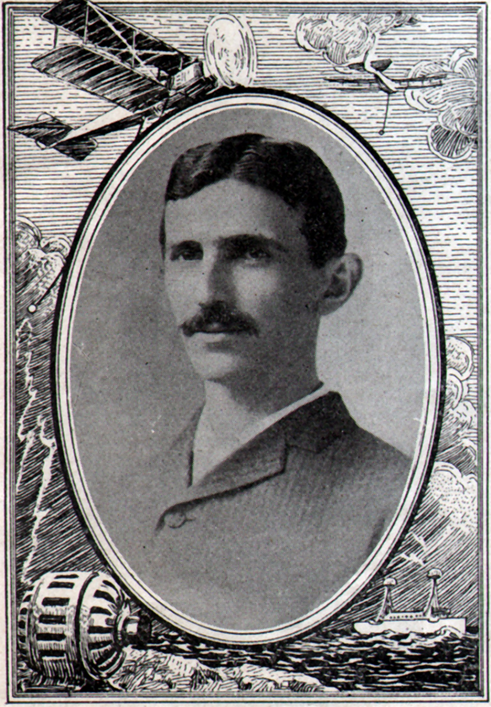
Nikola Tesla at the Age of 23.
From An Unpublished Photograph.



Mr. Tesla at the Age of 29. *Cop*

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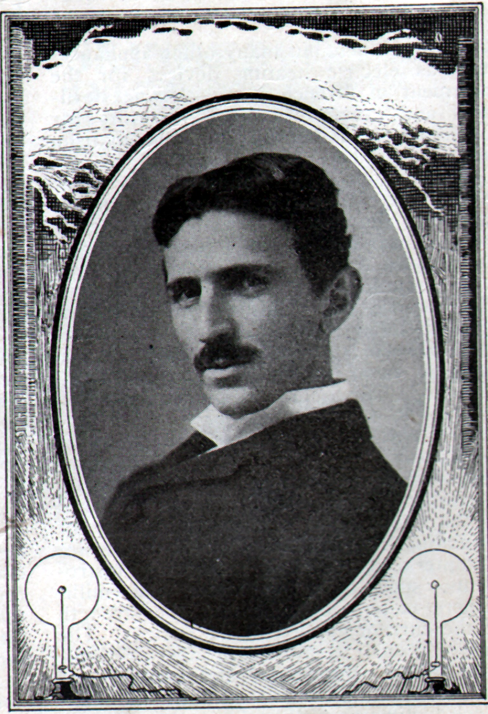


Mr. Tesla at the Age of 39.

My Inventions

By Nikola Tesla

1. MY EARLY LIFE

THE progressive development of man is vitally dependent on invention. It is the most important product of his creative brain. Its ultimate purpose is the complete mastery of mind over the material world, the harnessing of the forces of nature to human needs. This is the difficult task of the inventor who is often misunderstood and unrewarded. But he finds ample compensation in the pleasing exercises of his powers and in the knowledge of being one of that exceptionally privileged class without whom the race would have long ago perished in the bitter struggle against pitiless elements.

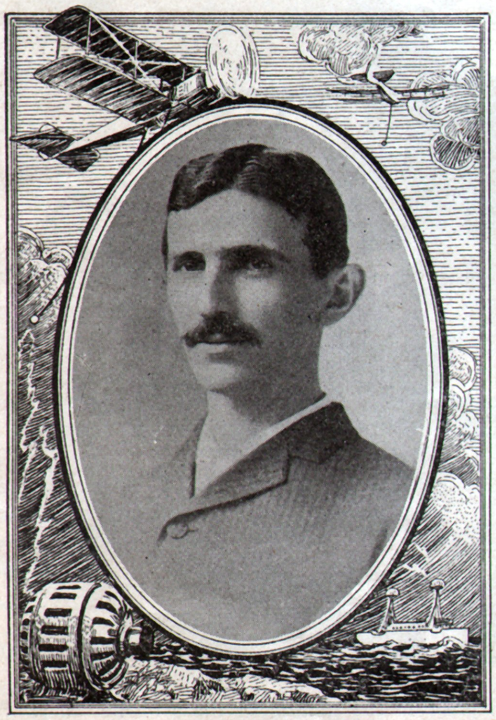
Speaking for myself, I have already had more than my full measure of this exquisite enjoyment, so much that for many years my life was little short of continuous rapture. I am credited with being one of the hardest workers and perhaps I am, if thought is the equivalent of labor, for I have devoted to it almost all of my waking hours. But if work is interpreted to be a definite performance in a specified time according to a rigid rule, then I may be the worst of idlers. Every effort under compulsion demands a sacrifice of life-energy. I never paid such a price. On the contrary, I have thrived on my thoughts.

In attempting to give a connected and faithful account of my activities in this series of articles which will be presented with the assistance of the Editors of the ELECTRICAL EXPERIMENTER and are chiefly addrest to our young men readers, I must dwell, however reluctantly, on the impressions of my youth and the circumstances and events which have been instrumental in determining my career.

Nikola Tesla at the Age of 23. From An Unpublished Photograph.

Our first endeavors are purely instinctive, promptings of an imagination vivid and undisciplined. As we grow older reason asserts itself and we become more and more systematic and designing. But those early impulses, tho not immediately productive, are of the greatest moment and may shape our very destinies. Indeed, I feel now that had I understood and cultivated instead of suppressing them, I would have added substantial value to my bequest to the world. But not until I had attained manhood did I realize that I was an inventor.

This was due to a number of causes. In the first place I had a brother who was gifted to an extraordinary degree—one of those rare phenomena of mentality which biological investigation has failed to explain. His premature death left my parents disconsolate. We owned a horse which had been presented to us by a dear friend. It was a magnificent animal of Arabian breed, possest of almost human intelligence, and was cared for and petted by the whole family, having on one occasion saved my father's life under remarkable circumstances. My father had been called one winter night to perform an urgent duty and while crossing the mountains, infested by wolves, the horse became frightened and ran away, throwing him violently to the ground. It arrived home bleeding and

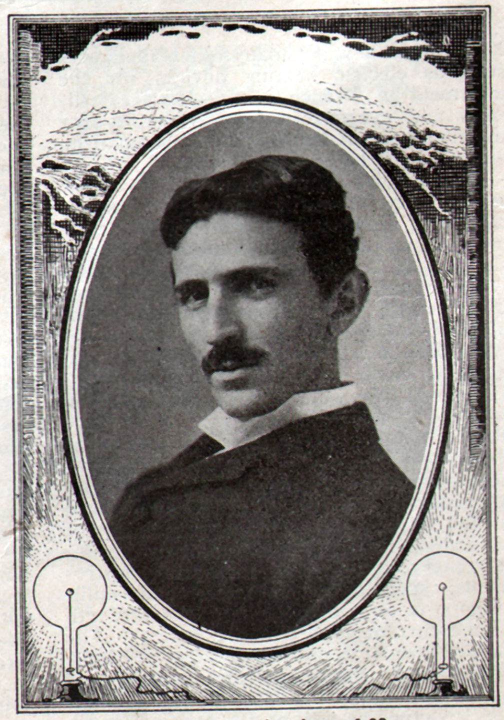


Mr. Tesla at the Age of 29.

HOW does the world's greatest inventor invent? How does he carry out an invention? What sort of mentality has Nikola Tesla? Was his early life as commonplace as most of ours? What was the early training of one of the World's Chosen? These, and many other very interesting questions are answered in an incomparable manner by Nikola Tesla himself in this, his first article.

In his autobiography, treating mainly on his early youth, we obtain a good insight into the wonderful life this man has led. It reads like a fairy tale, which has the advantage of being true. For Tesla is no common mortal. He has led a charmed life—struck down by the pest, the cholera and what not—given up by doctors at least three times as dead—we find him at sixty, younger than ever. But—read his own words. You have never read the like before.

—Editor.



Mr. Tesla at the Age of 39.

exhausted, but after the alarm was sounded immediately dashed off again, returning to the spot, and before the searching party were far on the way they were met by my father, who had recovered consciousness and remounted, not realizing that he had been lying in the snow for several hours. This horse was responsible for my brother's injuries from which he died. I witnest the tragic scene and altho fifty-six years have elapsed since, my visual impression of it has lost none of its force. The recollection of his attainments made every effort of mine seem dull in comparison.

Anything I did that was creditable merely caused my parents to feel their loss more keenly. So I grew up with little confidence in myself. But I was far from being considered a stupid boy, if I am to judge from an incident of which I have still a strong remembrance. One day the Aldermen were passing thru a street where I was at play with other boys. The oldest of these venerable gentlemen—a wealthy citizen—paused to give a silver piece to each of us. Coming to me he suddenly stopt and commanded, "Look in my eyes." I met his gaze, my hand outstretched to receive the much valued coin, when, to my dismay, he said, "No, not much, you can get nothing from me, you are too smart." They used to tell a funny story about me. I had two old aunts with wrinkled faces, one of them having two teeth protruding like the tusks of an elephant which she buried in my cheek every time she kist me. Nothing would scare me more than the prospect of being hugged by these as affectionate as unattractive relatives. It happened that while being carried in my mother's arms they asked me who was the prettier of the two. After examining their faces intently, I answered thoughtfully, pointing to one of them, "This here is not as ugly as the other."

