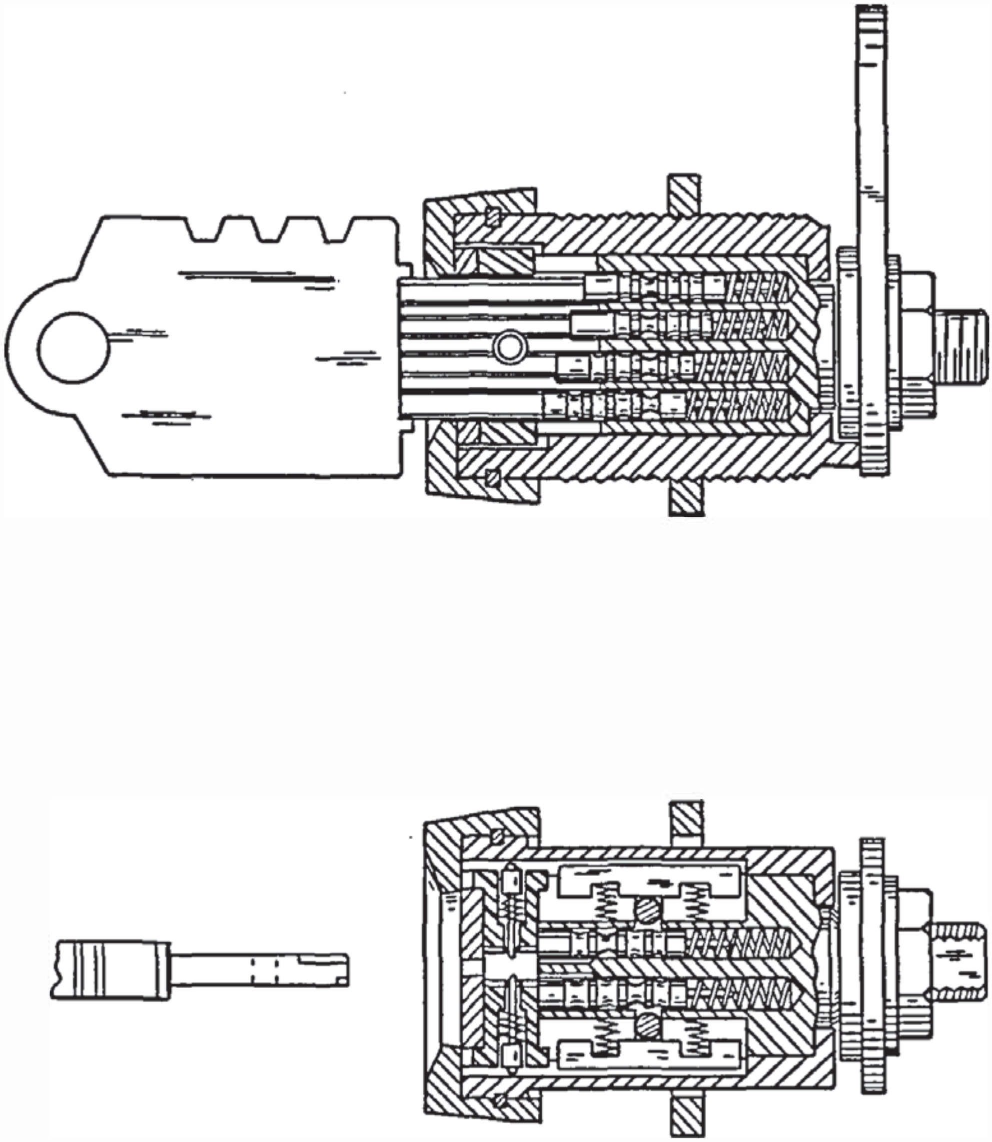


Figure 3J. Original prototype of the TuBar: Note that the side-bar springs are not necessary and roller-shaped yokes were replaced with the half-moon yokes shown in the previous illustration.

this lock is a dual side-bar, in order for the key to work properly it must compress the side bars in while turning the cylinder. So more tension wrench pressure was needed. But this also meant that you should be able to feel the tumblers as you picked them—they should stick! I realized that the problem was not enough tension wrench pressure, so I decided to design a new tension wrench. Here's how to make it:

First, take a small #1 Stanley screwdriver (Model #64-340 or the Stanley generic 2"/50mm) and grind the very tip back until it is .060" thick. Using the .032" cut-off wheel, carefully cut a slot down along the flat on both sides of the blade, being careful not to cut the slot through the blade. The tip of the screwdriver should now have an hourglass shape. The "waistline" of the hourglass should be no more than .035" thick. Next, grind down the wide sides of the blade on both shoulders until the end of the tool is .125" wide and looks like the form shown in detail in Figure 3K.

Next, put the end of the tool in a vise about 1/4 of an inch (.250") down. Tighten the vise, but not so tight as to flatten the blade. Heat with a propane torch just above the vise jaws for a minute or until it turns red and bend it to a 90-degree angle. Being careful not to burn yourself, remove it from the vise and quench in oil. Smoke will roll off the tool as it hardens itself to the new shape. You now have a TuBar hourglass tension wrench.

This hourglass tension wrench can now fit down past the front anti-Feather Touch plate and grab the cylinder. It wedges itself snugly but is just above the four center pins, allowing your straight pick to get to them. In Figure 3I, the key has a deep groove running down most of the length of the key bit. This groove allows the centering pins (3) to retract so that the anti-pick plug (2) will rotate when the proper key is inserted and turned. In the original patent illustration, redrawn for Figure 3J, this is accomplished with a hole in the side of the key. This, however, must have caused problems and the hole was replaced by the deep groove. This is the lucky break that a lockmith needs to open this lock.

The purpose for the centering pins is to prevent a rogue key from entering the lock and to discourage "center-fixing" tension wrenches.

But the centering pins cannot be so long that their ends touch in the center of the keyway or the key may not be removable—which is probably why they got rid of the key's hole. So they had to shorten the centering pins. However, the extra gap between those pins makes the lock work much better. It also allows for the use of the hourglass tension wrench. But don't get me wrong—this lock's still a bitch.

A thin (.018" to .025" thick) rim pick is used to depress each pin. I also like to use the .030" diameter piano wire picks on these locks. Either way, lightly push each pin down until you get one of them to click heavily into place. You may experience a light click just before this happens. Remember, with spool pins, light clicks don't count. You'll feel the difference once you start picking them. After getting a pin to give you a good solid click, search for another one that has lost its springiness and is ready to align. Keep your hourglass wrench firm throughout the picking process.

The cylinder turns a little bit hard, but make sure you don't push down too hard on the pins. Pick one row at a time. Find the row that the pins push down the hardest, then release the pressure on the wrench. Re-apply wrench tension and find the stiffest pin in that row and set it first. Then find the next firm pin in that row and set it. Once you have set that whole row, the following pins in the other row will set up nicely. But you must first find and set that row that causes the most relief against your tension wrench. In this way, you take advantage of the inherent tolerances (slop) in the lock. (Without some "slop," the lock would be too tight to function at all and would freeze up solid.)

Repeat this process as needed until all pins are set and then the cylinder will turn, shutting off the switch, turning the cam or dropping the dog mounted on the rear of the cylinder. You may have to play with the tension wrench a little because a pin went down too far. If you find a pin that

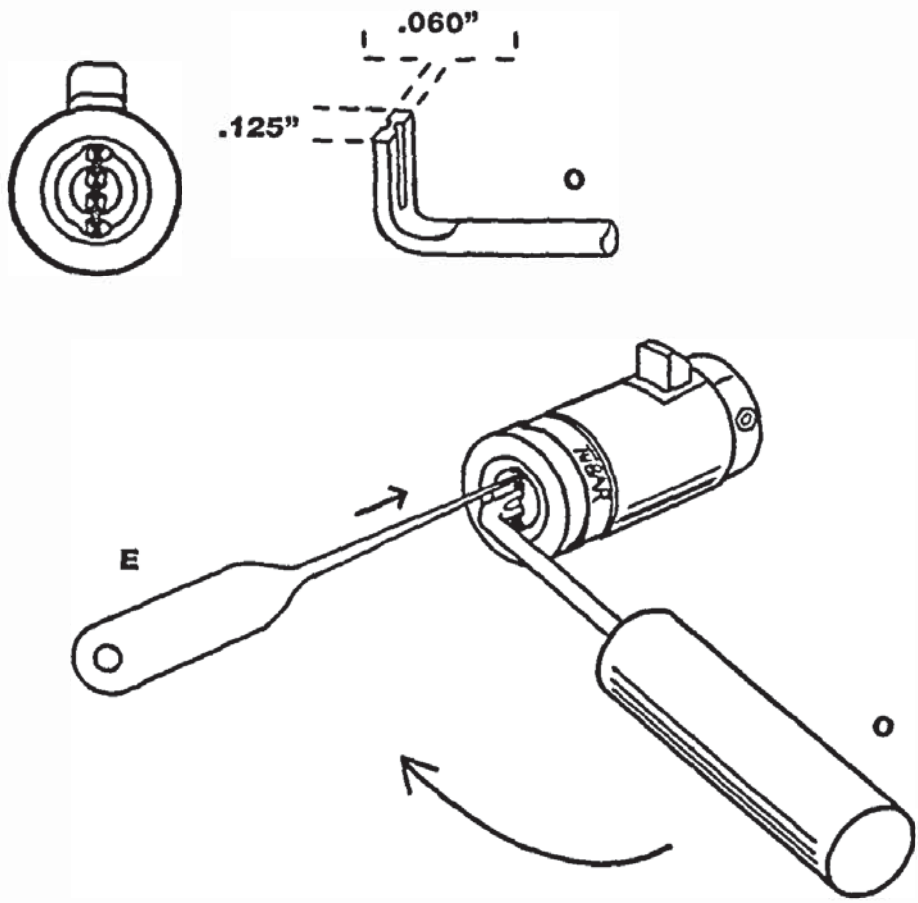


Figure 3K. Picking the TuBar lock. A firm, deep-seated tension wrench ("O") used with a light but constant turning force will set the spool pins. The wrench's special hourglass tip defeats the centering pins in TuBar's anti-pick plug.

pushes down hard, but smoothly, clear to the bottom of the cylinder, chances are it should stay up. Release tension and start again, but leave that pin alone.

Use caution when picking this lock. The anti-pick or "isolation" plug (2) has a tab (small arrow) on each side that engages the cylinder beneath. Since we are using this plug to apply rotary torque when picking this lock, do not apply too much force—just enough to bind the pins. Otherwise you will shear off those two tabs and no longer have a means to grip the cylinder behind. Only the right key will work the lock should this happen, as this plug will freely rotate once the two centering pins are overcome. This is also a telltale sign that someone has tried to pick your TuBar.

Both of my TuBar locks open to the right (clockwise). If yours do not, just remember that on any cylinder lock, if the pins will not bind or stick to the shear line you need to go the other direction with the tension wrench.

Helpful tip: In order for me to study this lock, I had to use a small, handheld Dremel tool with a cut-off wheel to bisect the rotating stainless-steel collar on the front of the lock. The collar is designed to spin so that thieves can't grab it with a pipe wrench and twist the lock out of its mounting, but once it is removed from its mounting it can be cut away by making two cuts 180 degrees apart. The isolation plug just pops out with a little prying (be careful not to lose items 3 and 4 while doing this) and the guts of the lock will spill out, exposing the toggle switch at the back of the lock. A small screwdriver may then be used to operate it.

Pick resistance: Considering the quality of machining, the steel pins with anti-pick grooves, the two side-bars, and the anti-pick plug, this is a well thought-out and very secure lock. It took me a good 40 minutes to open it after I had the right tools. I still gave it a **10.0** because of the shear audacity of the lock's damned anti-pick isolation plug. If you can't pick this lock within the first 60 minutes, or if the wrench is not fully into the keyway and slips out, the wear and stress will shear the tabs (see arrow in Figure 3I) on this plug. Then getting hold of the cylinder underneath again with any kind of tension wrench becomes quite out of the question. This is excellent security for its price—around $25 plus $5 per key.

1. *Advanced Lock Picking Secrets*, pp. 13-22. See the Dragon 6-'n-1 tension wrench.

4

Multiple Row Pin Tumbler Locks

Most new high-security locks use a variation of the old standard pin tumbler cylinder lock. Because it was (and still is) the most effective lock in use, the pin tumbler has evolved into a variety of complex systems, some of which may require three or more hands to pick. In some locks, one twist of the cylinder without the proper key sets off an alarm and locks down the cylinder. Nearly all of the locks discussed in this book were designed or made in Europe: Sweden, Switzerland, Denmark, Norway, or Germany. They are of high quality, which until recently made most of them too expensive or inaccessible for the average American home or business. (The large conglomerate ASSA recently bought into most of these small, innovative companies and, though it now dominates the security market, has brought the price of these high-security locks down to an affordable market price while maintaining the original company brand names. For the most part, these companies still manufacture their locks overseas.) The mechanical locks discussed in the next chapters operate with the precision of a Swiss watch.

Some of these locks are used to operate the on/off switch on burglar alarm systems and are commonly called "switch locks." It makes sense to concentrate on beefing up the pick-resistance of the alarm system rather than improving the quality of the door lock, because while a door lock can be picked, kicked in, or blown out, such treatment of the switch lock should automatically open the switch and set off the alarm, bringing the police.

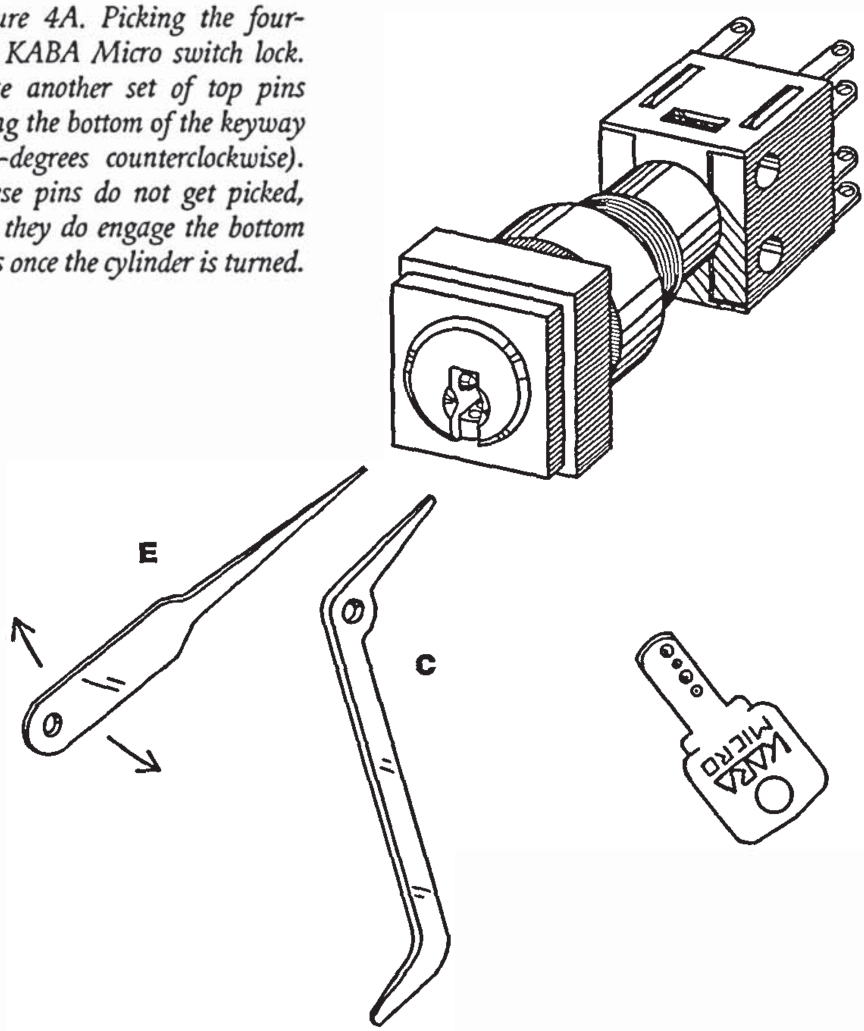
THE KABA MICRO SWITCH LOCK

One such interesting switch lock is made by two Swiss companies. KABA makes the cylinder lock and EAO makes the electrical switch to fit this lock. Thus was born the KABA Micro. It is only a small, four-pin tumbler lock with a fair amount of pick time involved for its inexpensive price. The four pins are situated on the upper left side of the tight, little keyway—about .058" wide. These four pins have to be depressed to the horizontal left to release the cylinder. The switch can be wired either to turn off or on with a left turning cylinder, or a right turn.

The key is stamped stainless steel and is quite simple, being flat with no ridges milled along its working length (bit). This is a very basic dimple key with dimples for the lock's four pins on both sides so that it may enter and operate the lock right side up or upside down. For the key to be removed with the switch activated, another row of shouldered top pins lie waiting 90-degrees counterclockwise along the bottom of the keyway in Figure 4A.

I used the narrow tongue of the Tiger wrench at the bottom of the keyway, being careful not to depress the first two tumblers. I then used a thin (.018" to .022") straight rim pick to pry each pin into position with a sideways (left-to-right) motion and basically picked it like a small pin tumbler cylinder. It pops easier with a clockwise wrench turn than it does with a counterclockwise one, as the wrench tends to get in the way of the pick. Chances are, should you encounter this lock, it will open in the more difficult to pick direction.

Figure 4A. Picking the four-pin KABA Micro switch lock. Note another set of top pins along the bottom of the keyway (90-degrees counterclockwise). These pins do not get picked, but they do engage the bottom pins once the cylinder is turned.



Pick resistance: This lock is actually a low-to-medium security mechanism, however, I included it here to familiarize you with the principle of right-angled pin tumbler arrays. In fact, the square housing surrounding the cylinder is plastic. But KABA makes more formidable locks, as we will soon see. This switch lock used to be employed on the old computer drives by universities and government facilities. This lock is fair security for its small size, and I rate it at **4.5**, mostly for its uniqueness.

ALPHA SLOT MACHINE LOCK

Gambling is, at best, a risky business. If you have a customer who owns a few slot machines, coin-operated bar-top video game machines, or even just a re-built, old-fashioned pinball machine, keeping the run-of-the-mill lock picker out may have been a real challenge in the past. Outside of illegal entry by strangers, sometimes employees like to dip their fingers into your pockets by using a homemade key from an impression of the key bit they made while they had access to the original key for a few moments. (The key's "bit" is the part that goes into the lock, while the "bow" is the end that attaches to the key ring.)

To make key duplication more difficult, the American company Key Devices markets their maximum security Alpha Cam or Slot Lock. Invented by Francis E. Gallagher in 1997 (patent #5,685,184), it sports 17 pin tumblers: six pins on the left side of the cylinder, six pins on top, and five pins to the right side. The maker claims over a billion possible codes. If you happen to be near a new gaming machine, chances are it has an Alpha on it. Take a gander down the keyway and you'll notice that it's full of pins. It goes a few steps further than the lock in 4A by using both sides of the key and the top edge.

The unique dimple key design allows for a small profile key to control the position of all 17 tumblers. The key is even dimpled on its uppermost edge to bring the top tumblers up to shear line. And most conveniently, the key is designed to go into and operate the lock either way. The sample key to the lock that I practiced on is covered with dimples. (It's the modern version of the old, and still used, Ford pin tumbler known as a "drunkard's key" because no matter which way you insert it into the lock, it will operate the cylinder.) It's almost hard to believe that they can get all that stuff in there, but the Alpha Slot Lock functions quite well. I am impressed with its machining and its smooth operation. However, I have noticed that some of the tumbler springs fatigue quite easily while picking this lock, allowing the pins to stick. This makes the key work rougher.

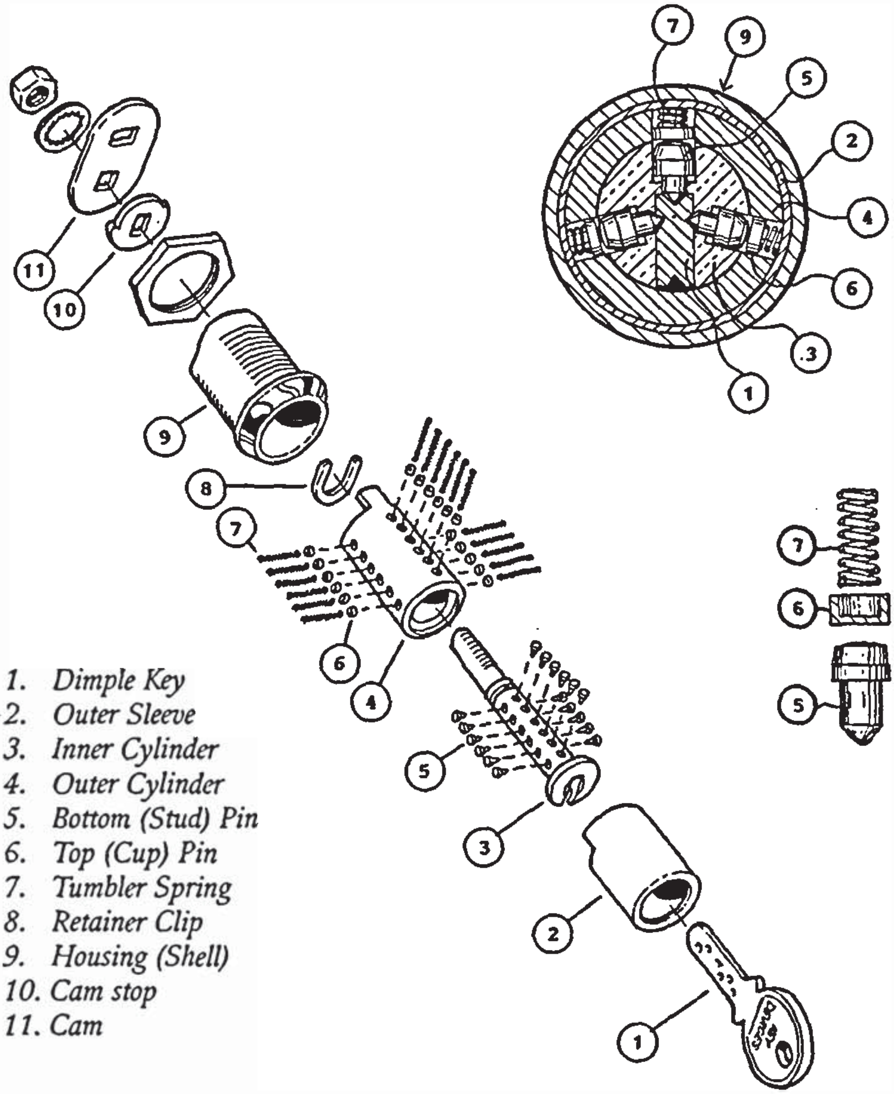


Figure 4B. The 17-pin tumbler Alpha Slot Lock. Though the tumblers travel a very short distance, there is little room for traditional lock picks in this cylinder.

To pick this lock, a thick tension wrench (like a small, bent screwdriver) or the wide end of the Tiger, must be placed at the very bottom of the keyway as if you were picking a regular wafer or small pin tumbler lock. Since the dimples in the key are shallow, be aware that the upper "cup-shaped" pins do not have far to travel to shear line. So care should be taken in the manipulation of the pick. I designed the Katana straight pick ("H") for this lock because you can gently teeter it vertically to engage the top pins, as well as rock it from side-to-side to set the left and right pins. Remember that there is very little space for driver pins and springs, so the pins do not have to be depressed very far. In fact, this is also part of its security. Not only is the key duplication nearly impossible because of the lack of tumbler exposure, but there is little room for pick movement within the cylinder. This is the lock's primary defense against picking.

Tension wrench play is important here, but only after the pins have quit clicking into shear line. You will have to support the bottom edge of the Katana with a finger or thumb from your tension wrench hand so that you can rock the pick. Keep the rocking angles low as the pins break fairly shallow as mentioned above. Note that the row of pins that click into shear line first are on the upper left if you are turning right, and vice versa.

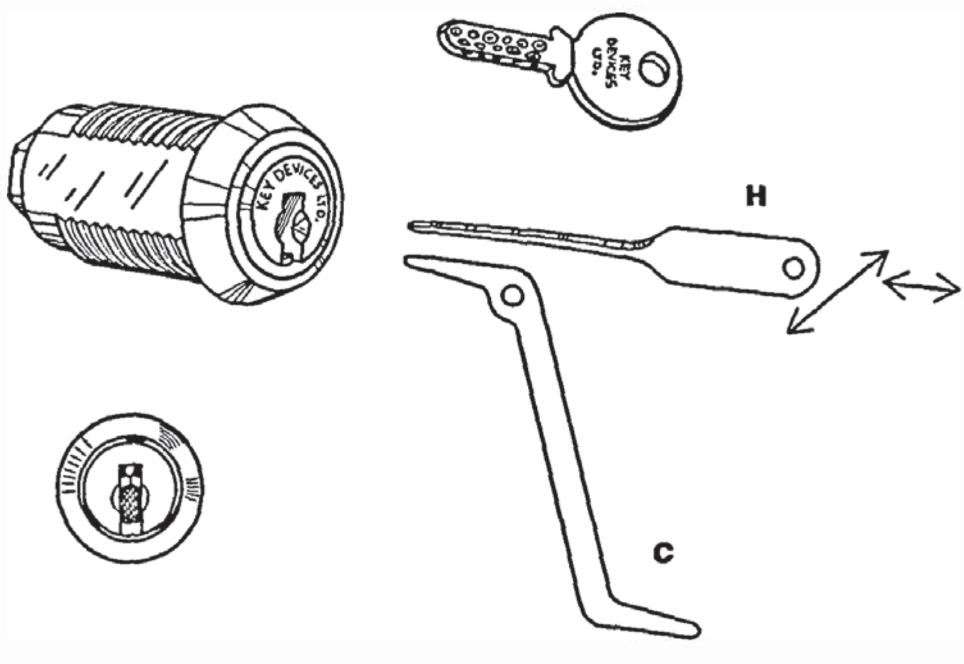


Figure 4C. Picking the three-row pin tumbler Alpha with the Katana ("H") pick. The samurai's direct approach: All pins at once.

Now, if the above technique does not work for the Alpha lock, then try the needle-raking/diamond technique mentioned for the KABA lock below.

Once you have picked this lock, you may wonder if (after you've turned the cylinder 90 degrees) the top driver pins in the shell will snap down and lock the left bottom pins that were riding in the cylinder. That will not happen to this type of lock because the pin rows are staggered and do not line up with their adjacent rows.

Pick resistance: Though I was impressed with the principle and the machining of this lock, the fact that it was full of pins makes it more difficult to pick than it appears. I give it a **7.5**, but this is still very good security as the key is very difficult to duplicate and the lock is time-consuming to pick. Priced around $22 plus $2 key.

Key Devices carries another lock invented by Gallagher—a keyed disc tumbler lock for the gaming industry that can also be used as a cam lock for sliding cabinet doors or an "inner cylinder" for T-handle functions on various types of vending and gaming machines. See Chapter 9 for the analysis of this lock.

THE KABA CAM LOCK

The Swiss-made KABA "Gemini T restricted keyway" also uses a dimple key. This new "stud" pin design was invented by Arno Kleinhaeny of Switzerland in 1995 (U.S. Patent #5,438,857). The Gemini T is an upscaled version of the Alpha Slot Machine Lock, with tighter tolerances and studded pins. Like the Alpha, it has three rows of pins that overlap when engaged by the key, but picking *this* lock is a real exercise in patience.

The lock looks and acts very much like the Alpha. The side pins, like those in the Alpha, come in at an upward angle of about 45 degrees to the horizontal, but have the tips of the pins machined down to a smaller diameter to thwart the use of a Katana-like pick. The top pins are not machined down.

In essence, the edged-pick gets caught on the shoulders of the stud pin's tip. This is what the company means when it refers to their "restricted keyway."

Unlike the Alpha, the KABA cam lock has 16 pins—five on the left, five on top, and six on the right. The vending machine lock or inner cylinder type with the locking-dog catch has 13 pins—five on the left, four on top and four on the right.

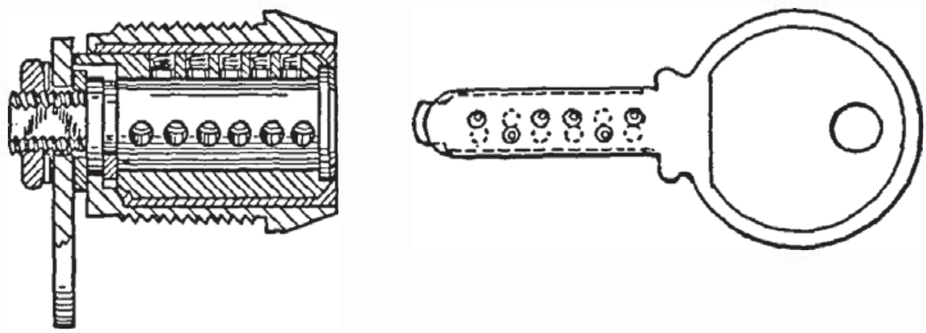
The ends of the pins in the Gemini T actually cross each other very closely when aligned, making a straight lock pick of just about any kind useless. If you try to pick the top row of pins and manage to align them, the side row studs must be pushed aside, which puts most of those pins too far into their drivers. So how do you pick this one?

Like all other locks, it has an inherent weakness: the upper left- and right-hand corners allow just enough room for a pin—a straight pin, that is (the next illustration exaggerates these gaps or the width of the keyway). So a different approach is needed when picking this lock.

Let's practice on the KABA 13-pin lock. Since the keyway is rather wide, use the large end of the Tiger tension wrench and apply tension as if you were picking a regular pin tumbler house lock. I found the best pick for this job is a large sewing needle, such as a light-duty carpet needle measuring between .030" to .036" in diameter. Round off the end on a grinder, then file smooth to prevent impaling yourself, but be sure that most of the tip remains. I mounted my needle by heating the eye-end with a lighter and inserting it into a plastic dowel rod. Using the eye of the needle allows the molten plastic to flow into it, which anchors it to the make-shift handle. To avoid ruining the fingerprints on your thumb and forefinger, use pliers to hold the hot needle during heating and insertion.

Next, while applying tension, you want to fully insert the needle pick into the upper left corner of the keyway and use the length of the shaft to push down and right—toward the center of the keyway—as you slowly and gently pull the pick out of the lock. The rounded ends of the stud pins in the left row and pins in the top row will push in—some harder than others—but some of those pins and studs will align. Then go to the right corner and do the same, pulling out and down and to the left. You will feel and hear some of the loose bottom pins rattling within the cylinder while doing this. Because of the shallow breaking of their shear lines, those pins are most likely aligned. Now lightly rock the needle pick directly against the bottom of the top row of pins.

It is doubtful that the cylinder will pop open the first time you do this, so very carefully release tension (sometimes



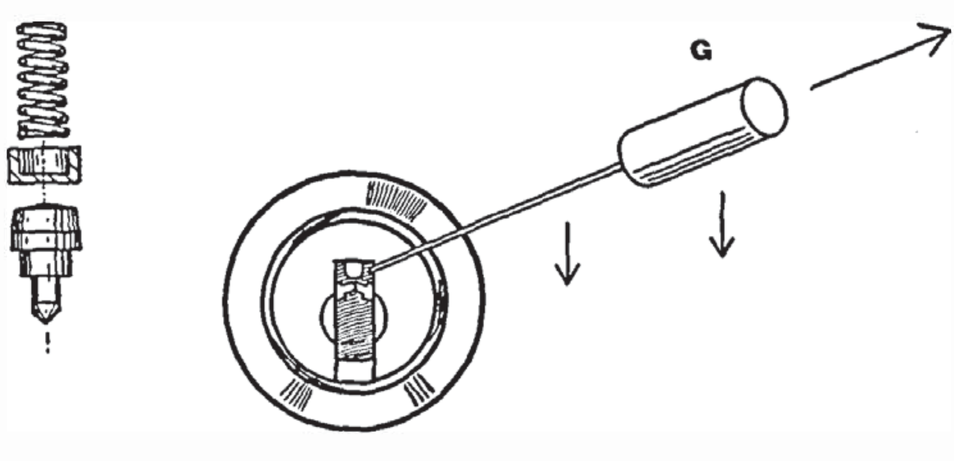


Figure 4D. Raking the three-row, 16-stud pin KABA lock with a needle pick ("G"). The tension wrench is not shown in the illustration.

cylinder locks pop open while releasing the tension wrench) to drop the pins and try again. Sometimes a sideways rocking motion of the pick will pop the lock. I have even tried using a circular motion with the pick. But the three times that I popped this lock, I used the method described above. Be sure that you use tension wrench play while picking.

On the 16-pin KABA lock, I alternated the needle pick with a small diamond. While maintaining tension wrench pressure as before, pick the upper left and top rows simultaneously with the needle pick by stroking the whole needle down, raking both rows. For both the 13- and 16-pin KABA Gemini T, while working the needle, point the tip down as you rake in one, single stroke outward. This will allow the tip to engage each pin in both rows individually as you draw the tip of the needle out of the lock. (This is done because the tips of the tumbler pins and studs intermingle with each other.) Then pull the needle completely out and run the small diamond in as if you were lightly raking a standard pin tumbler lock. Do this once with the diamond, concentrating on the top row only. Second, pull the diamond out and re-insert the needle to rake down the right and top row of pins. Alternate between the two picks (this is where that third hand would be useful); rake upper left and top rows, then small diamond pick top row; rake upper right and top rows, then small diamond top row; then carefully release tension and start over, varying the needle angle each time. While alternating picks, maintain a light tension on the cylinder.

You may also use a Feather Touch tension wrench on this lock if you have trouble opening it. Either Feather Touch wrench will fit into this keyway, however, with so many pins, and since there are no spool or mushroom pins, you may want the direct contact of the cylinder with your fingers through a stiffer wrench so that you can better feel the pins.

Pick resistance: This lock is very time-consuming. The quality and machining of this mechanism makes picking this lock a daunting task for the inexperienced locksmith. I found this lock to be tough to pick and rated it at **8.0.**

5

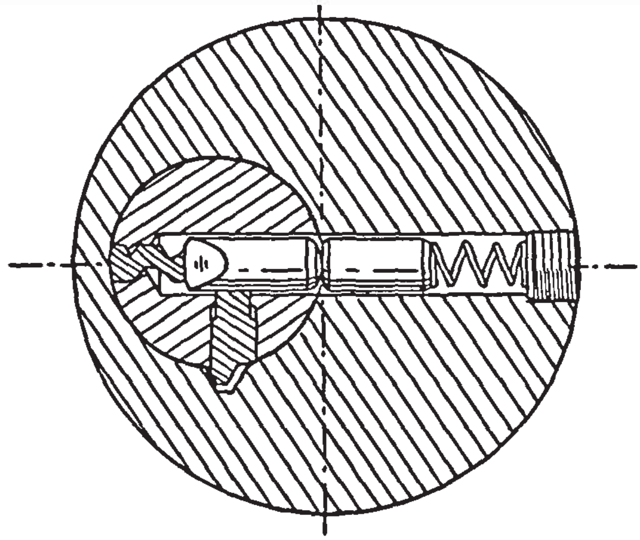
Topless Chisel Pin Side-Bar Locks

So just how do you make a pick-resistant pin tumbler lock with no top pins? Maybe we should look to how this species evolved: Remember the side-bar flat wafer tumbler locks used on GM autos since 1935?[1] Medeco turned those flat wafers into round, chisel-pointed pins with grooves and holes in the sides to align with a sidebar. Waitress! My tab, please! So here, "topless" does *not* mean that we are at first base.

Here, the real action is with the pin in the bottom—which has direct contact with the key. But before we can understand how a topless pin tumbler lock could be effective security, we must first examine the basic principle established by Medeco—the originator of the rotating chisel pin.

TWISTED TUMBLERS

Medeco locks have been around since 1970, though the first U.S. patent (#3,722,240) wasn't issued until March 1973.



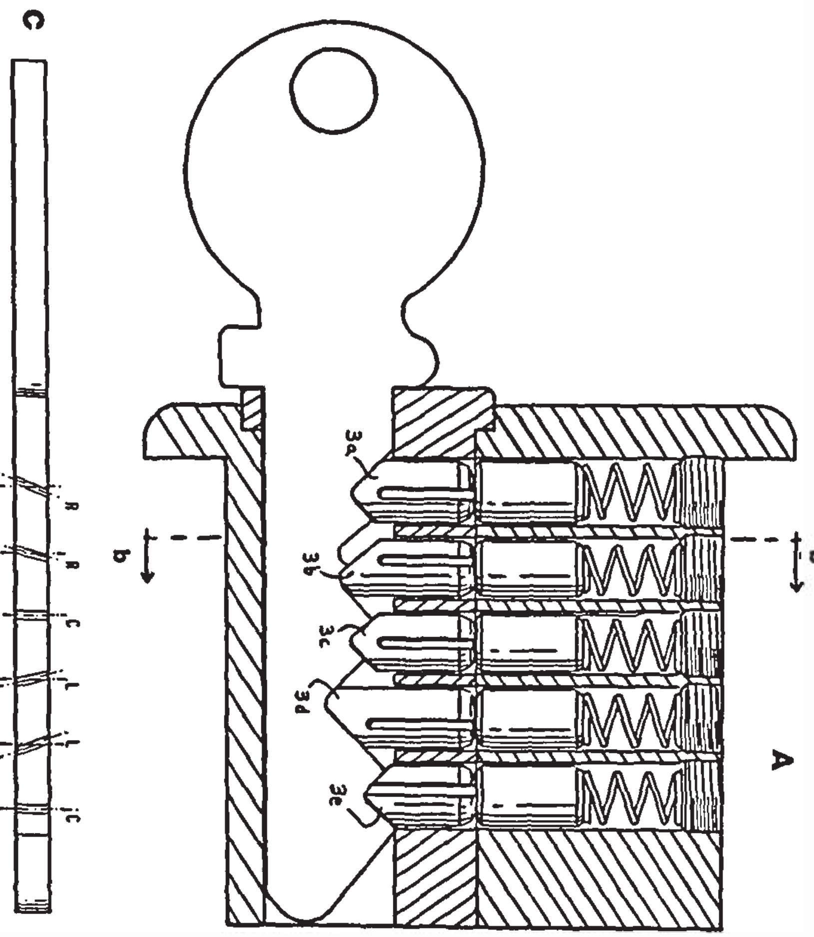


Figure 5A. Medeco's rotating chisel pin tumbler principle. Note that the vertical groove in each chisel pin must align with the side-bar as well as break with the cylinder before the lock can be opened.

Now owned by the ASSA/Abloy Group, no single lock company has had such an impact on modern security. The rotating pin or "twisting tumbler" concept patented (#4,635,455) by inventor Roy N. Oliver for Medeco Security Locks was designed to increase the number of key changes, thus improving security. In the process, he also created a more pick-resistant lock, as each tumbler must be positioned exactly for its groove (or hole) to align with the lock's side-bar rails or posts. Moreover, the chiseled pointed pins can rotate either forward or in reverse by up to 20 degrees on each side, with either left- or right-handed pins. See Figure 5B to view the skewed cuts on the key control where these pins align their slots (Figure 5B, #4) with the side-bar in addition to the standard rising of the pins to a breaking shear line with the cylinder. The tang (Figure 5B, #1) on each pin rides a broached slot[2] in the pin chamber of the plug and limits total rotation or spin of each tumbler in each direction (forward or reverse) by 20 degrees. The key (Figure 5A, item c) can be cut skewed by either 10 or 20 degrees in either direction or straight across perpendicular with the bit in any variation on the blank. Here, a key is shown with six cuts for a six-pin Medeco lock. As of this printing, this is the highest number of pins any Medeco may have.

For ease of manufacturing, there are only five distinctly different chisel points in a Medeco lock (refer to Figure 5A, item a):

- rear offset long chisel face (shown as item 3d in Figure 5A and item d in Figure 5B)
- rear offset short (item 3e)
- forward offset long (3b and item i in Figure 5B)
- forward offset short (3a)
- centered or no-offset chisel pin (3c)

The skewed key cuts can be either centered, skewed left 10 or 20 degrees, or skewed right 10 or 20 degrees. This gives the manufacturer 10 distinctly different types of tumblers to

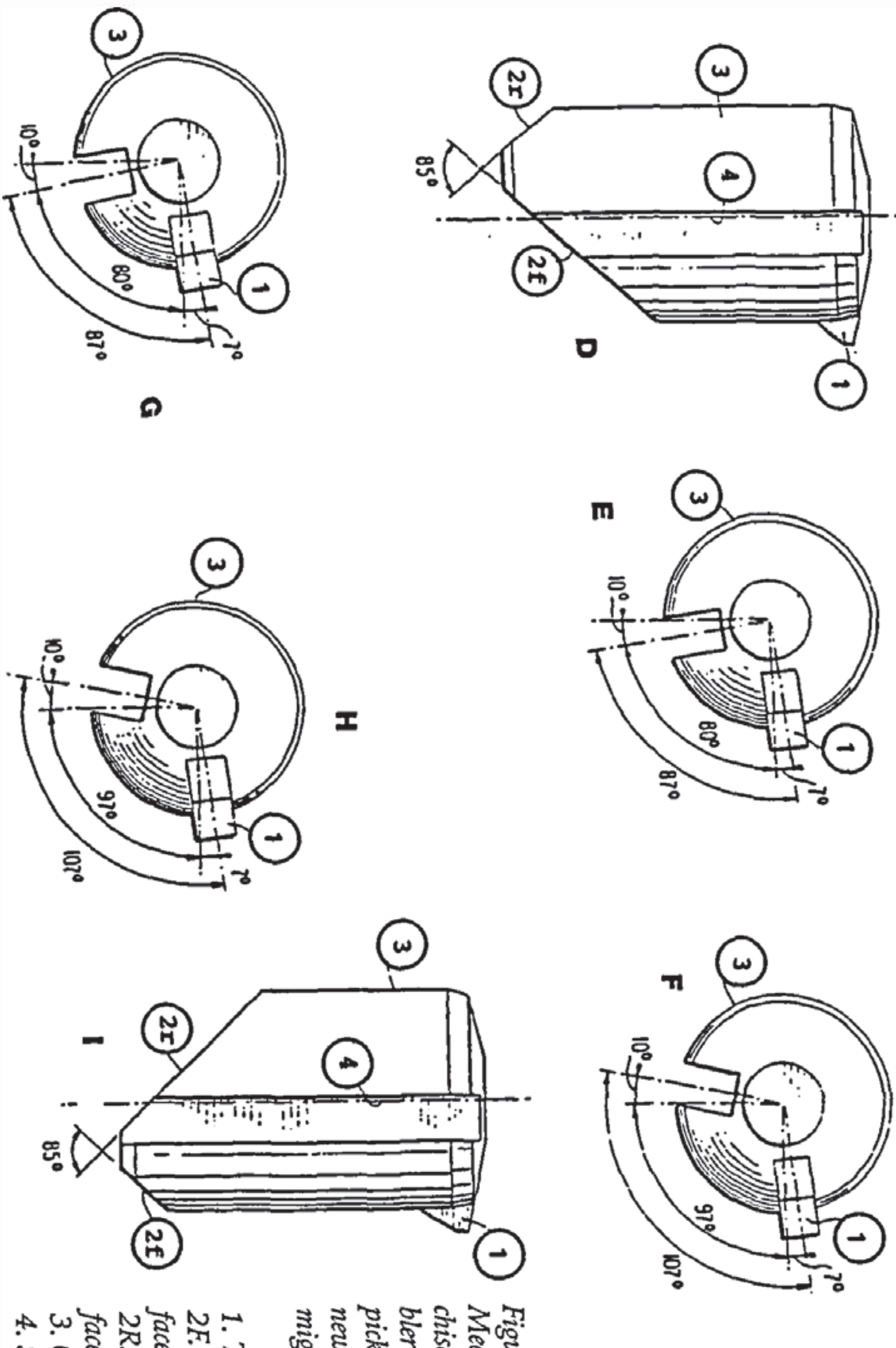


Figure 5B. Medeco's twisting chisel pin tumbler: Brings lock picking to a whole new plateau of migraine.

1. Tang
2F. Forward chisel face
2R. Rear chisel face
3. Chisel pin
4. Slot

use in each lock, along with the centered chisel tumbler with a .030" bias either in front or to the rear of centerline, making 13 distinct tumblers. This adds immense variety to the key code for each lock.

Referring back to Figure 5A, item c—at the top edge view of the Medeco key we see the extent to which these tumblers may twist before they can align with side-bar and shear line. Here, don't be concerned with the exact key and tumbler dimensions when picking this or any other pin tumbler lock; feel and visualization are the best guides. This patent, #4,635,455, will expire Jan. 13, 2007, but the race for better security will undoubtedly continue.

THE MEDECO THREE-PIN ALARM SWITCH LOCK

With only three pin tumblers, this little bombshell is packed with finely machined parts. Invented by Stevie C. Roop for Medeco back in 1989 (U.S. Patent #4,829,798), it has dual function—both as a switch lock and cam lock. But don't let the low number of pins fool you. Like its Daddy, the six-pin Medeco door lock (next chapter), it has a side-bar, but only has one spool pin (could be any tumbler.) Again, note that there are no top pins. The pin's flattened, chiseled ends also helps to prevent a rogue key from entering the keyway. But the Monkey pick ("K") can go right past the bouncer at the door—without paying the cover charge—and play with the pins. This is because the Monkey pick is much thinner and smaller than the key and can rotate the pins by its raking motion.

Once the pin has been turned (and it can turn a maximum of only 20 degrees in either direction) it can be raised and the groove (or hole in some Medecos) in its side can align with the side bar rails (or posts). But this alignment cannot occur until each pin has been raised to the right height as well. So once you have freed each pin by a slight rotation, you then have to position each pin vertically to clear cylinder shear line and so that the side bar will align and retract by the force of turning the cylinder. And this is where the Monkey comes in.

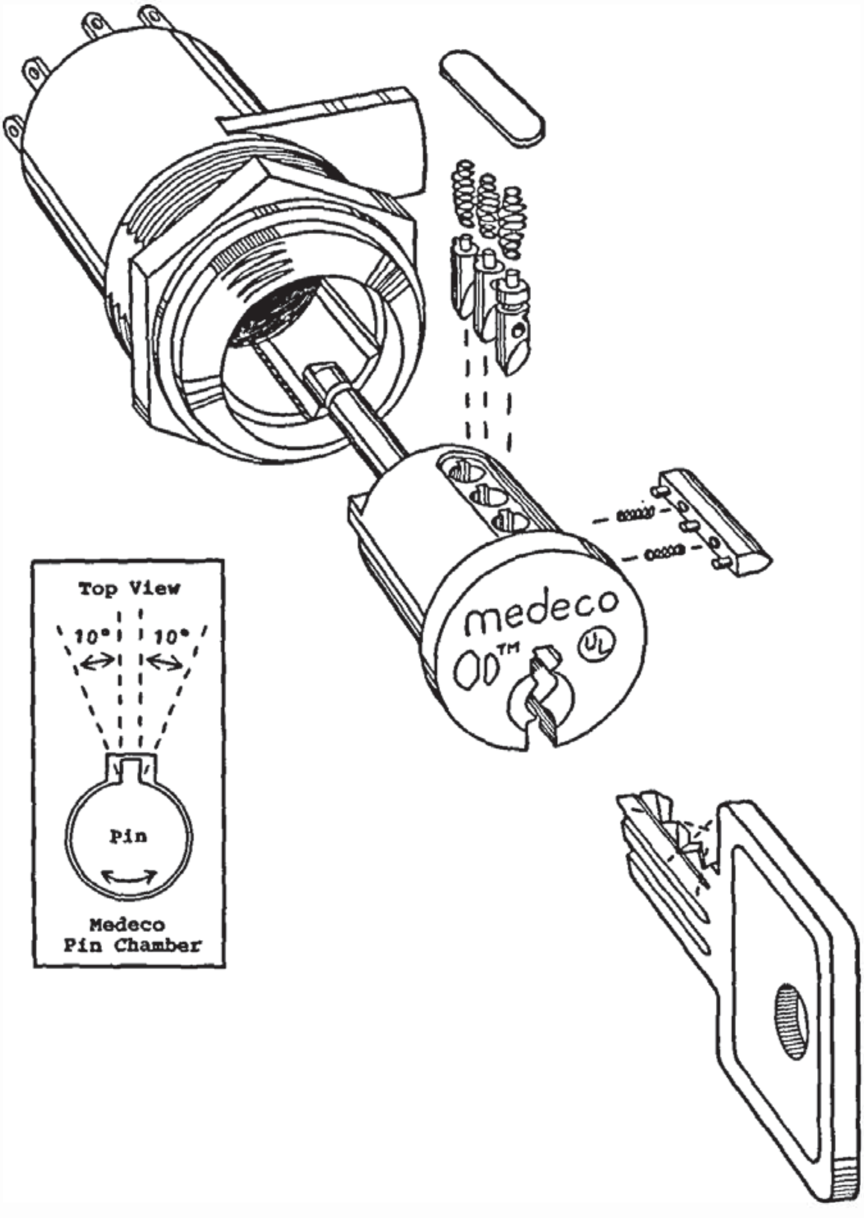


Figure 5C. Tougher than it looks: an exploded view of the Medeco three-pin tumbler, combination switch/cam lock.

Here's how to pick these little jewels: Approach the lock as if it were an automobile wafer side-bar, but use the standard Monkey pick (formerly the "twisted wedge-point," but ground on both sides instead of bent for smoother action) with a White Crane Feather Touch tension wrench. Gently run the pick in and out of the keyway while very lightly applying torque to the Feather Touch wrench. The wrench pressure can be no greater than the tension of the side-bar springs, but it must also be great enough to compress the side bar should the tumblers align with it, if you can imagine that. These side bar springs have very low force, so keep your torque light. Once the cylinder pops, you'll need to choke up (slide your grip up toward the lock face) on the Crane wrench and turn the cylinder by the Crane's head for the force needed to unlatch the cam or lower the dog (on T-handle locks). Be careful when the cylinder pops as the Crane has the tendency to fly out of the keyway, allowing the cylinder to snap back and re-lock itself.

