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POPULAR ELECTRICITY MAGAZINE

IN PLAIN ENGLISH

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See Page 671

Vol. III DECEMBER, 1910 No. 8

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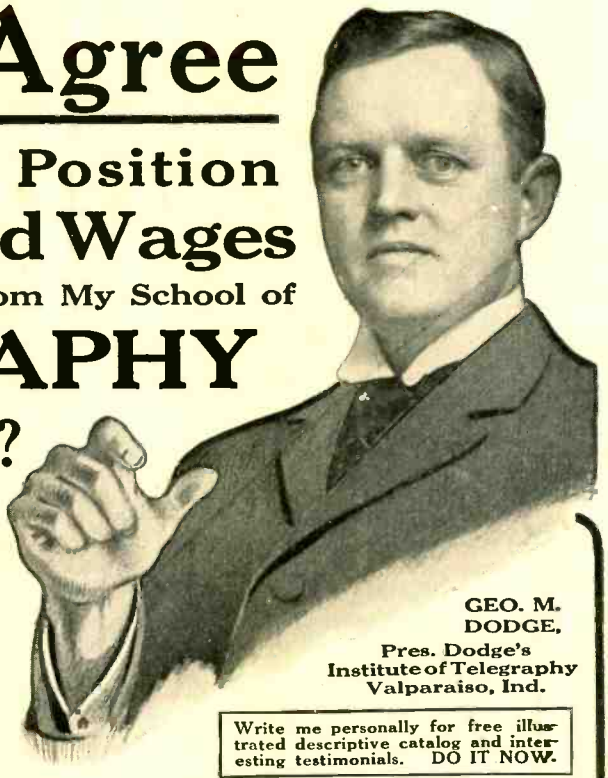

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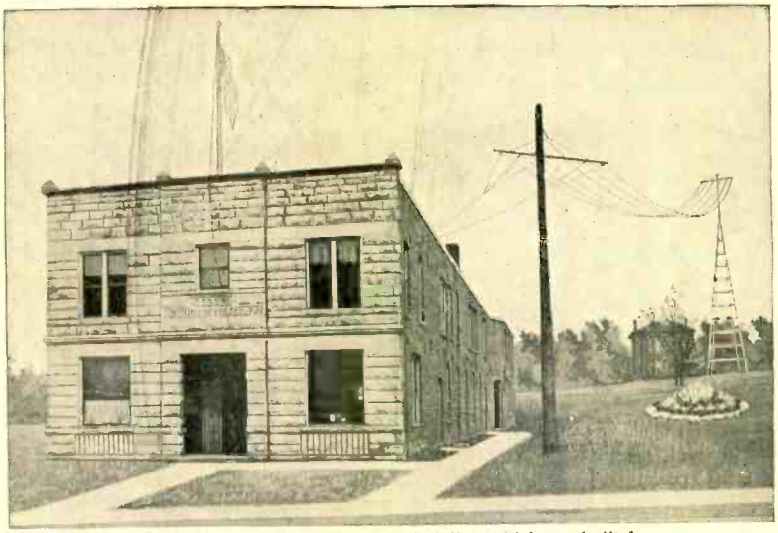

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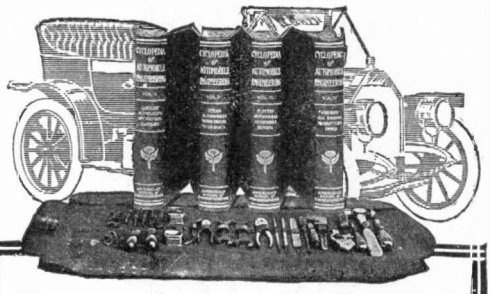

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Electrical Talks—Flash No. 6

IT is the man with the cash jingling in his pockets who eventually buys your product. To try to reach him you may advertise to sales agents and jobbers, through your trade papers; you may distribute heavily to these sales agents and jobbers and say to them: "Go seek the man;" the jobbers and sales agents distribute in turn to the dealers and say likewise: "Go you out and seek the man."

All this is very good and very essential, but where is the man? You haven't begun to find "all of him." Neither can your jobber or your retailer find "all of him," not without the aid of the last and most essential of all the aids that you can command—the class publication.

To illustrate the point, every day we get letters with queries like these:

"Will you kindly address the enclosed card to the maker or dealer in the Vohr Ozonizer referred to on page 235 of Popular Electricity?" "I notice in your October issue reference to a fireless cook stove called the 'Comet.' I would appreciate it if you would send me the address of the manufacturer;" "Please send me the name and address of the manufacturer of the electric washer and wringer described on page 435;" "I am a regular reader of Popular Electricity. I would like to know who are the parties that make the Automatic Electric Air Pump described in the March issue."

Now where were the trade papers, the jobber and the retailer? On their respective jobs, every one of them and doing good work. But the job of telling the American public about things is too big for all three of them combined.

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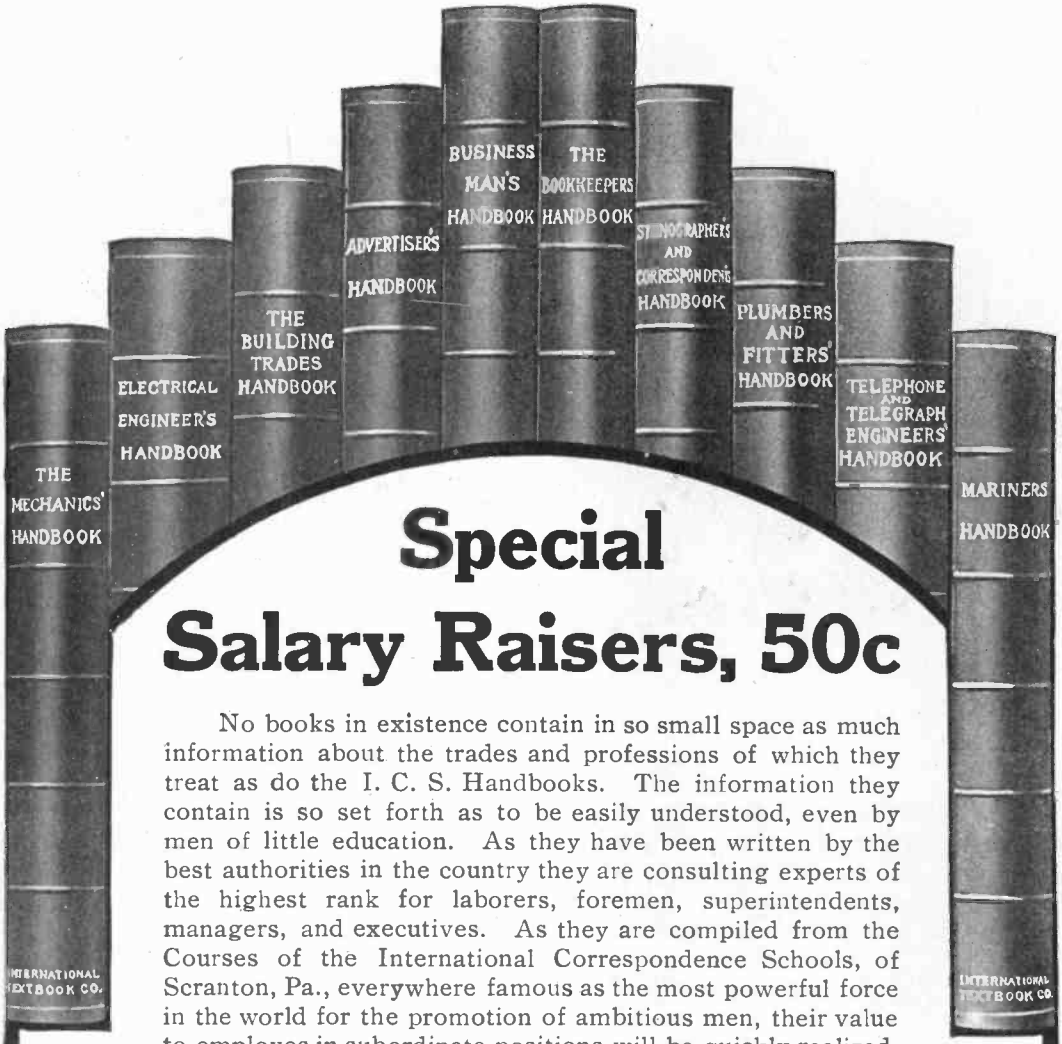

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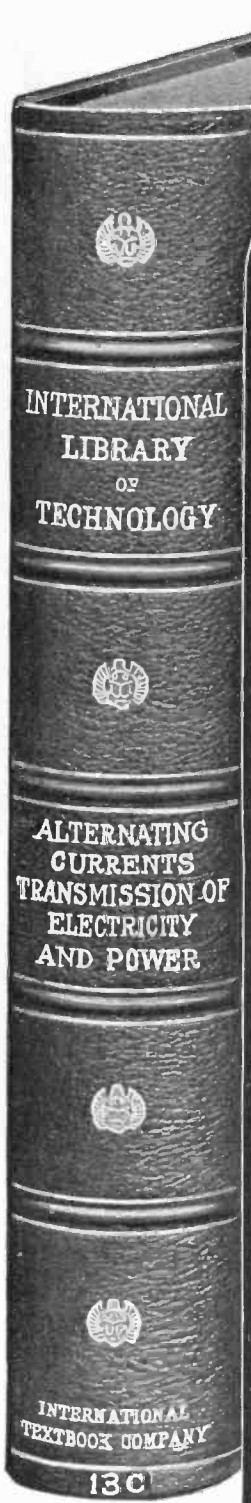

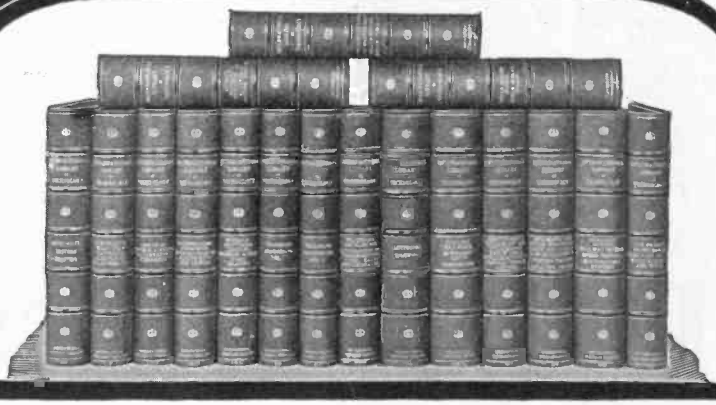

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POPULAR ELECTRICITY
IN PLAIN ENGLISH

HENRY WALTER YOUNG, Editor.

Vol. III — December, 1910 — No. 8

CONTENTS

ISSUED MONTHLY BY POPULAR ELECTRICITY PUBLISHING CO., Commercial Bldg., Chicago, Ill.
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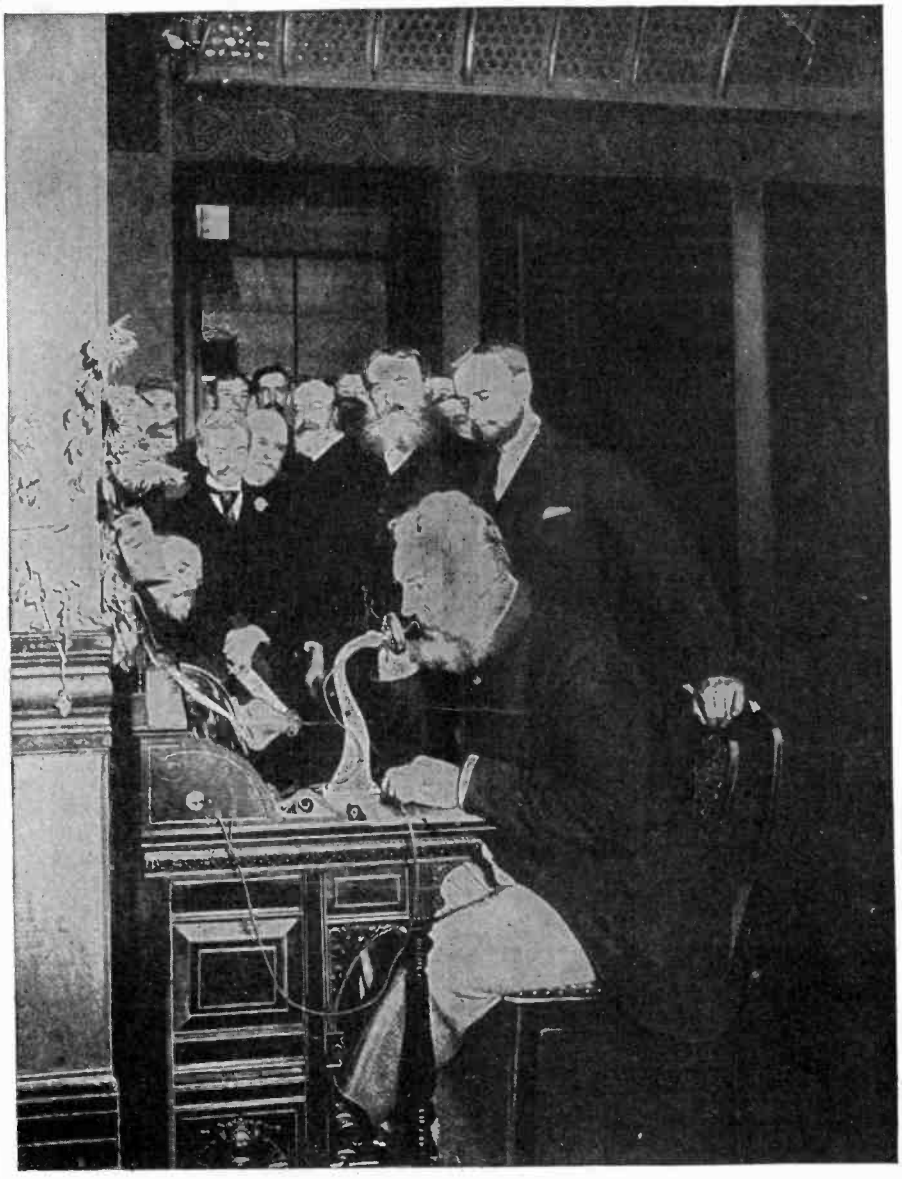


THE FIRST THOUSAND-MILE TALK

The above illustration is from a photograph of Alexander Graham Bell, famous inventor of the telephone, taken when he was officially opening the first long-distance telephone line between New York and Chicago, October 18, 1892. This event furnished conclusive proof of the practicability of the most comprehensive plans of Theodore N. Vail, now head of the American Telephone and Telegraph Company. For nine years Mr. Vail had worked to make his dream come true. That dream was to bring every city, town and village in speaking distance of every other city, town and village in the country. The first thousand-mile talk proved that the dream could be realized.

Popular Electricity
In Plain English

VOL. III DECEMBER 1910 No. 8

Some Account of the First Edison Central Station at Menlo Park, N. J., 1880-1881

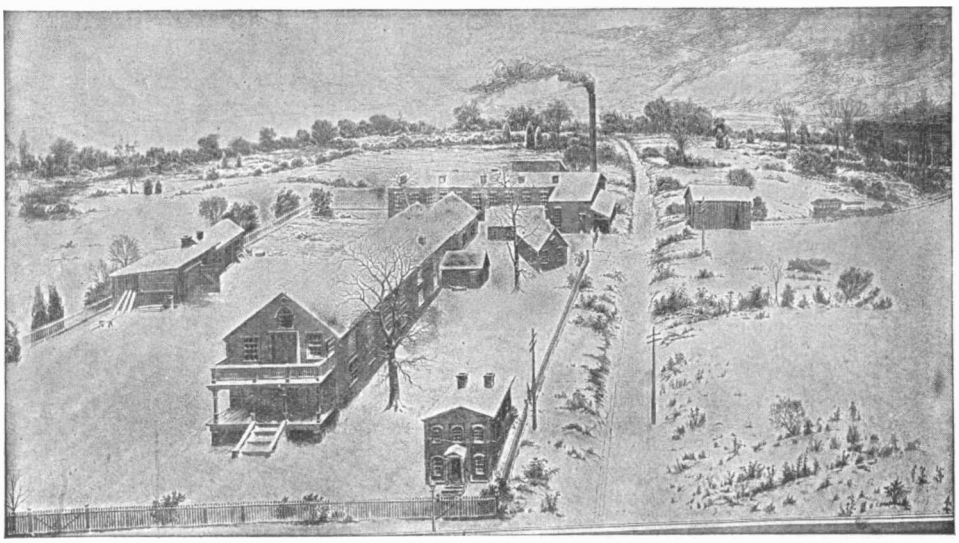
By W. S. ANDREWS

The statements in Mr. Andrews' article are correct.

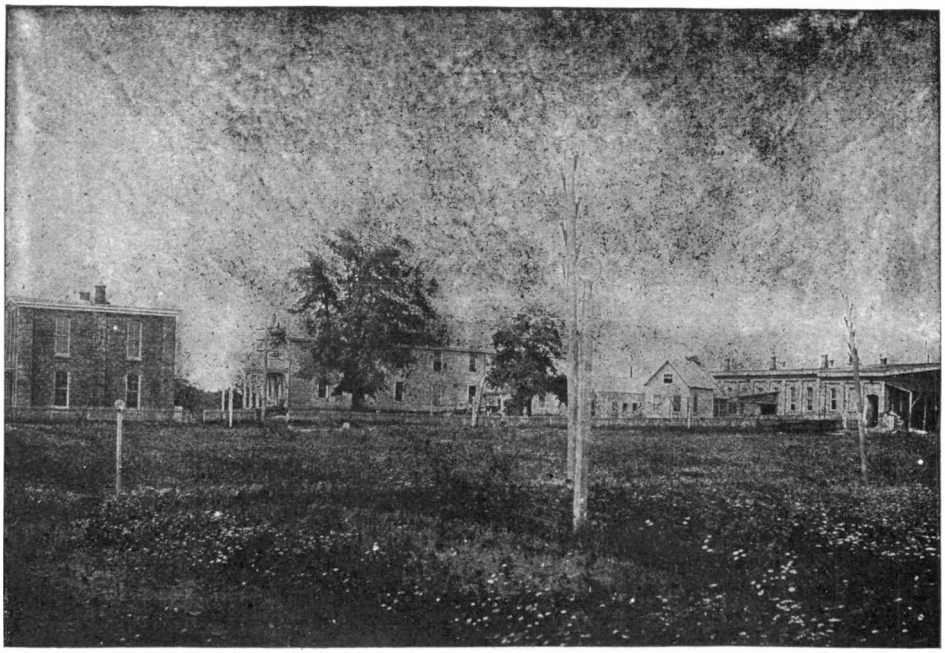
Thomas A Edison

FOREWORD

Thirty-one years ago, in the fall of 1879, the writer was living in the city of Newark, N J., and he read in a local paper one morning that Mr. Thomas A. Edison had sent a messenger from his Laboratory in Menlo Park, N. J., to Clark's Thread Works (Newark) for a pound of their best white cotton, from some of which he had made a *wonderful electric lamp.* This statement impressed the writer so strongly that he determined to seek employment at the Edi-



MENLO PARK IN WINTER, SHOWING THE EDISON FACTORY IN 1880-81, THE BIRTHPLACE OF THE ELECTRIC INCANDESCENT LAMP



MENLO PARK IN SUMMER

son Works forthwith and learn something about this extraordinary invention. Fortune was favorable to his wishes and he is thus enabled to write the following account from his own personal notes and recollections, supplemented by much interesting information contributed by Mr. Chas. L. Clarke, Mr. Wilson S. Howell and others who were privileged to assist Mr. Edison in his wonderful electrical work at that time, to all of whom the writer extends his cordial thanks for their kind assistance.

In the year 1879 the Edison Works at Menlo Park, N. J., consisted of an office building, a well equipped two-story laboratory, power house, machine shop and numerous small buildings devoted to various branches of specialized work.

Mr. Edison with his assistants and employees were working literally day and night on the development of a system of electric lighting by incandescent lamps, including dynamos, with their accessories, all kinds of fittings and safety devices to be used in the distribution of current, meters for measuring it, and finally the lamps that were to prove the culminating triumph of his persistent endeavor and brilliant electrical genius.

The field ahead was virgin soil, in which little or no pioneer work had been done. Having no authorities to consult and no precedents to guide, many mistakes were naturally made, and all had to learn by experience which was sometimes expensive.

The first job given to the writer, was to assist in building a bipolar, direct current, shunt wound dynamo, which had been designed to run 60 sixteen candle-power lamps at about 100 volts. The field magnet of this dynamo was first wound with No. 10 cotton-covered copper wire. It naturally followed that the magnet coils absorbed all the current that the armature could produce. Then external resistance was connected in series with the field winding, but this scheme of course cut down the magnetism too much. The fact then became apparent that smaller wire should have been used in the first place, so the field was stripped and rewound. Better results pointed to the use of finer wire yet, so at last after several trials the best size of wire was determined by a purely "cut-and-try" process.

Various kinds of incandescent lamps were made with filaments of carbonized cardboard, wood and all sorts of vegetable fibres, etc. Mr. Edison aimed to make these lamps

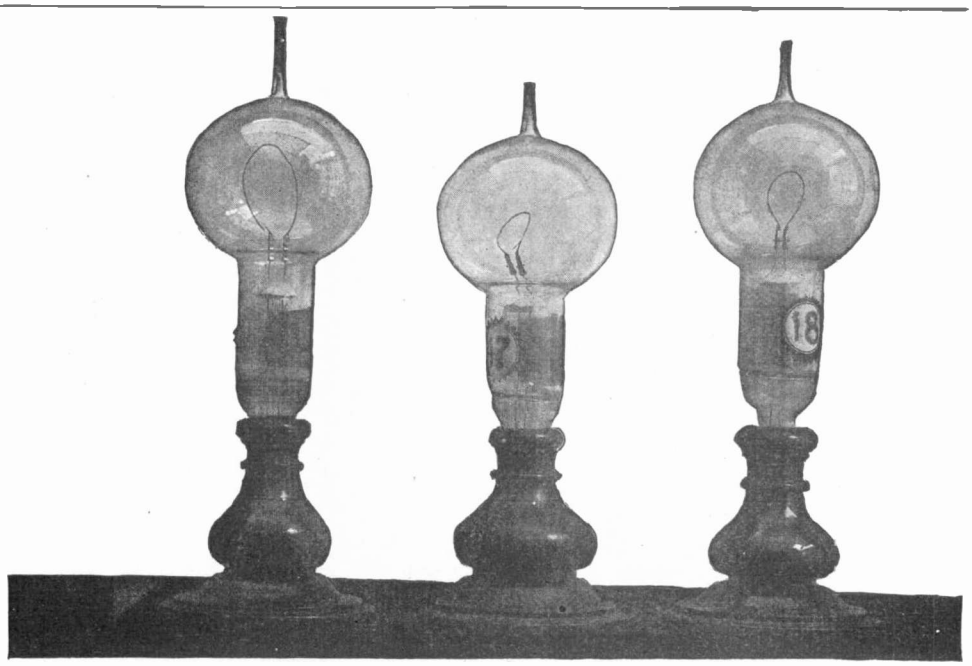
of about the same illuminating value as a gas burner that consumed five cubic feet of good illuminating gas per hour, the light being estimated at sixteen candle-power. It was soon observed that when the lamps burned with too brilliant and white a light, their life was short, and when their incandescence was weak and yellow it was of course unsatisfactory. Finally the experts began to make lamps so that they lasted pretty well and still gave light of fairly good quality and requisite intensity, and 110 volts was decided upon as a standard, for the reason that it was difficult to make any finer filaments that would be stable. One hundred and ten volts thus began to be recognized as the nominal standard for incandescent lamps, and after a time this standard became fixed and universal.

Notwithstanding many discouraging failures and mishaps, Mr. Edison felt from the very start so firmly assured of final success, that early in the year 1880 he began to make preparations for an elaborate public exhibition of his system, so that it became an actual necessity to carry on work simultaneously on all the different branches as before stated, including dynamo construction, lamps and fittings, underground conductors and fittings for same, and all the host of small paraphernalia that go to make up a complete system of electric lighting with incandescent lamps.

A system of underground conductors was laid out covering quite a large area of ground and extending in some directions more than half a mile from the power house Mr. Edison had not then considered the use of "feeders," "mains," and "services," which came into use later on, so these conductors were arranged on a plain two-wire "tree system," that is, they were started from the power house in the form of two big cables, each cable containing 25 No. 10 copper wires. Then where branches were required, the two cables were divided and subdivided until the end of the smallest branches consisted only of two No. 10 wires.

There was absolutely no previous experience to guide in the proper laying of these conductors, as this was the first installation of its kind. It was imagined, however, that the low pressure of 110 volts did not call for any expensive insulation against leakage, so ordinary cotton-covered copper wires painted with some compound of pitch were laid in shallow trenches in the earth protected only by *wooden moulding* and the usual covering board, similar to that now used for cheap interior wiring. The wires being laid

INTERIOR OF EDISON'S LABORATORY WHERE THE INCANDESCENT LAMP WAS DEVELOPED. FROM A PHOTOGRAPH TAKEN FEBRUARY 22, 1880



EDISON'S EARLY LAMPS WITH CARBONIZED PAPER FILAMENTS

in this moulding, were then covered with about six inches of earth, and the current was turned on. It was naturally discovered at once that the line was short circuited by excessive leakage between the conductors throughout their entire length.

An attempt was then made to insulate the line by opening the trenches, uncovering the wooden moulding and drenching the wires with boiling hot coal tar, but even after this treatment the insulation resistance was still found too low for practical service, and Mr. Edison's chemist discovered that the coal tar contained acid in sufficient quantity to destroy its insulating properties. Other experiments were then tried on short lengths of conductors but as they failed to show satisfactory results Mr. Edison confessed himself to be tired of haphazard trials, and he requested Mr. Wilson S. Howell to go into his library, read up the subject of insulation and insulation material, and make a report thereon with recommendations. When this report was finished Mr. Edison approved it and the various materials suggested for trial were purchased, together with a supply of pots and kettles, and Mr. Howell was installed in the chemical laboratory with instructions to produce a cheap and effective insulating material.

For some time thereafter Mr. Edison's chemist and his assistants were choked and distracted by the stenches and smoke of the various "cooking operations." The experiments were made on 100-foot lengths of No. 10 copper wire and when a promising mixture was produced, the wire was served with the compound held in place by muslin tape, and after being coiled up in a tank of water it was tested for insulation. The best of these insulating compounds was finally selected for use. It was composed of refined Trinidad asphaltum, mixed with oxidized linseed oil to give it the right consistency, and a little paraffin and beeswax were added to make the material smoother. Two or three tons of Trinidad asphaltum were bought, with a few barrels of linseed oil and litharge with which to oxidize the oil, several bales of cheap muslin, and some paraffin and beeswax.

Two 50-gallon iron kettles were mounted on brick work, and the compound mixed in these kettles. The muslin was torn in strips about two and one-half inches wide for the largest conductors, and passed through the compound while hot, and made into rolls to facilitate the winding of the conductors, this being always performed by hand.

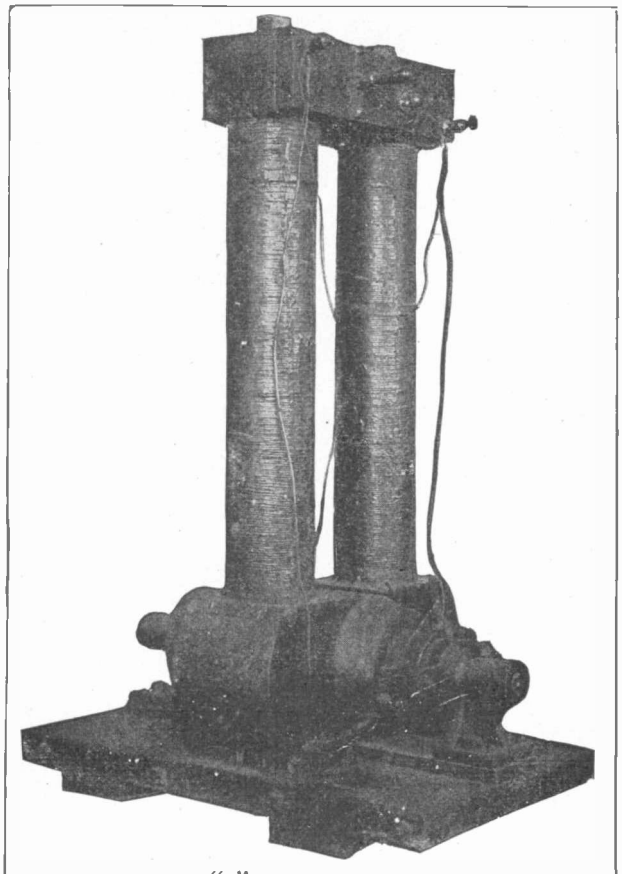
The wires were then taken up from the trenches and supported above the earth on short saw-horses. The method of winding was necessarily crude. A small boy straddled each cable, walking out towards the end of the conductor as he served the insulating tape carefully thereon. After he had proceeded ten feet or so from the home end of the conductor, a second boy was started out with a second roll of tape, and this one was again followed by a third boy; so that three servings of tape were put on each conductor, which was then laid back into the trenches, the wooden molding having been removed. Each line was then tested, and the insulation was found to be remarkably good.

The first line laid with this improved insulation ran from the dynamo room past Mr. Edison's house and along the tracks of the Pennsylvania Railroad Co., and it was finished just previous to election day in November, 1880. A row of incandescent lamps on wooden posts had been set up along the tracks, connections made and everything put in order for a trial run.

When informed that the line was ready for turning on the current, Mr. Edison's reply was characteristic:

"If Garfield is elected we will light up that circuit. Otherwise we will not light it."

Several of Mr. Edison's assistants gathered that evening with him in his laboratory to receive the returns. Mr. Edward H. Johnson was at the telegraph key which was in a loop run from the lines along the railroad tracks. Careful tally was kept of the returns, and when the result seemed certain, Mr. Edison gave orders to light up the circuit. Steam had been kept up and the dynamos were running, so the switch was closed and forthwith the long row of incandescent lamps by the railway tracks beamed forth brightly through the darkness of that night in November, 1880, when Garfield was declared elected—the first use of incandescent lamps to celebrate the election of a President of the United States!



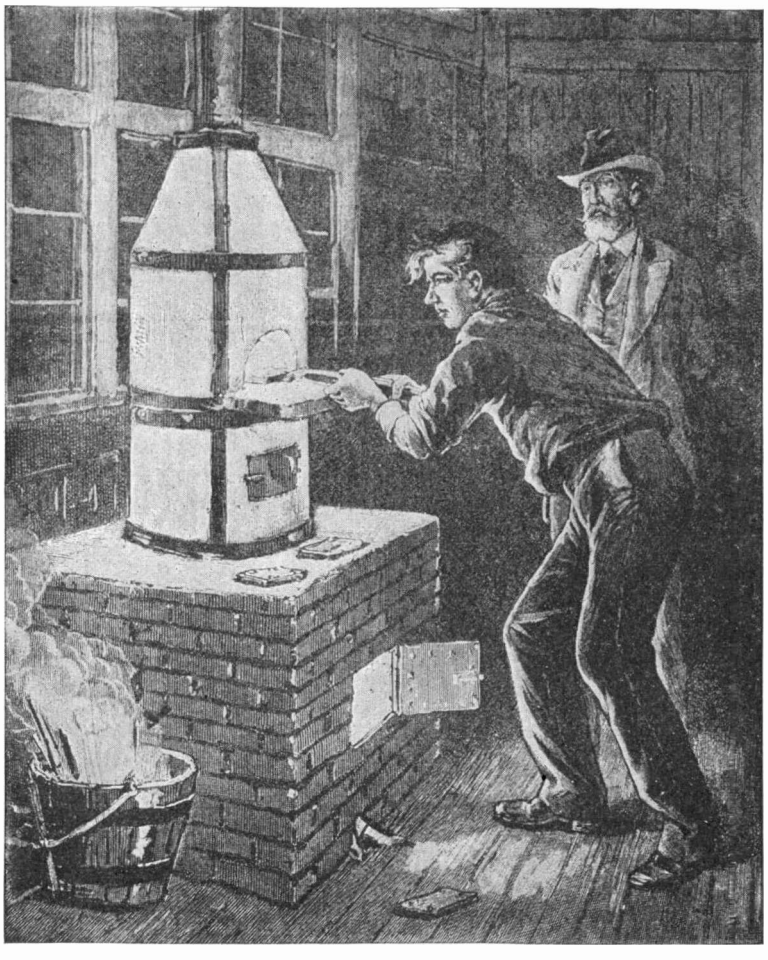
THE OLD TYPE "Z" DYNAMO—SEVERELY SIMPLE, BUILT FOR GOOD SERVICE

The problem of temporary insulation being thus solved, the system was rapidly pushed to completion, and rows of wooden lamp posts, topped with waterproof globes of clear glass containing the incandescent lamps, appeared along the streets and roads of the village. The illumination was also extended along the adjacent country roads and even into the neighboring woods, some of the lines running more than half a mile from the power station. The Edison Laboratory, machine shop and adjoining buildings were completely wired and fitted out with lamps, and also many of the surrounding dwellings.

In the meantime the number of dynamos was increased until the installation included ten of the before mentioned 60-light machines which were all belted to counter shafting driven by

an 80-horsepower Brown engine. The field magnets of these machines were separately excited by an independent dynamo.

The lamps used were of two sizes, classified as A and B. The A size was calculated to give sixteen candlepower, and the B size eight candlepower. The A lamps were made as nearly as possible for 110 volts, and the B lamps for 55 volts, so that the latter could be connected two in series across the line.



EDISON FIRING PAPER FILAMENTS. FROM AN OLD DRAWING SHOWING THE ARTIST'S CONCEPTION OF HOW THIS INTERESTING OPERATION WAS PERFORMED

It was naturally impossible to construct all the lamps of exactly the same voltage, so they were sorted out, and those of the highest voltage were used in the vicinity of the power station where the loss on the lines was the least, while the lamps of the lowest voltage were connected at the ends of the longest branch lines where the drop was greatest. In this way it became possible to operate all lamps at approximately normal voltage and thus obtain the best results. When about 500 lamps had been connected to the system, Mr. Chas. L. Clarke made his famous test to determine the efficiency of the Edison lamp, and prove the commercial possibilities of the new system as a competitor with gas lighting. Considering the novelty

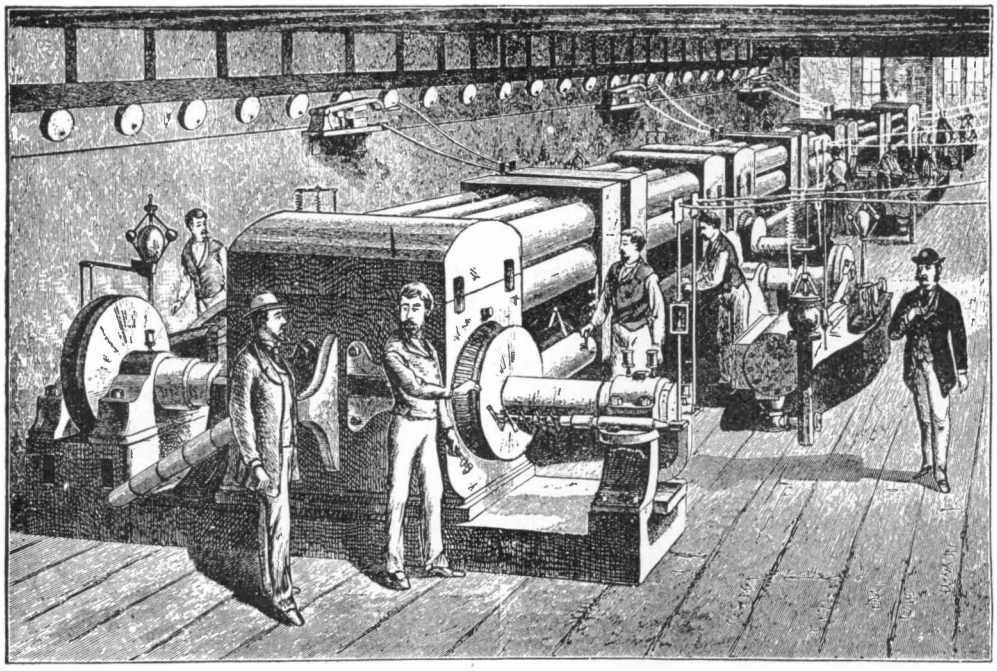
of the art it is not surprising that the efficiency of the lamps proved to be rather low (between seven and eight sixteen-candle-power lamps to the horsepower) but their durability was very remarkable as only three of the A lamps burnt out during this twelve-hour test, and none of the B lamps failed.

In the spring of 1881, when the installation was practically complete, Mr. Edison extended an open invitation to the public to visit Menlo Park and see his new system of lighting in actual operation. Many thousands of people responded and came from far and near to gaze at the glowing lamps, and many amusing stories could be told of questioners who wondered how these lamps could be lighted and extinguished, what kept them burning, and what sort of stuff they consumed, etc.

The following quotation from the *Scientific American* of June 18, 1881, indicates to some extent the appreciation with which this grand achievement was publicly received.

"Simply as an exhibition of perfect illumination under perfect control, covering a vast area, this array of lamps presents a most remarkable and delightful sight, and is alone worthy of a trip to Menlo Park. As a demonstration of the perfected working of a great and novel system of illumination, sure to become in a little while a potent contributor to the comfort and economy of city life, it is a spectacle which cannot fail to impress powerfully the mind of any observer."

The underground conductors still maintained their insulation and the dynamos and lamps continued to work well, but as Mr. Edison found it desirable to move his works to New York City, this first Central Station outfit was abandoned in the summer of 1881, the purpose of its installation having then been fully accomplished.



INTERIOR OF THE PEARL STREET STATION, NEW YORK CITY—ONE OF THE FIRST CENTRAL STATION LIGHTING PLANTS TO BE ESTABLISHED AFTER EDISON'S EXPERIMENTAL STATION AT MENLO PARK

Thirty years may seem to be rather a long retrospection, and yet how short a period it really is when we consider the magnificent and wide spread results that have developed in electric lighting during its flight.

The *first experimental* central station plant for lighting with incandescent lamps with a two-wire underground system of distribution was installed by Mr. Edison

at Menlo Park, N. J., and was started in November, 1880.

The *first commercial* central station was started to generate current for public service on the two-wire system on Holborn Viaduct, London, England, in January, 1882, and was closely followed in this country, first by a small plant in Appleton, Wis., and soon after by the famous Pearl Street Station of the Edison Electric Illuminating Co., of New York, which distributed current over a territory about one mile square.

The *first three-wire* Edison central station plant was started in Sunbury, Pa., on July 4, 1883. What do we now witness in 1910, only thirty years after the first practical incandescent lamp was made?

In every large city we find immense generating stations supplying current directly or through sub-stations to millions of incandescent lamps and other transformers of electrical energy and indeed there is hardly a village of any importance that is not blessed with electric light!

As to the amount of profitable financial investment and the countless thousands of individuals who are thereby privileged to earn comfortable livings in electrical pursuits the writer is unable to give any close statistics, rapid growth outstripping records. An authoritative statement has, however, been made that more than one billion dollars is now invested in this country in electric lighting plants whose pedigrees may be traced back to that first experimental central station that was started by Mr. Edison in Menlo Park, N. J., in 1880, and which marked in the history of the world the commencement of the Age of Dynamic Electricity.

FROM OUT THE LEYDEN JAR

All the telephone subscribers of the state of Texas can receive the weather reports free of charge by asking central.

* * *

In the canal zone it is the custom to keep electric lights burning inside pianos to prevent the wires rusting.

* * *

The city of Bangkok is the only place in Siam lighted by electricity.

* * *

Sixty per cent of the patents granted yearly in this country are worthless. Nearly ninety per cent of the electrical patents are practical.

* * *

After elaborate tests the Navy Department has installed electric ranges and electric bakers on the *Dixie*, and is considering electric cooking upon practically all the battleships and cruisers. The tests of these cooking devices were made at the Navy bakery school near Newport, R. I.

* * *

The Singer Building, New York, contains 3,425 miles of electric wire says a technical writer.

* * *

It is well to remember that many of the soldering fluids in common use are injurious to tools as well as to parts that may be laid on the bench where such fluids have been used.

* * *

Metallic radium has been isolated by Madame Curie in collaboration with Monsieur de Bierne. The metal is highly oxidizable, and from a clear white soon becomes black. It adheres firmly to iron, decomposes water, burns cellulose, and is rapidly dissipated. This pure element was obtained by electrolysis of the salt, by which means a miligramme of radium amalgam was secured, and on distilling off the mercury at a temperature of about 700° C., the pure metal was left behind.

* * *

The Marconi company has installed wireless telegraph outfits on eleven warships of the Turkish fleet, and in a land station at San Stefano.

* * *

Barges filled with stone and sand are now unloaded at the Gatun docks on the Panama Canal by the aid of search lights which cast light on the barges at the dock and over the storage piles. The searchlights are 18-inch standard Navy projectors, and are operated by a motor generator which converts current supplied at 600 volts from the power plant to current at 125 volts for the lamps.

The Telephone Operator as I Know Her

By H. N. FOSTER

The telephone operator has been inspected by the government and the report is filed. This report gives the height, the health, the age, the hours, conditions and wages, everything that expert sociological investigation can give.

But there are some things which must elude the inspector's eyes, however thorough he may be. The telephone operator is to him a well trained young woman, one of the many business girls of America, and she will take her place with the thousands of others in other lines of work when the report is published.

But there is a different picture in my mind. When I see the words "telephone operator," I do not see the sum total of the requisites of height and age, eyes and ears and education. These are but the skeleton of the person I know. She is all this, but she is so much more. She is not a business machine—merely an automatic servant of the public. To be sure, she has the poise which has come from discipline, she knows how to co-operate with others, she repeats her phrases correctly and conforms to rules, but she is far from being a machine. The summing up of these things does not make the picture of the telephone operator as I know her.

The telephone operator's work requires her undivided care and attention. She is one on whom rests the responsibility each day of assisting in handling a vital portion of the city's business. She is closely in touch with the pulse of the business world and the rise and fall of the traffic indicates to her the degree of its activity. Whether the traffic is high or low, the calls numerous or light in number, she realizes it is her part to meet the situation and continue to render service in an efficient and satisfactory manner. She cannot begin to estimate the importance of the individual calls which she continually handles, but must see that each is connected quickly and accurately; but when emergency calls are received such as fire and police alarms, and calls for ambulances, it is then she must think and act most quickly, often assisting the one who is calling, but who is too alarmed or frightened to do his part in summoning assistance.

Let me give a few sketches which help to make the composite picture which comes to me when I think of the telephone operator.

It is nearly five o'clock. The day force is beginning to realize that their day's work is nearly done, and the evening force is assembling in the operators' quarters preparatory to coming on duty. The busy hours of the day are about over and the heavier hours of evening work have not begun. The normal traffic is being handled easily and only a faint murmur of the operators' voices is heard in the operating room. As the force is getting ready to change, suddenly the boards are seen to be ablaze with signals. The operators, though surprised and wondering, immediately undertake to meet the unexpected rush in traffic, and make the connections as fast as called. The evening force comes into the room, but there is no thought, on the part of the day operators, of leaving their positions. There is no suggestion that they are tired from their day's work, or anxious to get home. They all realize the emergency which is back of the frantic calling, and day and evening forces together, often two to a position, one sitting, the other standing, turn to meet it without a murmur. It is no patient public, which they encounter. Wildly excited, begging imploring, crying, they are calling for numbers that are always

busy. The morgues, the hospitals, the newspapers, any one whom they hope can give them information—for it is the terrible theatre fire, and the telephone girls, many with tears streaming down their faces, are working hand in hand, with the desperate subscribers. They are no automatic machines mechanically serving the public. Every nerve is alive to the situation, and they are putting forth every effort to serve the people whom they cannot see, but with whom they sympathize and suffer. The overtime work goes unnoticed, and they work, relieving each other, until late in the evening, at times pulled away from the board almost fainting to be revived with nourishment, only to go back again to help with the connections.