Then again, I was intended from my very birth for the clerical profession and this thought constantly opprest me. I longed to be an engineer but my father was inflexible. He was the son of an officer who served in the army of the Great Napoleon and, in common with his brother, professor of mathematics in a prominent institution, had received a military education but, singularly enough, later embraced the clergy in which vocation he achieved eminence. He was a very erudite man, a veritable natural philosopher, poet and writer and his sermons were said to be as eloquent as those of Abraham a Sancta-Clara. He had a prodigious memory and frequently recited at length from works in several languages. He often remarked playfully that if some of the classics were lost he could restore them. His style of writing was much admired. He penned sentences short and terse and was full of wit and satire. The humorous remarks he made were always peculiar and characteristic. Just to illustrate, I may mention one or two instances. Among the help there was a cross-eyed man called Mane, employed to do work around the farm. He was chopping wood one day. As he swung the axe my father, who stood nearby and felt very uncomfortable, cautioned him, "For God's sake, Mane, do not strike at what you are looking but at what you intend to hit." On another occasion he was taking out for a drive a friend who carelessly permitted his costly fur coat to rub on the carriage wheel. My father reminded him of it saying, "Pull in your coat, you are ruining my tire." He had the odd habit of talking to himself and would often carry on an animated conversation and indulge in heated argument, changing the tone of his voice. A casual listener might have sworn that several people were in the room.

Altho I must trace to my mother's influence whatever inventiveness I possess, the training he gave me must have been helpful. It comprised all sorts of exercises—as, guessing one another's thoughts, discovering the defects of some form or expression, repeating long sentences or performing mental calculations. These daily lessons were intended to strengthen memory and reason and especially to develop the critical sense, and were undoubtedly very beneficial.

My mother descended from one of the oldest families in the country and a line of inventors. Both her father and grandfather originated numerous implements for household, agricultural and other uses. She was a truly great woman, of rare skill, courage and fortitude, who had braved the storms of life and past thru many a trying experience. When she was sixteen a virulent pestilence swept the country. Her father was called away to administer the last sacraments to the dying and during his absence she went alone to the assistance of a neighboring family who were stricken by the dread disease. All of the members, five in number, succumbed in rapid succession. She bathed, clothed and laid out the bodies, decorating them with flowers according to the custom of the country and when her father returned he found everything ready for a Christian burial. My mother was an inventor of the first order and would, I believe, have achieved great things had she not been so remote from modern life and its multifold opportunities. She invented and constructed all kinds of tools and devices and wove the finest designs from thread which was spun by her. She even planted the seeds, raised the plants and separated the fibers herself. She worked indefatigably, from break of day till late at night, and most of the wearing apparel and furnishings of the home was the product of her hands. When she was past sixty, her fingers were still nimble enough *to tie three knots in an eyelash.*

There was another and still more important reason for my late awakening. In my boyhood I suffered from a peculiar affliction due to the appearance of images, often accompanied by strong flashes of light, which marred the sight of real objects and interfered with my thought and action. They were pictures of things and scenes which I had really seen, never of those I imagined. When a word was spoken to me the image of the object it designated would present itself vividly to my vision and sometimes I was quite unable to distinguish whether what I saw was tangible or not. This caused me great discomfort and anxiety. None of the students of psychology or physiology whom I have consulted could ever explain satisfactorily these phenomena. They seem to have been unique altho I was probably predisposed as I know that my brother experienced a similar trouble. The theory I have formulated is that the images were the result of a reflex action from the brain on the retina under great excitation. They certainly were not hallucinations such as are produced in diseased and anguished minds, for in other respects I was normal and composed. To give an idea of my distress, suppose that I had witnest a funeral or some such

(*Continued on page 743*)

NIKOLA TESLA THE MAN

By H. Gernsback

THE door opens and out steps a tall figure—over six feet high—gaunt but erect. It approaches slowly, stately. You become conscious at once that you are face to face with a personality of a high order. Nikola Tesla advances and shakes your hand with a powerful grip, surprising for a man over sixty. A winning smile from piercing light blue-gray eyes, set in extraordinarily deep sockets, fascinates you and makes you feel at once at home.

You are guided into an office immaculate in its orderliness. Not a speck of dust is to be seen. No papers litter the desk, everything just so. It reflects the man himself, immaculate in attire, orderly and precise in his every movement. Drest in a dark frock coat, he is entirely devoid of all jewelry. No ring, stickpin, or even watch-chain can be seen.

Tesla speaks—a very high almost falsetto voice. He speaks quickly and very convincingly. It is the man's voice chiefly which fascinates you.

As he speaks you find it difficult to take your eyes off his own. Only when he speaks to others do you have a chance to study his head, predominant of which is a very high forehead with a bulge between the eyes—the neverfailing sign of an exceptional intelligence. Then the long, well-shaped nose, proclaiming the scientist.

How does this man, who has accomplished such a tremendous work, keep young and manage to surprise the world with more and more new inventions as he grows older? How does this youth of sixty, who is a professor of mathematics, a great mechanical and electrical engineer and the greatest inventor of all times, keep his physical as well as remarkable mental freshness?

To begin with, Tesla, who is by birth a Serbian, comes from a long-lived hardy race. His family tree abounds with centenarians. Accordingly, Tesla—barring accidents—fully expects to be still inventing in A. D. 1960.

But the chief reason for his perpetual youth is found in his gastronomical frugality. Tesla has learned the great fundamental truth that most people not only eat all of their bodily ills, but actually eat themselves to death by either eating too much or else by food that does not agree with them.

When Tesla found out that tobacco and black coffee interfered with his physical well-being, he quit both. This is the simple daily menu of the great inventor:

Breakfast: One to two pints of warm milk and a few eggs, prepared by himself—yes, he is a bachelor!

Lunch: None whatsoever, as a rule.

Dinner: Celery or the like, soup, a single piece of meat or fowl, potatoes and one other vegetable; a glass of light wine. For dessert, perhaps a slice of cheese, and invariably a big raw apple. And that's all.

Tesla is very fussy and particular about his food: he eats very little, but what he does eat must be of the very best. And he knows, for outside of being a great inventor in science he is an accomplished cook who has invented all sorts of savory dishes.

His only vice is his generosity. The man who, by the ignorant onlooker has often been called an idle dreamer, has made over a million dollars out of his inventions—and spent them as quickly on new ones. But Tesla is an idealist of the highest order and to such men money itself means but little.

NIKOLA TESLA AND HIS INVENTIONS.

(*Continued from page* 697)

nerve-racking spectacle. Then, inevitably, in the stillness of night, a vivid picture of the scene would thrust itself *before* my eyes and persist despite all my efforts to banish it. Sometimes it would even remain fixt in space tho I pushed my hand thru it. If my explanation is correct, it should be possible to project on a screen the image of any object one conceives and make it visible. Such an advance would revolutionize all human relations. I am convinced that this wonder can and will be accomplished in time to come; I may add that I have devoted much thought to the solution of the problem.

To free myself of these tormenting appearances, I tried to concentrate my mind on something else I had seen, and in this way I would often obtain temporary relief; but in order to get it I had to conjure continuously new images. It was not long before I found that I had exhausted all of those at my command; my "reel" had run out, as it were, because I had seen little of the world—only objects in my home and the immediate surroundings. As I performed these mental operations for the second or third time, in order to chase the appearances from my vision, the remedy gradually lost all its force. Then I instinctively commenced to make excursions beyond the limits of the small world of which I had knowledge, and I saw new scenes. These were at first very blurred and indistinct, and would flit away when I tried to concentrate my attention upon them, but by and by I succeeded in fixing them; they gained in strength and distinctness and finally assumed the concreteness of real things. I soon discovered that my best comfort was attained if I simply went on in my vision farther and farther, getting new impressions all the time, and so I began to travel—of course, in my mind. Every night (and sometimes during the day), when alone, I would start on my journeys—see new places, cities and countries—live there, meet people and make friendships and acquaintances and, however unbelievable, it is a fact that they were just as dear to me as those in actual life and not a bit less intense in their manifestations.

This I did constantly until I was about seventeen when my thoughts turned seriously to invention. Then I observed to my delight that I could visualize with the greatest facility. I needed no models, drawings or experiments. I could picture them all as real in my mind. Thus I have been led unconsciously to evolve what I consider a new method of materializing inventive concepts and ideas, which is radically opposite to the purely experimental and is in my opinion ever so much more expeditious and efficient. The moment one constructs a device to carry into practise a crude idea he finds himself unavoidably engrost with the details and defects of the apparatus. As he goes on improving and reconstructing, his force of concentration diminishes and he loses sight of the great underlying principle. Results may be obtained but always at the sacrifice of quality.

My method is different. I do not rush into actual work. When I get an idea I start at once building it up in my imagination. I change the construction, make improvements and operate the device in my mind. It is absolutely immaterial to me whether I run my turbine in thought or test it in my shop. *I even note if it is out of balance.* There is no difference whatever, the results are the same. In this way I am able to rapidly develop and perfect a conception without touching anything. When I have gone so far as to embody in the invention every possible improvement I can think of and see no fault anywhere, I put into concrete form this final product of my brain. Invariably my device works as I conceived that it should, and the experiment comes out exactly as I planned it. In twenty years there has not been a single exception. Why should it be otherwise? Engineering, electrical and mechanical, is positive in results. There is scarcely a subject that cannot be mathematically treated and the effects calculated or the results determined beforehand from the available theoretical and practical data. The carrying out into practise of a crude idea as is being generally done is, I hold, nothing but a waste of energy, money and time.