Pick resistance: This is a good alarm switch lock—better than what has predominated the market in the past—but the three pins make it relatively easy to open for this category of lock. Still, I rated at a healthy **8.5**.

THE MEDECO FOUR-PIN POP LOCK

This lock, holding the new type of chisel pin invented by Roop (U.S. Patent #4,829,798), is a small marvel in engineering and is tough to pick. The topless pins, like that of the above lock but with one more pin, also ride a vertical groove and must align the hole in their side with the side-bar posts. Having an extra pin seems to make a big difference (as these locks take a while to pick) but sometimes you can get lucky and pop one in 20 minutes. Follow the procedure described on the last lock above. So far I have picked this one four times (the last time took me longer than the first time). The point here is that these types of locks require time as well as skill to open.

The majority of the skill needed here is with the tension

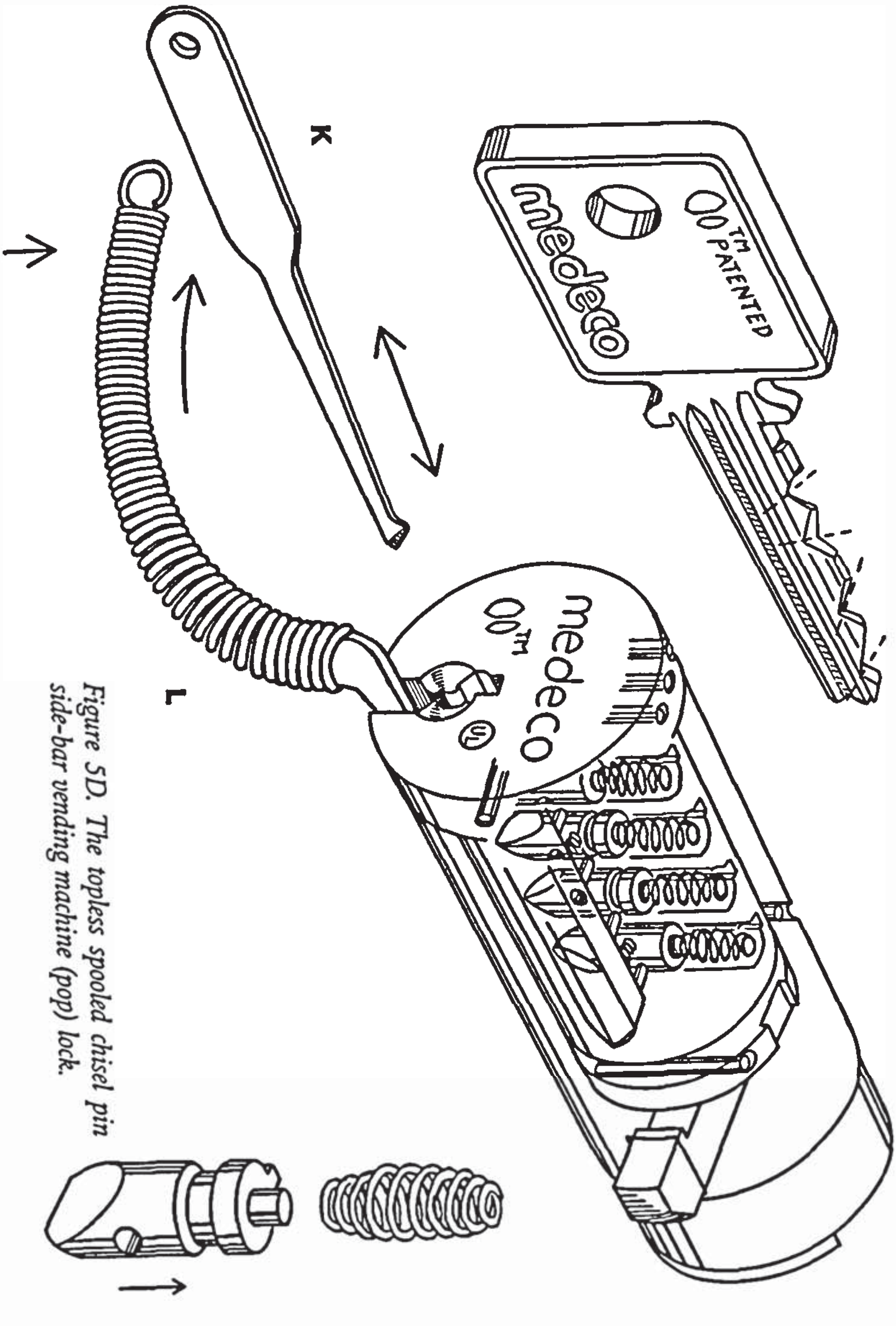


Figure 5D. The topless spooled chisel pin side-bar vending machine (pop) lock.

wrench, not the pick, though some skill is needed there as well. It's essential that you learn to use both hands independently of each other—to work both halves of the brain. This is the key to opening topless spooled pin side-bar locks.

While picking the locks in this chapter, you will frequently snag a pin. This occurs when the top of the pin's horizontal spool groove engages the leading edge of the cylinder due to its torque. You'll know when this happens if the cylinder gives a little to the right and stops after only a few degrees (usually, these locks open clockwise). When this happens, stop picking. Release the tension wrench until all the pins drop back down and start the picking all over again. There is no further need to keep picking, as the cylinder can't turn while that pin is snagged.

If this happens, you are trying too hard. Try using less upward motion of the pick and remember to keep the torque light. My White Crane tension wrench pressure varies from about 45 to 90 degrees in an arc. This data is dependent on the spring that you may have used for your Crane wrench.[3]

The keyway of this lock is designed to foil the setting or fixing of the tension wrench on the cylinder. Near the bottom of the keyway are two ridges that run across from each other and restrict the entrance of foreign objects. The White Crane tension wrench is designed to enter and affix itself to this and similar keyways. I have tried picking this lock with a looped Feather Touch ("M") wrench[4]—the kind sold in locksmith supply companies—but while it has a good feel for the pins, there is little room for the pick. This is important, as the act of raking the chisel-pointed pins causes them to rotate to their proper positions.

Occasionally pull on the end of the Crane wrench spring to stretch it. This is for tension variation, but be sure to maintain an overall light clockwise force. After spending about an hour trying to pick my sample lock the first time, it popped open. Light tension wrench pressure did it—just as I was about to pull out the tools to give up. Also, if you have trouble with your sample lock, try using a small diamond pick

("B") instead of the Monkey, as a pin might have to break low in your cylinder.

Pick resistance: This stainless steel lock is tough. Not only is it tough to pick, but it's made to withstand a bullet. In fact, a bullet would just piss it off, as the mechanism is so finely machined that any unreasonable force may flatten the side-bar alignment pins and jam the cylinder up tight. It is also loaded with three hardened anti-drill pins running vertically and one in the side of the face, along with two anti-pull pins near the back of the lock. See illustration. This is good security so I rated it at a healthy **10.0.**

THE MEDECO DURACAM GAMING MACHINE LOCK

When I first saw this lock in one of my locksmith's catalogs, I had to have it. Any lock that looked like "Pac Man" from the video game tables of the early 1980s had to be interesting. Looking down this keyway, one can see that there is plenty of room in there. Reminds me of a bowling alley.

This unique "horizontal keyway" design (U.S. Patent #4,635,455)[5] is more to prevent unauthorized key duplication (one of the biggest headaches in gaming) than to prevent picking—though this lock does that, too. The wide keyway is to allow for a thicker key, as broken-off keys in the locks are the second biggest headache in the gaming business when it comes to gaming machine locks.

Note how the key is cut at different angles across the flat side, rather than on the edge of the key as in the above locks. The key is cut deeply into its corrugated face. This means that the pins break low in the keyway, making little room for most lock picks. That is the only difference between this lock and the above locks in this chapter. This, too, is a side-bar mechanism that requires pretty much the same treatment as the four-pin pop lock above. The chisel pins must be jostled into place while the cylinder taps at the side-bar.

But in this case, because of the keyway design, we use dif-

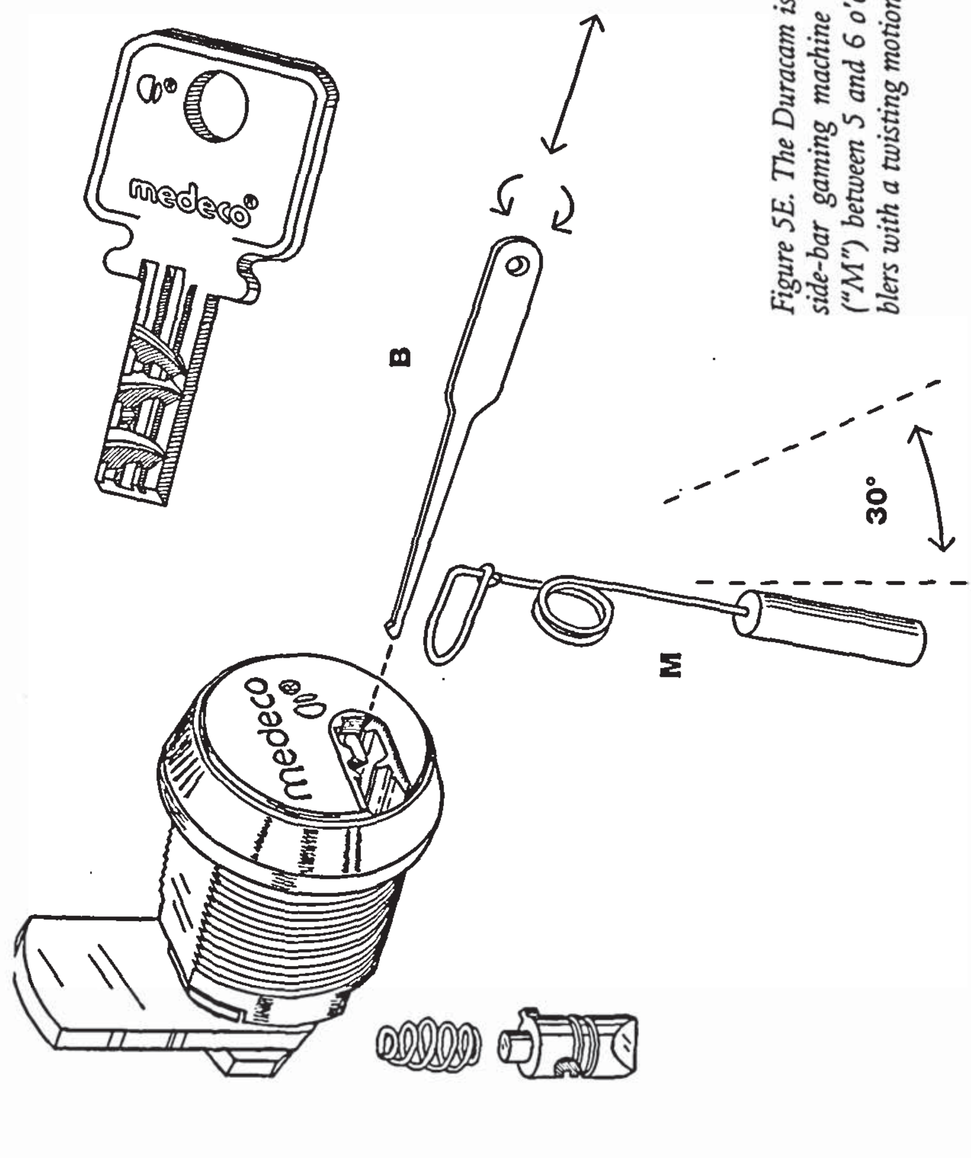


Figure 5E. The Duracam is a topless spooled chisel pin side-bar gaming machine lock. Play tension wrench ("M") between 5 and 6 o'clock while raking the tumblers with a twisting motion.

ferent tools and technique. You'll need to run a small diamond pick through the keyway with its back seated along the lower right-hand corner of the keyway. In Figure 5E you may view the pick top-edge-on as you slip it into the lock. (Also, all picks in the illustrations of this book are shown not burnished for detail. You must burnish your picks before using them or they will file off shavings from the tumblers and keyway and hinder picking.) You then want to give the pick an intermittent twist while inserting and withdrawing in order to rotate and push the tumblers up into place. In essence, you are using the side edge of your small diamond pick to raise the tumblers with the twisting.

The trick is to get a Feather Touch wrench seated in the keyway. Here is where the classic looped Feather Touch is of good use. The lock illustrated was set up for a counterclockwise turn by simply reversing the cam stop at the rear of the lock. This was the best way to show how the wrench would go into, and travel across, the lock. It inserts with its handle hanging down to the 6:30 position. When the proper force is applied, the wrench handle would point to the 5 o'clock position. While running the pick in and out with a twisting motion, vary the tension wrench pressure between 5 and 6 o'clock to set up the best transient conditions needed for the pins to align with the side-bar.

The easiest way to get the feel for this lock is to take it apart. First, simply take the cam lock cylinder out of its shell by removing the rear holding nut, cam, and cam stop. The cylinder with all its springs, pins, and side-bar will stay together, as it is self-contained. But the advantage for the locksmith here is that the keyway is exposed along the cylinder's length so that you can see and manipulate the pins while you press down on the side-bar with your finger.

Now, the uniqueness that makes side-bar locks difficult to pick is that from the outside at the face of the lock, you cannot apply direct pressure onto the side-bar to make the pins click into place. Being within a shell, the cylinder cannot turn until the side-bar is forced into place by the turning of the proper key. And this cannot happen until all the pins are aligned first.

But in this case, by applying direct pressure on the side-bar with a finger, one can see and feel each pin clicking into place, causing the side-bar to drop down flush with the cylinder. Sometimes, while picking the exposed cylinder this way, the side-bar will drop on one corner, then the other. Also, one can see when you snag a pin as the side-bar goes down only about halfway—not enough to clear the inner wall of the shell.

When picking this lock, be sure that the bottom edge of your small diamond pick runs down the very back of the keyway, or "Pac Man's" mouth. Turn the pick slightly clockwise as you run it in and out of the keyway. It takes a while to develop a feel for this way of picking; the tip of your pick will engage the tumblers sideways, so you will be using the side of the tool. Because of this, I find this lock almost fun to pick.

Pick resistance: This lock is made more for durability with key use than it is for pick resistance. But the wide keyway allows for plenty of room to manipulate the pins. I rated it at a **10.0** (includes one extra half point for originality, as most burglars would not know where to start with this strange-looking lock). It still took me more than 60 minutes to open this lock my first time.

1. *Secrets of Lock Picking*, Paladin Press, pp. 23-26
2. A broached slot is an internal slot that runs the vertical length of the pin chamber through both the lock shell and cylinder.
3. Please refer back to Chapter 1 for the spring dynamics of this wrench. This spring is specifically chosen for our tension wrench because of its characteristics.
4. *Secrets of Lock Picking*, Paladin Press, p. 9, figure 5D. Further research on my part has revealed that this tool is no longer available in locksmith's supply chains. Please see Chapter 1 for details in making this tool.
5. Note the identical patent numbers between the "Pop Lock" and the "Duracam" locks. This told me before I even started working with these two locks that they operate on the same principle. However, the Duracam is covered by the above patent because of the "claim" or "claims" detailing its unique keyway, which is perpendicular (right angle) to the action of the pins and horizontal keyway. This is the only true difference between the two locks. For more about patents and claims, see *Patent Secrets* by Steven Hampton and Craig Herrington.

6 Mushroom Chisel Pin Side-Bar Locks

Modern high-security locks have not evolved in an orderly, calm, progressive sequence. Sometimes evolutionary steps are skipped because of the ingenuity and marketing skills of the inventors of such systems. Some great ideas fall away; an incredible lock may come along only to be waysided by lack of knowledge on what to do next or just because of bad luck.[1] But most new, modern locks are sophisticated hybrids that are on the drawing boards of the big companies such as Medeco and the ASSA/Abloy Group.[2] The latter, by the way, has recently bought out the Yale Lock Co., one of the old schools of security—and locksmithing, for that matter. A new era in locksmithing has taken root.

What this all means is that there will be more high-security locking systems to come. Only large companies will be equipped to tool up for and maintain these well-organized keying systems for their customers. Duplicate keys will have to be ordered from the lock maker through the locksmith, making copying a key quickly impossible. Also, each key made will be logged into the lock maker's database, making unauthorized copies less likely. (You won't be able to take your boss's key down to the local lock shop for a personal copy on your lunch break. Aside from the embarrassment, your boss would get a phone call.)

Actually, we have been discussing these restricted locks, which have special keying requirements, since Chapter 4 (the Van lock and on . . .)

Now, the security steps up to an even more intense stage. If a species is to survive, it adapts and changes, carrying along with it all the genetic benefits of its past generations. In the same way, the pin tumbler lock has adapted to its environment and has evolved to the next level. It shows no signs of going extinct. This next group of locks is here to stay.

THE MEDECO FOUR-PIN PAYPHONE LOCK

In the last classification of pin tumbler locks (in the previous chapter) we discussed the use of chisel-pointed rotating pins, but it is within this classification that such a rotating pin has more impact, the reason being that these locks have top pins. But not just top pins; one or more of them can be a mushroom pin. And like the mushrooms growing in your yard as a child—the ones that mother told you not to eat—this mushroom can cause severe acid indigestion.

Because of these top pins the bottom pins can rotate more freely, as the tumbler springs are not pushing directly down on the chisel pins. This makes the pins a little more slippery when it comes to raking the lock.

If you are a thief and happen to be reading this, you may have assumed by the above subtitle of this chapter and lock type that you would never have to pay for a phone call again; but this is not why I included this lock in this chapter. I did so because this lock is coming into common use today and it is a unique and tough lock to pick. Also, many of these locks are used on privately owned pay phones—phones owned by individuals—and again, my intention is not to cause others loss. But because of the difficulty involved in picking this lock, I seriously doubt if this chapter will cause its extinction. Let's have some fun and tackle this one together.

Medeco, once again, has come up with a uniquely different and difficult to pick key-operated mechanism for the consumer, albeit a combination of past systems. Note the anti-drill pins in its face. Behind them are anti-punch and pull plates (the half-moon shaped discs). If a thief were to drill into this lock, he would get to break his drill bit. The next morning, the locksmith would get to carefully file out the keyway so that the owner's key would slip into the lock so that it could be opened and replaced—with coin box intact. But for the thief, the drill pins and punch plates are just the tip of the iceberg when it comes to breaking into this lock.

The bottom pins in this lock have more grooves than an old hippie reunion. These grooves are arranged in a vertical (up and down) and horizontal (left to right) fashion. The deep vertical groove must align with the studs on the back of the side-bar so that it can retract when the cylinder is turned. This groove is a deep V-shaped slot along the length of the pin (see blow-up of the bottom pin in the drawing) and its placement varies. The shallow vertical grooves are "fake" to confuse the expert lock picker; the side-bar will give a little when it encounters these grooves, and its compression locks up the pins from further rotary movement. The pin will still elevate, however, this pin lock-up prevents a rogue key from entering. Because the chiseled pin can't rotate, it leads the lock picker to believe that he is still picking the lock and that the pin is aligned.

The horizontal grooves act as shallow spool pins, which is another picking deterrent—a job normally associated with top (driver) pins.

The top pins in this lock are smooth, except for the mushroom driver(s), naturally, but these top pins do not have much area to engage shear line. So spooling them would require a larger diameter cylinder—which isn't necessary. Along with its tight, corrugated keyway this lock is damn near pick-proof.

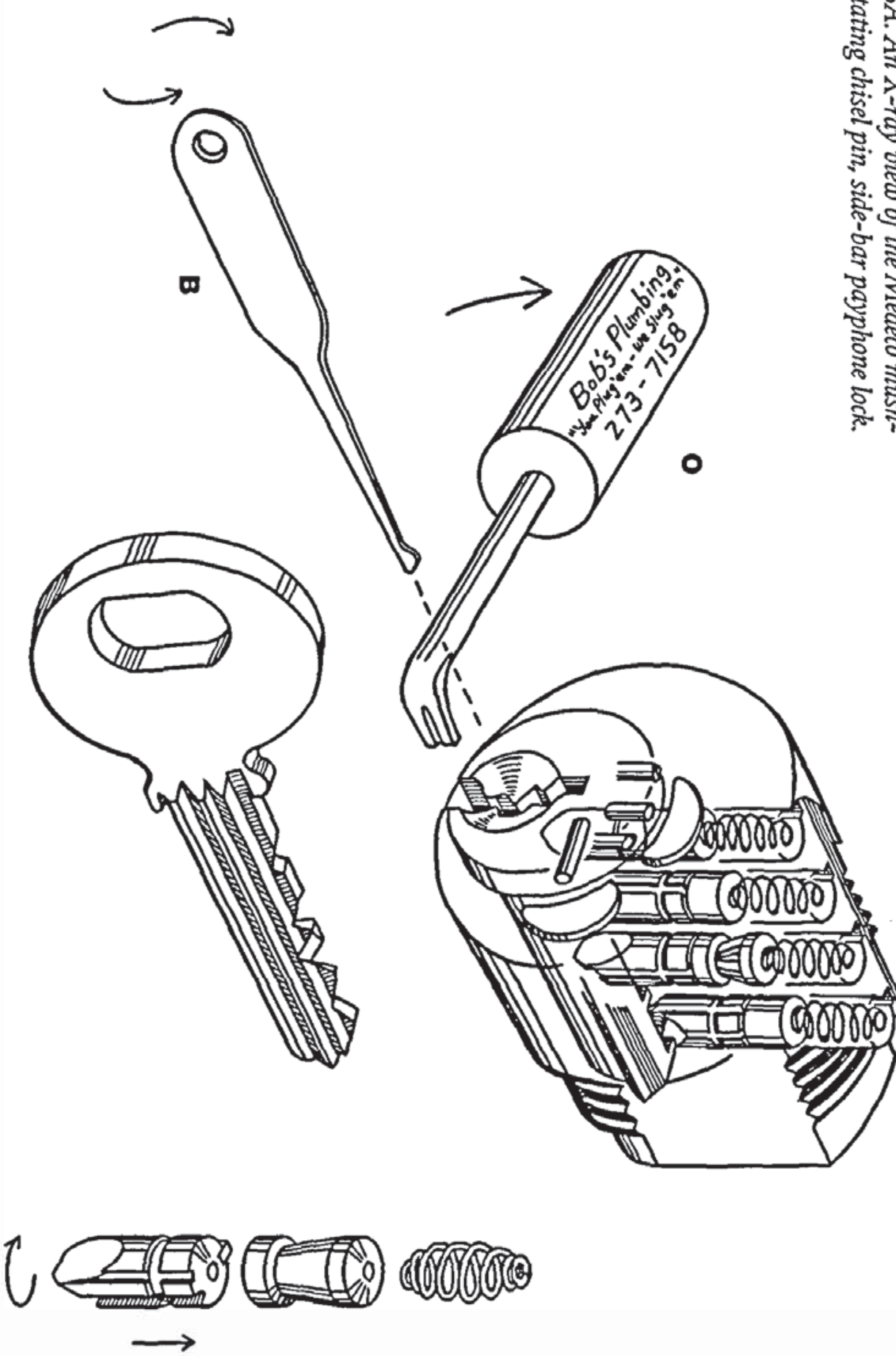


Figure 6A. An X-ray view of the Medeco mushroom/rotating chisel pin, side-bar payphone lock.

All-in-all, this lock is well designed in that nearly all the possible ways to secure the cylinder seem to have been utilized.

In Figure 6A, note the tiny spring behind the side-bar and seated between the side-bar's rails. This is one of two springs that maintain an outward force on the side-bar to keep it in the locked position. Generally, a side-bar also helps to resist the forced turning of the cylinder.

I first tried picking this lock using the White Crane tension wrench with a twisting force at its very end. I mounted the wrench into the bottom of the keyway upside down—that's right, upside down Crane. (Refer to Figure 7F.) This creates a uniform force along the length of the cylinder. When done properly, it will loop around the top face of the lock while you are doing this, to the right of the lock face when turning right, and vice versa the other direction. But, there is still room to slide the pick in.

The pick best for this job is the small diamond, no more than .031" thick. Even though the keyway is tight, this pick can maneuver quite easily along its length to engage the pins. (The standard Monkey pick will not fit into this keyway with a tension wrench inserted.) Use a gentle, raking motion while occasionally rocking the pick up and down slightly (this will be sufficient to rotate the pins while they are being elevated). Do this to get a feel for the lock. Vary the motions each time you pick to try all the options that are available with these tools.

The first time I popped this lock in this fashion, my Crane flew the coop and the cylinder snapped back tight. So, if you have trouble with this technique, try the looped Feather Touch wrench. There was less room for the pick, but I managed to open it again. This wrench will also help you find just which driver pin(s) are mushroomed, as this type of Feather Touch wrench has a slightly stiffer torque.

Sometimes, on certain locks like this one, you need a stiff wrench to find the mushroom pin(s). Because this keyway has a wide opening at its bottom, I discovered that the TuBar tension wrench fits nicely into this shallow part of the opening.

This allowed me to get a firm grip (but still, with a light touch) on the cylinder so as to find the mushroom pin causing all the problems. I then went back to using the looped wrench, and remembering where this pin was, I raised it slightly higher than the other pins to clear the mushroom "cap" pin end.

Because the side-bar spring pressure is so high in this lock, a stiff tension wrench is needed to compress it to turn the cylinder when you do get the pins aligned. However, if too much tension wrench torque is applied, then the mushroom pin(s) snags the cylinder. So one must alternate between wrenches to get a feel for that particular lock. As always with spooled and mushroom pins, if the cylinder seems eager to turn but won't, then you probably snagged one of them and must release tension to start over again.

Pick resistance: This lock is excellent security. The engineering of the bottom pins is a marvel of machining. Setting up to manufacture these pins for production—with several different pin configurations—must have been a huge challenge. The first pick took me 97 minutes, the second, about 38 minutes. But, oddly, I haven't been able to pick this lock open a third time so I rated this lock high: A respectable **11.0.**

THE MEDECO SIX-PIN DOOR LOCK

This Medeco lock has been around for some time now and has proven to be an effective deterrent to picking. As we have seen, Medeco locks use a rotating bottom chisel pin. Again, it is not that the chisel pin has to rotate to clear at the shear line, rather, it has to turn to allow the side-bar's rails to align with the pin's grooves.

The key is cut to turn the pins as it enters the keyway. So a rogue key—or even another Medeco key—cannot enter the cylinder, as the pins will jam up when turning the cylinder. But this is not what makes most Medeco locks so difficult to pick open; it's the fine machining of the lock itself.

Note in Figure 6B the following items: #6 marks the anti-pull/punch plates and #5 marks the anti-drill pins. These are

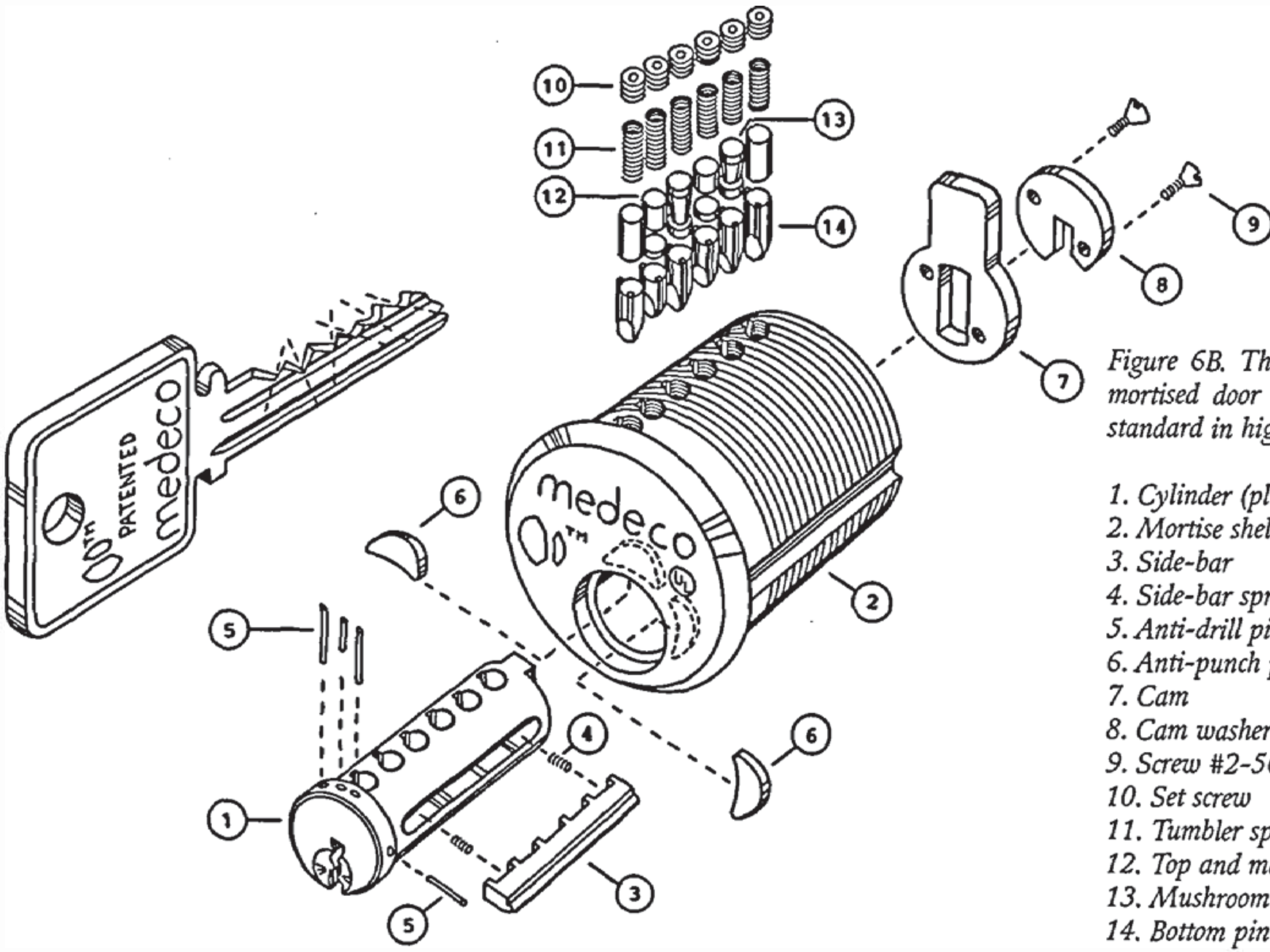


Figure 6B. The Medeco six-pin mortised door lock is a reliable standard in high security.

1. Cylinder (plug)
2. Mortise shell
3. Side-bar
4. Side-bar spring
5. Anti-drill pin
6. Anti-punch plate
7. Cam
8. Cam washer
9. Screw #2-56
10. Set screw
11. Tumbler spring
12. Top and master pin
13. Mushroom driver
14. Bottom pin

relatively new additions to the security features of these locks, along with Roy Oliver's patented pins. The older Medeco mortise cylinders did not use anti-drill pins and anti-pull/punch plates. About 25 years ago (in the mid-1970s), Medeco started using an anti-drill pin in the face of their cylinders. Over the years, they increased the anti-drill pins and added the anti-pull/punch plates as well and the Medeco 10 series mortise cylinder lock is the result.

But, the only real difference in the 10 series mortise cylinder from the four-pin phone lock is the two extra pins and the lack of horizontal grooves on the bottom pins. You can pick this lock much like the four-pin phone lock above. But this keyway has room for the Monkey pick, if you prefer. I found that there is also room for the looped Feather Touch wrench as well and since there are no horizontal grooves across the bottom pins, this makes up the difference for the two extra pins. In essence, the two locks are nearly equal in security.

Pick resistance: In *Secrets of Lock Picking*, I mentioned that I picked this lock once many years ago. But leaving nostalgia behind, in reality, this time it seemed much tougher—around 110 minutes—probably because of Oliver's chisel pins. I also believe that the overall machining has improved. I would have to rate this lock at **11.5**.

1. Conceiving, developing, and prototyping an invention is one thing. Getting it profitably to market without someone stealing it is another. For more information on inventions and inventing, see author's other work, *Patent Secrets*, Paladin Press.
2. As of the year 2000, Medeco was also acquired by the ASSA/Abloy Group.

7

Spooled/Mushroom Multiple Row Side-Bar Locks

Just when you think that you have mastered the pin tumbler and all of its descendants—when you know that you are the expert and the party is really rocking—a turd surfaces in the punch bowl. This is how the next lock group hit me. But, like an old friend and kung fu master once said, "This isn't heaven—this is the human realm."[1]

And this class of locks "isn't heaven" for a good reason. Take the best six-pin tumbler lock that you have ever encountered and throw a five-pin tumbler GM side-bar into the works for good measure. Now, make sure that all of those pins align at the same time before you even try to turn the cylinder with your tension wrench. See the problem? Not enough hands.

THE RUKO EUROPEAN BANK DOOR LOCK

Single row pin tumbler locks are relatively easy to pick, even if a spool or mushroom pin is thrown in for kicks; with a little bit of patience and skill, one can pop a six-pin within a reasonable amount of time. But what happens when you are presented with another row of pins out of symmetry with the main row? An Alpha or even a KABA can be picked without having to bring your lunch because the three rows of pins are arranged close together—and the pick can be utilized in one area within the keywell.

But when the rows are separated by the height of the keyway, one begins to ponder if it would not be easier to sprout an extra hand out of one's bellybutton.

Such is the Danish-made Ruko, a high-security lock that has a cylinder that sports 11 pins—six standard pins at center top and a five-pin side-bar down to the lower left side of the cylinder.[2] Amazingly, this lock has been in use for more than 20 years.

If, as an American, you should ever encounter this lock, chances are you are in the old country visiting neighborhood tourist shoppes. (However, we wouldn't want someone to use this information to rip off our European neighbors and friends. It would take so long to pick this lock that someone would turn the thief in to the local police, and being arrested in a foreign country with lock picks would ruin the vacation—indefinitely.) A few decades ago, this lock graced bank doors in various parts of Europe. But it is wise not to be too curious of locked doors in foreign countries unless you are specifically trained to be a spook. This lock is out of production, as Ruko is no longer in business. ASSA makes the IC (also known as replacement cylinders) for the Ruko locks still in use.

Note how the key is cut as if it were two keys in one. Also note the small steel rod embedded in both sides of the keyway entrance. This effectively deters drilling the brass cylinder by snagging the drill bit. Behind the cylinder face is a hardened anti-drill plate that catches the drill bit tip (should it break through the face) and takes the whole drill for a merry-go-round ride in the burglar's hands.

Also note that all of the six top pins in the main row are

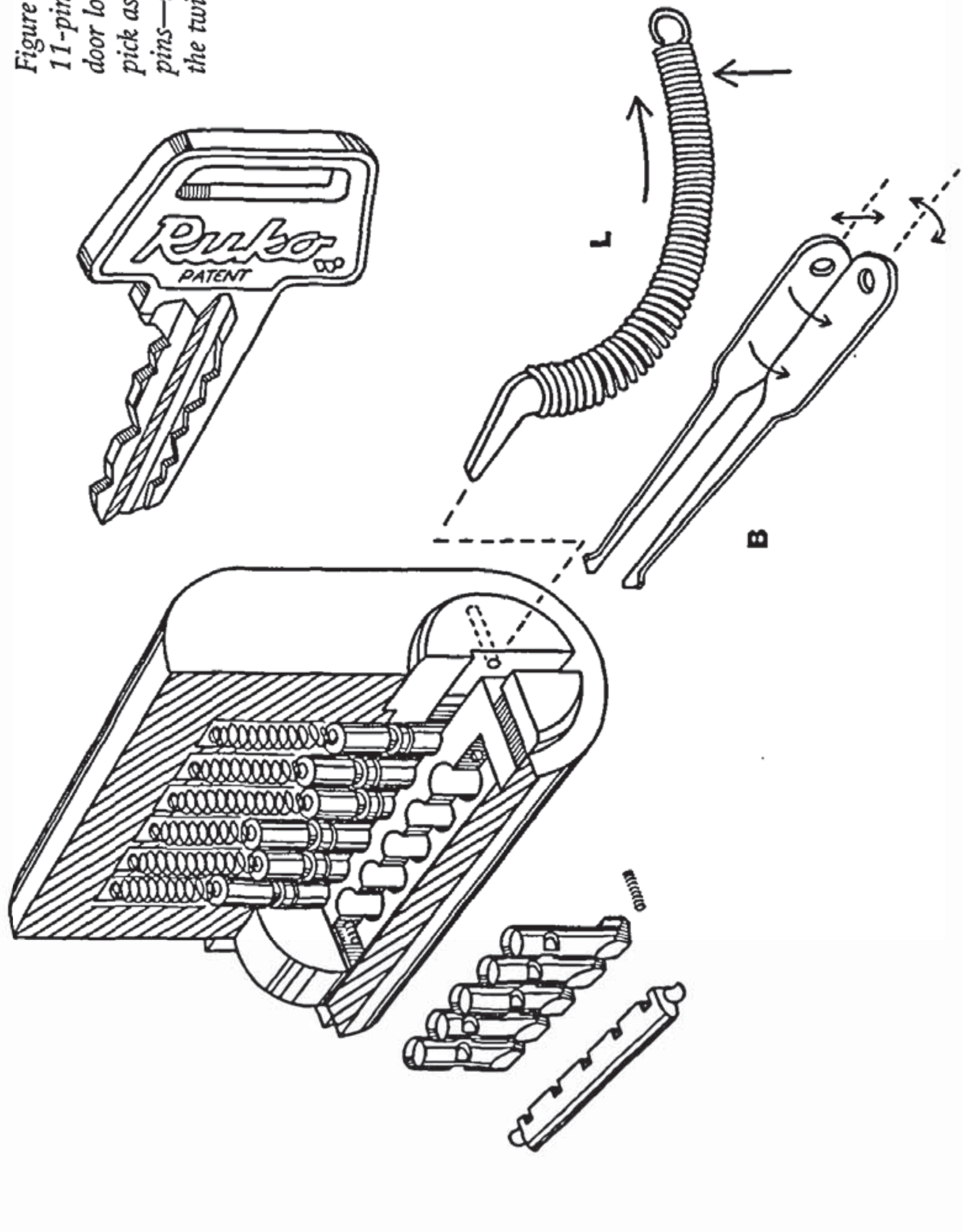


Figure 7A. Cutaway view of the 11-pin Danish-made Ruko IC door lock. Use the small diamond pick as a dual-function rake: Top pins—rock and roll. Side pins—the twist.

spooled. The five side-bar pins, though not spooled, offer an even bigger challenge in that they are chiseled—and unlike what we learned in the last chapter, these pins do not rotate. Instead, they are chiseled to allow for the very tip of the pin to catch as much of the key cuts (on the left lower side of the key) as possible because these cuts have little surface area to interface with the pins. In fact, the side-bar pins have a little tab near their ends so as to engage the lower key cuts more completely.

Also, the side-bar pins are "pinched" on their sides and these indentations (which are actually machined into the pin sides) align in vertical fashion with the side-bar slots to allow the side-bar to retract and release the cylinder. The tops of these pins are recessed into a bowl-like depression to seat and retain the end of a spring, unlike the side-bar pins in the topless spool pin locks that we discussed that use a peg to center and hold the spring. This minor difference, however, does not affect the way the lock functions, or is picked.

When picking the Ruko cylinder, use a small diamond pick (with a thickness of no more than .025" as the keyway is fairly corrugated) and a Feather Touch wrench. The looped wrench has a good tension and feel, but the Crane (with its .035" thick end) fits the keyway the best as it has a lower end-profile.

Place the tip of the Crane tension wrench at the top of the keyway (center of the cylinder face) so that you have room to run the pick in and out. Also, so the whole lock could be shown, Figure 7A depicts the Crane tension wrench positioned right side up. You want to mount the wrench upside down—the key-chain end of the wrench will loop over the top half of the lock. This is so you have room to maneuver the small diamond pick within the keywell. (Refer to Figure 7F.)

First, rake the six main tumblers on center line as you would any good spooled-pin tumbler lock. Rake the pins until they feel like you have moved them into some kind of position for alignment; do not rake until you snag a spool pin, as this will defeat the purpose of even going on with the next part of this procedure.

Next, while maintaining wrench pressure, pull out the pick and turn the same small diamond pick to the 90 degrees horizontal left—a "lazy diamond"—and slide the pick down to the lower left of the keyway. Now, rake this lower left set of five pins with a subtle twist of the pick. Do not teeter the pick. Gently twist it, but not too much—there is little clearance at the base of these side-bar pins and their tabs to the bottom of the keyway. Here, you don't have to worry about snagging a pin as these pins are not spooled and do not rotate.

You must alternate between these two sets of pins until the cylinder gives way to top pin snagging. Once snagged, release the cylinder of tension and drop the pins back down to start over. This type of tension wrench play is an important factor while picking high-security locks. The skilled lock picker will recognize the moment such treatment is needed on the lock when the cylinder engages the pick (via the tumblers) and responds directly to the motion of the tension wrench.

Pick resistance: Committed to picking this lock, I was Shanghied by my own ego onto a banana-boat cruise of frustration, and after two weeks of picking (I lost count of how many hours I had logged on this whacked-out tour of duty) I awoke with a drunkard's head. My bloodshot eyes fell upon my hands as they trembled the tools within the whored cylinder. I blinked. That moment, she slipped effortlessly open to port.

"I am free!" I cracked with hoarse voice as the shackles of pick and wrench fell from my joint-aching fingers. "FREE!" I exclaimed with clearing throat as the tools plinked into the submerging deck at my feet. They floated down like lost silver coins, resting flat and gleaming back at the sun-lighted hatch above my louse-ridden head.

Anyway, that's the way it felt when I finally popped this ball 'n' chain. But now, as I write this, I wonder if I didn't open it because I wore the pins down from sheer repetition and countless snagging of the spools. (I am certain though, that at the very least, the keyway is wider.) Actually, I exaggerate here—this lock is stainless steel. But, I haven't been able to (or felt the desire to) walk that plank again. Arrrrrr! This is a very high-security lock. I give the Ruko 11-pin tumbler/side-bar a pick resistant value of **12.**

And if that doesn't discourage the enterprising pirate, Ruko came up with a spooled, multi-pin row, multi side-bar lock (the Twintronic) that also incorporates an electronic recognition system within the cylinder and key. We will cover this lock in Chapter 10.

THE ASSA 6000—U.S. POST OFFICE DOOR LOCK

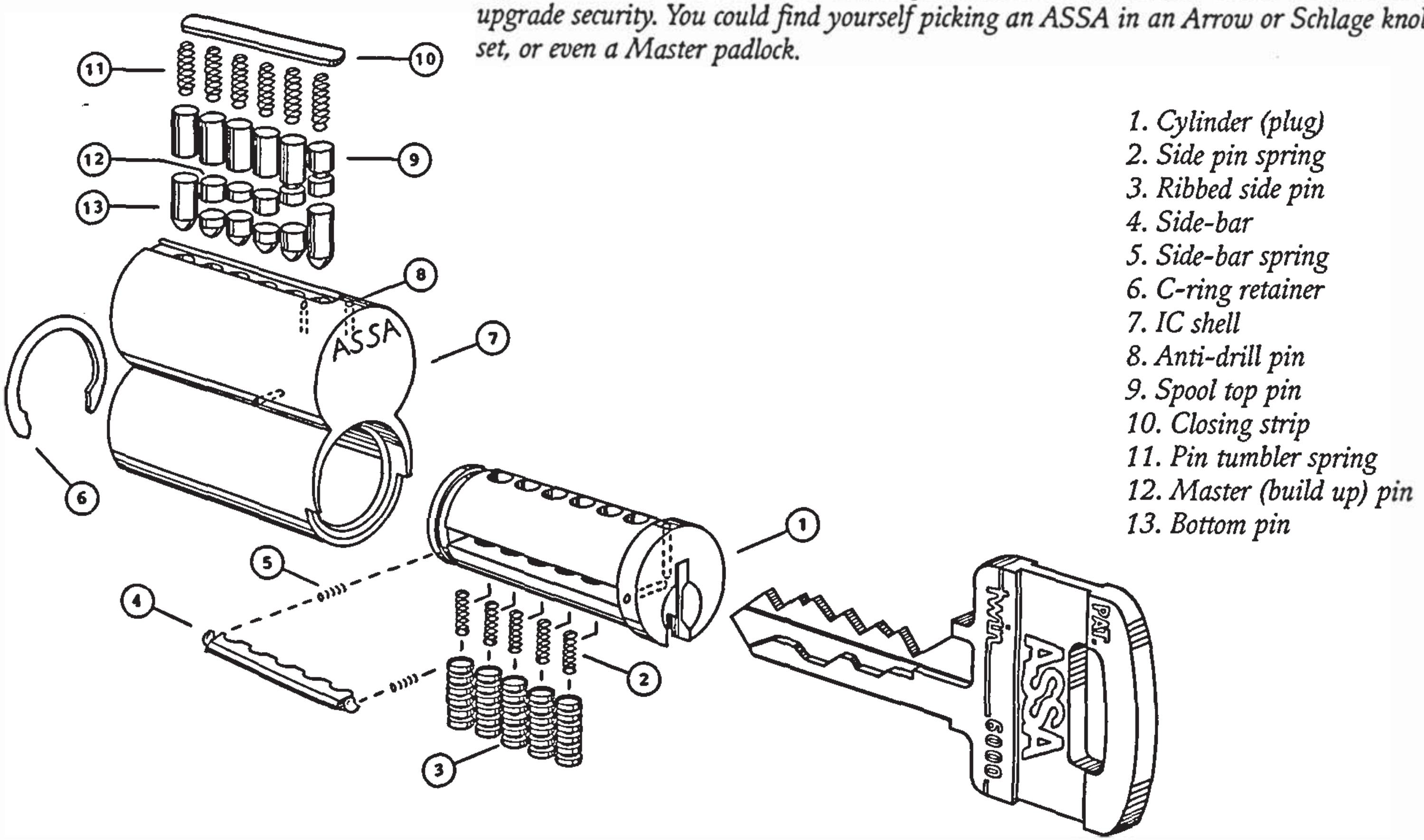
Building upon the success of the Ruko, the ASSA 6000 series also features a "coded" side-bar system, making the picking of this lock a supreme challenge. The side pins in the 6000 are all made the same—with two false shallow grooves flanking a deep middle groove—while the side-bar is cut to a code that matches the cuts in the side of the proper key.

The older ASSA 6000 series ICs (U.S. Patents #4,356,713; #4,393,673; #4,577,479) do not spool all of their top pins, but this lock is still, most certainly, considered "high security."

The 6000 comes in a variety of cylinder replacements. You may encounter a Schlage cylinder using this 11-pin set-up and not know it, unless you happen to notice the slightly wider opening at the bottom left of the keyway. These older ASSA 6000 cylinders were considered *the* security lock for the past 17 years and were used on the doors of some U.S. Post Offices (along with another brand lock, the Schlage Primus, which functions on the same principle of the 6000, but with fewer pins. Its patent number is also unpublished). Some post offices still use the 6000. Since the patent recently ran out (U.S. patents issued today are now good for 20 years—upped from 17 years), ASSA has designed the Twin V-10 with a "unique-but-secure keying system, making key duplication—by key machine or by hand—virtually impossible."

The ASSA 6000 ICs being deployed within other brand-name locks now have the insignia "ASSA" on the face of the

Figure 7B. ASSA's Twin 6000 series cylinders are used in other brand-name locks to upgrade security. You could find yourself picking an ASSA in an Arrow or Schlage knob-set, or even a Master padlock.



replacement cylinder. So if you approach one of these cylinders, you'll know right away what you are up against.

Other lock companies using the new ASSA system are Arrow, Corbin/Russwin (the companies are now merged), Sargent, and Yale, which now belongs to The ASSA/Abloy Group.

Now, what is bad news for the lock picker is that the upper driver pins in the IC locks are usually spooled—the first, third, and fifth top driver pins at the very least—depending on the locksmith who set up the cylinder. But the worst news is that the lower left pins are side-barred as well.

Pick resistance: This whole group of locks is tough to classify on a scale, but I rated the ASSA 6000 series in general to be very good locks at **12.0.**

ASSA TWIN V-10

In 1999, the patent ran out for the Swedish-made ASSA's Twin 6000 series lock. In order to improve the security of its cylinder, the ASSA Twin V-10 was created (covered by U.S. and Canadian patents #5,067,335 and #5,640,865). Like the Ruko, it has a cylinder that carries 11 pins—six standard pins at center top (but all mushroomed top pins) and a side-bar down to the lower-left side of the cylinder with five more "ribbed side pins" that are heavily spooled. Mushroom top pins are seldom used in other locks, as they can jam up in sloppy cylinders. Here there is little slop, which makes picking very tough.

The side-bar is also very different here. The side-bars are counter-spooled (each lock differently) by their recessed side-pin spaces to make picking even more distasteful. Note how this key is also cut as if it were two keys in one.

The ASSA Twin V-10 is one of the few locks that conforms to U.S. military standards in quality and function. It is listed under Underwriter's Laboratory's test #437, which has been established for high-security locks to determine the cylinder's physical resistance against various forms of attack. It is stainless steel throughout, including the pins (with the

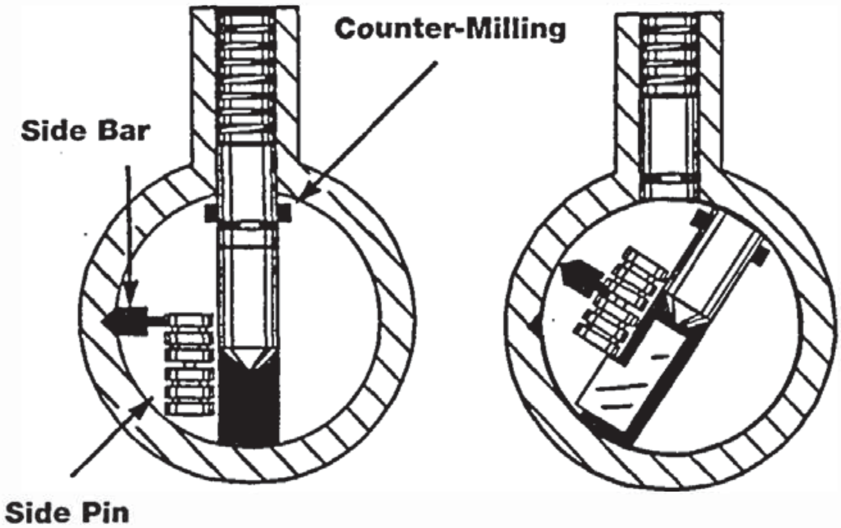


Figure 7C. Frontal cutaway view of the ASSA V10: Making the most out of spool pins.

exception of case-hardened anti-drill inserts), making this lock one tuff hombre.