I see an office, orderly and quiet. It is eleven in the evening and work is light. Suddenly there is a terrific noise, more sudden than thunder, shaking the very foundations of the boards where the girls are sitting. With it is heard the crash of falling glass and snapping timbers. A word of direction from the manager, and every girl's face is toward the board, and with fingers that tremble and voices that quaver, the brave telephone girls meet the sudden increase of calls. And day girls sleeping in their homes respond to the call to come again to the office. Not a complaint; for it is not a machine that responds because it has to; it is a thinking, responsive personality, meeting the emergency calmly and bravely, each girl giving herself to the work she has chosen.

STILL UNAFRAID THEY LEAVE WITH REGRET, WAITING TO PUT UP A LAST CONNECTION

Take another view that helps to make up the composite picture:

A generator is gone. It will be ready again at any moment. There at the boards sit the girls waiting, watching, alert. It is the busy time, but they are helpless. Thirty-five minutes they sit there, and it seems hours. The strain is more intense than when a full board calls for most active service. These are the ones who serve when kept from service, the hardest task sometimes.

Again, a gas main has broken. The insidious poison is penetrating an operating room. The girls are wondering why it is

so hard to work; why the numbers are so blurred; wonder why they seem to rock in their chairs, and then why they are opening their eyes in the rest room. They worked till the mind could act no longer; they fainted at the board.

In the dense smoke and under dripping ceilings I see girls who calmly serve their subscribers, who little dream that "Number, please?" comes from an operating room threatened with fire and filled with smoke from the blazing building next door. They may be in no danger from fire, but the smoke becomes so dense that they can hardly see the numbers. It is only when blinded eyes and choking throats refuse to serve longer that they move away from their places which others stand ready to fill. The service must never stop. That is the determination of the telephone Company and likewise of the devoted operator, and she does not hesitate at suffering to accomplish that purpose.

And I see them when fire is blazing in the very room where they work. With fine self-control they sit at their posts, trusting to the manager and the firemen; their faces to the board, illuminated now by the blaze, they calmly make connections while the crackle of the fire and the confusion of putting out the blaze added to the stifling smoke, makes such service the proof of character strong and faithful.

Finally, when the word is given that the room must be abandoned, still unafraid they leave with regret, stopping to put up a last connection; then forming in line, and carefully selecting their way through the confusion of water and wreckage, and through the crowds that have assembled, they gather to await the earliest summons to return to their posts of duty.

And here and there, everywhere, are girls who come to their work from homes where they would often prefer to stay. Here is a girl whose father is ill; he does not lack for care, but it would be pleasant to stay at home. But the force would be short; she is needed; she sets her mind to her work and all day faithfully puts her own private care aside to serve where she is needed.

The street cars are not giving service. For weeks the cars are held up. The more extended the lack of city service, the more essential is the service of the telephone. She is needed more than ever at her exchange. She walks miles to get there; she begs rides on milk wagons; she climbs up into express wagons; even rides in the police patrol. Get there she will.

Through blizzards and blinding storms of wind and rain, she goes, defying nature itself to keep her away from her place of duty.

Always willing to meet the demands of unusual traffic caused by special events, to work the unusual hours, such as evenings, Sundays and holidays in order that the public may have continuous service, could we expect a catalogued report to describe even in a general way the qualifications which go toward making up the telephone operator as she is today?

This composite picture is a "Telephone Girl" of character; unselfish, devoted, brave, resourceful, loyal, ready for emergencies; trained to be like all other telephone girls, to be sure, but trained only to bring out the qualities which prove her to be a noble woman —the telephone operator as I know her.

In Quest of a Voice

By FLOYD HAMILTON HAZARD

The faint, sweet tones of the voice, which seemed to reach out to him through the vastness of space—persuasive, yet distant; clearly distinct, but without volume—had awakened within him a sense of half-forgotten kinship. He was, however, completely at a loss to account for the insistence with which his mind dwelt upon them.

Their vague, but compellingly attractive quality had haunted him for days, continually suggesting retrospection; pleasant, though indistinct memories, tinged with the sadness of irredeemable loss; the joy of newly aroused hope, and the sorrow of baffled realization.

Try as he would, there was nothing upon which to base, definitely, a rational solution of their power over him, nor was he able to dismiss a matter which had almost become an obsession.

It worried him.

The voice was that of a woman—of that much he was certain—but it was not the voice of any woman he knew. He had formed the habit of listening for it daily, in the hope that some suggestion might be made which would enable him to discover the owner, but he had had no success.

Sometimes he failed to hear the voice, and was annoyed thereat.

He was also greatly annoyed at being annoyed thereat.

Van Doren was not given to morbidness. In fact, he was an extremely optimistic and wide-awake young contractor. But when the laughing notes of that same voice came joyfully up the elevator shaft from the car that had just shot downward past the twenty-third floor, he had felt a momentary quake of fear that all was not right with him. Instantly he had recognized them, but it was startling, indeed, to hear them this time full, rich, and distinct.

His expression of surprise, which had almost amounted to consternation, changed to one of alert eagerness, and he sprang to the grating, to peer down the shaft. The car was far below, and none of its occupants was visible. But, though he was disappointed over his failure to see them, there was much relief expressed in the tone with which he addressed his friend, Fred Osgood.

"Well! Thank goodness it's a real voice and belongs to a real person! It isn't the ice of some spiritual affinity of mine."

It was considerably past the noon hour and the two were waiting for the elevator, on their way to lunch, in the rathskeller of the building.

"What's the matter with you, Ted? Aren't you well?" exclaimed Osgood, in utter astonishment at such an outburst from his friend, in the midst of what had been a purely technical conversation. "Of all the dippy things I ever heard you say, that's certainly a winning sample."

"Do you mean to say, Fred, that you didn't hear that girl's laugh?" asked Van Doren, beseechingly.

"Why, of course I heard it. But what of it? Heavens and earth, Ted! What's got into you?"

"I don't quite know. At any rate, I'm mighty glad to be able to state that *I* heard that girl laugh; that it is the same voice I have heard many times before—under unusual conditions—and that, since you have also heard it, I am now *sure* my wheels haven't been turning around too fast. I was extremely doubtful about that latter question, a few moments ago."

"How long have you been interested in girls' voices, Ted?" asked Osgood, as they stepped toward the door of a car. "I thought they had no attraction for you."

"This is the tenth day."

"How very exact you are," said Osgood, mildly amused. "Why are you so interested?"

"Don't know much about that part of it myself," rejoined Van Doren. "However, I'll tell you what little I do know about it while we are at lunch."

They found a table for two, in a quiet corner of the rathskeller, and after their order had been taken, Osgood leaned eagerly forward.

"Now, Ted, tell me what this is all about," he said. "I'm quite excited about it."

"Well, in the first place, there's nothing the matter with me, except that, as nearly as I can judge, I'm in love with a voice—for keeps—and I can't find the girl who

belongs to it," announced Van Doren, despairingly.

His friend stared at him, gravely speculative.

"Then I was right, after all," he said. "You *are* crazy."

"Not a bit of it," objected Van Doren. "There is, however, such a possibility in the future, unless I succeed in solving the problem."

"It is a problem, that I'll admit," said his friend, soberly. "When did you begin to notice the first symptoms of this, er—a—this trouble?"

"Hold hard, old man. I'm coming to that part of it," continued Van Doren. "You know it is our custom to call each other on the wire about four o'clock every afternoon, just so as to keep track of ourselves."

"Yes, and we both need it," replied Osgood, smiling.

"Some time ago, I noticed that whenever I called your number, I could faintly hear other voices in conversation. Sometimes they were almost entirely inaudible and at other times I could hear whole conversations distinctly, although, even then, they were fainter than the faintest whisper.

"In particular, there was several times a conversation—which I could only hear with difficulty—between some girl and a man who was evidently either her husband, or an old and trusted friend."

"Don't say 'old and trusted friend,'" interrupted Osgood. "Say 'trusted friend.' We don't want to spoil a possible romance."

"This is no joke, I tell you, Fred. You keep quiet and listen. Day before yesterday, not knowing that you were out of town, I called your office at the usual time. I was wondering why you did not answer your telephone, when I heard these two in conversation again.

"If you remember, it had rained all the preceding night; and, either for that reason or for some other which I do not understand, the voices—though still very faint—were very distinct indeed."

"Didn't you try to make them hear you?" asked Osgood.

"Yes. I butted right in and attempted to get their telephone numbers, but it was of no use. They went on to talk about other things and evidently couldn't hear a word I said.

"Since then, I've done everything I can think of to get some clue as to who they are—because the girl's voice seemed familiar—but so far I've been unsuccessful. I'd even begun to think it was all my imagination until today, when I heard her voice in the elevator that passed us. Never had such a swift jolt as that in all my shocking life."

"Should think it might have been a bit surprising," Osgood remarked. "Had you thought of trying to find her through the telephone office?"

"No, I hadn't."

"Say, Ted!" exclaimed his friend. "I have an idea. You say that it is only when connected with my line that you hear these voices?"

"Yes. There's not the slightest hint of anything of the kind, except under the conditions I have mentioned."

"Then there must be something wrong with my line," said Osgood triumphantly. "By finding out what that something is, we may possibly be able to locate the source of the voice. It's the most romantic situation I've ever heard of, since I stopped having them myself, and I'm going to help you to solve the puzzle."

"How are you going to do it?" asked Van Doren, skeptically.

"We'll go and see my friend Treadworth. He's in the telephone business. Has charge of one of the downtown exchanges, I believe. Now that I come to think of it, my own line connects to the exchange he is in. At any rate, he'll help us out if he can."

"Fine!" exclaimed Van Doren. "Anything is better than suspense and this feeling of utter helplessness. When can you go?"

"Just as soon as we are through with our luncheon. I've an hour or two to spare if necessary."

Van Doren and Osgood had been close friends ever since their first year at college. Circumstances had permitted the continuance of this friendship—with brief intermissions—after their graduation; and, although Ted was an engineering contractor, and his chum a lawyer, they had many interests in common and sought each other's society whenever possible.

Leaving the restaurant, which was near the post office, they walked briskly along Broadway, discussing the possibilities and probabilities of the case all the way to their destination.

They were about to enter one of the elevators in the telephone exchange building, when Osgood laid a restraining hand on

Ted's arm, and turned toward a man who had just come down the stairs.

"Hello there, Treadworth," he called, drawing Van Doren along with him and walking up to his friend. "I want you to meet my old chum Ted Van Doren. We've dropped in to see you on some very important private business," he added, as the two shook hands, "but we can just as well talk it over and be sociable at the same time. Let's step across to Black's. You're in no hurry, are you?"

"Never was in a hurry but once in my life," replied Treadworth, laughingly. "That was when I was a boy, and fell out of a cherry-tree."

After the three were comfortably seated in the cafe and had lighted their cigars, Osgood proceeded to tell Treadworth the salient points of the problem which he and Ted were trying to solve.

"You see, Joe," he said, "it's not so much that there is evidently something wrong with my line—because it doesn't seem to interfere in the least with my service—but it's quite important that we locate the two people of whom I speak. Do you think we can do this by locating the telephonic trouble?"

"It's your only hope, as far as I can see," answered Treadworth.

"It's rather difficult, because it is evidently not a direct crossing of the wires. If that had been the case, these people could probably have heard you, Mr. Van Doren, and you could have possibly persuaded them to give you the numbers of their telephones. That's all we need for your purposes. If I can find out what their numbers are, I can easily give you the names and addresses of the people who have the telephones; and, after that, the rest ought to be a perfectly easy matter."

"But I could hear them so distinctly that last time," said Van Doren. "It seems strange that neither of them could hear me."

"Can't help that," replied Treadworth. "There's no limit to the impossible things that can happen in this business—and which do happen, every day. It's positively weird."

"What do you think is the cause in this case?" asked Osgood.

"Well, I think that probably it is a case of cross-talk, caused either by induction or by some slight grounding of your wire and one of their's. It might be a direct cross of very high resistance, but I am inclined to doubt it."

"Whew!" exclaimed Van Doren. "Is it as bad as all that?"

Treadworth laughed.

"Can you do anything for us in regard to locating the difficulty and by so doing get the addresses, do you think?" questioned Ted, with evident anxiety.

"Yes, I think I can," answered Treadworth, pulling on his gloves. "I'll drop into the office after five o'clock and make some tests. Just now I've got to go up town. I can get a better line on the electrical conditions after business hours, when the lines are pretty quiet. I'll also do some testing through the day, tomorrow. If you will come to my office about fifteen minutes before the time you have usually heard these people talking, we may be able to get some results."

"I'm sure I don't know how to thank you for your interest," said Van Doren, sincerely, as he and Osgood parted from Treadworth.

"Oh, that's all right," he rejoined, as he bid them goodbye. "I have a personal interest in the matter myself. The technical side appeals to me."

As Osgood had a dinner engagement, Ted announced that he was going up to the club.

"Guess I'll eat there and then get one of the fellows to go to the theatre with me," he explained, as their ways divided. "Got to do something to occupy my mind, until I get this matter settled—one way or the other."

"Best thing you could do, by all odds," said Osgood as he prepared to swing aboard a surface car. "Now, don't fail to let me know tomorrow in case you discover anything. So long."

Van Doren spent a feverish evening, and his dreams that night were a tangled maze of twisted wires, telephones, and imaginary young ladies with real voices.

When it came time for him to go and see Treadworth, the next day, he was forced to acknowledge to himself that he had practically accomplished no work at all; and he was glad indeed to get away from business until he could better control himself.

Entering Treadworth's office, he found that individual seated at the left end of a long, bureau-like desk, and entirely too busy to do more than to nod to him and to motion him to a seat.

It was the first time that Ted had ever been in the testing room of a big telephone exchange and he noted at once, with interested surprise, its tense atmosphere. Treadworth, and the assistant at his right, wore receivers which were clasped to their heads, so that their hands were free.

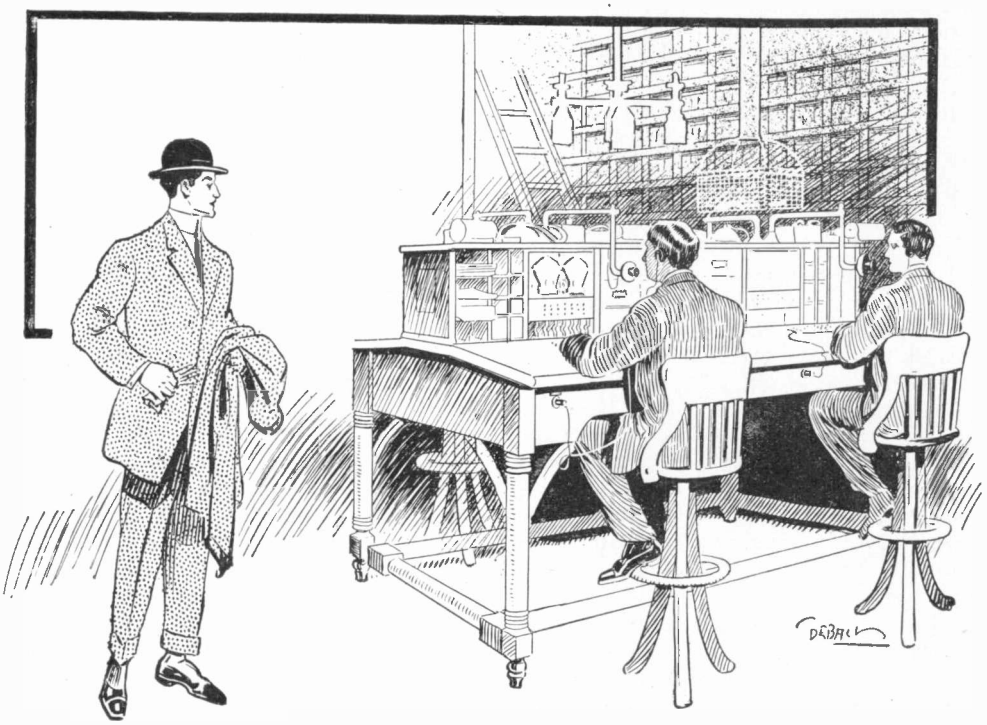
The portion of the big desk which corresponded to the upright, mirror part of a bureau, was filled with a multitude of small electrical signals and with a number of electrical testing instruments.

Each man had a separate set of apparatus and was busily engaged in manipulating small switches, reading the indicators on the

About the only thing he could recall having seen that was in any way similar, was the controlled excitement prevailing in the editorial rooms of some great newspaper, during the period immediately preceding the time for going to press.

"Good heavens, Mr. Treadworth," he exclaimed, as Treadworth arose from his chair and came over to greet him, "You don't have to drive like this all the time, do you?"

"Yes, pretty nearly. There's seldom any let up. When there is a lull, something is sure to happen to make up for it. It's these emergency conditions and the consequent



EACH WAS BUSILY ENGAGED IN MANIPULATING SMALL SWITCHES

various instruments, noting the results on the records, and talking, talking, talking incessantly—apparently each to himself.

He felt awed by their complete concentration of effort and their nonchalant handling of unseen forces.

His eyes wandered to the racks, with their maze of wires. He noted the humming of the dynamo, the shouting of the orders across the room, and the quick response of the men who executed them.

All this found him at a loss for a basis of comparison.

irregular hours due to extra work and to night work that's killing, however. We soon get used to the ordinary work, such as you see, and live on the excitement of it, to a large extent."

"I'd lose my wits inside of a week," asserted Van Doren, with firm conviction. "But—any results in the detective line?"

"Reporting progress, I'm glad to say," rejoined Treadworth, as he began picking out some cards from the record case. "There's a slight leak to ground on Osgood's wire, and I've located it in the big switchboard."

He handed over to Ted the cards he had been sorting out.

"Those represent the eight lines which are adjacent to Fred's line in the multiple of the switchboard," he said. "Look them over and see if you recognize any of the names or addresses."

Van Doren shook his head sadly as he rapidly glanced them over.

"No clue here," he said with regret. "None of these names are familiar to me."

"Hold on a minute," he added. " 'The Southern Construction Company, Earl Court Building.' Why, that's the building Osgood and I were in yesterday. I heard the voice of one of the people I am trying to find, in a passing elevator, but could not see who it was."

"It wasn't a woman's voice, was it?" inquired Treadworth, mischievously.

"Well, yes. It was," Van Doren replied, reddening.

"Oh," said Treadworth, but his tone gave evidence of considerable comprehension.

"Do your tests show that this line is the one which is interfering with Osgood's," asked Ted, ignoring the impeachment.

"Well, I'm in doubt about it. Several of the other adjacent lines show almost the same amount of leak. I'd like to have you listen for a while on Fred's line. It will help to make sure."

"Only provided that you'll guarantee not to make a telephone man of me," said Van Doren, with a shrug. "That sample of your duties which I have just witnessed rather frightened me."

"All right," laughed Treadworth. "I promise."

They entered the switch-room and stopped before a position of the switchboard that had just been vacated by the operator. Treadworth handed his visitor a telephone receiver attached to which was a flexible, green-braided cord, that terminated in a metal plug of peculiar design.

"What's it for?" asked Ted, accepting it doubtfully.

"Put it on your head and I'll show you."

Ted adjusted the receiver and looked at Treadworth expectantly.

"Now," explained his instructor. "All these holes in the upper portion of the switchboard, furnish points of connection to the various lines in this exchange. We call them 'jacks' and the whole collection of jacks we call the 'multiple' of the switchboard, because they furnish a multiple number of points of connection to each of all the lines we have. The plugs at the ends of the flexible cords you see the operators using, connect to other wires, and as each operator has in front of her at least one of the jacks on any given line, she can connect any line with any other line, by inserting the plugs of her cords in the proper jacks."

"Very interesting," said Ted, "but what am I to do with this thing?" indicating the plug which dangled from his head-receiver.

"I'll show you," replied Treadworth. "Here is the jack which connects with Osgood's line. Immediately below it is the jack which connects with the line of The Southern Construction Company. Put the plug which is attached to the cord of your head-receiver into the jack on Osgood's line. Now, if those people you are after talk to each other, you will be able to hear them just as if you were at your own telephone—except that you will probably hear them more distinctly. If you do hear them, remove the plug at once, and insert it in the jack below. In case we are right in our opinion that the two lines are crossed, you will then hear the same conversation between these people just as plainly as they themselves can hear it. You see, both lines are slightly grounded by some moisture and the current leaks from one to the other through the insulation."

"Proof positive, eh?" said Van Doren, admiringly. "They ought to be talking right now, unless this is one of their off days."

He listened intently for a moment or two, and then, with a sudden movement, changed the plug to the jack below.

"Right oh!" he exclaimed. "That's the line. Treadworth, you're a wonder! The conversation was too brief to get much real information, but I've the satisfaction of knowing that I'm on the right track, thanks to you. What she said was, 'Is that you, Will?' and then asked at what time they were to dine. He answered, 'At seven o'clock.' "

"Sure it was the same person?" asked Treadworth.

"I'm certain of it."

"What will you do now?" asked Treadworth, as they returned to his office.

"I'm going over to see Osgood and make up some excuse to call at the office of The

Southern Construction Company. As a lawyer, he'll be better able to invent one than I."

Treadworth laughed at the sally, as the two shook hands in parting, and made light of Van Doren's assurances of the deepness of his obligation to him for such quick and valuable assistance.

"I'm grateful to *you*," he said. "You've put me wise to a trouble which I can now clear before a formal complaint is made by the subscribers whose lines are affected. Goodbye. I wish you luck."

Van Doren found Osgood preparing to close his office for the day, and briefly stated his mission.

"I want you to come up with me to see those people," he said.

"But I don't know any firm by that name, Ted," replied his friend.

"No more do I. I'm just taking a blind chance that something will develop. We'll think up our excuse for calling, on the way. It's getting late and we'll have to hustle or they'll be closed up."

"We can drop in on them, I suppose, and go from there to the club for dinner," said Osgood, doubtfully. "I don't see what you'll gain by it, though," he added. "You, a stranger, can't cross-examine their entire force in order to find out who it is that has a seven o'clock dinner engagement."

"That's true enough," replied Ted, with some impatience. "But I can look around, can't I, and read the names of the firm's managers on the office doors, and all that sort of thing?"

"Well, there's one chance in a million that you may in that way get some definite information. However, we can at least find out who runs the concern. What'll you say? Ask about engineering supplies or contracts? Perhaps that would be as good an excuse as any."

"Of course it would, but somehow I hadn't thought of it," Ted agreed as they neared their destination.

It was a quarter past five o'clock when Van Doren and Osgood arrived at the entrance to the offices of The Southern Construction Company.

They feared they were too late, but as Van Doren reached to open the door, it swung inward and a stockily built young man stepped hurriedly out and almost into his arms.

(To be concluded.)

What Voltage Causes Death?

At a recent meeting of the British Medical Association Dr. S. Jellinek, of Vienna, read a paper on "Disorders and Death Following Electric Shock," He stated that, while in some cases fatal accidents had been brought about by shocks at 100 volts, in other cases, in which the voltage had been 1,000, and even 10,000, recovery had ensued. In order to understand a matter so seemingly inconsistent, the doctor stated, it should be kept in mind that the danger of an electric current depended on circumstances which might be placed in the following two categories: 1. The external: (a) voltage, (b) amperage, (c) number of poles, (d) the time limit of contact, and (e) the kind of current (A. C. or D. C.). The continuous current appeared to be more dangerous than the alternating. 2. The individual: (a) the resistance of skin and body, (b) the path of the current through the body, or over the surface of the skin, and (c) the condition of mind and body. The speaker stated that electric lesions were painless. With regard to the mechanism of death by electricity there was no definite scheme or model. In most cases it seemed like suspended animation. It is an interesting fact that there was between electric shock and death an interim of a few seconds in which the stricken person appeared to be quite in a normal state. By experiments on dogs in the physiological institute of Prof. von Tschermak it had been discovered that the irritability of the brain, which had subsided immediately after a shock, had a few seconds later become re-established, and everything then depended upon whether the action of the heart would be continued or not. As there were sometimes hemorrhages of the brain, and as the pressure of the cerebro-spinal liquid was increased, it was necessary and important in cases of first aid to lay the patient with the head elevated.

Largest Induction Coil

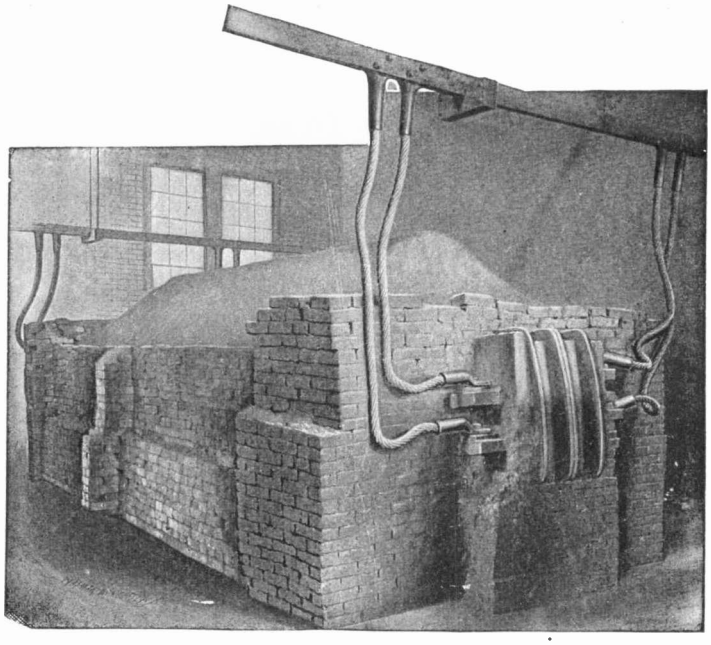
The largest induction coil, hitherto the famous Spottiswoode, is now stated to be a German coil which gives a 50-inch spark, requiring 30 amperes at 110 volts. The iron core is 80 inches long. The primary coil consists of six layers of copper tape, making altogether 792 turns, and the secondary coil contains 100 miles of copper wire about one-hundredth of an inch in thickness.

The Making of Near Diamonds

By GEORGE F. WORTS

Eighteen years ago a chemist while experimenting with an electric current, discovered carborundum. He had a small bowl, such as plumbers use, and into this placed some crushed coke and clay. Into the mixture he thrust carbon electrodes connected to a dynamo. The heat generated by the resistance of the mass, melted the ingredients in the bowl, and when one of the carbons was withdrawn, the trained eye of the chemist detected some minute crystals adhering to it. These tiny jewel-like bits were found to be most gorgeous in coloring and amazingly hard and sharp. The chemist at once thought he had made possible the dream of the alchemists—a man-made diamond. A few simple tests, however, dispelled this theory, but the fact remained that these crystals had wonderful abrasive properties that made them second only to the diamond in hardness and sharpness.

Edward Goodrich Acheson, the inventor, experimented again and managed to collect enough of the crystals to fill a small vial. This tiny vessel, holding the world's entire supply of carborundum, he tucked into his pocket and went to New York. Realizing the possibilities of his new invention as a substitute for diamond dust for jewel polishing, he interviewed several diamond experts, who were so impressed with the qualities of his product that he immediately secured an order. The price paid was 40 cents a carat or $880 a pound or nearly two million dollars a ton. However, the order was only for a few carats.



CARBORUNDUM FURNACE BEFORE BURNING

Other industries soon commenced to appreciate the worth of this new abrasive and as the demand increased, the output likewise grew and the price was lowered. Carborundum, today, sells for about 10 cents a pound in grain form. About 10,000,000 pounds of carborundum are manufactured annually.

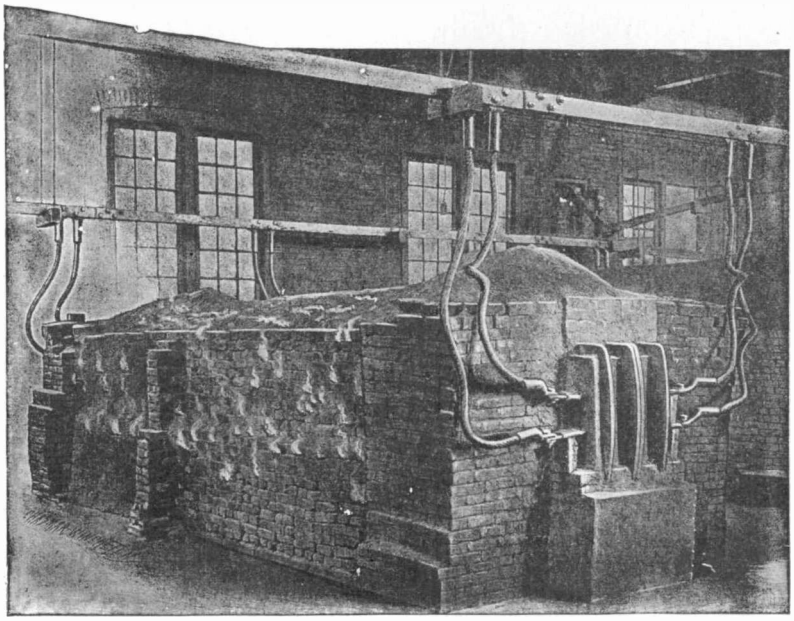
The process of manufacture is practically the same as it was in the beginning, excepting that everything is done on a greatly enlarged scale by wonderfully improved methods.

Carborundum is a trade name given to carbide of silicon, and carbide of silicon is a chemical combination of carbon and silicon. The chemical transformation is

brought about in a most interesting way. The element carbon is supplied by crushed coke and the element silicon, by sand. Accordingly, these two materials are mixed in a certain proportion and packed around a core in the electric furnace. The mixture is made porous, as a preventative of gas formation and explosion, by the addition of a small quantity of sawdust. The carborundum furnace is rectangular in shape, measuring about 50 feet long, seven feet wide and six feet high and built of fire brick. At each end of the furnace is a group of cables about two inches in diameter to carry the large amount of current required to make carborundum. The cables are connected to large carbon rods or electrodes. The mixture of coke and sand being filled in the furnace bed, the current is turned on at about 250 volts and 6,000 amperes. As the temperature of the mass rises, less voltage is needed and it is decreased to 160, but the amperage is raised to 9,400. Thus the actual consumption in kilowatts is practically always the same.

The current supply is regulated by autotransformers. Thirty-six hours are required for the crystals to form. The amount of heat developed in a furnace of this type is terrific and though never accurately measured it is estimated at about 7,000° F. This would readily vaporize steel, granite and marble, and in it the most refractory materials would burn like so much tallow. It is so hot that it is believed that if a person were to look into the heart of a burning furnace he would be instantly rendered blind. Incidentally, enough electric power is consumed in a carborundum furnace to carry the Lusitania half way across the Atlantic Ocean or an electric express train from Buffalo to Salt Lake City.

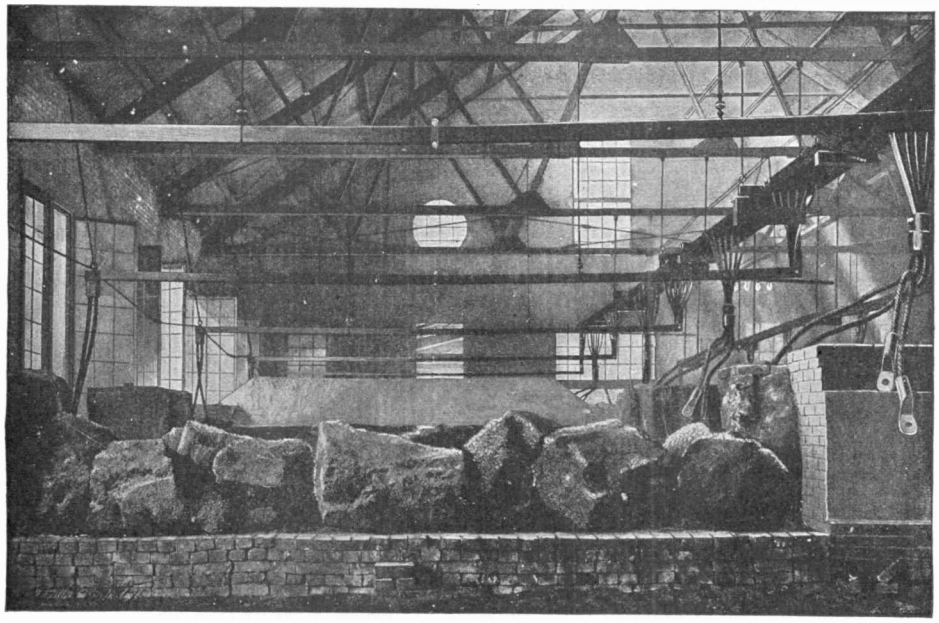
This, then, is the inferno in which carborundum crystals are created. At the end of the required period, the outer crust is removed and beneath are the carborundum masses that rival the radiance of precious gems. New purples, new greens and golden tints are discovered in every lump, colors which an artist would despair of truthfully reproducing. These crystal masses are taken from the furnaces and crushed into tiny, individual crystals or grains under large steel grinders. The grains thus obtained are carefully washed, then dried in rotary driers and sent to the sifting room. Much after the manner in which flour is bolted are the grains sieved through silk screens into sizes corresponding to emery. The graded grains or powders are then mixed with bonding materials and fashioned into grinding wheels. The grind-



CARBORUNDUM FURNACE DURING OPERATION

ing wheels are made in molds which are placed in hydraulic presses. The shapes are then placed in kilns and vitrified at a heat of about 2,500° F., after which they are removed, trued, tested and shipped.

The testing of the wheels is a very interesting proceeding. The finished wheels



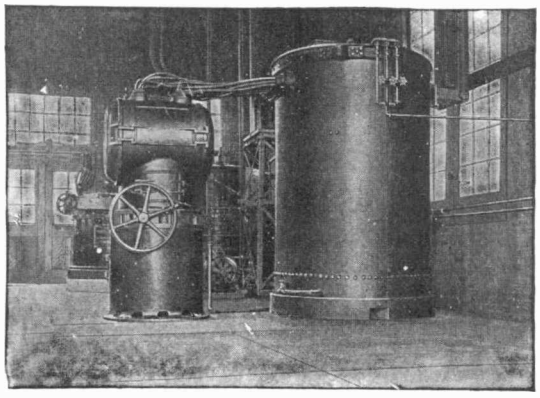
CARBORUNDUM FURNACE AFTER BURNING, SHOWING CRYSTAL MASSES

are fastened upon a shaft and boxed in and then revolved at a speed 70 per cent greater than they would be run under ordinary shop conditions. If the wheels are faulty they will break. Very seldom, however, do they fail to survive the test. The testers are required to sign affidavits specifying which wheels they test, the speed and minute details. This absolutely insures the user from danger from "exploding" wheels.

The abrasive superiority of carborundum over emery is this: where emery grinds, carborundum cuts. It is intensely hard and brittle, not tough. When the pressure of the material to be ground becomes so great that something has to give away the carborundum does not wear down to a smooth surface as does emery, but the grains split and break, thus presenting fresh cutting edges.

A microscopic examination of the metal removed by emery grinding shows little globules which have been rubbed off and melted by frictional heat. A similar examination of the metal removed by carborundum shows little shavings like those removed in turning a locomotive tire.

Throughout the entire process of making carborundum, after the crystals have once been formed, they forever remain in a crystalline form. From the coarsest grinding stone to the finest jewel polishing powder that will remain afloat in water a space of 60 seconds, the grains are always crystalline.



A CORNER OF THE TRANSFORMER ROOM

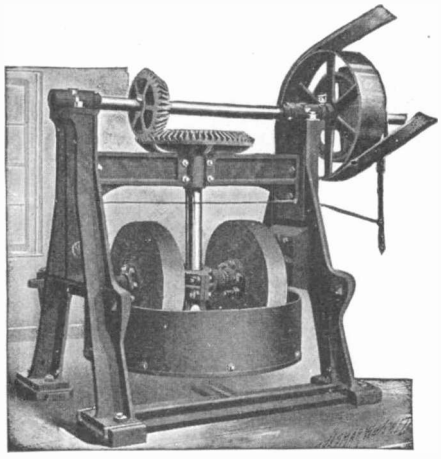
Though carborundum proved very satisfactory as an abrasive material for cutting

TESTING THE WHEELS

marble, grinding cast iron, tool grinding and sharpening, and in fact in almost every branch of work where abrasives are used, when it came to doing certain kinds of steel grinding it was not satisfactory to certain abrasive users. The Carborundum Company's metallurgical experts, as a result, have produced an entirely new abrasive called aloxite. The details of the manufacture of aloxite are kept secret. It consists principally of fused alumina and is made in a furnace of the arc type. This furnace differs from that in which carborundum is made, inasmuch as the heat of the former is caused by an electric arc, while that of the latter is caused by the resistance of the core and is called therefore a resistance furnace. Aloxite is manufactured from aluminous material and has a hard, tough crystal.

The Carborundum Company also manufactures silicon metal. It has been found that the introduction of silicon metal instead of ferro-silicon into steel, has had a threefold benefit, as the silicon metal combines the three qualities: purity, economy, and great deoxidizing power. The introduction of the silicon metal into the casting means the entrance of but a fraction of the

A CORNER OF THE KILN ROOM



CRUSHING MACHINE FOR GRINDING UP THE CRYSTALS

percentage of impurities that are found in the low grade of ferro-silicons; its use means practical foundry economy, as the action of the pure silicon is quicker and more pronounced and its wonderful deoxidizing qualities give better and denser castings. A typical analysis of the 90-per-cent grade of their silicon metal is as follows:

Silicon	90.60
Iron	6.70
Manganese	.08
Aluminum	2.35
Phosphorus	.02
Carbon	.22
Sulphur	.00

Ferro-silicon ranks very low in silicon, at times being below the 50-percent grade.

When the Carborundum Company undertook to make silicon for commercial purposes it was being sold for about $4.00 a pound. By careful study they have reduced its cost in the higher grades to about $140 per gross ton. With the perfection of the details of its manufacture and the inevitable increase in the demand for the product, this price will be materially lessened.

The electric furnace in which silicon is made is somewhat similar to the aloxite furnace. It is of the arc type, a square structure lined with carbon and from the top two carbon rods or electrodes are suspended. These rods connected to heavy wires or copper bar conductors send the tremendous heat-producing energy surging into the body of the furnace.

Into the mouth of the big furnace the mixture of crude materials is placed and the power turned on. A terrific arc forms between the two electrodes and drives a 3,000° F., "U"-shaped flame into the mass. At this heat the mixture is reduced to molten silicon and drawn off, not unlike slag from a smelter. For three hours 1,200 horsepower of electrical energy is consumed, reducing 25,000 pounds of crude materials to 8,000 pounds of silicon metal.

About the top of the furnace is built a wooden platform from which the men shovel the crude materials into the opening. The glare from the arc is so blinding that the men are compelled to wear smoked glasses in order to work in this position with any degree of safety to the eyes.

At the end of the required period the workmen climb down and prepare to tap the furnace. In its side is a glowing, red opening into which the workmen thrust a long rod, and instantly, amid a shower of sparks, the thick, lurid stream flows out into a small, clay-lined ingot buggy. This thick, lurid stream is the molten silicon metal. It is allowed to cool and then broken into lumps for convenience in handling by the steel makers or foundry men.

The amount of electric current consumed by the Carborundum works would keep a large-sized city constantly supplied with light and power. The current is delivered from the great plant of the Niagara Falls Power Company.

Making a Magnet Talk

By Robert Grimshaw

The phenomenon of the "speaking arc," in which the carbons of an electric arc lamp can be made to reproduce the human voice, is now fairly well understood. In line with the speaking arc Herr Emil Kosack of Magdeburg, Germany, has made some interesting experiments by which magnets have been made to reproduce speech and musical sounds, and in a different manner from the ordinary telephone. A description of his work appeared in *Die Welt der Teknik* and is of considerable interest.

Kosack did not confine himself to researches with magnetic circuits, but made experiments with bar magnets, and was able to get therefrom quite good reproductions of speech.

In one form of his apparatus an iron core is provided with two coils, one of which is connected with an electrical source and the other with the circuit of a microphone and battery. Fig. 1 shows this arrangement, the coil which is connected with the microphone being plainly seen. Further, Kosack showed that even when the electromagnet is unexcited, a telephonic reproduction is possible. The very weak results in this case may be strengthened by laying on the end of the bar magnet a plate of sheet iron or other material. This plate then takes part in the vibrations. In this way any piece of iron or steel may be made to reproduce melodies. This arrangement is illustrated in Fig. 2, in which there is shown a core with a coil connected to the microphone, and a reinforcing or resonance plate.

Kosack also noted the interesting fact that the coil which is in connection with the microphone circuit is influenced by the microphone currents even when the iron core is not present, so that melodies may be reproduced thereby with great clearness. But the volume of sound is naturally much less, so that the hearer must hold the apparatus close to the ear, as shown in Fig. 4.

By using iron wire instead of copper a better result may be obtained. The vibrations caused in the coil are supposed to be derived from an electrodynamic effect between the separate turns of the bobbin, although there is reason to believe that molecular action in the interior of the wire plays a role. In any case the vibrations be-

tween the separate turns are so slight that a bobbin bedded in a pitch-like material gave just as good tones as one which was not similarly bedded. Here, also, the effect is considerably increased by the use of a plate-like object as reinforcer. As even quite thick plates may be used, there is evidently no membrane-like effect as in the telephone.

The remarkable increase in the loudness of the tones may be ascribed to the fact that by reason of the increase in the surface of the plate, the diameter of the vibrating air column is also increased.

Making use of these discoveries, Kosack has been able to construct a telephone receiver without iron and of remarkable simplicity. This receiver consists essentially of a wire coil wound either free or on a spool, and mechanically connected to a plate which may be extended to a funnel. The tones are thereby given with extraordinary clearness and distinctness. Switching in an induction coil between the telephone and the microphone makes no difference in the excellent operation of the device. As this telephone may be constructed without any iron at all, it may be used where iron would be attacked by acid vapors. Fig. 4 shows the new receiver in use.

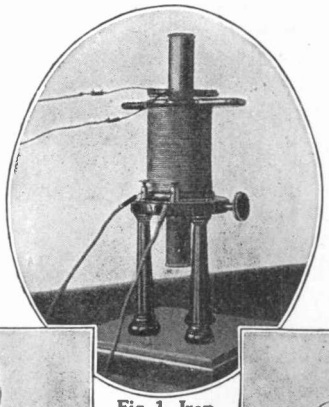


Fig. 1. Iron core with two coils

Fig. 3. Receiver constructed without iron

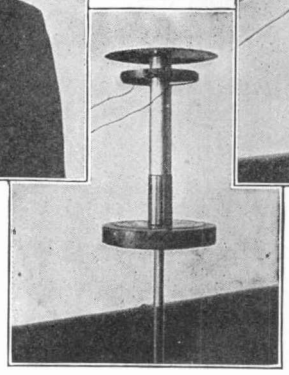


Fig. 2. Plate of iron made to vibrate

Fig. 4. Reproduces melodies clearly

While the well-known Bell telephone, the simplicity of which is proverbial, contains three more essential parts than the Kosack apparatus, (a magnet, a wire coil and an iron membrane) and the Peukert apparatus consists of two parts (a magnet and a coil) the above described Kosack receiver consists, aside from the necessary resonance plate, of only a coil.