My early affliction had, however, another compensation. The incessant mental exertion developed my powers of observation and enabled me to discover a truth of great importance. I had noted that the appearance of images was always preceded by actual vision of scenes under peculiar and generally very exceptional conditions and I was impelled on each occasion to locate the original impulse. After a while this effort grew to be almost automatic and I gained great facility in connecting cause and effect. Soon I became aware, to my surprise, that every thought I conceived was suggested by an external impression. Not only this but all my actions were prompted in a similar way. In the course of time it became perfectly evident to me that I was merely an *automaton* endowed with power of movement, responding to the stimuli of the sense organs and thinking and acting accordingly. The practical result of this was the art of *telautomatics* which has been so far carried out only in an imperfect manner. Its latent possibilities will, however, be eventually shown. I have been since years planning self-controlled automata and believe that mechanisms can be produced which will act as if possest of reason, to a limited degree, and will create a revolution in many commercial and industrial departments.

I was about twelve years old when I first succeeded in banishing an image from my vision by wilful effort, but I never had any control over the flashes of light to which I have referred. They were, perhaps, my strangest experience and inexplicable. They usually occurred when I found myself in a dangerous or distressing situation or when I was greatly exhilarated. In some instances I have seen all the air around me filled with tongues of living flame. Their intensity, instead of diminishing, increased with time and seemingly attained a maximum when I was about twenty-five years old. While in Paris, in 1883, a prominent French manufacturer sent me an invitation to a shooting expedition which I accepted. I had been long confined to the factory and the fresh air had a wonderfully invigorating effect on me. On my return to the city that night I felt a positive sensation that my brain had caught fire. I saw a light as tho a small sun was located in it and I past the whole night applying cold compressions to my tortured head. Finally the flashes diminished in frequency and force but it took more than three weeks before they wholly subsided. When a second invitation was extended to me my answer was an emphatic NO!

These luminous phenomena still manifest themselves from time to time, as when a new idea opening up possibilities strikes me, but they are no longer exciting, being of relatively small intensity. When I close my eyes I invariably observe first, a background of very dark and uniform blue, not unlike the sky on a clear but starless night. In a few seconds this field becomes animated with innumerable scintillating flakes of green, arranged in several layers and advancing towards me. Then there appears, to the right, a beautiful pattern of two systems of parallel and closely spaced lines, at right angles to one another, in all sorts of colors with yellow-green and gold predominating. Immediately thereafter the lines grow brighter and the whole is thickly sprinkled with dots of twinkling light. This picture moves slowly across the field of vision and in about ten seconds vanishes to the left, leaving behind a ground of rather unpleasant and inert grey which quickly gives way to a billowy sea of clouds, seemingly trying to mould themselves in living shapes. It is curious that I cannot project a form into this grey until the second phase is reached. Every time, before falling asleep, images of persons or objects flit before my view. When I see them I know that I am about to lose consciousness. If they are absent and refuse to come it means a sleepless night.

To what an extent imagination played a part in my early life I may illustrate by another odd experience. Like most children I was fond of jumping and developed an intense desire to support myself in the air. Occasionally a strong wind richly charged with oxygen blew from the mountains rendering my body as light as cork and then I would leap and float in space for a long time. It was a delightful sensation and my disappointment was keen when later I undeceived myself.

During that period I contracted many strange likes, dislikes and habits, some of which I can trace to external impressions while others are unaccountable. I had a violent aversion against the earrings of women but other ornaments, as bracelets, pleased me more or less according to design. The sight of a pearl would almost give me a fit but I was fascinated with the glitter of crystals or objects with sharp edges and plane surfaces. I would not touch the hair of other people except, perhaps, at the point of a revolver. I would get a fever by looking at a peach and if a piece of camphor was anywhere in the house it caused me the keenest discomfort. Even now I am not insensible to some of these upsetting impulses. When I drop little squares of paper in a dish filled with liquid, I always sense a peculiar and awful taste in my mouth. I counted the steps in my walks and calculated the cubical contents of soup plates, coffee cups and pieces of food,—otherwise my meal was unenjoyable. All repeated acts or operations I performed had to be divisible by three and if I mist I felt impelled to do it all over again, even if it took hours.

Up to the age of eight years, my character was weak and vacillating. I had neither courage or strength to form a firm resolve. My feelings came in waves and surges and vibrated unceasingly between extremes. My wishes were of consuming force and like the heads of the hydra, they multiplied. I was opprest by thoughts of pain in life and death and religious fear. I was swayed by superstitious belief and lived in constant dread of the spirit of evil, of ghosts and ogres and other unholy monsters of the dark. Then, all at once, there came a tremendous change which altered the course of my whole existence.

Of all things I liked books the best. My father had a large library and whenever I could manage I tried to satisfy my passion for reading. He did not permit it and would fly into a rage when he caught me in the act. He hid the candles when he found that I was reading in secret. He did not want me to spoil my eyes. But I obtained tallow, made the wicking and cast the sticks into tin forms, and every night I would bush the keyhole and the cracks and read, often till dawn, when all others slept and my mother started on her arduous daily task. On one occasion I came across a novel entitled "Abafi" (the Son of Aba), a Serbian translation of a well known Hungarian writer, Josika. This work somehow awakened my dormant powers of will and I began to practise self-control. At first my resolutions faded like snow in April, but in a little while I conquered my weakness and left a pleasure I never knew before—that of doing as I willed. In the course of time this vigorous mental exercise became second nature. At the outset my wishes had to be subdued but gradually desire and will grew to be identical. After years of such discipline I gained so complete a mastery over myself that I toyed with passions which have meant destruction to some of the strongest men. At a certain age I contracted a mania for gambling which greatly worried my parents. To sit down to a game of cards was for me the quintessence of pleasure. My father led an exemplary life and could not excuse the senseless waste of time and money in which I indulged. I had a strong resolve but my philosophy was bad. I would say to him, "I can stop whenever I please but is it worth while to give up that which I would purchase with the joys of Paradise?" On frequent occasions he gave vent to his anger and contempt but my mother was different. She understood the character of men and knew that one's salvation could only be brought about thru his own efforts. One afternoon, I remember, when I had lost all my money and was craving for a game, she came to me with a roll of bills and said, "Go and enjoy yourself. The sooner you lose all we possess the better it will be. I know that you will get over it." She was right. I conquered my passion then and there and only regretted that it had not been a hundred times as strong. I not only vanquished but tore it from my heart so as not to leave even a trace of desire. Ever since that time I have been as indifferent to any form of gambling as to picking teeth.

During another period I smoked excessively, threatening to ruin my health. Then my will asserted itself and I not only stopt but destroyed all inclination. Long ago I suffered from heart trouble until I discovered that it was due to the innocent cup of coffee I consumed every morning. I discontinued at once, tho I confess it was not an easy task. In this way I checked and bridled other habits and passions and have not only preserved my life but derived an immense amount of satisfaction from what most men would consider privation and sacrifice.

After finishing the studies at the Polytechnic Institute and University I had a complete nervous breakdown and while the malady lasted I observed many phenomena strange and unbelievable.

(*To be continued in our March issue*)

TEN TELEPHONE OR FORTY TELEGRAPH CURRENTS OVER ONE CIRCUIT.

POSTMASTER GENERAL BURLESON on December 12th made public a letter from Theodore N. Vail announcing the invention and development by the technical staff of the Bell system of a practical method of multiplex telephony and telegraphy, which is expected to revolutionize long-distance wire communication.

Mr. Vail, who is President of the American Telephone and Telegraph Company, explained that there can be a combination of telegraphy and telephony under this invention by which a pair of wires, i.e., one full metallic circuit, will be available either for *five simultaneous telephone conversations* (*ten voices*) or for *forty simultaneous telegraph messages*, or partly for one and partly for the other.

With this new system four telephone conversations over one pair of wires are simultaneously carried on *in addition to* the telephone conversation provided by the ordinary methods. Thus, over a single pair of wires a total of five telephone conversations are simultaneously operated, each giving service as good as that provided by the circuit working in the ordinary way.

Heretofore the best telephone methods known to the art provided only one telephone conversation at a time over a single pair of wires. A number of years ago there was developed the *phantom circuit* arrangement, by which three telephone circuits were obtained from two pairs of wires, an important improvement, of which extensive use has been made commercially. Now, by the multiplex method we are enabled to obtain *five telephone circuits* over one pair of wires, that is, *ten simultaneous telephone conversations* from the two pairs of wires which formerly could be used for only three simultaneous telephone conversations. This represents an increase of more than threefold in the telephonic capacity of the wires, as compared with the best previous state of the art.

Some proposals made by the earlier workers in this particular field have naturally proved suggestive in the successful solution of the problem, particularly a suggestion made by Maj. Gen. George O. Squier, Chief Signal Officer of the United States Army, about ten years ago, and which at the time attracted very general attention.

Furthermore, while working in entirely different fields and with a different objective, Dr. Lee deForest a number of years ago invented a wireless device known as the Audion, which by improvements and adaptation has been made an important part of the Bell telephone system.