Let me quote from the locksmith's service manual on this gem:

"Inactive 'dummy' grooves in the side pins catch the side bar when improperly positioned. When rotational force is applied to pick this lock, the mushroom-spooled pin tumblers, close tolerances, and counter-milled pin chambers protect the cylinder from virtually every known picking method."[3]

The side pin used in the ASSA Twin V-10 cylinder has four false grooves to confuse picking attempts. Out of five grooves only one, located in one of five positions around the side pin, is deep enough to allow alignment with the side-bar.

Note how the top driver pins in the main central row are not only spooled, *they are mushroomed as well.* The bottom ends of these spooled pins are turned down to a smaller diameter than the rest of the pin barrel, and then rounded on the ends—shaped like a cone-headed mushroom. This enhances their effective pick-resistance value. Plus, the pin chamber

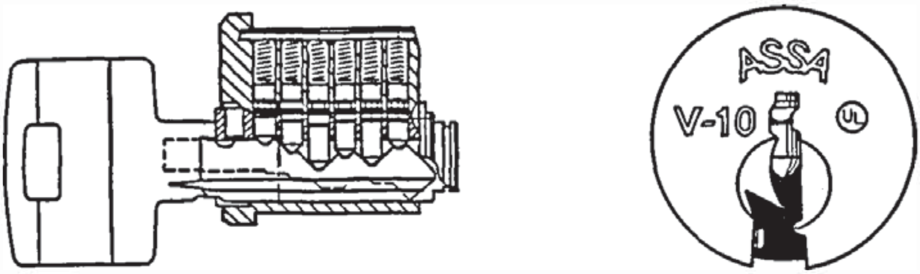


Figure 7D. Left: A cutaway side view of the ASSA Twin V-10. High precision in a small package—32 moving parts controlled by a key. Right: A peek down the throat of the V-10 cylinder.

counter-milling latches the spools up tight if not raised to their proper height.

The ASSA Twin V-10 has two different ribbed side pins: a left-hand and a right-hand. Like the Ruko, this side pin has a tab for maximum contact with the key cuts along the side of the key. Most locks use the left-hand side pins as is depicted in Figure 7F with the tabs protruding out to the right of the observer. Right-handed side-pin ASSA V-10s can be special-ordered, which messes up any picking skill that one may have mastered while learning the left-hand side-bar arrangement.

ASSA keeps fastidious records on who has what key for each and every one of its locks. You should have heard the discussion that I had while ordering one of these locks; I've applied for loans with less grilling. This company keeps detailed track of every key they make for each and every one of their locks.

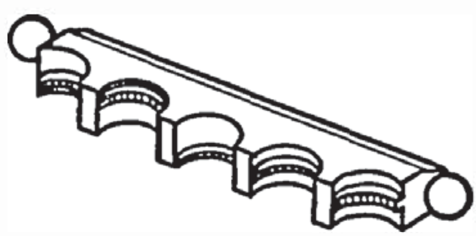


Figure 7E. The ASSA V-10 side-bars: counter-spooled and coded, this finely machined part is designed to catch the ribbed side pins the wrong way while picking.

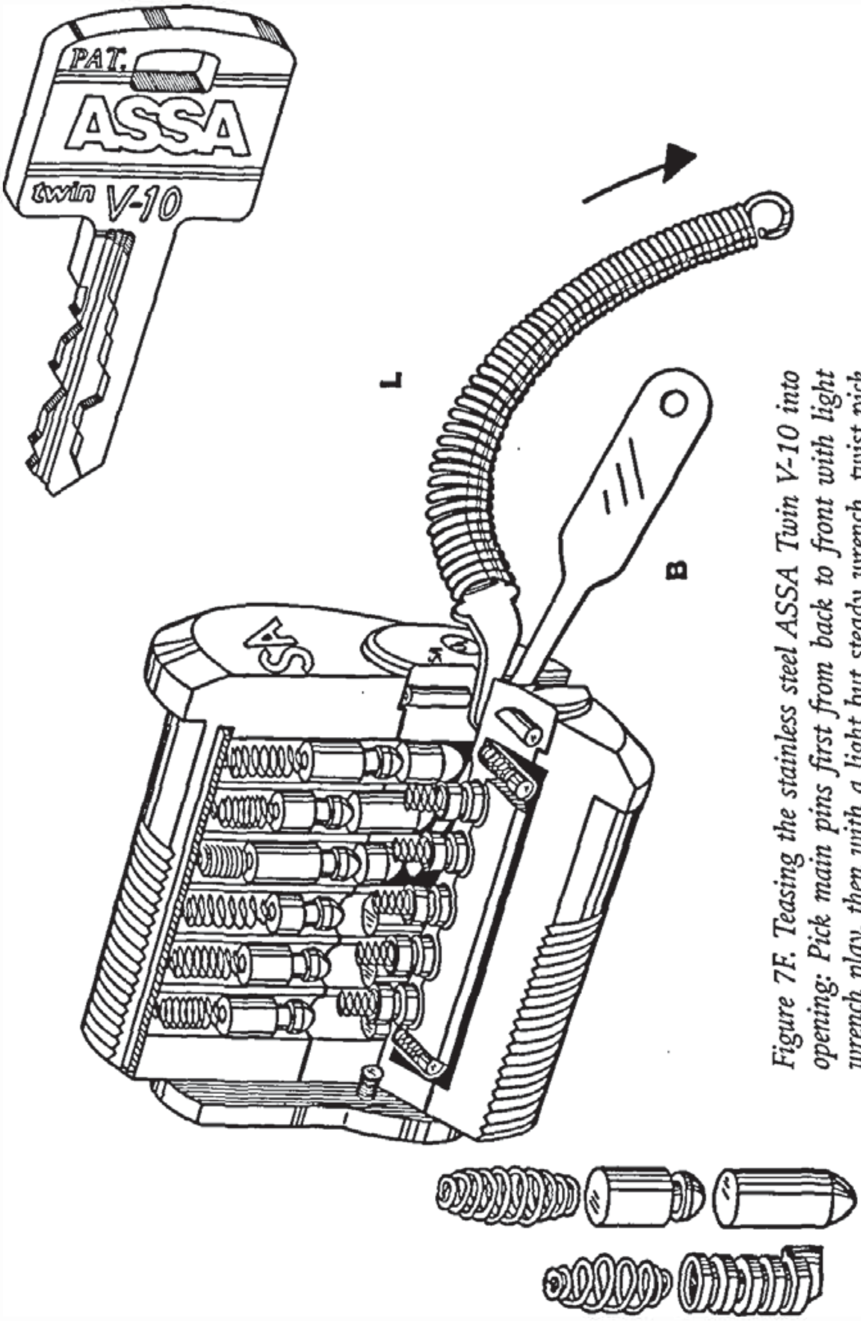


Figure 7F. Teasing the stainless steel ASSA Twin V-10 into opening: Pick main pins first from back to front with light wrench play, then with a light but steady wrench, twist pick and rake side pins in the same fashion.

This shows responsibility on the part of the lock maker and reflects how security has evolved—if you need a second key, you'll first have to tell them who you are giving it to. Here, the lock maker takes responsibility and logs its keys. The keying system is so complex and out of the scope of this book that I prefer not to discuss it here. It wouldn't do the emergency lock picker any good, anyway.

Pick resistance: I rate this lock at **12.5**, not only because it is just better than the Ruko, but because it is so good that it has to fill the gap between an even better lock (shown in the next chapter) made by the same company. Also, as of this printing, I have not been able to pick this lock. As such—if I may be so bold—all pin tumbler locks would seem to fall below the **13.0** range in pick resistance. Also, any lock rated at the **11.0** level and above acts as virtually pick-proof for the first two hours of non-violent attack, established by the current, up-to-date premise of this book. (Pick-resistance ratings above **13.0** are reserved for some of the newer rotary tumbler locks, electronic card/key locking systems, and mechanical and digital safe locks—some of which will be covered in later chapters as they require a broader-based knowledge of their operation.)

1. Sensei John Angelos, Boulder, CO, 1987
2. Compliments of René Larsen of Denmark
3. ASSA.

8 Isolated Keyed Tumbler Locks

Many unique locks have come and gone. It would be nice if there were a lock museum that housed exact replicas (if not the originals) of all the locks ever made. However, it would still be very difficult to trace the order in which the ultimate pin tumbler lock evolved. And, unbelievably, it is doubtful that this group of locks is the last word in high security.

If you are reading this chapter, you are well into maximum security (not the cell, I hope—locks, you know) because this lock is tops. Personally, I would not even try this next type of lock without first feeling out the Medeco line of security locks. I even thought about using my teeth (Harry Houdini's approach) to give me an edge on this lock—but that is not recommended. Even so, to the professional burglar, this lock is an enigma because this category of locks is in a class of its own: "Submitted for your approval . . . at the signpost up ahead, your next stop—the Twilight Zone."

In my drive to classify stuff, I could have entitled this chapter "Spooled/Mushroom *Springless* Multiple Row Dual-

Coded Side-Bar . . ." Well, I just had to shorten it somehow. But this is the real short of it:

When a tumbler locking system removes itself from the keyway as far as it possibly can, it becomes extremely difficult to pick. Take, for example, an old, simple safe. Its handle is attached to a "fence" or "bolt" that rides on the two or three disc tumblers, each having a notch or "gate." You can hear and even feel these gates when you put pressure on the handle and turn the dial driving the tumblers as they rub across the bolt. This makes it easy to deduce the combination. When these gates are aligned by dialing out the proper combination, the handle/bolt can drop into the gates and allow it to turn, opening the safe door. In newer safes, the last tumbler (or number dialed) directly operates the bolt. But the handle is attached to a separate mechanism that releases the door. The handle can't turn unless the bolt is retracted out of the way by the act of dialing that last number. In this way, the bolt is isolated from the act of turning the handle. This prevents one from feeling the tumblers directly by manipulating the tumblers against the bolt.[1]

In the same way, a superior pin tumbler lock would isolate its pins from the cylinder making it nearly impossible to manipulate the system open without the proper code or key because you cannot feel the effects of the tumblers that you are picking! There is little, if any, connection between the shearing force in the act of turning the cylinder (like that of the safe's handle) and the motion of the pins (the safe's discs) required to allow that shearing action to take place. The more of a buffer zone between the two actions, the more secure the system is going to be. And there is no other key-controlled lock that demonstrates the power of the principle of isolation than the ASSA Desmo.

THE ASSA DESMO PHARMACY CABINET LOCK

In 1995, Abloy and ASSA merged, forming the most powerful force in pick-resistant lock manufacturing known. Out of this merger came a concept lock that is like no other. The result was the ASSA Desmo, which made its debut in 1998. A similar lock—the ASSA Twin V-10 door lock is based in part on this principle. (Refer back to last chapter on the Twin V-10.)

The Desmo is used on drug carts in hospitals because of its restricted key control. As of 2000, the Desmo is also available for payphones in AT&T- and GTE (now Verizon)-type machines. The manufacturer claims 1 million different key codes per lock.[2] One peek down this keyway and Harry Houdini would hit the streets looking for a real job.[3]

This lock is stainless steel throughout—tumblers and all. But don't let the wide keyway fool you into a false sense of confidence.

This revolutionary lock uses either six or eight pins depending on the size of the locking function—cabinet or door. The maker claims that the lock can be extensively master keyed. The beefy key is constructed of silver nickel for long life. It is resistant to bending and breaking due to its heavy construction. The "V" notch on the top edge of the key bit is a key machine reference and hold-down point and also allows the side-bar spring guide pins to retract into this gap, holding the key into the lock.

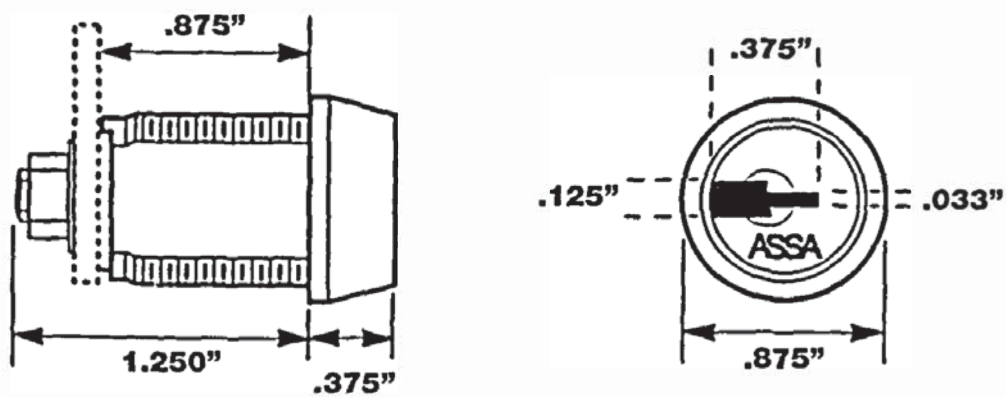


Figure 8A. The stainless steel ASSA Desmo is an isolated keyed tumbler lock that sets a higher standard in pharmaceutical cabinet and door locks.

The key slips into the lock so smoothly that operating this cylinder is virtually effortless. In fact, the key falls out of the tilted lock in the locked position. This is the most well-machined lock that I have ever encountered.

The ASSA Desmo incorporates a completely new locking technique based on directly driven pins. "The Precision Drive Pin System" operates independently of springs. According to an ASSA sales brochure, "The pins are 100-percent guided by the operation of the key." Being independent of the cylinder further isolates pins. Not being spring-loaded, the tumblers offer no feedback to your picking progress—it's like picking air. The Desmo dominates pharmaceutical locking applications because there is just no way that a person who is not firing on both hemispheres could open this lock by picking.

When I took this lock apart, I was at first disappointed. Is this all there is? I could not believe its simplicity. But when I saw all of the connections I realized why this lock is so good. Not only is the Desmo durable and reliable, it is amazingly simple. This is because the Desmo borrowed from past successful lock technologies:

- The Desmo pins—the main pick deterrent of the lock—are copied from the old reliable Yale lock (Chapter 2) spool pin technology of the last century;
- Like the TuBar discussed in Chapter 3, the Desmo demonstrates that two side-bars can fit into a cylinder;
- Also like the TuBar, it uses eight spooled pins with two false grooves;
- From the Medeco topless spooled pin side-bar locks described back in Chapter 5, the Desmo operates as a linear side-bar system with only one pin segment per chamber;
- This hybrid also uses the sides of the key to engage the tumblers rather than the edges, which is borrowed from the Ruko and ASSA V-10 designs detailed in Chapter 7.

The major difference between this lock and all of its ancestors is that it is springless, depriving lock pickers of getting the feedback they need.

Referring to Figure 8B, we see that the middle and bottom sections of each pin are sleeved by the cylinder, making its travel very linear and smooth. But most amazingly, the pin damn near floats down when dropped into its pin chamber. There is no pin/cylinder shear line or any place where a tumbler can be felt when torque is applied to the cylinder.

The tumblers are offset from the keyway down its entire length. You can't even see a tumbler directly. Peering down the keyway, with the narrow end of the keyway up, is a miniature scene from Stephen King's *The Shining*. It's like looking down a stainless-steel hotel hallway with recessed doorways—four on each side. The pins, like the V-10, have "tabs" that protrude out of their sides at the bottom of the doorways, looking like sets of unknown shoes ready to leap out of the doors into the hall. (I've been told that I have a "rich inner life.")

Actually, these "tabs" are round, like one end of a weightlifter's dumbbell, with a single plate (as opposed to the top end of the pin, which looks like a stack of plates on the dumbbell). This bottom end of the pin is also heavily deburred (no sharp edges) so as to accommodate the slots along the key. These key slots are "funneled" on the end of the key to pick up the tumbler "tabs" even if the lock is upside down.

The lower sides of the key have a machined groove that is one continuous slot that snakes along both sides of the key bit up to the bow. Each set of grooves is coded differently on each side of the key because this lock has two rows of these tumblers, one set on each side.

The lock's pins are entirely without springs (to wear out), yet when the lock is upside down the key slips smoothly into the keyway all the way back into the cylinder. Precision is the key to security and this lock has it.

At first glance at Figure 8B, one is reminded of a cutaway view of an eight-cylinder engine of some kind. But note the piston-like tumblers with what appear to be ring-grooves about their top ends. This is what spool pins have evolved into: a way to repeatedly (and most inconveniently) snag the pins while you are trying to pick them. Figure 8B shows these pins set into their side-bars with the lock unlocked. Basically, these grooves play direct interference with the link between the side-bar and the pins. This isn't new, though, as we discussed multi-spooled pins in the last chapter on the ASSA V-

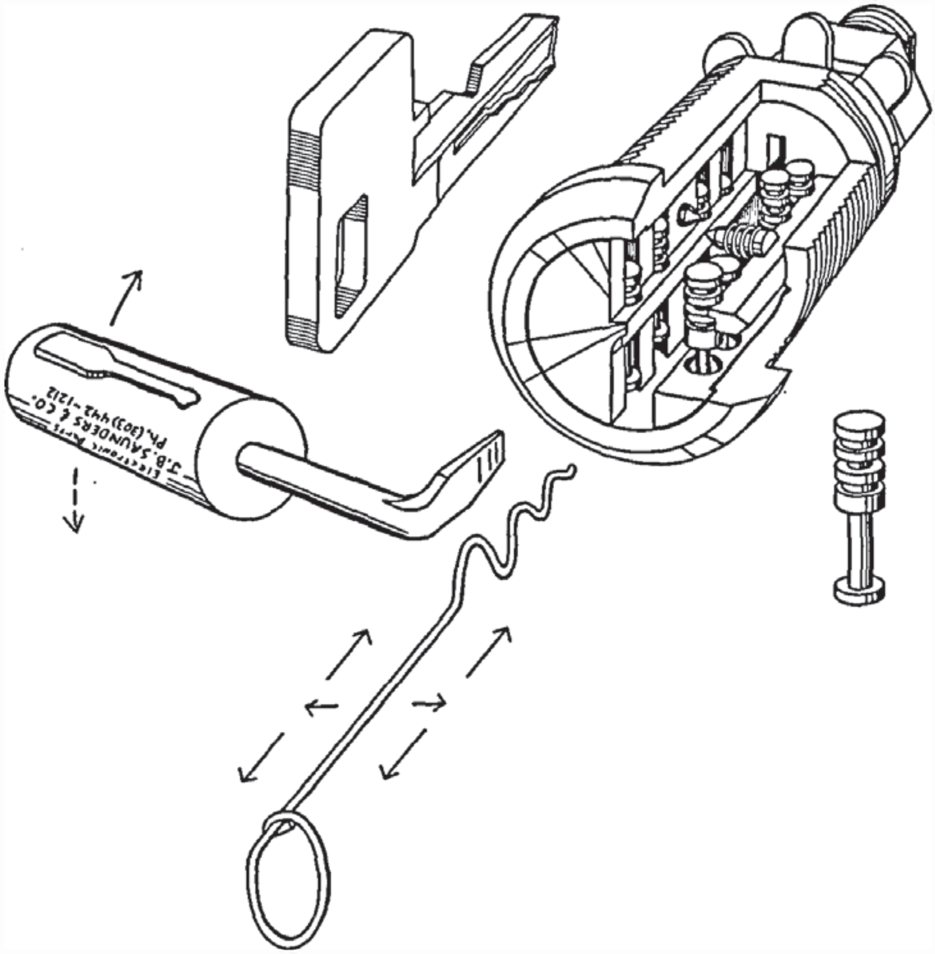


Figure 8B. Picking the ASSA Desmo with household items: A small, bent screwdriver tension wrench and wire snake rake. Rake in a "U" pattern: in left, out right; then in right, out left.

10. But here, all of the multi-spooled pins are not sheared. This almost totally isolates the pins from the action of the cylinder with the lock picks. If you haven't already guessed, the climax to this horror story is that there are two sets of side-bars.

At least with spring-loaded tumblers you get feedback of some sort. With this system, you really need to create the feedback system yourself somehow. In other words, short of using nanobots, this type of spool pin/side-bar arrangement actually requires at least three hands to pick it—one hand for the tension wrench and one hand each for the two spool pin/side-bar arrays. And, each of your three hands must know what the other two hands are doing while picking this lock and still act independently.

Each side-bar has only one spring, compressed only from the force of turning the key—another isolation feature. Note the beveled outer edge of the side-bar itself. When the right key is inserted into the cylinder and turned, this edge allows the side-bar to retract and slide into its recessed slot along the cylinder. Let's see if we can pick this lock. I've only tried it with the two-hand method (for various good reasons I wouldn't want to try it with a third) and unless you are an alien from the planet Oflybegon, you'll have to use the two-hand method too.

First, the lock must be mounted correctly, as depicted in Figure 8A. This is how our sample lock will be oriented for the picking procedure described. This is actually good, though, because gravity won't be working against you by letting the pins drop, plus, this is how they are mounted out in the field anyway. I have found the tools best for picking at this lock are the snake rake, pick "I" (as it can be used as a double tool, too—say that three times fast with popcorn in your mouth), and the looped Feather Touch ("M") tension wrench. (If you don't have this tool, you may try the small, bent screwdriver, with a .030" thick tip. You can grind it flat on your grinder. However, you'll need a lot of hand action with this type of wrench.) Set the tip of the wrench into the keyway at dead center of the cylinder face—in the thin slot section of the keyway. The handle of the wrench should be sticking out to the right of the keyway. Then gently slide the snake in along the top of the inner keyway, engaging the tumbler "tabs" hanging down.

As you draw the snake out, do so across the bottom set of pin "tabs." Be certain that you use very light tension pressure in the counter-clockwise direction and be sure that you are moving the pin tumbler tabs on both (up and down) rows of tumblers with a back and forth motion (in and out) with a gentle sideways action. As you are picking, go easy on the tension-wrench force and only release the tension after making an unsuccessful pass at the tumblers with the snake. Take your time because you've got two sets of non-spring-loaded, ribbed pins controlling two side-bars to contend with.

Now, if you do not have a way to grind out the snake rake,[4] which is the recommended tool, you can make one by copying the pattern with stainless steel wire .040" diameter (18-gauge American Standard). You'll need a pair of small (5") round-nose pliers. Most hobby shops carry these for about $8. Don't grip the pliers tight or you'll mar, pinch, or even cut through the wire. Hold them loosely as you bend the wire into shape. It will take some practice, but after three or four tries, you'll have a dependable snake rake that will not break.

Pick resistance: For obvious reasons this lock is rated very high for a keyed tumbler system. As of this printing, I have not opened my two sample locks—each keyed differently. Because of the pick-resistance scale rating I have set up, this lock automatically falls into the rating of **13.0**—a rating that is still one full point beyond my present skill level, and may be considered "maximum pick resistance."[5]

So effectively, we have reached the top end of the food-chain in the evolution of the pin tumbler lock. Next, we explore what happens when a locking system flattens out its tumblers into discs and knocks the world of security on its butt by bringing back the combination disc safe lock—once again—but in miniaturized form.

1. See *Techniques of Safecracking*, Wayne B. Yeager, Loompanics Unlimited pp. 22-33. (Available through Paladin Press.)
2. According to ASSA, but, unless my math is messed up, I calculated fewer possibilities: 3 to the 8th power = 6,561. (Just like the eight-pin TuBar in Chapter 3.) But because of the nature of the lock, this doesn't really matter
3. No offense to H.H. fans—I have been a fan myself since 1965. But because of the impossibility of picking this lock in any position other than a mounted cylinder (gravity being the hindrance here) makes betting one's life on picking open this state-of-the-art lock a foolhardy endeavor.
4. The Snake rake design is taken from nature. In electronics, (and physics) an oscillating circuit will dampen (fade) out into smaller and smaller peaks when the power is removed. A dampened waveform is the natural tendency of any object in oscillation (being vibrated) or being cycled with repetitious linear movements (like raking a lock's tumblers) to follow a predictable pattern consistent with both mechanical and electrical systems. For more on the physics of oscillations, see the author's work *The Principles of Electromagnetic Inertial Drive*, 1993, Appletree Press, <www.patentsecrets.com>.
5. Someday, someone will find a better way to pick open this lock. Perhaps it will be you! If you do, please write me and relay how you did it. I will make certain that you will be credited in our next book—but only if you really picked it. I will have to try your technique out myself before we can publish your name.

9

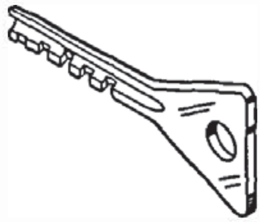
Keyed Disk Tumbler Locks

Some species devolve; the dolphin and whale were once land mammals that returned to the sea to better survive. They did this by re-adapting their systems to the long-lost environment to make their requirements for survival simpler and more direct. In a similar way, this next classification of locks has gone back to days past, when the disk tumbler safe lock ruled the world of security.

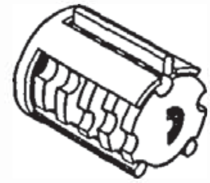
Remember Linus Yale Sr., the man mentioned at the beginning of this book who invented the pin tumbler lock? His son, Linus Yale Jr., was the man who invented the pin tumbler cylinder lock. Later, Junior went on to invent the rotary disk tumbler lock, the basic form of all safe locks for the past 150 years.

The Finnish company Abloy figured out how to use this basic principle of gated disk tumblers (while using only 1/4 of the disk's circumference[1]) and replaced the spindle and dial plate with a removable key. Thus was born the keyed disk tumbler lock, or "disklock." These locks are also springless.

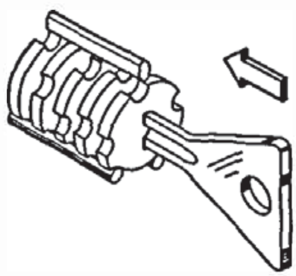
The Keyed Disc Tumbler Principle: Reinventing the Disc Safe Lock



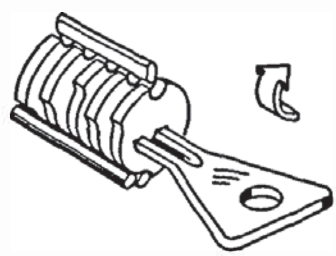
1. The key bit (shaft) acts like the spindle of a safe lock, while the key bow functions as the dial.



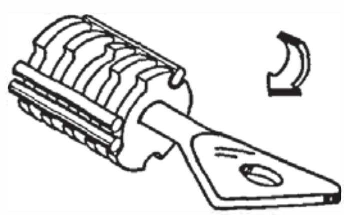
2. The tumbler carrier, an inner shell that carries the disc tumbler assembly when the proper key is inserted and turned, also guides the side-bar within the lock housing.



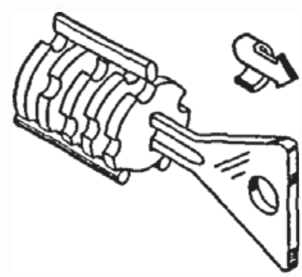
3. With tumbler carrier removed and disc tumblers exposed, the key is inserted. It meets no resistance going into the keyway, as there are no spring-loaded parts.



4. When rotated 90 degrees (usually clockwise) with the proper key, the notches in the key bit pick-up each tumbler in turn and carry it until its gate aligns with the side-bar.



5. With all of the disc tumblers aligned, the side-bar drops into place within the groove of the gates and disengages the plug assembly from the housing, opening the lock.



6. When turned back to its original position, the key may be removed. This action automatically scrambles the combination by the two return rollers.

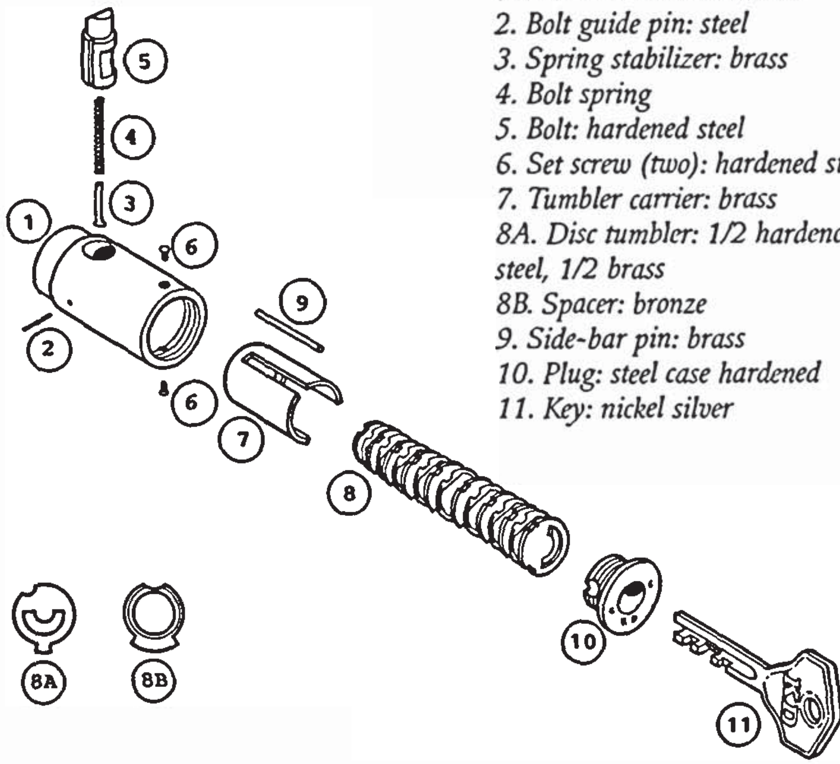
THE KEY DEVICES ROTARY TUMBLER LOCK

A popular keyed disklock in widespread use today is Key Devices' "rotary tumbler" lock, which is used in the gaming industry and for general-purpose locking applications. This American-made lock was invented by Francis E. Gallagher (U.S. Patent #4,838,055—1989), who also invented the lock in Figure 4B. It has nine disk tumblers that line up to a side-bar. The key is shaped as if it were a tube that was sliced down its length, making for a half-moon shaped keyway. (This is to prevent the use of flat tools to pick the lock.) Along its length are slots cut crosswise (perpendicular) that pick up the tumblers and align them to their proper places in various positions of up to 90 degrees.

In Figure 9B, the bottom tab on each tumbler (8A) is a stop that limits rotation to about 90 degrees within the tumbler carrier (7) and the notch on the outer circumference of the disk tumbler (8A) is its gate into which the side-bar drops (9). The half-moon slot in the center of the tumbler is where it rides the key. In this lock, about half of the disk tumblers are made of hardened steel while the other half are made of brass.

Like the last category of locks, the lack of tumbler springs makes this lock very tough to pick open. Since disklocks are keyed *through* the tumblers, instead of beneath or against them, and have no tumbler springs, a different approach is needed. Also, this is a side-bar lock, increasing the skill level needed to open it. But it can be opened by picking with some patience.

Because of the crescent-moon slots and the close proximity of the disk tumblers to one another, a standard diamond pick is too wide on its end to effectively engage these disk tumblers. The best tool for tagging the disks is the L-pick (see tool "J," Figure 1C). In order to see which tumbler you are picking, etch spacing marks of .050" apart on the pick's shaft so that you can easily gauge where you are. You may use an inexpensive electric engraving tool from your local hardware



1. Case: steel case hardened
2. Bolt guide pin: steel
3. Spring stabilizer: brass
4. Bolt spring
5. Bolt: hardened steel
6. Set screw (two): hardened steel
7. Tumbler carrier: brass
8A. Disc tumbler: 1/2 hardened steel, 1/2 brass
8B. Spacer: bronze
9. Side-bar pin: brass
10. Plug: steel case hardened
11. Key: nickel silver

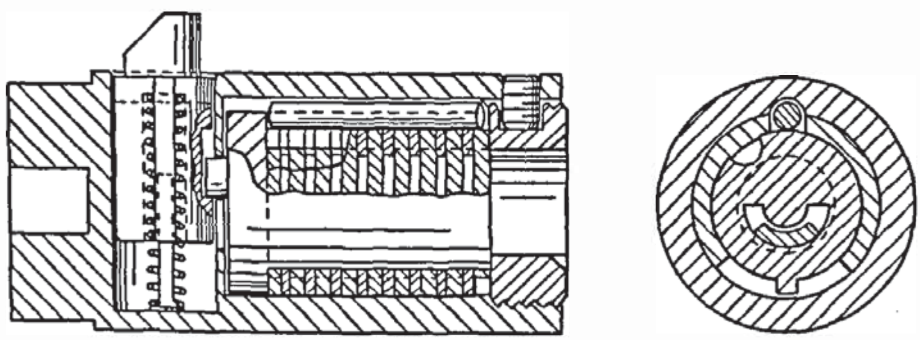


Figure 9B. Key Devices' nine-disc tumbler lock: Brass and hard steel tumblers are sandwiched to deter drilling. Note that there are seven different metals involved in the making of this lock and key.

store, or you can carefully scribe the marks with a carbide-tip scribe for a several dollars less. The latter will also allow you to have more control over your scribe marks. Don't etch too deep or you'll weaken the metal shaft of the L-pick. Use about the same force as printing your name. Even just a light scratch will last a lifetime.

On some disk tumbler locks, the last mark closest to the handle should stop at the opening of the keyway when the pick is all the way into the lock. The first mark should measure .100" from the end of the tool so that you do not etch right at the short end of the L, as this will weaken the tool at its most vulnerable place. There should be 15 of these .050"-spaced marks on your metered L-pick.

J

Figure 9C. With a carbide-tip tool engraver, meter your lock pick "J" for picking rotary tumbler locks. Etch lines .050" apart.

Also, a regular tension wrench will not work in the C-shaped keyway; the hole is too wide and that's not the way this lock works. When the key (11) operates the lock, the bit's end actually engages the last tumbler at the back of the keyway where it is the first to turn and the last to engage the tumbler carrier (7) with its stop tab. Its gate is also the last to align with the side-bar (9).

Because there are no tumbler springs and no need of an external tension wrench, we can set each tumbler one at a time and they will stay where we moved them with the pick. Lock pick "J" is also a unique tool, as it must rotate the tumbler instead of pushing it. This is why the pick must be metered—so that we can tell which tumbler it is rotating. This tool was also designed to be long enough to accommodate the 13-tumbler lock.

The internal tension wrench is the unmetered pick "J," and you want to run it back deep into the lock until you bottom out. Then you want to pull out the pick one tumbler's width—about 1/16 of an inch. Use a relatively firm, twisting motion to engage the last tumbler in the lock. This tumbler actually drives the tumbler carrier (7). Here, you will be turning clockwise and forcing the sidebar to contact the tumblers.

There are two methods I used to pick this lock. The first method is called the One-Pick Method. It involves one L-pick used as both a pick and wrench. Start by inserting it at the entrance of the keyway and turn each tumbler clockwise a few degrees until you hit the very back of the lock, where you engage the tumbler carrier. When you bottom out here, pull out 1/16" and turn with the very same L-pick, using slightly more pressure, and you'll feel the tumbler carrier mechanism give a little. If it stops, then you need to re-position some disks. Carefully remove the pick without moving any disks and re-insert it again to repeat the process. You can even turn counterclockwise occasionally in case you moved a disk too far. Each pass, go to the back of the lock and try again to turn the tumbler carrier at the rear. This is a random method and is dependent upon one's good karma.

A better approach is the Two-Pick Method. You need two L-picks for this method, which is faster but requires more skill. Again, pick "J" is the best tool for the job, but you don't need to meter this one, as you will be using it like a tension wrench. But instead of using it as a rotator hook wrench as we would on the Van lock in Chapter 3, we want to use this tool as an L-pick like on warded and lever locks.

Unlike most side-bar locks, there will be a little resistance to the disk tumbler as it approaches the side-bar, because the other disks are not being forced to work against the side-bar with their springs—the disks have no springs. So in a sense, being springless here is to the lock-picker's slight advantage.

This is an advantage because the ends of these keys are never cut. This means that the last tumbler is the first to move when the key is turned and the last tumbler to align with the side-bar and engage the carrier with its tab. (Refer back to

Figure 9A, sections four and five.) By picking the lock in this fashion, you will be forcing the tumbler carrier to bind against the side-bar and tumblers so that they can be more easily felt when their gates align. There is a slight relief in the wrench and pick as well. Note that five different metals are used in the making of this lock, and different metal densities will dampen picking sounds much to the lock's advantage. For example, the steel tumblers will sound and feel differently when aligning than will the brass tumblers. So you will have to listen and feel very attentively. A magnetically-mounted stethoscope would be a great help in picking this lock: Mount a ring-shaped disc magnet to a medical stethoscope using a good silicone-based adhesive.

Run the L-wrench all the way into the lock until it stops, pull out 1/16" and turn slightly. You'll feel the tumbler carrier give a little. When picking this method you search the tumblers with the metered L-pick like in the One-Pick Method, but instead of having to bottom out the metered L-pick, you have the other, unmetered L-pick already inserted at the back of the lock applying tension on the tumbler carrier. Once all of the tumblers are aligned in this fashion, the picks must be removed and a small screwdriver is then needed to carefully turn the very first tumbler in the front of the lock to operate the cam at the rear.

Pick resistance: I spent hours picking at this disk tumbler lock. When it finally popped, I lost track of the time. But, by using the Two-Pick Method, I popped it in about 30 minutes. This lock is rated above pin tumbler locks in general because of the skill needed to manipulate the individual disk tumblers into a static position unseen and essentially unfelt within the cylinder. However, this lock is relatively easy to mass produce in that the disks can be stamped out with only about four different patterns, making it inexpensive to the consumer. So, though this lock is relatively simple in design and function, the Key Device's rotary disk lock is still rated high on the pick scale: **10.0.**

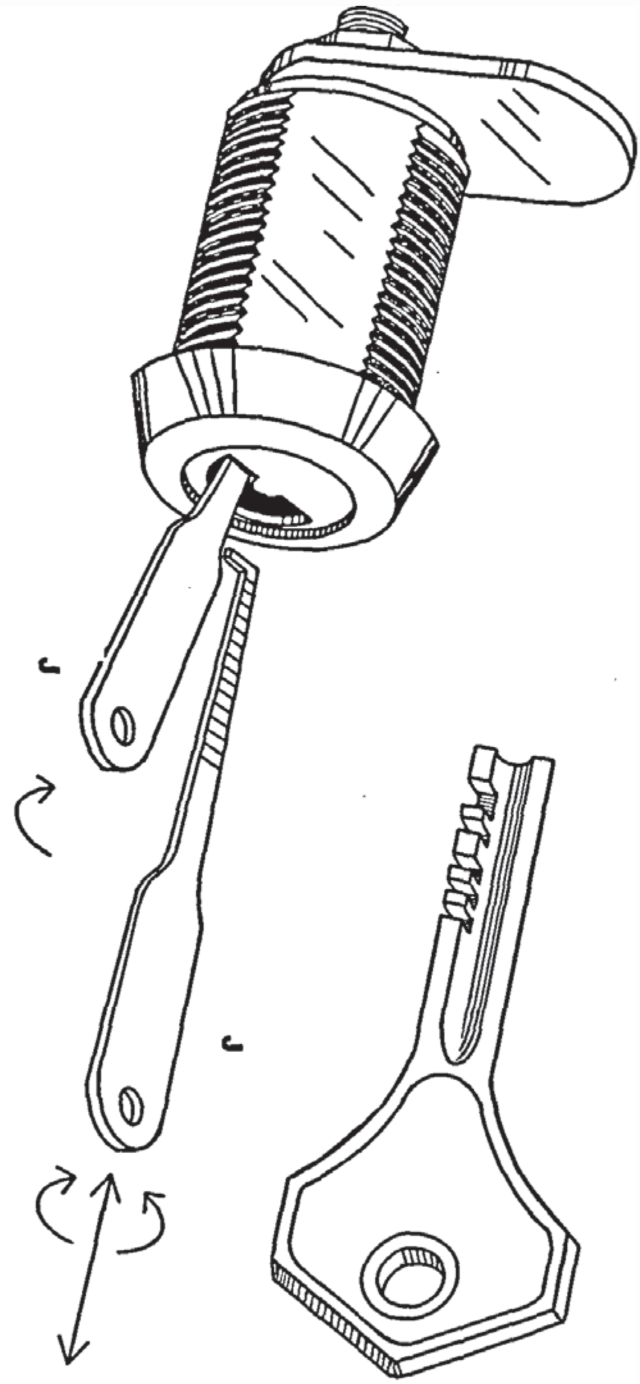


Figure 9D. Picking a keyed disc tumbler lock with two L-picks: one as tension wrench, the other metered to gauge and rotate the disc tumblers.

THE ABLOY CLASSIC (PULLDOG)

This beauty has been around for some time. The Abloy disklock principle was invented 1906, however, the Finnish lock did not hit American markets until 1980s where I had seen it used on coin operated washers and dryers. This lock was called to my attention by another reader[2] several years ago. It has tighter machine tolerances than the Key Devices rotary.

Because of its uniqueness, it is now also being used on soda machines, padlocks, and as door locks. The Abloy Classic "Pulldog" Disklock uses seven to nine disk tumblers that rotate 90 degrees in a clockwise direction to allow a side-bar (familiar theme?) to drop, clearing the housing so that the cylinder (in this case the tumbler carrier) can rotate. The maker claims 1.97 billion possible combinations.

The later models (Abloy Exec and Pro series) have disks with a "false gate" that is a shallow cut along its edge to confuse picking attempts. But each disk must be turned only a certain distance before aligning with the side bar. And since they are not spring-loaded, it is possible to rotate each disk individually, but you cannot rotate the whole plug without a contiguous link between all nine disks; this is accomplished by the tumbler carrier. The side-bar must drop into each disk's "true gate" indentation. You can identify the Abloy Pulldog locks by the half-moon shaped key hole. On the newer Abloy Profile, in the center of the keyhole is a tab that gives the keyway the appearance of a comma (,). The difference between the two locks is a more restricted and smaller keyway on the Profile. Both cylinders turn clockwise; in fact, nearly all keyed disk tumbler locks unlock clockwise, unless they are special ordered. (Also, an important note: *All* cylinder padlocks—no matter what type or brand—unlock clockwise.) It is Abloy who is dominating the padlock and small box locking niches of the market. But they have recently broken into the door-lock market quite successfully with their later disklock models, Abloy Exec and the Abloy Disklock Pro, which we may cover in another book.

A typical tension wrench and metered L-pick method described above for Key Devices rotary tumbler locks is especially tedious and very time-consuming with this lock. The reason? The fine machining, the false gates, and the fact that all tumblers must be engaged at once before any torque can be applied to rotate the plug to unlock this lock. This is because there is a very snug side-bar that must be engaged by all of the tumblers, making false gates more effective. Also, the spacers rotate, too, making one uncertain whether he's turning a disk or a spacer. There just had to be a better way to open this type of lock.

One day, while reminiscing, I remembered my early days as a locksmith apprentice out in the field making keys for customers who were locked out of their cars or had lost their car keys. We would use blank keys for that particular auto lock—most of which were GM side-bar wafer locks—and file a functioning key on the spot. This practice is called "impressioning a key." So, why not "impression" a key for the disk tumbler lock as well? But where would you get the key blanks? I immersed myself into this question while gazing at a roll of copper tubing.

Duh.

One of my Abloy Classics then slipped open after I had impressioned a key made from a piece of the copper tube.

First, acquire a copper tube measuring .250" (1/4") in diameter (a standard size.) Cut off a four- to five-inch length and bend it halfway down at 90 degrees, as illustrated. If you have medium to large hands, bend only to 45 degrees, as this will reduce impressioning torque with a lesser chance of breaking off the tool in the lock.

Carefully grind it flat on one side—halfway down into and along the length, as shown. Quench frequently in water to anneal the copper to keep it from becoming too soft. Then lightly sand the bright red copper along the two flat edges with a fine, 220-grit sanding paper on a flat surface until the edges are smooth and shiny. Finish up the edge by folding a sheet of paper over the edge of a hard-surfaced table and stroking the flat across the paper to polish it up.

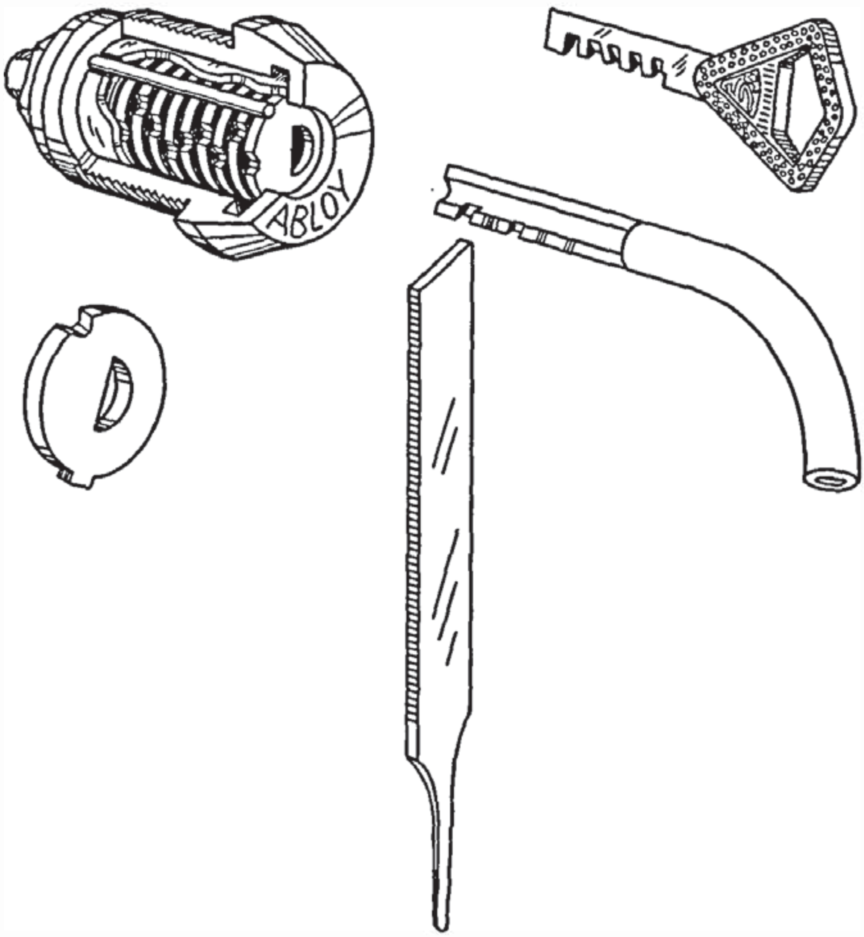


Figure 9E. Impressioning a rogue key for a keyed disc tumbler lock: An edge file cuts the marks left behind by the disks on the bisected copper tubing.

Insert the C-shaped, cross-sectioned copper tube into the keyway to the back of the lock (the Abloy Classic does not have a 1/16" gap at the rear of the tumbler stack like the Key Devices rotary). Now gently turn it clockwise until it binds. Release the pressure and remove the "blank key." You should see some tumbler scratch marks, or even polished shiny marks, on the leading edge along the length of the blank. There should be a mark near the end of your blank, which will be the last tumbler, along with a few other marks. The force of turning the makeshift key makes the round side-bar of the lock bind against the tumblers and copper tubing edge. Since copper is softer than steel, bronze, and brass, tumblers will dig into it and leave a mark. These marks will be very light and shiny, and thin lines will be visible running perpendicular across the edge of the cut copper tube. Other marks from the rest of the tumblers will show up further into the process, but sometimes, all nine (or 11) marks may be visible at first and they will all be evenly spaced. The spacing will remain the same throughout the process—about .035" wide for tumblers and .020" for spacers. But the depth of the marks will depend on the code of the lock.

With a small, 6" long by 1/4" wide flat-edged file (with a 3/64" or slightly smaller working face), remove the marks until they are no longer visible—do not file more than what is required to remove the mark. File lightly straight across and in one direction on each tumbler position mark. Copper is very soft, so don't get carried away with the file; use your thumb and forefinger to hold the file and use light strokes in one direction to avoid see-sawing the file and rounding your cuts. A few light strokes per mark are enough. Though it is not shown in figure 9E, it may help to keep your filing even by filing both edges—using the other edge of the tube to support your file. This will not affect opening the lock in the clockwise direction but will not be useful should the lock unlock in the counterclockwise direction.

Once you have filed away the light tumbler marks, reinsert the cut-away tube and carefully turn again to bind the tumblers, repeating the process over again. *Do not file where there are no marks in the spots where you have already filed.* If all tumbler marks are the same depth after several cycles of filing, you may be going the wrong direction—get a fresh blank and go counterclockwise. There are a few odd-ball locks out there and some customers, if they are smart, order reversed cylinder locks for added security. Eventually, the half-tube key will align all of the tumblers and the cylinder will turn, tightly at first. But stop, pull out, and re-file any new marks before turning any further. You are only a few tries away from making a fully functional key. This is how you can impression a keyed disk tumbler key. Note that this is not a durable key—temporary at best—and you will have to be careful not to twist the copper tube key off into the lock. To help prevent this while turning the unlocked cylinder, relieve pressure on the cam by pushing in on the locked door.

Copper is ductile (soft, flexible) enough to withstand much bending. However, again, when making this tool, be sure to quench the tube in water while cutting it lengthwise every 1/4-inch or so. Also dunk in water every 10 seconds of grinding the flat cross-section. This will keep the copper from gumming up your grinding wheel.