Looking Through Metals

Very thin films of some metals become transparent at heats not nearly sufficient to melt them. For instance, if we take a sheet of gold leaf somewhat thinner than the paper on which this is printed and heat it by an electrical current to temperature of about 2,400° Fahrenheit, it will become as translucent as a pane of green colored glass. If carefullv kept away from drafts, very much finer sheets of gold leaf can thus be heated by clamping them on frames of marble or slate and applying the current through the metal strips which clamp each end of the sheet. When this is done with gold leaf of about one hundredth the thickness of this paper and the current is gradually increased until the temperature reaches 3,000° Fahrenheit, the leaf becomes not only translucent but also transparent, so that it is actually possible to see through it. For apparently the same reason silver foil, which only requires 2,250° to make it clearly transparent shows a bluish-violet tint. Copper foil has also been made transparent in this way but remains so only for a short time as it combines with the oxygen of the air when thus heated and the resulting compound is not transparent.

In planning to keep in touch with his crew even when 20 or 25 miles from the same during his coming antarctic expedition, Capt. Scott is taking with him a telephone outfit including a supply of aluminum wire but no insulators. The wire will simply be laid over the ice and snow which are dry enough to give the needed insulation.

Making and Testing Telephone Cable

By WALDON FAWCETT

Of all the industrial activities identified with the electrical field, the one to which, considering its importance, the least thought is usually given, is that which embraces the manufacture of telephone cable. And yet this class of cable, in its present highly perfected form, has not only been essential to the development and extension of the modern telephone system but the industry in sheer point of magnitude of output is one of the most important in the whole electrical field. Incidentally it is gratifying to the patriotic pride of Americans that in this, alike to most other sections of the telephone realm, almost every important step in the evolution of the product has been attributable to Yankee ingenuity and skill and the manufacturing processes now employed in our up-to-date cable manufactories are accounted distinctly in advance of prevailing practice abroad.

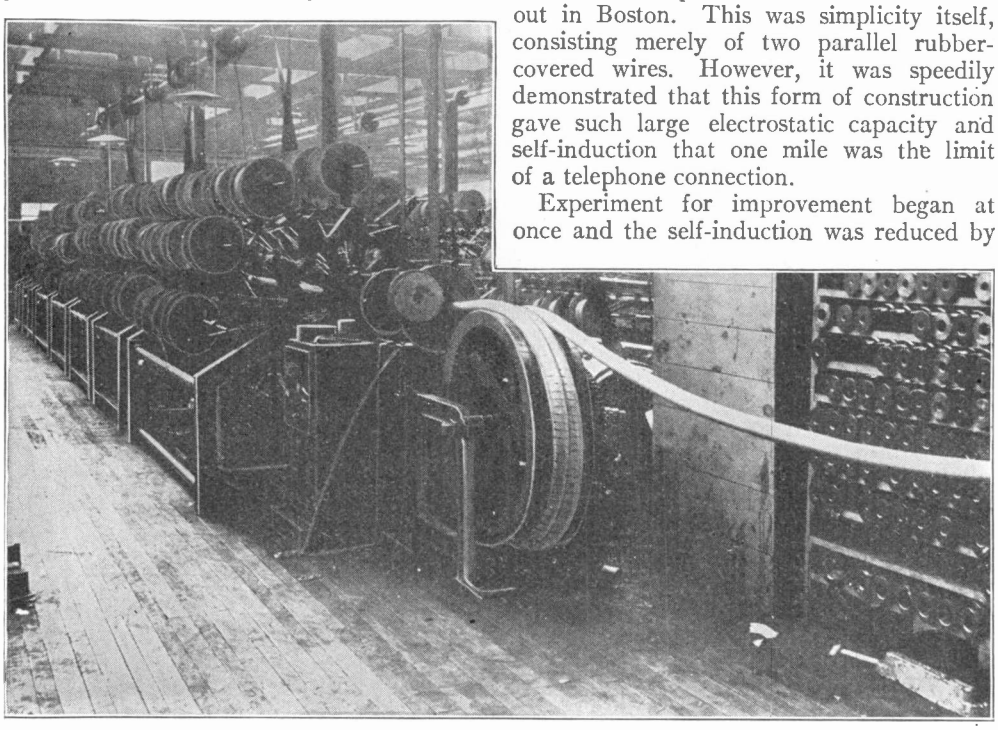


FIG. I. CORE MAKING MACHINE

The credit for evolving telephone cable, as we know it today, does not belong to any one individual in the same degree that personal achievement has been recognized in the case of certain other electrical essentials. The idea of the underground telephone cable seems to have had its inception in Philadelphia in 1881, but one of the very first of the experimental cables was tried out in Boston. This was simplicity itself, consisting merely of two parallel rubber-covered wires. However, it was speedily demonstrated that this form of construction gave such large electrostatic capacity and self-induction that one mile was the limit of a telephone connection.

Experiment for improvement began at once and the self-induction was reduced by twisting the wires together—an expedient which increased the usefulness of the cable. However, the electro-static capacity was still so high that only a very limited amount of this type of cable ever found its way into use.

Obviously the root of the trouble was to be found in the high electrostatic capacity of the insulating medium and therefore there ensued an earnest quest for an insulating material that would give a low electrostatic capacity. It was only after a long interval of random experimenting that Mr. W. D. Sargent of Brooklyn finally gave the investigators the right trail by his experiments with dry paper.

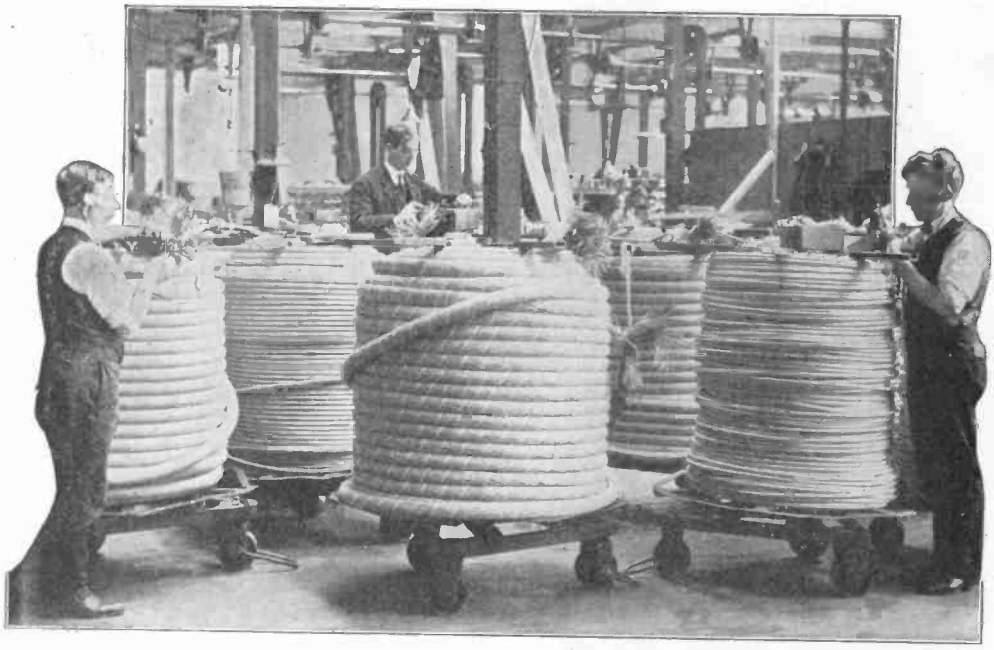


FIG. 2. TESTING CABLE CORES

Soon after this Mr. T. D. Lockwood discovered that the low capacity depended not upon the insulating medium but upon the dry air included in the loosely wound paper, but even then it became necessary to find some cheap and effective means for protecting the dry paper insulated wires from moisture and mechanical injury. The credit for the solution of this latter problem seems to belong to Mr. W. R. Patterson who not only evolved the first device for sheathing the cable in lead but also invented the hydraulic press which is, to this day, depended upon for this portion of the work in all large factories.

As the development of the standard type of telephone cable has progressed it has been found necessary to exercise more and more care as to the quality of the raw materials entering into the manufacture and upon which the life and usefulness of the cable is so largely dependent. Especially is this true in the case of bare copper wire which must not only be of high quality but must be handled with extreme care to avoid injury, a slight abrasion upon the surface of the wire being sufficient materially to decrease its strength at the point affected. The result of these exigencies is that in every cable manufactory there are regularly employed chemical and electrical experts.

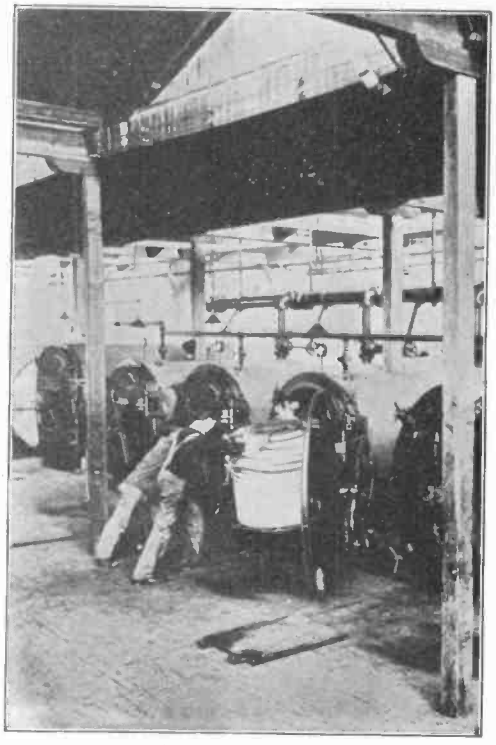


FIG. 3. FILLING ONE OF THE DRYING OVENS WITH CABLE

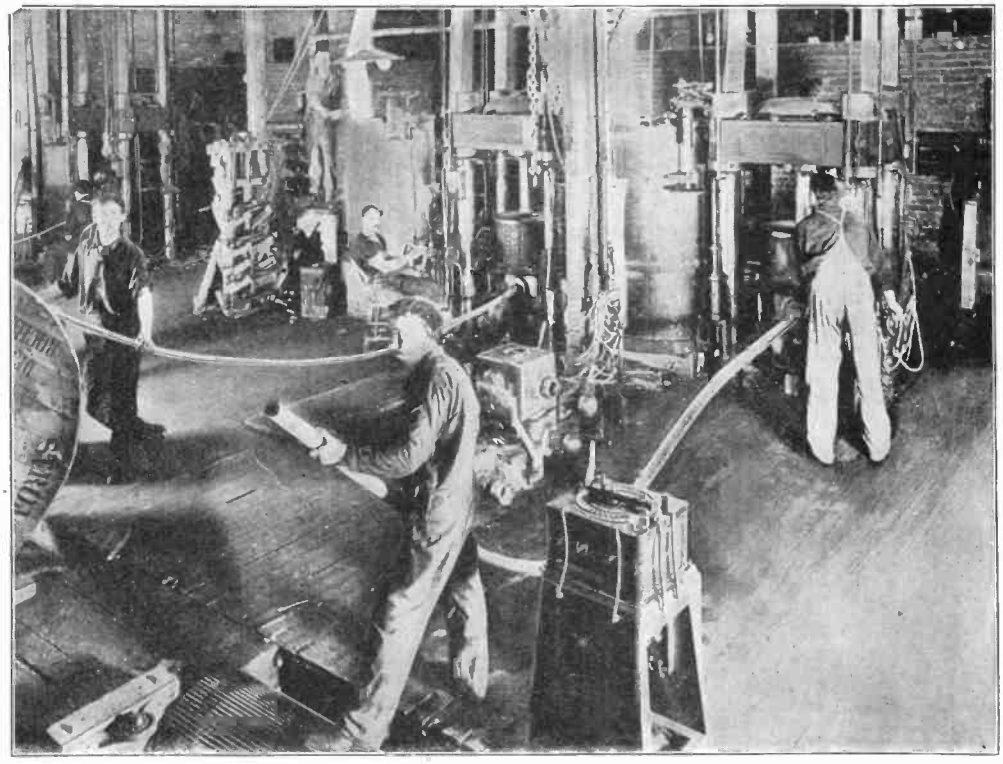


FIG. 4. FINISHED CABLE COMING OUT OF THE LEAD PRESSES. THE LEAD JACKET IS SMOOTH AND CYLINDRICAL, WITHOUT A SEAM

In the actual manufacture of telephone cable the first operation is the insulating of the single conductors. Three or four different standard sizes of copper wire are commonly used in cable manufacture and this wire which is pure, bright, annealed copper, with a conductivity of at least 98 per cent of that of pure soft-drawn copper, is fed from coils into horizontal machines. Special unreeling drums are employed and the wire upon leaving these passes through two heads set in line and revolving in opposite directions. Each of the heads winds one wrap of paper spirally on the wire, thus producing a double wind of paper so arranged that at every point four thicknesses of paper intervene between the wire and the outside of the insulation. The delicate part of this operation lies in the joining of the wires. This is done by experienced braziers who employ pure silver solder, thus insuring a joint that has a lower resistance and also a greater breaking strength than the wire itself.

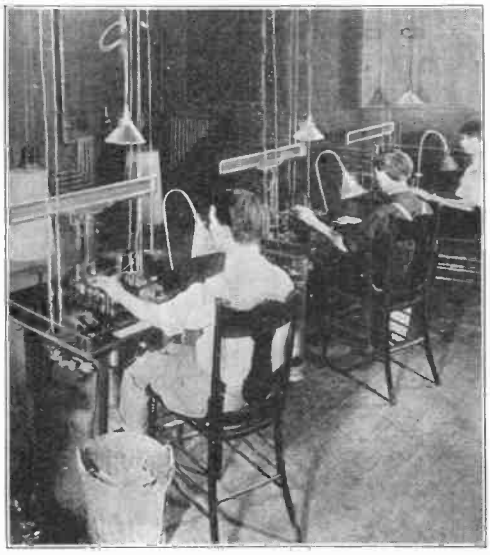


FIG. 5. TESTING NEW-MADE CABLE—IN THE LABORATORY

In the process of insulating the wire as above described the machines are so arranged that one-half of the wire received

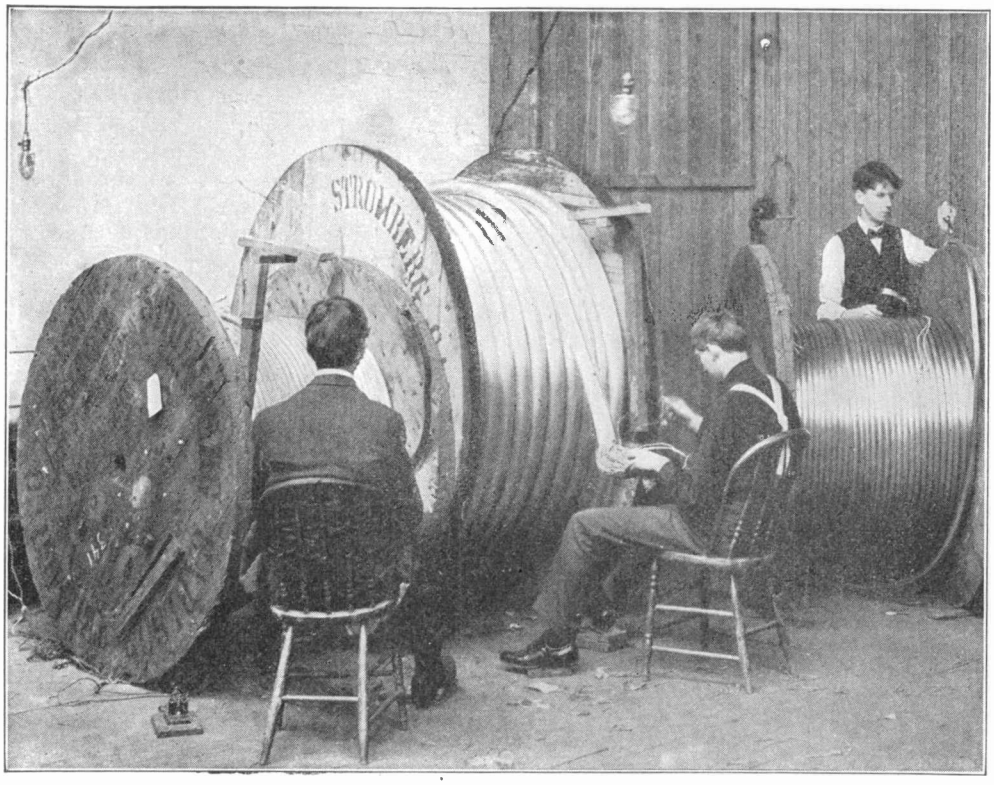


FIG. 6. TESTING CABLE. THESE MEN MAKE THE CONNECTIONS AT THE ENDS OF THE STRANDS

two wrappings of gray paper while the other half of the wire is wrapped in paper of a red hue. This distinctive color scheme is of advantage in the next operation which has as its object the twisting together of the two wires to form a pair. The wires after being twisted go to the core machine where they are "laid up" in the form of a cable core, as shown in Fig. 1. The core machines consist of series of drums on the periphery of which are spindles to receive the spools of twisted wires. The pair of wires on each drum are led through a mouthpiece in the forward end of the drum and thence into the rear of the drum immediately preceding it, the operation being repeated through the entire series of drums. The drums revolve simultaneously but in opposite directions—that is, alternate drums revolve in one direction, and intermediate ones in the other direction.

Inasmuch as each drum places one layer of pairs of wire on the cable, it results in the assembly at the end of the last drum of a cable core which has alternate layers of the conductors put on in the one direction and intermediate layers in the opposite direction. This construction gives the desired non-inductive core and after the final layer of wires is in place the whole core is wrapped with one thickness of heavy manila paper which not only insures high insulation between the core and the sheath in which it will later be enclosed, but also affords some protection from mechanical injury.

Before this portion of the work is pronounced complete the cable core is thoroughly tested for "opens" and "crosses." This is done through the instrumentality of a telephone head receiver and two dry cells. Every individual wire is tested as shown in Fig. 2 and steps are at once taken to remedy and repair any flaws disclosed by these electrical tests.

The next step in manufacture is the drying of the core—a very delicate operation, requiring the constant supervision, day and night, of an experienced man. Indeed, this might be denominated the most critical proc-

ess in the manufacture of cable, since both high insulation and low capacity in the finished cable are dependent upon it. The drying is done in the large ovens shown in Fig. 3, each of the iron chambers of which is capable of holding thousands of feet of cable core. After the heavy iron door of one of these ovens has been closed on a quantity of cable core the temperature of the chamber is raised by the manipulation of outside steam valves. When the core is deemed to be sufficiently hot a vacuum pump is started and the air and moisture pumped out of the chamber. Pumping continues until the core is perfectly dry, after which the vacuum is broken by the admission of dry air which is absorbed by the cable core.

Now comes the encasing of the core in its lead sheath, one of the most important of all the processes and one that is especially interesting because of its dependence for success upon a peculiar physical property of lead—namely its ability when highly heated to assume a plastic state if subjected to enormous pressure and to become solid again as soon as the pressure is removed. On this principle melted lead is placed in the cylinder of a machine shown in the back-ground of Fig. 4, known as a lead press and when it has cooled to 75° or 100° F. below the melting point, is put under pressure and forced around the cable core which is fed into the press as needed. As the cable core emerges into the open air with its plastic coating the lead quickly assumes a solid state and thus there is provided a continuous sheath around the cable.

The cable as it comes from the lead presses is wound direct on the large wooden reels on which in due course it will reach the "ultimate consumer." First, however, it must be allowed to cool to about 60 degrees and then pass muster in a final inspection consisting of tests for insulation and capacity by means of highly sensitive reflecting galvanometers in the laboratory shown in Fig. 5. These instruments which are brought into play in turn upon each individual wire in the cable under inspection, are located in a room carefully shielded from vibration. The connections for the various sets of instruments are made as shown in Fig. 6 by men stationed outside the room where the testing is done and all communication between these men and the men in charge of the instruments inside must be carried on by means of telephones and telegraph sounders. The outcome of the test of each cable is determined, of course, by comparing the deflection of the cable under examination with that obtained from a known and certified standard.

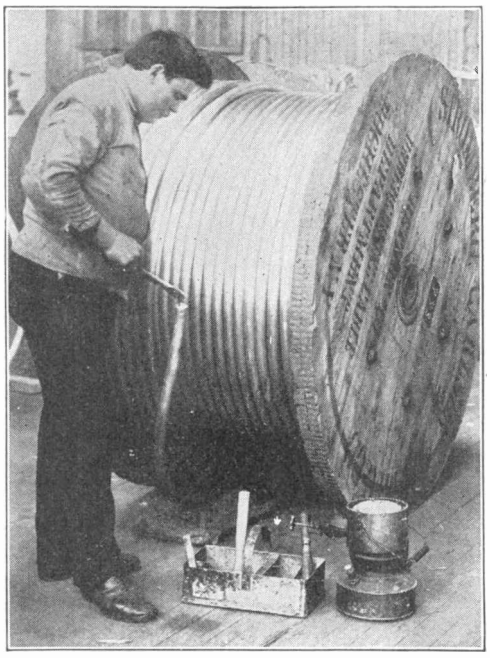


FIG. 7. SEALING UP THE END OF A TELEPHONE CABLE

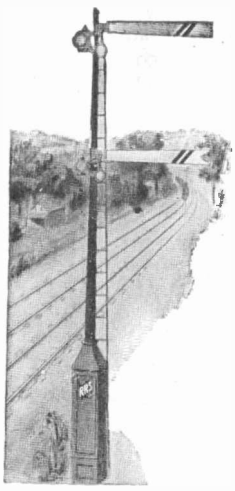
This brings us practically to the end of the evolution of a telephone cable. It only remains after the cable has been tested and passed its final inspection, to cut off the test end, which to the amount of two feet has been allowed on each length of cable when the core was made to allow for the practical demonstration at the factory. The ends are then sealed as in Fig. 7 with solder and bound securely to the sides of the reel with wire. It has been found that this precaution is essential, lest loose ends play havoc during shipment.

Finally the lags are bound securely with layers of twisted iron wire that completely encircle the reel along its ends and thereupon the reel, resplendent in its new shipping tag, is ready to be rolled into a waiting railroad car enroute to an underground resting place in any city in the country.

Electric Block Signaling

By SIMON DEUTSCH, E. E.

PART I.



How many of you who have traveled on trains, or walked along railroad tracks, and noticed the signal blades and lights bobbing up and down, know how these various forms of signals operate, and what the different colored lights and positions of the blades mean, and what an important part these same signals play in safeguarding your life and the lives of others? But very few, is the answer, even among those electrically and mechanically inclined.

This may seem strange, especially as the art of electric signaling is not only intensely interesting, but is comparatively young, when compared to the time and development devoted to other special branches of the electrical field.

Men in the employ of railroads became signal experts by necessity, building crude apparatus in the railroad shops, or contracting with some jobbing shop to make up the required apparatus from drawings and explanations furnished.

And so in years both the railroad men and the builders learned to see and fulfill their needs, by co-operating with each other, and today we find the positions of signal engineer, signal supervisor, and signal inspector filled by young men who are graduates from this school of practical experience and the small shops which started in so small a way but very few years ago.

Because of this silent though swift development all taking place in a little family, as one might say, but little has been published as yet on this important subject, even though at the present time it is fast becoming a study for the specialist, just as has the telephone, wireless telegraph, electric lighting and other comprehensive branches of the electrical art.

It is therefore only reasonable to assume that under these conditions railroad and signal companies are now looking among the ranks of the specialist to supply the demand for these talents, and with such search is beginning a period of general enlightenment on this subject.

DEVELOPMENT

The successive stages through which the art of signaling has been forced by necessity, and which finally resulted in the developing to the present efficient stage, the various systems of electric block signaling, are most interesting, and should be carefully followed.

It can readily be appreciated by the reader, that if a railroad company operates only one train a day between two points, no system of spacing, or giving of train orders, would be required.

As soon as more trains are put into service between these two points, and on the same stretch of track, a system of spacing is required to avoid collisions, and sidings have to be installed, so that meeting points can be arranged for trains to pass each other. And if trains run both ways on the same track, it is necessary to give protection from head-on collisions by blocking. In other words, some system must be installed to tell the engineer of one train that the other train has the right of way, and that he must take the siding. This information is conveyed and indicated either manually, half manually and half automatically, or entirely automatically.

The need of absolutely positive and reliable means for safely and economically handling a great many trains over a given section of trackway has brought about remarkable developments, and as is usual, electricity was turned to for meeting the requirements.

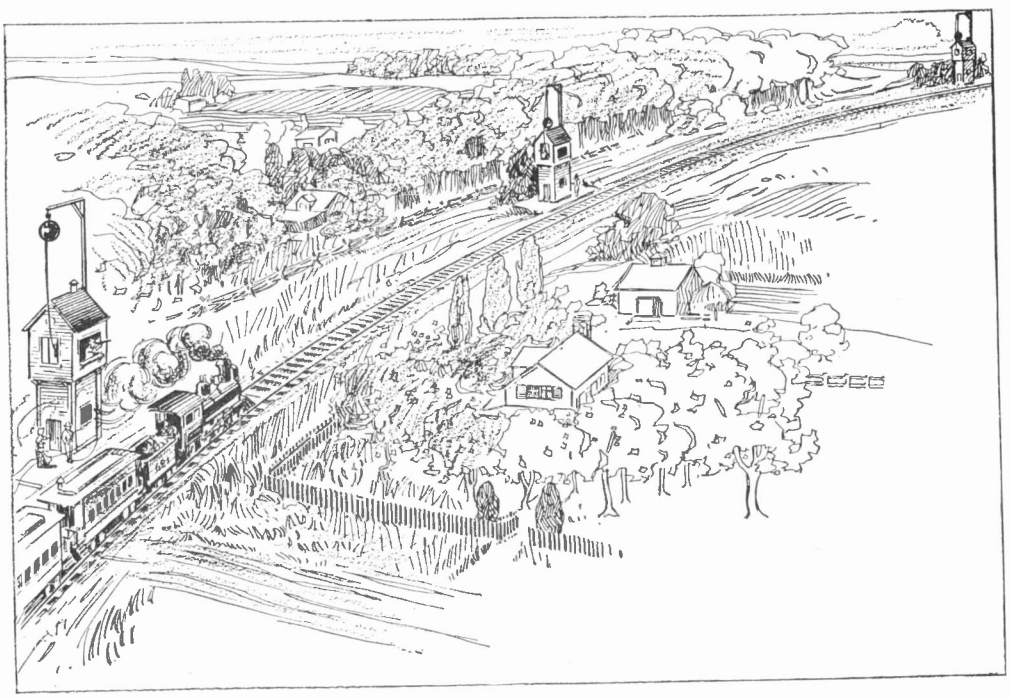
We all know the important position the telegraph holds in railroad work, although even now it is fast being displaced by the telephone. But long before the telegraph was even dreamed of, trains were running, and it was necessary to arrange for the proper handling of them.

In England stations communicated with each other by means of a large ball, raised and lowered on a high mast, which was erected at every station having an attendant. When a train left a station the ball was raised to the top of the mast and the attendant at the next station, which for convenience we will call Station No. 2, could thereby tell that a train was approaching, and signal to the station the other side of him, Station No. 3. When the train reached Station No. 2 and was ready to leave there, the attendant at that point would raise the ball to the top of the mast, and the attendant at the first station, or Station No. 1, would lower the ball to half mast. Likewise, when the train was ready to leave Station No. 3, the ball at Station No. 2 was lowered to half mast, and the attendant at Station No. 1, seeing this, would lower the ball at his station to the ground. Thus we see the first beginning of the block signaling system.

Of course, no reliability could be placed on such a system, as too many things could interfere, such as fog, sickness of attendant, forgetfulness, etc.; and the system was therefore acknowledged as unsafe.

Then came the inventing of the telegraph, which was hailed with joy by railroad managers, and with it came the establishing of block stations with telegraph operators in attendance, the operators communicating with each other as to the location of trains, the kind of signal to display, orders for trainmen as to meeting points, etc. Where the traffic was heavy, these stations were placed close to each other, so that trains could follow each other more closely. This system of controlling train movements by telegraphic communication is still in use on many railroads, especially between points having but few trains a day. Although this system has decided advantages over the mast and ball system, or for that matter any system depending entirely on the eye, it was found that operators grew careless and that it was necessary to provide some means to prevent them from letting a train onto a certain section of track, or block, as it is called, before finding out whether or not the block was clear.

The lock and block system, which is a system requiring the co-operating, at the same time, of the operators at each end of a block, before a clear signal indication can



THE FIRST BLOCK AND SIGNAL SYSTEM AS USED IN ENGLAND

be displayed, was designed to overcome the faults of the systems described above. Code bells, telephones and telegraph were installed between stations for communication. Mistakes, however, were still made, and always will be made, where the human being entirely controls the displaying of signal indications. It was found that operators would not co-operate with each other and would set certain signals at the wrong time. These mistakes occurred so often that other protective means were sought; which finally led to the development of the controlled lock and block system.

As the name indicates, this system included the control of the signal indication by the train itself. The first introduction and application of track rails carrying and controlling a part of a signal circuit, was made in the installing of this system, which makes it impossible for the operators to display a clear indication, while a train is between the two stations.

The objections to this system is that only one train is allowed in a block at one time, and where the blocks are long, trains are spaced too far apart. To bring the stations closer, makes necessary more stations and operators, which again adds heavily to the operating expenses of the railroad company. Then again, all of the systems described above require attendants who first have to establish communication between each other, which is none too fast a process, and which is open to errors, and with the enormous increase in traffic is not sufficient to handle trains rapidly or safely enough.

The automatic block signal system is a system that does not require attendants for the actual operation of the signals, other than to maintain the mechanisms and wiring in good order. The signals operate by means of gearing and motors, magnets, or electric lights, controlled by trains using the track which the signals govern. Signals will show "clear," which means "proceed," providing there is no other train, no open switch, or broken rail in the block at the entrance of which the signal is placed.

The signal will show "danger," which means "stop," as soon as the front part of the train passes the signal, and will stay in this position until the train has passed out of the first or second block ahead, according to the spacing desired, after which it will again show "clear" for following trains.

Editoral Note—This is the first of a series of articles by Mr. Deutsch, who will undertake in everyday English to explain how electricity is used in the signal system of a railroad. In the next and succeeding chapters illustrations will be shown of the different types of electric signals now in use on the most prominent railroads, and explain just what the position of the blades in the daytime and color of the lights at night mean to the man in the engine cab.

ELECTRICITY

From the infinite space of a sphere unbound,
Where the arches of the universe span;
Where the elements clash and the storm clouds roll,
I come as the servant of man.
With the speed of the wind I answer his call;
I bring him a message without delay;
He can hear the sound of a well-known voice
Though a hundred miles away.

Weary and worn, with lagging feet
The traveler who journeys afar
Would faint by the way ere he reached his home,
Were it not for my swift-wheeled car.
When dread disease racks the human form,
And baffles the surgeon's skill,
I send my rays through tissue and flesh,
And he uses his knife at will.

When storms range wild on the trackless main,
And the thunderbolts I hurl
O'er the billowy deep of a surging sea,
Where the foam-capped breakers curl,
The ship that swerves from her wonted course
In that black and starless night,
Would dash on the deadly wave-swept rocks
Were it not for my searching light.

I fashion the bands for the cannon's throat,
And give edge to the keenest steel,
I gild the chain that my lady wears,
And polish the engine wheel.
My light gleams forth from the highest tower,
And down in the deepest mine;
The banquet hall and prison bars
Alike in its radiance shine.

—RENICE RADCLIFFE.

Talks With the Judge

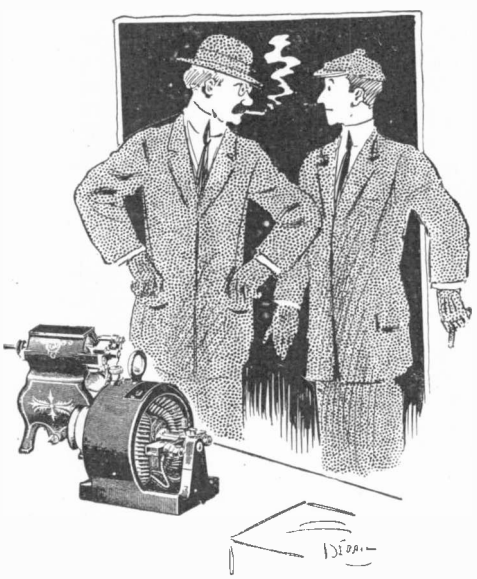
DYNAMOS AND MOTORS—THE DIFFERENCE

"What is the difference between a dynamo and a motor?" said the Judge one day as he was fussing around in an electrical supply store trying to tell the salesman all he didn't know about igniters and spark plugs for automobiles. We had become interested in looking over the general stock and a fine line of small motors had attracted his attention.

"Thousands of people ask that same simple question every day," I replied. "I say simple, because to anyone who understands electricity it is one of the very A B C's. Yet, strange to say, the majority of the people who are living in this Age of Electricity have never taken the trouble to even find out the difference between a dynamo and a motor.

"To explain in the simplest language I can employ, a dynamo is a machine driven by mechanical energy which converts that mechanical energy into electricity—another form of energy. A motor is a machine that takes the electrical energy generated by the dynamo and converts it back again into mechanical energy. And curiously enough, the two machines are almost identical in their construction. Indeed some dynamos can be operated as motors and some motors as dynamos without any change whatever.

"It isn't so strange, therefore, owing to the similarity of the construction of these machines, that you hear some one remark, 'And the dynamos under the street car just hummed,' or 'the great motors in the power house revolved at tremendous speed,' not knowing that he had exactly reversed the meaning of the words.



What's the difference between a dynamo and a motor?

"Going a little more into detail, a dynamo, or a generator, as it is now more commonly called by electrical men, is a machine consisting of what is called an armature which is made to revolve between the poles of a magnet or group of magnets. The armature contains a great many loops of wire which cut the lines of magnetic force which flow from one magnet pole to that of opposite polarity. Although no one can see how it is done, it is nevertheless true that this simple process causes a current of electricity to flow through the wires of the armature, which may be led out of the latter through suitable sliding contacts or brushes and sent out through the conducting wires of a circuit which may extend many miles. The current is supposed, for convenience, to flow out over one wire and back over the other, keeping up a continuous flow through the armature and outside circuit.

"There you have the dynamo. To operate the dynamo mechanical energy as that of a steam engine or water wheel is required. The more current you take out of the armature the harder it is to turn.

"Now if you take a machine similar to a dynamo away out somewhere on the line and connect its terminals to the two wires of the circuit, the current which is being generated by the dynamo flows through the armature of this second machine and, lo and behold, the armature begins to spin. There you have the motor, which is nothing more than a dynamo running backwards and using up current instead of producing it. Put a pulley on the shaft of the motor and you get mechanical power again, which

is what you started out with. That is why motors are so economical and convenient where mechanical power is required. Great dynamos in a power station generate current in vast quantities which is sent out over the lines to be used up in motors of all types and sizes from a thirty-second of a horse-power up to a thousand horse-power, as desired. Now when you want to operate a sewing machine by power you buy a little motor to do it. A few years ago it would have been necessary for you to put in a boiler and steam engine."

Non-electrical Conceptions of the Northern Lights

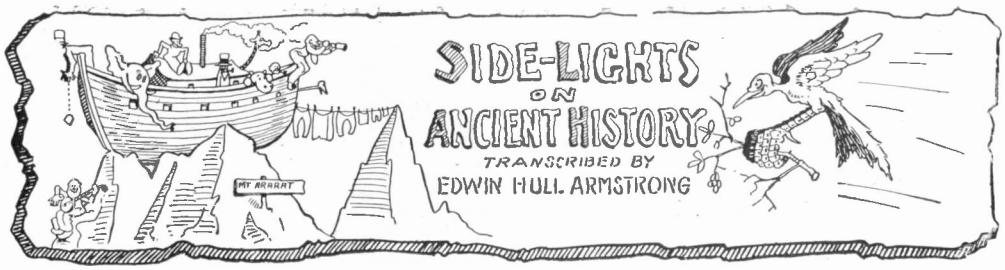
Only during the last decade has it become generally known that the beautiful phenomenon which we call the Aurora Borealis in the northern hemisphere and which those living south of the equator call the Aurora Australis, is an electrical manifestation. Today it is universally admitted that this beautiful luminous phenomenon is the result of a discharge of electricity through the rarified aqueous vapor in the cold air.

Nowadays the appearance of this interesting display at the point in the sky towards which the magnetic needle points, usually comes as a pleasant surprise. But in earlier times these northern lights (like the less frequent appearance of comets) were looked upon as manifestations of the supernatural and generally as omens of some impending calamity. Some of the rare books issued three or four centuries ago show some of the old conceptions of the northern lights, the earliest being that of a winged witch with a whip, hovering among the clouds and threatening dire vengeance. A century later the popular notion changed to that of battling warriors.

Nor has this superstitious dread been entirely outgrown to this day, since those looking for mishaps can always find some early event to link to such a premonition. Hence right within our own time thousands, if not millions, have held a superstitious fear that dire happenings would follow any generally visible manifestation of the polar radiation, not understanding that this is just as natural a sequence of certain weather conditions as is the appearance of hail or sleet. For instance, an unusually brilliant aurora was visible in most of Europe on the 24th and 25th of October, 1870, when the war between France and Germany was at its height. Two days later the city of Metz capitulated to the Germans and 173,000 French soldiers were taken prisoners. The superstitious among the French were never more sure of having a great misfortune foreshadowed by an aurora; but how about the equally superstitious German peasants who had seen the same sign? Still more speedy was the apparent sequel to the aurora of September 9, 1898, for twenty-four hours later the Austrian queen was assassinated. And if instead of Halley's comet an unusually attractive aurora borealis had been visible in England early in May of this year, it would undoubtedly have been connected by many with the unexpected death of King Edward.

ILLUSTRATIONS CONTAINED IN BOOKS THREE OR FOUR CENTURIES AGO, SHOWING EARLY CONCEPTIONS OF THE ORIGIN OF NORTHERN LIGHTS

Truly, the suppression of superstition is a slow process as long as every week brings one or more important mishaps somewhere on this great globe, any one of which can easily be linked to a misconception of that most beautiful of all meteorological phenomena, the so-called northern light.



It was demonstrated yesterday that hens will lay at any hour in electric lighted apartments. Ham has kept the electric lights burning continuously in the hennery and as a consequence the hens lay any old time, day or night. It is not unusual for a biddy to jump off the nest and give a series of hysterical cackles at midnight.

The other morning Noah arose at two o'clock and began to build a fire. When informed of the hour he said he thought it past sun-up as he had heard a hen jump off the nest and cackle.—*Ark Record.*

◇

"What time is it, Hammy," asked Noah, as a particularly dark cloud turned day into night.

Ham looked at his watch. "It is just 12 o'clock, father," he said. Then, as he took a step or two in the direction of the dining room, he stopped, took out his watch again, shook it and looked puzzled. "It's running all right," he said, holding it to his ear. "But I would have sworn it was just the same time four hours ago." It stayed 12 o'clock for three days, the watch running all the time. Then the truth became known. It had been magnetized by "stray magnetic field" surrounding the eel tank.—*Deluge News.*

And to this day, because of this incident, we are uncertain just when dinner time really occurs, preferring, as we do, to yield to the dictates of our stomach rather than the record afforded by our office clock.

◇

Noah came out of the kitchen with his sleeves rolled up. He made directly for the eel tank under the impression that it was the place where the catfish were kept. Plunging his arm into the greenish water up to his elbows he fished around for a moment, when with a roar of pain he withdrew his hand and started back to the kitchen on a trot, holding the injured member in his other hand.

He made directly for the eel tank

"Shades of Leyden jars," he muttered as he stumbled along, "why couldn't I have remembered that those were electric eels. It said plain enough on the bill of lading—'10,000-volt eels, for perpetuation purposes only.' They feel like trolley wires." With which remarks he gazed up again wearily at the dripping sky.—*Ark Record.*

Among the forms of disorder from which Noah hoped to escape by the Ark voyage was the old style method of celebrating the Fourth of July. The following from the *Deluge News* speaks for itself:

Fifty-fifth Day:—Gauge above low water mark of Adam's time 3500 cubits.

It was on the evening of the Fourth. Noah's strict instructions that the children should have no matches had been religiously obeyed. The old saint was overjoyed and was telling the children (all but one) of the accidents that formerly had followed in the wake of the popular celebration. He had drifted from that to commending them on their obedience, when a series of shots, booms and other loud reports rent the humid atmosphere at the front of the vessel. With that the youngsters made for the lower deck, and Noah, his faith in humanity greatly shaken, followed.

The whole trunk of fireworks exploded

The whole trunk full of fireworks which were being saved to celebrate any possible future landing of the Ark had been exploded.

"Where's that Shem boy," suddenly exclaimed Ham's wife. That was enough to start trouble and they looked him up. He was a mere child of 63 but he was what is called an amateur wireless fiend. All day long he had been flinging C. Q. D. calls out from the roof of the Ark—only toward evening he had bethought himself of his new relay which he contemplated exploding mines and blasts. Of course he tried it on the fireworks with the result that the younger element were extremely peeved over the loss of the only fireworks in existence.

◇

City Marshall Murphy brought in a battered specimen yesterday. He had been trying to beat his way to Orchard City on the electric suburban. Investigation proved the man to be Cain who has been strictly up against it since his parents had to give up their home in the old Garden. Previous to that time, Eve would occasionally hand out an apple pie or some dumplings to her unfortunate first born when he came home from some long pilgrimage to Egypt or Ethiopia.

It appears that Cain got a job with the First Parents Electric and Railway Company, that is im

proving the old Garden of Eden, but as soon as his identity was disclosed they let him go. For our part we think Cain has had the ragged end of it. The affair of his brother's death, in which he was involved, and in which he hardly had a fair trial, no doubt was an accident.

In this connection it may not be amiss to say that this proposed trip of Noah and his family in the Ark, with all the rest of the world at the bottom of the deep is a mighty clear case of favoritism.

When will the people awaken to their wrongs?—*Serpent's Hiss* (Socialist).

◇

Fire broke out in No. 7 trundle bed on the night of the 29th day.

Noah was just retiring when he said: "I smell smoke."

"The children are all in bed," said Ham's wife, with assurance. There was always a disposition to look to the children in case of trouble.

A few smothered cries from below, and a couple of childish forms appeared on deck enveloped in flames. For a few moments all was confusion. Then with great presence of mind Ham soused both youngsters in the eel tank, to the accompaniment of frantic yells.

A couple of childish forms appeared

"It was so chilly," said Ham's wife, after the fire had been extinguished and the youngsters quieted, "that I put the children between the electrically heated blankets."

"What, those electrotherms?" said Noah, "I guess there must have been a short circuit in them. Where did you buy them, Agnes?" turning to Shem's wife.

"Oh, from one of the department stores," she replied. "I saw an ad. in the last Sunday paper before we sailed. It seemed that the store management was somewhat unsettled over the talk of New Nationalism and were cutting prices awfully. I couldn't resist, especially when they told me the electrotherms could be regulated to three degrees of heat."

"Evidently the third degree meant combustion in this case," said Noah as he turned down the light and put the cat out.—*Deluge News.*

◇

The local Fruit Growers Association in conjunction with the railway company gave a picnic yesterday in the old Garden of Eden. It was the first glimpse the public has had of this world renowned orchard.

The place shows the effect of neglect. Four hundred years makes quite a change in things. The cottage inhabited by Adam and Eve is badly shattered. It needs paint and should be reshingled. The old shed kitchen where Eve did her washing, is the best preserved of all. There is a nail at the side of the house where the clothes line was tied, and Adam's fishing rod stands leaning against the house.

The gathering was made memorable by the presence of Adam himself. The old man is well past nine hundred but his memory is still alive to the stirring events of four hundred years ago. As Adam was expelled from the garden it was necessary to procure a permit before he was allowed the freedom of the grounds. Our reporter had no trouble in persuading Secretary Robbins to issue the permit.