PRACTICAL MECHANICS FOR EVERYDAY MEN

Everyday ENGINEERING Magazine

IT TELLS YOU HOW TO MAKE AND DO THINGS

VOLUME V JUNE, 1918 NUMBER III

A Low-Tension Transformer

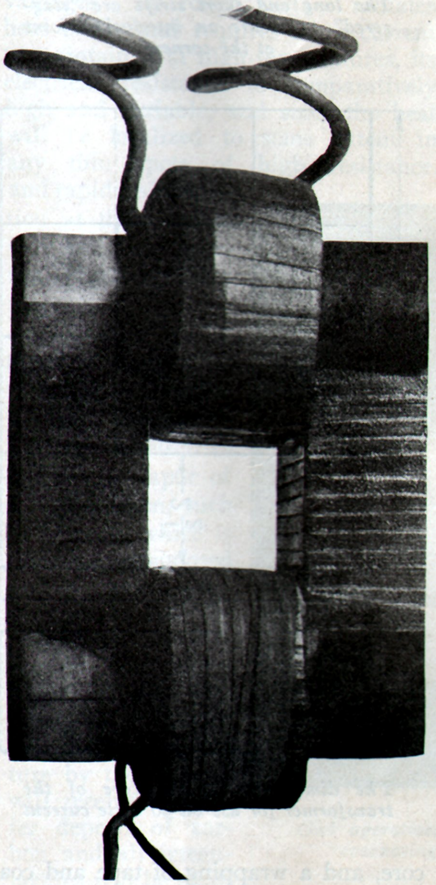
Construction of a Machine for Use with the Arc Furnace Described in the April Issue

By Raymond Francis Yates

WHILE the small arc furnace which appeared in the April issue may be operated on direct current from the 110-volt mains with the interposition of suitable resistance, where alternating current is available an ideal solution to the current supply problem is found in a magnetic leakage transformer designed to supply a heavy current at about 40 volts pressure to the furnace. In addition to providing a high current density at the arc without causing an excessive overload on the line, good automatic regulation is secured with a machine of this type, and troubles due to short circuit when the arc is struck are completely eliminated. Since the coupling between the primary and secondary windings is made very loose, when the carbons are touched and the secondary short-circuited, heavy magnetic leakage takes place between the windings and the secondary voltage drops to practically zero. Upon separation of the electrodes, normal conditions are resumed and the leakage becomes very low. Regulation of the arc, should this be deemed necessary, is readily obtained by the interposition of a small bundle of transformer iron between the windings.

The transformer illustrated herewith was designed to operate on the regular 110 to 120-volt, 60-cycle line, and operates a one-half inch carbon arc with perfect satisfaction. In the event that the machine is to be operated upon 25-cycle current the core must be made considerably larger than that shown, but the character of the windings need not be altered. The transformer takes a primary current of about 15 amperes at full load, equivalent to a secondary output of 45 amperes.

The core of the machine is to be assembled first, and consists of sheets of silicon steel of the dimensions indicated in the drawings. About 25 pounds of this material are required for the complete core. The long sheets are laid on one another alternately projecting in either direction for a space equal to their width, and the ends of the strips comprising the short legs of the core are fitted in the ends of the long leg thus formed in a similar manner. This assembly is clearly depicted in the sketch, and is one which is soon mastered. Three legs of the core, two short and one long, are thus built up together, and all of them bound securely with two layers of friction tape. It is advisable to wear heavy gloves when working on the core, as the edges of the iron are exceedingly sharp. The core, when thus assembled, is ready for the windings.

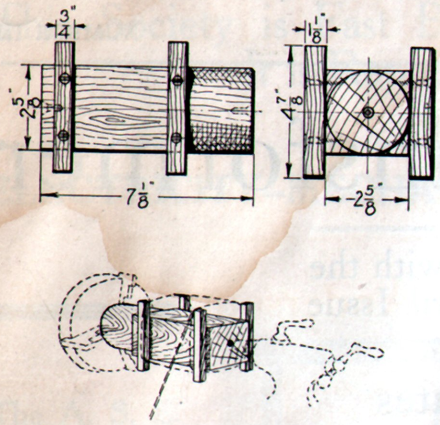


The finished transformer. Note especially the position of the last strip of iron on the left leg

Both the primary and secondary coils are wound upon the wooden form illustrated diagrammatically in the sketch. This may either be mounted between centers in the lathe and driven from the faceplate, or one end grasped in the chuck and the form steadied with the tailstock center for winding. A substantial winding jig may be employed in the absence of a lathe, although the work is rather heavy.

The primary is wound with 150 turns of No. 14 cotton covered wire. The winding form was first wrapped with a layer of heavy cord between the cross bars and a wrapping of insulating paper secured over the cord. One end of the wire is secured to the form and a layer of wire wound on the form, running the lathe backwards and at its lowest speed. The wire should be free from kinks and fed from a spool under constant tension. Considerable care must be exercised to get the turns close and even. Any imperfections in the insulation of the wire may be covered with empire cloth wrapped around the wire at that point.

After the first layer is completed, it is covered with insulating paper and a second layer wound over it, repeating the procedure until as many layers as are necessary to secure the 150 turns are in place. The form is then removed from the lathe and, maintaining a hold on the coil, the two crosspieces on one end of the form are removed. The layer of cord under the wire may now be pulled out and a few pieces of cord passed through the coil and tied around it, holding the wire in place temporarily. The coil is now lifted off the form and wound with friction tape, the ends of the winding are soldered to flexible

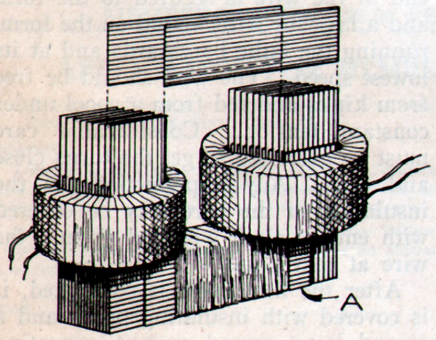


The form on which the coils are wound. After winding, the cross pieces are removed to allow the winding to be withdrawn

leads, the soldered joints being insulated first with empire cloth and then taped to the coil. The winding is now ready to be placed on the core.

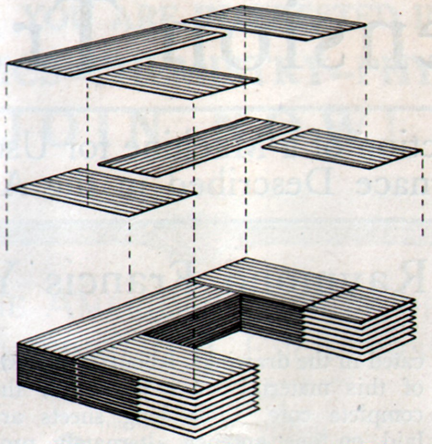
The secondary coil was wound in precisely the same way, with the exception that two No. 10 wires in parallel were employed. Fifty turns of this double wire, or one hundred turns in all are required. Since wire of this size is far from flexible, the turns may have to be tapped lightly with a mallet to get them in place at the ends of the layers. The ends of the winding are soldered to heavy leads which are fitted with lugs at the terminals for connection to the electrodes of the furnace. Stranded No. 4 wire, rubber covered, is suitable for these leads, though a somewhat more flexible connection is preferable. After thorough taping, both primary and secondary windings and the core are given a coat of shellac.

The windings should be a loose fit on the short legs of the core, and are held in place by small wooden wedges driven in on opposite sides. With the windings in place, the magnetic circuit may be completed by insertion of the strips comprising the fourth leg of the core. The ends of the projecting short legs are spread one by one and the long strips inserted, being "staggered" exactly as were the other strips. In this case, however, the two outside strips are placed so as to project halfway over each end strip, being centered on the core, and a wrapping of tape and coat of shellac applied. While it is not essential to mount the transformer for temporary work, some style of support is usually added, and may well consist of two hardwood strips clamped over each long leg which are long enough to allow the transformer to stand up without resting on the windings. The machine may also be laid down flat if desired.



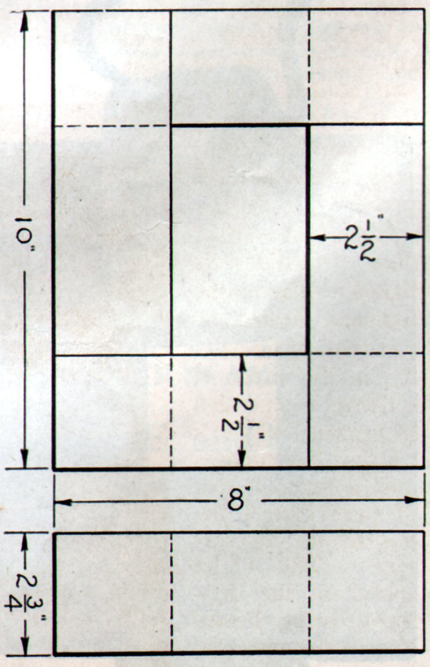
METHOD OF FINAL ASSEMBLY

Inserting the final strips which complete the core after the windings are put in place



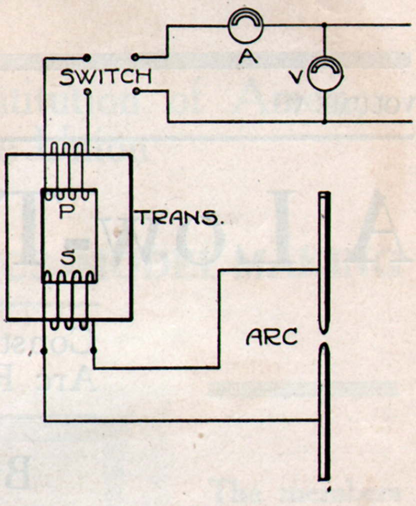
METHOD OF FORMING LAYERS

Showing the assembly of the core. The long and short strips are "staggered" to secure an interlocked joint at the corners



The dimensions of the core of the transformer for use on 60 cycle current

In operation the machine shown in the accompanying photograph has given excellent results, and its core loss, or current taken on open circuit secondary, is not readable on the meter. The windings become only slightly warm after continued operation. The laminations of the core rustle slightly, but this is no way impairs the efficiency of the machine. The diagram of connections is given herewith, and while the voltmeter and ammeter are not requisite, the latter at least affords a valuable check on the behavior of the arc.