Pick resistance: The Two-Pick Method mentioned above for the Key Devices rotary tumbler lock should open this one, but I couldn't do it with my sample. But here, the impressioning process to open this lock does not reduce its security factor because the above technique requires enough skill to make it secure against common thieves. It also takes a good deal of time and bright, full spectrum light to see the marks, making exposure too risky. I would rate the Abloy Classic at a good **10.5.**

THE ABLOY PROFILE DISKLOCK

This lock can also be opened by impressioning. Repeat the technique detailed above for the Classic, but use 1/4" aluminum tubing. The tubing walls are thinner, making the I.D. (inner diameter) larger so that it can easily slip past the displaced center tab of the Profile's comma-shaped keyway to impression a "tube-key." Aluminum is also softer than copper and makes only a fair key, but is much more "gummy" when it comes to machining the substance. Use less force and more water when cutting and grinding your flats on this material. Spray water on the grindstone while cutting to prevent material drag along fresh-cut surfaces. Carefully and very lightly

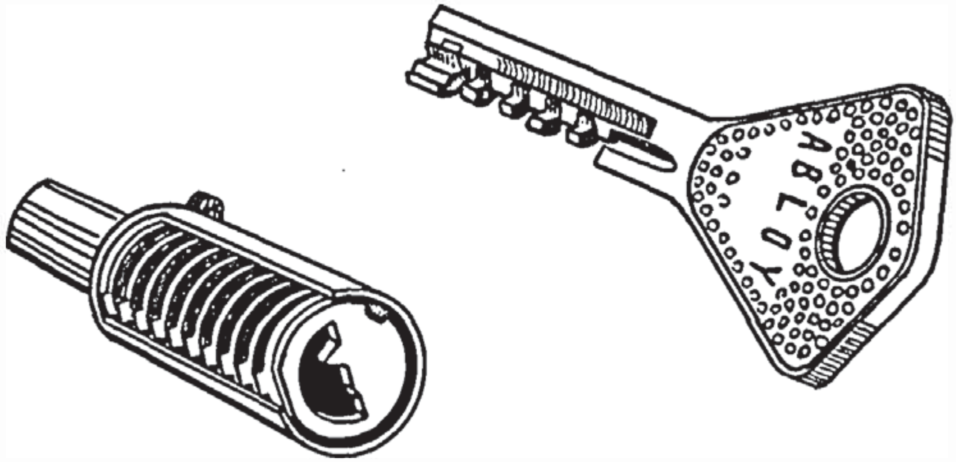


Figure 9F. The Abloy Profile disklock IC fits into padlock housings. The key engages the tumblers clockwise into the tight, restricted area of the keyway, making the impressioning of a rogue key more difficult.

file away the soft splinters along the face that will engage the tumblers to leave marks. Caution: to avoid getting aluminum splinters in your eyes, rinse your hands in running water after completing this procedure.

Pick resistance: Since the material used to impression a rogue key is softer, the skill-level also increases a bit. So the Abloy Profile is rated a little higher: **11.0**.

This is the last chapter covering the purely mechanical tumbler locks. We have followed the evolution of the pin tumbler lock from its divergence from wafer locks (to be covered in my next book) and its cousin, the disk tumbler lock with its slower, but significant, climb up the ladder of higher security. After the safe was developed in the middle 1800s, the next development in the line of defense against the night thief was electronic alarm systems. So logically, in the remaining chapters we will explore the latest in electronic locking systems.

1. *Secrets of Lock Picking*, pp. 49-54.
2. Compliments of Frank Pittman, St. Augustine, Florida.

10 Electronic Key Locks

When it comes to security, just the word "electronic" scares most people. And it is surprising just how little most people know about true "electronics"—the functioning guts of video, audio, and computer circuits. The average person has enough to contend with just living everyday life, which is also filled with things that are electronic in function (which helped to cause all of the stress with coping in the first place).

Well, if it is of any help, no one can define on the molecular level why a transistor works (in any certain terms), but it works. Invented by three men at Bell Labs in 1951, this simple, silicon-based switch—the transistor—makes everything run in this world (this position was formerly held by the vacuum tube). In fact, we have become so dependent on this little switch, that the world could not function without it.[1]

Few people could tell you how this "solid-state" switch can be used to convert AC (alternating current) from the wall socket in our house into DC (direct current) for autos and making our televisions and stereos function—which is the basic operation of a simple DC power supply. In fact, the average person doesn't even know the difference between AC and DC, for that matter, or how simple solid-state switches evolved into mega-microprocessing circuits occupying a cubic quarter-inch area. But this is also the intended direction of high security: *Security is dependent upon the ignorance of the masses*. However, security must evolve to keep up with the "Information Age."

In order for us to fully grasp the significance of the technology now ruling modern security, let us consider the next series of new locking systems.

SECURITRON DUAL ALARM SWITCH/DOOR LOCK

The now all-powerful ASSA/Abloy Group has acquired another company called Securitron Magnalock, which features high-quality electronic security hardware and systems. One product they manufacture that caught my eye is the dual alarm/door switch. The stainless steel plate looks like any other electrical box cover plate except that there is a mortise cylinder mounted on it and the plate is held with tamper-proof screws. Now, this looks like a normal electric door lock; you insert your key and turn the cylinder, activating a switch to release the solenoid bolt with a "clack" and unlock the door. Note that these electric "strikes" (electrically controlled dead bolts) cannot be pried open with a knife as with a spring-loaded latch. A large crowbar might be a match for a few of them. But most are made with hardened steel and interlock vertically with their mating half, making crowbarring an act of utter futility.

In any case, the Securitron Dual Alarm Switch device gives you a 50/50 chance to get it right the first time or an alarm will trip.

The cylinder can be anything: a standard pin tumbler, radial pin tumbler, a Medeco, or even an Abloy disklock. Furthermore, clockwise may unlock the electric solenoid-controlled bolt to open the door and counterclockwise may

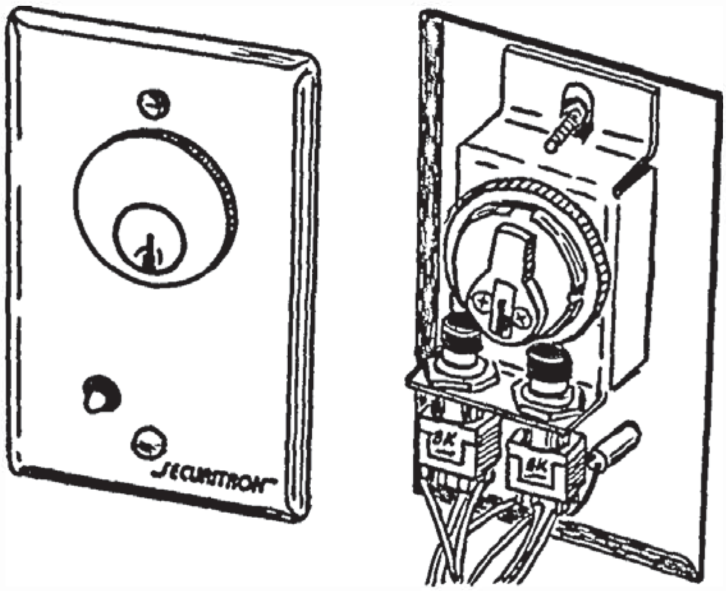


Figure 10A. The Securitron Dual Keyswitch. An electric deadbolt and alarm switch makes picking the lock twice as risky.

turn off the alarm, or, is it the other way around? A burglar could inadvertently unlock the door and walk right into the police station.

The point is, you have to pick the cylinder twice—once to snap the switch "off" on the left for the alarm (but, could be wired for the door) then pick it right to unlock the electric door lock (but, could be the alarm's "on" switch). If, perchance, the alarm was already turned off, you could pick the lock to inadvertently snap it back on, setting your own trap. It's a Catch-22: damned if you do, and damned if you do.

Furthermore, this simple system can be changed on the spot by the owner. He simply reverses the position of the switches should he lose a questionable employee (and change the lock too, if he's wise).

One approach might be to pick it in one direction to activate the bolt, in which case you would hear the clack of the electric door strike. Then, pick the cylinder again in the opposite direction to disable the alarm, then pick it back again in the previous direction to unbolt the door again. The strike (or bolt) switch is only a momentary switch, which means once you release the cylinder, it re-locks. But this process means that you might have to pick that cylinder three times. If the cylinder is an Abloy disklock, you could be there all night. If the lock is an ASSA Twin V-10, you could be there for three to five years.

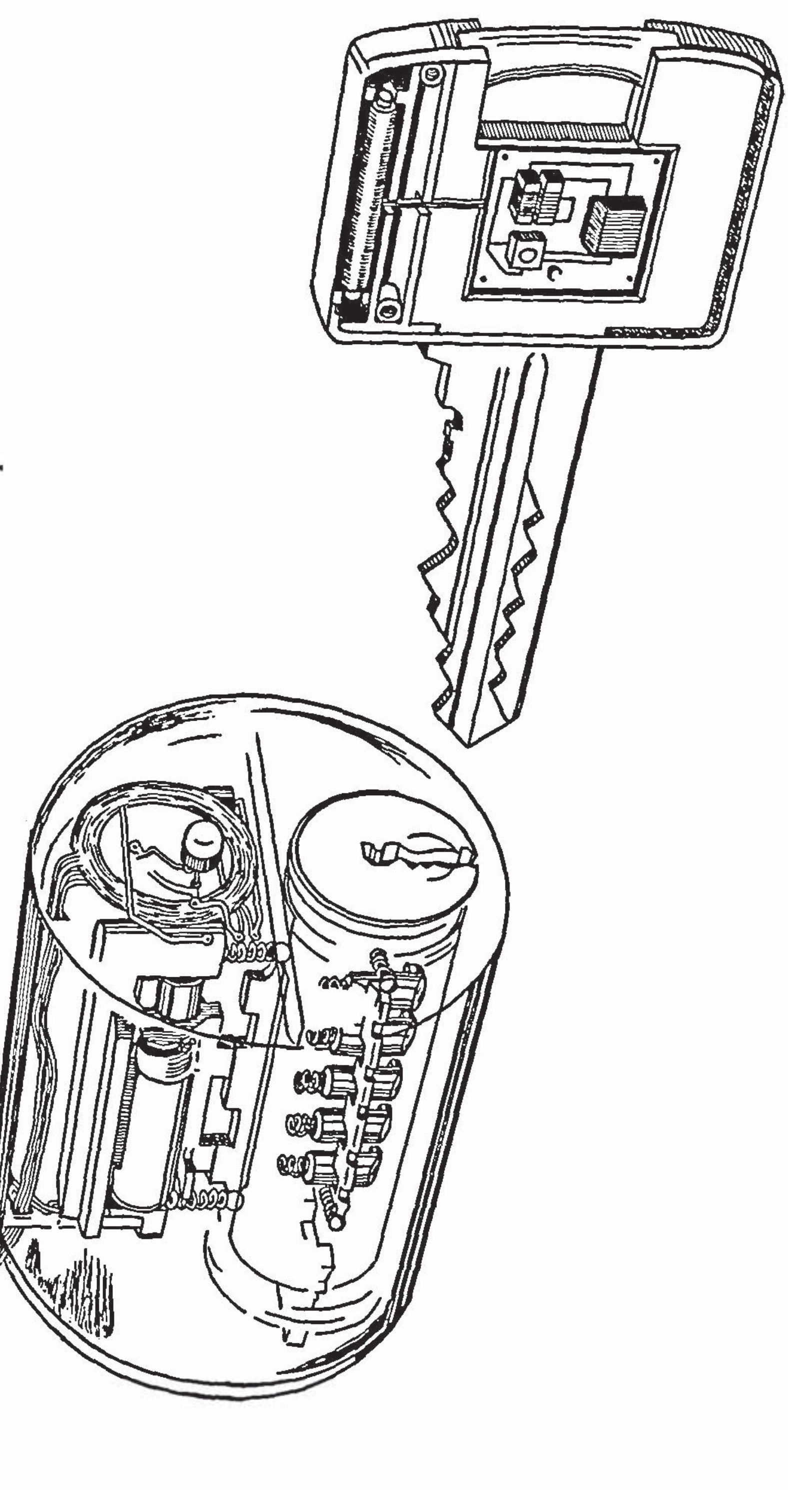
The foggy white or translucent button on the lower left of the face plate is actually a bi-color LED lamp; the green light is for enter and open and the red light means locked and alarm on. (Or is that the other way around? Just joking.)

In any case, I thought that this simple system is a good one and worth mentioning, but there is no pick resistant rating for it because the lock could be anything.

THE RUKO TWINTRONIC MAX SECURITY BANK DOOR LOCK

The Ruko, a multi-row spooled pin tumbler side-bar lock, has a sophisticated version of its already complex security features—the Ruko Twintronic,[2] which also incorporates an additional side-bar (making it also a multi side-bar lock), which is controlled by an electronic recognition system within the cylinder and key.

You are already familiar with the lock mechanism from our trials in Chapter 7. But in this version, there is the added security feature involving electronics. The key bow contains (in counter-clockwise fashion from upper left) a tiny pushbutton switch that turns on a micro-oscillator circuit (below) with its tuned inductor (above and right of switch). In the top edge of the key bow is a tiny ferrite rod antenna that broadcasts a frequency to match the pick-up coil at the top front and just beneath the surface of the cylinder face (the ring-shaped loop above the cylinder). The pick-up coil relays its signal out to a remote receiver box through the electronics and connector (the plug running out the back of the lock housing), which can send back an electrical current to release



10B. The Ruko Twintronic is stuffed full of pins and electronics. The additional side-bar above the cylinder is allowed to retract when the solenoid is triggered by a signal from the right key. Entries and attempts can also be recorded.

the tiny solenoid controlled side-bar (just above the main pin springs in the cylinder). When the solenoid-coil energizes and slides forward, the side-bar is free to rise under the force of the turning cylinder after all 11 pins have been properly aligned. The system can also log in when and who (individual key holder identity) gained entrance.

In the Ruko, the key contains its own power source—a long-life (10+ years) miniature battery. The small protrusion above the keyway and centered in the pick-up coil is a bi-color LED lamp indicating status of the cylinder. Red is locked and green indicates that the key is accepted and the cylinder is free to turn. These locks have been used primarily on European industrial applications and bank doors since the 1980s. Though still in wide use in Europe, the Ruko company went out of business in the middle 1990s. However, ASSA is now making replacement ICs for the existing Ruko cylinders whenever re-keying is required.

This basic type of electronic system (excluding the data logging circuits) is also being used in some of the new automobile locks manufactured today.

The usual electronic jamming method employed on magnetic card readers[3] will not work on these systems, as each unit is programmed to receive only its computer-coded frequency from the proper key. All other frequencies and pulses are filtered out by the mainframe electronics of the system. Then you have all those tumblers to deal with . . .

Pick resistance: Naturally, this lock is near pick-proof with all that stuff crammed into it. This type of system is **14.0.**

This ends our excursion on keyed tumbler locks. Note that we have reached near the top end of my arbitrary pick-resistance scale. The next logical classification of locks will be the ones that can be truly called "lockpick-proof" because they use numerical combinations rather than physical keys. Here, dexterity gives way to wits.

1. For more about transistor switches for security, see the author's *Security Systems Simplified*, Paladin Press.
2. Compliments of René Larsen of Denmark.
3. *Advanced Lock Picking Secrets*, Paladin Press.

11 Electronic Combination Locks

People die. Combinations are lost. As a locksmith, you may be called out to open a digital push-button door or safe lock. You could call the manufacturer, but he can't give you the code because the serial number of the lock is not available to you because the owner neglected to fill out and mail his registration card. Or the serial number either melted off in the fire, is locked inside the safe, or just plain wore off with age. But you actually have two options. You could blow the lock and possibly damage it beyond ever opening again and risk damaging the contents, or you can pop it with logic.

I've had to open several safes because of deaths; the added distractions of grief and expectation can be annoying. The worst case involved the reading of a will (locks open much easier when you are not under pressure). So to master this skill requires more than just a basic knowledge of locks and electronics.

Most sane people would never attempt to bypass a digital electronic security system. And fortunately for everyone,

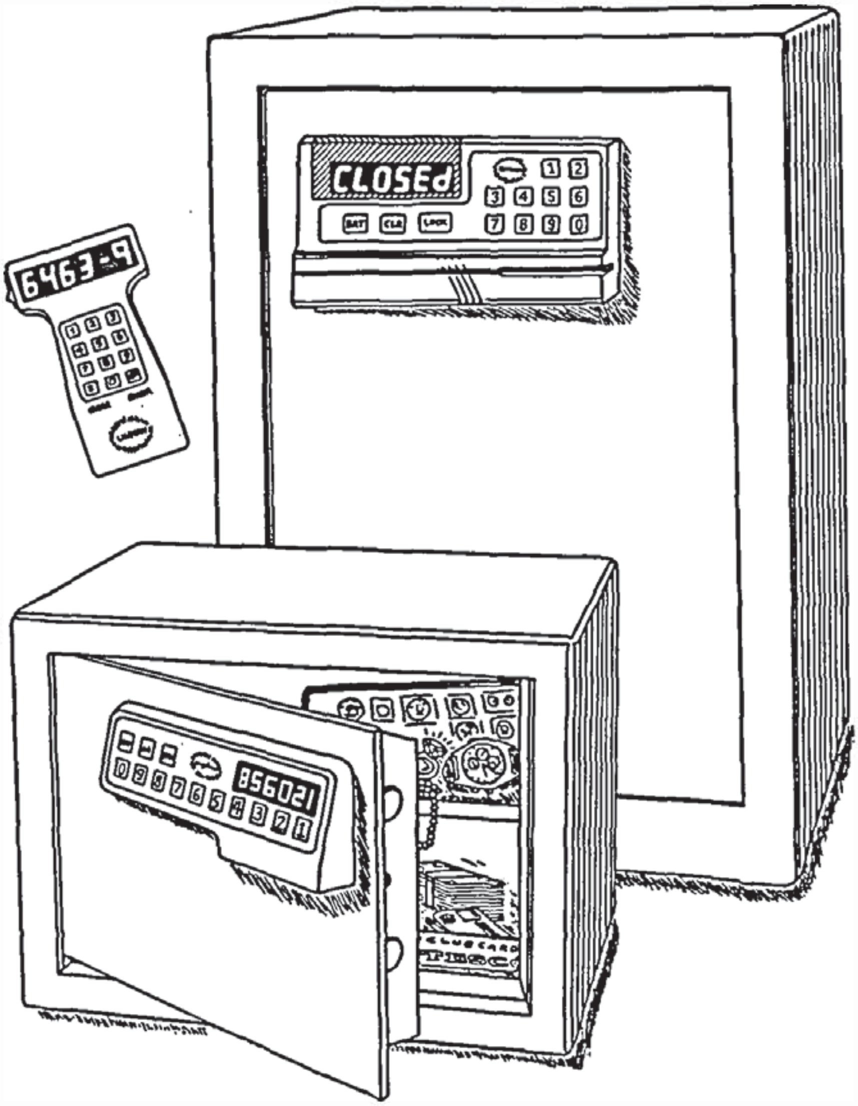


Figure 11A. Ilco Unican's Solitaire Series 200 hotel room safe is about as safe as you can get away from home. Most digital combinations can be deduced by using the most familiar numbers, logic, or footprints.

maybe only one in a million people would have the aptitude, patience, or skill to decipher and outwit digital combination locks. Most of the main-line hotels now have rooms with safes shielded by digital combination locks. In fact, you can go down to your local Staples office supply store and buy a safe with a digital combination lock with a key controlled backup[1] for around $250.

ILCO UNICAN SOLITAIRE 200 HOTEL ROOM SAFE

The Ilco Unican Solitaire 200 series features convenience and security in its new line of small hotel room safes. The Solitaire 200 is a solid, battery-powered, maintenance-free, user-friendly "intelligent" safe. (It even has a lighted interior.)

The computerized locking system allows guests to lock the safe with either a credit card or personal identification number (PIN). Each time the safe is locked, the same card or PIN must be used to open it. The safe will not lock on low battery. In the event of lost cards or forgotten codes, a master card or master PIN can be programmed into each safe and used to override a locked unit.[2]

A handheld override module is used to open all safes, regardless of the way they were locked. This separate unit has its own power source and is independent of the master card or the PIN in use.[3] As far as losing memory with loss of battery power, integrated circuit chips now have long-time residual memories. But usually, you have to re-program the combination after the battery has been replaced or you cannot lock the safe door—a consumer consideration most appreciated.

Hotel managers have access to a 12-event audit and can program up to eight operating functions to meet their hotel's specific needs. Factory programmed site codes prevent the use of unauthorized (rogue) override modules.[4] This means that a successful rogue module must also be programmed to match the additional secret code that only the factory has a record of.

Most of the newer systems can pick up commands via infrared laser to rewrite the safe's combination. The codes that are transmitted vary from manufacturer to manufacturer.

Note that this is not a fire-resistant safe (which usually has concrete between the walls). But that's OK because most hotels have a sprinkler system of some sort. In Figure 11A, the upright safe model 202 is "briefcase size" (22"x 15"x 14") and weighs 103 pounds. The safe model 201 in the foreground is "laptop" size and measures 11"x 16"x 13," weighing in at around 33 pounds.

The override module (200-1) will work only on the safes that it is programmed to work on, so there is no known "magic circuit" that will open all of these models of safes. Ripping off the electronic keypad would ensure that the door remains locked. But, since they are just small safes with 5/16"- and 1/4"-thick doors, more primitive safecracking methods can be employed. In this volume, we are interested only in the locking mechanism—not in classic safecracking techniques—because this type of lock on a larger safe would make it quite formidable.

There are two methods used to crack codes for digital locks on doors and computer programs. For the first, you'll need to know something about the person who chose the safe's combination. People by nature are forgetful—in this modern world there is just too much to remember. The most common practice used by the citizens to ensure not finding themselves locked out is to use familiar numbers. Numbers relating to the birthdays of children, one's spouse, or self are often used as combination codes. So are Social Security numbers, addresses, phone numbers (real stupid), and, yes, even driver's license numbers. Even I was once dumb enough to use my old military service number on a manuscript safe. But the real winners use their winning lottery ticket number. And the really clever chap might use any of the above series of personal numbers in reverse fashion.

By the way, if you have to come up with a combination, you are best off if you force yourself to sit down and memorize a new series of random digits by writing it over and over on a single sheet of paper (not on a note pad). Then, put it in a safe place for a week to be certain that you have memorized it. Then burn the paper.

The second technique to defeat digital locks is dirty. Most digital encoding pads used to punch-in codes allowing entry are heavily used, and the dirt from dozens of people's fingers can accumulate quickly on the pad numbers, leaving behind "footprints." Most people would not think to keep these pads clean, but the numbers that have the most dirt around them are the code numbers that the professional burglar would track. Wear patterns are another problem, and once he has those three or four digits, he can try out a series of combinations that would allow him to open the lock within one to three minutes.

For example, suppose that you have a customer with a lost combination to an entrance keypad that had three digits that seemed to have a halo of light scum around the numbers 3, 5, and 7. To reduce the risk of losing the footprints, punch your try-out codes with a retracted ink pen or toothpick, just in case you read your numbers wrong. Let's see how you would work the try-out combinations. First, treat the combination like a whole number (357) with the smallest number first. Then try that combination. Next, swap the last two digits in the base number to 375 and try it. Next, shift the hundreds from 3 to the next number up, which is 5, and use the same procedure with those numbers: 537 and 573. Then shift the hundreds again to 7, which is 735 and 753. So, let's review:

357, 375
537, 573
735, 753

Out of a possible 999 combinations to open that lock, it is quickly narrowed down to six possible combinations. Scary, ain't it? Of course, a four-digit combination ups the ante by four-fold to 24 possible combinations out of 9,999. But still . . .

And, logically, if one button is half as "clean" as the rest (or twice as dirty, depending upon one's outlook on life), then that digit is used twice. For example, if 3 looked dirtier than only one other key, say 5, then we would get: 335, 353, 533. Just three possible combinations! Ten seconds and we're in.

Now, let's look at what most keypads use—four digits. Let's say that you have found four digits dirty or worn: 3, 5, 7, and 9. Now, we have to work in thousands, as well as hundreds. First, break the base number 3579 into four groups of a thousand with the first group using 3 in the thousand's place and swap the last two digits:

3579, 3597

Then, within that thousands group, shift the hundreds, smallest numbers first, and swap the last two digits again:

3759, 3795

Then, work your way up through the numbers like so:

3957, 3975

See? Then shift up to the next thousands group of 5 from your base number like so:

5379, 5397, 5739, 5793, 5937, 5973

Next thousands group of 7:

7359, 7395, 7539, 7593, 7935, 7953

And lastly, the 9 thousands group:

9357, 9375, 9537, 9573, 9735, 9753

These are the total possible codes from four digits: Just

24! This is because we are only using the digits, not all of the possible numbers in between those digits. *You can use this technique with any four-digit combination* as long as those numbers are not being used 2 or more times.

Best defense: keep the keypad clean and replace it when worn keys appear. Some companies now feature a keypad with "hardened" buttons to help solve the wear problem. But regular cleaning will ensure better security. Also, one should not use the same number more than once in a three- or four-digit code, as this lowers your security by a factor of at least four.

Digital safe combination locks can be deduced in this way as well: Here, with three to four sets of double digits, the possible combinations can range up into thousands—a few hours work, once a thief has crunched the numbers by computer. Well worth most burglars' efforts.

Pick resistance: If the keypads are kept clean and have wear-resistant keys, and the combination is random, this type of lock is virtually pickproof. I know of no other way to open a digital combination lock outside of knowing the combination from "footprints" or having access to the hand-held encoder system. But, digital combination locks still have one more major security design flaw that is inherent and unavoidable. It is only because of the next electronic lock mentioned in this book, (which solves the above problems) that I can place digital push-button locks in general on the PR scale of between **13.5** to **14.5**.

THE HIRSCH SCRAMBLE PAD SYSTEM

Burglars and street thugs will often peer—sometimes with binoculars—over the shoulder of their intended victims while they are having quality time with their ATMs. Now, with high-powered video cameras, they can decipher bank account numbers, PINs, and even (Lord forbid) Social Security numbers.

Your Social Security number is one code that should be sacred to you. Do not give it out freely. Do not have it printed on your driver's license. Do not have it printed on your checks: With it, a crook (anyone) can have access to your whole life—bank account numbers, credit card accounts, driver's license number, military service records, police records (if any), even your Social Security benefits, should you be alone and happen to die. If your Social Security number gets out you would be exposed. Social Security number theft doesn't happen often, but it does happen. Also, I have a few acquaintances who have had their Social Security numbers "borrowed" by persons on the run or covering their trails, causing them a variety of problems.

Crooks can get all of this information just by watching you, usually from a distance, as you punch in your personal numbers. Since most keypads don't change, it is relatively easy to decode keypad positions and sequence the numbers punched in from the videotape, or live with binoculars. This sort of crime happens quite frequently.

The Hirsch Scramble Pad solves the problems described above, both code number deduction through skin debris and/or keypad button wear and keypad pattern recognition (peeping).

The digits are LED displays within each keypad number position. Every time a code is punched in, and the system allows entry or access to cash, etc., it scrambles—at random—the next display on the buttons. This makes it impossible for a thief to peer over your shoulder and see your code through pattern recognition. By the time he gets to the keypad, the digits have already changed position. Also, all of the keypad buttons wear evenly, making it impossible to deduce a code.

The maker advertises that the system eliminates the cost and maintenance of cards or other physical credentials. This is the wave of the future. The system is microprocessor based with more than 111 million random code possibilities. The latest version of the system interfaces with conventional card readers and upgrades the readers to dual technology.

Here, no wear pattern develops on the buttons. Vertical and horizontal light guides narrow the viewing field so only one person standing directly in front of the keypad can see the display.

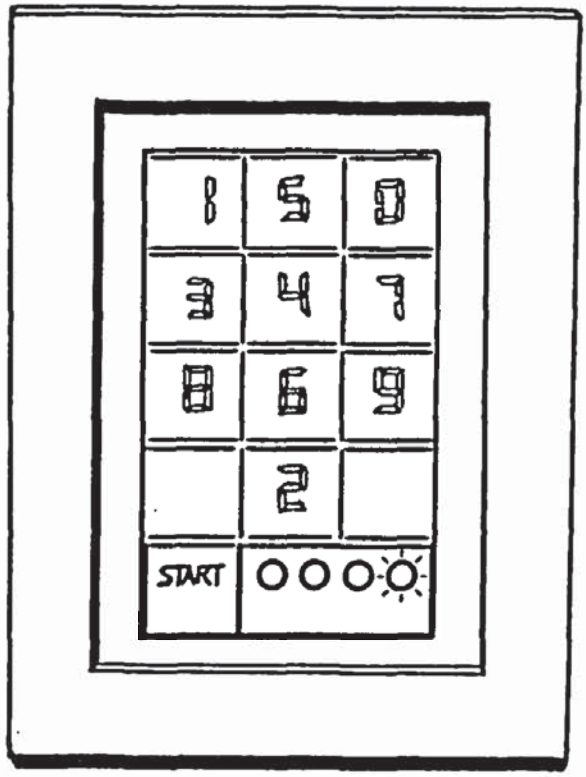


Figure 11B. The Hirsch Scramble Pad is the last word in modern security. The digits change position after each use and built-in viewing guards prevent peeping.

The Hirsch Scramble Pad uses a PIN code of three to four digits. The system administrator can assign the digits or let the system controller randomly generate them. The manufacturer also points out:

"Use of memorized credentials means that an individual cannot leave the credential at home, as often happens with cards. Nor can another person copy the credential without the owner's knowledge. Since the credential is so secure and traceable to its owner, it is not likely to be loaned out, a constant risk with card technologies. Thus each user is held accountable for his/her individual code use."

The keypad face is one-piece molded to prevent tampering, but just in case, the pad has a tamper alarm system.

Someday soon, this system will be more commonplace. I have no intention in even trying to figure out how to crack this system—and even if I did know how, I wouldn't tell for obvious reasons.

Pick resistance: Currently, there is no known technique for bypassing this type of system short of using ESP while someone is punching in a code. Today, it represents the ultimate in pick resistance for keyless entry door locks and is rated at **15.0.**

1. A key-controlled backup for a digital safe fully defeats the purpose of having the digi-lock in the first place. I find this silly and a waste of money.
2. Ilco Unican Electronics Division.
3. Ibid.
4. Ibid.

Techniques of SAFECRACKING

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Contents

Introduction

A constant technological war exists between safe-makers and safecrackers. To construct a safe or vault strong enough to keep burglars out, but functional enough to let authorized personnel in, has been the ultimate goal for the manufacturers of safes and vaults since their invention. The race towards this ideal safe has caused frustration for those on both sides of the law in their attempts to defeat the technology of the other. And while neither side may ever ultimately triumph, they both win their share of battles.

The most powerful weapon in the safe manufacturer's arsenal is his ability to attack the burglar on one or more fronts: denying initial access to the safe, strengthening the safe itself, alarming the safe, etc. But the burglar is not completely defenseless either, for he knows a safe can never really be made absolutely foolproof. Why? Because a locksmith or other authority must always be able to enter a safe in case the combination mechanism malfunctions. In other words, while a safe can offer a reasonable amount of protection, it can never be made, out of practical necessity, indestructible. Another problem that facilitates the safecracker's operation is that of obsolescence in safe technology. By the time an anti-burglary device is designed, patented, manufactured, marketed, and made commercially available, professional safecrackers have been experimenting and working to defeat it. The question is not *if* a safety device *can* be bypassed, but rather *when* the device *will* be bypassed.

When one buys a safe, what one is really buying is time. If the safe is on the lower end of the price scale, it can only be expected to resist attack for a short length of time, and if the burglar is using only basic tools and basic knowledge, the safe will more than likely do its job. But as the potential reward inside the safe increases, so does the risk, and so, too, must the protection. This very simple and obvious maxim is often overlooked by homeowners and businessmen. I could not count the number of times I've seen a $200 fire safe holding thousands of dollars in cash, or an 1890 safe expected to withstand 1990 attacks.

This book lists and explains just about all of the methods that are used by both locksmith and safecracker to open safes, vaults, and safe deposit boxes. These techniques range from "soft" openings, such as combination deduction and manipulation, to "hard" openings, such as the application of nitroglycerine or C-4. While some of these techniques may be obsolete on some of the newer, high-tech safes, many will be overkill on the older or less sophisticated models. I've not tried to identify what is obsolete and what is unnecessary, but I do note throughout the text on what models each technique is most often applied.

Safecracking is a crime that has been with us and will be with us for many, many years. I subscribe to the theory that you can't solve a problem unless the problem is fully understood. This book, like my others, is a textbook on crime, a guide so that the security and law-enforcement community may more accurately understand what they're up against. If you are a security consultant, use this guide to more accurately recommend equipment for your client's needs. Police and private investigators will discover invaluable information here for conducting a safecracking investigation. And although this book is written for individuals with no previous locksmithing experience, I believe even the most seasoned safemen will find several new safe-entry tricks here.

1
Safe Mechanics and Operation

Despite the multitude of safes on the market today, they all cling to a basic theory of operation: the protection of contents from outside forces (such as fire and burglary), while allowing authorized entry via a combinational dial, key, or keypad. Safes differ from model to model in the way they accomplish this task, but this is, nevertheless, the basic premise of each. There are two basic types of safes: fire safes, which are insulated to protect important documents from extreme temperatures, and money chests, which are specially designed for extra security, to withstand attacks from determined burglars. Actually, these are overlapping categories, for most fire safes offer some burglary protection, and money chests are protected from small fires as well.

In order to discuss safes intelligibly, we must make ourselves familiar with the basic terms regarding the operation of the typical safe. Figure 1-1 shows an example of the Diebold brand safe. It is essentially a five-walled seamless steel box with an attached door. The door is very thick, with hardened steel plates, and is attached to the box with very strong hinges and a steel deadbolt.

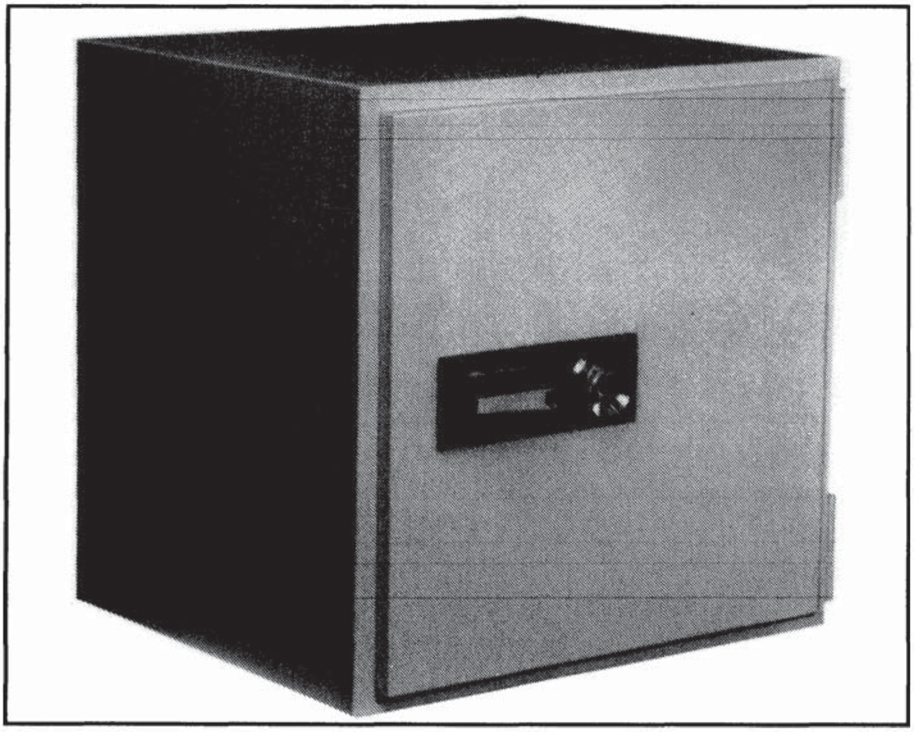


Figure 1-1

This Diebold brand safe is a five-walled seamless steel box with a door attached with very strong hinges and a deadbolt. The door is very thick, containing hardened steel plates.

The safe is opened legitimately by dialing the proper combination on the dial, and turning the handle to release the bolt from the safebox; the door is then free to open. This is a deceptively simple operation, for much more occurs within the walls of the safe, hidden from view.

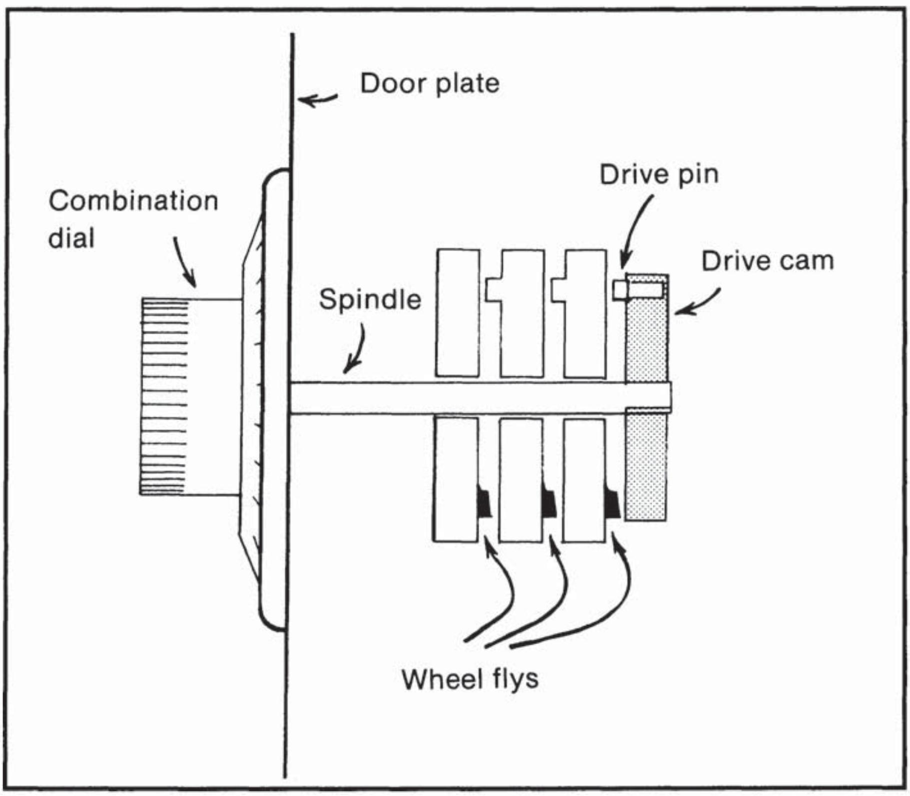


Figure 1-2

The wheel-pack is the mechanical device that "knows" the proper combination has been dialed. Located behind the combination dial, the wheel-pack consists of wheels (usually three or four but sometimes more) that are moved about by turning the dial.

Behind the combination dial is the "wheel-pack," the mechanical device that "knows" when the proper combination has been dialed. The wheel-pack usually consists of three or four wheels (depending on the amount of numbers in the combination sequence, so a 10-20-30 combination will require three wheels) and they are moved about by turning the dial (see Figure 1-2). The combination dial is attached by the spindle to the drive cam. If the dial is turned, the drive pin on the drive cam comes into contact with the fly on the wheel adjacent to it, and that wheel begins turning also. If the combination dial continues to turn, the fly on the first wheel comes into contact with the fly on the next wheel, and so on, until the turning of the combination dial turns all of the wheels in the wheel-pack simultaneously.

Into each of the wheels of the wheel-pack, a deep notch is cut. When the proper combination is dialed, all of these notches in the wheels are aligned perfectly. Just above the wheel-pack is a device known as a gate and fence. As long as the correct combination has not been dialed, the notches will not all be in perfect alignment, and the gate and fence will merely rest upon the wheels (see Figure 1-3). But when the right combination is executed, the wheels align accordingly, and both the gate and fence are allowed to fall into the groove formed by the aligned notches (see Figure 1-4). The lever and fence which were guarding the bolt are now out of the way, and if the handle is turned, the bolt is retracted, and the door opens. If this procedure seems a bit complicated, study the diagrams until you understand this completely.

The lever/bolt mechanism varies slightly from safe to safe. Some are gravity activated, as in our example, but they may be friction or spring-loaded. This is of no consequence, however, for they all act pretty much the same, and the slight differences do not alter the safecracker's methods in the least. The only thing worth noting here is the fact that spring-loaded fence/bolt mechanisms do away with the need for outside handles, since the combination dial retracts the bolt (after the combination has been dialed, of course). This is the type used almost exclusively on round-door safes.

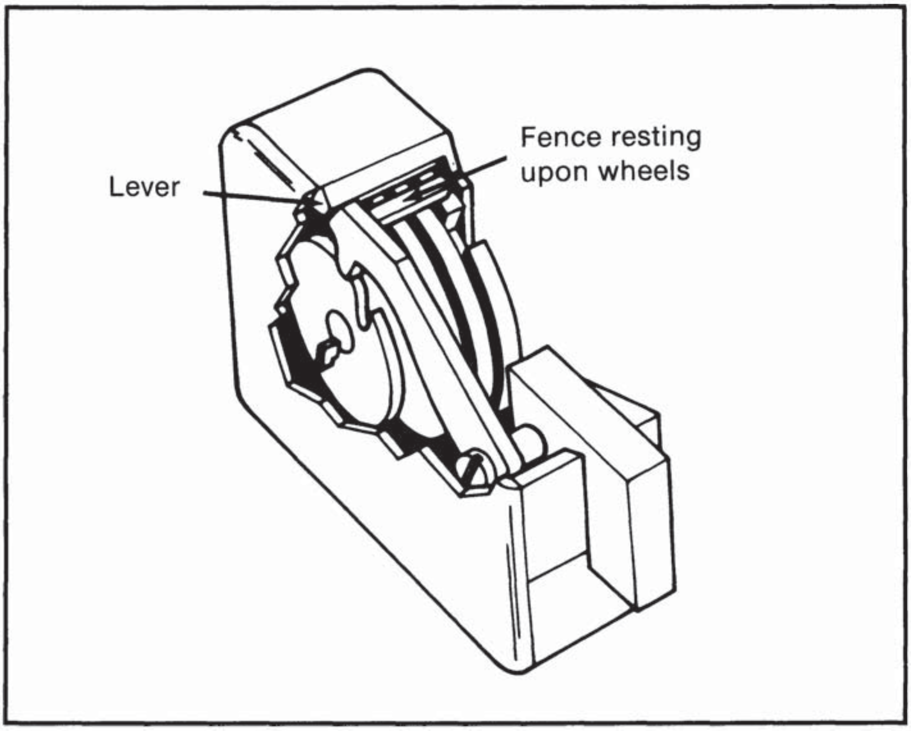


Figure 1-3

If the correct combination has not been dialed, the notches in the wheel-pack will not be aligned, and the gate and fence will merely rest upon the wheels.

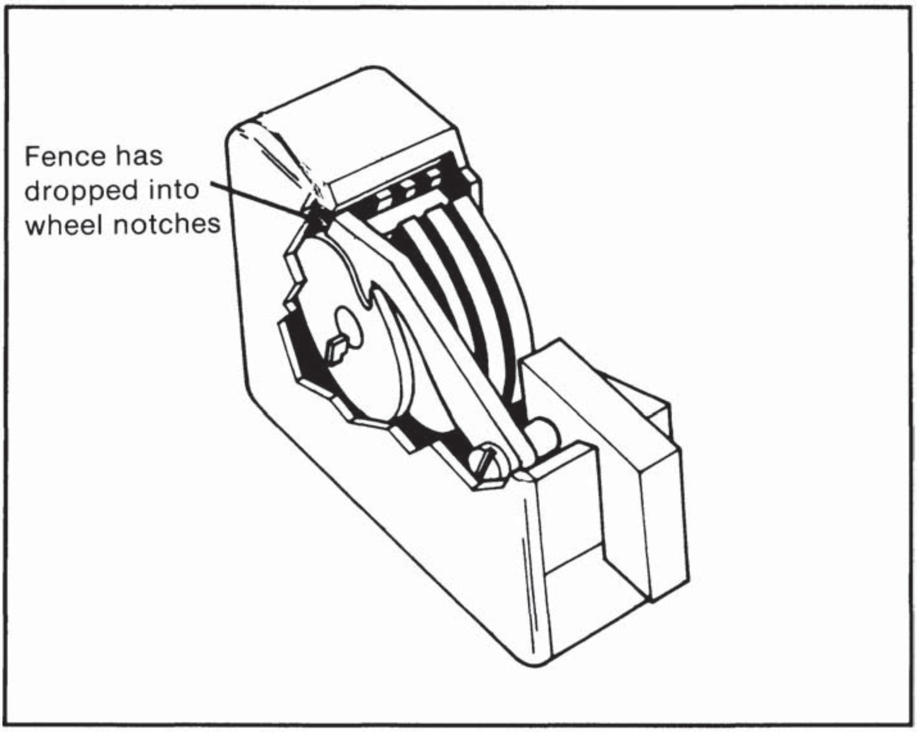


Figure 1-4

When the right combination is dialed, the wheels align, the gate and fence fall into the right notches.

When one is dealing with safes, it helps to know all one can about the particular model that is encountered. Underwriters' Laboratories has facilitated this procedure by labeling most safes with a universal code. On the safe body, a small metal tag (see Figure 1-5) will be displayed telling the amount of protection one may expect from fire or burglary. In other words, a burglar in the know can judge by the UL tag just how the safe is protected, and what techniques will or will not work. Handy, huh? Although the people at UL have coded this information slightly, every safecracker worth his salt knows exactly what each identifying code means. Figure 1-6 is a chart of the various codes currently in use.

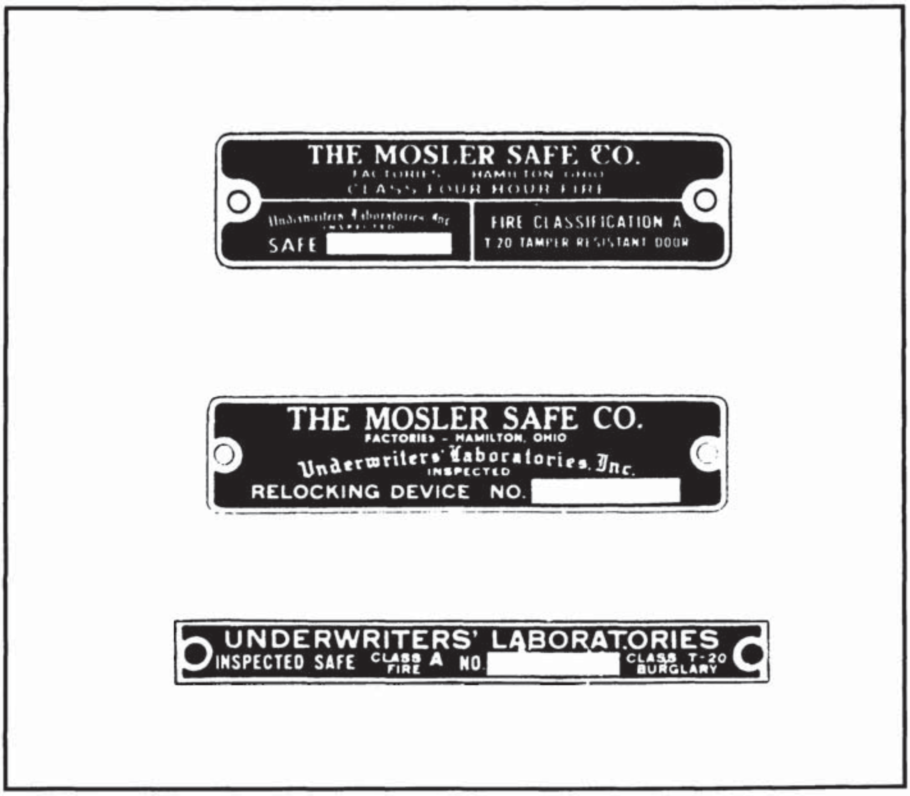


Figure 1-5

Most safes display a small metal tag which contains a coded rating from Underwriters' Laboratories indicating the amount of protection from fire or burglary the safe can be expected to provide. Above are three such tags.

Any other specifics of safe operation will be discussed more thoroughly whenever that information is needed to clarify a certain procedure. You have now, however, all the information you need to understand the next chapter.

UNDERWRITERS' LABORATORY CODES CHART

	Common tools: hammers, chisels, screwdrivers	Jack hammers and impact drills	Power saws and cutting wheels	Oxy-acetylene torches (thermic lances not tested)	High explosives
TL-15 — limited protection from burglary by common tools. Test time: 15 min Test area: door only	Yes	No	No	No	No
TL-30 — moderate protection from expert burglary by common tools. Test time: 30 min Test area: door only	Yes	No	Yes	No	No
TRTL-30 — moderate protection from expert burglary by common tools and cutting torches. Test time: 30 min Test area: door only	Yes	No	Yes	Yes	No
TRTL-30 (x6) — moderate protection against expert burglary by common tools and cutting torches. Test time: 30 min Test area: door and body	Yes	Yes	Yes	Yes	No
TRTL-60 — high degree of protection against expert burglary with common tools, cutting torches. Test time: 60 min Test area: door and body	Yes	Yes	Yes	Yes	No
TXTL-60 — high degree of protection against expert burglary with common tools, cutting torches, and high explosives. Test time: 60 min Test area: door and body	Yes	Yes	Yes	Yes	Yes

Figure 1-6

This chart explains the meaning of various Underwriters' Laboratories safe codes currently in use.

2

Combination Deduction

Since the most convenient way to open a safe is to dial out the proper combination, this chapter deals with how one may go about procuring it. Besides the obvious brute tactics, such as beating it out of someone who knows it, or threatening to do so, there are several tricks burglars use to come by this elusive combination. One of the most successful ways, manipulation, requires in-depth explanation, so the next chapter is devoted exclusively to it. Another method is by using try-out combinations. These combinations are set on the safes by the manufacturers, and are intended to be changed by the new owners, although many people don't know this or are too lazy to bother. Some examples of try-out combinations are in Appendix A, and these will open a surprising number of safes in use today.