Adam states that just previous to the time that the incident occurred he was making a series of electrical experiments to determine if there were any such things as eddy currents. Having need of a high resistance material, Adam induced the Serpent to allow a few of his coils to be introduced into the circuit. When the current was turned on the Serpent boiled inwardly, not only from indignation but also from C^2R loss within his folds. When his extremities were taken out of the binding posts he at once set about using his influence to have Adam and Eve expelled.

The distinguished visitor viewed the scenes of his former activities with greatest interest. Once, when the attention of the reporter was directed elsewhere, Adam stole a glance at the tree of Forbidden Fruit, which since the expulsion has been enclosed in an iron cage. As the old man's gaze rested on the ripe, luscious fruit, a dreamy far-away look came across the fine old countenance and an unwonted glimmer into the dim old eyes, and he smacked his shriveled lips reminiscently. The action was momentary and involuntary—the memory of a sensation. The fact of the matter is that the doctor has advised against fruit of any kind for the last hundred and fifty years, and as to apples: after that unfortunate affair of the Garden, the Doctor never would consent to Adam eating any more apples.—*Serpent's Trail.*

◇

"Have you noticed," asked Ham of Shem's wife, "how beautiful Matilda is growing?"

Agnes cast a deprecating glance at the object of the remark, as she stood at the bow watching for the dove. "She doesn't appear a bit better looking than when I first saw her. She's too tall and then she's thin as a rail and her feet are too lar—"

At that moment Shem and Noah joined them and each in turn commented on the growing beauty of Japheth's wife.

A few days later, while Mrs. Japheth was below, helping her husband trim the Polar Bear's corns, Shem's wife and Mrs. Ham found an electric massage vibrator and some sponge electrodes in Mrs. Japheth's bed room.

"There," said Ham's wife, "that explains why she's getting better looking."

"You mean," said Shem's wife, "that is why people have thought she looked better. For my part I can see no improvement in her looks."

"You see," said Ham's wife, paying no heed to Mrs. Shem's comments, but looking at the toilet articles more closely, "she removes wrinkles with the vibrator and imparts vigor to the skin and tones up the system by means of the sponge electrodes."

"Well, all I can say is this:" said Shem's wife with a pout, "If I wasn't presentable naturally, I wouldn't try to make myself so by artificial means," and she looked scornfully at the apparatus.

"I don't believe in such things either," said Ham's wife, and she drew back preparatory to giving the inventions an overhand fling into the sea, when Shem's wife caught her arm.

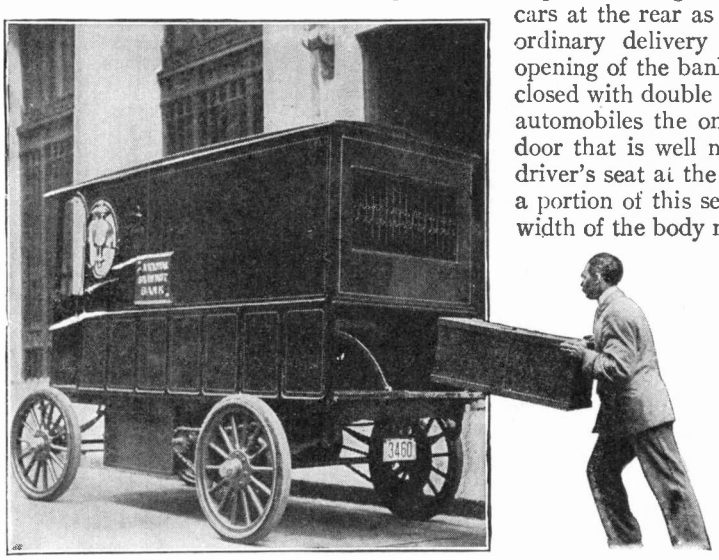
"Let me have the vibrator and one of the electrodes," she said, then lowering her voice to a whisper she added,

"I want to try them and see if it was really that."—*Deluge News*

Transporting Money by Motor

It has been said that the great and permanent future of the automobile lies largely in the field of the commercial vehicle. If this be true it is very safe to predict that the electric motor car will attain a pre-eminence more marked than has characterized it in the sphere of the pleasure vehicle. The commercial car finds new adaptations almost daily and it is notable that in a majority of cases the preference of the hard-headed business men who are responsible for the innovation, is for electrics. The latest outcome of this tendency of the age is found in the recent introduction in several of our large cities of special motor cars devised by leading banks for the transfer of money, gold bullion and securities of all kinds.

The cars are designed, as may be surmised, for the use of bank messengers and collectors on their daily rounds of visits to other banks and to business houses. Time was when bank representatives made such tours afoot and on street cars, carrying in hand satchels the funds entrusted to their care. However numerous robberies compelled bank officials to put a veto on this plan of freely mingling with the crowd on congested thoroughfares. Then carriages were provided for the bank "runners" but as the business districts of our cities expanded and prominent banks came to have close relations with branches in outlying districts and independent banks in the suburbs and near-by towns the horse-drawn vehicles proved inadequate to "cover" the territory within the narrow limits of banking hours. Necessity proved the mother of invention as in many other instances and bankers in various parts of the country, unconsciously co-operating with their demands and suggestions, have brought about the evolution of the modern bank car.



MODERN ELECTRIC BANKING AUTOMOBILE

The up-to-date bank car presents outwardly, to the casual observer, much the appearance of an ordinary delivery car, but beneath its commonplace exterior it shelters a steel cage or case which makes the vehicle in effect a portable safe. Moreover it is impossible to gain access to some of these cars at the rear as would be the case in any ordinary delivery wagon. If there is an opening of the bank car at the rear it can be closed with double locks and in most of these automobiles the only entrance is via a steel door that is well nigh concealed behind the driver's seat at the front of the car. Indeed a portion of this seat which extends the full width of the body must be raised ere one can enter at the door which is, of course, closed by heavy locks and cannot be opened from the outside except with keys.

However in the new regimé the bankers who must convey millions of dollars of gold, currency and securities through crowded city streets are not depending for its safety wholly upon the steel-lined automobiles, difficult of access as they undoubtedly are. A second line of defense is provided in a corps of armed guards attached to each motor car. There are one, two or three of these guards in addition to the chauffeur. They are uniformed; have credentials as special policemen and are armed with the latest type of magazine or automatic guns. It is customary to have one or two guards ride on the seat with the driver of the car, forming a

cordon across the entrance to the repository of valuables, and some banks have adopted the extra precaution of having an armed guard stationed within the locked enclosure during the run through crowded thoroughfares in going from one bank to another.

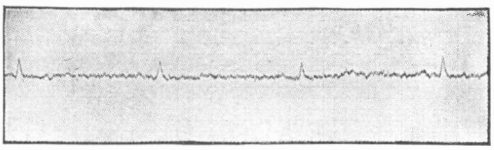
ANOTHER TYPE OF BANK AUTOMOBILE—VALUABLES PLACED IN FRONT

The average bank automobile of the new pattern is fitted with a two to three horsepower motor and is capable of 35 to 45 miles on one charge. It has been found that in actual service a car is very seldom, if ever called upon to cover an aggregate of more than 30 miles in any one day and consequently the use of excessive speed is never required. The charging of batteries is generally done at night in accordance with the usual practice, but the short day that obtains in the banking world affords especial leisure for charging, cleaning, or making any slight repairs. Most of these cars have a carrying capacity of about 1,000 pounds and this is ample for the requirements of a majority of banks, although the heavy, iron-bound chests employed for the transportation of securities, etc., have no slight bulk.

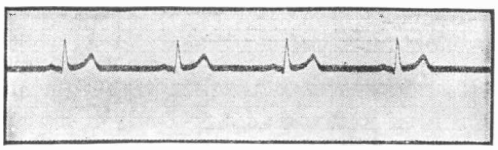
Recording Heart Beats Electrically

When the French physician René Laennec invented the stethoscope some 90 years ago, he laid the foundation for the modern practice of diagnosing which has saved the lives of untold thousands afflicted with diseases of the heart or lungs. In recent years the improvements of Dr. Camman (of New York City) have made this instrument much more sensitive than it was in its original form, so that it admits of finer diagnosing. In some instances a microphone attachment is also said to have been used to advantage, magnifying the sounds so that they could be more clearly noted. But in every case the distinctions had to be noted by ear and any comparisons as to the intensity of the chest sounds or their intervals could only be based on the doctor's memory or his description.

Now in transatlantic telegraphy the siphon recorder (one of Lord Kelvin's masterpieces) traces a permanent record of the fluctuations in a current too feeble to operate a sounder. Why not do the same for the delicate current variations due to impulses of the heart action? The throbbing of the heart makes a difference in the resistance of the circulatory system, so that if a current is passed through the body from one hand to the other, it will vary in strength with the heart beats. Having determined this fact, Professor Bull of Paris (a pupil of the celebrated physiologist Etienne Marey who has experimented so cleverly on the electric phenomena accompanying movements in animals) has been using a similar recording device for tracing heart throbs. The patient is comfortably seated, with each hand dipping into a bowl of salt water so that a battery current passes through him to the instrument which traces the valve action of the heart. Of course the current used must be uninterrupted and too



RECORD OF DISEASED HEART



RECORD OF NORMAL HEART

weak to exert any action on the system. By noting the characteristic curves of those afflicted with different heart troubles, many of the latter can be speedily distinguished so as to avoid any guesswork in the diagnosing. Then repeated heart-beat records of the same patient can easily be compared so as to show just what change has been effected by any given treatment.

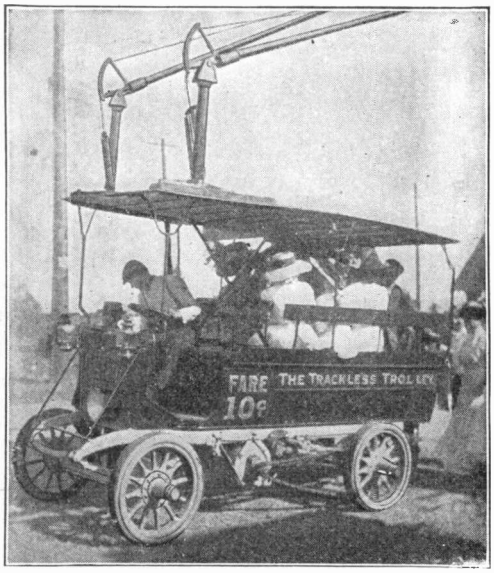
First Trackless Trolley in America

While Germany and other parts of Europe have made extensive use of the trackless trolley system, the first equipment of this kind in America is now in successful operation at Laurel Canyon, Hollywood, California. The service affords communication from the mouth of the Canyon, where the electric railway ends, to Bungalowland, a new settlement further up the Canyon.

Owing to the steep grade and the heavy cost of a regular electric line, a trackless trolley system was tried out. Two overhead wires and two trolley poles serve the car with current which passes into the car over one trolley and out by the other.

The cars attain a speed of from 20 to 25 miles an hour. The Company at present has two passenger cars in operation. Each car accommodates sixteen passengers. It requires eight minutes to make the trip of a mile and a half over a twelve-per-cent grade. On the down trip the power is in use only about half the time.

The cars have a latitude of eleven feet on either side of the road, making it possible for them to turn out for any passing vehicle without losing the trolley. This play is compensated for by a system of springs, shown in the picture, which keeps the trolley wheel in perfect contact with the wire at all times. The cars resemble an automobile except for the two trolley poles mounted on the forward part of the roof of the car. A controller is mounted on the front dashboard while the fuses and cut out switch are overhead instead of underneath, as on a standard electric car.



TRACKLESS TROLLEY CAR IN CALIFORNIA

The roadbed is of crude oil and sand. The cars are making regular trips on a fifteen-minute schedule, the fare for the trip being ten cents.

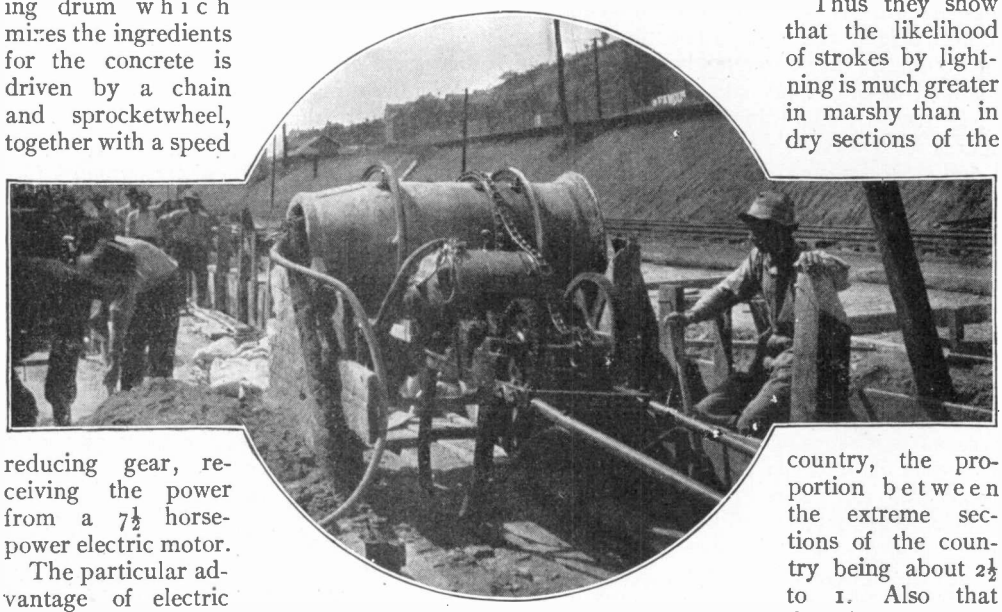
R. B. YALE.

Suspended Railways Conquer Snowstorms

One advantage prophesied for electric railways of the suspended type (as pictured on page 518 of our October issue) is their being unhampered by the drifting snow which might pile up ten or twelve feet high without even reaching the cars. The correctness of this claim was demonstrated last winter by the similarly suspended railway connecting Barmen and Elberfeld, for while it could not maintain its regular schedule during some heavy snowstorms it was the only line in that section of Germany which did not have to suspend its service completely.

Mixing Concrete by Electric Power

Wherever electric power is available it may be utilized to special advantage in the mixing of concrete. The concrete mixer shown in the illustration was used in mixing concrete for the retaining walls at the Edgar Thomson Steel Works at Bessemer, Pa. The revolving drum which mixes the ingredients for the concrete is driven by a chain and sprocketwheel, together with a speed reducing gear, receiving the power from a 7½ horsepower electric motor.



CONCRETE MIXER WORKING AT BESSEMER, PA.

The particular advantage of electric power here lies in the ease with which the whole apparatus may be moved from place to place and in the simplicity of its operation over an engine driven outfit.

Where Lightning Strikes

Although lightning is causing a heavy annual loss of property and some loss of life in nearly all civilized countries (the property loss in the United States alone averaging over a million and a half dollars a year), but little effort has been made towards obtaining reliable statistics as to anything beyond the property loss in insured buildings. The one section of the globe in which more extensive figures have been kept for a long enough period to show dependable averages is Schleswig-Holstein, that northermost province of Prussia which Bismarck's scheming wrested from the Danes 45 years ago. In this section, about equal in area to New Jersey but with only two-thirds as large a population, careful records have been kept ever since 1874 as to the havoc played by lightning. A study of these records, as recently undertaken by the provincial Society for Natural History, brings out a number of interesting conclusions, many of which would seem equally logical and likely for the average conditions found in this country.

Thus they show that the likelihood of strokes by lightning is much greater in marshy than in dry sections of the country, the proportion between the extreme sections of the country being about 2½ to 1. Also that the frequency of the strokes decreases with a growth of the forests, but increases with a devastation of the woodlands, a fact particularly well proven there, as no other section of Germany has less woodland than Schleswig-Holstein. The number of strokes per million of buildings averaged 362 per year, being 236 annually for city buildings and 425 for country houses, which makes the rate in the rural districts nearly double that in the cities. Of the houses struck by lightning, the number having wooden or thatched roofs was 2½ times as great as those having slate or metal roofs; but the damage done to the former was about eighteen times as common, since 94.4 per cent of the buildings set on fire by lightning had the wooden or thatched roofs.

In analyzing these records, Dr. Hans Brodersen endeavored to trace some connection between chimneys and the direction of the lightning, but could find no conclusive proof of the popular assumption

that chimneys attract lightning, although the chimney was struck in 40 per cent of the cases examined by him. On the other hand he feels convinced that the weather-vanes which have also been popularly supposed to attract lightning, do not act in that capacity.

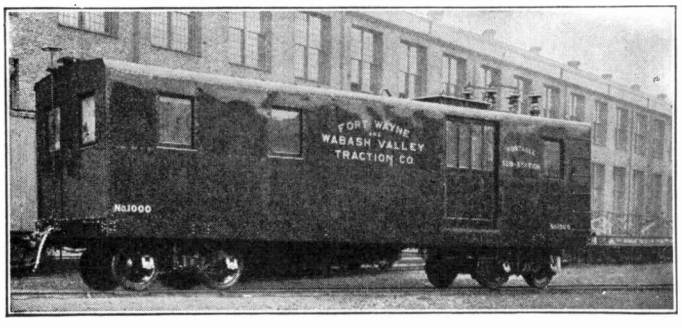
As to trees, the conclusion drawn from these records is that they do not generally protect neighboring houses and that poplars are by far the most frequently struck. The common notion that oaks are most often devastated by lightning is upset by the figures for a total of 239 trees struck during a period of fifteen years. These comprised 109 poplars (or 46 per cent of the total,) 26 oaks, 23 linden, 21 ash, eleven fruit, ten willow, ten pine, six alder, three elm, one birch and one beech.

During the same fifteen years the loss in life amounted to 30 persons and 393 animals. Of the former 290 were struck indoors, 19 of them fatally; while outdoors the fatality was eleven out of a total of only 22 persons struck. The small number injured out of doors is easily understood, as people naturally seek refuge indoors when a storm approaches and would only be exposed in the open if caught unexpectedly. Then the difference in the percentage of fatalities implies that the force of the lightning is readily spent on the structure itself when it strikes a house or is conducted to the ground by various paths, such as drain pipes, which are better conductors than the bodies of the people in the house. On the other hand, the human body is a better conductor and hence forms an easier path for the lightning from the wet leaves to the ground than is done by the dry trunk of a tree, hence the large proportion of deaths due to exposure under trees in open fields.

A Portable Sub-station

To send a heavy electric current over a long distance requires a heavy wire; and copper costs money. Power companies therefore distribute current over large areas by transmitting it at high voltage but low current to points where needed and then change it to low voltage in what are called "sub-stations," after which it goes out over other wires to customers.

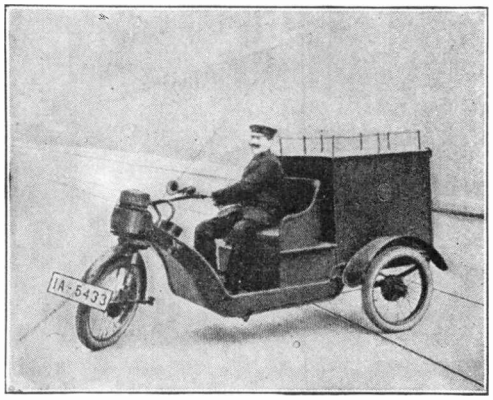
An interesting portable sub-station built by the Westinghouse company is now in operation on the lines of the Fort Wayne and Wabash Valley Traction Company, the whole equipment being contained in an all-steel car 40 feet long. Whenever current is needed in construction work anywhere on the system the car is taken there and connections made to a high voltage line instead of to the trolley wire.



A PORTABLE SUB-STATION

Handling Mail with Electrics

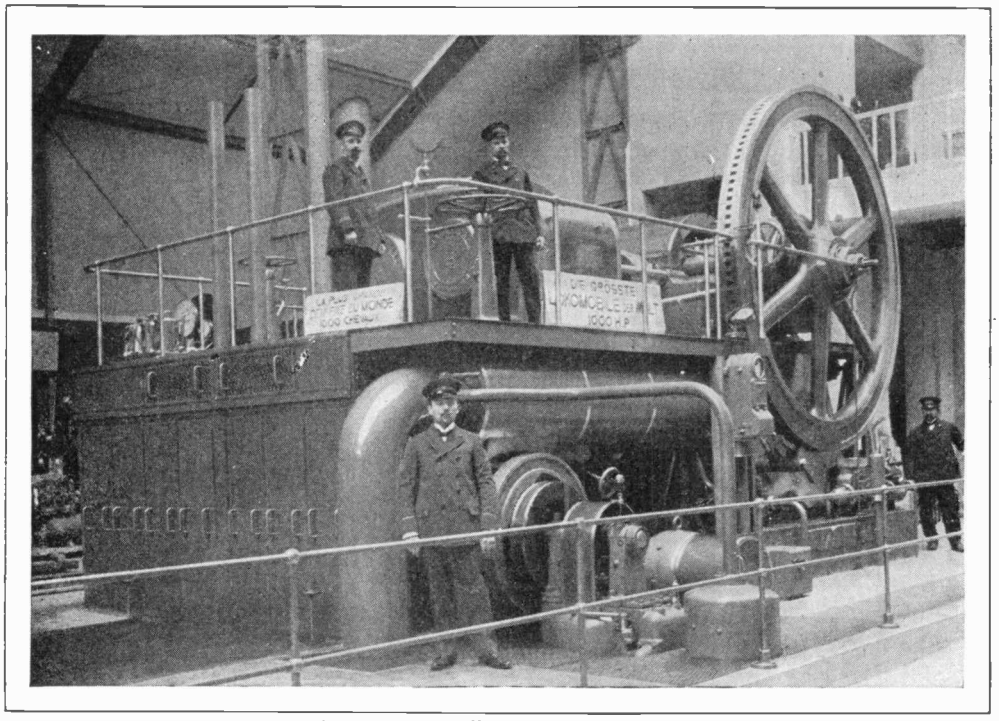
The "familiar step of the postman" may be replaced by the "honk, honk" of the automobile horn. The German Postoffice Department is trying out the electric automobile for carrying the mail, one type of the machine used being a three-wheeled affair. The propelling and steering wheel are one, the motor being mounted just above the wheel. The brake is applied on the rear wheels.



NOVEL MAIL CARRIER'S AUTOMOBILE

Largest Steam-electric "Locomobile"

"Locomobile" is a German term for a particularly compact and efficient type of prime mover, which engineers of that country have perfected. A locomobile is a combined boiler and engine equipment in which the engine is mounted on top of the boiler and drives a dynamo also mounted on the boiler. The one shown in the picture



STEAM-ELECTRIC "LOCOMOBILE" AT THE BRUSSELS EXPOSITION

is the largest in the world and is therefore of more than passing interest. The engine and flywheel are plainly seen, but the dynamo is not visible in the illustration, being on the other side of the engine cylinder.

The dynamo of this equipment is capable of developing 735 kilowatts, which is about 1,000 horse-power. The engine is very efficient in the matter of steam consumption, only consuming 9.9 pounds per horse-power. There is also very little heat radiation in getting the steam from the boiler into the cylinders, which is not true where long piping systems are required. The steam is superheated and delivered to the cylinders at a pressure of ten atmospheres.

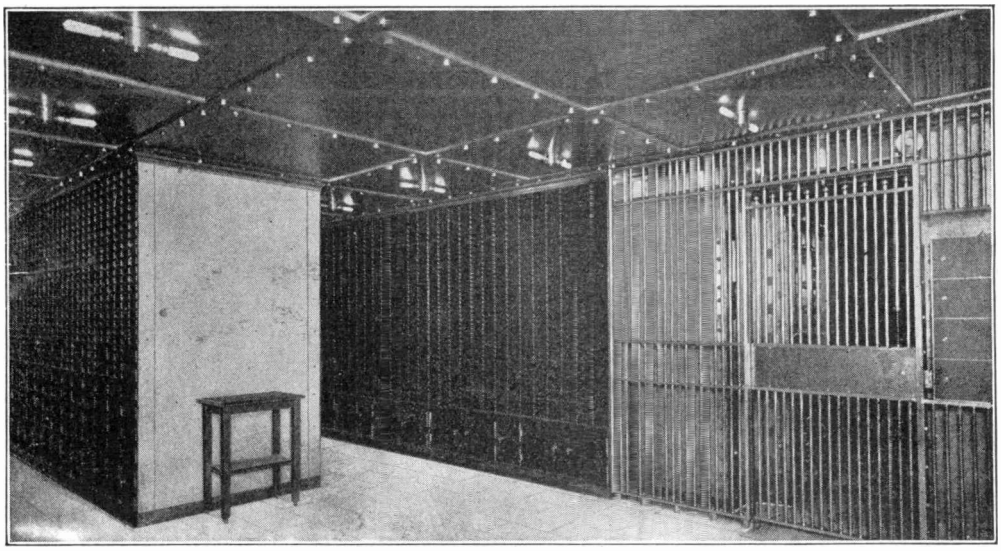
This particular equipment was installed at the exposition at Brussels, Belgium, and supplied current for lighting and power service operating continuously day and night.

Frictional Electricity on the Violin

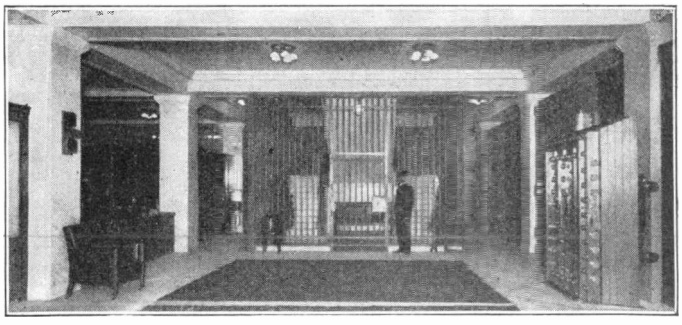
In cold and snappy weather when we generate enough frictional electricity in walking over our carpets and rugs to get a shock when we touch radiators or metal fixtures, what becomes of the same when generated by the playing of a violin? According to the volume of transactions published by the Royal Philosophical Society at London for the year 1777, William Henley proved 133 years ago that the strings of both the bow and the violin become oppositely electrified during the playing. If they do—as our musical readers can easily verify—they must attract each other. Now who can tell just what effect this has on the playing? Does it make the bow press more firmly on the string towards the end of each stroke? Does it make the bow snap against the string with a jerk when again approached to it and does it add to the effort of raising the bow from the strings? In other words, must the violinist reckon with these frictional electrical effects in dry, cold weather?

Electrical Protection of Vaults

The upper illustration on this page shows a modern banking vault as just completed for the old Colony Trust Company of Boston. In this vault electricity has been put to every possible use including the lighting of the great steel chamber with a peculiar type of long tubular incandescent lamps which show up plainly as the source of light with which the photograph inside the vault was made.

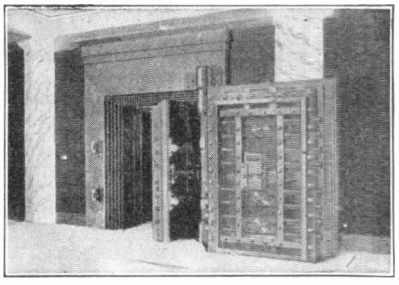


BANK VAULTS WHICH ARE PROTECTED BY A CHARGED WIRE MESHWORK



ELECTRICALLY OPERATED ELEVATOR FOR CONVEYING CURRENCY AND SECURITIES FROM BANK TO VAULT

The vault door giving access to the vault is made of armor plate between the three layers of which is electric wire netting so arranged that the slightest hole drilled through any part of the door will short circuit one or more of the fine wires and instantly call the watchman. The interior of this vault is protected by a steel armor plate ceiling and floor, on the outside of which are several layers of charged wire netting which serve the same purpose as that in the vault door.



ENTRANCE TO THE VAULTS

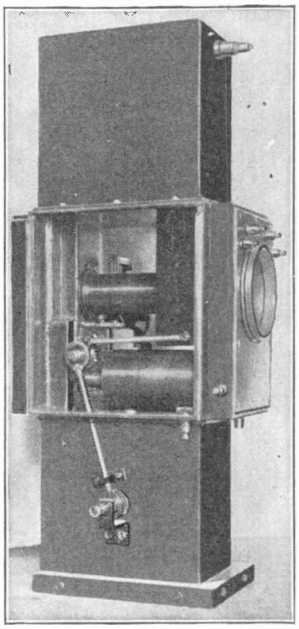
To guard against dishonesty on the part of deposit box holders an annunciator in the office of the cashier of the bank indicates which box is being opened by a box holder, and the man in the office may immediately learn whether an attempt is being made to open a box that is not rented by the party attempting to gain access thereto.

As a further protection against the negligence of any of the employees a tiny electric light near the teller's desk keeps him constantly informed as to whether the vault is locked or unlocked.

Recording Checks with an Electric Camera

A camera in which the shutter opens and closes automatically when the object is ready for exposure, is certainly a rarity, and still more so if it will make a thousand such exposures in an hour. Such a device is the check photographing camera invented and developed by Thomas Jansen, assistant cashier of the National Bank of the Republic in Chicago. It was designed to replace the slow and laborious method of keeping a written record of each check deposited with the bank and of the various endorsements on the same, whereby the check can be traced and replaced if lost. As these records are only a safeguard for the bank and are not often consulted, a miniature negative showing both sides of each check was deemed ample, provided that the negatives are sharp enough to be easily read with a convenient magnifying glass. A film with 6,000 of these negatives easily slips into a case 1½ inches high and 4½ inches in diameter. Developing and fixing the film takes about twelve minutes, hence in the four hours, time available daily in banking practice one man alone can photographically record the face of over 4,000 checks, or both the face and back of over 2,000 checks. The camera is also provided with safety devices to make sure that the film always feeds before the shutter opens, that the shutter opens and closes promptly, and that there is still film on the spool.

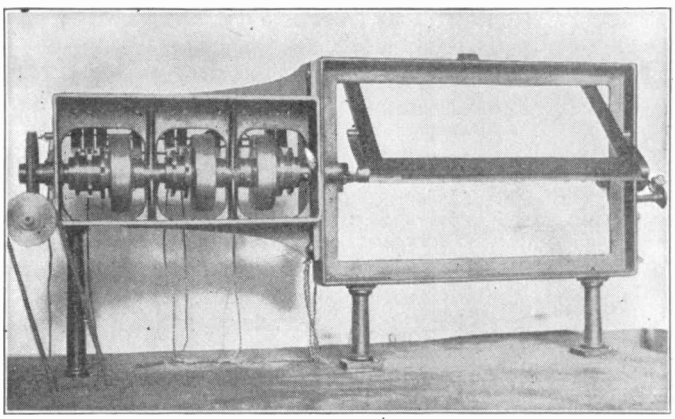
These important precautions complicated the apparatus somewhat, but were all successfully worked out by Capt. A. de Khotinsky (later mechanician of Chicago University), who built the practical camera to meet these exacting requirements.



ELECTRIC CAMERA WHICH TAKES 1000 PICTURES PER HOUR

The moving parts in the camera proper are all actuated by magnets which are so arranged that if the film fails to feed or if the shutter fails to operate, the whole mechanism stops. The lighting is done by a focusing arc lamp which is self-adjusting, while an alarm bell tells the operator when the film is nearly exhausted.

The Jansen apparatus consists of a check exposer driven by an electric motor and connected electrically to the camera which is mounted at the other end of a table, four or five feet off, with the lamp alongside it but screened from the operator. All the latter does is to drop the check into the pocket between a vertical and an inclined glass plate and to push a button which starts the moving cams and contacts on the shaft of the check exposer. Then the glass pocket closes so as to hold the face of the check verti-



COPY HOLDER USED WITH CHECK RECORDING CAMERA

cal while the film feeds about ⅜ of an inch. Next a shutter opens and closes automatically and the film feeds again while the check holder rotates so as to expose the back of the check. Then the shutter acts again and the glass pocket opens so that the check can be replaced by another.

After exposing the day's run of checks, the film is cut off, strung on a special spiral frame, developed in a tank and wound on a compact spool for filing. Before exposure, each check is stamped with a consecutive number to identify it and the bank's entries or references (as in sending it out for collection) merely mention this identification number. Should it be necessary to refer to it, the spool is slipped into a box containing an empty reel and an opalescent glass plate with an incandescent lamp under it the cover of the box having a strong magnifying glass. Then the film is fed rapidly over the glass plate to the reel until it shows the check having the desired number, which check can easily be read right from the negative through the magnifying glass as the light of the lamp brings out the lines sharply.

Who Discovered Magnetism?

Of the three common explanations as to the origin of the word magnet, the most prosaic tells us that it is derived from the Latin word magnis (meaning heavy) and refers to the high specific gravity of the magnetic iron ore known as lodestone. Another theory attributes the name to Magnesia —not the section of Greece known by this name, but the city in Asia Minor founded by emigrants from this section. It is there in Asia Minor that the lodestone (a form of the ore which is found in this country as magnetite) was first said to have been found by a Greek some three thousand years ago. Hence the lines of the Roman poet Lucretius, whose poems are so often in accord with modern science:

"Now, chief of all, the magnet's power I sing
And from what laws the attractive functions spring:
The magnet's name observing Grecians drew
From the magnetic region where it grew."

But still more poetic is the explanation which traces the word magnet back to a shepherd named Magnes who is said to have made this discovery of the lodestone on Mount Ida in Asia Minor. One version of the legend claims that his shepherd's crook, which had a rod of iron, was held by the lodestone in the ground so that he could not carry it away. The other legend goes still further by claiming that he stepped on the magnetic ore unconsciously and that this held him a prisoner owing to the iron nails in his shoes. Either legend would have lent itself to an interesting picture or work of sculpture and it would not be surprising if one of the numerous exploring parties in the old Greece should unearth some representation of the amazed shepherd.

Testing a High Voltage Line

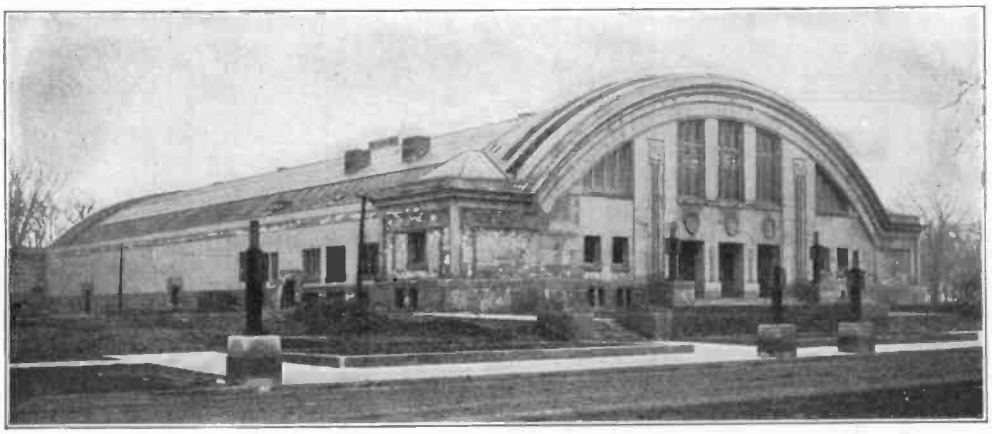
A portion of the high voltage power transmission line by which Ontario is to be supplied with current from Niagara Falls was recently tested out. A pressure of 165,000 volts was turned upon the wires and no sparking whatever was noticeable, although this is 55,000 volts higher than the voltage to be used on the line. The test satisfied the hydro-electric Commission that their plan for the distribution of power is a success.

Patents on the Electric Flasher

In the October number of Popular Electricity a description was given on page 531 of an electric flasher. It develops that basic and detail patents on flashers of this type are held by a company prominent in the manufacture of electric heating devices. We were unaware of this at the time the article was printed, and it is of course not the policy of this magazine to encourage in any manner the infringement of patented devices. It is not out of place here to say that any one making the device would be liable to infringement proceedings.

Locating Springs Telephonically

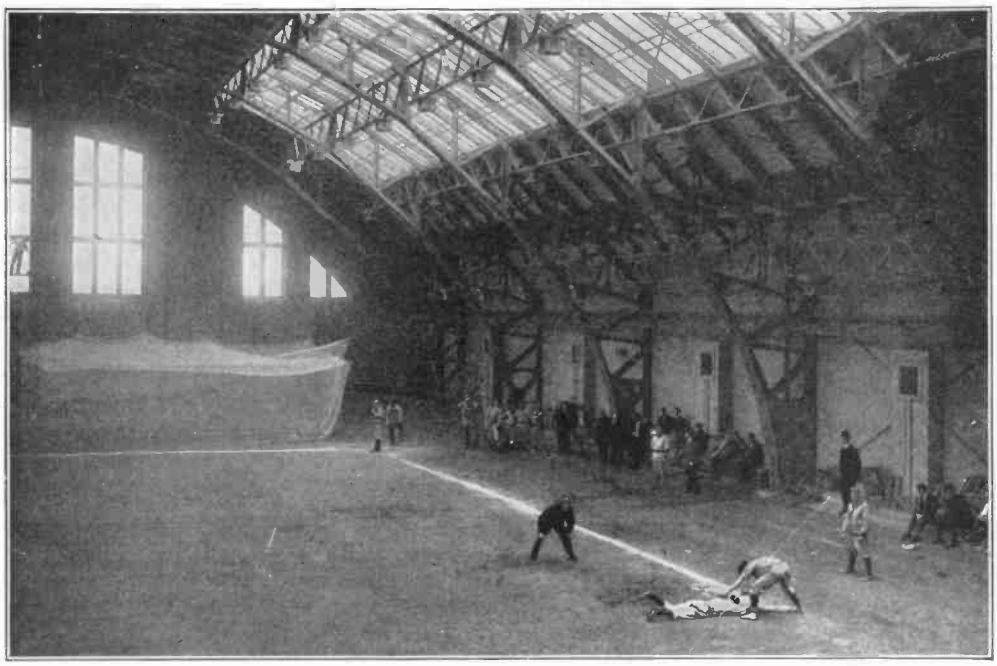
According to reports from Paris a local engineer named Dienert has been successfully using a sensitive microphone with a listening tube for magnifying the rumbling or dropping of underground streams of water so as to make them audible to the human ear. It is claimed that several subterranean springs were thus located at depths of about 50 feet and if further tests substantiate these reports, we may at last have found what believers in the so-called divining rods had been seeking for centuries.



EXTERIOR OF NORTHWESTERN UNIVERSITY GYMNASIUM

Lighting a Big Gymnasium

Northwestern University, Evanston, Illinois, has just completed, at a cost of approximately $200,000, a new gymnasium which is of interest on account of its size and also because of the question which arose as to how the track room should be lighted. This room is 193 by 129 feet, affording a straight-away sprinting course of 60 yards. The highest point of the arched roof is 50 feet above the floor. To light the track and floor, and at the same time illuminate the walls and ceiling so that in games of basket ball and indoor baseball the ball can be easily followed, the direct and indirect systems of lighting are combined. Attached to the steel-arch trusses are 156 box shaped



BASE BALL CAGE AND RUNNING TRACK ILLUMINATED BY BOTH DIRECT AND INDIRECT SYSTEMS

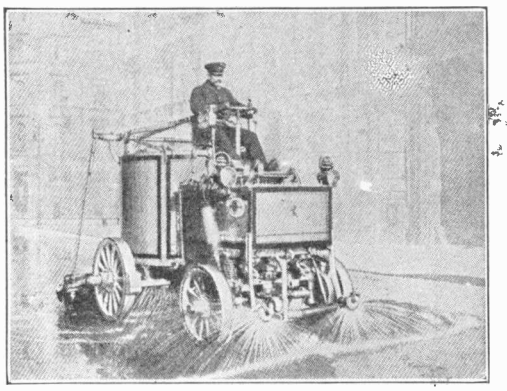
metal and art glass lantern fixtures as shown in the picture. Each fixture contains a 100-watt tungsten lamp suspended by a short flexible cord within a deep corrugated mirror-glass reflector which throws the light downward. For the indirect lighting two mirrored half-reflectors pointed toward the ceiling are placed on the top of each lantern fixture and one sixteen candlepower carbon lamp used in each until less fragile 25-watt tungsten lamps are produced, the breakage on these being too high at present. All the wiring of the building is in metal conduit. At the side walls of the building may be seen the metal cut-out cabinets built into the trusses and containing push button switches controlling the lighting circuits.

The push button portion of these switches is connected through a solid brass plate on which each switch is marked with the circuit it controls.

Opal reflectors are used in other parts of the building except the trophy and social room, where box art glass fixtures add to the attractiveness. Pillars at the front of the building are also enclosed in long rectangular art glass box fixtures for use in lighting the roadway and entrance on gala occasions.

Electric Power Cleans Streets

A prophecy that the children of the near future generations may have to go to the museums to find out what the word "horse"



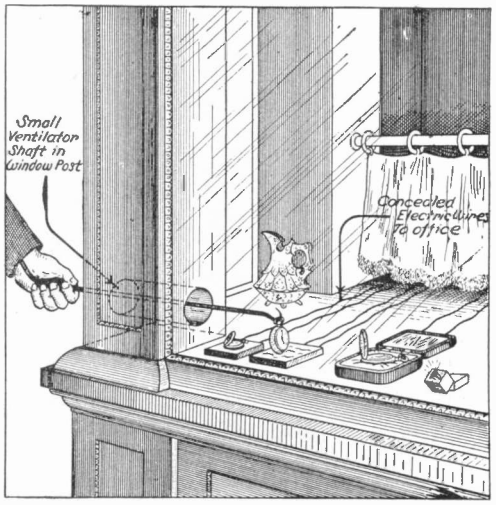
ELECTRIC STREET CLEANING CART

means seems premature, yet almost daily in the large cities instances may be found where horse energy is being displaced by electrical energy.

Berlin, as explained by *Die Mitteilungen der Berliner Elektricitætswerke*, affords an example of the change by the use of an electrically driven street washing machine here illustrated which is furnished power by a storage battery of 40 cells. Results have been most satisfactory and the fact that the care of the horses is eliminated has done much to increase its popularity.

How a Thief Was Caught

A thief was recently trapped in Montreal by the aid of an ingenious application of electricity. Watches and jewelry had mysteriously disappeared from a show window and for a long time no one could account



HOW A THIEF WAS CAUGHT

for the loss. Finally some one remembered that in the lower wood work enclosing the window some holes had been made for ventilators, and when another watch had disappeared and its case was found to be drawn over slightly toward one of the holes it was plain that the thief had removed the watch through the hole by means of a wire. So an electrical trap was set to catch him in the act.

Several watches were disposed about the window with concealed wires connecting them in what is known as a "closed circuit" alarm. As long as the circuit in such an alarm is not opened no signal is given, but when it is broken at any point a bell begins to ring.

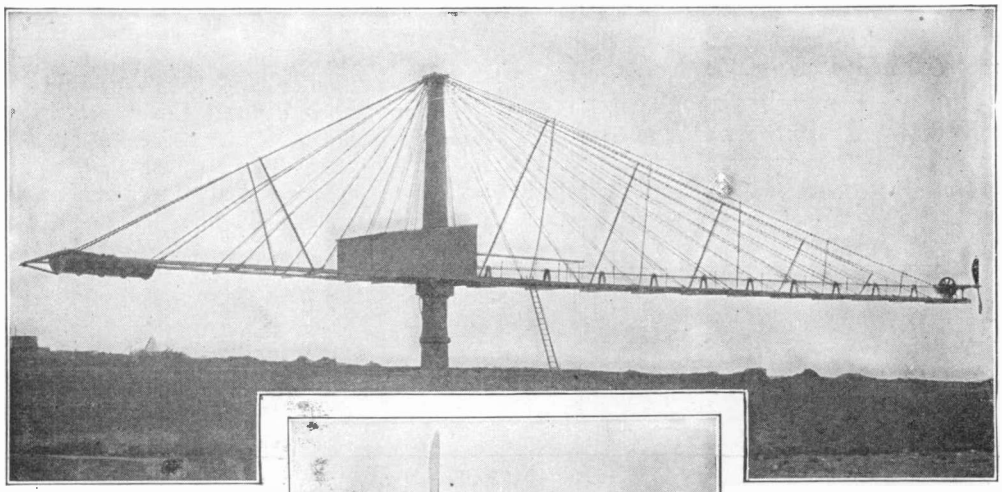
It was not many days before the "curtain call" on the act was announced to the men in the store. It was then that the man with the hook "got the hook."