WIRING DIAGRAM

A wiring diagram of the circuit. The ammeter and voltmeter may be omitted although their use is to be recommended

If D.C. is used to operate the furnace, some form of resistance, preferably adjustable, and an ammeter are all that need be included in the circuit. The current supplied the arc is, of course, regulated by the rheostat, and should be as large as may be safely drawn from the supply mains. While this will in most cases be nowhere near as large as that which is secured from an A.C. line with the transformer, very satisfactory results are obtainable on D.C. To equalize the carbon consumption in the furnace, the polarity of the electrodes may be reversed periodically by interchanging the connections at the terminals or attachment plug.

"Boiling-Acid" Proof Cement

A CEMENT which is proof against acids, even boiling acids, can be made by melting india-rubber over a gentle heat and stirring into it, until thoroughly mixed, 6 to 8 per cent (by weight) of tallow. This is left until the following day, when dry slaked lime is added until the mixture assumes the consistency of a soft paste. Then add 20 per cent of red lead to act as a dryer and to make it set.

A 300-Watt Arc Light Transformer

By H. H. Parker

Drawings by the Author

THE small magnetic leakage transformer described below was designed to furnish a stepped down voltage of 30 or 60 for experimental work with an arc struck between two half-inch standard carbons, which would cause no undue disturbance on the 110 volt 60 cycle house circuit to which the transformer primary was connected. There will be sufficient current at 30 volts, to operate a small arc and of course a more intense one at 60; the contacting of the carbons to strike the arc causes only a light flicker on a forty watt lamp on the same branch—very much less disturbance than the running of a fractional horse-power induction motor. The windings allow for about five amperes at 60 volts and five or ten at 30, depending upon whether one or two coils are used, in the secondary; this is sufficient for ordinary purposes though the transformer is not of sufficient capacity for an electric furnace or other heavy work. An interesting experiment is to strip the wood off an ordinary pencil, break the lead in half and attach the two pieces to the 30 volt terminals, using a single secondary coil. A small but energetic arc will be struck which will throw off considerable light. Here is a suggestion for the model making enthusiast: a miniature searchlight operated by small pencil carbons should prove most realistic and give an intense light.

The transformer as described is designed for either 110 or 220 volts by connecting the two primary coils in parallel or series; the secondary voltages will be the same in each case. The standard frequency of 60 cycles is provided for; other frequencies require a change in the cross section of the core, as explained later. The secondary winding is in two coils also; they may be connected in series or parallel or used separately.

To start with, we have the well-known transformer equation:

$$T = \frac{E \times 1000000000}{4.44 \times f \times B \times A}$$

Where "T" is the number of primary turns,

"f" the frequency,

"B" the magnetic flux through the core,

"A" the area of core cross-section.

It is assumed that the core will be built of "stove" iron, the most easily obtained material; for such iron, "B" is usually given a value of 40,000. If transformer iron or silicon steel can be obtained, a smaller core may be used, for "B" will then be 60,000 or more. Our core will be given an area of two square inches, making it 1¼ inches wide and 1⅝ inches thick. With "f" at 60 and "B" 40,000 the above equation gives 516 as the number of turns required; we will use 500.

If other material is used for the core, as mentioned above, or a different frequency, the following core areas are suggested:

With "B" at 60,000 and "f" still at 60, "A" will be 1.37 sq. in.; a core one inch wide and 1⅜ inches thick would do. The number of turns would be the same.

At a frequency of 25 cycles, "B" 40,000, "T" 500, "A" would be 4.95 sq. in., requiring a core 2 by 2½ inches.

At 25 cycles with "B" 60,000, "A" would then be 3.3 sq. in. and the core would be 1½ by 2¼ sq. ins.

For a different frequency or value of "B," substitute the values in the above equation, with "T" at 500.

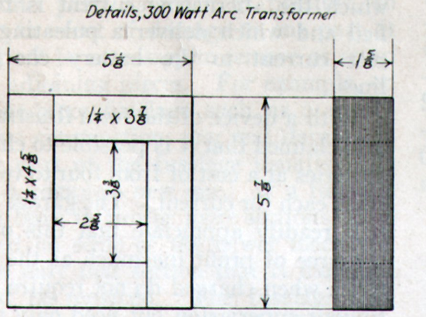


Fig. 1. 60~Core, "Stove" Iron, 0.025 or less. If transformer iron or silicon steel used, cross section may be reduced See Text.

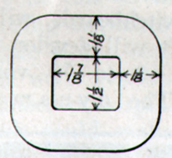


Fig. 4 Insulating spacer fibre or shellacked cardboard. Trim edges after in place and coils wound

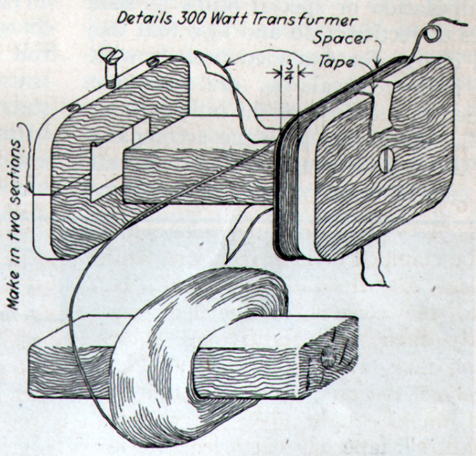


Fig. 3 One section (half coil) wound on mandrel, remainder of wire rewound on another mandrel ready to start second section in opposite direction, when flange is screwed in place

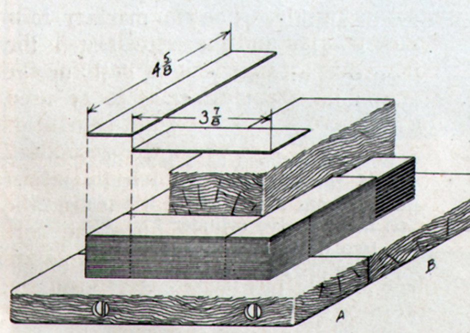


Fig. 2 Assembling the Core. How the two legs and one yoke are built up round a wooden form

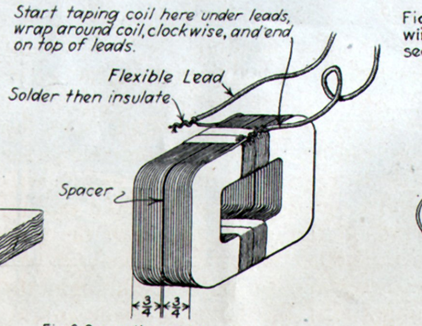


Fig. 6 One coil complete, temporary tape bindings in place and off of mandrel, ready for final tape wrapping. How leads are soldered so as to leave coil in same direction.

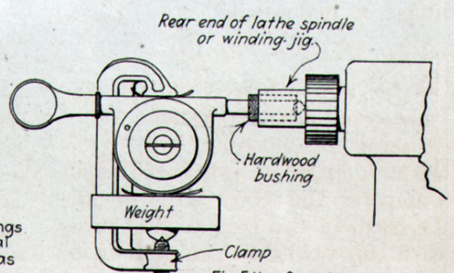


Fig. 5 How Speed counter may be attached to lathe or winding jig to count the number of turns in coil winding.

Construction of Core

Taking up the core, primary and secondary windings in order: for the core, get some black stove iron, as thin as possible, though it generally runs about 0.025 inch in thickness. If obtainable, regulate transformer iron or silicon steel will be better and a smaller core may be used as mentioned above. Have this iron cut up, if possible, into strips an inch and a quarter wide; the amount required depends upon the thickness of the iron. Then cut up the strips in two lengths for the core and yoke pieces, to the dimensions given in Fig. 1; pile them up, clamp in a vise and file the ends even and square, then separate and give one side of each a thin coat of shellac. When dry assemble the two cores and one yoke around the wooden form shown in Fig. 2, being careful to stagger the joints. The other yoke must be left off until the windings are in place, when the pieces are pushed into place separately. The pile should be 1⅝ inches high when tightly compressed; clamp the two legs to the board "B" and remove the board "A." This frees the yoke, which may be clamped or held in a vise while the legs are freed from board "B." Round the corners of the legs very slightly, then wrap tightly with black friction tape, always keeping a clamp just above the tape as it is wound on. Wind on a single layer of cambric "armature" tape on each leg, release the yoke and clamping only the corners, wrap this also with friction tape. Give the whole several coats of shellac, especially the taped legs where the windings will be located.

How to Make the Primary Coils

Now for the primary: we will use two coils, connected in parallel for 110 and in series for 220 volts; two No. 17 dcc wires in parallel will carry about three amperes and 1000 turns of this will be used, in two coils of 500 turns and each coil wound in two sections of 250 turns each. Winding in this manner subdivides the E. M. F. in the coils and as both ends are on the outside, the bothersome inside end is eliminated. Make a wooden winding mandrel as shown in Fig. 3, the core being 1½ by 1⅞ inches to allow room for the tape wrapping on the coils. One flange of the jig should be adjustable; for winding the first section it should be placed ¾ inch from the end flange; after the first section is wound it is moved along to allow for winding the second section of the same width.

Prepare some sheets like those in Fig. 4, of thin fibre shellacked cardboard or other insulating material. Thread one of these spacers on the No. 17 wire, then the loose jig flange and then pull through and measure off about 224 feet of the wire, enough for 250 turns approximately. Without cutting the wire slip the spacer and flange over the mandrel, with the wire just measured off OUTSIDE; then wind it temporarily around the OUTER end of the mandrel, screw the flange in place ¾ inch from the other end, lay some friction tape in the groove on each side to hold the sections temporarily when wound and wind on 250 turns; the wire is fed from the spool while the first portion measured off stays on the mandrel and revolves with it. This winding may be performed upon a lathe or a made-up winding jig or even simply by hand. As it is bothersome to keep track of the exact number of turns, if a revolution counter is at hand it may be attached to the rear end of the lathe spindle as shown in Fig. 5 or to the shaft of the winding jig. A weight clamped to the body keeps it from turning with its spindle.