A locksmith I know was called upon to open a safe whose owner had just died. The locksmith walked around the room for a few minutes before sitting down in front of the safe. To the family's amazement, the locksmith dialed out the combination and opened the safe in ten seconds flat. Magic? No, my locksmith friend simply realized that most people have terrible memories for numbers, and almost invariably write the combination down somewhere near the safe. He had found it written on the wall by a window, two feet away. I've found combinations written on desks, door frames, window panes, walls, picture frames, telephones, and even on the safe itself! This tendency is so universal, burglars almost always allot a few minutes to combination-hunting before moving on to more extreme measures.

Similarly, due to fallible memory, people have a propensity for making combinations out of notable numbers in their life. For example, I've seen a man whose birthday is October 12, 1931 use 10-12-31 for the combination to his safe. I've also known people to use anniversary dates, parts of Social Security numbers, Armed Forces serial numbers, and birthdates of children and spouses. Next to writing the combination down, this is the favorite method of combination retrieval, and you can bet professional burglars are well aware of it. Many safecrackers will undoubtedly do research to uncover such numbers prior to a house-breaking.

If the above techniques are impossible, the burglar may then try to determine whether or not the owner has left the safe on what is known as "day-lock." Day-lock means that the safe door was closed, and the combination dial was turned slightly. This scrambles only the last wheel of the combination, and the combination dial has only to be turned back to the original number for the safe to open again. Business owners like this, since unauthorized employees cannot open the safe, yet the entire combination does not have to be redialed every time the safe is opened. Many businessmen forget about this completely, and occasionally leave their safes on day-lock even at night, and this affords yet another opportunity for an enterprising thief. Day-lock is exploited by turning the dial to the left as far as it goes before any resistance is felt. This resistance is due to the drive pin on the wheel being turned, coming into contact with the drive pin of the next wheel. At that point, the dial should be turned no more to the left. Now, the dial is turned to the right, one number at a time, with the handle tried at each number. If the safe is indeed on day-lock, the handle will give at the proper combination number, and the safe will open. If, however, the dial is turned to the right until resistance is felt again, the safe combination must have been completely scrambled after closing.

Surveillance certainly has its place in combination deduction, also. Basically, there are three types of surveillance possible: long range, video, or close range. At long range, one attempts, through binoculars or a telescope, to see the combination dialed. This assumes, of course, that one can spy the safe in question from a concealed place. Even if one cannot discern the exact combination, one may be able to see what neighborhood each number is in, thus lowering the possible combinations if one chooses to trial-and-error it. Video surveillance requires a remote control or timed video camera which attempts to capture the combination dialing on film for later viewing. The camera is, of course, disguised, and one must devise pretexts for planting and retrieving it. The third example of surveillance is close range, where one hopes not to see the entire combination dialed, but rather just the last number. This happens in small banks or businesses where the safe or vault is kept open during business hours, and the number on the dial is plainly visible. If the number on the dial remains the same for a long period, it is more than likely the last number of the combination sequence. One may ask what good one number of a three number combination is, but with just one number, a burglar can trial-and-error the other two in just one weekend. This trial-and-error trick was accomplished on a six combination vault in the film *Honor Among Thieves*, which was supposedly based on a true story. In addition, if one knows the make of the safe, one can plug that number into the try-out combination formula used by the manufacturer (see Appendix A).

Another trick to learn a safe's combination is to first knock the combination dial off of the safe or otherwise mess it up, then plant a bug in the room the safe is in, to listen in on the conversation while the locksmith fixes it. Chances are, the combination will be discussed during his visit.

Before moving ahead to manipulation, there are a couple more ways of combination deduction to discuss. These methods are rather fantastic, and I lend little credence to their success, but they are included here for the sake of completeness. One doubtful technique is the tape-recorder trick. Supposedly, one can place a disguised tape recorder in someone's not-too-quiet safe, and upon retrieval, the tape speed is slowed and the volume amplified to produce a series of "clicks." These clicks are then counted to deduce the combination. Assuming a tape recorder can capture the precise number of clicks, how does one know from where the safe-opener began dialing, or where the combination dial changed direction? There are simply too many variables for this to be a reliable technique. And the same negative appraisal goes for hypnotism. Assuming one can hypnotize the manager of a bank under a pretext, that he knows the combination, and that he will not remember your asking him for it, it is generally agreed by professional psychologists that no one will do under hypnosis something they would never do while conscious. These last two tricks are interesting and fine for mystery novels and the movies, but I sincerely doubt their effectiveness in real life.

3

Manipulation Techniques

The art of manipulation has been around at least 100 years, for manipulation-proof locks were manufactured as early as 1910. This method of safe entry, however, was and has always been known only to a few highly-skilled locksmiths. Manipulation today is based largely on the techniques of Harry C. Miller, who developed a scientific approach to manipulation in the 1940's.

Manipulation is the safe opening trick you've seen countless times on television. Our hero sticks an ear to the safe, turns the dial a few times, and *voila*... the safe is open. Well, of course, it's not that easy in real life (thank goodness), but it is indeed possible. Locksmiths must practice manipulation a great deal to master it, and so too must a safecracker if he wishes to apply it successfully. If you wish to follow along with this chapter, and fully understand it, I suggest you get an old safe, or perhaps a mounted combination lock mechanism.

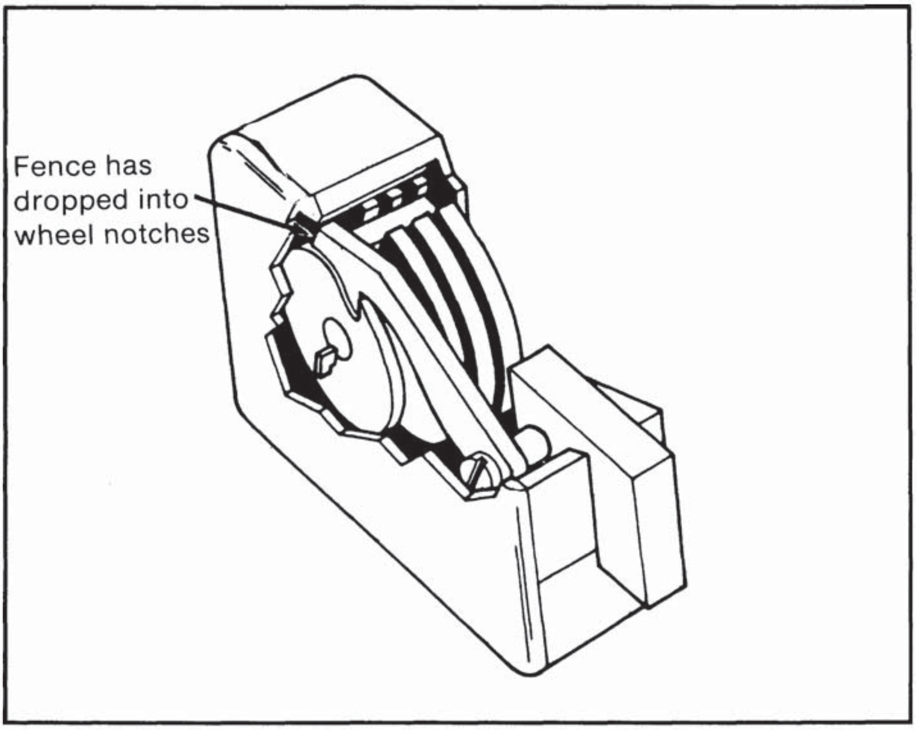


Figure 3-1

When the proper combination is dialed, the lever and fence fall into the notches of the wheels of the wheel-pack, allowing the bolt to be retracted.

As you'll remember from Chapter 1, when the proper combination is dialed (see Figure 3-1), the lever and fence fall into the notches, allowing the bolt to be retracted, but when an improper combination is dialed, the fence and lever simply rest upon the wheels. When the sloped notch in the drive cam comes in contact with the lever, it allows the lever to fall slightly into the notch. This is called the *drop-in area*, and its discovery is the first step in manipulation. To do so, rotate the dial at least four times to the left to pick up all the wheels. Continue turning left slowly until the nose of the lever drops into the drive cam gate slightly (see Figure 3-2).

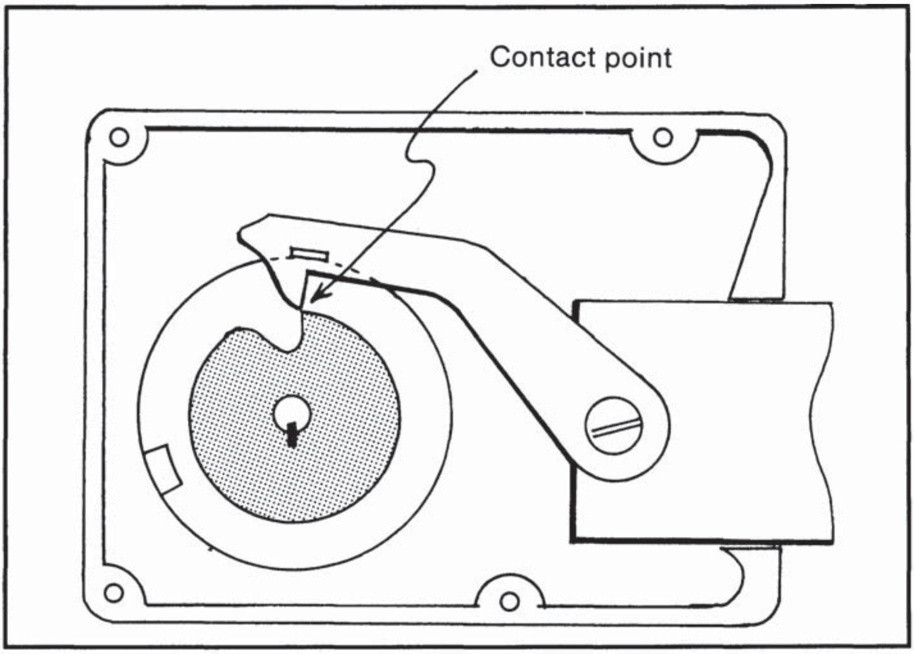


Figure 3-2

In safe manipulation, the dial is turned to the left until the nose of the lever drops slightly into the drive cam gate. This is the first contact point.

Continue rotating the dial slowly to the left. The next indication will be the nose of the lever striking the right side of the drive cam gate (see Figure 3-3). These are called the *contact points*, (the space between them is called the *contact area*), and it is these points which will allow you to determine the combination.

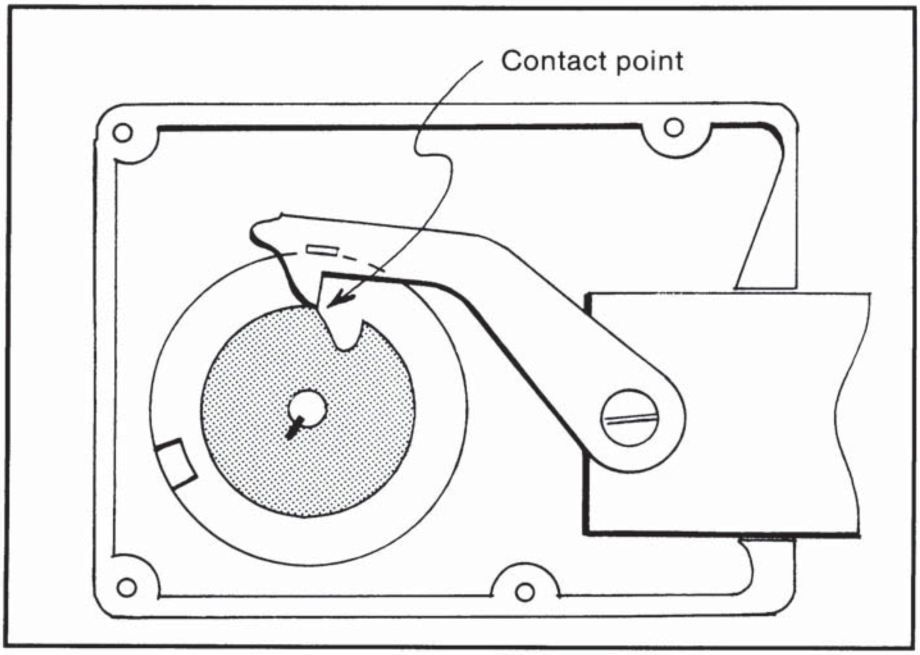


Figure 3-3

After finding the first contact point, the dial is turned to the left until the nose of the lever strikes the right side of the drive cam gate. This is the second contact point.

The second stage of the manipulation process is to determine the exact number of wheels in the lock. Turn the dial to the left at least four times to pick up all the wheels. We know the contact area — let's say, for example, it is between 10 and 20 on the combination dial. Continue to move the wheel-pack to the left, and park the wheels at a number far away, say 60, from the contact area. Now, turn the dial to the right, and as you pass 60 (or wherever you parked the wheels), you'll hear the drive pin come in contact with the fly of the first wheel. That's one. Continue rotating to the right, and every time at 60, you'll hear and feel another wheel being picked up. That's two. Continue this process, and when you hear no more fly contact at 60, you've run out of wheels. Most safes have three or four, but some have six, seven, eight, or more. For the sake of simplicity in this example, though, we will use a standard three wheel mechanism.

The third phase of manipulation is the actual charting of data taken from the combination dial. On a graph, such as the one shown in Figure 3-4, enter the left and right contact points in the appropriate boxes. Fill in the other boxes with the whole numbers nearest the contact points. We begin the graph by turning the dial right, four times around to pick up all the wheels. Continue right until the dial comes to "100" (or "0" on some safes), and park the wheel-pack there. Now, rotate the dial left to the contact area and take the left and right contact point readings. In our example graph (Figure 3-4), we see that our left contact point, 48⅛, was transferred to the graph by placing a dot on 48⅛ on the left "100" line. The right contact reading, 56¼, was transferred to the graph by placing a dot at 56¼ on the right "100" line. As you see, the graph goes in increments of three, so our next reading occurs at 97. Now, rotate the dial right again to "100" to pick up the entire wheel-pack, then park the wheels at 97. Now, rotate the dial left again to the contact area, and record left and right contact points on the graph, just as you did before. The new contact points in our example are 48½, and 56¼. These new points are now placed on the 97 line. This process is repeated until the entire graph is filled out. If you've taken accurate

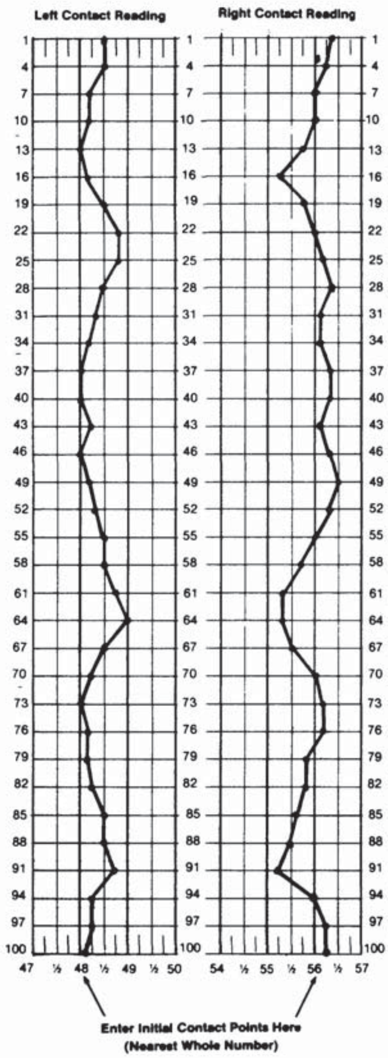


Figure 3-4

The third phase of manipulation is charting the data taken from the combination dial.

measurements, your graph should look something like Figure 3-4, with three (or however many wheels you discovered in step two) sections of the lines converging on one another. The numbers where the lines approach each other are the numbers of the safe combination.

As you see, the lines approach one another in the upper-teens, the mid-sixties, and the lower-nineties. More often than not, it will be difficult to determine the exact combination with this graph, so an amplified graph must be done for each number, since this first graph reflects such broad allowances.

On the amplification graph of the first number (see Figure 3-5), the readings are taken every half number, instead of every three numbers, and the increment lines are adjusted to read ⅛ measurements instead of fourths. The rest of the process is done exactly as for the original graph. An amplification graph is done for each number, and the numbers of the combination will be found.

Since you don't know which wheel is indicating which number, you must try all possible combinations to find the proper sequence. With a three number combination, there are six possibilities. In other words, since the numbers from our amplification graphs would be 16, 63, and 92, we must try all of the following combinations: 16-63-92, 16-92-63, 63-16-92, 63-92-16, 92-16-63, and 92-63-16. One of these should be the proper combination. If the safe refuses to open with any of these attempts, it is possible that a slight error was made in the amplification graph, so you'll have to "bracket" each number slightly. Bracketing means that if your amplification graph gives you a number of 16, you should try 15 and 17, just to be sure.

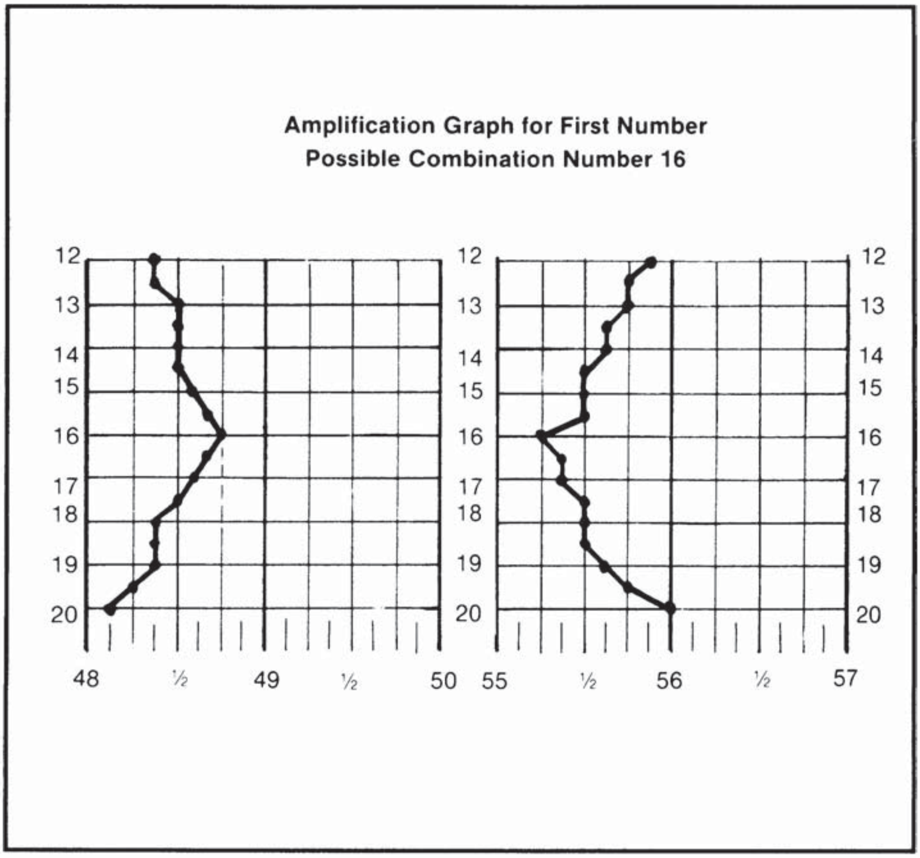


Figure 3-5

The amplification graph for the first number gives 16 as a possible combination number.

On newer safes, dials are extremely quiet and well balanced, making manipulation, which requires a lot of listening and feeling, much more difficult. To aid in manipulation, locksmiths and burglars alike use audio amplifiers which attach to the safe to detect tiny noises that would ordinarily go unnoticed. Many different types are available from locksmith suppliers, but just about any high-quality amplifier that is altered to attach (via magnet, suction cups, etc.) to a safe will probably suffice.

Some high-tech safecrackers eliminate the human element altogether, by using electronic sensing equipment (see Figure 3-6). This equipment is designed to

Courtesy: Wayne B. Yeager

Figure 3-6

Some high-tech safecrackers eliminate the human element by using electronic sensing equipment.

combine the sight and sound elements of manipulation, without the potential of human error. It consists of high-quality headphones for maximum sensitivity, specially designed filters to eliminate undesirable and irrelevant noises, and an electronic "memory" oscilloscope with a sound wave analyzer. The human ear is not sensitive enough to detect the different sounds which emanate from the lock, but when using this equipment, each "click" is illustrated on the oscilloscope as a wave. Since the memory function can be utilized to freeze-frame and compare various waves with similar characteristics, it is not too difficult for the user to calculate the combination by locating three or four identical wave patterns.

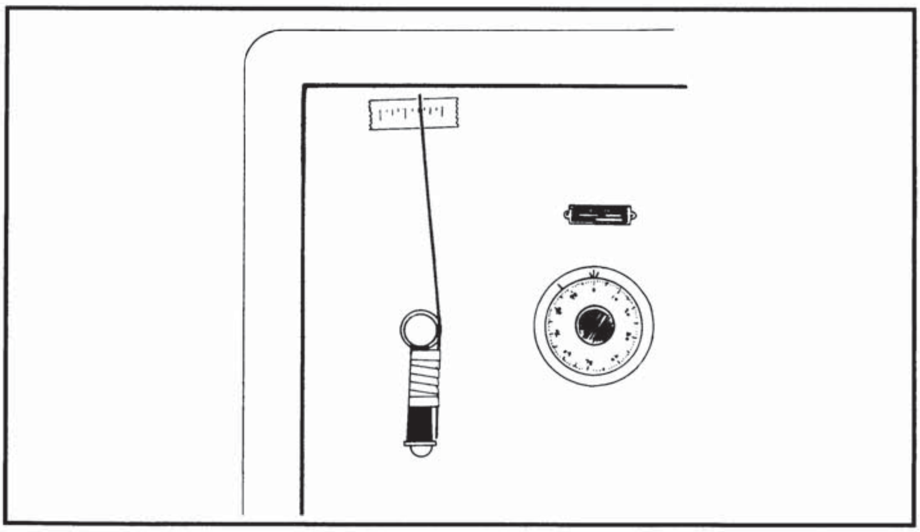
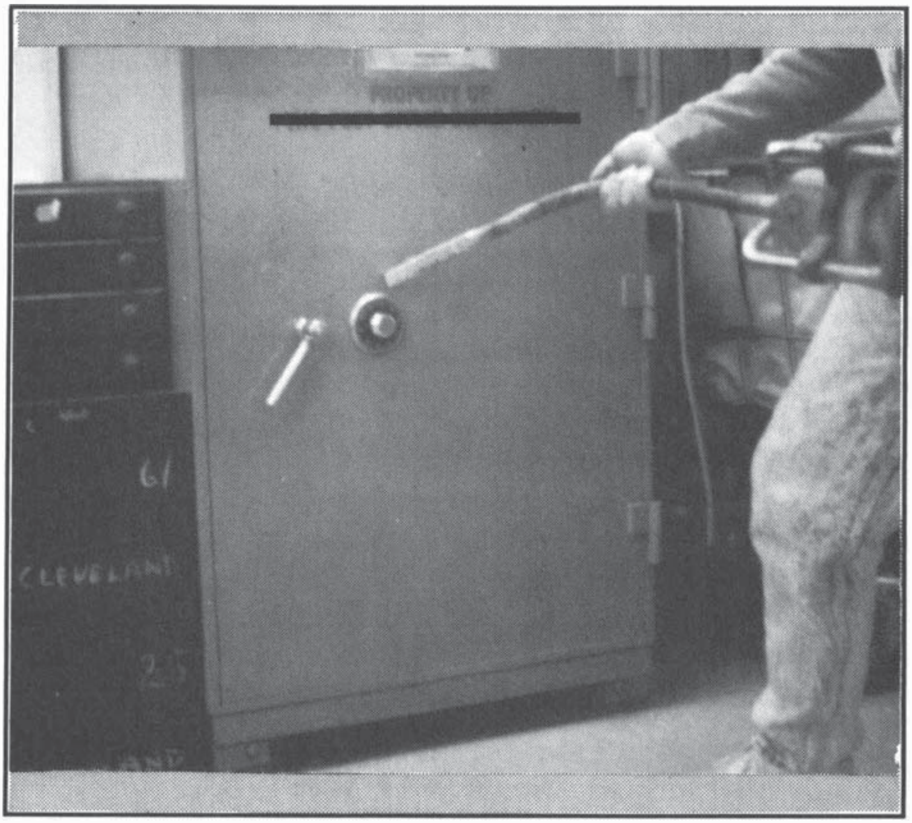


Figure 3-7

Some people use a "handle meter" for safe manipulation. A long piece of stiff wire attached to the handle amplifies the handle's movement so that it is easier to detect the slight increase in handle movement when one of the wheels is in the drop-in position.

Some people also design a "handle meter" for manipulation, since there is a slight increase in handle movement when one of the wheels is in *drop-in* position. This trick uses a long piece of stiff wire attached to the handle to amplify the handle's movement so that slight variations are more easily detected. The wire, at least 12″ long, is attached to the handle very securely. At the top of the wire, a calibrated card is placed on the safe so that the wire movements can be recorded more accurately (see Figure 3-7). The wheels are all turned to the left and brought to the contact area, or drop-in point. Note the position of the wire at this point before continuing. Now, turning the dial one number at a time, the handle is turned each time and a reading taken. When a wheel's notch is under the fence, indicating one of the numbers of the combination, the wire indicator will move ⅛″ or more on the card. Continue this process as in normal manipulation, until all of the wheels have indicated a combination number. This process, though sometimes used alone, is even more effective when used in conjunction with the previous manipulation methods.

I've also opened safes by vibration (see Figure 3-8). If a good-sized industrial vibrator (used in concrete settling) is applied to an inexpensive safe, the wheels will begin to spin slowly from the intense vibration. Sometimes, if a wheel spins its way under the fence, the fence will catch slightly on the notch of the wheel and trap it, so that it cannot spin further. By altering the directions of the vibrating force, it is possible to catch every one of the wheels in this manner. I suppose the reason that this hasn't become really popular among safecrackers is because industrial vibrators are terribly loud, and they numb your hands after holding them a few minutes.



Courtesy: Wayne B. Yeager

Figure 3-8

An industrial vibrator can be used to discover the combination of a safe.

Obviously, the various versions of manipulation are not techniques that are easily learned by reading about them. One must practice diligently if one is to master the intricacies of this exacting procedure. Although manipulation is sometimes difficult, anyone with perseverance can perform an opening with these techniques, if they adhere to the basic guidelines outlined here.

4

Safe Drilling Methods

Drilling is perhaps the most common method used by locksmiths to enter a locked safe, and is becoming increasingly popular with safecrackers as well. There are several different ways to drill a safe, all bringing about different results which ultimately lead to the safe's opening.

The first and most direct way to perform an opening is to drill for the locking lever or cam, and remove the obstruction that is causing the safe to remain closed. As shown in Figure 4-1, the tip of the cam cannot pass the locking bolt as long as the bolt is extended. In order to remove it, a hole is drilled as shown in Figure 4-2. Now the cam tip can either be partially removed by drilling chunks out of it, or moved out of the way by using a punch rod. The rod is used to bend the cam tip so that it passes on the other side of the locking bolt. It usually doesn't take a lot of bending to accomplish this bypass. The handles can then be turned to open the door.

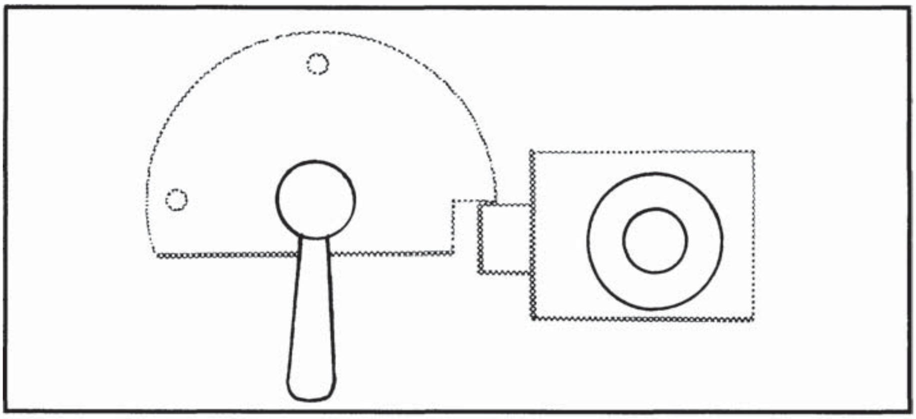


Figure 4-1

The tip of the cam cannot pass the locking bolt as long as the bolt is extended.

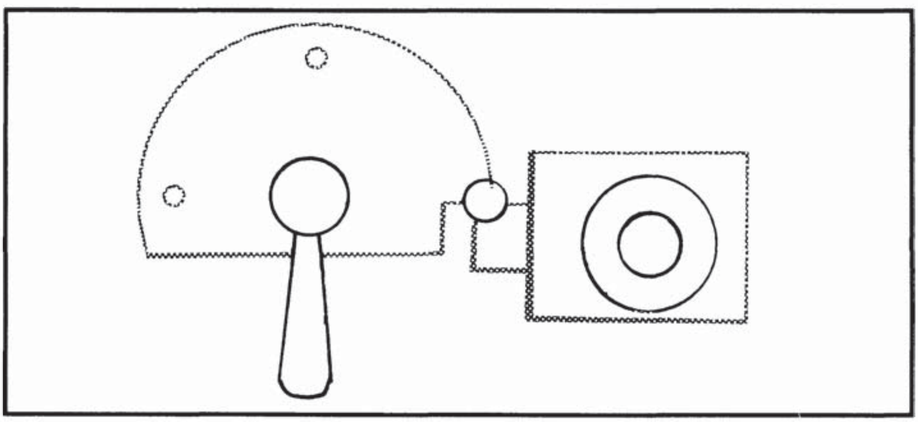


Figure 4-2

If the hole is drilled as shown, the cam tip can be partially removed, or moved out of the way.

The second method of drilling is not an attack on any safe mechanism itself, but rather it is a way to create a "peephole" into the wheel-pack. This type of drilling requires an intimate knowledge of safes, for one must know the proper angle and depth to drill. If seen from a side view (see Figure 4-3), the wheel-pack can be accessed

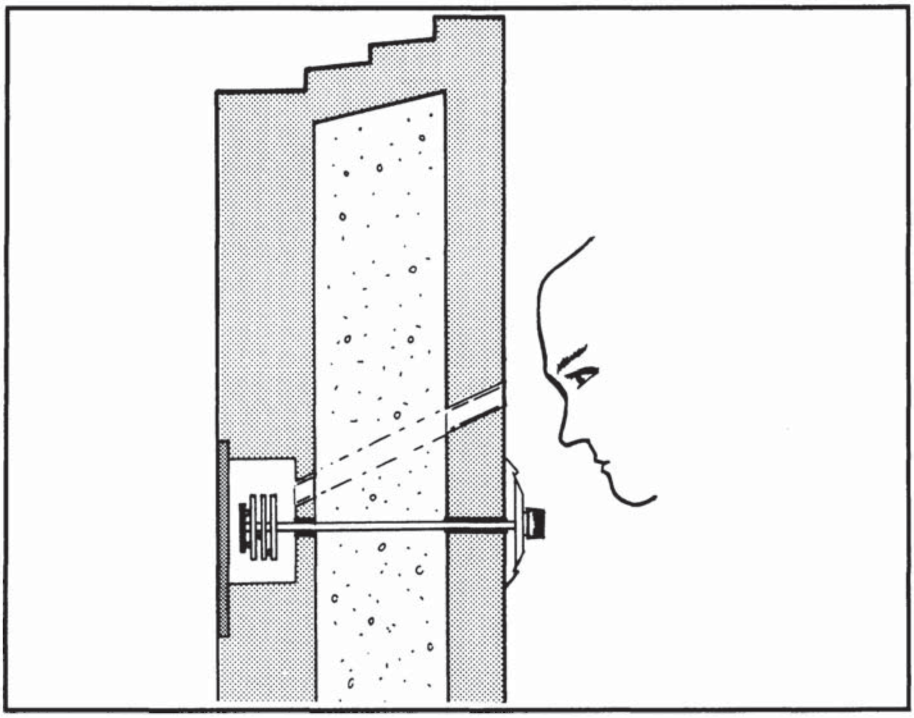


Figure 4-3

The wheel-pack can be accessed by drilling a small tunnel to it.

by drilling a small tunnel to it. Through this tunnel, a borescope (see Figure 4-4) is inserted. A borescope is a flexible, fiber-optic viewer that allows one to see into small holes or around corners. They are used in many professions, from medicine to engineering, and are avail-

Courtesy: MDS, Inc.

Figure 4-4

A borescope is a flexible, fiber-optic viewer that allows one to see into small holes or around corners.

able from any locksmith or scientific supplier. With a borescope, one is allowed to see the wheel-pack (see

Figure 4-5), and one can then deduce the combination. This is done by recording the numbers seen on the dial when aligning the wheels, seen through the borescope. This set of numbers will not be the exact combination, but these numbers will be the same distance from one another as the numbers of the real combination. So, all one has to do is add 1 to all of the numbers until the right combination is found. Say, for example, that in order to perfectly align the wheels (as seen through the borescope), you had to dial 30-40-50. One then begins dialing 31-41-51, 32-42-52, etc., until the proper set of numbers is hit.

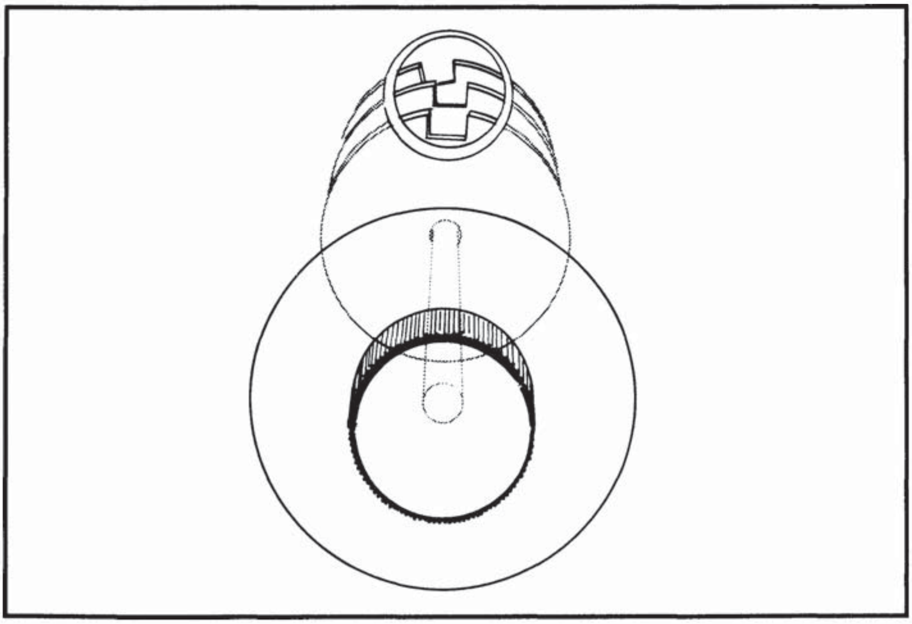


Figure 4-5

With a borescope inserted into the tunnel drilled to the wheel-pack, one can see when the wheels are aligned, and one can determine the correct combination.

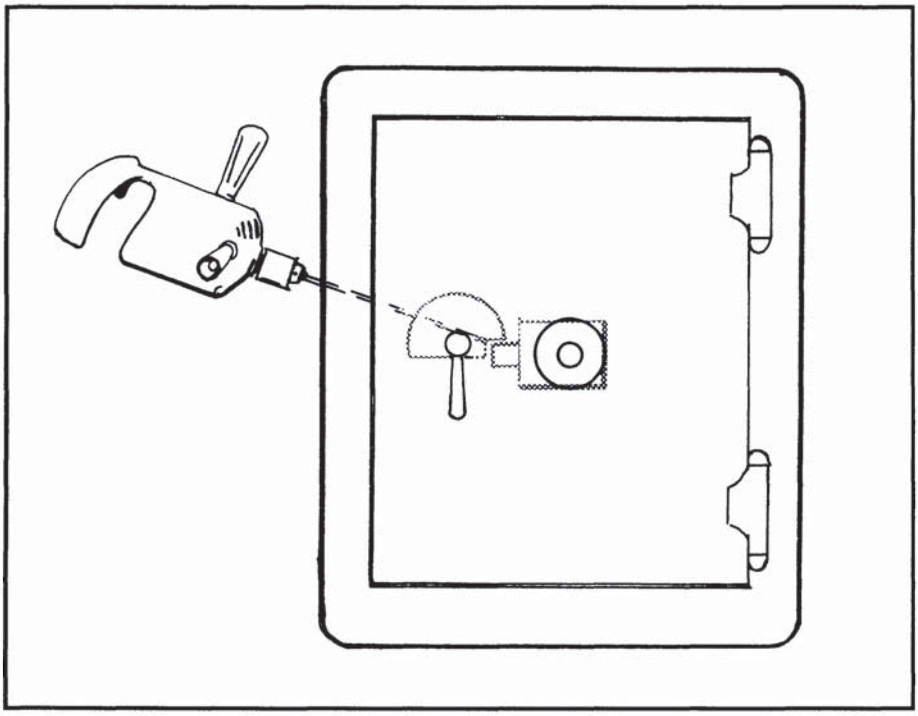


Figure 4-6

In side drilling, a drill bit about 9 or 10 inches long is used to drill from the side of the safe to the locking bolt. The locking bolt can then be punched out of the way allowing passage of the bolt cam.

The third method of entry is side drilling. This method requires a very long drill bit, about 9″ or 10″, to reach the distance from the side of the safe to the locking bolt (see Figure 4-6). The theory of this method is that by gaining access to the locking bolt, one may punch it out of the way to allow the passage of the bolt cam. Determining the proper place to drill requires some knowledge of the safe encountered, but there are some general rules of thumb that can be applied. Draw an imaginary line from the center of the combination dial, and extend it around to the side of the safe about 3″ (see Figure 4-7). Drill here, while tilting the drill bit down slightly. A good, lighted borescope is needed here to penetrate the darkness, but once the bolt is located, a long punch rod replaces the borescope. The rod is then given a good punch with a hammer, so that the bolt is driven out of the way. The cam is now free to turn, so the handle will then open the safe door.

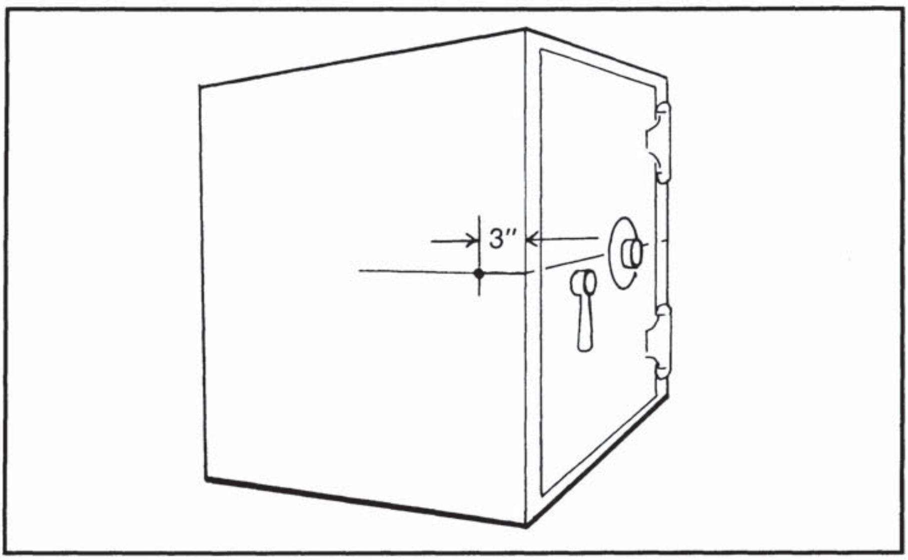


Figure 4-7

There is a general rule of thumb for finding the proper place to drill in side drilling. The safecracker draws an imaginary line from the center of the combination dial, and extends it around to the side of the safe about three inches.

The fourth method of drilling is an attack on the handle shaft itself. The plan here is to drill directly through the center of the handle shaft to shear off the threads of the attaching screw, which permits access to the cam.

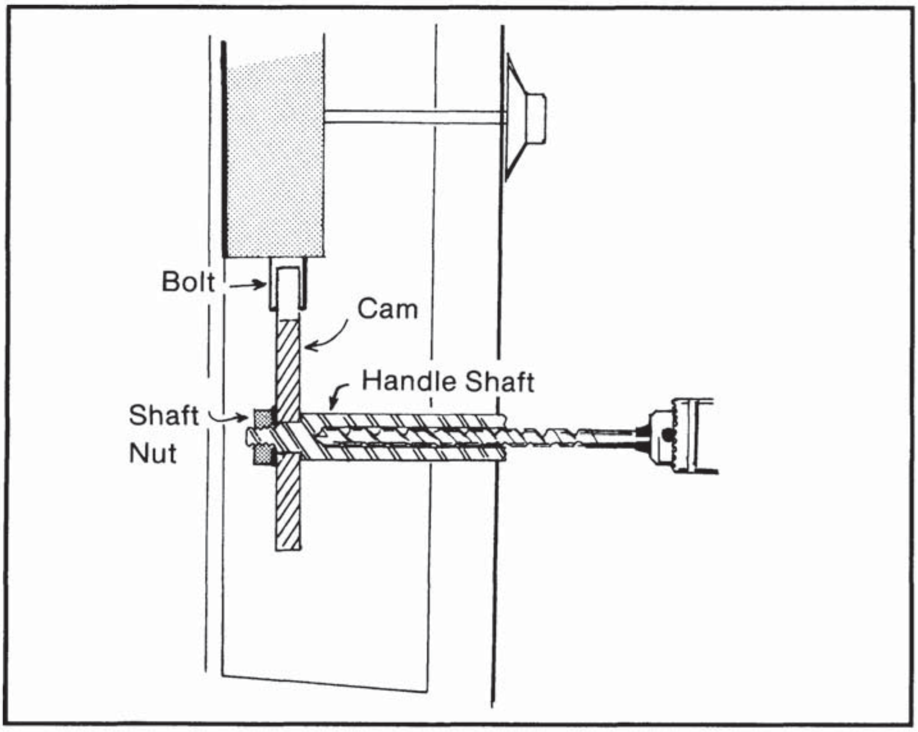


Figure 4-8

If a safecracker drills through the center of the handle shaft, all the way through the shaft, he will drill off the thread at the end of the handle and the attaching nut will fall off. This allows him to remove the handle shaft completely.

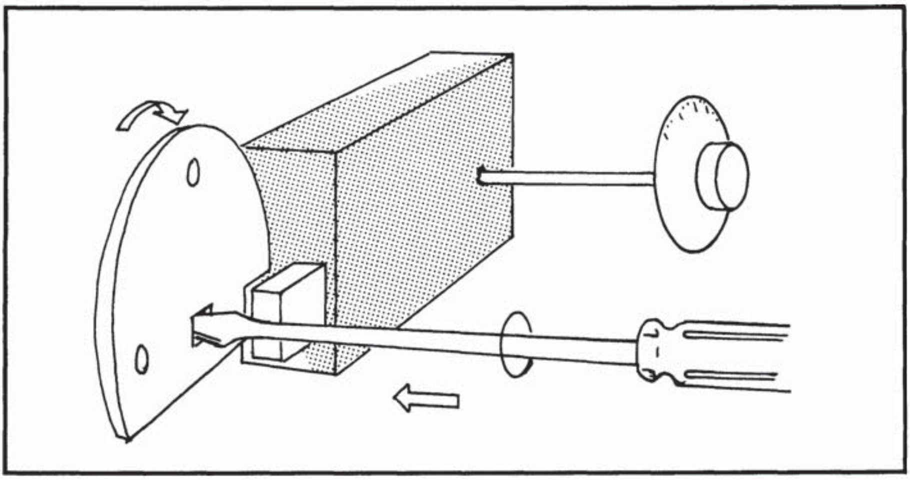


Figure 4-9

After removing the handle shaft, the safecracker inserts a large screwdriver into the square hole in the center of the cam, and presses firmly. This moves the cam under the bolt and allows the cam to be bypassed. The door can then be opened.

The usual method of approach is to first cut the handle off as close to the door as possible, so that the handle shaft can be seen. The exact center of the shaft is marked, and a long ⅛″ bit is used to drill a leader hole all the way through the shaft. A larger bit, about ⅜″, is then used to follow this hole to the end of the shaft (see Figure 4-8). If the hole is straight and accurate, you will have drilled off the thread at the end of the handle, and the attaching nut will fall off. This will permit you to remove the handle shaft completely. With the shaft gone, a large screwdriver is inserted into the square hole in the center of the cam (see Figure 4-9), and pressed firmly while turned in the opening position. As the inward pressure is applied, the cam will be moved in under the bolt to allow the bypass of the cam. The door will then open.

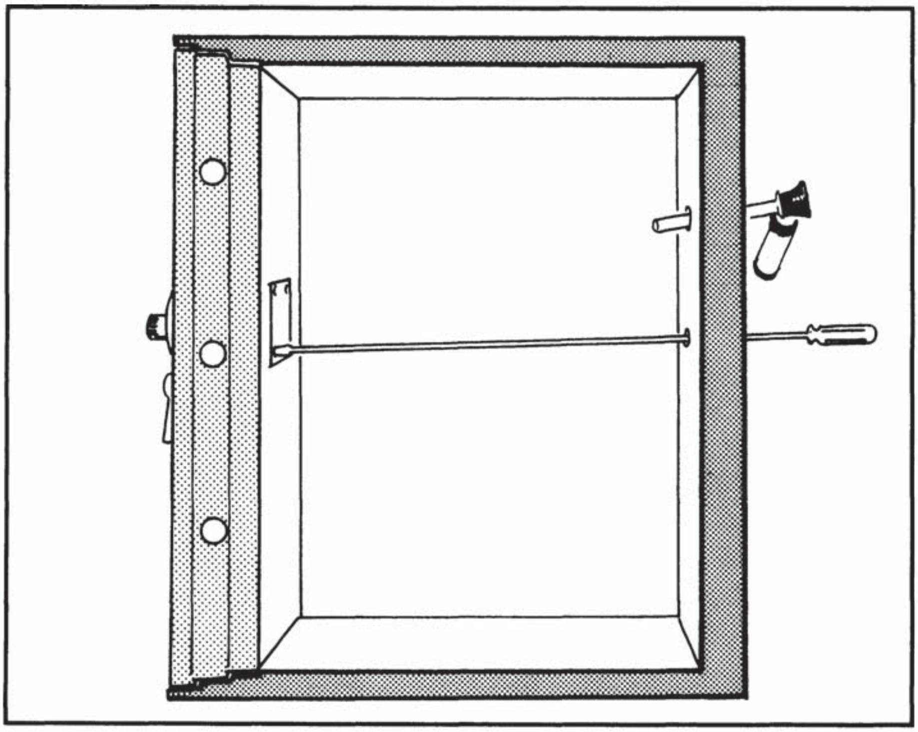


Figure 4-10

A safe man can drill two holes into the back of the safe, one for a borescope, and the other for the insertion of a long screwdriver.

Another area of a safe that is vulnerable to a drilling attack is the back. Two holes are drilled into the safe interior (see Figure 4-10). One hole is for a borescope, and the other is for the insertion of a long screwdriver. The safe man removes the screws on the back of the wheel cluster so that a portion of the wheel cluster is now visible. Using the special screwdriver, the wheels can be turned and the bolt retracted.

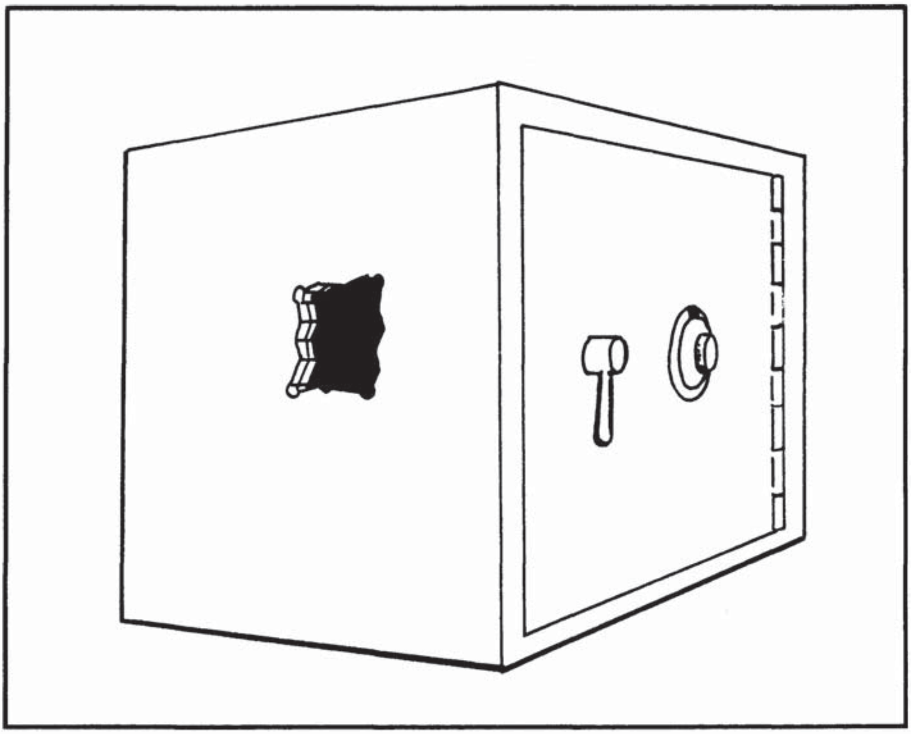
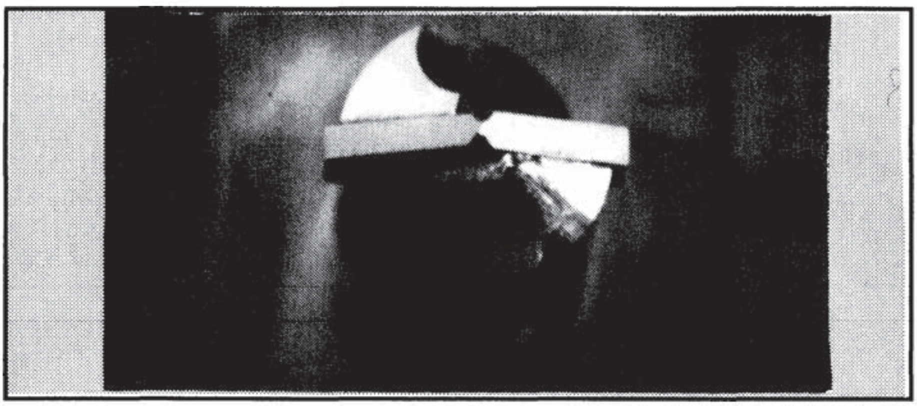


Figure 4-11

A safecracker can drill a series of holes to create a 4" x 4" square. This square can then be punched out with a sledgehammer, allowing a hand to reach in and remove the contents of the safe.