Testing Airship Propellers

Perhaps no move of recent times is more indicative of the ultimate success of the airship as a practical business commodity than the action that an English firm of naval shipbuilders has taken in erecting at Barrow-in-Furness an electric air propeller testing plant.

At present the system usually used in the securing of angles for propeller blades is to take the same angle that is used in power fans and make it up in laminated wood. No firm has thought it possible to make tests of a propeller under the same conditions that would govern its use in the dirigible or aeroplane and thus determine not only the best size of propeller but its greatest efficiency in relation to the angle of the blades. At present it is evident that the air propeller, having a material of much less density upon which to work, will require greatly different lines from those of the water propeller; furthermore, the greater speed at which it must be run to secure an equal thrust on the air introduces complications in construction to withstand the centrifugal force and back pressure which are certain to be developed.

With the idea of testing air propellers under the same conditions that exist when in actual use the English shipbuilding firm has erected at a cost of about $100,000 a huge steel cantilever, which rises 70 feet from the ground and is accurately balanced in such a manner that the entire structure is free to revolve from the head of a great cast iron column. At a distance of 110 feet from the balancing point on the end of one of the arms is affixed the propeller to be tested. A shaft runs from an observation house in the center, containing a 100-horse power electric motor, to the bevel gears, which drive the propeller to be tested, and an operator in the observation house turns on the current to the motor and makes his observations from the recording instruments in the house.



SWINGING CANTILEVER FOR TESTING PROPELLERS

When running trials the revolutions of the propeller may be varied from 250 revolutions per minute to over 1,000 and propellers absorbing as high as 200 horse power may be tested. The passage of the propeller through the air may be regulated by the use of resistance screens and the highest speed attainable is 70 miles an hour. The whole

cantilever is balanced by letting water in or out of the ballast tank on the other extreme of the structure and the whole rests on ball bearings concealed in the lower section of the iron column.

Conditions for this machine are exactly similar to those of a ship running in a straight line through the air, as an ingenious method of compensating for the circular path of the propeller has been arrived at without which the portion of the propeller blade nearest the center would travel less rapidly than the outer portion. A means of accurately measuring the thrust of the propeller to within one per cent of 500 pounds is included in the design of the bracket and gearing, the propeller shaft being allowed to move forward against a spring, which movement is mechanically recorded in the observation house.

Rochester's Industrial Exposition

During Rochester's Industrial Exposition which was held in October, the main street was illuminated in a pleasing manner by large canopies of lights which rose from both sides of the streets to form huge domes of white lights surmounted by small red balls.

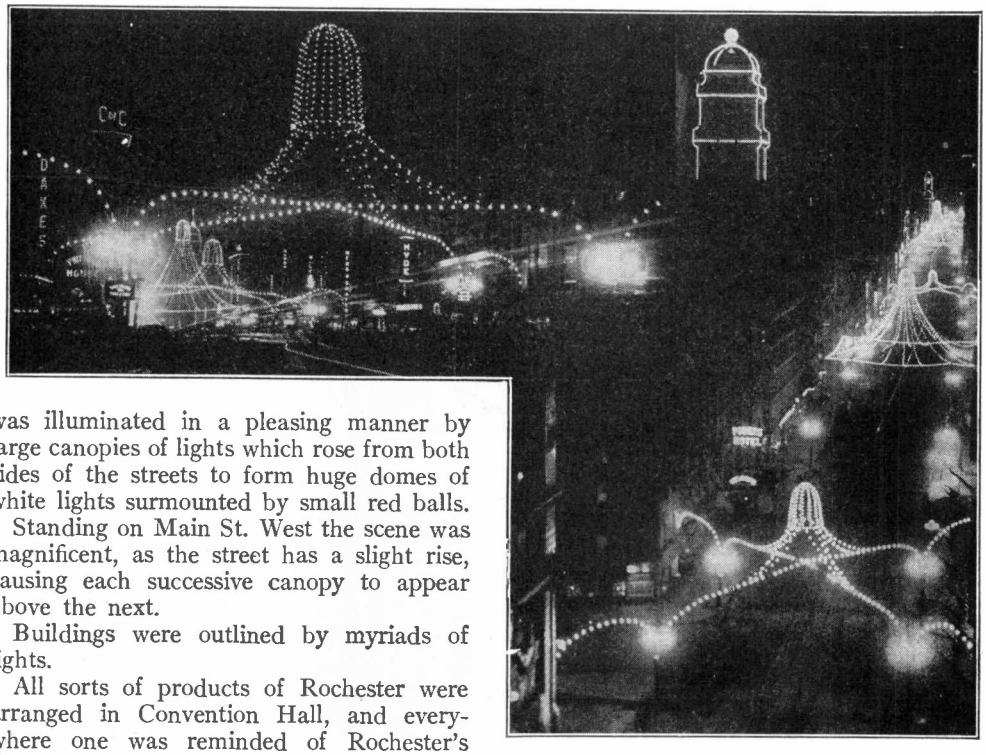
Standing on Main St. West the scene was magnificent, as the street has a slight rise, causing each successive canopy to appear above the next.

Buildings were outlined by myriads of lights.

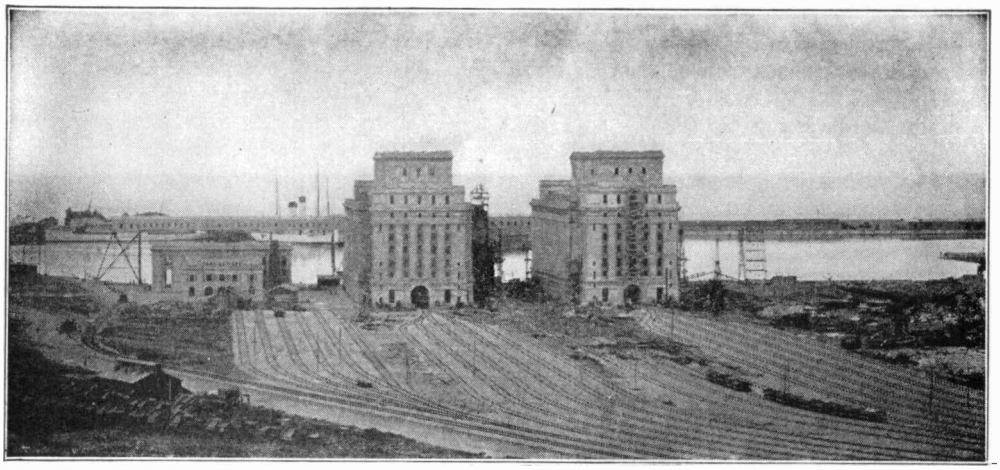
All sorts of products of Rochester were arranged in Convention Hall, and everywhere one was reminded of Rochester's slogans, "Rochester-made means quality," and "Do it for Rochester."

Platinum in Lamps

Before Edison produced a practical carbon filament and thus made the incandescent lamp a commercial article, many experimental lamps had been built with the filament made of a single loop of platinum sealed into the bulb so that its two ends projected and made the terminals of the lamp. As platinum is fully as costly as gold, its price alone would have made its use prohibitive. With the coming of carbon as a practical filament material, the use of platinum was restricted to the short lengths needed for passing through the glass of the bulb. Even this length has gradually been reduced, but so tremendous is the annual consumption of incandescent lamps that the cost of the platinum used for this purpose is estimated at half a million dollars. Efforts to replace the platinum with inexpensive metals or alloys have not been very successful as yet, but in view of the large saving that might be effected, a good deal of experimenting is being done along this line.



ILLUMINATIONS AT THE ROCHESTER INDUSTRIAL EXPOSITION



LARGEST GRANARIES OF EUROPE—CONSTANTZA HARBOR

Europe's Greatest Inland Harbor

In the September, 1910, issue of POPULAR ELECTRICITY there was contained a brief description of the extensive harbor improvements in the Roumanian city Constantza. Some photographs of this unusually interesting work have since become available and are here reproduced.

After completing in 1894 the regulation of the Sulina arm of the Danube which ensures a safe entrance into the river, and inaugurating in 1895 the huge railway bridge at Cernavoda, constituting the shortest connection of the Black Sea with the Baltic and North Sea, and in 1896 the Iron Gate canal, which likewise is of much importance for commercial connections, the Roumanian Government in October, 1896, commenced the extension work of Constantza Harbor, which has recently been opened to navigation.

In order adequately to gauge the importance of this harbor it should be remembered that the rather limited coast of Roumania does not comprise any natural harbors worth speaking of. The Government, intent upon furthering the trade and commerce of the country, therefore decided on creating an artificial harbor basin in connection with the existing, though quite unimportant equipments of the town of Constantza situated on the coast of the Black Sea.

The harbor mainly serves for the shipment of the greater part of Roumanian export articles. This installation, comprising granaries for millions of tons of corn, is the largest on the Continent.

The harbor is protected against the tempests of the Black Sea by extensive piers comprising a number of quays, large mechanical and locomotive workshops, docks, granaries and loading plants.

Special attention was paid to those installations which are intended for ensuring an easy and rapid unloading of export goods, the most important of which are corn, petroleum and timber.

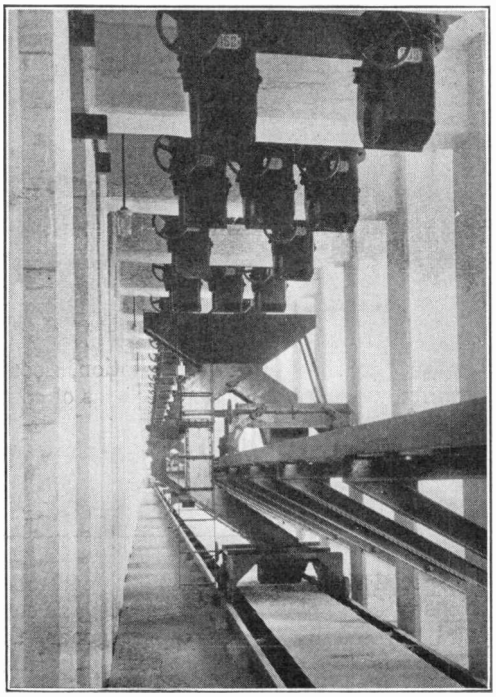
The equipment provided for the transfer of corn comprises two huge granaries built of concrete, each of which contains 255 silos of a total capacity of 70,000 tons, plant for the immediate transfer of corn from railway cars into vessels, an iron frame 1,870 feet in length with hoppers for unloading the corn, supplied by belt conveyors, into telescoping tubes, and thence into vessels, and quays of the same length for the anchoring of five (and if desired even ten) vessels to be loaded simultaneously.

All the operations in handling the corn are effected by horizontal belt conveyors and vertical elevators. In addition to storing the corn, and transferring it into vessels, the cleaning, aerating and mixing is effected in the granaries.

Outside of corn, petroleum and its products are of special importance for export from Constantza harbor. The installations pro-

vided for the storing and shipping of petroleum are situated in the western part of the harbor and comprise a plant for receiving and unloading the petroleum trains, installations for storing the petroleum products, and machinery for transferring them into vessels.

The petroleum trains arrive at a special station comprising six feeding tracks con-



CONVEYOR BELT BELOW THE GRAIN BINS

nected up with the various railway lines terminating at Constantza. Between these six tracks are provided four discharging conduits to which are connected flexible tubes communicating with the discharging cocks of the petroleum wagons. Each of these four lines of conduits is destined for some special product (benzine, refined petroleum, distilled petroleum and residues) and is able to unload a whole train containing the same product, conveying it under the influence of gravity into a storage tank from which it may be pumped into the tanks on the ships.

These extensive harbor works, arranged on quite modern lines, are mainly operated by electricity, which also provides the lighting.

The electrical energy is generated in a large power house, situated close to the harbor basin on an artificial plateau made from concrete. This comprises at the present moment four generating sets of a total capacity of about 1,500 horsepower.

The greater part of the electrical energy is used up in the huge granaries, all the conveying belts and elevators, as well as the cleaning and sorting machines being operated by motors. An electrical signaling system serves to superintend and check the weighing operations.

The belt conveyors and traveling elevators with telescoping tubes installed on the extensive iron frames alongside the corn quays for transferring the corn into vessels are likewise operated by electricity. The railway trains supplying the corn are taken by electrical locomotives from the termini to the granaries, or as far as the corn vessels.

The petroleum ships which before entering the petroleum harbor (separated from the remaining harbor basin) have to put out their fires, are drawn into the petroleum basin by a number of electrically operated capstans which are a very convenient form of power. A lift with electrically operated capstans serves for the repairing of small-sized ships.

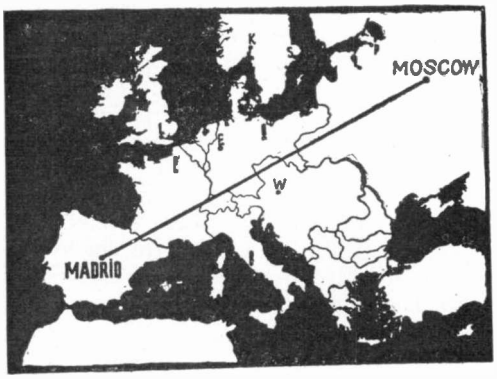
These harbor works, in the construction of which the most recent achievements of modern engineering have been utilized, will soon make the harbor of Constantza one of the centres of commerce on the Black Sea.

Dodging German Taxes

The varied special taxes which Germany is levying in order to maintain its tremendous military and naval expenditures are having curious effects, as the natural tendency of the public is to avoid the use of the articles thus taxed. For instance the tax on matches has given such an impetus to the manufacture of lighters using either an electric spark or one allied to the old flint-steel method that over a hundred types of such lighters are already on the market. Now the tax on arc lamp carbons (amounting to about 10 cents per pound of the carbons) is likewise being felt and the users of the old time "open arc" lamps are replacing these with long-burning types which consume only about 1-15 as great a weight of carbon per hour, thus cutting the government's expected revenue down to a mere nominal amount.

Across Europe on Welded Rails

The smoother riding due to the welding of rail ends to each other means added comfort for the traveler and less wear on the rolling stock. Both reasons have contributed to the extensive use of electric welders



ACROSS EUROPE ON WELDED RAILS

for this purpose not only here, but in Europe as well. Indeed, a recent estimate of the trackage thus smoothly joined made it reach from Madrid to Moscow—a particularly fine showing when we consider that governmental railways with their lack of competition are often inclined to stifle progress.

Increasing Life of Tungsten

The hot wire system for tungsten lamps is being used on eastern railroads to minimize breakage. A small current, keeping the filament at a dull red, is always on the line, thus giving longer life to the filament. The lamps are lighted from storage batteries at 60 volts, this being reduced to four volts when the lamps are extinguished.

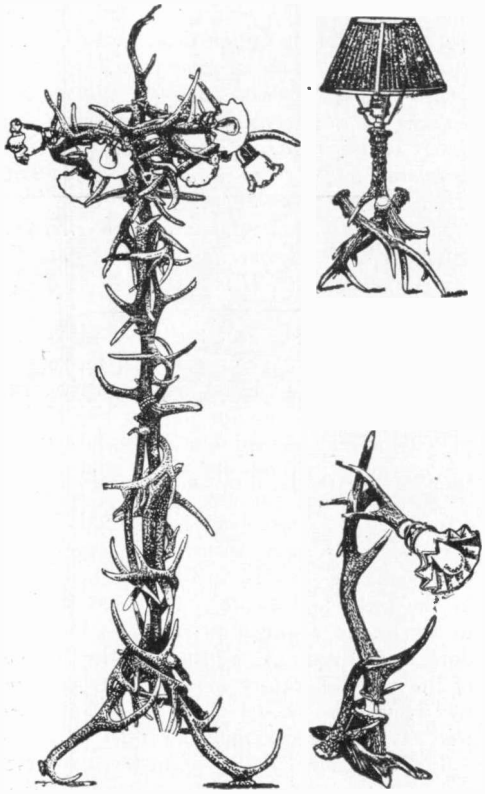
Hoosac Tunnel to Be Electrified

A contract involving more than $1,000,000 has been awarded to the Westinghouse Electric and Manufacturing Co. for apparatus to be used by the New York, New Haven and Hartford Railroad which will electrify the famous Hoosac tunnel under the Hoosac mountain in Massachusetts.

This tunnel was completed in 1874, after years of construction work. It is four and three-quarters miles long, exclusive of approaches. The total length of the electrification work is seven miles, and it will eliminate for good the long-standing trouble of smoke and foul gases in this tunnel while trains are passing through. The general plans for the electrification are uniform with the work on the main line of the road, and are conducted with the one idea of ultimately making the New York, New Haven and Hartford an electric line.

Antlered Electric Fixtures

To the enthusiastic sportsman the sight of antlers or other trophies of the hunt is always a source of pleasure as it recalls so many enjoyable days and events. The conventional lighting fixtures with their polished brass or oxidized copper tubes and balls may be more true to the canons of art, but the lover of outdoor sport gets only



a tame sort of satisfaction from them. To him the rustic intertwining of horns and antlers makes by far the stronger appeal. One German firm is catering to this taste by offering a whole line of antlered fixtures to please the huntsmen.

Learning to Use our Forest Products

By DENTON L. GEYER

Editorial Note.—We have in mind a certain large river in the state of Wisconsin. It measures in width a quarter of a mile to a mile from bank to bank. Twenty years ago, before the great forests to the north had been hacked to pieces, it was a noble stream. Today it is a maze of sand bars and islands and, except during spring freshets, one may wade across it by judiciously picking his way. Denuding of the forest lands has wrought the change, in this and in thousands of other cases. When we speak of the conservation of natural resources we mean for one thing the great movement now on to remedy such conditions and conserve not only our forests but the water supply of our rivers; for another thing we mean the development of the water power of these same streams, to be turned into electrical energy. These two features of the conservation movement are closely interlinked. The following article, therefore, treating as it does of steps now being taken to prevent waste of our forest products, has a direct bearing on electrical development and merits attention of the readers of an electrical magazine.

Realizing that one of the most important phases of the great conservation movement in the near future will be to save every scrap of wood taken from our forests, the United States has established one large laboratory to determine methods for using all the lumbering products to the greatest possible advantage. To save our forests it is necessary, we know now, to utilize a larger fraction of the tree that is cut than has been done in the past, and to keep the used fraction in service for a longer period than has been done in the past. It is primarily the purpose of the new laboratory to work out processes by which the waste parts of a harvested tree can be given a market value.

In Twentieth Century industry, conservation means concentration—centralization of machines, of brains, of efforts. Recognizing this tendency as sound economics, the United States has concentrated in this one immense laboratory its entire equipment and its entire experimental staff, that the tests to be undertaken may be carried out on a large scale. Heretofore such work as has been done has been scattered through the country in some half-dozen necessarily incomplete plants; these have now been dismantled, and their equipments combined.

Of the possible locations for the new project, Madison, Wisconsin, was chosen because of its central situation in the nation as a whole, and because here a building and site would be provided without any cost to the Forestry Service whatever. A $44,000 structure has been erected and presented to the federal government by the University of Wisconsin. Even before its formal dedication in June, the actual routine of work had begun. The building occupies a place on the campus of the University, and in return for its use the forestry experts detailed to it will give as a regular part of their duties a course of lectures to students of the university interested in forestry.

Situated not a great distance from the northern forests, the laboratory has all the materials for experimentation at hand. Throughout the past year government forest rangers have been scouring the nation's woods for the specimens that would be needed in these experiments. As a result, the yards and sheds of the new building are piled high with barks and bits of trees unknown to curious northwestern lumbermen. There are strangely grained logs of the most pungent odors, there are bundles of "saplings" hardly bigger than fishing poles, there are little cross-sections of trees coming all the way from regions semi-tropical. And all are neatly lettered and numbered.

But why this carefully arranged collection? There is a scope of work here that is worthy of nothing less than a national enterprise, for the area of forest growth represented by these specimens is as great as the nation itself. The staff of experimenters holds some of the most able men in any department of the government's employ. Of what import is this growing interest in forestry study?

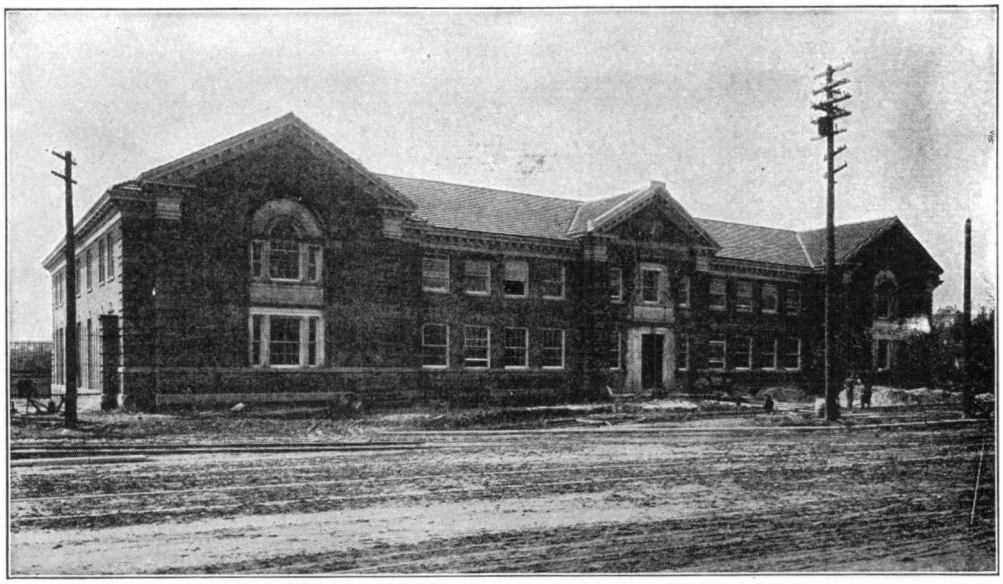
Today we are cutting our forests, says ex-Chief Forester Pinchot, just about three times as fast as they are reproduced. Not that such an amount of wood is needed;

there is enormous waste in every operation, —in cutting, logging, sawing, and every later stage of wood manufacture.

The paper industry offers one way of saving this waste. The wood that is lost in the form of slabs, edgings, cull logs, and unused tops and butts would supply our pulp mills five times over. But can it be used? At present the only kind of wood available for paper is the spruce; and it is a question whether other kinds can be made to serve. To solve this problem is one of the major *raisons d'être* of the new laboratory. Every kind of wood in any way resembling spruce will be thoroughly tested out under every kind of condition. For this purpose a miniature pulp mill has been set up, with machinery comprising a grinder, a beating machine, a "digester" each for the soda and sulphite processes, and a Froudrinier completing machine turning out a continuous fifteen-inch sheet of finished paper. Since all timber for paper must be ground to pulp before using, irrespective of size, it is obvious that a collection of chips will serve about as well as an entire log.

Today the country is using four million tons of paper annually. And since the available supply of spruce is rapidly disappearing, the subject of cheaper paper making—lowering the "tax on intelligence"—is a subject pretty well worth investigation.

The South, too, is now being rapidly devastated of its forests. If the spruce is useful to the North, the pine is the one supremely useful tree of the South. And as the spruce is being sacrificed for paper, the pine is being sacrificed for tar and "naval stores." The pine's destruction is largely the result of the wantonly wasteful methods by which these commodities—turpentine, rosin, and the like—are procured. The "production process" is barbarously simple: in the selected tree a notch or "box" is cut, so deep that the exuded tar may be caught in the wound. And by this "boxing" the tree is either killed after a time, or so weakened that the next hard wind storm blows it down.



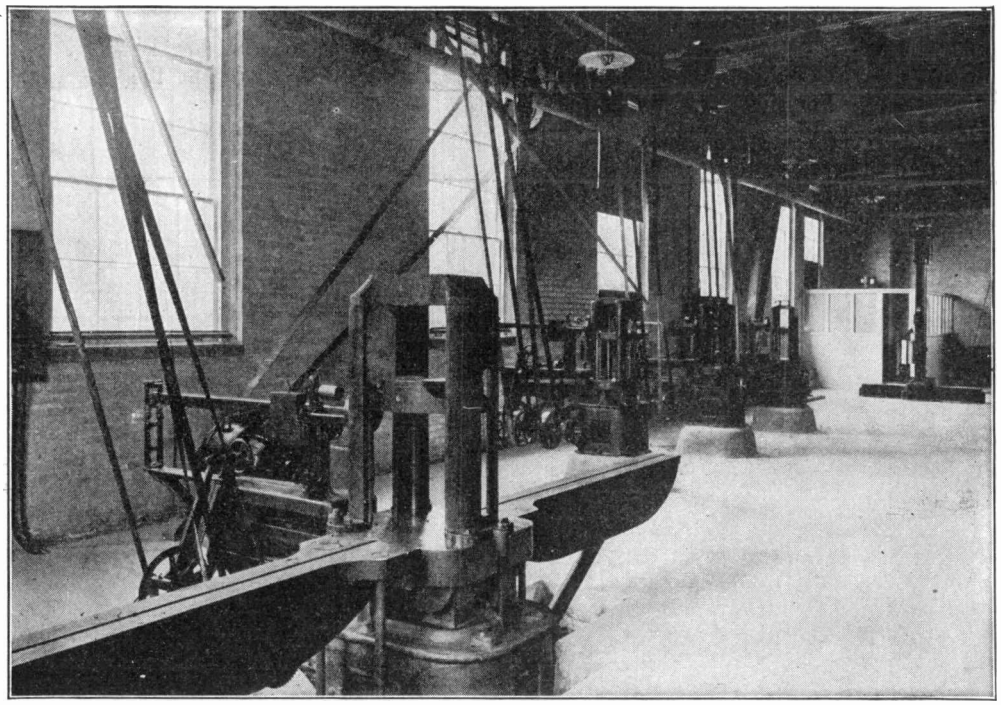
NEW UNITED STATES FOREST PRODUCTS BUILDING AT THE UNIVERSITY OF WISCONSIN

The remedy is to devise a process by which these resinous products can be chemically extracted from the waste of the saw mills and manufacturing plants using pine. This wasted material would fully supply our entire demand, could the process of extraction be perfected. For work on this problem, and for allied problems in wood distillation, the chemical department is supplied with distillation retorts, a refining still, and the necessary accessory apparatus.

But besides wasting wood in these various ways, we allow forest fires to burn every year as much as we use. The annual fire loss, it is asserted by authorities, is actually equal to the annual consumption.

"This large loss is due primarily," states McGarvey Cline, director of the new forest products laboratory, "to the burning of large tops and limbs, called 'slash,' left in logging operations. If, through this new laboratory, there can be discovered some new method of making turpentine, wood alcohol, etc., from such slash, it will not only mean an enormous increase in the value of timber land, but it will also solve the problem of our most destructive forest fires."

range of the process, however, is very narrow. The method of treatment is to force certain chemicals, such as zinc-chloride and creosote, into the wood in large "treating cylinders" at a pressure up to 600 pounds per square inch. It has been already demonstrated that the material treated—such as railroad ties, mine props, fence posts, shingles, and piles—will have its period of usefulness prolonged from ten to eighteen years. Besides increasing the life of the woods now in use, the treatment it is thought



TIMBER TESTING LABORATORY IN THE FOREST PRODUCTS BUILDING

Thus, by working out methods for the utilization of the portions of a tree at present wasted, the investigators hope to accomplish a double object. They will not only make useful what is now thrown away, but also by getting this material out of the forests they will avert the indiscriminating and terribly destructive forest fires.

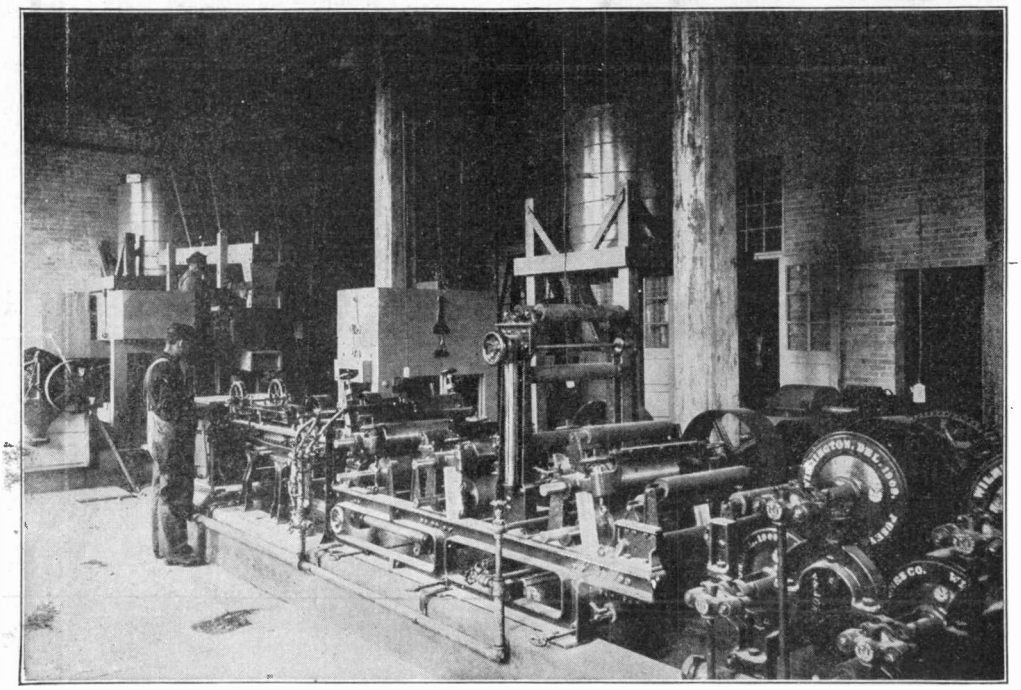
But not only are we to learn to use more of a tree than we use now, we are to learn to use it longer. We want to know how to make timber last longer.

Protecting wood from decay and from the attack of insects has already been shown in certain cases to be practicable. The known may bring into use softer and inferior varieties. Many of these softer grades, which will not last long enough in service to warrant installing them, may be made fit to take the place of the hard grades, at least for the coarser kinds of work. It is possible, for instance, that the great tamarack swamps may yet furnish the main portion of our railroad ties.

By an adequate system of chemical treatment our annual wood consumption could be cut down, says President Van Hise of the University of Wisconsin, by about 12 per cent. That would mean a saving of $72,000,000. The chemistry staff will at-

tack this problem by furnishing artificially the conditions that make decay most rapid. A "fungus pit" is utilized, whose contents are thoroughly inoculated with various wood-destroying fungi, with the humidity and temperature so regulated as to be most favorable to their growth. Wood treated with given preservatives are placed in this liquid. By this means the efficiency of the preservative being tested can be determined under these conditions of forced rotting in a very short interval.

The investigators will by no means confine themselves, however, to the laboratory itself. To save the forest "slash," to control



PAPER PULP MACHINE IN THE FOREST PRODUCTS BUILDING

fires, to prevent exposed wood from rotting—these are only the problems which happen to lend themselves to indoor experiment. The results thus experimentally determined will not be considered as final, but will all be tested out on a commercial scale. Experts will be sent out for short periods to the larger mills desiring to co-operate with the Bureau, and under their direction a newly discovered process will be given a trial "life-size."

The lecture courses will furnish a method of spreading information almost equally good. By explaining the history of forest destruction and the present activities of the conservation agitation, the officials hope to create a healthy indignation against waste in all the forms that it assumes. Scientific cutting—felling the selected trees in such a way as to spare the younger growth—allowing to stand an occasional specimen of the desired varieties to serve in reseeding, leaving for further growth those young trees not yet near their maximum usefulness—these are some of the measures of lumbering reform that the forestry workers have been demanding with increasing insistence for several years. The necessity for reforesting less fertile areas, especially mountain slopes where the gullying action of every rain is carrying away the soil so rapidly that any sort of growth at all will soon be impossible—this can be shown to be even more pressing.

Add to these things the recognized urgency of taking steps to *maintain* the existing growth on such of these areas as have not been entirely devastated by wasteful lumbering, and we have material for a course of instruction that may give the great movement for the conservation of our natural resources a very observable and genuine advance.

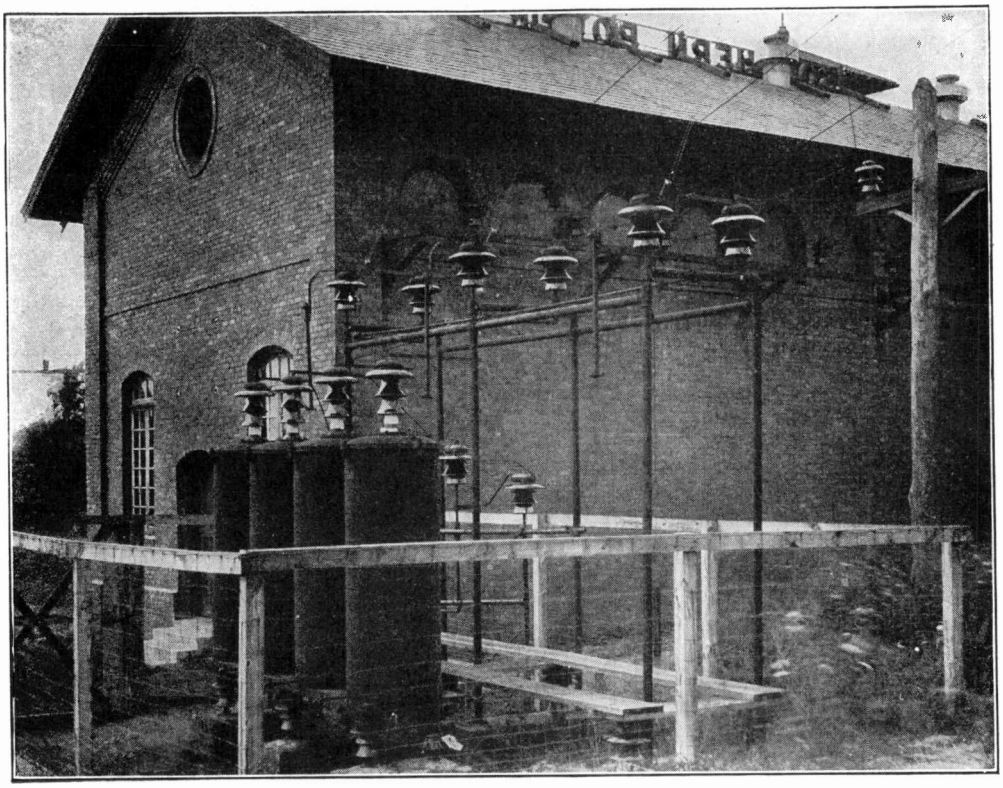
ELECTRIC CURRENT AT WORK

NEW DEVICES FOR APPLYING ELECTRICITY

"Safety Valve" for Lightning

Lightning is a discharge of electricity under extremely high pressure or voltage. If its potential could be measured by any device constructed by man it would no doubt be found to reach into the millions of volts. Imagine, then, what takes place when a bolt of lightning strikes an electrical transmission line. The line is designed to carry current at voltages which have so far been brought under control for practical purposes—say 125,000 volts at the outside. Insulators which will carry 125,000 volts safely are as nothing when placed in the way of a lightning discharge, and the latter will jump to earth from the line by the most unexpected paths, starting arcs which the current from the dynamos will follow through, doing great damage.

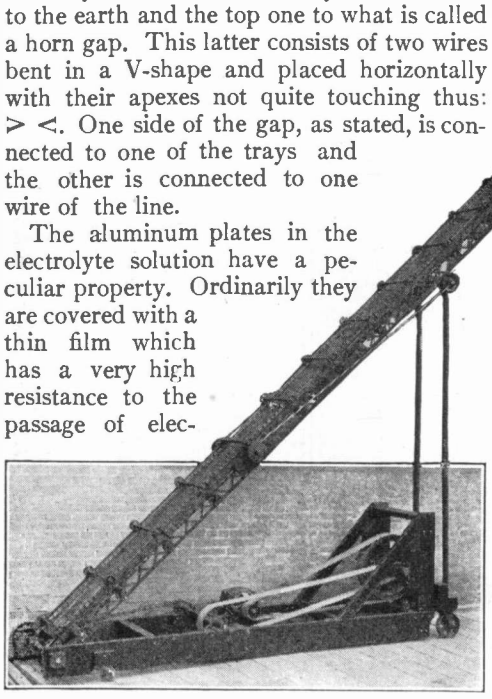
It is customary then, to connect lightning arresters to the line—they are really lightning by-paths or safety valves. One of the most interesting types is the Westinghouse "electrolytic" arrester, which comes the nearest to fulfilling the term electric "safety valve" of any of the various forms. Several of these arresters are shown in the picture, which was taken just outside of a transformer station. Three of the copper power wires are shown in the foreground, entering the building just under the eaves.



AN INSTALLATION OF ELECTROLYTIC LIGHTNING ARRESTERS

The four cylindrical tanks are the electrolytic arresters. Each contains a number of aluminum trays stacked one above another like dinner plates, but insulated from each other and filled in between with a liquid electrolyte. The bottom tray is connected to the earth and the top one to what is called a horn gap. This latter consists of two wires bent in a V-shape and placed horizontally with their apexes not quite touching thus: > <. One side of the gap, as stated, is connected to one of the trays and the other is connected to one wire of the line.

The aluminum plates in the electrolyte solution have a peculiar property. Ordinarily they are covered with a thin film which has a very high resistance to the passage of electric current. When a very high voltage or pressure is impressed upon them, however, greater than the "critical voltage", this film breaks down and current flows freely from one to the next and so on to earth, until the abnormal pressure is relieved. Then the film forms again.



PORTABLE GRAIN ELEVATOR

Now this is what happens when lightning strikes one of the wires: the voltage for a moment is extremelv high and easily jumps across the horn gap to the first tray. If its pressure is high enough to injure the line or electrical equipment it is also high enough to overcome the resistance of the films on the plates and so the surge of current escapes to earth. This flow of current through the trays starts an arc in the horn gap. As the surge of pressure dies down, however, this arc in the gap between the two V-shaped horns is automatically blown out and the line has been relieved before damage can be done.

Portable Grain Elevator

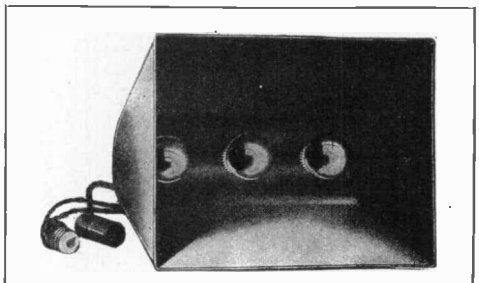
A unique electric driven labor-saving device has been designed for piling sacks as shown in the accompanying illustration. A portable elevator is provided with an electric motor mounted under the conveyor, about two horsepower being necessary for doing the work. The platform is eight feet long and about two feet wide mounted on roller bearing casters and equipped with a conveyor 17½ feet long. This machine handles one ton per minute, only two men being required to operate it, one loading and one piling.

The elevator is used on the Pacific Coast extensively, in piling flour, barley and other grains. More than 50,000,000 bushels of grain have been handled in this manner since the machines were put upon the market. The work of piling the grain was formerly all done by hand.

It is maintained that one of the largest grain handling firms in the world, at Portland, Ore., piled with a machine of this kind on their dock 1,600 sacks of wheat weighing 140 pounds each in one hour and 45 minutes.

A Bath of Electric Light

The Radiotherm, as it is called, is in reality a small, portable electric light bath. Every one knows that it is very healthful to be in the sunlight as much as possible,



RADIOTHERM

the sun's rays having a very decided therapeutic value. The Shaler Radiotherm concentrates rays, not of the sun, but of incan-

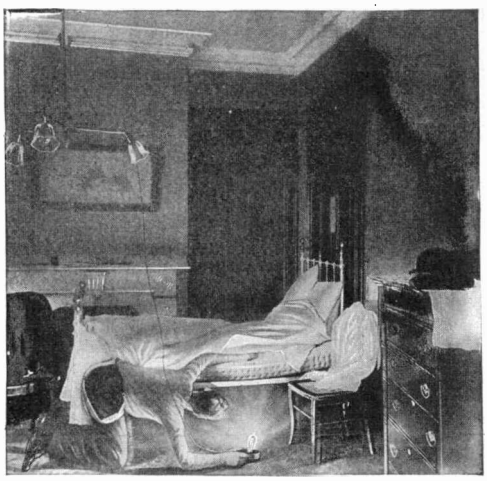
descent electric lamps, directly on any desired part of the body.

Unlike all other devices for applying heat to the body, the amount of heat can be instantaneously increased, lowered, or turned off altogether. This is due to the fact that there are three lamps in the device and that one, two or all of them can be turned on, or they can all be turned off by one motion of the patented four-way switch.

Some Uses of the Flexilyte

In the September issue of Popular Electricity was a brief description of the Flexilyte portable lamp, a handy device by means of which a small incandescent lamp and its conducting cord are arranged somewhat on the principle of the ordinary tape measure, so that the cord may be wound up or let out at will. This makes a very practicable portable lamp, as will be at once appreciated by a glance at the pictures. Aside from reading in bed and looking for pestiferous lost collar buttons there are a hundred other ways in which the little portable can make itself useful. The cord will reach from the lamp socket to a closet, writing desk, dressing table, or cupboard, and give you a light just where you want it.

Storing things away in a closet is easy enough, but to find them is another matter. You may try lighting one match, two, perhaps three, but this carries with it an element of danger. Instead of wasting time and trying your patience, connect a Flexilyte and see how quickly you will find what you are looking for.

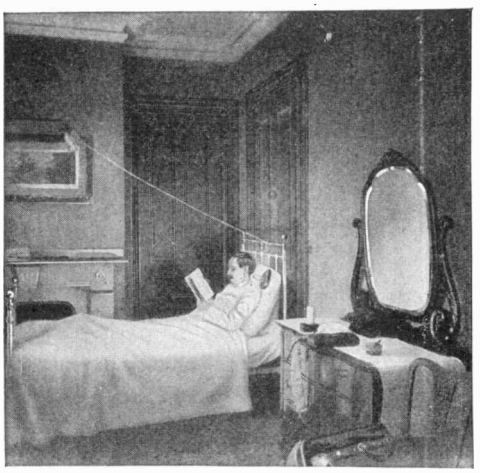


LOOKING FOR THE COLLAR BUTTON

Farmers' Telephones

There is no better way to obtain country telephone lines than by organizing mutual companies among the people who actually want and use the telephones. In any cooperative movement of this kind there must be some one who will take the initiative in developing sentiment in favor of the proposition, and who will attend to the details of organization. The usual method is for one or more of the farmers most interested to interview their neighbors on the subject, after having ascertained approximately the first cost of a line, and get them to promise to subscribe either a certain definite amount of money or for a certain number of shares of stock, in case the company is incorporated. After a sufficient number have been interested in the project, the whole question can be easily closed by calling a mass meeting, employing a lawyer to draw articles of incorporation, and inducing each of the interested parties to take sufficient stock in the concern to meet the expenses of construction. Besides the usual officers, it is customary to choose a board of control, which will have the power of making contracts, purchasing supplies and employing expert labor when necessary.