One section being wound, stay the loose end and move the flange along for its second position; the first section will usually remain in place without taping. Wind off the outer portion of the wire on to another mandrel or spool; it will be necessary to pull it through the flange or if the latter is made in two parts and screwed together this trouble will be obviated. The wire being rewound, the second section of the coil is ready for winding, but be sure to wind this in the OPPOSITE DIRECTION from the first, otherwise the two sections will neutralize each other. Another method would be to wind the two sections, separately and opposite, then solder the inner ends together, but while this might be practicable with the No. 17 wire, the secondary wire is much heavier and might cause difficulty in making a smooth joint; the joint would also have to be specially insulated.

The two sections being wound, bind them temporarily with the friction tape and slip off the mandrel; the coil will then look like Fig. 6. Solder flexible leads to the coil and as it is convenient to have both leads leave the coil in the same direction, solder one reversed as shown. Insulate the joints and then soak the whole coil in shellac and bake in an oven. When dry and hard wrap the coil in cambric or insulating tape (Do not use black friction tape) beginning the wrapping under the leads and working away from them around the coil and back over them. Secure the tape with a few stitches and give the tape several coats of shellac. Mark the corresponding end of each coil so that they may be properly connected in series or parallel.

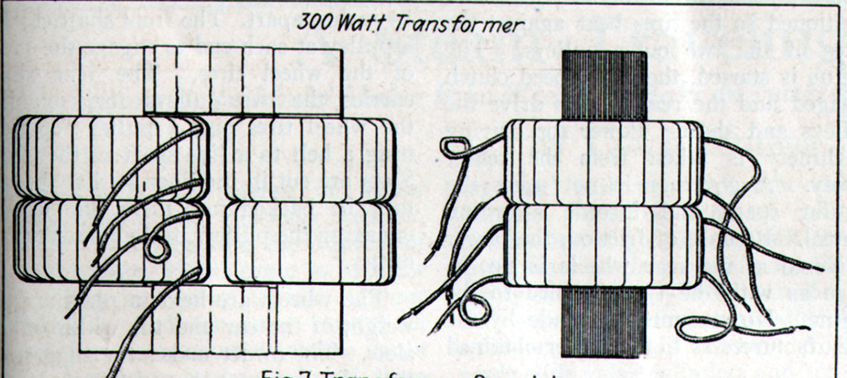


Fig. 7 Transformer Complete (Except for Connection Panel)

Winding Secondary Coils

The secondary coils are wound in the same way but they will be harder to wind as the wire, No. 12 dcc is rather stiff. Each coil will contain 136 turns in two sections, 68 turns, or about 60 feet, to the section. As the leads should always be carried to some kind of connection panel and as flexible secondary leads would have to be rather heavy, it would be best to carry out the No. 12 wire itself to the panel; the No. 17 wire, being smaller, would be in danger of being broken.

If the builder desired a different secondary voltage, the number of turns could be varied in accordance with the proportion

Primary EMF: Secondary EMF= No. turns in primary: No. turns in secondary.

After all the coils are thoroughly baked dry, they are slipped over the legs of the core; if a coil should stick, taper off the end of the wooden winding mandrel and drive it into the coil to open it slightly. The two primary coils are on one leg and the secondary on the other; this arrangement is best for the purpose the transformer is to be used for, as there will be a certain amount of magnetic leakage when the secondary terminals are shorted, which will assist in cutting down fluctuations in the house circuit. To complete the core assembly, the remaining yoke pieces are pushed into place across the top of the core, the corners clamped, the yoke taped and the clamps released for good. Fig. 7 shows the transformer complete, but no connection panel or mounting is shown.

PRACTICAL MECHANICS FOR EVERYDAY MEN

Everyday ENGINEERING Magazine

IT TELLS YOU HOW TO MAKE AND DO THINGS

VOLUME V APRIL, 1918 NUMBER 1

A High Temperature Electric Furnace for the Laboratory

The First of a Series of Two Articles Describing a Complete Metallurgical and High Temperature Equipment Including the Design and Construction of a Special Low Tension Transformer

By Raymond Francis Yates

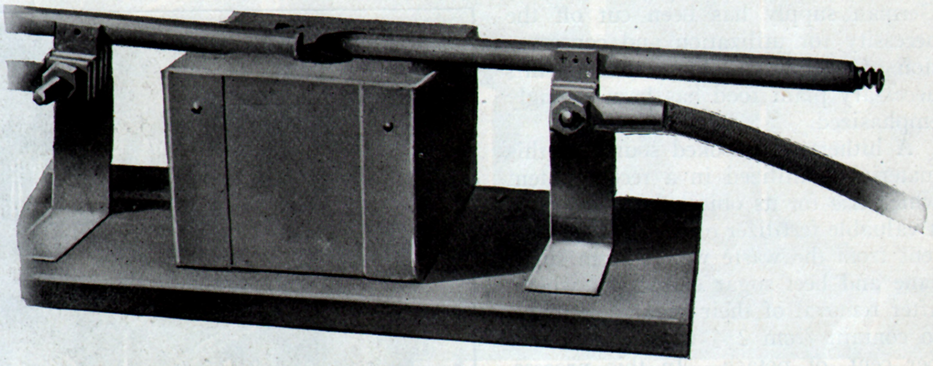
HIGH temperature research is one of the most romantic phases of scientific experimentation. The behavior of matter under great calorific influence is so erratic and uncertain that a person with very little technical knowledge may place certain substances within a furnace and cause either a chemical combination or dissociation that would create an entirely new compound. Wilson was trying to reduce the oxide of calcium when he accidentally discovered calcium carbide, and Acheson was endeavoring to impregnate clay with carbon when he discovered carborundum or silicon carbide. It is the element of uncertainty that makes high temperature research romantic; brute materials are robbed of their natural destiny when placed within the flowing radiance of the electric furnace and changes are produced that would make the genii of Aladdin's lamp turn green with envy.

Few experimental engineers have their laboratories equipped with electric furnaces for metallurgical or high-temperature research, and it is the purpose of these articles to describe the construction of a simple but effective equipment that will enable the builder seriously to enter into the interesting realm of experimentation at ultra-temperatures.

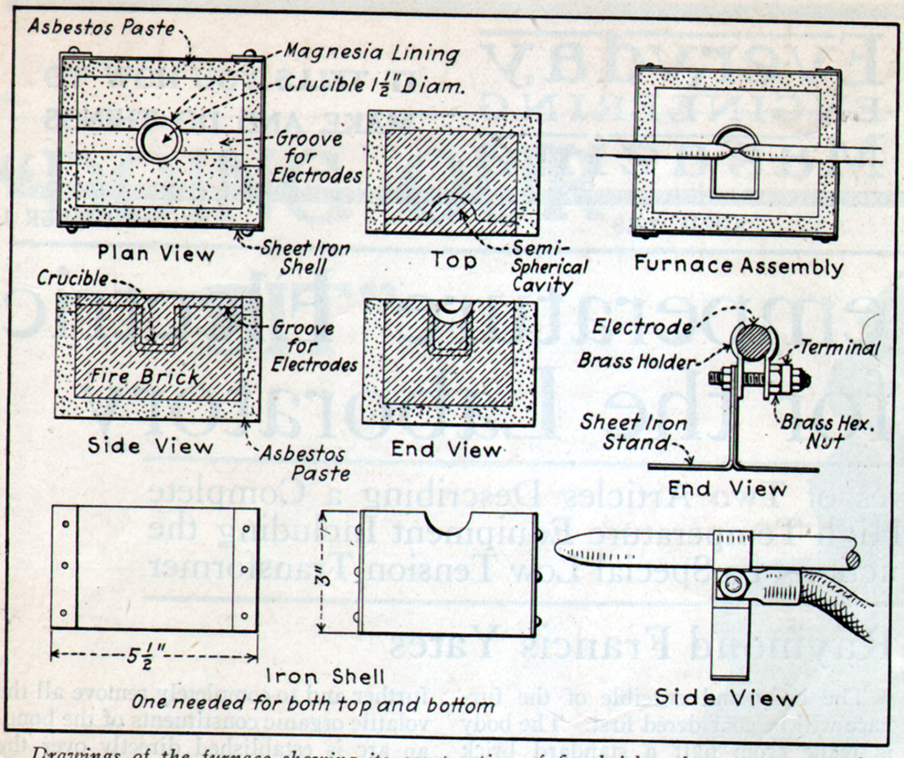
Electric furnaces for the laboratory may be one of two types—resistance or arc. Owing to the great amount of current necessary to produce a high temperature in a furnace employing a resistor, the arc type is not only preferred, but it is more adaptable to the needs and limitations of the home laboratory. The furnace described in the following lines is capable of attaining extremely high temperatures and its limit in this respect will depend only upon the current available.

The body and crucible of the furnace will be considered first. The body is made from half a standard brick of some good heat-insulating material of considerable refractory endurance. There are several good brands of refractory bricks on the market, such as Sil-O-Cel, Nonpareil, Osceola, etc. A hole 1½ in. deep is chiseled in the center of the brick. A groove is then cut through the center of the brick to accommodate the electrodes, as shown in the drawing and photograph. As the electrodes are ½ in. in diameter, this groove should be just a trifle larger than ½ in. The cavity in the center of the brick is lined with magnesia which may be obtained at any drug store. Being in the powdered form, it is necessary to mix it with some bonding material. While it may appear peculiar to the builder, either molasses or common syrup is used as the bond. The magnesia is mixed into a thick, consistent paste and applied to the walls and bottom of the cavity or crucible of the furnace. The whole brick is then placed in a hot oven and allowed to remain until the magnesia lining becomes baked. To carry this baking further and to completely remove all the volatile organic constituents of the bond, an arc is established directly over the cavity to thoroughly heat the magnesia. Silicate of soda may also be used successfully as a bonding substance.