One final trick of the safecracker is to drill a square of holes (see Figure 4-11), and punch this square out with a sledgehammer or cut it out with a cutting torch. After making this small hole, he then reaches inside the safe to remove the contents. Crude, but effective.

Well, now that you know the methods and purposes of safe drilling, we should discuss the actual mechanics of the drilling process. Any area vulnerable to a drilling attack, such as the door, sides, or back, will most likely contain, in the higher security models, a plate of hardened steel. The placement of this hardened steel varies from safe to safe, but you'll know it when you hit it. Plates vary in thickness from ⅛″ to ⅜″, but most are about ¼″ thick. This steel is usually hardened to 62-64 on the Rockwell scale, and requires a carbide, tungsten, or cobalt-tipped drill bit (see Figure 4-12) to penetrate it. Drilling hard



Courtesy: Strong Arm Security, Inc.

Figure 4-12

To penetrate a hardened steel safe, a carbide, tungsten, or cobalt-tipped drill bit is necessary.

steel requires a great amount of steady pressure, and plenty of drill bits. A freshly sharpened ⅜″ bit will cut efficiently for only about two minutes, and it often takes up to ten to penetrate the plate. A strong individual who can maintain a steady pressure should use a drilling speed of about 2000 RPM, but a smaller person should consider a higher speed of about 5000 RPM. The higher the drill speed, the smaller the drill bit required, and the less pressure needed to penetrate the hardened steel.

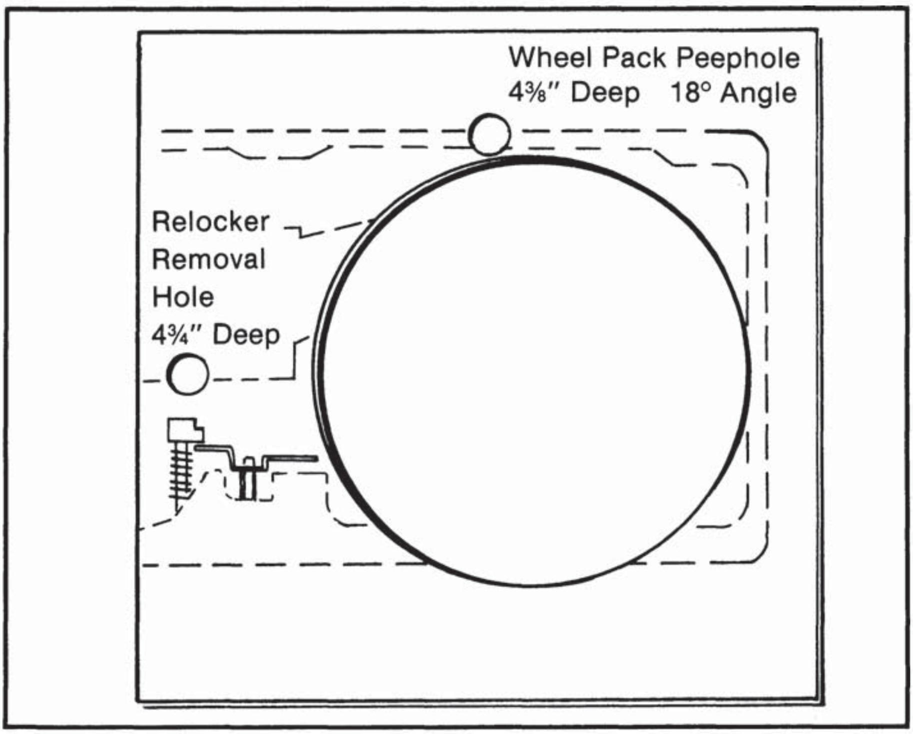


Figure 4-13

A drilling template is available for just about every make and model of safe.

Another factor one must consider is the angle at which the safe is to be drilled. This depends upon the physical construction of the safe itself, and is adjusted for the minimum amount of work. Such information is best obtained by a working knowledge of safes, or by using drilling templates. A drilling template (see Figure 4-13) is available for just about every make and model of safe. All a safe man must do is place the template against the safe, and he has an instant x-ray view of the contents. Using this, he has no trouble in deciding exactly how to drill. There is caution taken in the distributing of safe drilling templates, so the safecracker most often has to use the trial-and-error method. As you can see in Figure 4-14, the

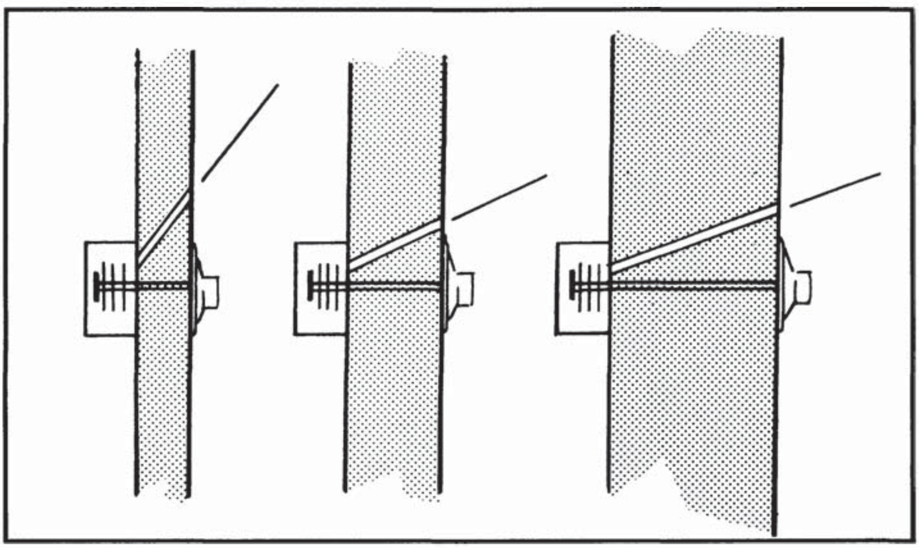
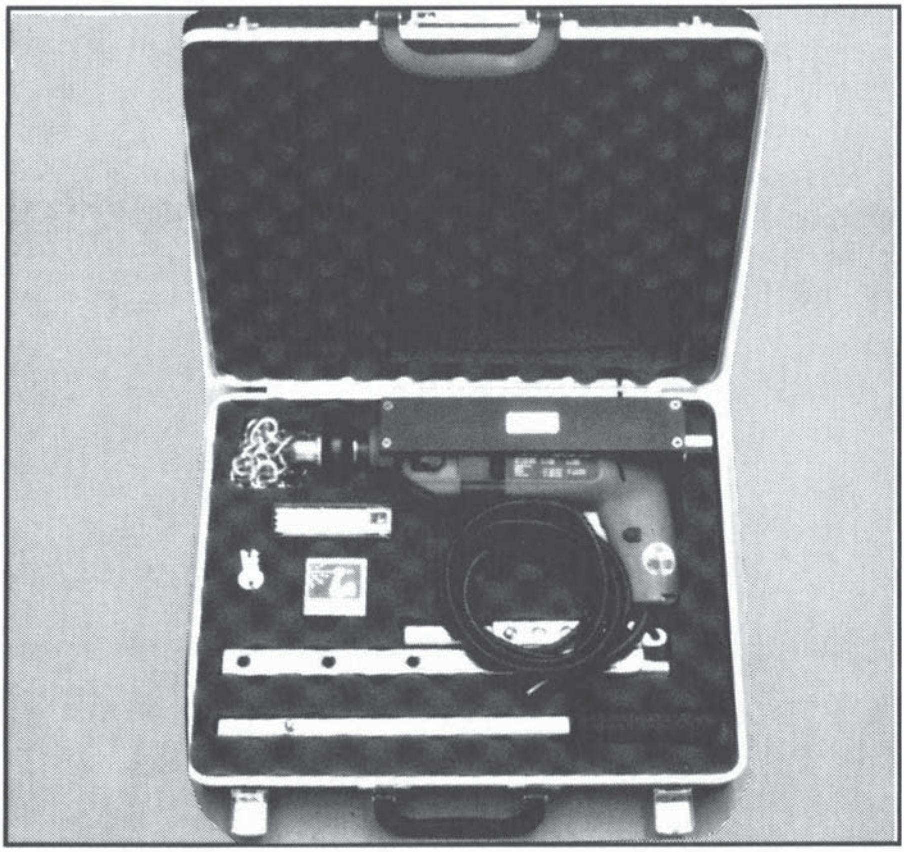


Figure 4-14

The proper angle of drilling depends on the thickness of the safe door.

thickness of the door determines the proper drilling angle. It is rather hard to know how thick a safe is by looking at it, but 15° is a good starting angle when door drilling.



Courtesy: Strong Arm Security, Inc.

Figure 4-15

A drilling rig is a portable drill press which attaches to the safe itself and allows much more control and drilling pressure than free-hand drilling.

One problem with safe drilling is that one must drill very accurate holes at sometimes precise angles, under difficult circumstances. Framon Manufacturing Co., Strong Arm Security Co., and others, have come to the rescue with their various drilling rigs. These devices, which attach to the safe itself, are portable drill presses which allow much more control and drilling pressure than free-hand drilling.

Now that we've seen the purpose and mechanics of safe drilling, it is obvious that drilling is quite an effective and efficient means of safe entry. It is also much neater than the methods that follow.

5 Punching and Peeling

Punching and peeling, more violent methods of safe opening, are very popular means of attack among safecrackers when facing older or cheaper safes.

Peeling, or stripping as it is sometime called, entails delaminating a safe by prying up a corner, and removing sheet after sheet of metal like a multi-layered can of sardines. One uses a crowbar, axe, or steel wedge to pry an edge at the upper right hand corner of the safe, near the door. One layer after another is peeled until the interior of the safe is reached. With models made prior to 1960, this can be quite successful at times, although it takes a great deal of time and effort.

The primary tools of peeling are very crude, and include the ax, pick, crowbar, steel wedges, bolt-cutters, and sometimes an electric jackhammer. In a few minutes, a burglar can inflict an incredible amount of damage to a safe with these tools.

Many years ago, safe manufacturers began replacing the relatively thin steel faceplate with thicker metal, and started using cement-like lining under this metal. This slowed the burglar down, but cheaper safes and fire safes are still particularly susceptible to this type of attack. New high-quality safes, however, have seamless one-piece bodies which defeat any attempts at peeling.

In punching, the theory is to force the cam out of the way of the lock bolt, so that the door will open. This is accomplished by knocking the combination dial off the safe, and using a strong punch rod to forcefully knock the spindle into the cam. This will, on older model safes, force the cam out of the way of the lock bolt, allowing the handle to turn and the door to open. Modern safes have effectively removed this opportunity, however, by using relocking devices which engage during a punching attempt, plus many have spindles of lead or other malleable, soft metal which spreads out on impact rather than moving the cam.

6

Torches, Etc.

Since any metal can be melted at a hot enough temperature, even the toughest safes lend themselves to various methods of burning. One way to accomplish this is by torch, and the other is by incendiary.

One type of torch is the oxy-acetylene variety, capable of temperatures between 4000° and 4500° F in the hands of a skilled operator. At this temperature, an oxy-acetylene torch is a very effective tool for cutting most steel materials, but has some difficulty in piercing thick, hardened steel plate. Another type of torch, the thermic lance, or burning bar, is used extensively in the construction industry and can reach temperatures of over 7000° F. In the hands of an expert, the lance will penetrate the most advanced safe construction in the world, if given enough time.

Usually, cutting is accompanied by other methods of safe opening, such as drilling or the use of explosives. However, cutting itself is often used if one needs only to make a hand hole large enough to retrieve the safe's contents, or remove enough metal to reach the internal lock mechanisms. Cutting with an oxy-acetylene torch is quickly becoming out-dated as safe manufacturers are graduating to harder, high-tech alloys, but is still effective in opening older and less expensive safes.

The thermic lance has become the weapon of choice for most advanced safe burners, and for good reason. Its incredible heat will penetrate a six-inch thick block of tempered steel in 15 seconds. The lance is actually a hollow iron pipe packed with a combination of high-carbon steel and magnesium rods, which burn and act as a flux to remove the molten metal. Burglars who use a thermic lance simply cut themselves a new door in the safe or vault, and grab the loot. Because of the drawbacks of using a thermic lance, such as the need to wear a special fire suit, the dense quantities of smoke produced, and the bulk of the equipment, a new, smaller version, called the Keri-Coil, was produced.

The Keri-Coil is essentially a miniature version of the thermic lance, and is used extensively in underwater metal-cutting. It uses a 40-foot long flexible steel cable which replaces the rods of the burning bar. The Keri-Coil is portable and easy to conceal, and will, I feel, become a very popular burglary tool in years to come.

Thermite, a mixture of iron and aluminum flakes, is also a very useful tool in the burglar's arsenal. When ignited, (which is difficult and must be done with a small torch) it burns at an incredible temperature, and quite literally turns hardened steel plate into bubbly, molten metal in seconds. If placed on a safe, it will melt the metal almost instantaneously, allowing a metal punch or long screwdriver to be poked through. Recipes for thermite and other incendiaries are given in Kurt Saxon's *Poor Man's James Bond.* Gas masks are usually worn when using thermite, for it gives off noxious fumes when burning.

Although it seems safe burning is an easy way to gain entry, there are many drawbacks for the would-be safecracker. First, in order to create a temperature hot enough to cut the safe's metal walls, the temperature inside the safe (even with insulation) may reach a point hot enough to burn the contents. Paper currency ignites at about 500° F, and this poses a problem for those using this type of heat. Most burglars, once a hole has been pierced into the safe, pour water into it to protect any money or other important objects from burning.

Torches and thermite also create a lot of noise and huge quantities of smoke, which is likely to set off any burglar or fire alarms nearby. (See *Techniques of Burglar Alarm Bypassing* for information on this subject.)

7

Explosives

One of the burglar's favorite methods of safe entry is via high explosive. Nitroglycerine is still widely used today, but the power, reliability, and safety of plastic explosives, such as C-4, is favored by modern safe-crackers over the Old Timers' "grease."

Back in the old days, nitroglycerine was simply drained from dynamite sticks, but when stricter guidelines for dynamite manufacture were introduced, burglars found it necessary to make their own. Nitro is simply a mixture of Nitric and Sulfuric acids with a little glycerine thrown in. There are several books on the market today which offer the recipe, but one of the best is Uncle Fester's *Home Workshop Explosives.*

When blowing a safe with nitroglycerine, the safe-cracker also needs a moldable substance to create a funnel-like device. Historically, soap (such as Fels

Naptha) has been used for this function. When the soap is hand-kneaded for about 15 minutes, it becomes a very malleable substance with a consistency that will not permit the nitro to leak through it. Also in the safecracker's tool bag should be a strip of cellophane, blasting caps, and a prybar.

Of all nitroglycerine techniques, the most common is what is called the "jam-shot." It is feasible on most safes, round and square door alike, and requires no physical movement of the safe. The purpose of the jam-shot is to blow the door open while still on its hinges. Occasionally a safecracker will use too much "grease" and blow the door completely off, or not enough "grease," which requires either another shot of nitro, or some serious door-prying.

The piece of cellophane is folded into an 8″x ½″ strip, and placed lengthwise into the space between the door and the door frame. The soap is fashioned into a cup, with a funnel shape made around the cellophane. This must be a tight fit, so that the nitroglycerine will not dribble down the front of the safe door. When the cup and funnel is finished, the cellophane is carefully pulled out, with pains taken not to jar the soap funnel. This provides a channel for the flow of the nitroglycerine once it is introduced into the cup. The blasting cap is placed carefully into the cup, and the wires are unrolled and extended to the battery hookup, which should be safely out of the way of the explosion.

The nitro is now poured into the cup, and the safecracker observes the rate at which the safe is "drinking." Nitro is a syrupy liquid, and there must be a continuous, unbroken chain of liquid all the way to the detonator. When approximately one ounce has been consumed, and the burglar has determined that a continuous river of nitro exists from the last drop down inside the door, all the way to the blasting cap, he sets off the detonator. This is the real art of safe blowing — knowing exactly when to detonate. If all goes well, the safe door will be blown open, and the contents revealed.

The "gut-shot" or "spindle-shot" is another very popular nitroglycerine method. The use of the gut-shot is limited, though, since the safe must be moveable, and the modern safe's relocking device (see Chapter 10) may render this technique useless.

The gut-shot requires that the burglar first knock off the combination dial with a hammer, then tilt the safe over on its back. A blasting cap is attached to the spindle, and an eyedropper-and-a-half of "grease" is allowed to trickle down the shaft of the spindle. The nitro will find its way into the locking mechanism, and when detonated, will destroy the entire "guts" of the lock. The door can then be opened by simply turning the handle.

In addition to nitroglycerine, professional burglars use castable high explosives such as C-4, PETN, RDX, or TNT to either blow a hole in the safe, or blow the safe apart. These high explosives can sometimes be purchased from legitimate users, or can be manufactured using a formula in *Home Workshop Explosives.*

The ribbon charge is simply a rectangular box of high explosive placed on or near the target safe (see Figure 7-1). To help direct the force of the explosion, several bags filled with water are placed on the charge. This also serves to significantly reduce the noise level of the explosion. This type of explosive technique will usually penetrate 3-4 inches of steel, so obviously a great amount of damage is done to the safe. Under certain circumstances, shaped charges may be used to blow a safe. These are much more efficient since they have a predetermined direction of force, but a situation where they may be used effectively is often difficult to contrive.

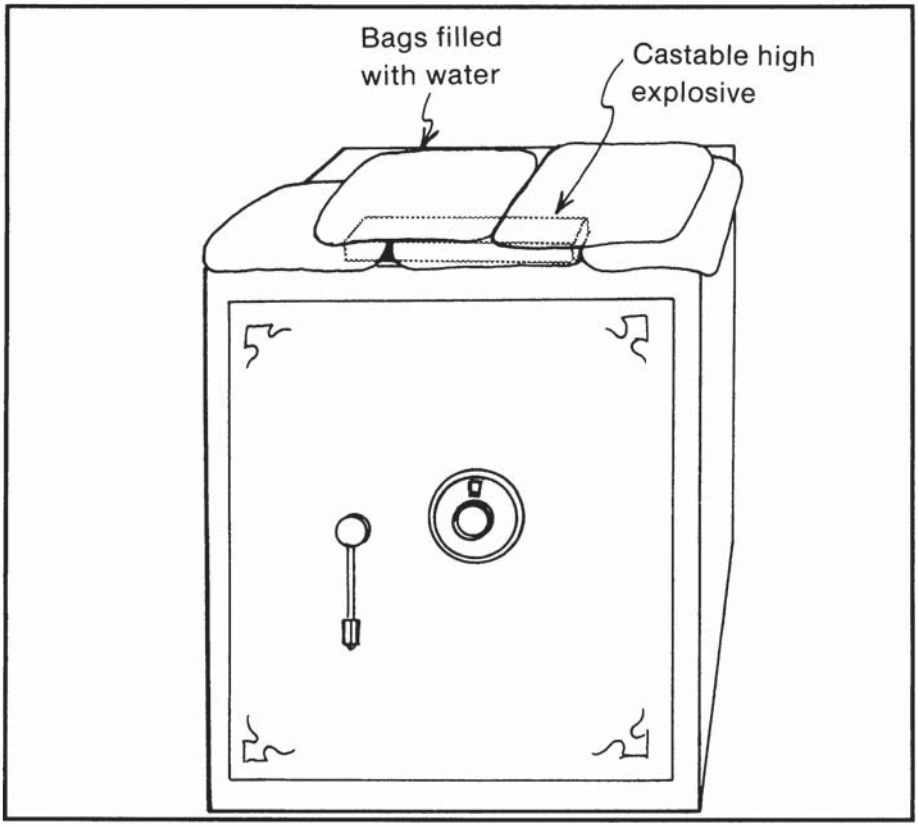


Figure 7-1

A ribbon charge is a rectangular box of high explosive placed on or near the safe.

Another popular trick among safe blowers, is to drill a small hole into the top of the safe, and fill it with butane, propane, or other highly combustible gas. A stopper made of modelling clay is placed over the hole, and a fuse is inserted. When the gas is ignited, the force of the resulting explosion may be enough to demolish the safe, I've even heard of one obviously amateur burglar who actually filled a safe with gasoline, and lit it. Not only did it blow the door off, but it destroyed the entire safe, the contents, and very nearly the safecracker as well. These techniques would obviously be worthwhile only if the safe's contents could not be burned.

Finally, a new and ingenious method of safe blowing is being seen more and more frequently these days. Again, a burglar drills a small hole into the top of the safe, and fills it completely with water. Then, a pencil-shaped section of C-4 or other moldable high explosive is inserted in to the hole. As you know, water does not compress, so when you detonate the explosive in this setup, the safe is usually obliterated (with the contents more or less intact).

Several recent technological advances in safe design and manufacture have curtailed the use of explosives by some burglars, but professional safecrackers don't see mechanical improvements as a real threat. Any safe can be beaten with explosives; it is the time and noise factors that actually catch criminals.

8
Miscellaneous Methods of Safe Entry

I've decided to lump all the other common methods of safe entry into this one chapter, since most of these can be fully described in a paragraph.

One of the most common tricks to defeat small safes is to simply remove it and work on it elsewhere, with a little more safety and privacy. Fire safes, small money chests, and even wall safes can be pushed, pulled, or rolled to the burglar's vehicle. If burglars can find a way to attach it, a winch is sometimes used to remove large floor safes and wall safes. Also, if a safe is located on an upper floor of a tall building, it may be dropped to the pavement, in hopes that the impact will jar the door open. (If this sounds kind of silly, you should know that Underwriters' Laboratories tests new safes for protection against this.) But if the safe doesn't bust open, the thieves will try to make off with it somehow.

A relatively new method of safe opening is by using radiological equipment. The operator positions the device in such a way that he is able to see a real-time x-ray of the working parts. He has only to dial the combination by watching the wheels line up under the fence. This method has not yet been exploited by burglars, as far as I know, but if it ever begins to gain popularity, safe manufacturers will simply install a sheet of lead in front of the locking mechanism to prevent this from being accomplished on all new safes.

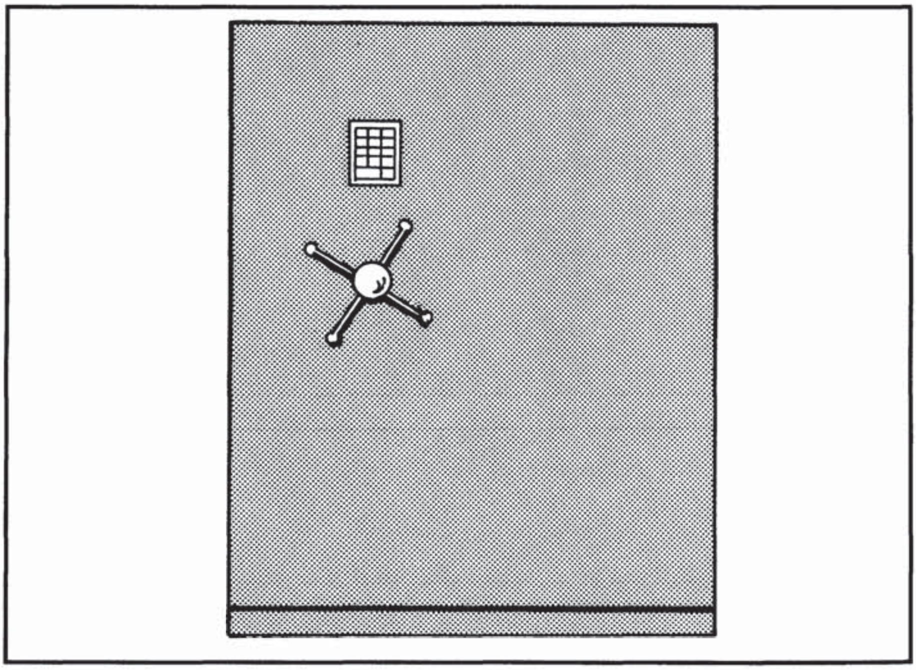


Figure 8-1

Safes with digital keypads are gaining popularity. To open such a safe, one has only to press several numbers consecutively.

Safes with digital keypads (see Figure 8-1), instead of combination dials, are gaining popularity these days. In order to open a safe with a digital keypad, one has only to press several numbers consecutively instead of dialing a combination. The handle is then turned to allow the safe to open. Therefore, if the burglar knows the proper buttons to press, he can enter the safe just as easily as the owner.

To discover these numbers, a burglar will often apply invisible Ultra-Violet ink to something that the legitimate safe opener must touch (door knobs, handrails, etc.) prior to his opening the safe. When he then presses the buttons, some residual UV ink will invariably stick to them. The burglar then has only to place an Ultra-Violet lamp near the keypad to discover which buttons were pressed. A variation on this trick is to use a detective's fingerprint kit. Once the keypad is dusted, it should be easy to tell which buttons are pressed, by observing the latent fingerprints.

Some safecrackers also attempt to "grind" an opening by using a gasoline powered concrete saw (see Figure 8-2). I suppose this may work with cheaper fire safes, or when one needs to remove an outer layer, but the use of this high-speed abrasive wheel would probably be totally ineffective against hardened steel plates.

Although you don't hear of it much in America, the use of acids still remains a major threat in other parts of the world. The crook with various acids, and an expert knowledge of their use, can do incredible damage to safes which contain normal alloys. Some safe manufacturers have experimented with various combinations of metals to curb this attack, but acid is still highly effective if given enough time. I suspect, though, that the use of acids as a safe attack will remain relatively rare, for they usually do more damage to the inexperienced safecracker than they do to the safe.

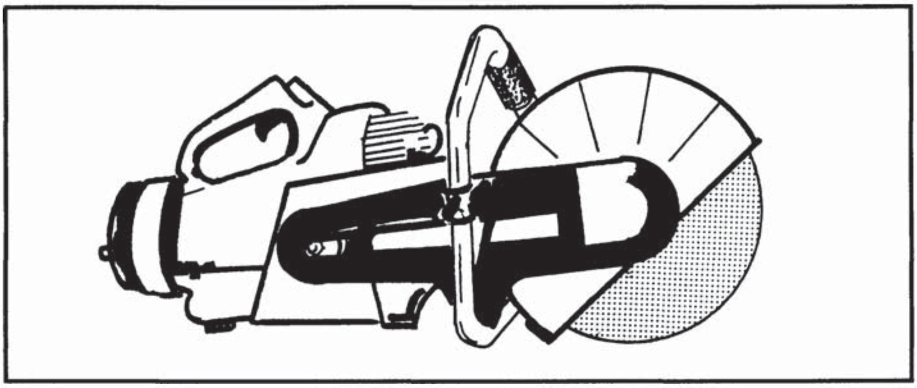


Figure 8-2

Some safecrackers use a gasoline powered concrete saw to "grind" an opening.

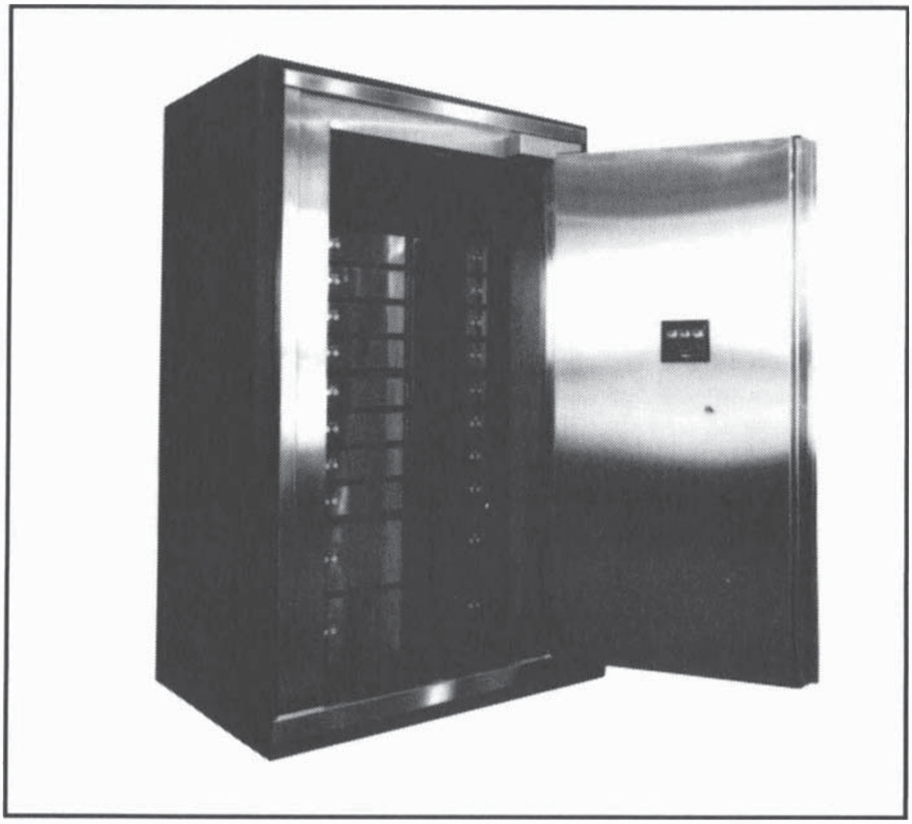
9

Safe Deposit Boxes

Once inside the safe or vault, the safecracker may encounter either a "keister," a miniaturized inner safe, or safe deposit boxes. The small internal safe is defeated with the same techniques given throughout this book, but the safe deposit box requires a different approach.

The typical modern safe deposit box (see Figure 9-2) consists of two keyways, one for the guard key, and the other for the customer's key. So two different keys are required to open each box. The insertion and turning of the two keys cause a bolt to retract, allowing the box to open on its hinges.

The most common method used by amateur thieves to perform an opening is sheer physical force. By using a crowbar, sledgehammer, steel wedges, and other tools, a safe deposit box will eventually yield. This, however, is loud, slow, and not guaranteed, so most advanced burglars prefer to use a nose puller (see Figure 9-3). A nose puller uses a threaded machine screw to actually pull out the cores of both lock mechanisms. A screw-driver can then be inserted in the holes to turn the cam and release the bolt. This is fast, quiet, and effective.



Courtesy: Mosler Safe Co.

Figure 9-1

The American Pac2 Mini-Vault from the Mosler Safe Co. contains safe deposit boxes.

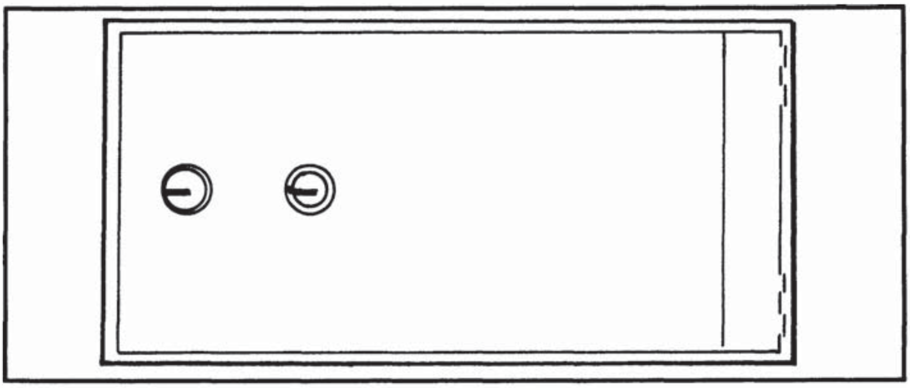


Figure 9-2

The typical safe deposit box has two keyways, one for the guard key, and the other for the customer's key.

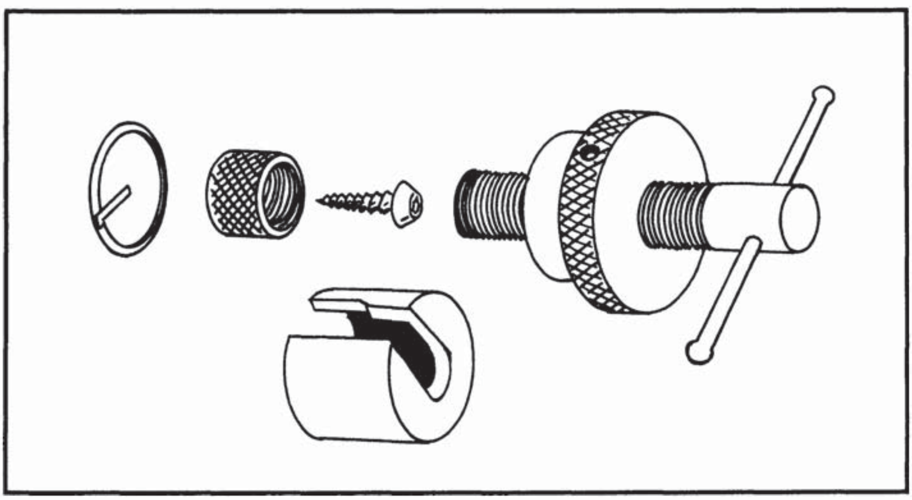


Figure 9-3

To open a safe deposit box, most advanced burglars use a nose puller.

There is also the hinge method of attack. The first step in opening safe deposit boxes with the hinge method is to break a portion of the hinge (see Figure 9-4) with a sharp ½" steel chisel. Notice in the illustration that the box is designed to retain the door, even if this happens.

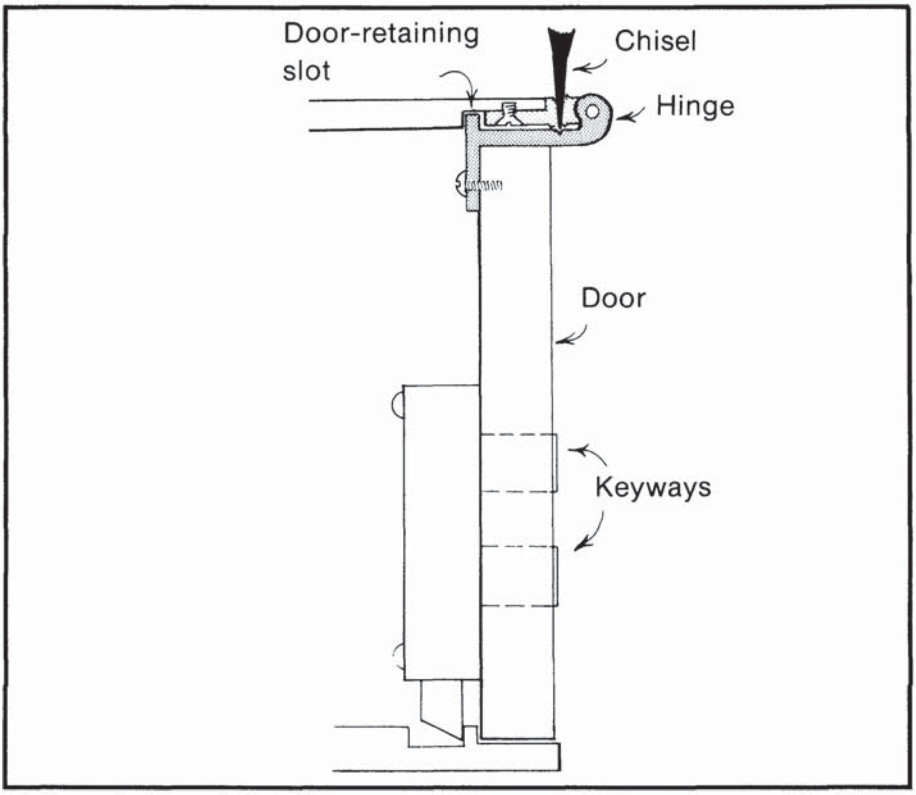


Figure 9-4

The first step in opening a safe deposit box with the hinge method is to break a portion of the hinge with a sharp ½ inch steel chisel.

Therefore, a wedge shaped chisel is used to spread the door hinge out of the retaining slot. A few hard raps with a hammer will cause the door to snap in (see Figure 9-5). This trick is very quick and easy, but can be used only on boxes with exposed hinges.

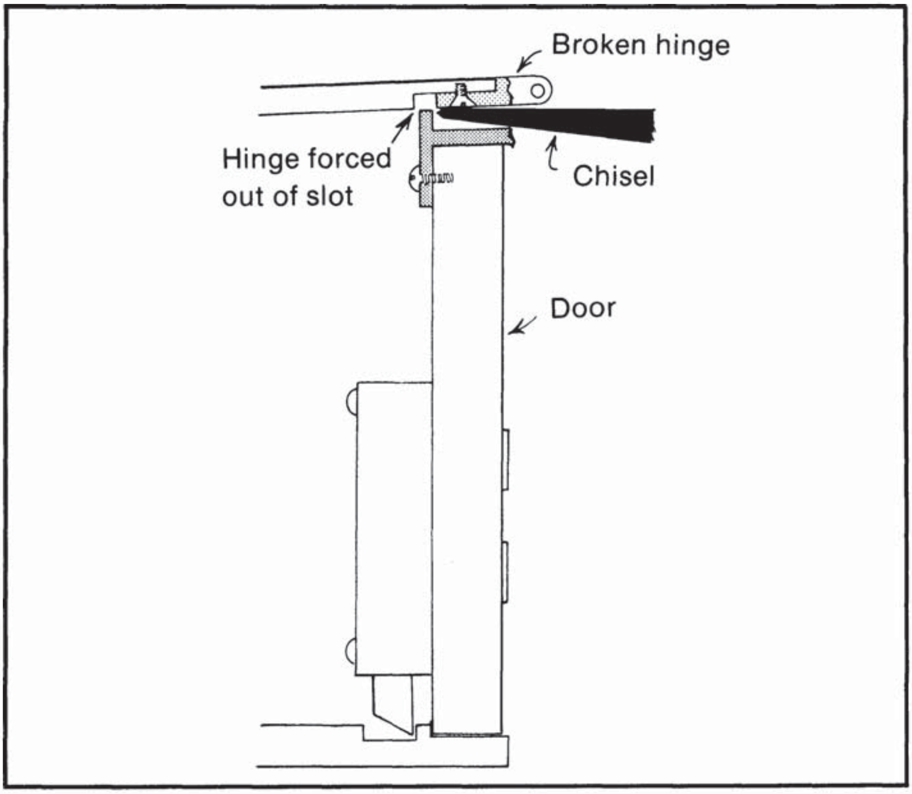


Figure 9-5

A few hard raps on the butt end of the chisel with a hammer will cause the door to snap in.

The most common method of opening used by locksmiths is drilling with templates. Templates are available for just about every model of safe deposit box currently used. Below is an example of a fairly common template. It is placed against the box itself, and one knows immediately where one must drill to open it. The locksmith usually attacks the hinge screws so that the door may be removed completely. Note also that the template has a drilling location for a sight hole, which would allow the locksmith to actually see the tumblers. He could then raise the individual tumblers to their necessary heights, so that the gate will pass, allowing the bolt to retract. This isn't difficult to do with practice, and does not harm the safe deposit box at all. In fact, once the hole is plugged, it's as good as new.

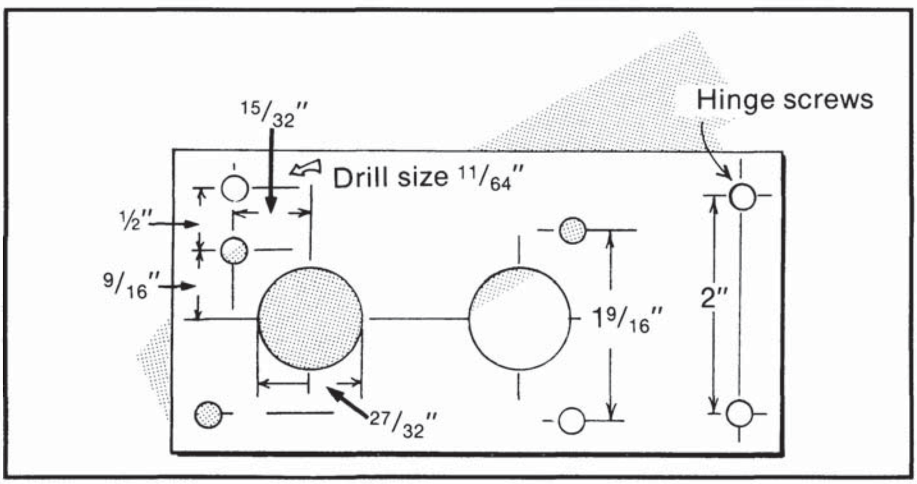


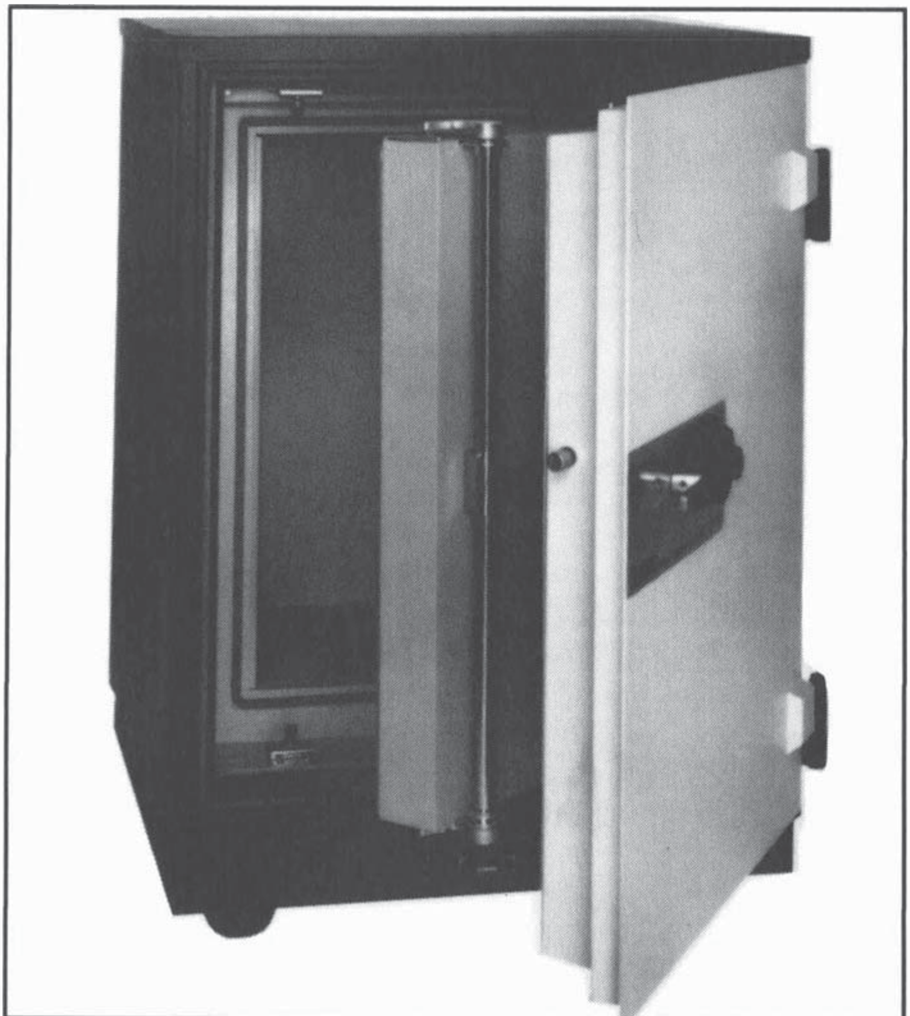
Figure 9-6

Locksmiths most commonly open safe deposit boxes by drilling with templates. A template is placed against the box itself and the locksmith immediately knows where he must drill to open it.

10 Deterrence and Prevention

The first line of defense for safe owners is to deny the safecracker access to the safe itself. This is accomplished by hiding wall safes behind paintings (as seen hundreds of times in the movies), disguising a safe as an end-table, hiding floor-mounted safes under rugs or flooring, or submerging them in steel-reinforced concrete. Also to prevent anyone from obtaining the combination by long-distance surveillance, many lock and safe manufacturers have started using spy-proof dials (see Figure 10-1).

The second line of defense is to equip safes and vaults with alarm mechanisms, so that even if the safe is discovered, it cannot be tampered with. One of the most popular safe alarms is the proximity sensor. It is attached to the safe itself, making the safe one giant sensor. It detects the presence of the electrostatic charge inherent in every human body, and is sometimes sensitive



Courtesy: Schwab Safe Co.

Figure 10-1

To prevent anyone from obtaining the combination by long-distance surveillance, many safe manufacturers have started using spy-proof dials. (See also Figure 10-1a on next page.)

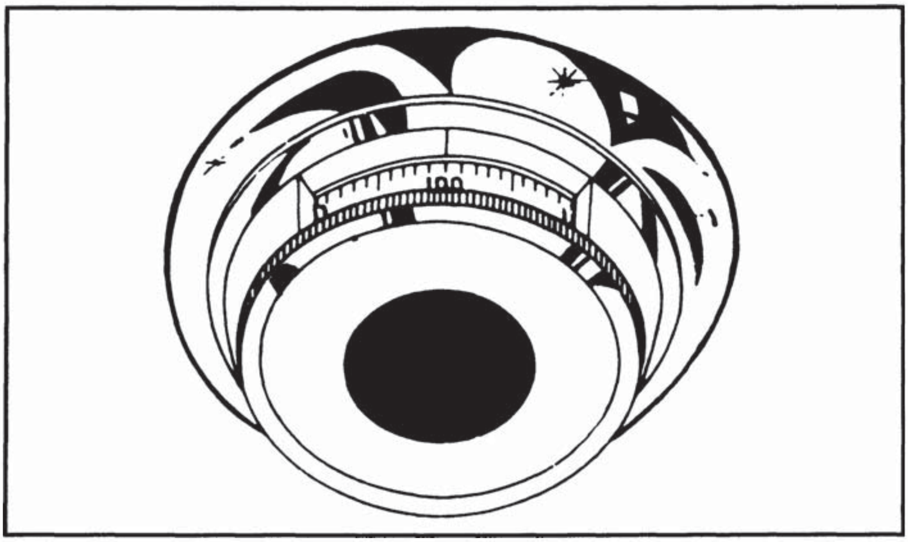


Figure 10-1a

enough to detect an intruder at four to five feet. Safes and vaults may also contain a magnetic switch on the door, to alert someone when the door is opened, or they may contain a Passive Infra-Red sensor that detects motion once the safe door is open. To learn how burglars overcome these devices, read *Techniques of Burglar Alarm By-Passing*, available from the publisher of this book.

Some safes and most vaults rely on a Time-Lock mechanism to protect the contents during non-business hours. When the time-lock is set, the safe can be attacked with the methods previously described, but will not open (in theory) until the prescribed time has elapsed. Safe-crackers have found that time-locks, which are usually attached to the inside of the door, can be overridden by tilting or dropping the safe, or by attacking the doors and sides with a 20 pound sledgehammer. These repeated blows are often enough to off-balance the tiny, precision components of the timing mechanism. UL also tests for this on many of the new vaults, and many of the time-locks fail during this test.

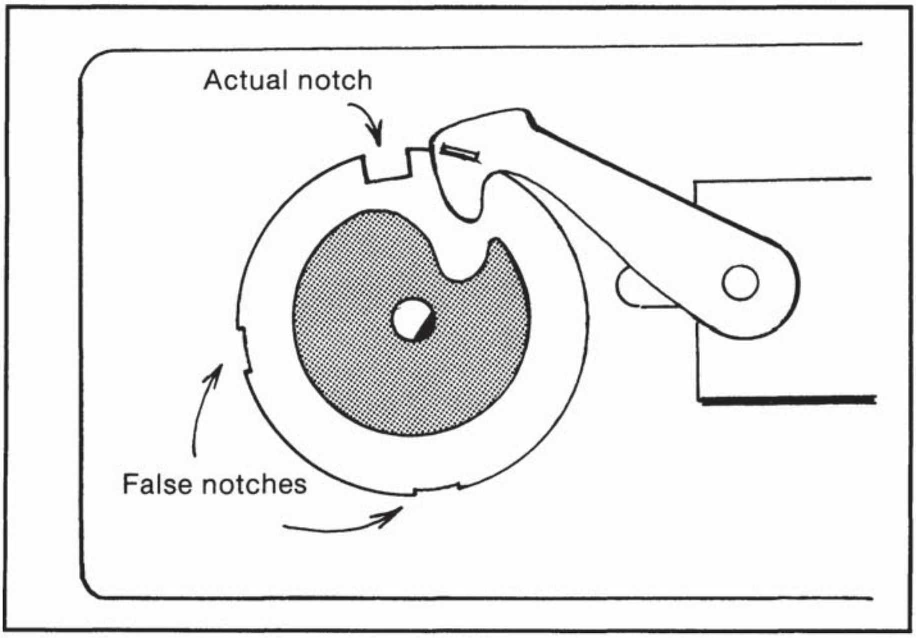


Figure 10-2

Many safe manufacturers cut false notches into the wheels. This slows down safecrackers opening safes by manipulation.