—Orange Judd Farmer.

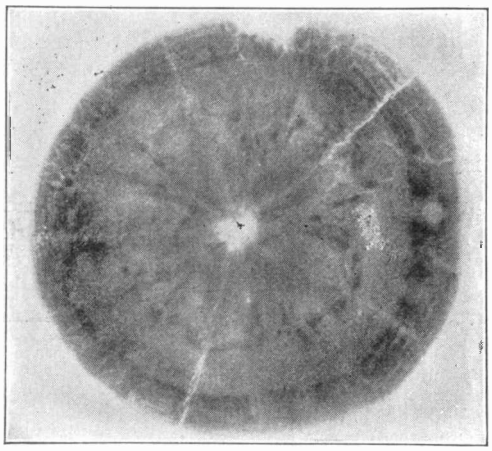


READILY ADJUSTED AT THE HEAD OF THE BED

X-Rays for Examining Petrifactions

By DR. ALFRED GRADENWITZ

The extremely numerous technical and scientific uses of X-rays are known to be based on the differences in transparence shown by the various tissues in regard to



X-RAY PICTURE OF PETRIFIED STARFISH

these rays. The silhouettes produced by the passage of X-rays therefore give an insight into the internal structure of human and animal organisms, which would otherwise be forever closed to our eyes.

The latest achievement in this connection is the use of those wonderful radiations in investigating the internal structure of petrifactions, viz., pre-historic organisms converted into a mineral condition. In fact, a French scientist, M. Pierre Goby at Grasse, has recently obtained some excellent X-ray pictures of petrified starfishes, of which a sample is here reproduced.

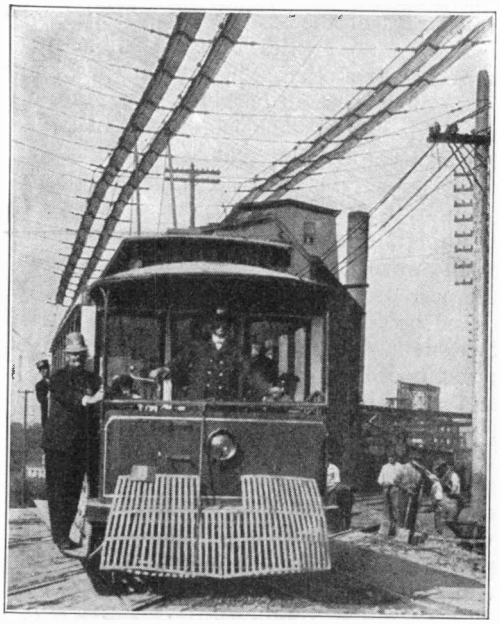
In order to understand the possibility of using X-rays in this connection, it should be considered that all the internal parts of a petrified starfish are filled up by a remarkably homogeneous quartz mass which mainly consists of an agglomeration of minute transparent grains, bound together by a glue so loose as to leave small cavities in the interstices.

Though being little transparent to X-rays, this mineral mass is far less opaque than carbonate of lime, the substance of which the shell of the starfish consists. This is how the X-ray picture of the petrifaction, surprising though this be, absolutely resembles that of a living starfish.

Any slight discontinuity in the various portions of the petrifaction will result in a difference in the depth of shades. The five radial grooves, for example, are distinctly visible and the thinnest portions of the petrifaction, viz., those at the edge, are especially clear. The digestive tube which surrounds the central cavity is seen with remarkable distinctness, each of its circumvolutions being clearly marked.

An Effective Trolley Guard

A street car loaded with people bumps and jars itself part way over a railway crossing and stops. The trolley has been thrown from the wire and a train is approaching. To prevent just such conditions and save life



WIRE MESH TROLLEY GUARD

many devices and inventions have been offered. Cincinnati grade crossings are using an effective arrangement shown above the trolley wires in the picture. It consists of an inverted wire mesh trough supported by insulated guy wires. The trough is electrically connected to the trolley wire so that should the wheel leave the wire, current will still be supplied the car until it is safely over. Snow readily passes through the trough and its use has proven most satisfactory.

FOR PRACTICAL ELECTRICAL WORKERS
HOW TO MAKE AND OPERATE ELECTRICAL DEVICES

The Romance of Electric Power

By WARREN H. MILLER

I. LARGE GAS ENGINES

Did it ever occur to you what a very important part the fire grate plays in the power-generating industries of the world?

Aside from water power and the concentrated rays of the sun, our only source of bottled-up power lies in combustible fuel of some sort. Excepting natural gas and crude oil it must all be burnt on a grate of some kind, and the poorer the fuel the larger the grate, until, as soon as you get below a certain grade of fuel, the grate becomes too large and unwieldy to yield anything but a very limited amount of heat, and so we are forced by the grate to abandon the use of vast amounts of combustibles stored up for us by the sun in the form of inedible and worthless vegetable products, peats, poor lignites and all sorts of industrial and agricultural refuse such as used tan-bark and straw.

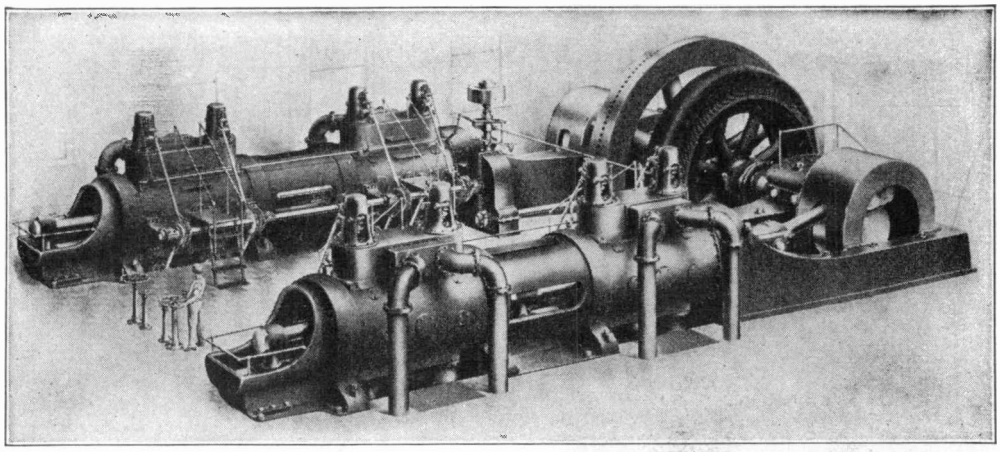
The Germans, who are great students of broad economic questions, have proved in the case of Power vs: the Potato that, except in very special cases, ordinary river water power is worth five times as much in dollars and cents if used in improving agricultural yield than if used for power. There is no denying their arguments or their figures so that the world's future power will tend to economically develop in the lines of combustion,—on a grate.

In the same way natural gas is far too valuable in the general case, as a direct source of illumination, to be used for power, which would be later turned into light through the medium of electricity—so we again arrive at the grate as the logical first step in the generation of the world's power.

After the grate has done its work in gasifying the combustible, you can either turn this gas forthwith under a boiler and generate steam, or you can lead it to a gas engine and explode it behind the piston to get your work out of it direct. Again the grate interferes and sets a limit to the steam engine, especially in moderate sizes of from two to three hundred horsepower, because a too great amount of combustible must be burnt in a short time to generate a horsepower or a kilowatt by way of steam. Wherefore the combustible must be of good quality, such as coal, or else the grate grows out of all proportion to the boiler and becomes unwieldy, wasteful and hard to fire.

The only way out of this dilemma is to *cut down the steam consumption of the engine,* and so we find the modern European superheated steam unit, developed by the scientific genius of the German steam engineer, spreading all over Europe and Europe's trade dependencies in thousands of installations. Our own small steam engines use from 30 to 60 pounds of steam per horsepower-hour:—the German locomobile or superheated steam unit of 75 horsepower uses only *nine* pounds of steam to the horsepower-hour. Therefore the grate need only be one-third or even one-fourth as large as with us;—or, what amounts to the same thing, they can keep our size of grate and burn all sorts of poor combustibles which we couldn't think of using.

One therefore encounters them all over the world in out of the way corners, a Lanz locomobile even as big as 300 horsepower getting along nicely burning plantation refuse in Portugese East Africa; a 2,500 horsepower Wolf installation of three 800-horsepower units running on pampas straw in Argentina; a 200 horsepower unit in Wurtemburg using paper mill waste products; a 125-horsepower plant running on bagasse



A TYPE OF MODERN GAS ENGINE FOR DRIVING ELECTRIC GENERATORS—CAPACITY 2500 HORSEPOWER

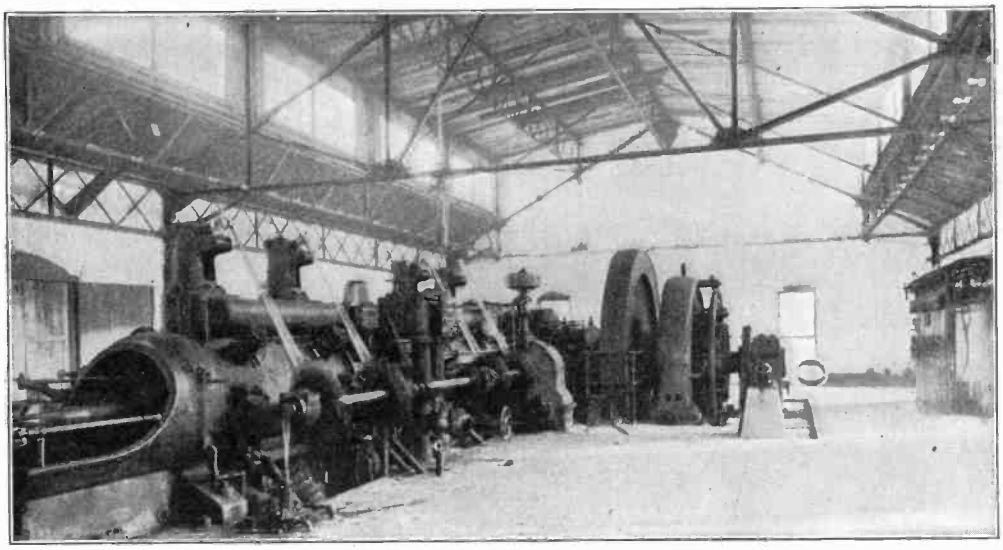
in Cuba; but more of them in a later article—we were talking of grates.

You will note how the careful scientific use of steam, in cutting down the engine-consumption to ten pounds per horsepower, let in all these poor grades of fuel which the grate otherwise kept out. Now a gas producer is really nothing but another form of grate. It may be likened to a poor stove—something that will just give enough heat to gasify everything in the producer, most of the combustible being partially burnt to produce carbon monoxide gas. Here is the ideal grate for a poor fuel. Instead of a roaring white-hot fire such as you want under a steam boiler, the very opposite is required, a slow red fire with just enough heat to drive out all the gases in the fuel, and at the same time to split up the steam and air fed to it into useful hydrogen and oxygen, which combine with the carbon of the fuel to form carbon monoxide and hydrocarbons. If the fire is thin and white hot, steam and air will either be burnt to inert carbon dioxide or will get through unchanged and spoil the gas for the engine. Not only that, but they will start fires inside the producer and either burn up the gas already generated or blow up the whole thing.

With such a slow fire almost anything combustible, can be treated in a producer to yield a good power gas, leading us to the reflection that the logical development of the world's combustible resources would be, and probably will be, to reserve the good coals exclusively for house heating and use all the poor grades and combustible refuse of all kinds for power. Once the conditions are realized that a kilowatt of power costs less from agricultural and industrial waste than from coal hauled hundreds of miles, we may see the cost of keeping us warm in winter drop off somewhat from the present preposterous figures. There are over three million horsepower of absolutely unused gas engine combustibles in blast-furnace and oil-distillate gases alone, to say nothing of agricultural, industrial and civic waste-products

About 3.3 per cent of this is being exploited today in large gas engines, generating electric power.

As all small gas engines using gasoline, city gas, and kerosene are but consumers of a manufactured product which has already used up its share of the world's coal in being manufactured, our interest will rather center on the large horizontal gas engines designed to develop thousands of horsepower from the by-products of the world's coal-consuming industries, and also from the poor and worthless coals and lignites, valueless except when turned into power. Every one knows that a gas engine must do four things to run; fill its cylinder with gas mixture, compress it, explode it, and sweep the cylinder clean of the exploded gas. One can devote four strokes to this, one to each operation as in the four-cycle engine, or you can combine the operations of filling and compressing in one stroke and the explosion and emptying in the other, as in the two-cycle. But the latter cannot be done except with very small engines, and causes considerable loss of

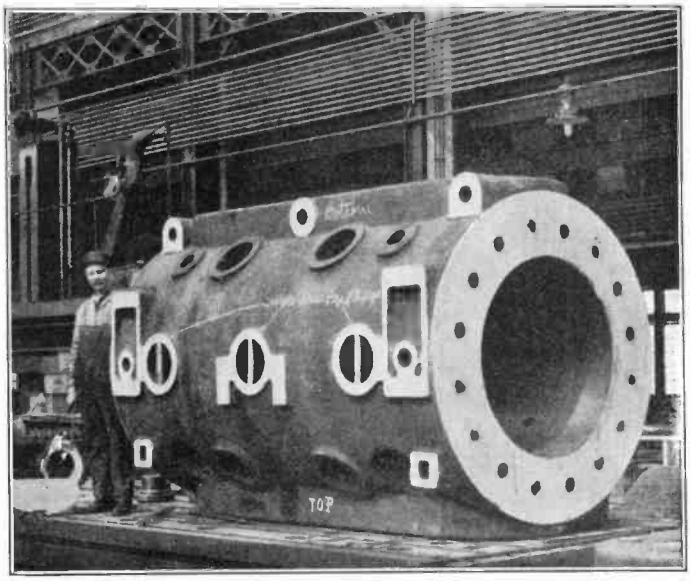


FIVE HUNDRED HORSEPOWER GAS ENGINE AT WORK

power, so that the four-cycle is the only logical type for large gas engines.

Moreover, it certainly will not do to have only one explosion or power stroke in four, as it makes the engine too irregular to drive alternating current dynamos in parallel, not to mention all other cases where the speed must stay steady. One must have one explosion for each stroke, and to do this the large gas engine invariably takes the form of two double-acting cylinders in tandem. While the head end of No. 1 is exploding its charge, the crank end on the other side of the piston is compressing. In No. 2 cylinder the head end is filling with fresh gas while the piston is sweeping out the exhaust in the crank end. The igniters touch off each one in turn, so that you can readily see that the crank end of No. 1 which was compressing is the next one to be set off, making the return stroke. This stroke sweeps out the exploded gases in the head end of No. 1, compresses the gas in the head end of No. 2 and fills the crank end of No. 2 with fresh gas. Just make a little picture of the two cylinders and this system of events will become entirely apparent. The series of ignitions is followed out in regular rotation, giving a very uniform speed under steady load.

But as the load fluctuates, often violently when driving street railways or industrial plants, some means of governing the force of the explosions must be provided. It is obvious that the "hit-or-miss" system of small gas engines, where the charges are fired or not at the fourth stroke, depending



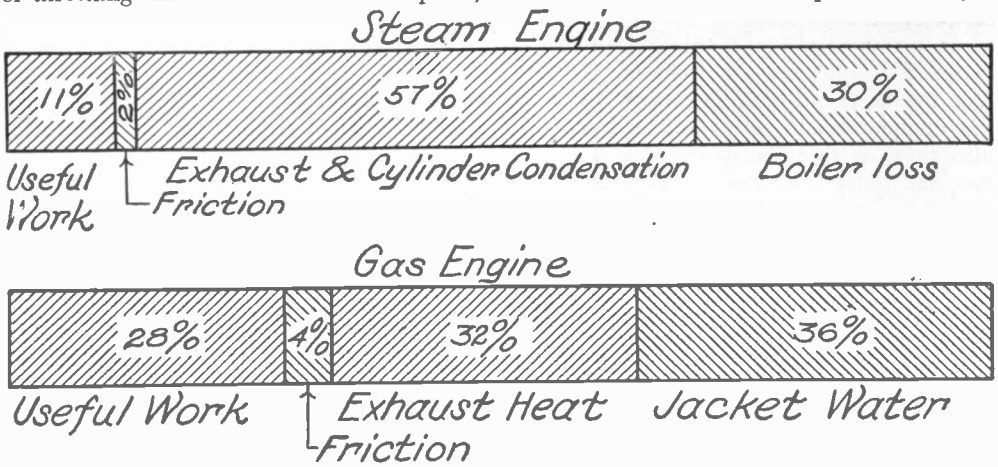
SHOWING THE SIZE OF A GAS ENGINE CYLINDER

upon the general speed of the engine will not do, as this introduces quite wide variations in angular flywheel speed. Alternators in parallel are so closely tied together electrically that a variation of only about one-third the width of a stator slot is the maximum permissible, say $\frac{7}{8}$ inch in a rotor ten feet in diameter. Yet this is the very form of electrical service that the gas engine is wanted for, particularly in the future, for only by alternating current can the power be distributed far and wide around the location of the source of waste gas or waste combustible. For this reason the very best engineering brains of the world have been turned upon the governing of gas engines driving alternators in parallel.

The "hit-or-miss" was discarded in favor of throttling the mixture at a certain point, combined with variable lift of the inlet valves, both being controlled by the governor. In other makes this was replaced by control of the mixture directly at each of the four inlet valves by a movable-port valve. At present America leads the world in this form of gas engine governing, the proportions of gas to air being fixed approximately constant by the sizes of the gas and air ports in the valve and the opening of these is varied simultaneously at all four inlets, by the governor as the load changes.

If the load is very light you can readily see that the governor will shut these ports to mere slits, so that the mixture will not remain of the same proportions due to friction along the port edges and the engine will miss and become very irregular at light loads. As every mis-fire is generally followed by a back-fire somewhere in the exhaust piping, an engine will often be thrown completely out of parallel on light loads and all the engines in the power house will be booming like siege-guns while the electric instrument needles go wild. To avoid this, the very latest designs of large American gas engines have the governor designed to vary, not only the opening of the ports, but the *time* also that they remain open during each stroke, so that the ports are never shut very much even on light loads, as the time cut-off also advances simultaneously with the closing of the ports.

The cylinders are now made of cast steel by the most advanced firms, as it has all along been quite a problem to make these huge tubes strong enough in cast-iron to withstand the shock of explosion and yet thin-walled enough to allow the jacket-water to cool the cylinder walls properly.



COMPARISON OF THE RELATIVE ECONOMY OF STEAM AND GAS ENGINES

As made today the American horizontal gas engines stand at the head as prime movers for driving alternating current dynamos in parallel.

Meanwhile on the electrical side of the problem, the best scientists of America and Europe—men like Steinmetz at home and LeBlanc in France—have worked out the *kind* of alternator best adapted for gas engine drive. The design must provide for something to resist all tendencies to throw the alternators out of parallel. If an engine misfires or prematures, its whole load is immediately transferred to the other engine in parallel with it, and it itself becomes a drag on the powerhouse. The governor of the other engine instantly opens wide, while that

of the back-firing engine closes, because it for the moment has thrown off its load and tries to speed up. The other engine, with wide open governor soon has too much gas because the first one is taking back all the load, being too fast, so it in its turn speeds up, while the other, gorged with all the load, slows down. This swinging action is known as "hunting," or surging in parallel.

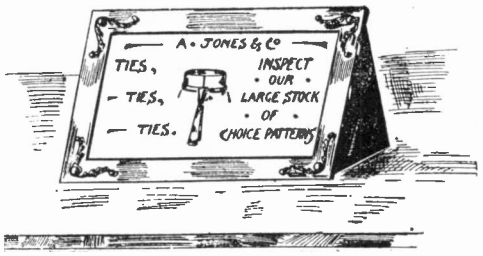
The best cure for it is the electric "damper" or amortisseur as the French call it. The damper usually takes the form of a complete "squirrel-cage" winding, built into the revolving field of the alternator by running heavy copper rods through holes bored in the steel pole-pieces and joining these rods by copper rings at each end. This makes the revolving field in effect also the rotor of a simple induction motor the stator being the stator of the alternator. As you may know, an induction motor always drags behind the cycles of the alternating current and is therefore the best anti-hunting device. Now if one engine tries to speed up, its frequency also rises, so that the damper on the slow machine must drag behind it, whence the engine which is trying to get fast will have to pull the other one with it,—which at once slows it down. The damper thus acts automatically to resist *any* changes of speed. So long as both engines are going along nicely, the dampers take no part at all in the game, but, let one engine try to get even a fraction of an inch ahead of the other,—presto! the damper of the other machine instantly drags behind and discourages it.

The amount of combustible available for gas engine power is so vast as to be almost incomprehensible. For every ton of coke burnt in smelting pig iron in the world's blast furnaces, 750 horsepower is available for outside sale and distribution; for every barrel of refined oil in the world's oil-yards, four horsepower are liberated in oil distillate gas. After these come all the world's solid combustibles in the order of gas-producing capacity per pound as follows:—Coke, 104 cubic feet; bituminous coal, 75 cubic feet; lignite or brown coal, 55 cubic feet; turf, peat, 45 cubic feet; wood, 35 cubic feet, including all the by-products of the lumber, bark, cane and agricultural industries. These are all available for gas-producer service, and as to the comparative heat losses of steam and gas engines our illustration gives a very graphical comparison.

(To be continued.)

A Flashing Counter Sign

Just why an unexpectedly illuminated sign will attract one's attention more than adjoining larger and perhaps prettier ones, is a matter that the psychologists will have

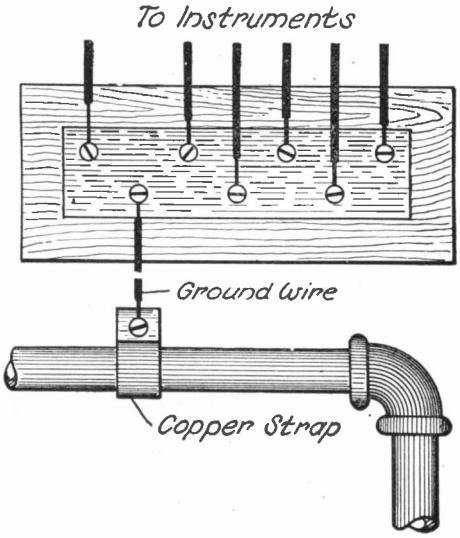


FLASHING SIGN FOR SHOP COUNTER

to explain. For the practical storekeeper the one great point is that these electric signs do catch the customer's eyes whether they want to look or not. A simple variation from the usual types is in the shape of an easel with enclosed sides and with the glass front slid into place so that it can be exchanged for others. In this way the same outfit can be made to advertise a variety of different items alternately, the only added expense being for the painted glass slides.

Handy Ground Block

It is often desirable in laboratory work to be able to make a ground connection. The accompanying illustration suggests a plan for



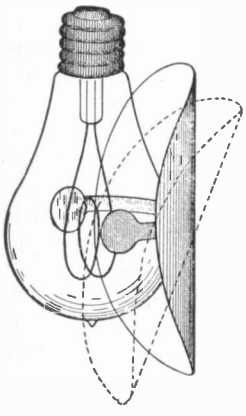
HANDY GROUND BLOCK

doing this. Take a piece of sheet brass about 1 by 4 inches and bore several 3-16-inch holes in it for round-headed brass screws. Fasten this plate to a hard wood block on the wall and connect to a water pipe if possible. Any instrument that you wish to ground may then be easily connected by wire under one of the screws of the ground plate. This device should be used only where very small currents are involved and if possible a slate block provided in place of the wood.

FRED S. WALKER

Adjustable Lamp Shade

An ingenious shade for use on incandescent lamps is here shown. It consists of a metal disk bent into a semicylindrical form and provided at opposite sides with spring clamps adapted to press against the lamp globe, holding the device in position. As can be seen the shade may be fastened in any position so that the shadow is cast in any desired direction. This arrangement will be found especially useful for hospitals and sick-rooms, enabling the nurse to protect the patient's face from the direct rays of light yet leaving other parts of the room illuminated. By painting the interior of the shade with white enamel it may be used to a certain extent as a reflector also.



ADJUSTABLE LAMP SHADE

Hint on Making a Small Rheostat

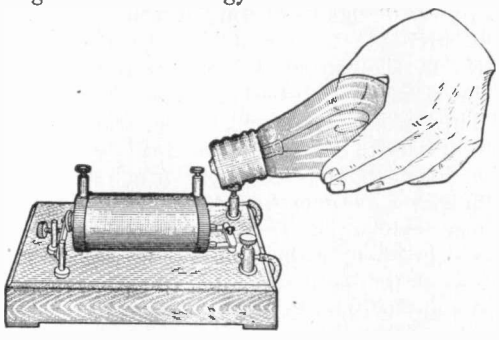
As resistance wire is somewhat expensive and quite frequently amateurs in electricity need a good resistance in some experiment I might suggest that they look about the house for one or more curtain shade rollers that have been discarded. Inside the roller will be found a nicely wound metal coil whose resistance is high and which will stand considerable heating by current. One can arrange these coils on porcelain knobs or tubes to his own liking and so build a rheostat at little cost.

G. H. DALTON.

Testing Lamp Vacuum

In the patents granted Mr. Edison in 1879 the incandescant lamp is described as consisting essentially of a high resistance carbon filament hermetically sealed in a nearly prefect vacuum.

When this vacuum becomes low the lamp begins to waste energy. You have no doubt found the globe of one lamp very hot while another near it was only slightly warm. The first lamp is losing its vacuum, the air within the lamp affording a means of transmitting heat from the filament to the bulb. The illustration shows a simple means of determining how good the vacuum is by using as small as a one-half inch induction coil. If in a dark room a lamp is held in the hand and brought nearly or quite in contact with the secondary post of the coil no effect is noticeable if the vacuum is good. If a low vacuum is present a bluish or yellowish haze will fill the bulb.



TESTING LAMP VACUUM

Vat for Electroplating

A well made vat of oak may last for 12 or 15 years if it be smeared inside with the following mixture:

Burgundy pitch	1,500 parts
Old gutta percha in shreds	250 parts
Finely powdered pumice stone	750 parts

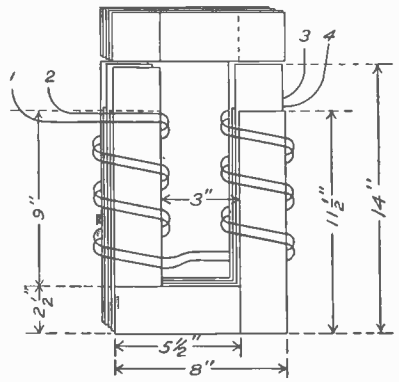
Melt the gutta-percha and mix it well with the pumice stone. Then add the Burgundy pitch. When the mixture is hot smear the inside of the vat with it, laying on several coats. Roughness and cracks may be smoothed off with a hot soldering iron. The heat of the iron makes the cement penetrate the pores of the wood and increases its adhesion. The vat will stand sulphate of copper baths, but not baths of cyanide.

E. BERTHOUD.

Construction of a Tesla High-Frequency Apparatus

Many requests are received for information on the construction of a Tesla coil and transformer to go with it. As this requires specific directions of some length we believe it advisable to reprint the article by Mr. H. L. Transtrom which appeared in the January, 1909, issue of Popular Electricity. This article contains all the information necessary to construct a coil and transformer with which to perform the usual high frequency experiments such as lighting a sixteen candle-power lamp one terminal of which is held in the hand and the other connected to one terminal of the Tesla coil, the production of fantastic brush discharges, the melting of fine wire by high frequency current passed through the body, lighting of a vacuum tube, etc. The outfit may also be used for medical work and wireless telegraphy. Following is a description of the apparatus:

A transformer is needed, giving 10,000 to 20,000 volts to charge the condenser. To



Connect No. 2 and 4 together for series connection and for parralell No. 1 & 2, And also 3 and 4.

FIGURE I. TRANSFORMER FOR HIGH FREQUENCY WORK

construct one it is necessary to make a core from soft sheet iron strips, with a cross-section 2½ inches square, built in the shape of a rectangle eight by fourteen inches outside dimensions and three by nine inches inside (see Fig. 1).

Cut from the sheet iron, strips 2½ by 5½ inches and 2½ by 11½ inches, a sufficient number to make a mass five inches thick of each size when compressed in a vise.

Then take three strips at a time and build a core of the dimensions given in Fig. 1, leaving the top section unfinished until the secondary coils are placed in position.

To hold the core in shape after it is assembled, take two pieces of dry wood twelve by three by 1½ inches and bore a hole in the ends of each, nine inches apart. Put one board on each side of the bottom section and place in a vise, when the six-inch bolts can be drawn tight and then the core will be rigid.

On the vertical sections wrap tightly two or three layers of friction tape to within 2½ inches from the top. Over this wrap a couple of layers of Empire cloth.

The primary consists of 110 double turns wound in a single layer over the Empire cloth, the conductors being two No. 12 cotton-covered copper wires placed side by side, 55 double turns on each vertical section (see Fig. 1).

Over the primary winding next wind tightly 15 layers of No. 7 Empire cloth nine inches wide and we are ready for the secondary winding.

In winding the secondary much care must be exercised, as a transformer's insulation is no better than its weakest spot. This secondary consists of 20,000 turns of No. 32 single cotton-covered copper wire wound in eight coils of 2,500 turns each, which are connected in series, four coils on each side.

The coils are rectangular in shape 1¼ inches wide, four inches square inside and six inches square outside dimensions. They are wound on a form 1¼ inches wide and four inches square, the lateral edges being slightly rounded off to facilitate winding. This form is carefully centered and a metal rod about six inches long of any convenient size is passed through, with a small crank fastened on one end. To keep the coil from sliding out of shape make two disks seven inches in diameter, and when centered screw one on each side of the form.

Set this form between two supports and begin winding, first a layer of Empire paper

and then a layer of wire alternately, until the 2,500 turns are on. It will be found very easy to wind this fine wire in layers if it is allowed to slide over a rod a foot or so away and guided with one hand while winding with the other. Leave a margin of $\frac{1}{4}$ inch in each layer.

All coils should be tested to see if there are any bare places or if the wire is in one continuous piece. If not, do not attempt to use it as it will surely burn out when run a short time. When all coils are completed they should be dried in an oven, not too hot, and then laid flat in hot petroleum and boiled for several hours, and then left to cool in the mixture until set, which will take quite a long time.

When thoroughly cold, take carefully out of the mixture and after taking the surplus off the coils, assemble on the core over the primary, four on each side. To keep the coils insulated from each other, cut 36 squares of Empire cloth seven by seven inches and cut out of their centres a hole that will fit snugly over the Empire cloth on the primary. Use six thicknesses between adjacent coils, there being only six places to use these separators.

The coils should all be connected in series as though it were one continuous wire beginning at the top of one section and ending at the top of the other. (See Fig. 1.)

Connect all coils so that they have the same relation to one another as the turns in the primary. Keep the coils one inch from the bottom of the core by inserting narrow strips of birch wood across the binding boards and cover with several thicknesses of Empire cloth.

When all the coils are assembled and connected properly, the top part of the core may be completed. A sheet of micanite nine by four by 0.1 inches should be used to separate the vertical sets of coils. Make a box of close-grained hardwood seven by fifteen by fourteen inches inside measurements and coat thoroughly with hot paraffine to make it perfectly tight.

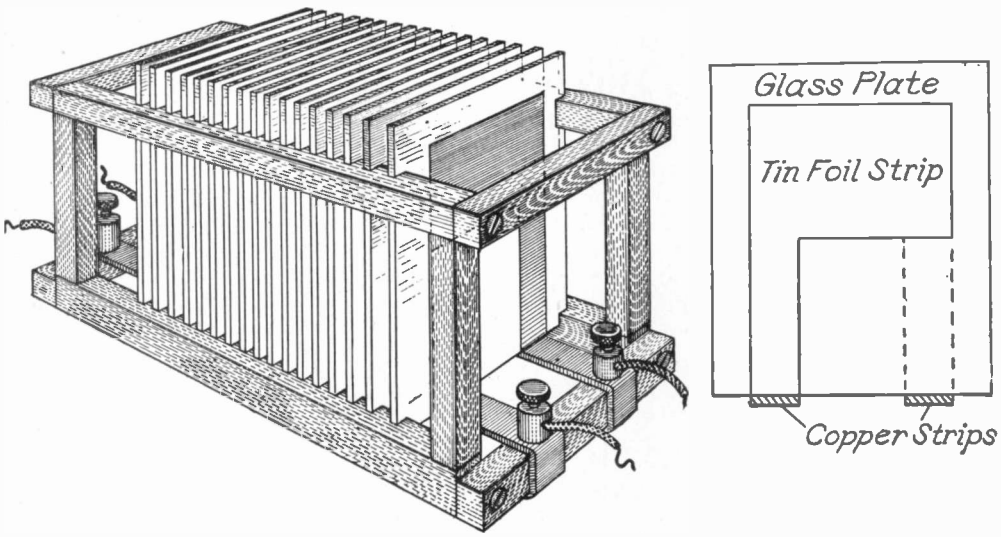


FIG. 2—CONDENSER FOR HIGH FREQUENCY APPARATUS

When the transformer is set in the box it may be fastened by screws to the bottom binding boards.

Bring the ends of the primary wires to one side of the box and the secondary to the other side where they can be connected to proper binding posts. The secondary wire should be kept clear from the core and be led out through hard rubber rod binding posts. The four primary wires should be arranged so that they can be easily connected either in series or parallel.

Boil 40 pounds of extra amber petroleum and fill the box to the top and screw fast the cover and the transformer is complete.

Next we construct an adjustable condenser of seventeen plates of double thickness window glass ten by twelve inches. Coat all the plates with tin foil five by six inches on both sides. Leave a margin of two inches on top and sides and five inches on the bottom. On eight of these plates

paste a strip of tin foil on the lower right hand corner to reach the bottom and on the other nine paste them on the lower left hand corner of the foil. These are the connectors which rest on two copper strips laid parallel four inches apart on the bottom of the crate with binding posts on each end. The strips are fastened on and insulated from the bottom of the wooden crate, with slots in the sides to receive the plates. (See Fig. 2.)

The Tesla coil consists of a primary of seven turns of No. 6 bare copper wire and a secondary of 180 turns of No. 22 bare copper wire wound in a single layer on a drum six inches in diameter and fourteen inches long made of dry birch boards glued together in a circle and then turned off in a lathe. The turns of wire are carefully spaced apart 1-16 inch when winding, leaving a margin of $\frac{1}{2}$ inch on the ends. The primary is wound on a wooden drum eight inches in diameter and $4\frac{1}{2}$ inches long, the turns being carefully spaced apart and fastened. The secondary coil is set on top of the primary coil and the base fastened to the bottom drum.

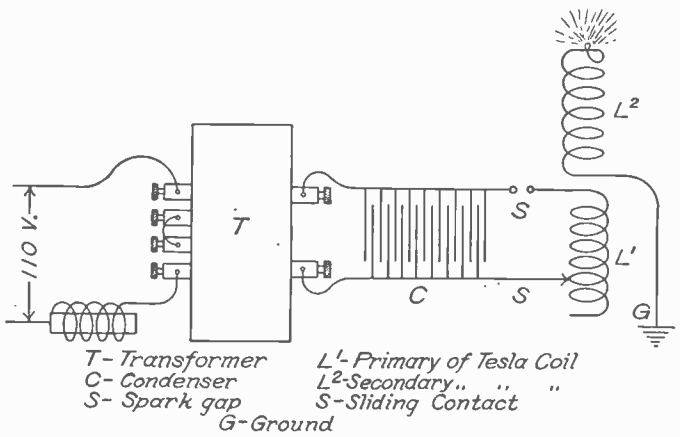


FIG. 3. CONNECTIONS OF TESLA OUTFIT

Give the secondary winding a coat of orange shellac, being careful not to disturb the turns while doing so. A nice turned top can be added for appearance, and a brass rod four inches long and $\frac{3}{8}$ inch thick driven tightly in the centre of the top and well rounded off, will be the discharge rod, being connected to the top end of the secondary wire.

The lower end of the secondary terminates in another binding post.

On the primary a binding post is fitted at only the upper end, while the other connection is a sliding contact.

For a spark gap take a glass jar about six inches in diameter and eight or ten inches in height and make a hole in the bottom $\frac{1}{4}$ inch in diameter. To do this take clay or putty and lay a thick layer over the centre of the bottom of the jar. Make a $\frac{1}{4}$-inch hole in the clay down to the glass and fill with hot solder. The glass will fall out the shape of the hole in the putty or clay.

Make a cover from some nice hardwood to fit tightly in the top of the jar, and bore a hole in the centre, in which fasten securely a threaded $\frac{1}{4}$-inch nut which is connected by a wire to a binding post on one edge of the cover.

A $\frac{1}{4}$-inch rod threaded the whole length is fitted with a hard rubber handle $\frac{3}{4}$ by three inches long. This is screwed in the threaded nut. The length of rod depends on the height of jar used. Another rod is fitted with a metal ball $\frac{3}{4}$ inch in diameter and inserted in the hole in the bottom and then through a base of hardwood on which a binding post is placed.

Now to operate the completed apparatus connect as per diagram, Fig. 3.

Connect the lower terminal of the secondary of the Tesla coil to a good ground with stranded wire, as a stranded wire is a better conductor for high frequency currents than is solid wire.

Although good results can be obtained by using the primary in parallel on 110 volts, 60 cycles, consequently 20,000 volts secondary voltage, yet as good results with better control may be had by using the primary sections in series and an adjustable choke coil in series with them. The choke coil can be made from a mass of sheet iron $2\frac{1}{2}$ by $2\frac{1}{2}$ by eight inches, which is inserted in a hollow coil of No. 10 copper wire of 110 turns.

By inserting the core in the coil the current can be varied according to the depth inserted. This outfit is for the uni-polar or single pole method of generating high

frequency currents. If all connections are correctly made the spark gap should be turned until the spark will just jump easily, then on the primary of the Tesla coil move the sliding contact on the second turn from the top, then onto the next turn and so on until the desired results are obtained.

To light a lamp use the fourth or fifth turn and slide the lamp along the side until the brightest light is obtained.

Always disconnect the primary of the transformer before attempting to adjust the different parts.

By adding condenser plates or taking them out of the crate, one by one, the coils will be brought in tune under certain conditions.

How a Farmer Secured Electric Lights

W. H. Neville, of Vista Farms, Edison, Pa., by the exercise of a little ingenuity and using second-hand apparatus constructed a very satisfactory electric light plant at small cost. He sends us the following description.

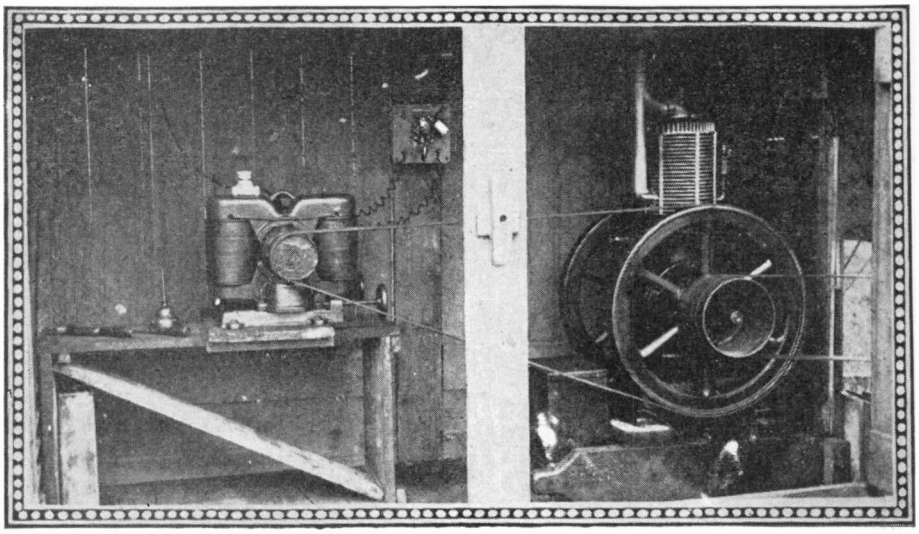
"A two and one-half horsepower gasoline engine was already in use. A second-hand, one horsepower, 110-volt shunt-wound motor was purchased and belted to the engine and used as a dynamo, as shown in the picture. By running the motor fifteen per cent faster than its rated speed it lights to full brilliancy sixteen, sixteen-candlepower lamps. One gallon of gasoline will run the engine over five hours. so that the cost per light is but one-fifth of a cent per hour. Kerosene lighting used to cost me more.

"The pulleys on the engine are so arranged that I run the engine to pump water, saw wood, churn, etc., so that I figure the lighting as costing nothing when other savings in labor are considered. No storage battery is used so there is the inconvenience of having to start the engine each time light is needed but I am amply repaid by having plenty of light and no oil lamps to handle and care for.

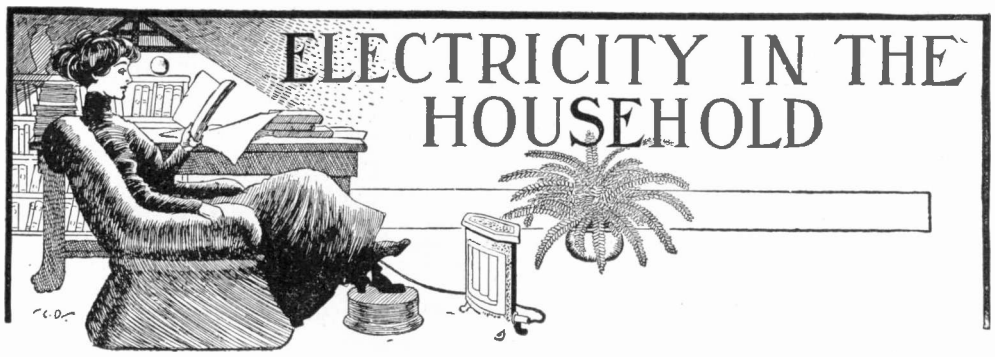
"The engine and generator require hardly any attention and an old motor such as I use can be purchased for as low as fifteen dollars. By rewinding the starting box with a fine gauge resistance wire I made a good field rheostat."

A Potato Polarity Indicator

That ordinary vegetable, the potato, may be used to tell which is the positive and which the negative terminal of a circuit. Insert the two current carrying wires into the freshly cut surface. A green stain due to dissolved copper indicates the positive wire. If both wires are surrounded by dark-colored stains the current is alternating.

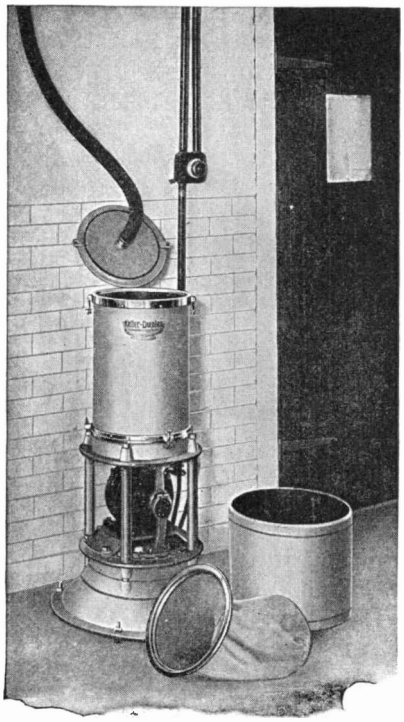


ELECTRICAL GENERATING SET FOR FARM USE



Permanent Vacuum Cleaning System

The time is approaching when arrangements will be made in building a house for a vacuum cleaning system the same as for the heating, lighting and plumbing systems.