An outer casing of stove-pipe iron is now made for the furnace. This is made ½ in. larger than the refractory brick so that the brick can be placed in the casing and the intervening space between the two filled with some good heat-insulating material. Heat insulation is a prime factor in designing laboratory furnaces. The heat produced in a furnace escapes very readily, and if high temperatures are to be produced the furnace must be properly insulated. The thermal resistivity of contacting surfaces is very high, therefore a small furnace should have several different layers of refractory or heat-insulating substances in its body. The great thermal resistance of contacting surfaces is the reason it takes an onion so long to boil. The heat-insulating substance used between the shell or casing and the brick of the furnace need not have a high refractory power. Ordinary asbestos paste will do very nicely. If



The lower half of the furnace showing crucible and electrodes. The arc is adjusted by pushing the electrodes into the furnace



Drawings of the furnace showing its construction of fire brick, asbestos cement, and sheet iron. The electrode holder shown is very simple but quite satisfactory for the furnace illustrated

the little furnace is not provided with an outer covering of a heat-insulating substance, it will operate at a very low point of efficiency, as the surface radiation will account for a dissipation of heat as fast as it can be produced beyond a certain temperature of the arc.

A cover of high refractory power is now made. The builder should take great care in making this cover. It should fit as accurately as possible in order to prevent dissipation of heat from the crucible. The other half of the brick used in making the body of the furnace may be employed for the cover. A cavity and two grooves are cut in the brick as shown. The cavity is lined with magnesia and made in a semi-spherical form so that the heat of the arc will he reflected from the surface of the cavity downward into the crucible. Heat waves are reflected just as the shorter ether waves of light. The whole cover is then placed in the stovepipe iron shell with asbestos paste just as the body was.

The electrode holders are made rugged and heavy, but of simple design. These are plainly shown in the drawing. If the builder alters this electrode holder design, he is cautioned to provide means of establishing a firm, low resistance contact between the electrodes and the feed cable. With a low pressure and high current strength, a poor contact will heat badly and cause a lowering of working efficiency. The electrodes should be of carbon ½ in. in diameter. They are adjusted by pushing them in or out of the furnace. The advantages of an electrode adjusting device do not justify the trouble of its construction. The electrodes and terminals rest on the sheet iron standard as shown. The furnace sits on a slab of ½ in. slate.

A New Way to Save Potash

One of the most vital chemical problems with which the United States has been confronted since the outbreak of the war has been the production of fertilizers, and since the German supply has been cut off the necessity for utilization and conservation of every available source of this necessary plant food has been strongly emphasized.

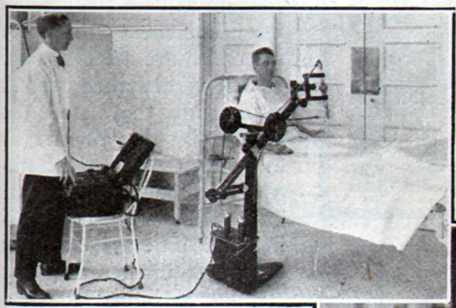
A hitherto overlooked source of this material is utilized in a recent patent which has for its object the recovery of a valuable fertilizer of high potash content from the waste waters from sugar cane and beet sugar extraction, which, after removal of their sugar, are found to contain from 2½ to upwards of 6 per cent. of potash. In this process, the waste extraction waters are concentrated by passing them in a shower through a sheet of burning oil. This alkaline product is acidified with sulphuric acid, to secure the fertilizing materials in the favorable form of sulphates, and calcium superphosphate and 10 per cent. of sawdust are added, resulting in an admirable fertilizing material whose value may be further enhanced by the introduction of nitrogen-bearing organic matter at this point. Finally, the mixture is submitted to a drying process, being burned in special furnaces, and the ash thus secured is marketed as raw potash fertilizer. The inventor is here shown in his laboratory at work on the process, which is one of the most interesting of the many which have been developed to reclaim the potash-value of by-products of existent industries.

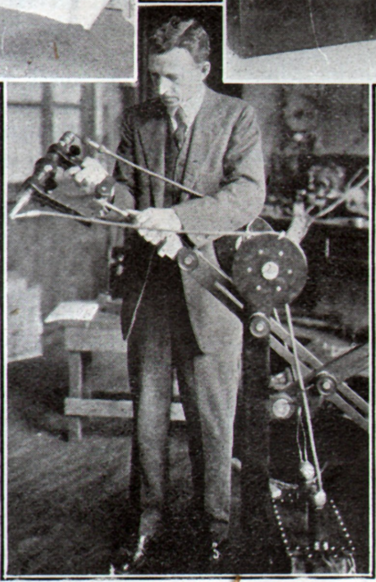
©Newman Traveltalks and Brown & Dawson, N. Y.

The inventor of the new potash recovery process at work in his research laboratory

A New X-Ray Outfit

FOR many years the X-ray has been the invaluable ally of surgery and medicine, but until recently it has been necessary always to transport the patient to the X-ray laboratory. Those sufferers whose condition forbade this, were, through no fault or desire of their own, deprived of the X-ray's benefits with the result that medical skill has been handicapped in diagnosing conditions which otherwise might not have been recognized. Dr. W. D. Coolidge and his associates in the Research Laboratory of the General Electric Company at Schenectady have recently perfected a portable X-ray outfit which meets this need. The U. S. Army Portable Outfit, which they devised, rendered service of a high order in the European war and the new and more compacted outfit is the peace outgrowth of the army set.





Dr. Coolidge, inventor of the new X-Ray outfit

It is now possible for any doctor to transport the entire new outfit, packed in four hand-borne units, to any home wired for electricity and produce radiographic results as good as those secured in a completely equipped X-ray laboratory. The process of operating the machine is simplified for him by control systems enabling him to use the exact ray intensity he needs and a time switch that accurately controls the length of each exposure. With these adjusted, the doctor merely presses a button and the machine does the rest. Plates can thus be produced which show remarkable uniformity. An ordinary incandescent light circuit supplies all the necessary current.

The portable Coolidge X-ray outfit is made also for hospital use, so that it can be taken to the bedside of patients who cannot be conveniently moved to the X-ray laboratory. The results produced with this outfit are comparable with those of any ordinary X-ray machine except its power is too low for instantaneous gastro-intestinal radiography which requires greater speed and power.

The portable Coolidge set has been greatly compacted and simplified over the army type familiar to medical corps men. The bulb itself has been reduced in size to 2½ inches. By making the tube of thick lead glass thus replacing a heavy shield, the total weight of the tube and its protection was reduced five pounds with a consequent lightening of the frame which supports it. This lead glass made from a formula developed in the Schenectady laboratory contains about 57 per cent metallic lead and in its resistance to X-rays, is equal in protective power to lead one-sixteenth of an inch thick.

The new tube rectifies its own current, thus doing away with a heavy, bulky rectifier and adding to the efficiency of the set as a whole. The transformer has been reduced in size by the use of smaller windings and a case shaped to fit the coils. A minimum of weight and bulk is secured in all other parts of the outfit by a careful choice of materials and a study of sizes and shapes. Thus when the outfit is ready to be taken out for use, the doctor carries an ordinary size suit case, containing the tube, reels, cables, base of the stand and other small parts, the transformer borne by a special carrying cover, the tube stand in a cloth container resembling a golf bag and a small instrument and control box. The whole load is such as can be put easily into the tonneau of a small automobile and as easily carried in or out of a house. The transformer, which is the heaviest unit of the four, weighs 43 pounds with its case. It is oil insulated and delivers to the tube 10 milliamperes at 60,000 volts.

DETACHABLE BROOM MADE POSSIBLE BY LOW COST OF OXWELD MANUFACTURE

THIS is the day of H. C. L. plus—but it is also the day of new and crafty ways of sidestepping the onslaughts of the ugly ogre. The latest device to enlist on the side of the people is the detachable broom handle.

At first thought the broom handle seems inconsequential. Isolated and individually it is. Multiply it by some fifty millions or more, which probably approximates the number of brooms sold yearly in the United States, and you have something quite different.

The detachable broom handle is a brand new idea and it is "taking". At the present time there is a factory in Vermont devoted exclusively to manufacturing brooms with this type of handle. The handle is of wood fitted into an oxwelded metal holder that clamps easily onto the brush of the broom. The metal part is light but very strong, being securely welded by the oxy-acetylene process, which not only makes it rigid but allows the entire piece to be neatly finished.

This is but one of a long list of interesting new departures from man's habitual thriftlessness that have sprung out of the need for widespread economies to combat living costs. In fact, the oxy-acetylene process itself is perhaps the most far-reaching of all modern economies in the metal working industries. Owing to the superior quality of welds made by this process, its remarkable speed and almost unbelievable economy, it is now almost universally applied in manufacture, construction and repair work. All that is required for a complete portable outfit is an Oxweld blowpipe for welding, a cutting torch, a cylinder of Linde oxygen and a tank of Prest-O-Lite dissolved acetylene, with which practically everyone is familiar.

HOW TO FILL HOLES IN FURNITURE

A CEMENT for stopping holes in mahogany and other furniture or woodwork may be made by melting together five parts of shellac with one of Indian red and enough yellow ochre to give the correct color.

Or beeswax may be used, in the proportion of one part to Indian red to four of wax. When properly mixed and applied this filler after drying cannot be distinguished from the wood itself.