As you remember from Chapter 3, manipulation is made possible because one can detect the changes that occur when the notch of a wheel comes under the fence. To slow this process, many safe manufacturers cut false notches into the wheels, so that one does not know if one has detected a real notch or a fake one (see Figure 10-2). These manipulation-resistant wheels do slow the process down considerably, but a safecracker with time and perseverance can still perform an opening. In addition to the false notches, new safes have a very quiet wheel-pack, and it is next to impossible to manipulate these without electronic amplification.

If a burglar attempts to knock the combination dial off, and punch the spindle, he may be in for quite a surprise. Several safes now contain (and many people are requesting locksmiths to install) a glass vial of tear-gas just behind the spindle. If the spindle is punched into this glass vial, the tube will break and release a large quantity of strong, irritating vapor. I don't think this method of prevention is extremely effective, for the safecracker who plans to punch a safe can simply wear a gas mask to avoid any potential fumes. If the spindle is punched, and no tear-gas appears, he could safely remove the mask. This would certainly deter only the amateur safecracker.

Speaking of fumes, some high-security safes, which risk an expert attack by a thermic lance, have chemicals embedded in the barrier material which emit a nasty smoke when burned. This smoke, however, must conform to federal guidelines, and cannot be in any way toxic. Therefore, this smoke is simply a minor nuisance, for the safecracker who uses a thermic lance is, more than likely, already in an asbestos helmet. Also, safes which risk thermic lance attack almost always contain a sheet of copper or other good heat conductor at vulnerable cutting points. This copper sheet spreads the thermic lance's heat so quickly that the barrier material beneath it receives only a fraction of the actual heat output. As in most other attempts at deterrence, this is more of a delay than a protection device, for the copper can only withstand 7000° F for so long.

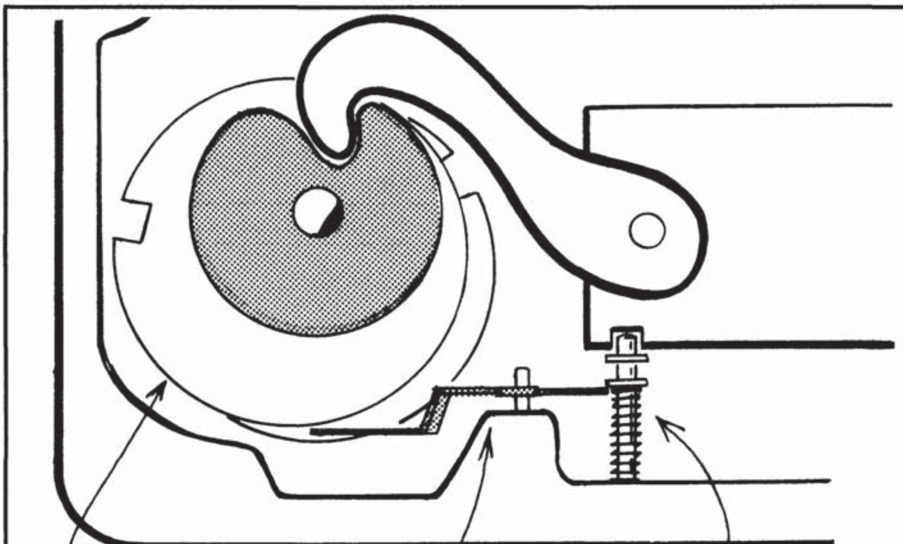


Figure 10-3

Most safe combination locks have some sort of relocking device which keeps the bolt from being retracted should anyone try to get inside the safe. The relocker has a trigger which must be tripped before the relocker engages.

Most manufacturers of safe combination locks have implemented some sort of relocking device in the locking apparatus. The relock mechanism serves to keep the bolt from being retracted should one try to punch the spindle, detonate explosives, or physically attack the safe in any way. The relocker has a trigger which must be tripped before the relocker engages (see Figure 10-3). About the only way to defeat a relocking device is to drill to it, and move it from its holding position. This spring-loaded lever can be pushed away from the locking bolt with ease; the only real problem is getting to it. The location of the relocker varies from safe to safe, so templates are indispensable for determining these exact locations.

Drilling attempts are now occasionally frustrated by ball bearings, which some manufacturers embed in the safe-wall material. When a drill bit hits a ball bearing, it has a tendency to roll off, rather than penetrate it. A steady drilling rig alleviates this problem somewhat, but burglars often find it necessary to incorporate other devices, such as torches or chisels, into their plan of attack as well.

If you have a safe that is of inferior quality, or was manufactured before 1940, you should consider having a professional locksmith upgrade it a little. For around $50, he can make some alterations to the locking mechanism, lengthen the bolt, and generally modernize the safe a bit. As this will greatly increase the chances of outlasting an amateur attack, this is money well spent. Also, theft insurance is a very worthwhile investment for businesses that handle a lot of cash. If you live in a small town, don't make the mistake of thinking that a weak safe is strong enough to protect against any attack from the amateur locals. It may very well be, but there are gangs of expert safecrackers that roam the country, and they actually prefer small town Mom and Pop stores.

As we've seen, there are far too many points of vulnerability for any safe or vault to be labeled "absolutely secure." And, as history shows us, what is difficult to defeat today will eventually become child's play for the professional safecracker. As the saying goes, anything man can create, he can destroy. With safes, it just takes a little longer.

Appendix A Manufacturers' Try-Out Combinations

The combinations listed here were set by the manufacturers at the factory, and were intended to be changed by the new owners. Many people do not know this, or do not bother to change them, so these combinations will open a surprising number of safes in operation today. The combinations listed here are preceded by a coded dialing guide, such as R4L3R2L. This means that if a combination is given as 10-20-30, one must turn the dial RIGHT FOUR turns, stopping at 10, then LEFT THREE turns, stopping at 20, then RIGHT TWO turns, stopping at 30, then LEFT until the wheel-pack stops.

American Safe Co.

R4L3R2L

30-20-10	10-20-30
40-10-50	30-20-10

Cary Safe Co.

L4R3L2R

40-60-35	56-13-36
50-86-32	10-60-35

Chicago Safe Co.

R4L3R2L1

7-8-2-1	35-71-39-7

R5L4R3L2

40-70-60-30	40-50-60-70	40-50-67-70
30-60-40-70	40-30-60-70	50-30-70-60

Diebold Safe Co.

L4R3L2R

45-70-35	60-20-40	35-70-45	70-30-55
40-20-60	17-37-62	67-27-47	22-44-88
11-22-44	18-36-72	45-35-70	90-70-35

Mosler Safe Co.

L5R4L3R2L
64-95-60-5   91-39-76-59

L4R3L2R
50-15-80   25-15-30   45-52-50   50-40-50

R5L4R3L2R
15-30-45-65   20-40-60-80

L4R3L2R1
36-39-43-87   40-20-60-88   20-40-60-80

L4R3L2R1
9-4-3-2   25-60-45-5   5-25-45-60
40-20-60-30   20-40-60-30   40-30-60-20

Meilink Safe Co.

L3R2L1R

2-34-10	0-34-10	0-36-12	0-38-14	0-40-16	0-42-18
4-36-12	2-36-12	2-38-14	2-40-16	2-42-18	2-44-20
6-38-14	4-38-14	4-40-16	4-42-18	4-44-20	4-46-22
8-40-16	6-40-16	6-42-18	6-44-20	6-46-22	6-48-24
10-42-18	8-42-18	8-44-20	8-46-22	8-48-24	8-0-26

etc.

(each digit increases by two until 48, where it begins at 0)

Schwab Safe Co.

L4R3L2R
15-75-0 75-50-0 40-70-35 35-75-45 65-35-45

Victor Safe Co.

R4L3L2R
0-12-82-92 1-13-89-93 2-14-84-94 3-15-85-95 4-16-86-96
5-17-87-97 6-18-88-98 7-19-89-99 8-20-90-0 9-21-91-1
10-22-92-2 11-23-93-3 12-24-94-4 13-25-95-5 14-26-96-6
15-27-97-7 16-28-98-8 17-29-99-9 18-30-0-10 19-31-1-11
etc.
(each number increases by 5, until 99, where it begins at 0)

Appendix B
Suppliers of Lock and Safe Opening Equipment

C.O.L. Manufacturing
7748 W. Addison
Chicago, IL 60634

Thermic Lance manufacturer

Foley-Belsaw
6301 Equitable Road
Kansas City, MO 64141

Sells various safe-opening tools and books, also nose puller

HPC, Inc.
Schiller Park, IL 60176

General locksmith supply, some safe tools

Lockmasters, Inc.
5085 Danville Road
Nicholasville, KY 40356
Sells safe-opening videocassettes and training packages

MDS, Inc.
1640 Central Avenue
St. Petersburg, FL 33712
Manufacturer of special safe-opening borescope system

Safeman Supply
1104 NE 126th Avenue
Vancouver, WA 98684
Sells drilling templates for most safes

San Diego Safe Co.
PO Box 9795
San Diego, CA 92109
More drilling templates

Strong Arm Security, Inc.
2228 Kenry Way
So. San Francisco, CA 94080
Safe drilling bits and drilling rigs

The Locksmith Store
1229 E. Algonquin Road Unit E
Arlington Heights, IL 60005
General locksmith supplier

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Saxon, Kurt. *The Poor Man's James Bond*. El Dorado, AR: Desert Publications, 1972.

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HOW TO OPEN HANDCUFFS WITHOUT KEYS

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DESERT PUBLICATIONS

HOW TO OPEN HANDCUFFS WITHOUT KEYS

by
Carl Roper

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INTRODUCTION

"Handcuffs," "cuffs," or "manacles" are all the same; merely a differentiation in their design, application and terminology. All have the same end purpose: the temporary restraint of a person upon their application.

This volume covers a selection of handcuffs in popular use today and discusses some of the specific features with which you should become familiar. Further, with the knowledge of these features and the specifics presented, you will be able to manufacture your own "personalized" set of lock-picks and be able to open a wide variety of handcuffs with them.

Over two hundred types of handcuffs are known to exist. By virtue of their uniqueness, but also their relation to other types, the handcuff stands out. In the United States alone, over a hundred types have been patented. Further many variations and derivative types, both U.S. and foreign, are on the market.

As a locksmith or a collector of locks, handcuffs — especially the more modern types are within easy grasp, while older ones, these being made before WWII and some dating back over 125 years, are extremely hard to come by. When you come across one, either in viewing, possessing, or having to open, repair, or make a key for it, at least examine it in as much detail as possible for future reference.

Some police departments and even private detective agencies still use handcuffs that were purchased many years ago. Some even use the many foreign types of handcuffs on the market. The Japanese and Spanish types of handcuffs are in many different models and varieties, but are fairly simple to work on, while the English and German handcuffs will be much more difficult. The reason for this is the craftsmanship and construction techniques that have been refined and the 'precision' of their manufacture. In England and Germany, "precision" is a by-word used constantly in this craft.

In this booklet on opening handcuffs, we will be discussing various techniques and methods for entry into handcuffs when a key is not available. Also included will be a generous portion of detailed illustrations of the handcuffs, parts, identification of these, key types, and picks that you will be making.

No book can cover every type of handcuff made, nor can it foresee variations that have been developed, but not necessarily documented (as in a patent), and put into use. Thus, within this booklet, we will consider only the basics and their general application to the majority of handcuffs you may have an opportunity to work with.

The earlier handcuffs, even those back in the 1860's, used the ratchet principle that is still in use today. (FIG 1 illustrates an early handcuff.)

Today, the most current accepted types of handcuffs in use are the Smith & Wesson and the Peerless. They are almost the same in design and construction. Each has a double-locking mechanism which makes it harder for the unitiated to open them. A newer one, but not yet in popular use, has been produced by Smith & Wesson, and instead of a flat or a 'pipe' key, uses the tubular key cylinder. Since they have not yet caught on in popularity, it is rare that you may be called upon to work with one of these.

In order to get the most out of this book on handcuffs, it would be wise to start collecting different makes, models, and varieties of handcuffs. Old, foreign and difficult handcuffs should also be considered. You have a definite advantage when you have more than one of a specific type; this allows you to disassemble one to study more closely its interior. With other types — especially those which are more difficult to obtain, by holding onto them several years, you may be able to sell them at a price which will compensate for that one you sold, a duplicate in your collection, and possibly another one; having one pay for the cost of several is definitely worthwhile in the long run.

BACKGROUND ON HANDCUFFS

Locks, and most especially handcuffs, are able to be picked for a variety of reasons:

1. Poor manufacturing process, i.e., shortcomings in the actual process of manufacturing resulting in a lack of precision between the parts in relationship to each other.
2. Design shortcomings, i.e., the initial designs, while they may be new in their parts relationship, do not improve upon an earlier model in the method of parts relationship and their applicability to the further security of the locking mechanism, nor in their overall security to ward off attempts to pick the lock or spring the shackle by other means.
3. The keyhole is too large — the key and lock mechanisms are left open to a variety of means of opening the handcuffs. Too simplified.

All of these flaws and shortcomings interrelate. The flaws allow simple everyday items, such as a standard lockpick, a hatpin, paperclip, metal pen inserts, and other devices to be turned into temporary makeshift keys or shims to open the handcuffs, thus thwarting their security features.

The loose tolerances developed in poor manufacturing processes mean a lower precision of interior locking parts, this, for the manufacturer, means a lower production cost — but a higher profit margin. After all, he is in the business to make money and sell his product. He does not necessarily concern himself with the overall precision of the product. This makes for weaker handcuffs, and means they are more easily opened than a set of handcuffs that have been designed and manufactured with as close as possible tolerances to each part. Thus, these tolerances allow shims to be inserted, and even homemade keys, or even a 'wrong' key, to enter and operate the mechanism or one of its many parts, and open the handcuff shackle.

Handcuffs have certain pecularities that are created in the manufacturing process and thus make them quite susceptable to various forms of "manipulation" in order to open them without the proper key. As a prime example, consider the handcuff with too much space between the ratchet and the lock box. Here a thin shim comes into use to open the lock of the cuffs.

Another form — or uniqueness — in some handcuffs is one in which the bitting of the key is exceptionally thin so that, with excess pressure, it breaks off inside the lock. Here an ordinary button hook is a valuable aid in opening the lock — after all, why use a key which may break when an ordinary household item will suffice!

Regrettably, many police department purchasers of handcuffs — and the police themselves, regrettably — are not concerned with these "peculiarities," but with the convenience and easy method of operation of the handcuffs when in use.

Another major flaw in handcuffs in use is that, unlike other types of locks, only a low number of keys are required to open a great variety of makes and models, (with the exception of the S & W High Security). THERE IS NO INDIVIDUALITY IN THE DESIGN OF THE KEY OR OF THE LOCKING MECHANISM. In fact, that is what makes it all the easier for you, the serious student of keys, locks, and now handcuffs, to be able to open these locks much more easily.

J. J. TOWER & H. W. KAHLKE.
Hand - Cuffs.

No. 200,950. Patented March 5, 1878.

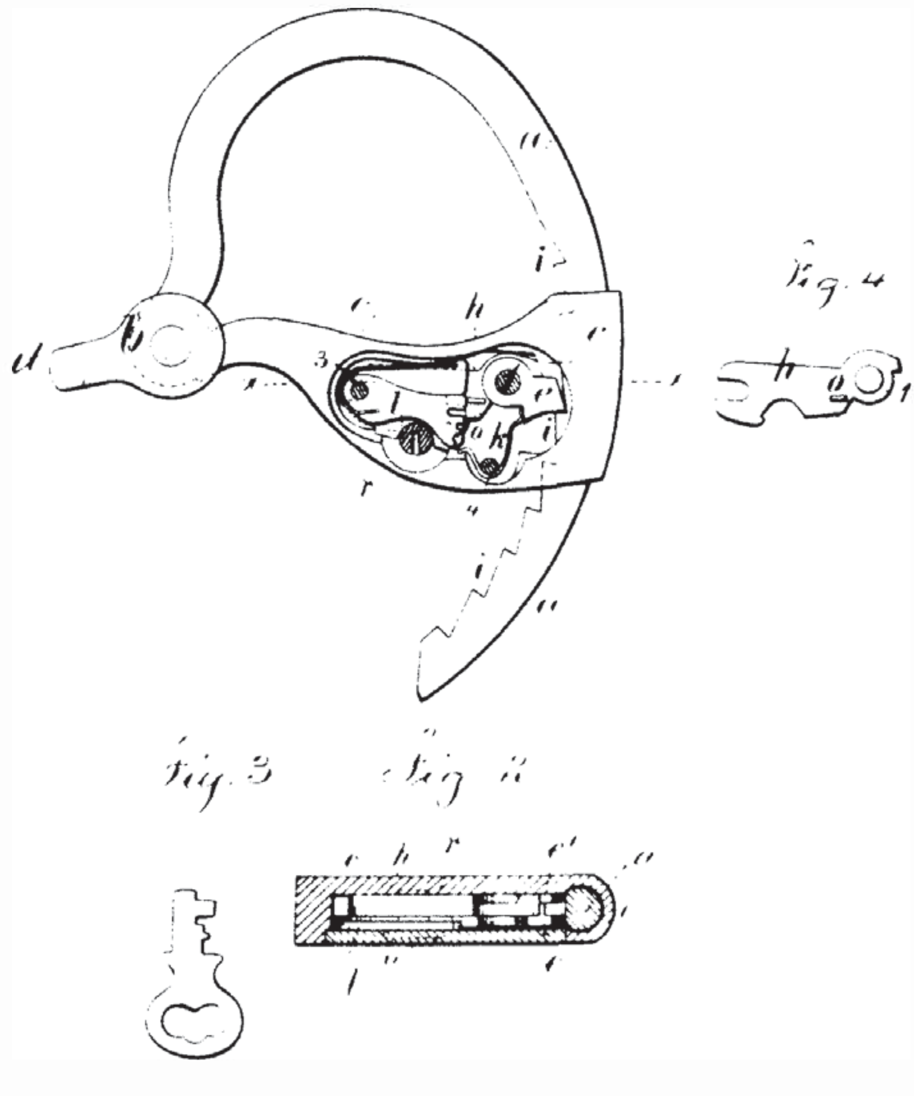


FIG 1

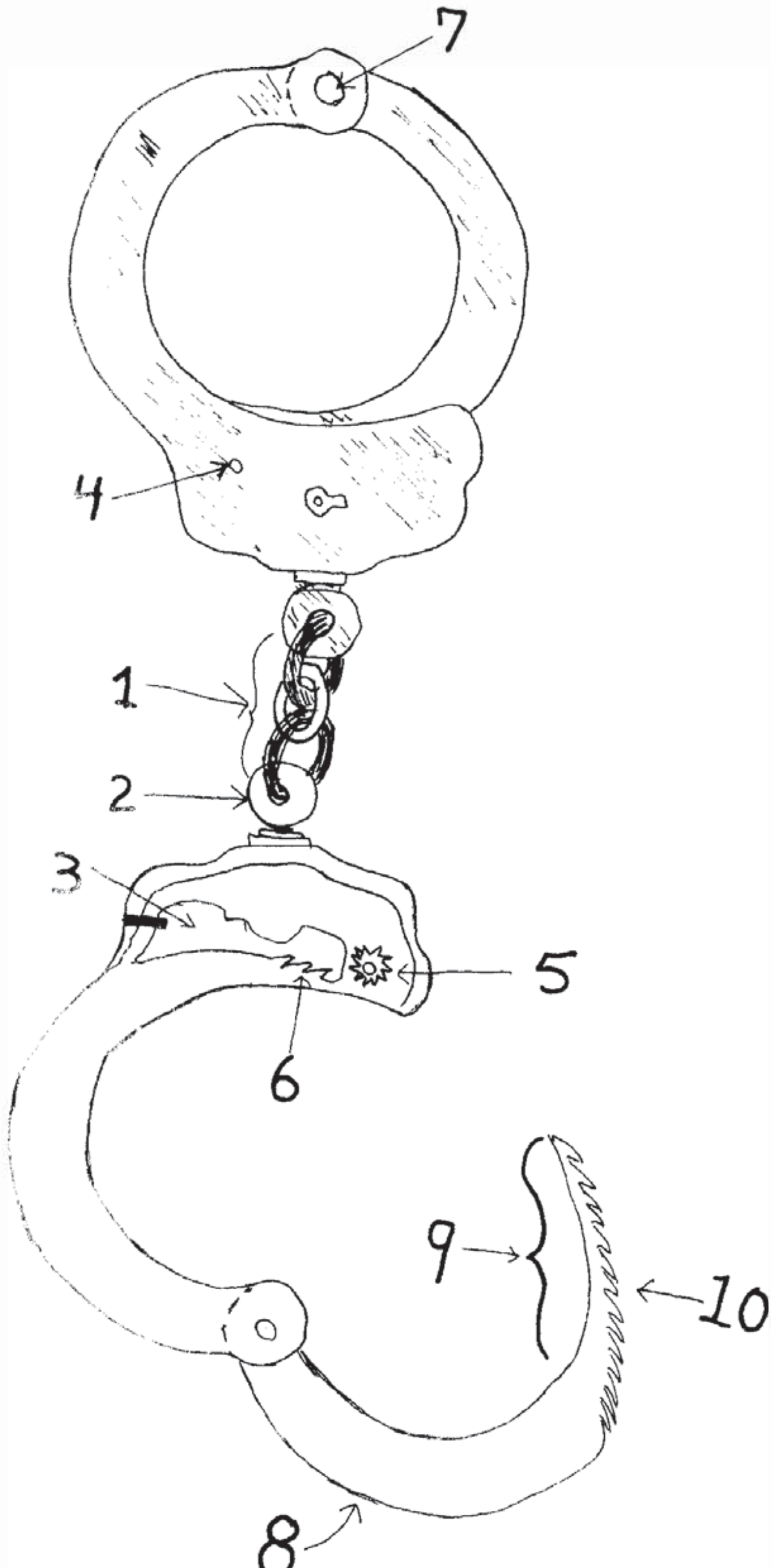


FIG 2

INDENTIFICATION OF HANDCUFF PARTS

The standard handcuff set is limited only by its size (exterior, overall, and interior space) to a limited number of lock parts. On the whole, FIG 2 illustrates the parts most common to handcuffs in use today. FIG 3 shows a variation for the cylinder pin handcuff, and FIG 4 illustrates a set of handcuffs with the tubular lock. Not all parts are integral to every type of handcuff in use.

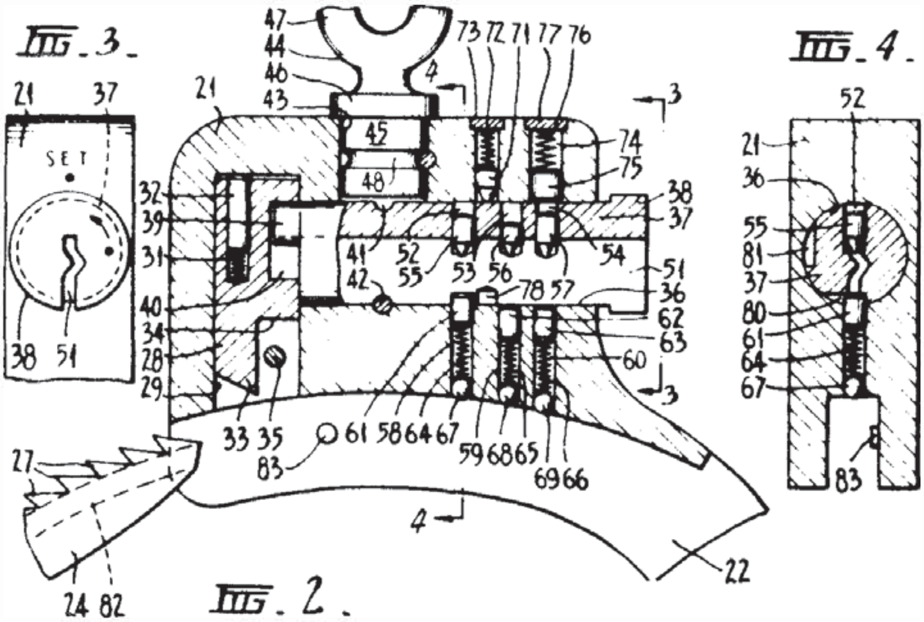
The parts of the handcuff are: (the numbers are used to identify the parts on the various handcuffs)

1. Chain
2. Swivel
3. Latch Arm
4. Pivot Pin
5. Anti-shim Device (free-wheeling)
6. Latch
7. Hinge Pin
8. Bow (or shackle arm)
9. Ratchet
10. Ratchet Teeth

July 16, 1968 J. P. WILLIAMSON 3,392,554

HANDCUFFS

Filed Oct. 19, 1965 3 Sheets-Sheet



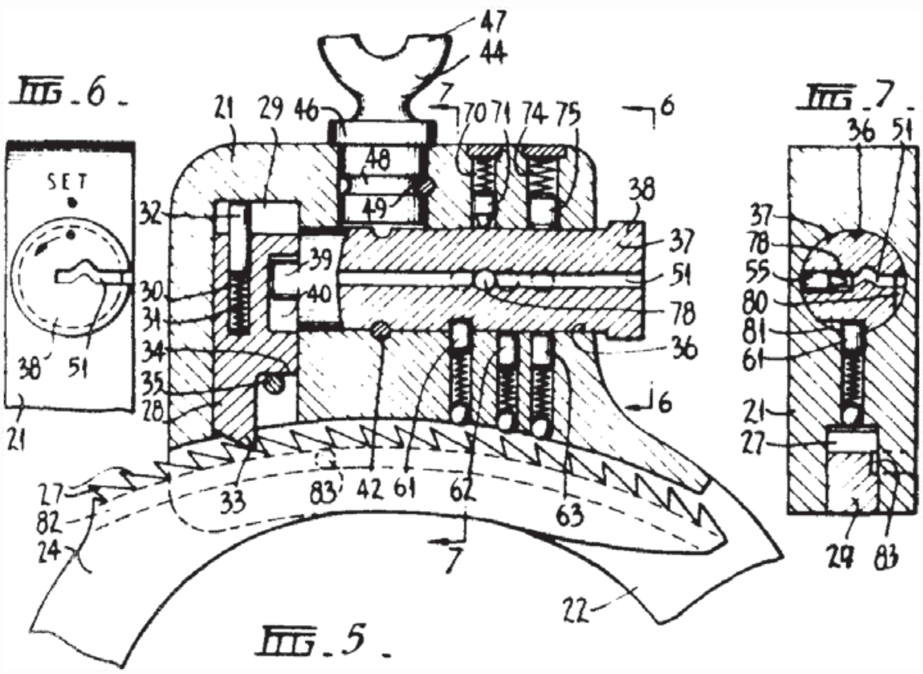


FIG 3

FIG 4

LOCKPICKS AND SHIMS

Background

Since the first lock mechanism was developed, there has been someone willing to try and open it — without a key. This individual might have been the locksmith who made it, the person who bought it, or the burgular who attempted and was caught . . . or succeeded and got away.

Through history, all types of people, from kings to peasants, have at one time or another, shown an interest in various locking devices and how to pick them.

During the 18th and 19th centuries, locks advanced on all fronts. At the same time so did the techniques of making tools — other than the key — to open them. Thus was created the lock pick, a new and somewhat "novel" way to open more than one lock without the proper key.

Even today, as with the early locksmiths, you cannot walk into a lock shop and "order" a set of lock picks for a certain type of locks. Thus, like the locksmith of old, and his criminal counterpart, you learn more about lock mechanisms — their strenghts and weaknesses — by the construction of various types of lockpicks.

In making lock picks yourselves, you learn the intrincies of a lock, why the keyhole is a certain size and shape, where the weaknesses of the lock are, and how the strengths and innovations applied to various locking devices can slow, stop and/or absolutely defeat a lock pick . . . until, at some later date, a new method or technique is developed that will circumvent that particular lock's mechanism and allow an individual to pick it open without the proper key and without damaging the lock itself.

Materials, Tools and Equipment.

Materials to be used in the construction of lockpicks, shims, and other devices for opening handcuffs, include the following:

1. hairpins
2. thin strips of steel

3. piano wire of varying degrees of thicknesses
4. watchspring wire (varying degrees of thickness also)
5. small dowelling (for lock pick handles)
6. metal can openers (preferably of steel; not cheap aluminum
7. button hook

Not many tools and associated equipment are necessary for working on handcuffs. Basic to working are:

1. screwdriver set (standard size)
2. screwdriver set (jewelers size)
3. pliers (combination pliers & wire cutters) (FIG 5)
4. pocket knife
5. wire cutters
6. small vise
7. micrometer
8. assorted files
9. emery paper
10. wire bender
11. metal rule (such as a Stanley)
12. ruler

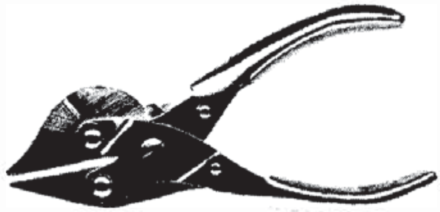


FIG 5

CONSTRUCTION OF HANDCUFF PICKS & SHIMS

Since different models of handcuffs do exist, the techniques for picking and shimming them require that a variety of picks be used. Sometimes you may use only two or three different picks and one shim on a small collection of handcuffs, but then you come across three or four other different models that — suddenly require a completely different pick or shim for each one. For this reason, a wide variety of picks and shims are necessary in your work area.

SHIMS

Shims can be made out of clockspring, piano wire, metal tape measure, and sometimes, thin hatpins and even paperclips.

In essence, the shim is used at only one point on a handcuff. FIG 6 illustrates how a shim would be used and at a particular point. The purpose of the shim is to create a smooth surface between the teeth and locking dog so that there is no point for the locking dog to catch and hold the teeth, thus keeping the handcuff in a locked position. By using the shim properly, you create a smooth surface and, at the same time, create a "buffer zone" between the teeth and the locking dog. This buffer zone means that nothing is holding the teeth and it allows the shackle arm to be removed, thus unlocking the shackle from the rest of the handcuff.

In considering the specific materials for a shim, look at metal that is roughly between .025 and .060" in thickness. Other thicknesses may be used, but these will more than likely be what will be used most of the time.

The most simple shim is made from piano wire, or in an emergency, a paperclip. Since piano wire has a longer life span and the strength makes it a better tool, we will consider it first.

The wire should be approximately 4 1/2" long. Of this, approximately 1 1/2" to 2" is for a handgrip. Use a piece of small dowelling, maybe 2" long. Split the dowelling in half, lengthwise, and with an exacto knife, create a thin line, just a fraction of a 1/16th inch deep. Place the end of the wire into this artificial 'trench' and apply, lightly, airplane glue, and reapply the other piece of dowelling. Wrap with a rubber band until it has dried and then remove. FIG 7 illustrates this and another type of handle you may consider using.

At the tip of the shim, take a fine file and create a slight angle. This angle is necessary to allow the shim to slip more easily between the teeth and the locking dog of the handcuff. (FIG 8 is an exaggerated view of the shim tip.

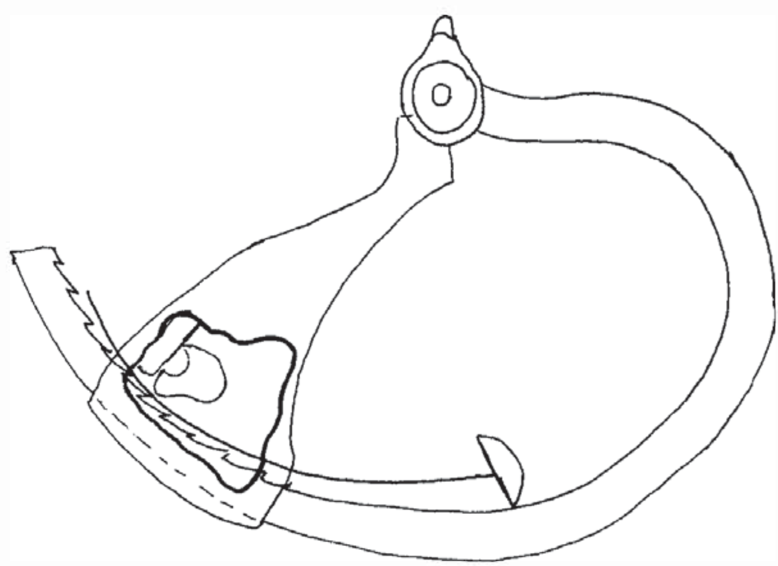


FIG 6

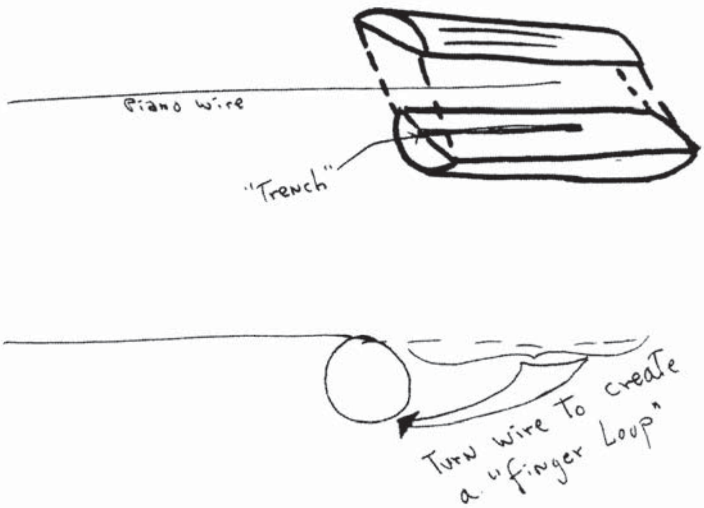


FIG 7

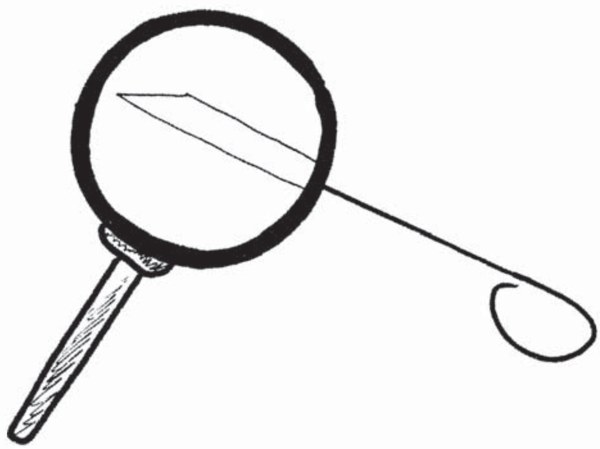


FIG 8

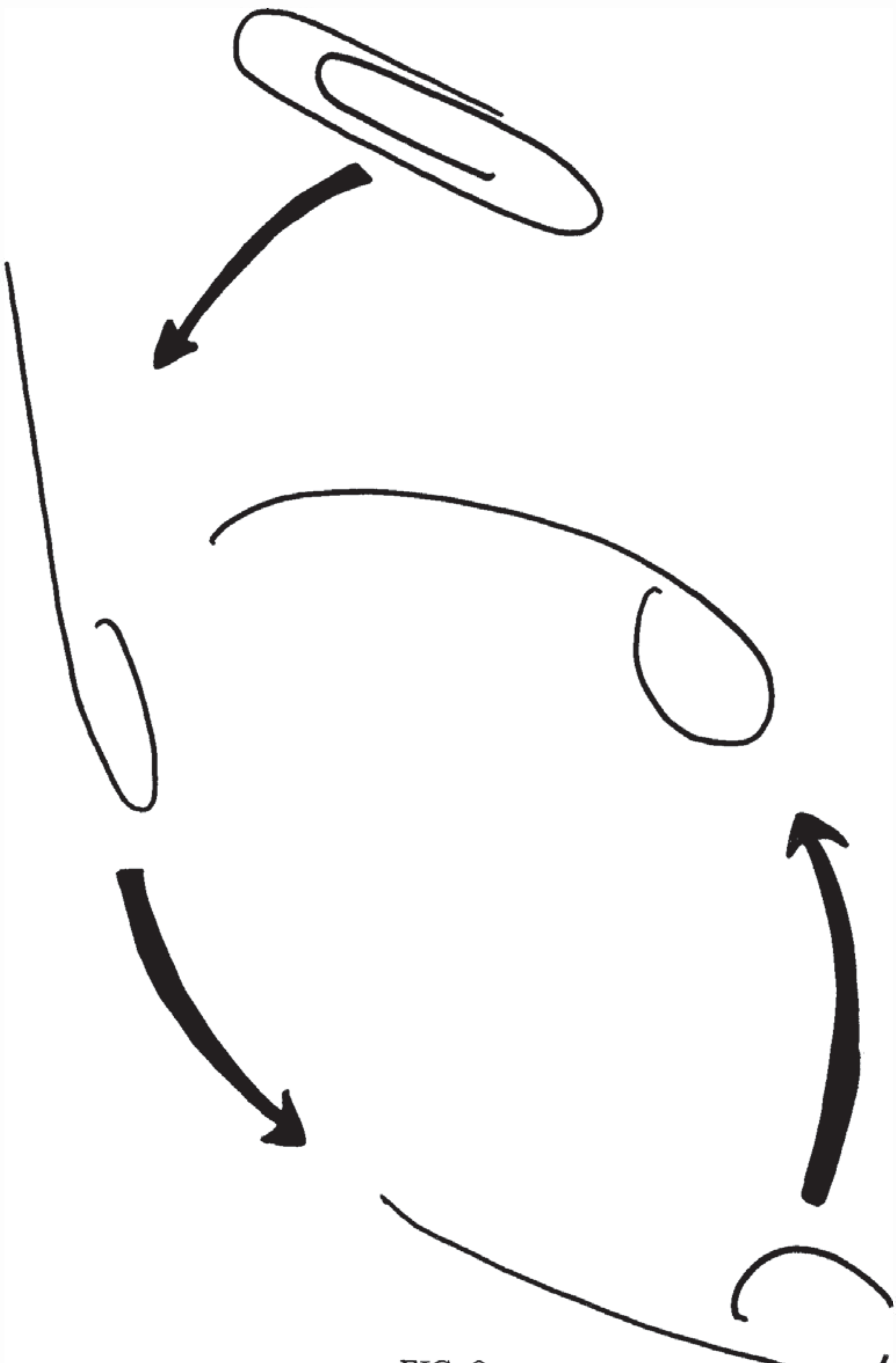


FIG 9

There may come a time when you need to shim open a set of handcuffs and do not have your regular tools with you. This is where a paperclip can come in useful. Take a standard paperclip and unbend. Create a loop at one end as a fingertip; the other end — the tip — is flat, and in an emergency, you will have to use it without a slight tapering tip as in a normal shim. The paperclip should be curved slightly, roughly that of the handcuff, so that when it enters, the movement will be smooth and sure — not rough. FIG 9 illustrates the steps necessary to use a paperclip as an emergency shim.

A fallacy may be created here; that of a paperclip always being a substitute shim. This is not the case. Many handcuffs are precise enough that a paperclip may enter part-way, and then become stuck. The reason: the diameter of the paperclip is greater than the area through which it must past. Thus, paperclips can be used on many cuffs in emergencies, but never as a standard.

When considering clockspring for shims, two different types are made. The first is a single shim; the second, a double, or split, shim.

For each of the above shims, several should be made, of different lengths. The procedures are as follows:

SINGLE SHIM. Take a strip of clockspring, approximately 3" to 3 3/4" long. 'Roughly' flatten it out, but not to the point where it is actually flat. The tension of the spring itself should insure this. Cut the strip in half, lengthwise, and smooth down the edges. At the tip, create an angle as was done with the piano wire shim. Since the edge roughness has been smoothed down, no handle will be necessary. FIG 10 illustrates the steps for this shim.

SPLIT SHIM. Take a strip of clockspring, approximately 4" long. As above, cut it in half, lengthwise and smooth down the rough edge. The next step is creation of the 'split' in the shim. Carefully cut down the center of the shim, allowing yourself about 1 1/4" at the base for a handle. Finally, taper both tips, both on the sides and on the tip ends. FIG 11 illustrates the procedures required.

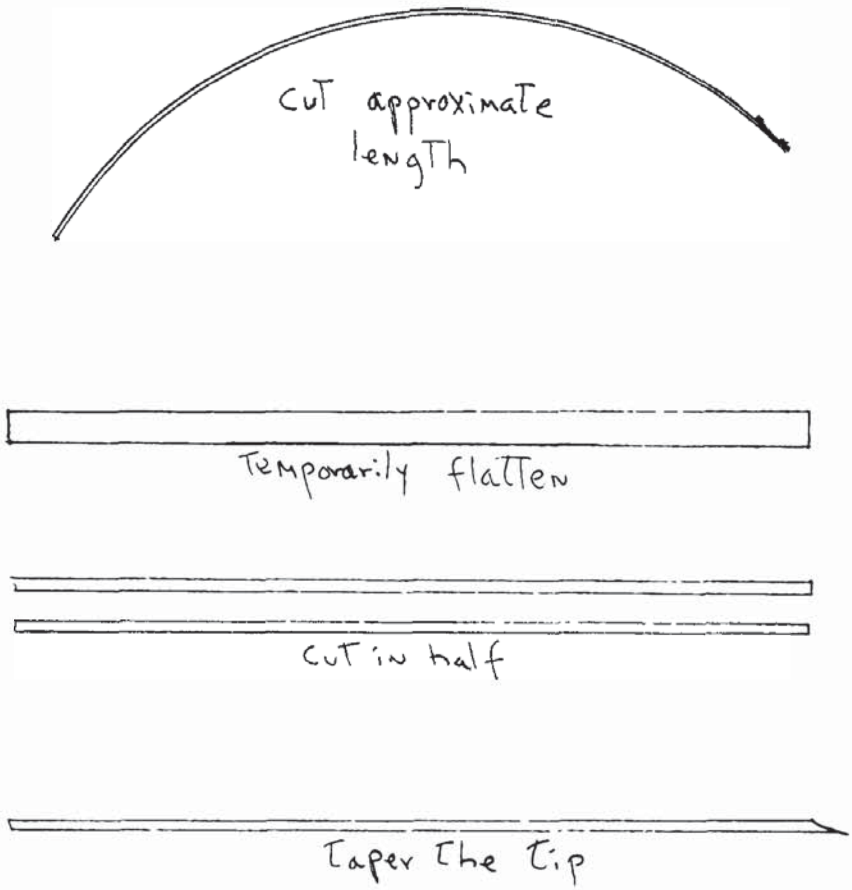

Cut approximate
length
Temporarily flatten
Cut in half
Taper the tip

FIG 10

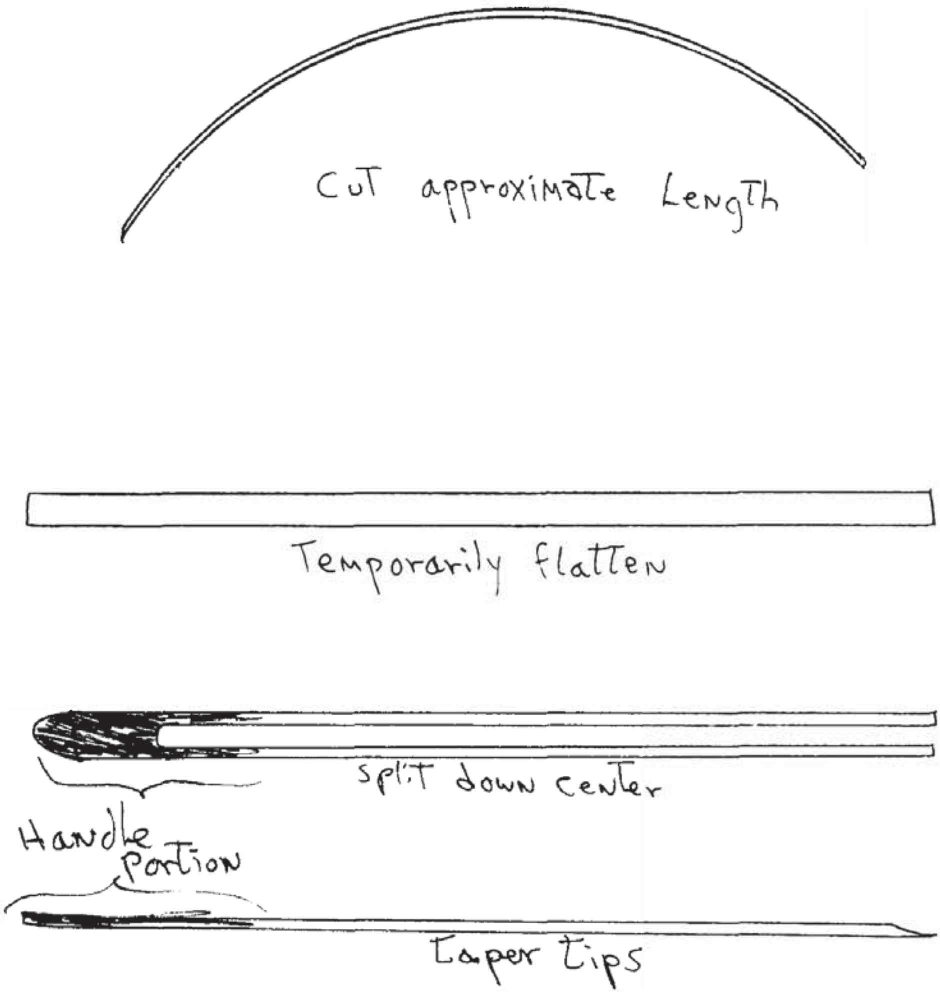

CuT approximate Length
Temporarily flatten
split down center
Handle portion
taper tips

FIG 11

FIG 12

FIG 13

FIG 14

Several types and sizes of shims should be made. The first is the standard, or single, shim, as above. Handles are not necessary for these clockspring shims, but you can make them if you feel it is necessary. The maximum width of the standard shim is 1/8". 1/16th, 1/32nd, and 3/32 inch shims are also quite popular.

Shims can also be constructed from a portion of a metal tape ruler, such as that produced by the Stanley Corporation. In fact, from a strip 12" long, you should be able to make all the single and split shims that you will need. The procedure for making shims from a metal rule are the same as from a clockspring, as indicated above.

In the case of these shims, you should allow slightly more for a handle that can be wrapped with tape. It is exceptionally easy to cut your hand on these types of shims. As a final note, while the metal is the proper size, don't forget to put a slight bevel at the tip to allow the shim to operate more smoothly against the locking dog of the handcuffs.

PICKS

Essentially the technique for making each pick is basically the same. The variations come in the size of the pick; the amount of turn at the tip of the pick; the length of the pick; and the method in which each pick will be used.

Since bobby pins are found almost everywhere, and they are the correct size, it is quite easy to create various picks from them. USE LARGE and MEDIUM size bobby pins.

The first step is to remove the finish from the bobby pin; this can be done with an exacto knife, although using a metal wire wheel is much more effective and ensures that all of the finish is removed. (FIG 12)

Next, straighten out the bobby pin. You are actually concerned with only the flat end, not the opposite side.

Taper the end slightly. (FIG 13)

Now look at the next illustration (FIG 14). You will notice that the pick is, so far, ready. At the end of the pick, the tip has been turned 90^{o} from the body of the pick. This corresponds to the bitting of the key that the pick

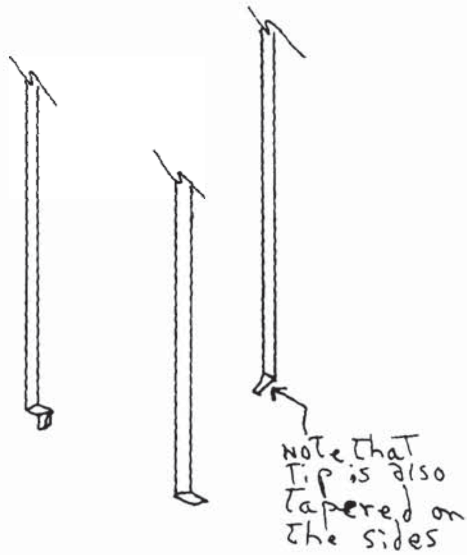

note that
Tip is also
Tapered on
The sides

FIG 15

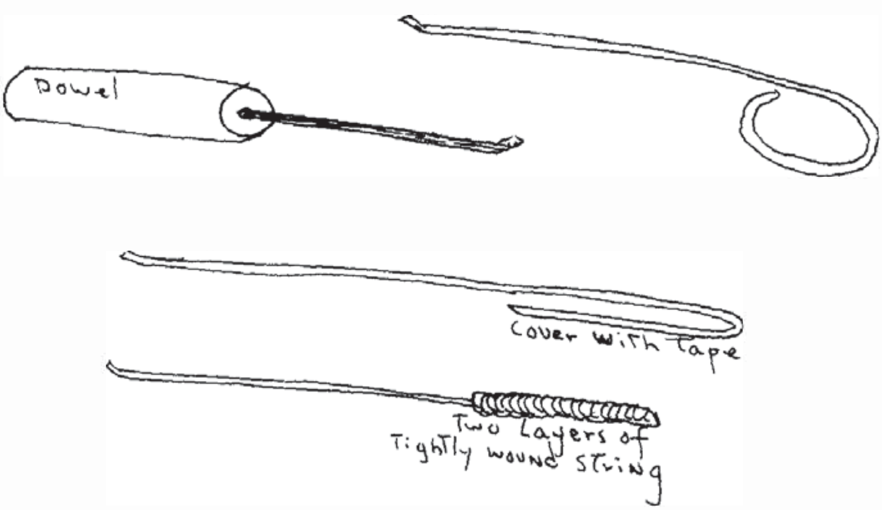

Dowel
cover with tape
Two Layers of
Tightly wound string

FIG 16

replaces. From the illustration, you will notice that the turned end is no larger than the bitting. If it were bigger, it would not fit into the keyhole, muchless be able to operate the locking mechanism. Since some handcuffs have a different size bitting on the keys, your various picks will also have to have a different sized tip that is turned. FIG 15 illustrates several different picks. All are full size so you only need to put your pick over the drawing to see if it corresponds correctly.

The next stage is to prepare some sort of handle. You can make one from a piece of dowelling, or you can make just a finger grip. Some of the better picks have no handle, so to speak, but rely upon either a piece of string wound about the opposite end over a fine layer of glue or a simple piece of masking tape. FIG 16 illustrates variations of handles.