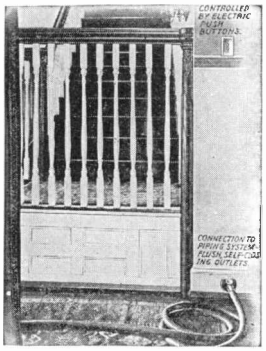


PERMANENT VACUUM PUMP AND MOTOR IN THE BASEMENT

A little piping will be necessary, but not nearly so elaborate as for the heating and plumbing which are now recognized necessities.

One way of acquiring this most desirable adjunct to a modern home is by the use of what is known as the Keller-Duplex system, which is shown in the illustrations.

In the basement is located the machine for creating a vacuum in the system of small pipes which lead to the various rooms of the house. This part is stationary, and the little motor which operates the pump is connected directly to the lighting circuit



SHOWING CONNECTION TO INLET

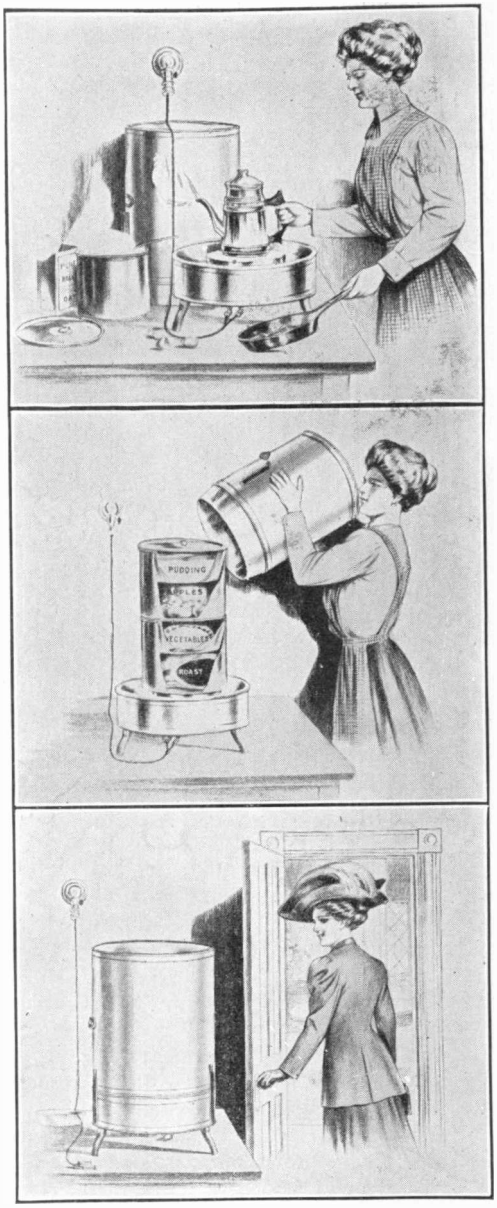
in the basement, being started and stopped by ordinary snap switches located on all floors. The air which is drawn down through the system of pipes is passed through muslin bags in the vacuum creating chamber and all dust and dirt so removed.

Up stairs, all that is visible of the system is a small inlet in the base board, to which the hose is connected. The hose is plenty long enough to reach to all parts of the room and the usual "tools" are provided for cleaning carpets, rugs, draperies, curtains, etc.

The pipes for the system range from $1\frac{1}{2}$ to one inch in diameter and so are readily run through partitions and between floors.

ELECTRIC FIRELESS COOKING

To many people the term "fireless cooker" is an apparent self-contradiction. It sounds like saying a "wingless bird," or an "unfrozen icicle." Nevertheless there are such things as fireless cookers which effect considerable economy. They are devices for keeping food in a state of being cooked after the process of cooking has been properly started either over a fire or by means of electric heat. Such a cooker consists essentially of a containing receptacle which will not allow the heat to escape from the steaming hot ingredients, once they are put inside.



One of the newest departures in this line is known as the Quad electric stove and fireless cooker. It embodies all the advantages and economies of electric cooking with those of the fireless cooker.

The illustration shows clearly the method of operation. In the upper picture the housewife is preparing the breakfast. This is done on the small electric disk stove which is placed in the bottom of the cooker proper. The cereal is already cooked and the coffee, bacon and eggs are in the process of preparation for the breakfast table.

At her right hand is the fireless cooker which by means of an air-tight, beveled rim fits down into the base which holds the stove. While the breakfast is being prepared or at any time during the morning work the various dishes may be prepared for the noonday meal. These find places in the various compartments of the fireless cooker as shown in the middle picture. These may be set going as soon as the breakfast is out of the way, for fireless cooking is a slow process, and nothing is wasted in steam or vapor, and there is no burning of a dish, which is always a possibility where an oven is used. When the vegetables, roast, etc., are all in the cooker and the cover clamped down, the current is turned into the stove, which remains in the bottom of the cooker, and left on for a short time until everything is at cooking temperature. Then, owing to the non-conducting sides and bottom of the cooker the heat is retained and the cooking process goes on.

The one who has presided over these operations may then go out, to do her shopping without fear of coming back to an oven and kitchen full of smoke. If a hurry call comes in to put off dinner for a half an hour it causes no consternation, for the things will come out of the cooker at the end of that time and be just as good.

Sweeping, Beating and Dusting in One Operation

Some of the most painstaking housekeepers maintain that it has been and always will be necessary to beat carpets, shake rugs, sweep thoroughly and then dust. In other words they do not feel things are being cleaned unless they can "see the dust fly."

For this reason they very likely have not taken readily to the quietly operating vacuum cleaner. Perhaps however, they have never seen the Hoover suction sweeper in operation, which not only embodies the vacuum cleaning principle but also that of the ordinary carpet sweeper.

SWEEPING AND DUSTING AT THE SAME TIME

These principles are all embodied in the design shown in the illustration, which consists of but five parts —the motor, the fan, the brush, the case and the bag. The suction is created by a fan driven at a speed of 3,400 revolutions per minute, by a compact but powerful Westinghouse electric motor, which also operates a revolving soft hair bristle brush at high rate of speed. These elements, in their operation combine the three cardinal principles of cleaning: vibration, formerly accomplished by beating and shaking; brushing, formerly done, ineffectively, with the broom and carpet sweeper; suction, the gathering and holding of all the dirt after it has been dislodged.

The initial cost of the electric suction sweeper and the cost of the current necessary to operate it are very insignificant when compared with the time and expense, and the personal worry and fatigue connected with the old fashioned method of house cleaning. Besides, a sweeper of this kind keeps the home clean, not once in a while, but all the time, and not partially but absolutely clean.

Automatic Batteries for House Lighting

Portable storage batteries now so commonly used for operating the ignition system of automobiles, and giving about 60 ampere hours at six volts, have found many uses besides that for which they were primarily intended. For instance, in the home of the maker of one of the well known types of battery, the Jewel, extensive use is made of the current derived from two of these batteries.

One of the batteries is placed upon a shelf in the basement, and connected with fourteen tungsten lamps of various sizes from two to ten candlepower, and within each of five closets are lamps in oval reflectors, these lamps being connected with burglar alarm springs on the closet doors, in such a way that when the doors are opened and closed the lights are lighted and closed off automatically.

Also above the five mirrors are lamps, and on the piano is a lamp in an oval reflector. In the bedrooms eight-candlepower lamps are used to furnish light for retiring, and in the basement a ten-candlepower lamp is used when coaling the furnace, etc. This battery is also connected with a jump spark coil, which ignites the burners of the kitchen gas stove, and also to operate a system of burglar alarms, electric door chimes, electric fans and electric cigar lighters.

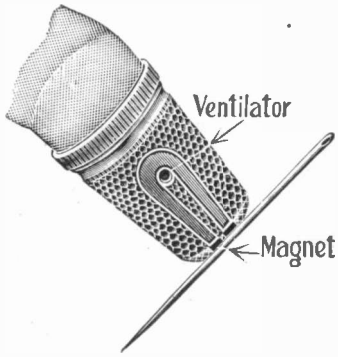
The other battery is used for the operating of a vacuum cleaner, and sewing machine, and massage vibrator. There is also being

constructed for this residence an electrically lighted and operated water spray fountain for the parlor.

About every two weeks one of the batteries is taken out to be re-charged. The cost of re-charging a "6-60" battery, is only fifteen cents. Where central station current is not available such a system is satisfactory and economical.

Magnetic Thimble

An ingenious novelty in the form of a magnetic thimble is shown in the cut, the object being to enable one to pick up a needle readily without getting out of temper. A little horseshoe magnet is fastened to the thimble, the ends projecting slightly beyond the end but not interfering with the ordinary use of the thimble. This department is edited by a couple of men and far be it from them to pass upon the practicability of the device. But it will pick up fish-hooks and there is no reason why it should not work on needles.



A MAGNETIC THIMBLE

"Electricity in the Service of Woman"

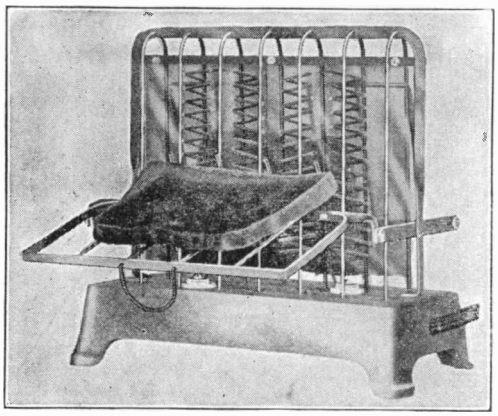
Twenty years ago one of the best electrical books available for the general reader was Urbanitzky's "Electricity in the Service of Man," an 800-page volume of which repeated editions were issued both in German and in English. In giving it this title, the author evidently thought of electricity as serving mankind in general, although the contents are devoted almost entirely to the industrial uses which benefit the average person rather indirectly. The well illustrated volume did include medical batteries, incandescent lamps and telephones which even at that time were invading the homes and making their appeal to women, but outside of these three items it was practically a man's book.

The electric heater that takes the chill off my lady's dressing room in the morning, the thermal pad that warmed her feet last night, the electric curling iron and vibrator that help preserve her beauty; the hair drier that relieves part of her toilette making of its wearisomeness; the coffee urn, toaster and chafing dish that make her breakfasting a joy; the washing machine and electric sad irons that lighten the household work; the vacuum cleaner that leaves no need for the terrors of spring cleaning; the fan motor that insures baby's sleep or mother's comfort even on the hottest days—all these have come since Urbanitzky wrote and revised his memorable book.

To describe and picture these and a score of other electric devices of interest to housekeepers with the same clearness would make fully as large a volume on "Electricity in the Service of *Women*." Is it not time that some man showed his gallantry as well as his thoughtfulness by treating this theme in an adequate volume?

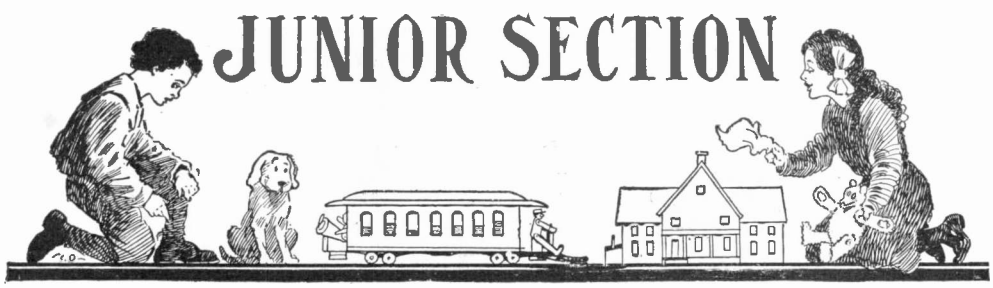
The "Cozy" Toaster

Among the more recent portable devices for cooking by electricity is the Phelps Cozy toaster which prepares a slice of bread just to your liking for a cost of only one-twelfth of a cent a slice. It toasts two slices at a time,



A NEW ELECTRIC TOASTER

one on each side. The heating element is practically indestructible, and the toaster presents a handsome appearance. There is a little hinged holder for the slice which, when turned up and fastened in place, holds the slice near the red hot wires but not touching them.



An Electrical Laboratory for Twenty-Five Dollars

By DAVID P. MORRISON

PART XII.—SOME SIMPLE EXPERIMENTS

All magnets have the power of attracting toward them any magnetic material that may come into the region surrounding the magnet, which is termed the magnetic field. This magnetic field is then a region in which magnetic forces exist and its strength at any point will depend upon the strength of the magnet producing it and the distance the point considered is from the magnet. This magnetic field will have a definite direction at any point and this direction is determined by the direction a north magnet pole would tend to move when placed in the field at the point. If a compass needle were placed in the field the north pole would point in the direction of the field.

Place a good size bar magnet on top of a piece of paper as shown in Fig. 108. Now

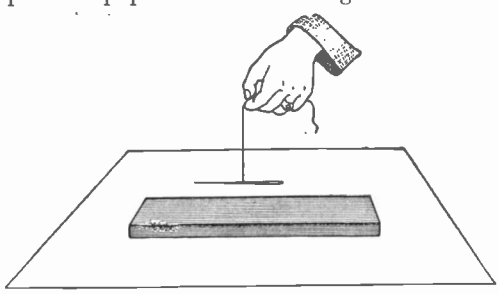


FIG. 108. DETERMINING THE DIRECTION OF MAGNETIC FIELD

take a very short steel needle and magnetize it and arrange to support the needle by a piece of very fine thread so that it is perfectly free to turn and well balanced. The direction of the magnetic field surrounding the magnet at any point can now be determined by the small magnet or compass needle and marked on the paper with a pencil. If the compass needle be carried from one of the magnets to the other, and its position marked for a number of different points, and a line drawn through all these points, corresponding in direction with the position of the needle at the point, the line will correspond to what

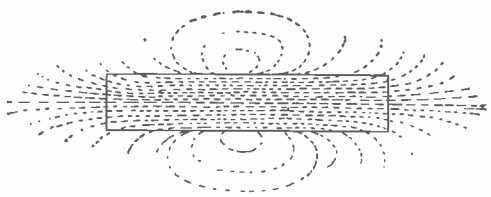


FIG. 109. MAP OF LINES OF FORCE

is termed a line of force. Any number of different paths may be taken by the needle and a line drawn for each path. The position of these various lines with respect to each other will be similar to that shown in Fig. 109.

The above method of mapping out the magnetic field of a magnet will be found to be very tedious and the following method will be much easier and it will require a great deal less time. Place the magnet whose field is to be investigated under a sheet of heavy paper or cardboard and sprinkle some rather fine iron filings on the paper, tapping the paper at the same time. The iron filings will arrange themselves in curves corresponding in direction to the magnetic field. Such a field is shown in Fig. 110.

These imaginary lines, called lines of force, always start from the North Pole of a magnet and terminate at the South Pole. If a magnetic substance be placed in the

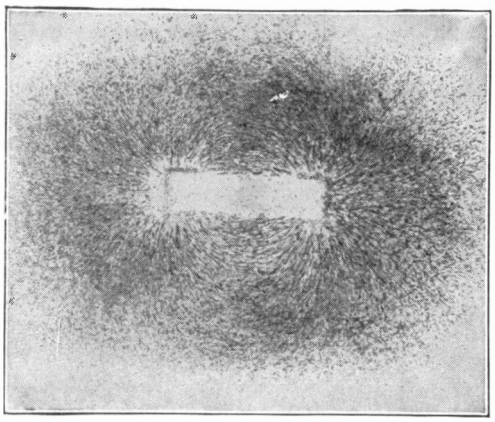


FIG. 110. IRON FILINGS IN MAGNETIC FIELD

field of a magnet the field will be distorted or changed. The lines of force per unit area will be a great deal greater through the magnetic substance than through the air. This is on account of the substance being a better conductor of magnetism than air. If, for instance, a piece of iron be placed in the field the result will be similar to that shown in Fig. 111.

The arrangement of the lines of force existing between the opposite poles of two

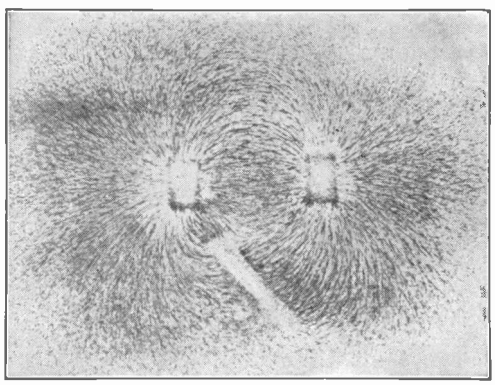


FIG. 111. PIECE OF IRON IN MAGNETIC FIELD

magnets is shown in Fig. 112. It can be seen that the lines pass between poles of opposite polarity. When the like poles of the magnets are presented, the lines no longer pass from one magnet to the other but pass around and terminate at the opposite pole of the same magnet, as shown in Fig. 113.

To preserve the field as shown by the position of the filings upon the paper, take the sheet of paper the field is to be formed on and dip it in some hot paraffin and then hang it up by one edge and allow it to drain and cool. The field can now be produced on this sheet of paraffined paper. After all the filings are arranged as you want them, and without moving the magnet or paper, take a hot soldering iron or poker and hold it over the paper which melts the paraffin and allows the filings to sink

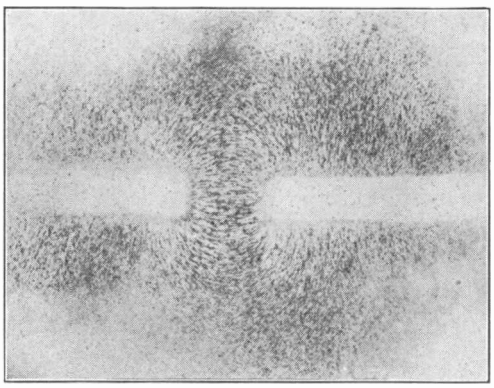


FIG. 112. ACTION BETWEEN OPPOSITE POLES

into it, and they are as a result held in place when the paraffin cools.

Another simple experiment that serves to show the direction of a magnetic field may be performed as follows: Obtain a shallow vessel, preferably glass, and of

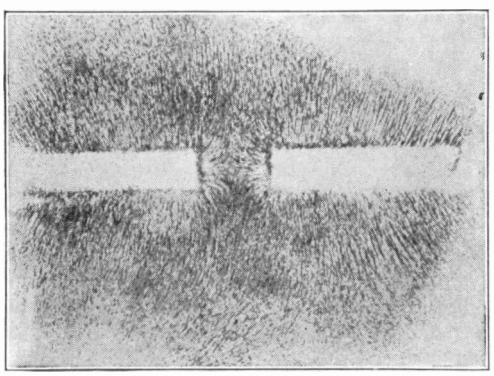


FIG. 113. ACTION BETWEEN LIKE POLES

rather large diameter. Place in the bottom of this vessel a permanent bar magnet and

cover it with water to a depth of about one inch. Now magnetize a steel needle several inches in length and put it through a cork in such a way that it will float in a vertical position, when the cork is placed in the water, see Fig. 114. First, however, determine the polarity of the needle and arrange to have the lower end the North Pole. When the cork and the needle are placed in the water they will move, due to the magnetic

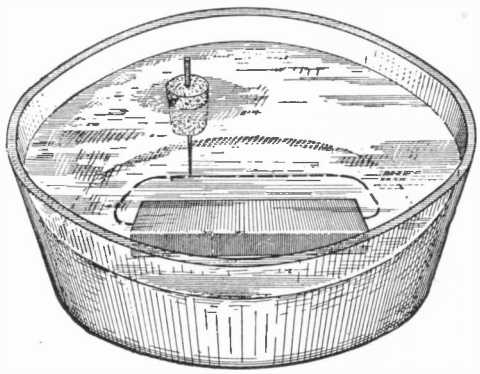


FIG. 114. FLOAT SHOWS DIRECTION OF LINES

field of the permanent magnet upon the North Pole of the needle. The cork will follow a curve similar in form to one of the lines drawn in Fig. 109 and it will pass from the North Pole of the permanent magnet to the South Pole.

This experiment can be made to appear very mysterious in the following way. Magnetize a short piece of steel and imbed it in a piece of cork so that the magnet itself is not visible. Obtain a steel rod about one foot long and ¼ inch in diameter and magnetize it by means of a powerful electro-magnet if possible. After the bar has been magnetized it may be placed inside of a wooden tube and the ends covered in some suitable way. With this wand the cork can be made to move in the dish in any way you choose. You can hold the dish in one hand while you are performing the experiment and the results will be entirely dependent upon your movement of the wand. Give the wand to some one and at the same time place the dish on a table with a strong magnet under the cover on the table. Have the pole of the magnet that is under the table, of the opposite polarity to the lower end of the magnet in the cork. When this is the case the cork will be held in a position directly over the magnet under the dish and if this magnet is very strong there will be practically no change in the position of the cork produced by any movement of the wand.

Here is another experiment. Obtain a small quantity of iron filings and place them in a shallow dish. Now get a piece of very soft iron about ¼ inch in diameter and six inches long. Place one end of this piece of iron in the dish of iron filings and withdraw it. There will be no iron filings adhering to it. Place the end of the piece of iron again in the dish and present one end of your wand to the other end of the piece of iron and withdraw the end of the iron rod from the dish of filings still holding the wand near the other end. When the wand is placed near the piece of iron the latter becomes magnetized due to the process of magnetic induction and as a result attracts the iron filings.

The magnet produced by the process of magnetic induction has a polarity just the same as any other magnet and this polarity can be determined by presenting one end of the bar, in which the magnetism is induced, to a compass needle. The polarity thus determined will bear a definite relation to the polarity of the permanent magnet that is inducing the magnetism in the iron bar. It will be found that by marking the polarity of the magnets that the pole of the induced magnet nearest the end of the inducing magnet will be of opposite polarity to that end of the permanent magnet.

Magnetism is supposed to be due to a molecular condition of the material forming the magnet because a magnetic needle when heated red hot is found to lose its magnetism completely, and if a magnet is jarred or hammered or twisted, the ability of the poles to pick up particles of magnetic materials is greatly diminished. Again, if a magnet be broken into a number of small parts, each part is found to possess two magnetic poles. The subdivision may be continued indefinitely but always with the same result that two poles are formed at each break.

Fill a small glass tube with iron filings and magnetize the tube by stroking it with a magnet. This magnetized tube will then produce an effect on the ordinary compass needle the same as that produced by any magnet and from all outward effect it is itself a magnet. But it will lose its magnetism as soon as the filings are shaken up. You can magnetize the tube with your wand,

present it to the compass needle and the needle will be affected. Hand the tube now to another person and in doing so give it several good shakes. The person to whom the tube was presented, much to his surprise, will be unable to cause it to produce any effect upon the compass needle.

Another interesting experiment that might be called magnetic writing can be carried out as follows: Round off the end of a piece of steel and magnetize it as strongly as you can. Now with the end of the magnet write on a piece of thin steel such as a saw blade and then sprinkle with iron filings. The writing, which is quite invisible in itself, comes out in the lines of the filings that stick to the magnetized parts. This writing will continue in the steel for a considerable time, depending of course upon the treatment of the piece of sheet steel.

In making magnets some care should be exercised in selecting the material for the magnet. All kinds of steel cannot be used in making permanent magnets, although they may possess good machine tool properties. Certain grades of steel that contain a certain percentage of manganese cannot be magnetized. Some brands of mild plate steel, spring steel, and cast steel can be readily magnetized, but they do not retain their magnetism permanently. Select a piece of good close-grained rolled steel and cut from it a piece whose dimensions correspond to those of the magnet you want to make. This piece of steel should now be bent into its final form and finished with a fine file. Temper the piece glass hard by heating it to a moderately bright red temperature and then plunging it into a bath of water or preferably oil. The piece of steel can now be magnetized as follows, often called the "single touch" method and the proper procedure for carrying out this method is shown in Fig. 115. The dotted line indicates the path the end of the magnet used in magnetizing the bar should travel in. A better magnet will be obtained by magnetizing each half separately as shown in Fig. 116.

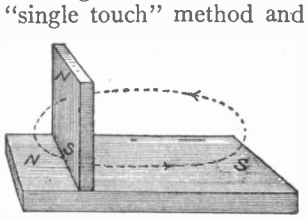


FIG. 115. MAGNETIZING BY "SINGLE TOUCH"

Oftentimes there is no permanent magnet available to be used in magnetizing your bar and the magnetism of the earth may be utilized. If the bar to be magnetized be placed as near as possible parallel to the earth's magnetic field, the north end dipping down, and in this position be struck a number of times with a piece of wood, it will be found to have acquired magnetic properties.

If a number of turns of insulated wire be wrapped around a piece of steel to be magnetized, and a strong current of electricity be passed through the coil from a battery as shown in Fig. 117, the bar will be permanently magnetized with a North and a South Pole, after the current is turned off. Tapping the bar while the current is turned on will increase the strength of the magnet formed.

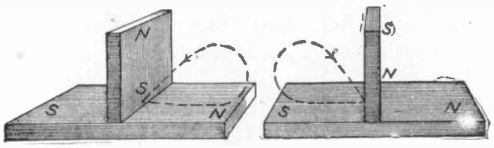


FIG. 116. MAKING A MAGNET

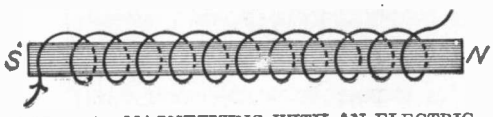


FIG. 117. MAGNETIZING WITH AN ELECTRIC CURRENT.

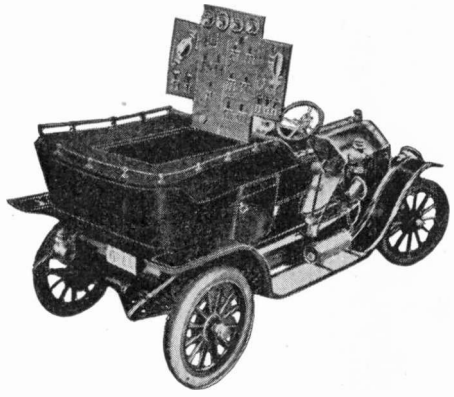
The coil may be wound on a wooden form and any number of bars magnetized by simply slipping them into the coil, which eliminates the trouble of winding and rewinding the coil for each magnet. If a soft piece of iron were placed in the coil it would lose its magnetism as soon as the current was turned off. This fact is used in what might be termed a silent telegraph instrument which consists of a piece of soft iron surrounded by a coil of wire and mounted over a small box of fine iron filings. These filings are attracted to the bar of iron when there is a current in the coil of wire surrounding it and they are released when the current ceases to flow. The coil can be connected in a telegraph circuit in the place of the ordinary sounder. A sheet of white paper placed over the end of the bar of iron will add greatly to the ease of determining whether the filings are attracted to the bar or not. The duration of the time the filings are held by the bar corresponds to the dots and dashes of the code you use.

(The End.)

An Electrical Laboratory on Wheels

The management of a system of evening schools in New England has devised a very novel method of furnishing electricity for the use of the students.

Four specially designed automobiles made with an enclosed tonneau are used to transport the apparatus from place to place. Under the chassis is suspended a two-kilowatt, direct or alternating current generator, driven by the same gas motor that propels the



LABORATORY READY FOR USE

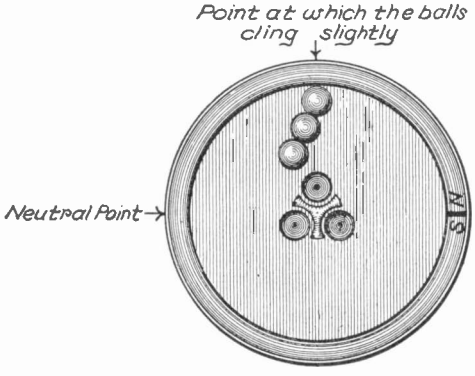
vehicle itself. Wires lead to part of the tonneau cover which when opened up forms a good sized switchboard. Connections are made to the board and students have the benefit of a complete laboratory outfit. The automobiles are also equipped with a 200-mile wireless station so that it is possible for the schools to be in communication with each other at all times.

An Electrical Fishtale?

Smiles were abundant among readers of the last number of the Swiss "Technische Blaetter," a serious technical journal, on account of an article in the same purporting to be based on experiments made by a Frenchman named Rose. The article stated that Rose dipped the terminals of a dynamo into a stream in which dace or darts (a small variety of fish allied to our familiar minnows) were plentiful and that the current strongly attracted the little fish to the positive pole; in fact, they were so forcibly drawn to it that if this positive wire had been barbed they would have been speared alive! Perhaps there is some action of the current on fish of which we are not yet aware, but with all due regard to the never ending wonders of electricity, does not this report sound rather fishy?

A Magnetic Puzzle

Every year brings new varieties of the "Pigs in the Clover" type of puzzle in which a series of balls or marbles is to be placed simultaneously in one or more pockets. Among the more recent of these is one which depends on magnetism for its tantalizing qualities. It consists of an aluminum case not much larger than a silver half dollar, with a glass cover and with three steel balls which are to be manipulated into three pockets at the center of the case. This would be simply a matter of careful tilting were it not for a circular magnet which lines the rim of the case and to which the steel balls persistently cling. Moreover the pockets are separated by little ridges or fences which so increase the difficulty of getting the balls into them simultaneously as to spoil the most logical solution of the puzzle.



MAGNETIC PUZZLE

In a circular as in a horseshoe magnet the greatest attractive strength is at or near the ends and the neutral point (or point of no attraction) would be opposite the split part of the magnetic ring. The natural inference therefore would be that if the puzzle is tilted with this neutral point uppermost, the balls will easily leave the magnet to which they cling even at this neutral point because (being of hardened steel) they have themselves become slightly magnetized. But anyone trying the puzzle

soon finds that while the balls are easily tapped off this neutral point, they will roll off independently and separate too far to be caught in the pockets; for the moment a ball gets near the rim again, it is drawn to the same. The really logical point of detachment for the balls is one where the attraction is not as strong as at the poles, but still strong enough to let the balls magnetize each other and thus cling closely together while they are being manipulated into the center by tilting and tapping the casing.

Telephone Helps Save Forests

The enormous fire loss in the forest reserves of the United States during the year has caused considerable discussion as to the best means of prevention and has also raised the query as to the protection now available.

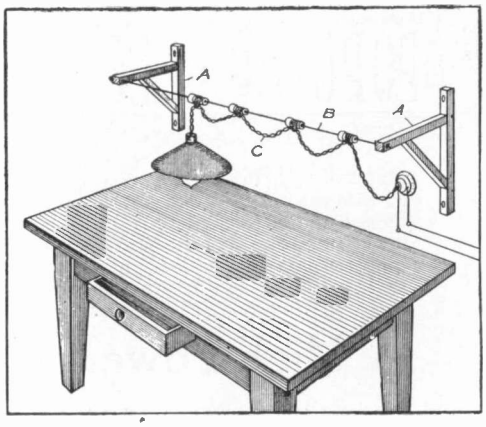
Five years ago ex-Chief Forester Pinchot caused telephones to be installed in connection with the patrol system. Immediately after a fire made its appearance aid was summoned over the telephone and the fire stopped before it was beyond control. Many lives and thousands of dollars' worth of lumber have thus been saved. Formerly the ranger after discovering a fire was obliged to ride to the nearest settlement for assistance, during which time the fire would probably get beyond control. Up to the present time 600 miles of telephone wires have been strung and enough use made of the telephone to show that it is of the greatest value in the forestry service.

An Adjustable Bench Light

A work bench light which can be readily located where required is a very necessary part of a shop equipment especially during the winter months.

A light that can be shifted along the entire length of the bench is shown in the accompanying illustration. Two brackets (A) either of wood or iron may be placed on the wall above the bench and a wire (B) stretched tightly between them. String four small porcelain tubes or knobs on this wire and to these tape the flexible cord to the light. An attachment plug or a rosette may be used where connections are made to the circuit and a cord adjuster will serve to raise and lower the light.

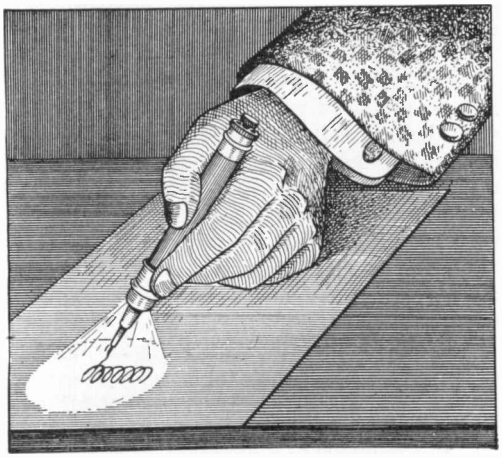
W. M. KISHPAUGH.



WORK BENCH LIGHT

Writes by Its Own Light

An architect desires to make a note of some defect in the dark basement of a building, an author to record a sudden midnight inspiration, the sleuth to sketch a plan on the spot; in fact many instances arise where the electric pencil shown in the sketch would be useful in giving a little light and that only



COMBINED PENCIL AND LIGHT

where needed. By turning the screw at the top the light is switched on. When the pencil attachment is removed the device may be used like the ordinary pocket light. In designing a novelty of this kind the battery could be placed in the barrel of the pencil and one of the very small "grain of wheat" lamps which are made for dental purposes, etc., could be used.

POPULAR ELECTRICITY WIRELESS CLUB

Membership in Popular Electricity Wireless Club is made up of readers of this magazine who have constructed or are operating wireless apparatus or systems. Membership blanks will be sent upon request. This department of the magazine will be devoted to the interests of the Club, and members are invited to assist in making it as valuable and interesting as possible, by sending in descriptions and photographs of their equipments.

A High-Power Wireless Equipment

By ALFRED P. MORGAN

PART VIII.—A TWO KILOWATT CLOSED CORE TRANSFORMER

Some perhaps may wonder why I describe the construction both of a transformer and an induction coil in a series of papers which are supposed to deal with the equipment of one station only.

The transformer is employed only where alternating current is available. By its use the always troublesome interrupter is avoided and it is possible to use larger currents at a greater efficiency. But even though the induction coil is somewhat less efficient and more expensive to construct it cannot be condemned, for it must be remembered that it often plays its part where a transformer would be out of the question. For example, in portable outfits or isolated stations it would be impossible to supply a transformer with alternating current unless a cumbersome engine and dynamo were at hand.

While a detailed description of the design of transformers cannot well be given here I will undertake a brief discussion of some of the fundamental principles and factors entering into the design.

Transformers exist in two different forms, known as the open and closed core types. The first is much like an ordinary induction coil connected directly to an alternating current system without any form of interrupter.

The induction coil which has been previously described would operate as an open core transformer but is somewhat less efficient than the closed core type of transformer which consists of two independent coils of wire wound upon an iron ring or rectangle. When an alternating current passes through one coil known as the primary it generates a magnetic flux which in flowing through the other coil induces in it an electromotive force. The magnitude of this secondary electromotive force is almost directly proportional to ratio of the number of turns in the windings. For example, if it were desirable to raise the voltage of a 110-volt circuit to 22,000 volts, the number of turns in the secondary must be about 200 times

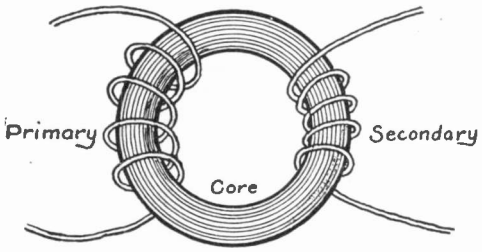


FIG. 91. SIMPLE TRANSFORMER WITH RING CORE

those in the primary winding, providing the transformer is of good design.

A transformer having a core which is ring-shaped as in Fig. 91 presents several theoret-

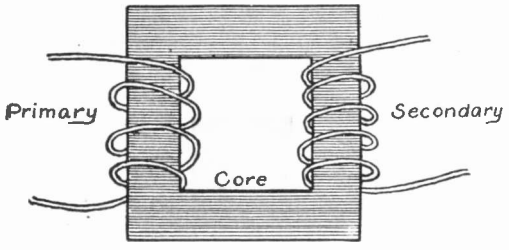


FIG. 92. SIMPLE TRANSFORMER WITH RECTANGULAR CORE

ical advantages as such but would be exceedingly difficult to construct. The core is therefore usually given a rectangular shape as in Fig. 92. In a well designed transformer the primary and secondary are usually divided into two halves and one wound on each "leg." This has the advantage of requiring considerably less wire to attain a given number of turns since they are all closer to the core. It also reaches another result which is somewhat more important. The greater part of the magnetic lines of force generated by the current flowing through the primary surge through the iron circuit but part of them pass also through the air immediately around the primary and core. The magnitude of the current in-

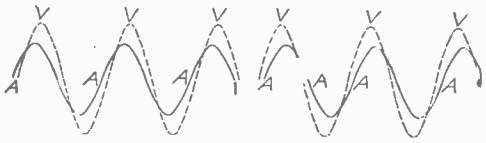


FIG. 93. ILLUSTRATING LEAD AND LAG IN PHASE

duced in the secondary is dependent upon the number of lines of force which it cuts. Thus we see that by splitting the coils and winding one over the other it is possible to raise the efficiency considerably.

In considering however a transformer designed to give high potentials from the secondary we must take into account the insulation between the primary and secondary. Perfect insulation is much harder to secure when the coils are wound over one another. Not only this, but the fact that the transformer is to be used for wireless telegraphy where a condenser is shunted across the secondary also puts a difficulty in the way.

When an alternating current is passed through a circuit containing either inductance or capacity it does not always keep step with the alternating voltage impulses. The effect of capacity, which is the relative ability of the circuit to retain an electrical charge is opposite to that of inductance which may be defined as the property of the circuit whereby lines of force are developed around it. If there is capacity in the circuit there will be a lead in phase, while if there is inductance the current will lag. Fig. 93 illustrates this. The figure at the left shows the lead produced by capacity and the one at the right the lag due to inductance. The curves (A) and (V) represent respectively the current and the voltage.

We may more readily see the influence of these two factors if we imagine the high tension oscillation condenser to be connected directly to a source of alternating current of high potential. The current of course charges the condenser, and its voltage since the current is alternating ranges from zero to its maximum, say 25,000 volts, then from this back to zero, from zero to minus 25,000 and back again to zero. This is called a complete *cycle*. During this period the condenser twice takes energy from the circuit and twice on every cycle returns it.

But if a spark gap and a sending helix are bridged across the condenser it will discharge through the helix and across the gap at least four times per cycle.

Mechanical work is measured by a unit called a horsepower, which is equivalent to 33,000 pounds raised one foot high in a minute of time. Raising the same weight the same distance in two minutes would be exercising only one-half horsepower. Likewise if we are able to increase the number of discharges per cycle of the alternating current not only will more energy be drawn from the line but more energy will be transformed into oscillations and go forth as waves into the ether. The station will then have a greater transmitting range.

To return to the relation of the impulses of the charging current it may be said that the effect of the condenser is to cause the current to lead as we have seen in Fig. 93. That is, the proportionate instantaneous values of the current occur sooner than the voltage values and are always greater. This is why the condenser is able to give energy back again to the line every half cycle.

If an inductance coil consisting of a number of turns of large copper wire wound around an iron core is connected to a source of alternating current it will likewise draw energy from the line and return it every half cycle. But in this case the proportionate instantaneous current values are always smaller. By properly proportioning the amount of inductance and capacity it is possible for them perfectly to neutralize one another and the proportionate values of the amperage will correspond to the instantaneous voltage values the same as in an ordinary direct current circuit. Then it will be impossible for energy to be returned to

the line and the power factor of the apparatus will be materially increased.

A wireless transformer does not ordinarily have enough inductance itself to bring about this result and so it is usual to insert an impedance or reactance coil in the circuit by placing it in series with the primary of the transformer.

Much the better way, however, is to so construct the coil of the transformer so that it

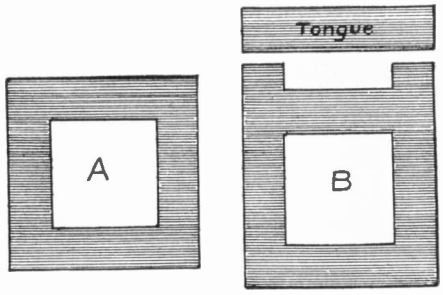


FIG. 94. TWO FORMS OF CORE FOR PRACTICAL PURPOSES

gives rise to magnetic leakage and the inductance of the primary is increased thereby.

Such construction precludes the possibility of arcing at the spark gap and allows the electrodes to remain cool. Freedom from arcing means that the frequency of the discharge is considerably increased and so

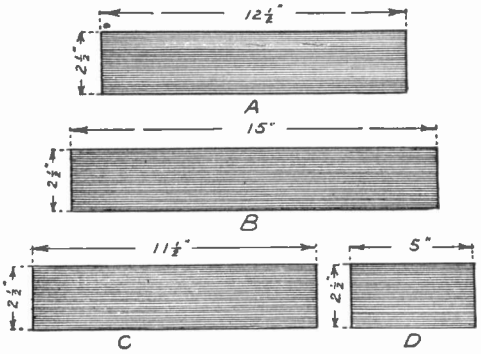


FIG. 95. STRIPS FORMING CORE

while the efficiency of the transformer is not quite so high, when used as a wireless transmitter *more* energy is actually sent up into the aerial to be transformed into electromagnetic waves.

By constructing the core as in (B), Fig. 94, these results are attained. By varying the size of the air gaps or by varying the number of turns in the primary it is possible very closely to regulate the form and amount of current.

CORE

The iron core is made of the best soft transformer iron obtainable. In lieu of this the stovepipe iron sold at plumbing shops may be used but is not to be recommended.

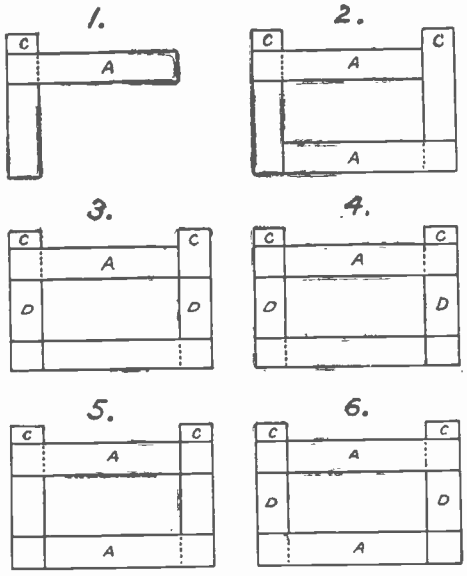


FIG. 96. STAGGERING STRIPS

About 80 pounds will be required. It should be as thin as it is possible to obtain it. Strips 2½ inches wide are cut from the sheet and dipped in some such insulating varnish as P. and B. or M. I. C. compound. About two quarts of the varnish will be required to cover the iron. It is well to thin it with some gasoline so that the coating will be thinner and more iron can be gotten into the core. If the iron sheets or laminations were not insulated from each other in this way the effect would be the same as if the core were solid and heavy currents of electricity known as *eddy currents* would be set up therein and considerable energy would be lost in heat resulting in a general lowering of the efficiency of the transformer.

After the varnish has thoroughly dried the strips are cut up as shown in Fig. 95 into lengths of five, 11½, 12½ and fifteen inches long. Enough strips are cut off the five, 11½ and fifteen inch sizes to form a pile of each 2½ inches high when compressed. A pile five inches high of the 12½ inch sizes are required. The core is fifteen inches long and 11½ inches wide without the tongue. The legs are each ten inches long and are

separated from each other by a space of five inches.