It is also good for other woods of a dark color, as oak and cherry. The proportions may be varied to suit the shade of the woods and all cracks and holes which are not too prominent may be well hidden.—JOHN UPTON.

Curing Soldiers' Ills with Electricity

By PAULINE BERGINS

ELECTRICITY is playing no mean rôle in the vast reconstruction work now being carried on in the great Red Cross as well as Army and Navy hospitals thruout the country. Not only has the electric current been cleverly employed in many diversified ways to treat the many ills and maladies with which the soldiers and sailors have been afflicted in this country, but thousands of these appliances have been and are being used every day in the field hospitals in France, and in other lands which were not many months ago raging battlefields. Portable yet powerful X-ray ambulances sped over the battlefields but a few miles behind the front line trenches, ever ready to loan a helping hand in the merciful work of the medical corps. And not only do we find in these shell-torn regions the invaluable X-ray machines, but many other appliances such as electric heating devices for the treatment of "trench feet", electric sterilizers and cauterizers, Faradic outfits for the treatment of lameness and rheumatism, electric light baths, etc.

The accompanying photographs show several very interesting and practical applications of the electric current for the treatment of war ills. The photograph, Fig. 1, showing an American soldier seated in the large reclining chair, was taken at Fort MacPherson, Ga. This curious and complicated looking electric outfit comprises one of the most wonderful electro-medical devices ever invented—the "Bergonié" Electric Chair. The Bergonié invention involves the application of low voltage electric currents of peculiar wave form to the patient's body while seated in the chair here shown, the body being weighted with a number of sand bags. The switch-board in the background contains a number of regulating rheostats and motor-driven interrupters as well as measuring instruments, such as a voltmeter and milliampere meter for indicating the strength of the current applied to the patient. The Bergonié chair treatment produces rythmic pulsations in the nerves and muscles and has been found very efficacious for shell-shock victims as well as for treating severe nervous cases caused by excessive fatigue, and for over-strained muscles and cords.

There are more shell-shock victims from this great World War than there have been in any other. And therefore, the fact that the Bergonié electric chair will help to alleviate and cure these cases, is indeed a great blessing.

It might be said that the majority of shell-shock victims lose a part or all of their mental faculties, and to all appearances cannot use their reason at all. They have all sorts of delusions as to whom their folks are, or where their home is. Practically everyone has heard of, or has been in contact with, one or more cases of shell-shock, and so it is not necessary to expatiate further on this important phase of the problem of reconstruction, except to say that the various hospitals and sanitariums engaged in this work are doing wonders over night, literally as well as metaphorically, for some of these cases of shell-shock are cured suddenly and instantly by the most peculiar incident or happening. In a large French hospital just prior to the signing of the armistice there

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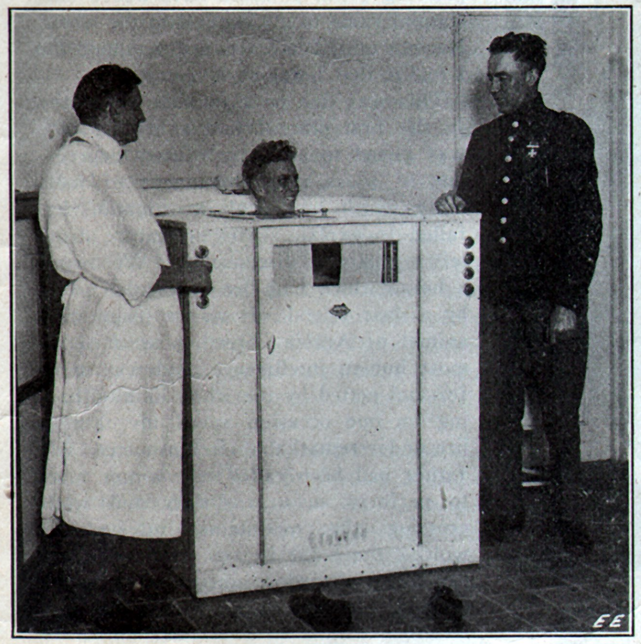

Three Interesting Views Showing Electricity's Role In the Reconstruction Work of the Army Hospitals. Above: Fig. 2, Soldier Patient Receiving Electric Arm Bath Treatment For Rheumatism, at the American Red Cross War Hospital at Paignton, Devon, France. Fig. 1, Below, Shows American Soldier Being Treated in the Bergonié Electric Chair, Extensively Used for Shell Shock Treatment, at Fort MacPherson, Ga. Fig. 3, at Left, Illustrates the Electric Light Bath Cabinet in Use. A Wounded Marine Is Enjoying the Glowing Warmth Produced By This Electrotherapeutic Apparatus For Treating Sore and Stiffened Muscles.

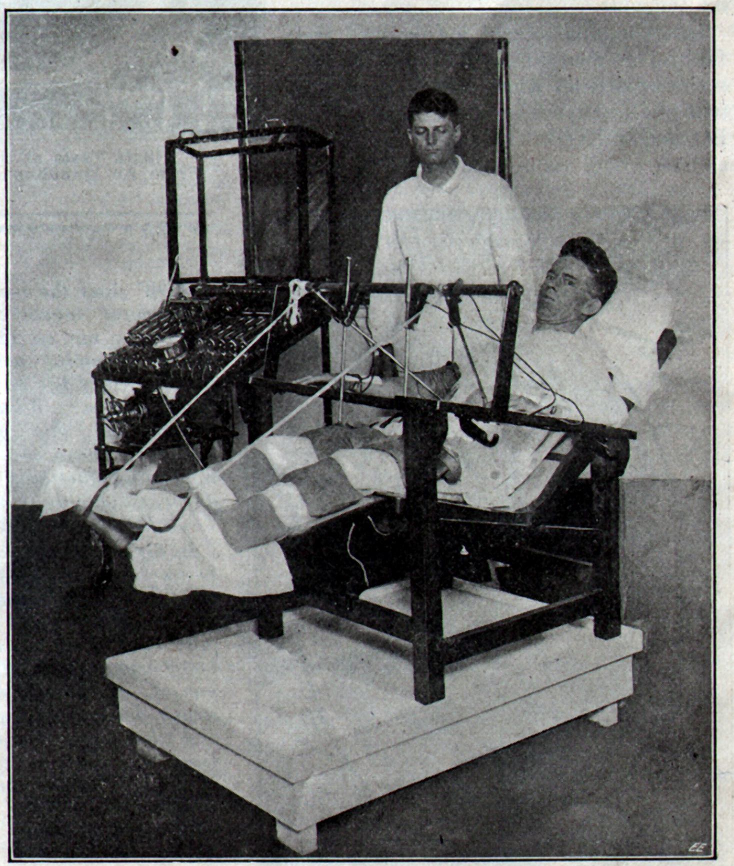

Photo © by Underwood & Underwood

CURING SOLDIERS' ILLS WITH ELECTRICITY.

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were 3,000 shell-shock victims; the day the armistice was signed 2,000 of them recovered, showing what a peculiar and baffling mental ailment this is.

The photograph, Fig. 2, was taken at the American Red Cross War Hospital, located at Paignton, Devon, France, which is one of the finest and best equipt in the Red Cross service. This hospital has a staff of 150 nurses under the direction of Army medical officers. The photograph shows a soldier undergoing an electric bath treatment for rheumatism. This treatment is given in the massage room at the hospital, where multifarious other electrical machines and appliances are to be found, including electrical massage vibrators, electric heating pads, etc.

In some of the larger base hospitals, very elaborate electrical equipment has been made available. In some of the American Army hospitals in the United States, where the returning wounded are being carefully attended to, so as to make them as well and strong as they were when they went overseas to fight the Boche, there are some of the very latest instruments and apparata about which little is known outside of the medical profession. This equipment includes among other things the *Electro-cardiograph*, which comprises an extremely sensitive electrical galvanometer, capable of recording the beats of the heart on a photographic film, so that the exact condition of the heart with regard to its manner of beating and its strength, can be minutely and accurately studied by the physicians.

At one of the large New York debarkation hospitals everything is done by electricity—even to the cooking. This hospital has one of the largest X-ray laboratories in the world, each of the 26 X-ray rooms being equipt with a special dark room for rapidly developing and finishing the X-ray plates. The X-ray in itself has undoubtedly saved thousands of lives in the great conflict, in many cases when the victims of bullet and shell wounds would certainly have died, had it not been for this wonderful scientific machine. Owing to the terrific fragmentation (splintering) of the shell now used, which often causes small steel splinters to penetrate parts of the body where they would never be suspected, and which, if they were not quickly discovered by the X-ray, would be quite liable to affect the heart, lungs or blood vessels at some unexpected time and cost the victim his life. For this reason the returning wounded are most minutely examined and X-rayed, especially in the abdomen and chest regions, where many of these shell splinters, and even bullets, are fond of lodging and camouflaging themselves for long periods, only to cause trouble at some later date, with possibly fatal results.

THE UNKNOWN PURPLE.

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last act, in which scene the hero is visible to the eye in flesh and blood but slowly and gradually fades away into nothing, leaving only the purple glow. This was quite impressive and, of course, was done by the usual magician's mirror effect, whereby the hero was not on the stage at all, but below it, thus casting his reflection on a fine screen on the stage; then by manipulating the lights in a certain manner the picture would dissolve into emptiness.

Altogether the stage technique is very cleverly arranged with an absurdly simple effect which in a similar attempt would be very elaborate. Outside of that the plot and theme of the play is quite out of the ordinary and is deserving of mention.

To show just how different this play is from others, reference must be made to a note in the program over which audiences puzzle themselves until the play itself makes the meaning clear. To wit: "The first epi-