The next pick should be a variation of the above. In this case, the tip will not be as long as before. See FIG 17 for a full sized illustration.

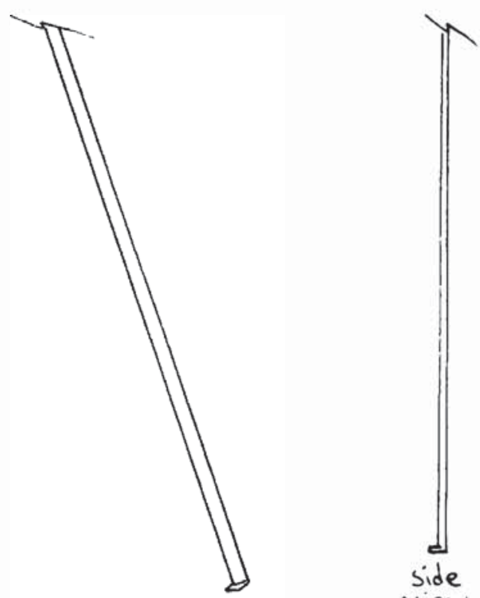


FIG 17

Picks do not necessarily have to follow the contours of a key and its bitting, as above. The next pick under consideration is actually a long curved bobby pin. Also the sides have been filed down "just a hair," and again, the end is tapered. FIG 18 illustrates this pick.

Sometimes you will not need to put in a pick and turn it, but apply a curved pick instead, and just push back the locking dog with a gentle shove.

Now we consider a variation of both of the above types of pick. This one, illustrated in FIG 19, is tapered, and the tip is bent, but besides being bent at 90^{o} from the direction of the body. An advantage with this is just inserting it into the keyway and pushing the opposite end (the handle) in the direction away from the direction you wish the pick to move. This also will open some types of handcuffs. This technique is illustrated in FIG 20.

FIG 21 illustrates a minimum set of lock picks that you should have in your collection. All of these are full size, based on the common bobby pin.

You may also consider making shims from bobby pins. If this is the case, after removal of the finish, taper the tip to a slight angle, and cut down the sides of the bobby pin. The wavy end of the bobby pin can be used as a handle for the shim by either applying string, tape, or making a finger-grip. Many individuals just rely upon their own grip, thus a bobby pin does not stand out in their pocket.

I have spoken of a wavy end on the bobby pin. Other manufacturers of bobby pins do not use a wavy side, but rather just a bent piece of metal, one half being a fraction shorter than the other. This shorter half would be considered the wavy side.

Lockpicks are also made of piano wire. Select piano wire from .020 to .060 for these picks. FIG 22 illustrates the necessary picks you should have available. All are full size so you need only lay your pick over the top to determine if it is correct.

NOTE: Sometimes a key breaks off inside the lock and a pick made from a bobby pin will not enter to open the lock; here is where a piano wire pick is quite useful.

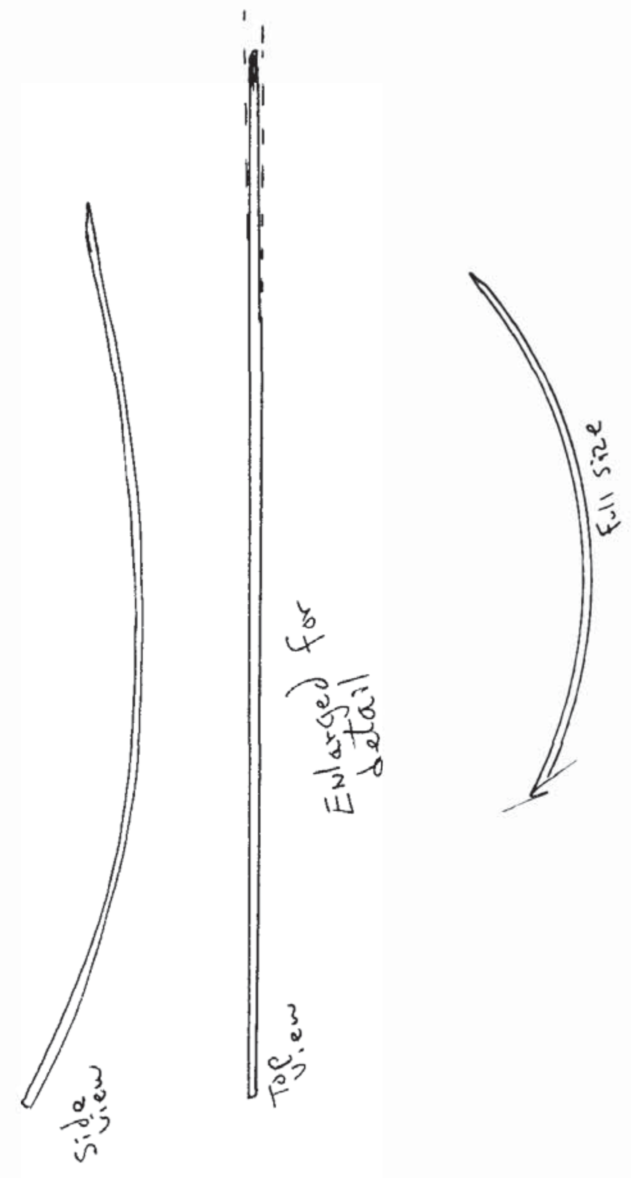


FIG 18

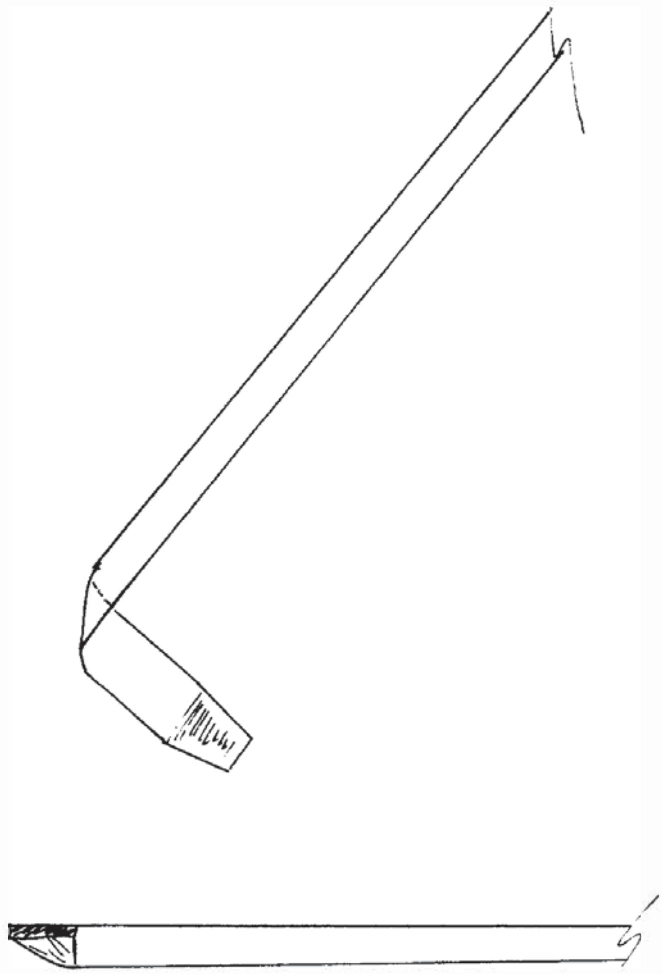


FIG 19

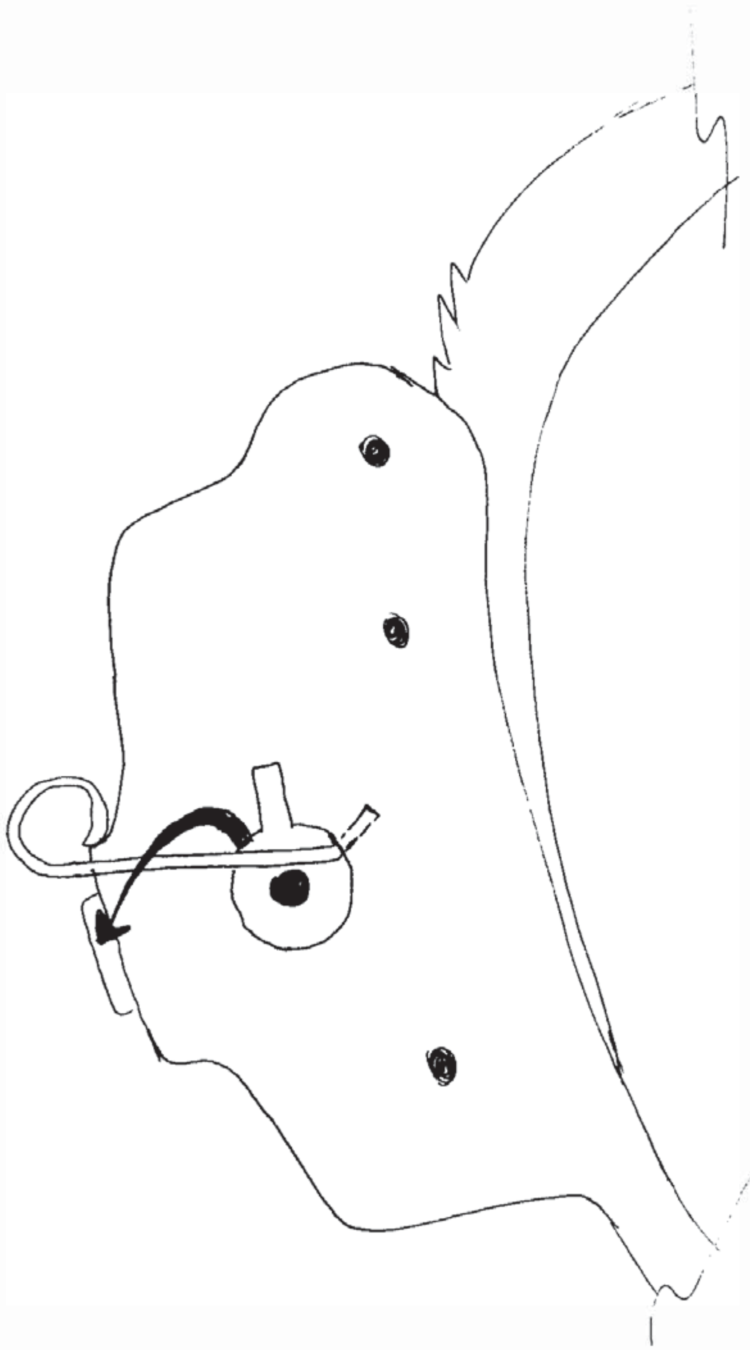


FIG 20

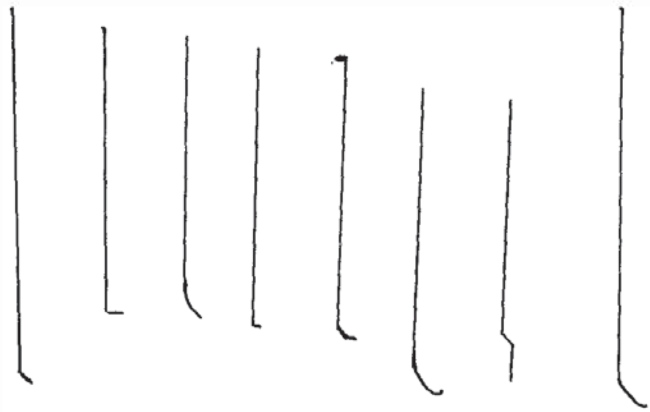


FIG 21

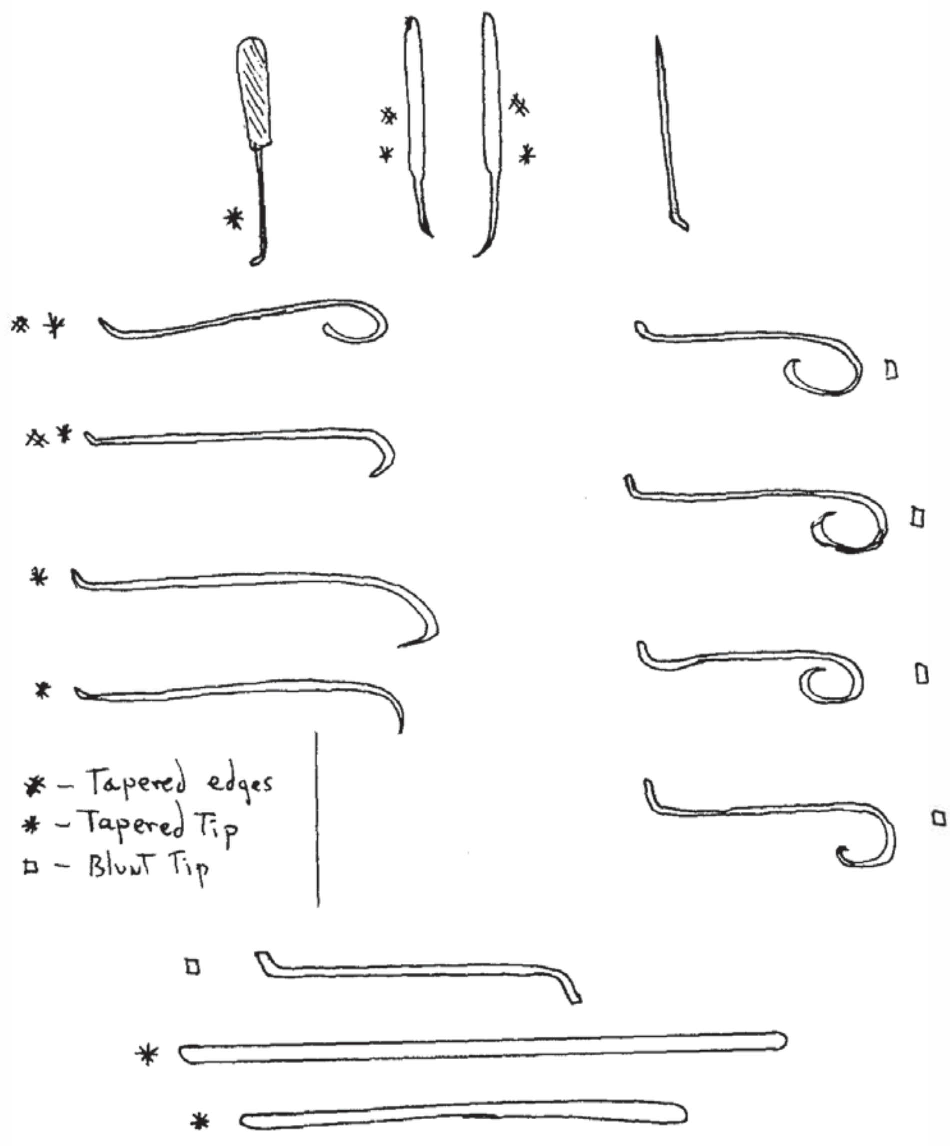


FIG 22

Three basic techniques are used in the picking of handcuffs and their locks:

1. Rapping
2. Shimming
3. (Actual) picking of the lock mechanism

RAPPING. Rapping is not an actual lock picking technique, but it is integral to opening some types of locks. A prime example is the Peerless double-locking handcuff locks. In the Peerless model, you first turn the key to lock it the first time, then with the handle end of the key, you apply the protrusion to a pin set in the edge of the handcuff. This is the double, or second, lock of the handcuff. Until the key is inserted and turned opposite the normal direction of opening the cuff, there is no way you can open the cuff by picking or shimming. BUT YOU CAN RELEASE THIS SECOND LOCK BY RAPPING THE HANDCUFFS, THUS ALLOWING YOU TO SHIM OR PICK THE OTHER LOCK.

Rapping is best applied to handcuffs made before and during the early part of the 20th century, but as indicated above, it does have certain advantages on the more modern handcuffs. In essence, it is the application of a sharp "rap" to the side of the handcuffs, allowing the locking dog mechanism to bounce upwards for a fraction of a second, and thus, leaving the handcuff shackle free to be pulled outward. In actuality, a rap and a pulling action must be applied at approximately the same time.

In preparing to rap open a set of handcuffs such as this, a piece of elastic (medium strength) with a small hook such as a fishhook with the point filed off if necessary. When in use the hook end is hooked to the handcuff shackle, not quite half way between the shackle pin and the locking mechanism. The opposite end of the elastic can be hooked about the foot or the upper arm. Stretching the elastic somewhat creates a pulling tension force that will be required to put the shackle free of the locking mechanism. At this point, the handcuff is rapped, the locking dog bounces backward, and the shackle is pulled outward by the tension on the elastic.

Depending upon how far the shackle has been pushed inward, it may take two or three raps for the shackle notches (the teeth) to clear far enough to allow the hand to be removed.

In considering how, and on what to hit the handcuffs, you may well find the technique used by many magicians of value: Just above the knee of your trousers, create a small slip pocket and insert a slightly curved piece of steel. The curve should approximate that of your leg. It need not be more than 1" wide nor longer than four or five inches.

When working at home in your shop, the corner of the workbench can be used. Take care not to damage the handcuff when practicing this technique. Apply several layers of heavy masking tape, one over the other, onto the handcuff at the point which you will rap.

SHIMMING. Shimming is the time-honored technique whereby you would use a thin piece of wire, piano, thin steel, etc, and insert it along the end edge of the swinging shackle, and force back the catch mechanism of the locking dog (FIG 6). In doing this, you create the smooth surface which is necessary so the locking dog cannot catch and hold (any more) the teeth of the shackle on the handcuffs. This smoothness allows you to pull the shackle free from the locking mechanism.

PICKING. Picking the handcuff lock may be the last, and sometimes the only method available to you in opening a set of handcuffs. Since the handcuff lock can, for purposes herein, be considered a single lever locking mechanism (although double levers do exist), there is only one point you must concern yourself with. Thus, you must worry about only the movement of a single lever, and this lever must be shifted only slightly, in order to open the handcuffs.

In essence, you are inserting a pick (one of the different ones previously made) and applying pressure in such a fashion that it substitutes for the correct key, shifts the locking dog, and allows the shackle to open.

HANDCUFF KEYS

FIG 23 illustrates a variety of handcuff keys you should have. These are not to scale. At times you will come across a set of handcuffs that are either open or locked – but there is no key available. YOU MUST MAKE A KEY. Selecting the most appropriate blank, or trial key, insert it into the locking mechanism to see if it will turn at all. If you are using a trial key, it should open the handcuffs. When using a blank, sometimes you may have to cut it down slightly. In this case, blacken the bitting with smoke from a match or candle. Insert it and turn. Upon removal you can ascertain from the sharp marks left, where the locking dog is, and thus determine what portion to file away. Cut just slightly and carefully. Since the bitting is small, cutting too much off weakens the metal, which could cause it to break off inside the handcuff.

MASTER KEYS. Now and then you hear the phrase "master key" applied to a number of locks and their keys. Certainly they exist, but not for all handcuffs. Because of the individual peculiarities and design differences and the tolerances between different makes, models and styles, the best you may get is a "master key" that will fit 8 to 12 handcuffs at any one time. There is no true overall "master key" that will open every handcuff on the market. Even here, a number of these keys can cut down the amount of keys that must be carried in order to unlock a great number of different handcuffs.

Keys such as those found on ladies' jewelry cases and children's toys should be kept. Many times, they will fit a pair of handcuffs. Sometimes you may have another key in your collection that is just sitting there; it is possible that it may be cut down to fit a pair of handcuffs.

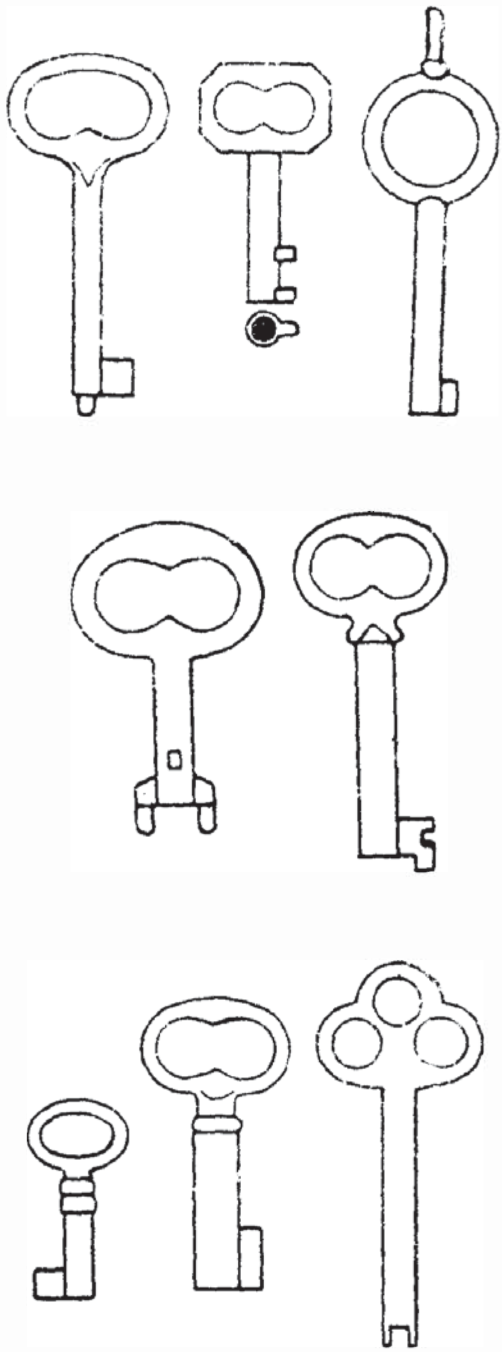


FIG 23

S&W Model 94
— Maximum Security Handcuff —

This latest addition to the Smith & Wesson handcuff line is unique. (See FIG 4) This model departed from their standard key and uses a tubular lock & key design. This design is similar to but not the same as the "Ace" tubular lock. The standard tubular lock has 7 tumblers, each with 7 different heights. The model 94 cuff has only 4 tumblers with 2 different heights, allowing for a miximum of 16 different keys. (See FIG 24)

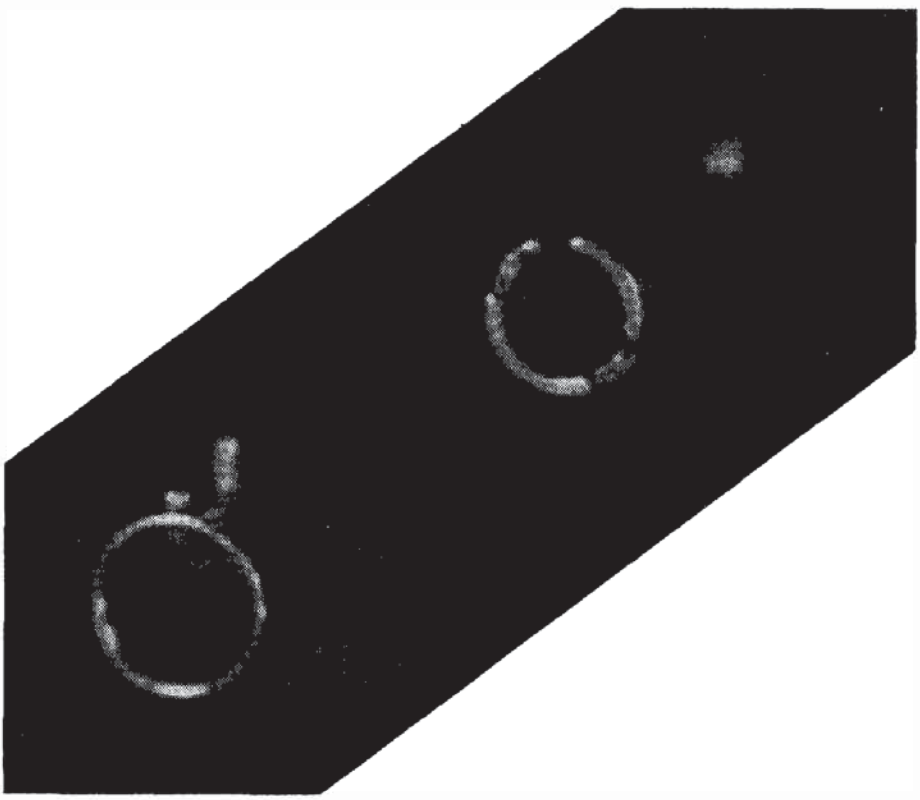


FIG 24

The above photograph shows the difference between an "Ace" type tubular lock key (left) and the Smith & Wesson Maximum Security handcuff key (right). The "Ace" key has an outside diameter of .375 inch and the S&W is .340 inch in diameter.

This handcuff was designed especially for the U.S. Marshal Service and is termed, by the manufacturer, as "Maximum Security." A better term might have been "complicated security."

In the design of a device such as a handcuff there is only so far you can go in the direction of security before suffering somewhere else. S&W put forth an effort to design a handcuff that departed from the standard cuff lock & key with everyone remotely associated with law enforcement having a key that fits nearly all commonly used handcuffs. What they created is one of the easiest to pick handcuffs available. On the plus side, however, they are strong and well constructed.

In picking the standard handcuff (Peerless & S&W) the inside of a ball point pen was used. To pick this "High Security" version we, again, look to our ball point pen — only this time we will fashion a torsion wrench from the clip. This is done by simply bending the spring portion of the clip out at a 90^{o} angle to form a handle. (Take care not to break it off) The round portion of the clip that fit around the pen is a perfect fit into the round keyway.

We now have a very good improvised torsion wrench and the only remaining "tool" needed is a small flat piece of steel to use as a pick. A common bobby pin serves our purpose nicely. (See FIG 25)

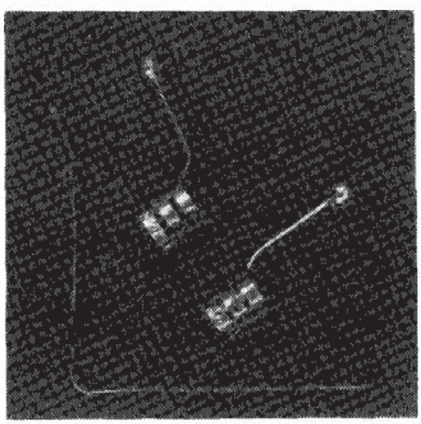


FIG 25

Shown above is the improvised tools needed to open the S&W maximum Security handcuffs. The two "tools" are easily recognizable as a straightened bobby pin and a ball point pen pocket clip with the spring bent outward 90^{o}.

The picking procedure is quite simple. With the improvised torsion wrench inserted into the circular keyway, torque can be applied while each tumbler is picked to its shear line. (See FIG 27)

From a "neutral" position the lock can be turned slightly in a direction away from the chain, to open the shackle. It can be turned 90^{o} toward the chain to activate the double lock feature. In this double lock position the key can be removed. (See FIG 28)

Since replacement keys are unavailable, even to locksmiths, a drawing for making a set of 16 keys that will open all handcuffs of this type is included. (See Fig 29 & 30)

FIG 26

In the photograph above we see a set of S&W Maximum Security handcuffs, their matching key, an "Ace" type key and a set of improvised picking tools.

FIG 27

The photograph above shows the actual picking process. Notice that tension is being applied with the improvised torsion wrench while the tumblers are picked to their shear line with a bobby pin. Take care not to insert the torsion wrench into the lock too far — where it touches 'he tumbler pins.

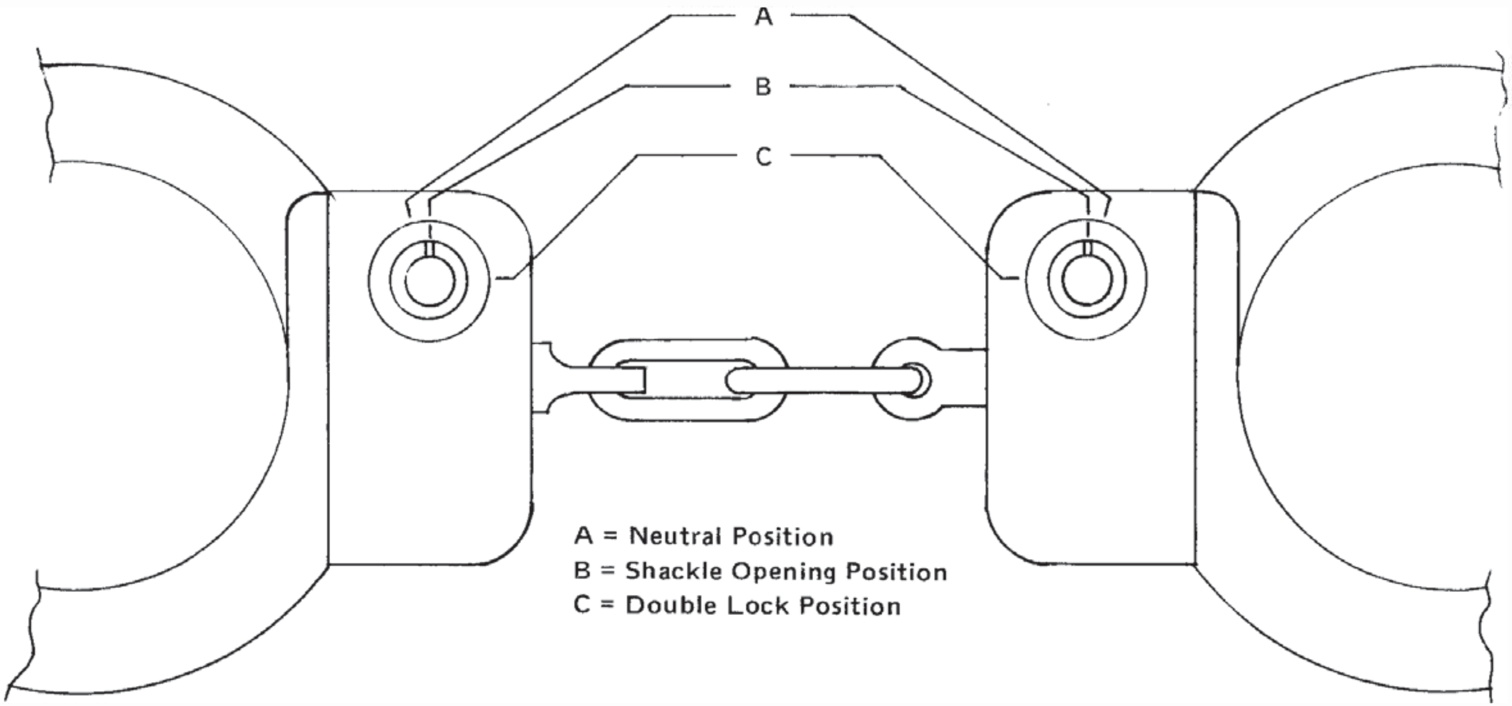

A
B
C
A = Neutral Position
B = Shackle Opening Position
C = Double Lock Position

FIG 28

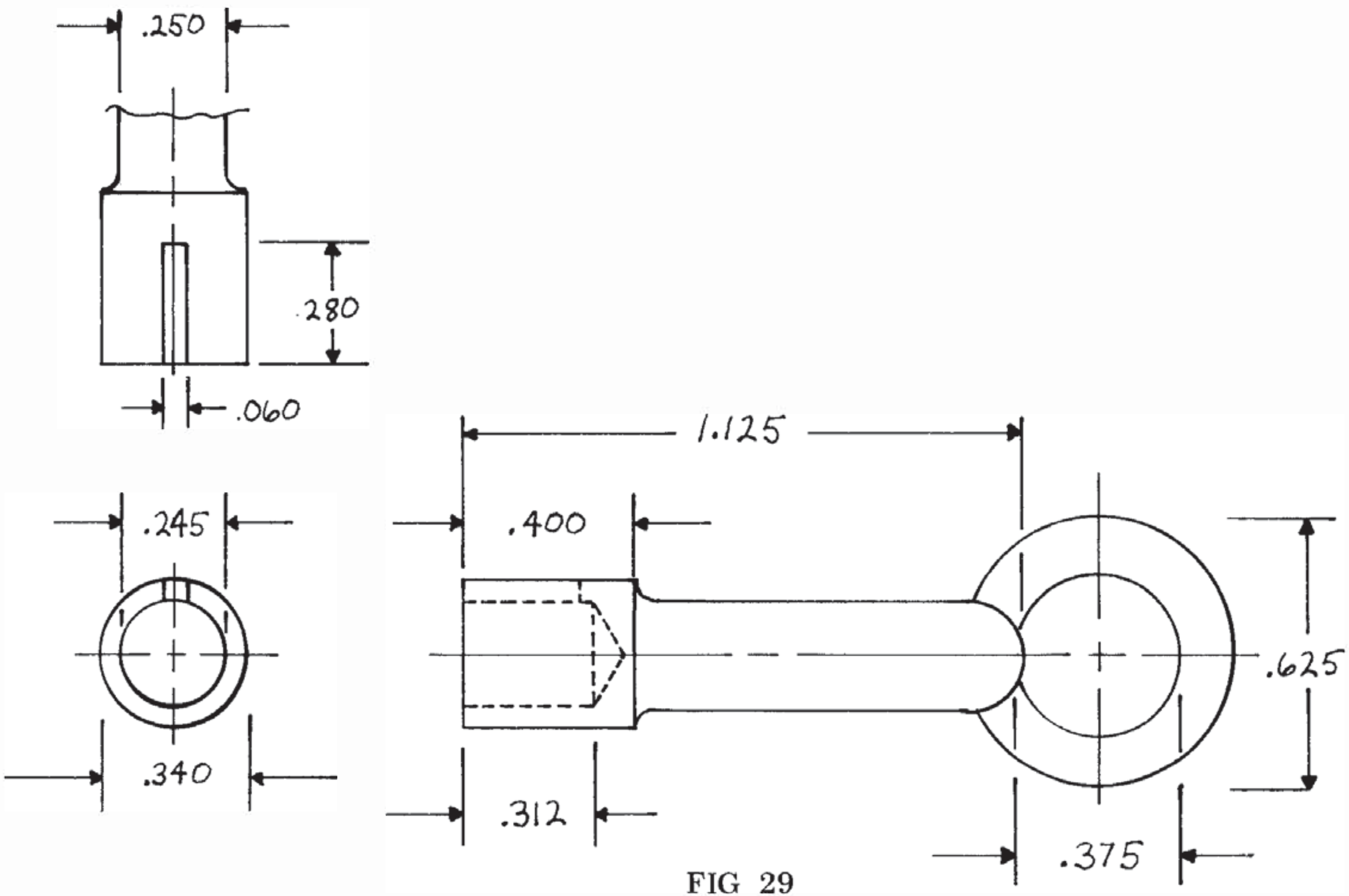
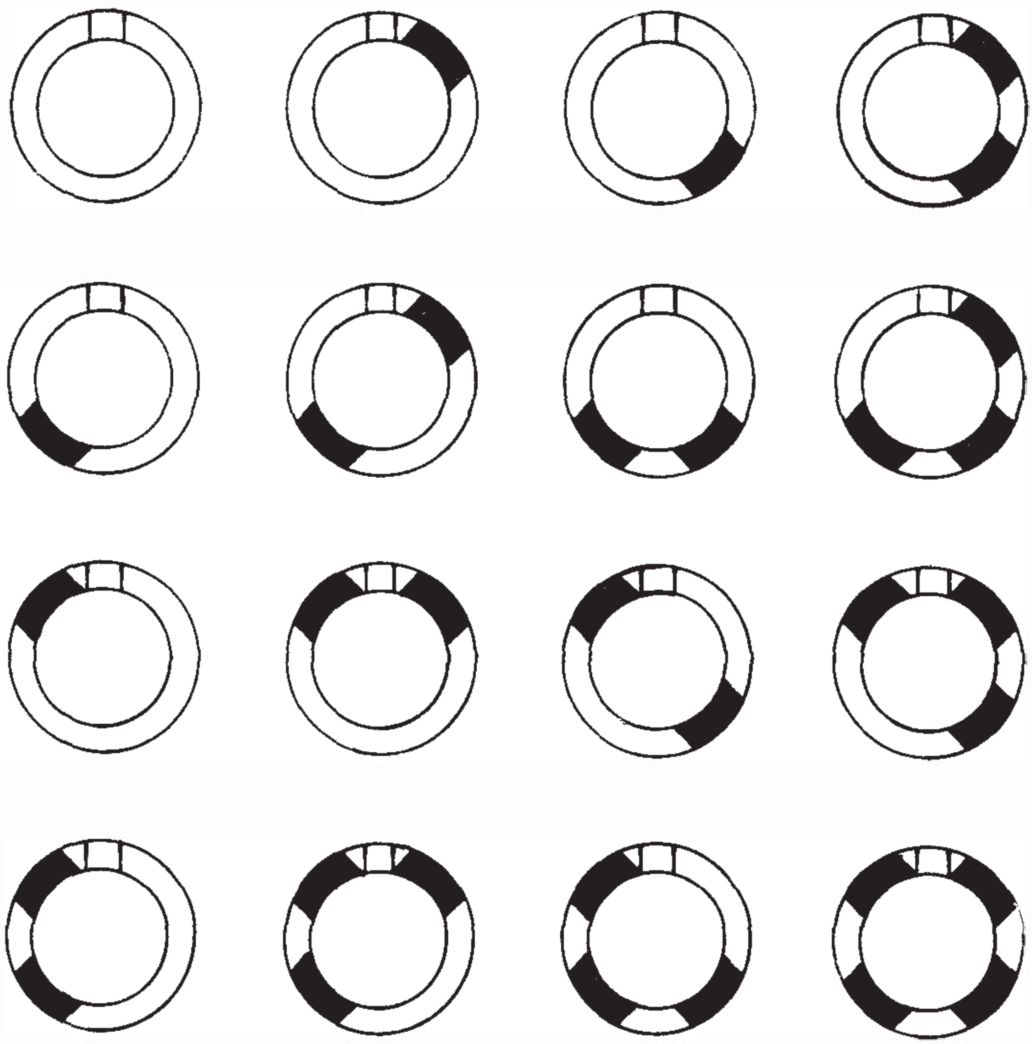
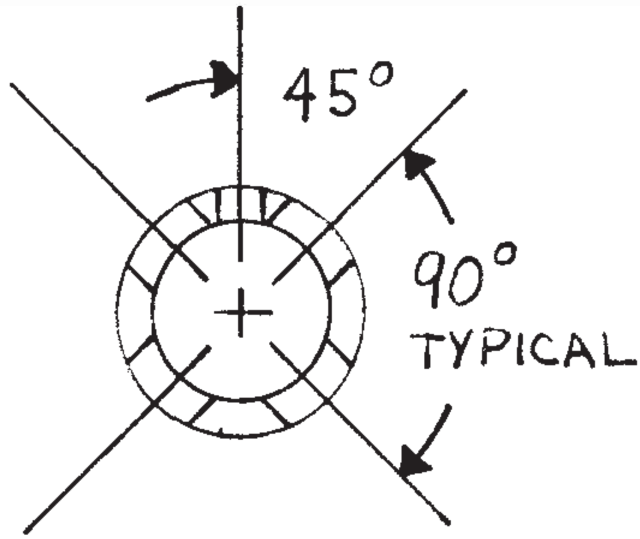


FIG 29

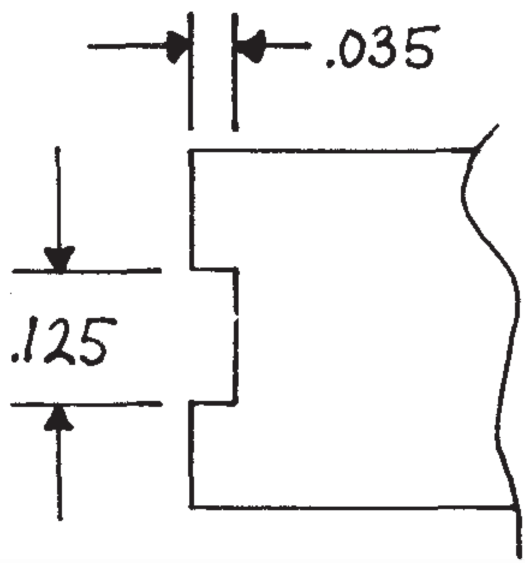
S&W MAXIMUM SECURITY HANDCUFF KEY BLANK



CUT LOCATION OF ALL 16 KEYS



LOCATION OF TUMBLER CUTS



TYPICAL TUMBLER CUT

FIG 30

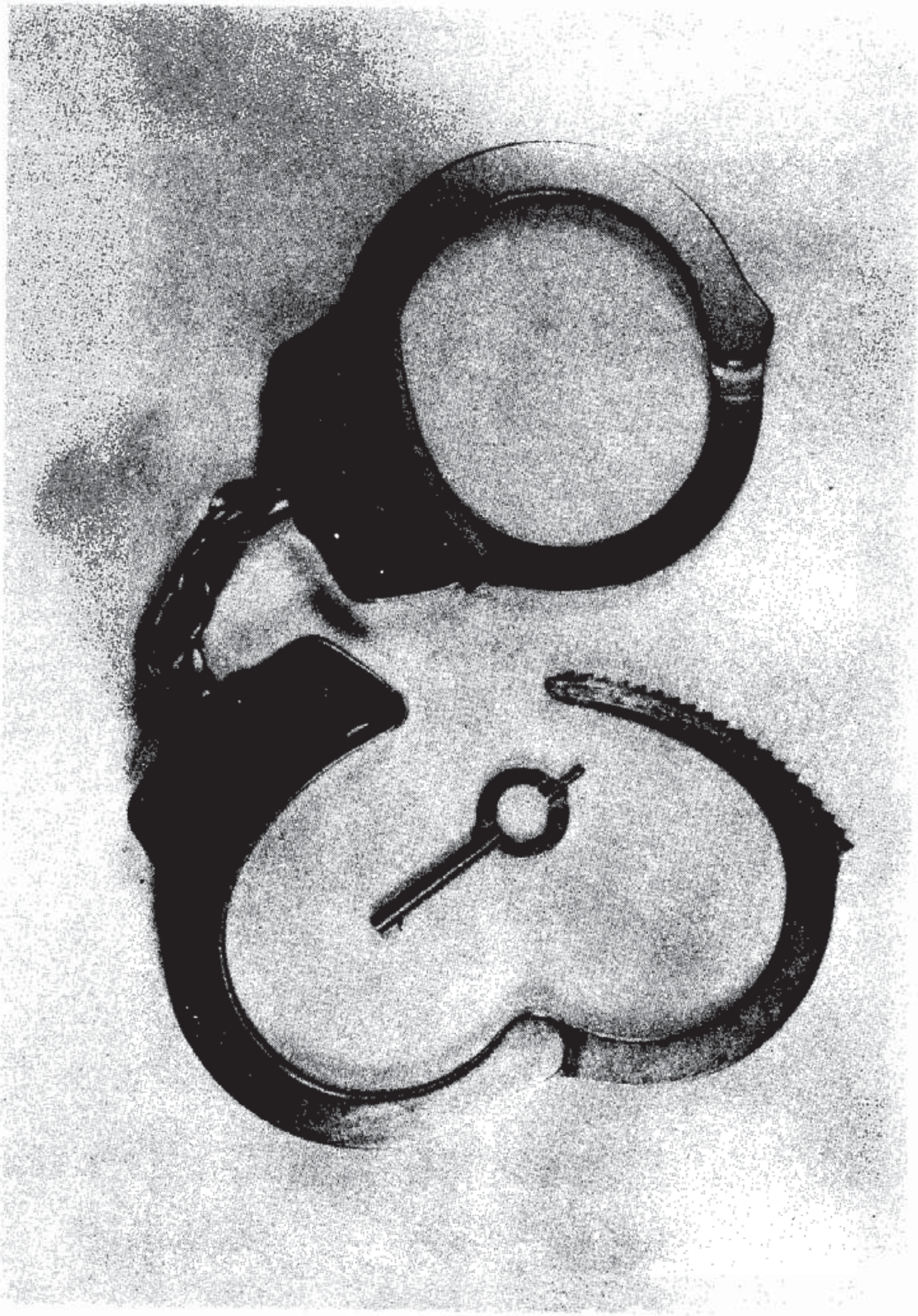
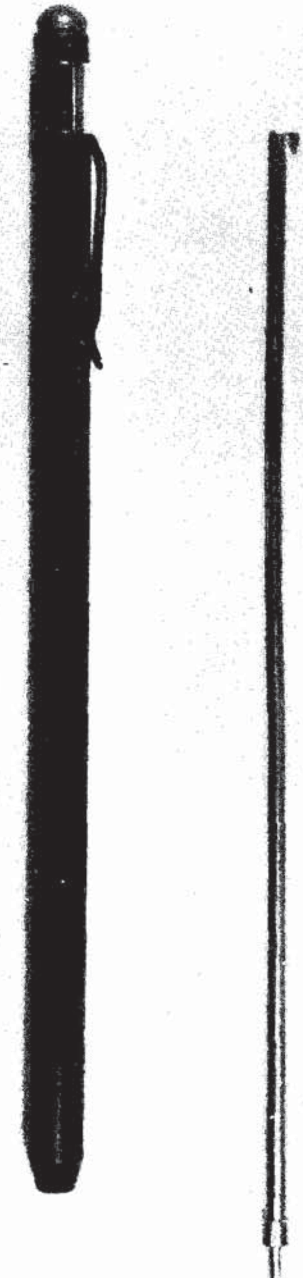


FIG 31
Standard S&W Model 90 handcuffs

FIG 32

Shimming a standard handcuff open. Note: the double-lock feature must be disengaged or this method of opening cannot be accomplished.



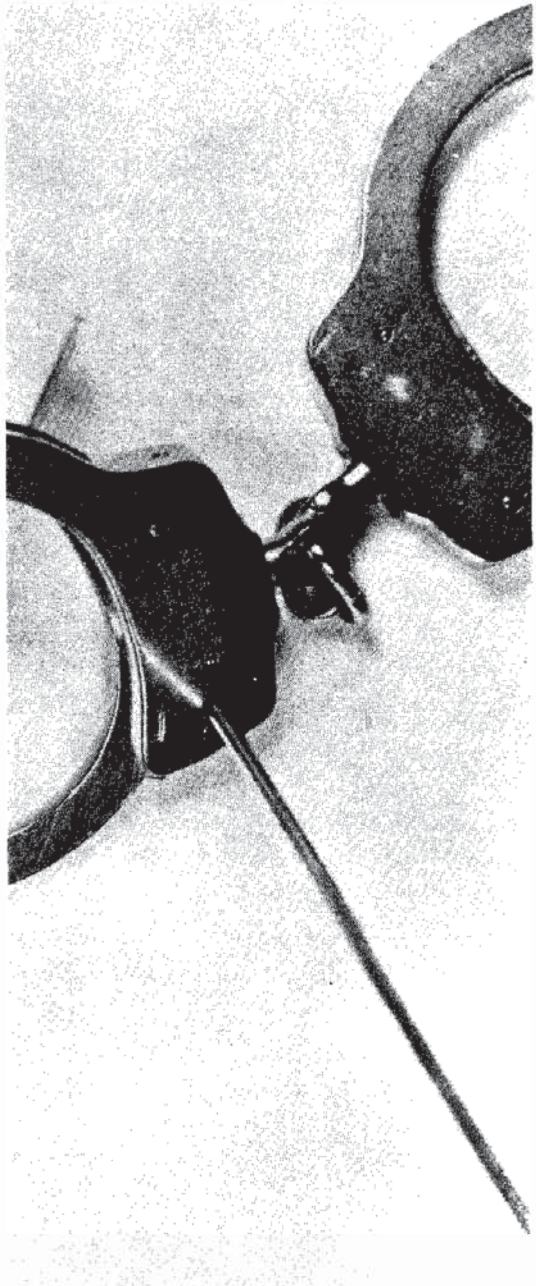


FIG 33 FIG 34

The two photographs above show how the "insides" of a ball point pen can be used to fashion an improvised key that will open all standard handcuffs such as S&W and Peerless.

NOTES TO THE READER

If you know that the handcuffs cannot be picked or shimmed, and you are sure that the set may be rusty, you might consider various lubricants on the market, such as "lock-ease" and naval jelly. With lock-ease, it should be squirted into the keyhole and allowed to 'work' for a short period of time before you attempt to shim or pick it again. Sometimes, several applications are necessary.

With naval jelly, force it into the keyhole, ensuring that enough is put in to allow all parts of the lock mechanism to be reached. Allow it to work from 15 minutes up to a half-hour. Next, force water through, washing away the residue. Follow this with either 3-in-1 Oil or lock-ease to ensure that the lock parts will not rerust. This slight film helps to prevent the rusting.

If, even after the above, you cannot open the lock, the final step is to dismantle the handcuffs. Locate the pins or rivets holding the handcuffs together and carefully remove them. Then lay out each part so you know its exact location when you put the handcuffs together again. Replace work or rusted parts and springs. Many times, in older models, you may have to make new parts by hand. In instances such as this use a good grade of steel and be careful in cutting the part so that it is not longer or smaller, and definitely not thicker or thinner than the original part. Many times you can adapt springs to replace the original spring. As a last resort here, you may have to make a spring from scratch.

Points to Consider

Keep a variety of small keys, both flat and 'pipe' types on hand; you may luck out and have one that will open a difficult lock, or be able to modify an existing key.

Consider having several sets of shims and picks available for use. A damaged or broken one means only obtaining another from your duplicates — and not having to stop and make one.

Handcuffs are made as a TEMPORARY RESTRAINING DEVICE. The overall security is temporary, and not exceptionally high.

Be fully prepared for any handcuff that may come your way. Research, view lock collections, talk with locksmiths and specialists in the security field. Above all, don't pass up even a small piece of information. It may fit in with something you learned elsewhere and solve a problem handcuff.

Simple locks on medium and low quality handcuffs can create problems. Only study and practice will allow you to pinpoint each and every flaw associated with a particular model or series of handcuffs.

Avoid over-exertion when using picks and/or shims.

Avoid letting other people see how you open the handcuffs with picks and/or shims. You learned the hard way; why should they do it the easy way. Also, you may not know who the person is, or what his motives are.

BERSERKER

BOOKS