The strips are staggered in assembling in the manner illustrated in Fig. 96, so that a solid core with no air gaps save at the short

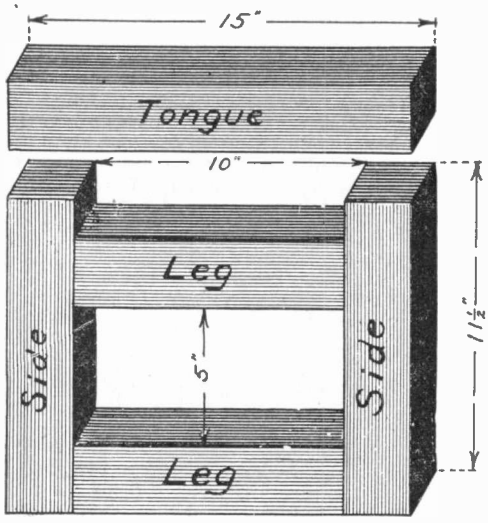


FIG. 97. CORE COMPLETE

ends projecting beyond the primary leg is the result.

The core is squared up by knocking in any strips of iron which project. It will then

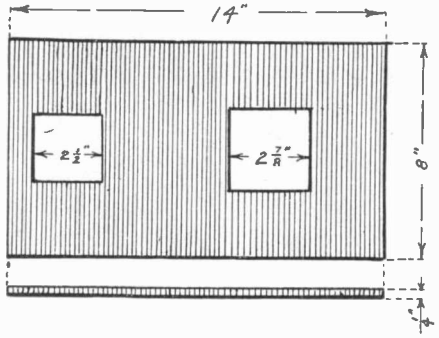


FIG. 98. FIBRE HEAD

appear as in Fig. 97. The primary leg is wrapped with two or three layers of empire insulating tape or well-varnished linen preparatory to winding on the primary wire.

Two fibre heads eight inches wide and fourteen inches long are cut out of a sheet one-fourth of an inch thick. Two square holes are cut in each in the position indicated in Fig. 98.

Twenty layers of No. 6 Empire linen in the form of a strip ten inches wide are wound over the secondary leg of the transformer. Empire cloth is obtainable at almost any electrical supply house. It is made of a closely woven fabric, which has been coated with films of pure oxidized linseed oil. The result is an insulator of high electrical resist-

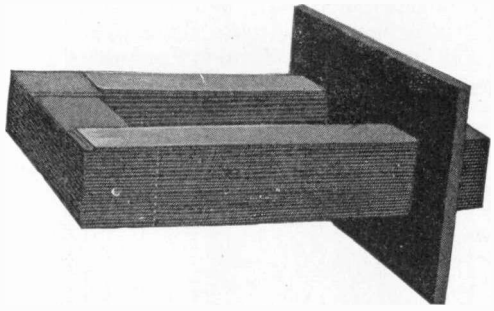


FIG. 99. CORE WITH HEAD SLIPPED ON

ivity and considerable mechanical strength. No. 6 is six thousandths of an inch thick and has an average puncture voltage of 7,800. This part of the transformer serves to insulate the secondary from the core and must stand the greatest strain. It is therefore not good policy to substitute doubtful insulation.

One side of the core is then pulled out so that a fibre head may be slipped over the legs as shown in Fig. 99. It is well to place two clamps on the core at the other end when removing the side.

(To be continued.)

Honolulu Heard by Wireless

The atmospheric conditions at San Francisco during the month of September seem to have been very favorable.

Operator K. M. Kristensen of the Massie Wireless Station was in direct communication with Honolulu at 9:30 p. m., Sept. 26, and also with the Matson liner, Lurline, at that time 1,645 miles from the San Francisco Light-ship.

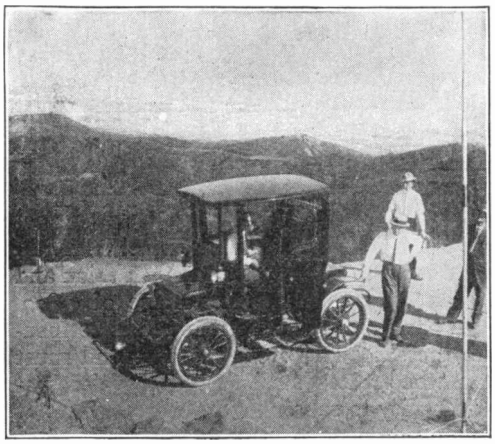
Operator Frank E. Daubenbiss of Station C. O., Capitola, California, picked up the S. S. Hilonian at 8:00 p. m., September 27, 1,145 miles out, and the S. S. Santa Rita from Kahului for San Francisco, 1,350 miles away. Also the S. S. Asia from Hongkong via Honolulu to San Francisco, 1,191 miles out. Mr. Daubenbiss' remarkable feat was accomplished with a silicon detector and a 100-foot aerial amateur set built by the owner from descriptions given in POPULAR ELECTRICITY.—F. E. DAUBENBISS.

Automobile Wireless on Mountain Top

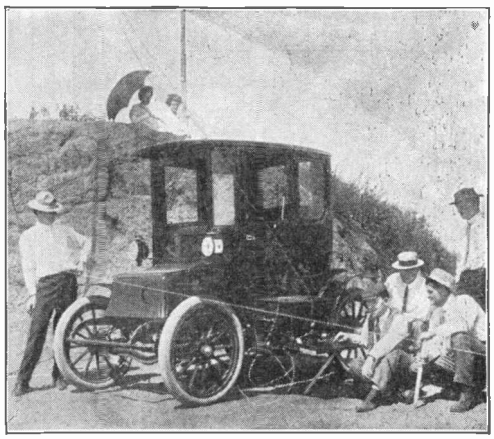
By F. C. RYAN

To be seated in an electric coupé by the side of a portable wireless set, whisked over fifteen miles of country and then up to the top of a mountain more than 2,000 feet above the sea level was my novel experience as one of the operators at the United Wireless station in the Examiner Building, Los Angeles, California. At the top a mast and aerial were set up, communication with the city established and commercial stations within a radius of 100 miles reached.

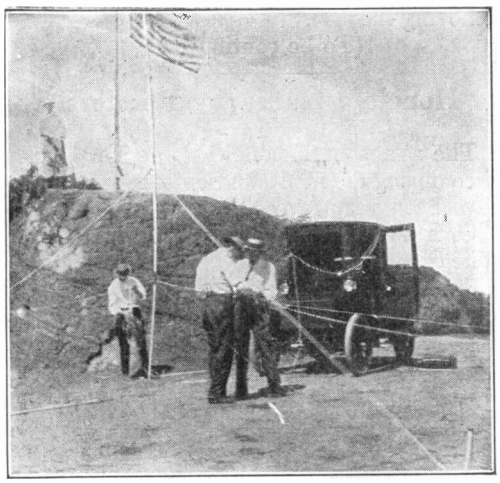
The "stunt" was done at the behest of an automobile concern of the city who were anxious to demonstrate the range and pulling capacity of one of their electric coupés—a four-passenger car intended for the use of the ladies. The demonstrator for the firm conceived the idea that it would be a good thing to take along a portable wireless plant and communicate with the city, should the mountain be successfully scaled by the electric car.



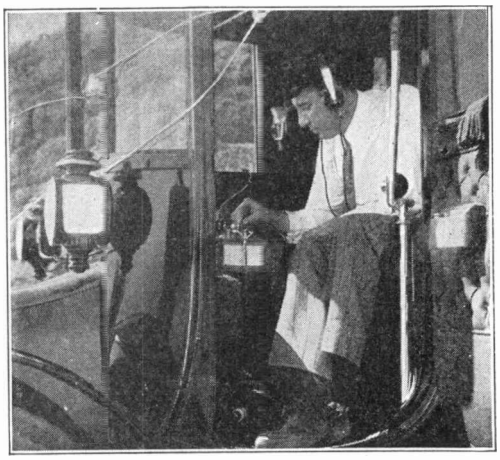
LOOKING TOWARD THE PACIFIC FROM THE TOP OF LOOKOUT MOUNTAIN



SENDING THE FIRST MESSAGE FROM THE MOUNTAIN TOP



CONNECTING THE AERIAL OF THE PORTABLE SET



INSIDE OF THE AUTOMOBILE WIRELESS STATION

The mast used was modeled after that furnished for the portable sets of the United States Signal Corps, being made up of six sections, each five feet long, of split bamboo. The aerial was composed of eight 30-foot lengths of No. 12 aluminum wire which were extended on out with rope guys. The aerial was laid out in "umbrella" form, and directly underneath and fastened to the same stakes were eight duplicate wires suspended from the mast at a point five feet above the ground forming a counterpoise which was used instead of a ground.

The portable set was made up of a six-inch Collins coil, a copper-foil jar condenser, a small helix of No. 9 copper wire and an ordinary telegraph key. The power for transmission was obtained from the storage battery of the automobile. The receiving set was of the double slide type with fixed condenser. A silicon detector with no battery was used in conjunction with 1,000-ohm head phones.

Arriving at the top of Lookout Mountain with the electric coupé which carried a load of two large men and the portable wireless plant which weighed about 150 pounds, it was found that there was a space barely 40 feet in diameter in which to lay out the aerial. The mast and aerial were erected under this disadvantage, and the necessary wires connected to the set. Immediately upon listening and getting the detector in adjustment the Navy station at Point Loma 100 miles south was heard very distinctly, sending their midday weather report to Point Arguello about 150 miles north. Then the faint response of the northern station was heard. After they had finished, the two commercial stations at Avalon, Catalina Islands, 40 miles distant were heard very clearly. Then the steamers Admiral Sampson and Governor somewhere out in the Pacific ocean were heard endeavoring to get into communication with the coast. The opportunity soon presented itself however to see what the portable would do in sending. The storage battery of the automobile was connected to the coil and the station in Los Angeles called. No sooner was the switch thrown back to the receiving side than an avalanche of interested amateurs in and around Los Angeles were busily inquiring who the new intruder into the air might be. After the amateurs had stopped the station in Los Angeles was "picked up" and a message of greeting sent to the Mayor announcing that for the first time in the history of the Pacific coast an electric automobile carrying a portable wireless plant, had successfully climbed the steep mountain grade to the top of the mountain peak. This done, the station was dismantled and the return trip made to the city without mishap.

Open Core Wireless Transformer

By A. B. Cole

We are often asked whether an open core wireless transformer is as efficient as one of the closed core type. Before answering this question it will, no doubt, be of interest to many of our readers to explain the working principles of these two types.

In the closed core type of transformer the iron core forms a complete path for the magnetic lines of force developed by the windings. When alternating current flows through the primary winding a counter electromotive force is developed, which tends to choke back the current supplied. When current is drawn from the secondary winding, this counter electromotive force is reduced to an extent depending on the quantity of current supplied by the secondary, and consequently more current flows through the primary. The counter electromotive force is directly proportional to the number of lines of force passing through the primary. When no current flows through the secondary these magnetic lines of force are large in number, but placing a load on the secondary winding reduces the number of lines and consequently the primary is allowed always to draw sufficient current from the source to generate the required amount which is being drawn out by the secondary. Carrying this a step farther, if you short circuit the secondary and take theoretically an unlimited amount of current from it you will cut down the counter electromotive force in the primary practically to zero and enough current would then flow through the primary to burn it out.

In the ordinary wireless transformer of the closed core type an auxiliary path of the lines of force is provided which prevents the primary from burning out under such conditions, by generating the necessary counter electromotive force in the primary coil.

In the operation of a wireless transformer the secondary is practically short circuited for an instant during the passage of the spark, a certain part of the electrodes being

vaporized and forming a conducting path in the spark gap. The effect on the primary of this short circuit in the secondary is overcome in the open core transformer as follows:

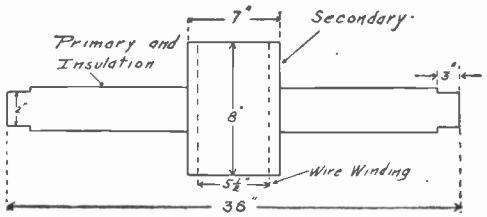
In an open core transformer there is a much greater magnetic leakage than in the closed core type, the leakage path being the air space outside the windings, starting out from one end of the core, and returning to the opposite end. For this reason no other path of magnetic leakage is needed.

The primary of an open core transformer must, however, have a much larger number of turns of wire, since only a part of the magnetic circuit is through iron, and since air presents a much higher resistance to the lines of force than iron.

In consideration of the above facts, it is our opinion that an open core transformer, properly designed and operated, is just as efficient as one of the closed core type. The open core type is the standard of the United Wireless Telegraph Company, who claim that it is as efficient as the closed core variety.

The following data will enable our readers to build an open core transformer which will operate on 100 to 125 volts alternating current, and any frequency from 60 to 133.

The core is two inches in diameter and 36 inches long, and is made of twelve pounds of No. 20 black Norway iron wire. The pri-



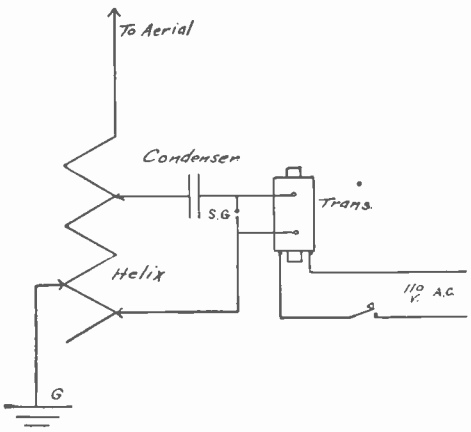
OPEN CORE TRANSFORMER

mary winding is 30 inches long and consists of one layer of No. 10 D. C. C. magnet wire, of which six pounds are required.

The secondary consists of one section seven inches wide, having an outside diameter of eight inches. The wire winding is 5½ inches wide, and consists of 104 layers, each of 264 turns of No. 28 D. C. C. magnet wire. About ten pounds of wire are required for the secondary. A good grade of paper 0.004 inch thick is used to insulate each layer from the next.

The primary is insulated from the core by a hard rubber or fibre tube 36 inches long, and having a wall 3-16 inch thick. The secondary is insulated from the primary by several layers of Empire cloth so as to give a thickness of the cloth of ⅛ inch. The secondary may be wound on a cardboard tube which fits outside the Empire cloth.

In winding the transformer and the reactance coil described below, great care should be taken to wind the wire on evenly. After the transformer is wound, it should be boiled in paraffine until no air bubbles rise from it. It should then be placed in a wooden case which should be filled slowly with hot paraffine or sealing compound.



CONNECTIONS OF TRANSFORMER

The primary and secondary wires should be connected to binding posts. Too much emphasis cannot be laid on the importance of having the very best insulation in the secondary.

The adjustable reactance coil consists of seven pounds of No. 12 D. C. C. magnet wire wound in six layers on an iron core eight inches long and 1½ inches in diameter. About 1½ pounds of No. 20 black Norway iron wire will be required for this core. A tap is brought out from the end of each layer, the wire leading out being securely soldered to the wire on the coil. This coil may now be placed in a wooden case, and the six taps and that from the end of the coil brought to binding posts, so that any number from one to six layers may be connected in circuit at will.

The reactance coil is always connected in series with the primary of the transformer and the line. With all layers in use the transformer may be rated at ½ K. W., and various capacities are available up to about 1½ K. W. by using more or less of layers on the reactance coil. This arrangement is of

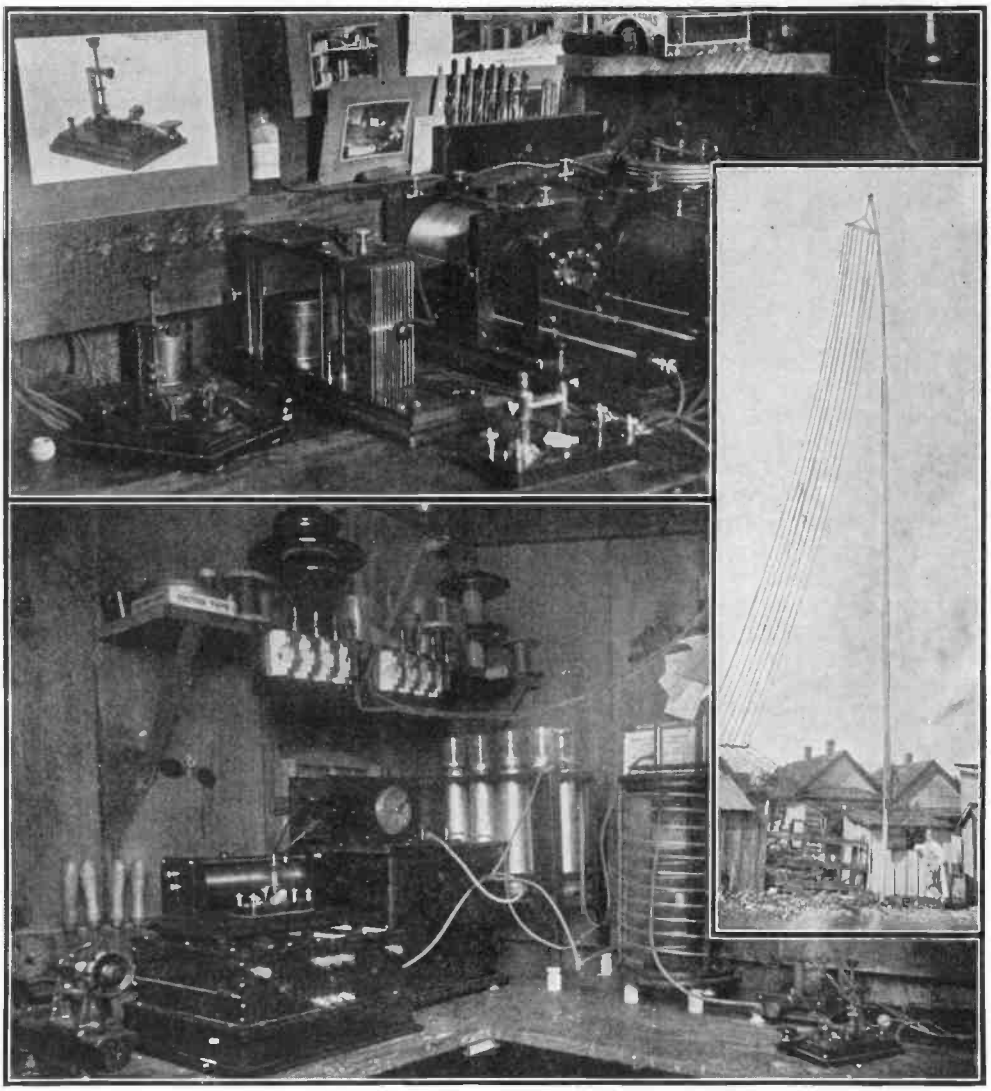
especial advantage where there is considerable interference between stations, as small power can be used for short distance working.

If so desired this transformer may be operated in series with an electrolytic interrupter on 110 to 220 volts direct current.

Amateur's One-Kilowatt Station

A more than usually complete amateur station is that of Bernadotte Anderson of Kansas City Mo., who sends us the accompanying pictures of his sending and receiving outfits and aerial, together with the following synopsis of the equipment:

Transmitting apparatus: One K. W. closed-core transformer, operating on 10,



AMATEUR'S ONE KILOWATT STATION

volts a.c., 60 cycle. Present consumption ½ K. W. High tension condenser, leyden jar type, in rack. Sending inductances, both closed and loose coupled type. Special type antenna switch. Zinc spark gap, open type. Special type key, heavy alloy contacts.

Receiving apparatus: Tuners of various types, including loose coupled, closed, etc. Several variable condensers. Silicon and carborundum detectors are given preference over other similar kinds. Receivers of 2,000 ohms.

Antenna and mast: Height of mast 75 feet. Aerial composed of eight wires leading to eight individual switches located inside of station on hard rubber baseboard. All wires being open at top and divided into a loop aerial of four wires each, permit of any number of wires being used, by cutting in and out the switches. This has proved very valuable both on transmitting and receiving, by securing a large variation of the electrostatic capacity and inductance of the aerial. Insulation is given due attention, several 75,000 volt high tension insulators being used. The bushings in the wall through which aerial wires pass are of porcelain tubings, a smaller one inserted in a larger one, thereby giving a wall about ½ inch thick. The aerial wires proper are insulated from each other on spreaders by ordinary porcelain cleats.

The method I use in protecting the aerial from lightning is by weaving a large brass bar through the eight wires and attaching a ground wire of automobile cable. After learning of a disaster which occurred in the case of one of my wireless friends, due to his failure to ground his aerial properly, the lightning playing havoc with his mast, I am very cautious in this respect.

With the transformer consuming ½ K. W., have been able to cover a transmitting distance of 65 miles, using directional radiation. As there are no commercial stations within a radius of 500 miles, except a few government experimental stations, within 100 or 200 mile radius, have not been able to give the receiving apparatus a fair test, although am able to procure very sharp and selective tuning. A good deal of the apparatus has been constructed myself, including the transmitting set, while I have replaced the shop constructed receiving equipment, with Murdock type apparatus. Hope to have a set of measuring instruments in the near future, in order that I may determine interesting calculations in connection with my experiments. Have also a wireless telephone set nearly completed, using the oscillation arc for producing continuous oscillations. On this set am using a combination of systems in use by the prominent wireless telephone men.

WIRELESS QUERIES

Answered by A. B. Cole

Questions sent in to this department must comply with the same requirements that are specified in the case of the questions and answers on general electrical subjects. See "Questions and Answers" department.

Condensers for Sending and Receiving; Battery for Two-Inch Coil

Questions.—(A) How many 5 by 7 inch glass plates should I use for a fixed condenser for receiving? (B) How many 5 by 7 inch glass plates should be used for making a secondary condenser for a two-inch coil? (C) Will six carbon cylinder batteries be sufficient to run the above coil? If not, how many?—R. J., Muskogee, Okla.

Answers.—(A) Six or eight will give good results for most stations.

(B) From ten to 20, depending on the speed of the interrupter and the capacity of the aerial.

(C) Yes, but eight will give better results.

Condensers for Sending Set

Questions.—(A) What size of condenser should I use across the vibrator contacts of a four-inch coil? I wish to employ glass plates either 5 by 7 or 8 by 10 inches. (B) How many quart size Leyden jars shall I make to bridge across a spark gap? (C) Would a plate condenser be better than Leyden jar? If so, give size and number of plates to use, plates to be stacked as compactly as possible.—E. L. F., Osceola, Ia.

Answers.—(A) The number of plates for this purpose would be prohibitive, owing to the thickness of the glass as compared to that of paper. For example, the table on page 163 of the June issue shows that 2,500 square inches of foil would be required with paraffined paper as the dielectric. This paper should be .002 inch thick. About 150 glass plates each 5 by 7 inches would be needed to take the place of the paper and give the same capacity. For this reason paper is nearly always used.

(B) From two to six, depending on the speed of the vibrator and the capacity of the aerial.

(C) A plate condenser will take up less space. From 20 to 40, each 8 by 10 inches, would be required, if their thickness is that of photographic plates.

Receiving Condensers; Ground Wire

Questions.—(A) Is a short aerial better than a long one for sending? (B) Give dimensions for a tin foil and paper sending condenser for a one-inch coil. (C) Give dimensions for a tin foil and paper condenser for receiving. (D) What size of wire is best for a ground wire?—A. E., Bronx, N. Y.

Answers.—(A) No, a long aerial, within limits, gives better results.

(B) Paper cannot be used as the dielectric for such a condenser, as the voltage developed by the coil will puncture it.

(C) Alternate a layer of tin foil, one of thin paper, another of foil, and another of paper, and roll up into any convenient form. Dimensions of foil, 2 by 50 inches. Dimensions of paper, 3 by 56 inches.

(D) A large wire, in the neighborhood of a No. 4, should be used for this purpose.

Voltage and Spark Gap; Noise in Telephone Receiver

Questions.—(A) What voltage is required to jump an air gap of ½ inch? (B) How can I get rid of the humming in a telephone receiver?—C. F., Alamogordo, N. Mexico.

Answers.—(A) For sinusoidal voltages, 10,000 volts will jump a gap of one-half inch between sharp needle points.

(B) If the noise is due to the nearness of light and power and other wires the induction effect may be destroyed by transposing the wires at intervals along the line.

Helix and Condenser for One-Kilowatt Transformer

Questions.—(A) How many feet of No. 0 B. & S. aluminum wire will I need for a helix to go with a one K. W. transformer? (B) How many glass plates and sheets of tin foil are required for a sending condenser? What are the size of plates and foil for the above transformer?—A. R., Grand Island, Neb.

Answers.—(A) About fifteen feet.

(B) On page 450 of the September, 1910, issue, there is given a full description of a plate condenser which will serve your purpose very well.

Sliding Plate Condenser

Questions.—I wish to make a variable condenser of the sliding type composed of five stationary brass plates four inches wide by five inches long and four movable ones of the same dimensions. (A) How far apart should the plates be and of what thickness? (B) Would aluminum be better than brass to use for the plates? (C) Would you advise me to make the plates larger or is the size I describe good practice?—H. J. R., Philadelphia, Pa.

Answers.—(A) They should not be over 1-16 inch apart, and may be No. 20 or No. 21 gauge, about 1-32 inch thick.

(B) One is as good as the other.

(C) The size and number you describe are all right, but it should be remembered that the distance between them must be small.

Variable Condenser

Questions.—(A) Would the oil-immersed condenser described on page 452 in the September, 1910, issue be just as efficient if covered with paraffin instead of oil? (B) Would a variable condenser for receiving set consisting of stationary and movable aluminum plates be just as efficient if the plates were separated by sheets of thin mica instead of an air gap?—C. R. H., Des Moines, Iowa.

Answers.—(A) No, because it would be extremely difficult to obtain the required insulation between plates, on account of the formation of air bubbles, and because if the oil gives way the point of the rupture is immediately covered.

(B) Yes, more so, on account of the higher dielectric capacity of the mica.

Purpose of a Spark Coil Condenser

Question.—Of what use is a condenser in connection with a spark coil?—A. C. K. Lytton, Iowa.

Answer.—At the "break" of the circuit in an induction coil a rush of current takes place which produces a bright spark at the contact breaker and also prolongs the period of demagnetization of the core. This is a bad effect since the power of the coil depends in part upon the rapidity of the magnetization and demagnetization of the core. To reduce the effect of this "extra" current a condenser is connected across the contact breaker and the rush of current is stored until the circuit is again made, when it to a certain extent aids the battery current. The condenser, therefore, reduces the destructive sparking, shortens the period of demagnetization of the core and increases in length, thickness and brilliancy the spark from the secondary coil.

QUESTIONS AND ANSWERS

Use of this department is free to readers of Popular Electricity, but attention will not be given to questions which do not comply with the following rules: All questions must be written in the form of a letter addressed to the Questions and Answers Department and containing nothing for the other departments of the magazine; two-cent stamp must be enclosed for answer by mail, for space will not permit of printing all answers; the full name and address of the writer must be given.

Square to Circular Mils; Volts Lost

Questions.—(A) How can I change square mils to circular mils? (B) In the formula, $V=\frac{IxLx10.8}{C.M.}$ for determining the volts lost in a certain wire with a given current flowing what is the 10.8?—B. L., Chicago, Ill.

Answers.—(A) A circular mil is .7854 of a square mil, so divide the number of square mils by .7854 to express the same in circular mils.

(B) It is the resistance of one foot of commercial copper wire one circular mil in section and at 75° F.

Which Plates are Positive?

Question.—I have seven plates out of a storage battery. Three are red and four are grey. Which are positive plates?—C. B., Sparks, Nevada.

Answer.—The number of negative plates always exceeds the positive by one in a storage battery, the object being to use the two sides of every positive. When a battery is first started on charge the negatives are a yellowish grey and the positives dark brown.

Battery Solution; Gas Lighting Coil

Questions.—(A) What is the solution in a Leclanché battery (B) How much and what size wire should I use in winding a coil for gas lighting purposes? (C) How much No. 34 copper wire will have a resistance of one ohm? No. 35? No. 36?—C. K., San Angelo, Texas.

Answers.—(A) Make a strong solution of ammonium chloride (sal ammoniac) by stirring this powder into water until the water will dissolve no more. Place this solution in the outer jar.

(B) On a soft iron wire core ¾ inch in diameter and eight inches long wind five layers of No. 18 wire and connect in series with key, battery, and gas tips.

(C) No. 34, 3.839 feet; No. 35, 3.045 feet; No. 36, 2.414. By reference to a standard wiring table a column will be found in which "Feet per Ohm" for different sizes of wire is given. Booklets containing such a table and other information can be had by writing to any wire manufacturer or dealer.

Protection Against Lightning

Question.—Where can I obtain information regarding the installation of lightning conductors to protect buildings, chimneys, etc.—D. W. G., Punxsutawney, Pa.

Answer.—Write to the National Board of Fire Underwriters, 93 Water St., Boston, Mass., for their booklet, "Protection Against Lightning," which will be mailed to anyone interested.

Depolarizer; Transformer Losses

Questions.—(A) What is the object of the powdered manganese in a dry cell? (B) What relation do the losses in a transformer bear to the frequency?—H. G. W., Chicago.

Answers.—(A) The manganese acts as a depolarizer.

(B) Reference to any standard work on transformers will show from the equations for hysteresis and eddy current losses that these losses are directly proportional to the frequency which is only one of the factors of the equation, however.

Electromagnetic Effect

Question.—Explain the effect upon a fixed iron bar core when current flows through a coil wound around it.—G. M. L., Longmont, Colo.

Answer.—It becomes more or less strongly magnetized according to the number of turns in the coil and to the number of amperes sent through the coil. One end becomes a north pole and the other a south pole determined by the direction of the coil winding and current. A point will be reached finally where a stronger current will fail to add magnetism, and this point is called the saturation point.

Defenses to Patent Infringement

By OBED C. BILLMAN, LL. B., M. P. L.

STATUTORY DEFENSES; DEFENSES OTHER THAN STATUTORY; USUAL DEFENSES

STATUTORY DEFENSES.—The statute specifies certain special matters which a defendant in an action for infringement may prove in his defense.

The First of These Special Matters is that the patentee has with fraudulent intent filed a description and specification containing less or more than the invention or discovery warrants.

The Second Special Matter Pleadable is that the patentee has surreptitiously and unjustly obtained the patent for that which was in fact invented by another.

The Third Defense specified by the statute is that the invention had been patented or described in some printed publication prior to the supposed invention or discovery of the patentee.

The Fourth Defense open to the defendant is that the plaintiff was not the original or first inventor of any material or substantial part of the thing patented.

The Fifth Defense allowed by the statute is that the invention had been in public use or on sale in the United States for more than two years before the application of the plaintiff for a patent, or that it had been abandoned to the public.

DEFENSE OTHER THAN STATUTORY.—*In General.*—The statutory defenses above enumerated are not the only ones which may be made to an action for infringement. A patent may be open to attack in one or more of the numerous elements that combine to constitute its validity, and any plea that attacks the validity of the patent constitutes, if established, a defense to a charge of infringement.

USUAL DEFENSES.—The more usual defenses of this class are here enumerated, and their force and effect are briefly set forth.

A License granted by the patentee or owner of the patent is a perfect defense to an action for infringement or to a bill for an injunction. The existence of the license must be determined by the court, and it must be strictly construed and limited to its exact terms. Where the defendant sets up a license and offers to pay into court the usual license fee, or claims breach of the contract of license, the court will refuse an injunction. Having been compelled to pay damages for infringement does not constitute a license to the defendant or to any one else to continue the infringement. Purchasing an interest in the patent carries a right to use a machine made thereunder, and such right includes an extended term. The defense of license is not inconsistent with the defense of invalidity of the patent.

The Infringer May Set Up a Release from All Liability for infringement, executed upon sufficient consideration of the patentee.

Other Matters.—But the infringer of a patent cannot set up that he did not intentionally infringe, nor that he made no profits by the infringement, nor that the patent is about to expire or is of little value, nor that the patentee refused to furnish the device when requested, nor that he infringed as a public employee and for the public benefit, nor that the patentees were not in fact joint inventors, nor can the patentee set up in a court of equity a purely technical defense unless able to support it by ample and satisfactory proof.

That the Patent is Void for failure to observe prerequisites to the issuance thereof is a good defense.

Absence of Patentability is a very broad ground of defense, and should usually be narrowed down to more specific terms. When clearly apparent, the court may dismiss the suit on this account although not set up as a defense. And the existence of the original patent cannot be set up as a defense to infringement of a patented improvement thereon.

The Want of Utility in the invention may not generally be set up by an infringer. The fact of use is sufficient to stop the user from making such plea.

Absence in the Record of Evidence of the Patentee's Oath is not a defense, since the oath need not be in writing and may have been properly administered.

Article not Marked.—The defendant in an infringement suit cannot plead the fact that either the article infringed or the article

infringing was not marked "patented" as required by section 4900 of the Revised Statutes.

Use of the Invention Before Grant of the Patent is no excuse for infringement after such grant.

That the Patentee has Created or is Attempting to Create a Monopoly in the patented article or business, or is a member of an illegal trust, or resorts to infringement suits or compromises in order to secure a practical monopoly, is no defense to infringement.

Estoppel as Defense.—Either the complainant or defendant may be met at some stage of the proceedings by the assertion of an estoppel. When set up by the defendant it is usually in the nature of a plea in avoidance, and sets forth some act by which the complainant has deprived himself of the right to object to the act claimed to constitute infringement. Thus license to use or sell the patented article will estop the licensor to deny the licensee's right. The complainant is furthermore estopped by his admission that another than himself has the power to grant a license. In an action against a license under another patent, the complainant is not estopped by a judgment declaring his patent to be an infringement, when the license was granted before the judgment was rendered. Where, by agreement, a final decree has been entered directing a perpetual injunction, and such injunction has issued, the plaintiff does not, by subsequently granting a license to the party enjoined, deprive himself of the right to demand his commitment for disobedience to the injunction. A complainant corporation is not estopped to sue an infringing corporation by the fact that both corporations are subsequently absorbed by a third corporation. When the defendant has not acted upon the notice of infringement, the complainant is not estopped by the notice to claim for prior infringements. A patentee is not estopped by his representations as to the identity of the foreign and United States patents if made under a misapprehension as to the facts. But a correction limiting the duration of the patent, although made under mistake, will estop the patentee and his co-owners when cognizant of his actions in the matter. A complainant is not estopped by the discontinuance of one action from bringing a second.

Silence, Unless Misleading, Works no Estoppel; hence an inventor is not estopped by standing by and silently hearing an infringing invention described.

Collateral Attack.—It is a general rule that the validity or regularity of a patent cannot be attacked collaterally in an action for infringement. The proceeding preliminary to issuance and the signature of the proper officers are presumed to be regular and must be respected until impeached or set aside in a direct proceeding instituted for the purpose.

NEW BOOKS

MOTOR TROUBLES. By E. B. Raymond. New York: McGraw-Hill Book Company. 1909. 197 pages with 98 diagrams and illustrations. Price $1.50.

A book treating of the specific troubles to which motors are subject; how to trace and remedy them.

FLYING MACHINES: CONSTRUCTION AND OPERATION. By W. J Jackman, M. E., and Thos. H. Russell, A. M., M. E., with an introductory chapter by Octave Chanute, C. E., Chicago: Chas. C. Thompson Company (Not Inc.). 1910. 221 pages and 94 illustrations. Price, cloth, $1.00; flexible leather, $1.50.

This book is intended to give the reader interested in aerial navigation, practical instruction in the building and operation of flying machines.

PRACTICAL HANDBOOK FOR MILLWRIGHTS. By Calvin F. Swingle, M. E., Chicago: Frederick J. Drake & Co. 1910. 411 pages with 226 illustrations. Price $2.00.

A work embodying useful information on how to plan and build mills and install mill machinery from the foundation up.

ELECTRICITY EXPERIMENTALLY AND PRACTICALLY APPLIED. By Sidney Whitmore Ashe, B. S., E. E. New York: D. Van Nostrand Co 1910. 349 pages with 422 illustrations. Price $2.00.

A book for the beginner and for the practical man, containing principles, experiments, practical applications and problems.

WIRELESS TELEGRAPH CONSTRUCTION FOR AMATEURS. By Alfred P. Morgan. New York: D. Van Nostrand Company. 1910. 188 pages with 147 illustrations. Price $1.50.

An excellent book for those who desire practical information on the building and operation of wireless equipments which are more than toys yet not so expensive as commercial equipments.

ON POLYPHASE SUBJECTS

Wellman's Achievement

Many of the newspapers that had no hand in the fitting out of Walter Wellman's dirigible balloon expedition poked all sorts of fun at the daring aviator and made humorous "mind bets" that he never would start—humorous in the light of later developments. Nevertheless Wellman did start and did not stop until he had made a record eclipsing all previous balloon feats. It is now a matter of history that he started out with his intrepid crew at eight o'clock on the morning of October 15 and was rescued at sea by the steamer Trent after being in the air 72 hours. The previous record, made by the renowned Count Zeppelin, was a continuous flight of 37 hours' duration. The distance covered by Wellman is variously estimated at from 800 to 1,200 miles. Zeppelin's record was 850 miles.

During the first part of the flight the world was kept fairly well informed of the movements of the dirigible through the wireless messages sent out from it. From the time it began to be blown southward, off Nantucket, nothing was heard, for the adventurers were not willing to waste their power which might be sorely needed later.

The details of construction and the method of operation of this wonderful aircraft were fully explained in last month's issue of Popular Electricity. This description, which was the first magazine article on the subject, was fortunately made available at the very time the trip was in progress. The life-boat which held Operator Irwin and the unique arrangement of which was fully explained in the article worked exactly as it was intended to, and the entire crew was saved, including the now famous cat.

The expedition shows one thing: namely, that the most carefully constructed dirigible now possible is in reality at the mercy of the winds. If the winds were favorable all the way it is quite possible that the America or another craft of like design could fly across the Atlantic. But with present knowledge of dirigible ballooning the "if" is decidedly the most important factor.

Lectures on Illuminating Engineering

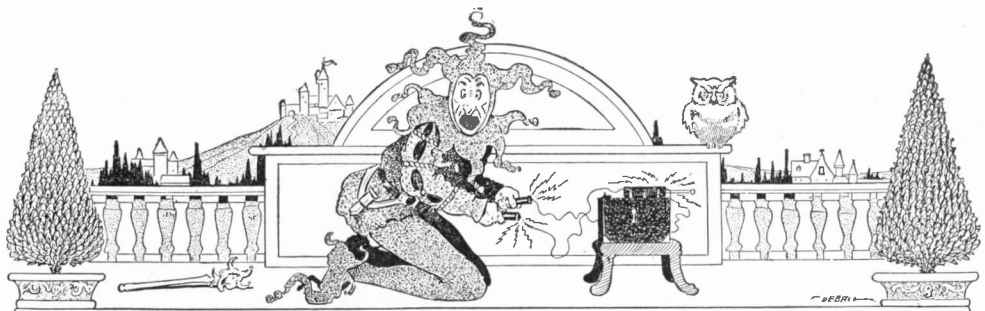
Johns Hopkins University offers for the academic year 1910-1911 a course of 36 lectures on the science and art of illuminating engineering. This course owes its origin to the following considerations:

The Illuminating Engineering Society, recognizing the fact that there is an increasing demand for trained illuminating engineers and that the present facilities available for the specialized instruction required are inadequate, determined, through an act of the Council of the Society, to encourage the establishment of a course of lectures on the subject of illuminating engineering. This course should have three objects: (1) to indicate the proper co-ordination of those arts and sciences which constitute illuminating engineering; (2) to furnish a condensed outline of study suitable for elaboration into an undergraduate course for introduction into the curricula of undergraduate technical schools; and (3) to give practicing engineers an opportunity to obtain a conception of the science of illuminating engineering as a whole.

The course covers nineteen subjects, with laboratory work in connection. The lectures represent the best talent in the country, including such men as Charles P. Steinmetz, J. W. Lieb, Jr., L. B. Marks, Louis Bell, Edward B. Rosa, Clayton H. Sharp, Edward P. Hyde, Van Rensselaer Lansingh and John B. Watson.

Georgia Section of the N. E. L. A.

A new geographic section of the National Electric Light Association has been formed, known as the Georgia Section. The officers are: President, John S. Bleecker, Columbus; vice-president, W. R. Collier, Atlanta; executive committee, J. J. Cagney, Macon, R. P. Mayo, Augusta, Burdett Loomis, Jr., Waycross; secretary-treasurer, H. M. Corse, Columbus.



SHORT CIRCUITS

One day a Jew who kept a pawnshop had to leave it in charge of his son. On returning he asked how business had been during the day.

"Yes, fader, an' business vas very goot to-day."

"Vell, den, an' vatt did you sell, Isaac?

"Nottings, but der man vat bought der diamonds yesterday came in and pawn dem dis mornin."

"Vell, and didn't ye sell him nottings else?" asked the elder.

"No, fader, he look too depressed to vant anyting's else."

"Vell, if he looked depressed, why fer didn't ye sell him a revolver?"

* * *

The Imperial Barber was talkatively trimming the beard of King Archelaus.

"How shall I cut it, your Majesty?"

"In silence," replied the King.

* * *

"Sure it's an Irishman that's the greatest inventor o' the age an' a particular friend o' mine," blurted out Mike, after a fifth "high one."

"And who is this great inventor you know?" taunted his companion.

"Pat. Pending is me friend's name. Yez must of heard o' him afore this."

* * *

"I tell you I must have some money!" roared the King of Maritana, who was in sore financial straits. "Somebody will have to cough up."

"Alas!" sighed the guardian of the treasury, who was formerly the Court jester, "all our coffers are empty."

* * *

The victim of the dentist held up his hand. "Doctor,' said he, "before you put the lid on my conversation, will you answer another question?"

"Yes," said the dentist, selecting a square piece of rubber and snipping it with his scissors.

"Do people chew more on one side of the mouth than the other?"

"Certainly," said the dentist, picking up the clamps.

"How interesting. Which side?"

"The inside," replied the dentist, as he slipped the rubber dam over the verbal one that issued from the patient's lips.

* * *

Gertrude to Mabel (as she bumps the bumps at the State Fair)—"What's your favorite sport?"

Mabel to Gertrude (as she picks up her hat)—"Billie."

* * *

"What're ye comin' home with your milk pail empty for?" demanded the farmer. "Didn't the old cow give anything?"

"Yep," replied the chore boy, "nine quarts and one kick!"

This is the message the telegraph messenger handed to the young husband: "Come down as soon as you can. I am dying—Kate." Eight hours after, he arrived at the summer hotel, to be met on the piazza by Kate herself. "Why, what did you mean by sending me such a message?" he asked. "Oh," she murmured, "I wanted to say that I was dying to see you, but my ten words ran out and I had to stop."

* * *

"Say, Boss," says the tramp, "will ye give me fifteen cents for a bed?"

"Sure, bring it around, and if it's worth fifteen cents, I'll buy it."

* * *

Mamma—Johnny, what is the baby yelling about?

Johnny—Nothin'. I jest took his milk and showed him how to drink it.

* * *

"Mike, how would yez like to live to be a hundred years av age?"

"I don't want to. Pat. I never seen a man that old who could put up any kind av a foight."

* * *

A Worcester County farmer was sawing wood, when it occurred to him that he ought to have the help of one or more of his five boys. Lifting up his voice, he called, but not a boy appeared.

At dinner, of course, they all appeared, and it was not necessary to call them.

"Where were you all about two hours ago, when I wanted you and shouted for you?"

"I was in the shop, settin' the saw," said one.

"And I was in the barn settin' a hen," said the second.

"I was in gran'ma's room, settin' the clock," said the third.

"I was in the garret, settin' the trap," said the fourth.

"You are a remarkable set!" remarked the farmer. "And where were you?" he continued, turning to the youngest.

"I was on the doorstep, settin' still."

* * *

Reverend Gentleman:—Do you know, my friend, that half the cases of cancer are caused by people smoking those foul, dirty, short, black clay pipes?

Son of Toil—And do you know, Guv'nor, that 'alf of the black eyes are caused by folks not mindin' their own business?

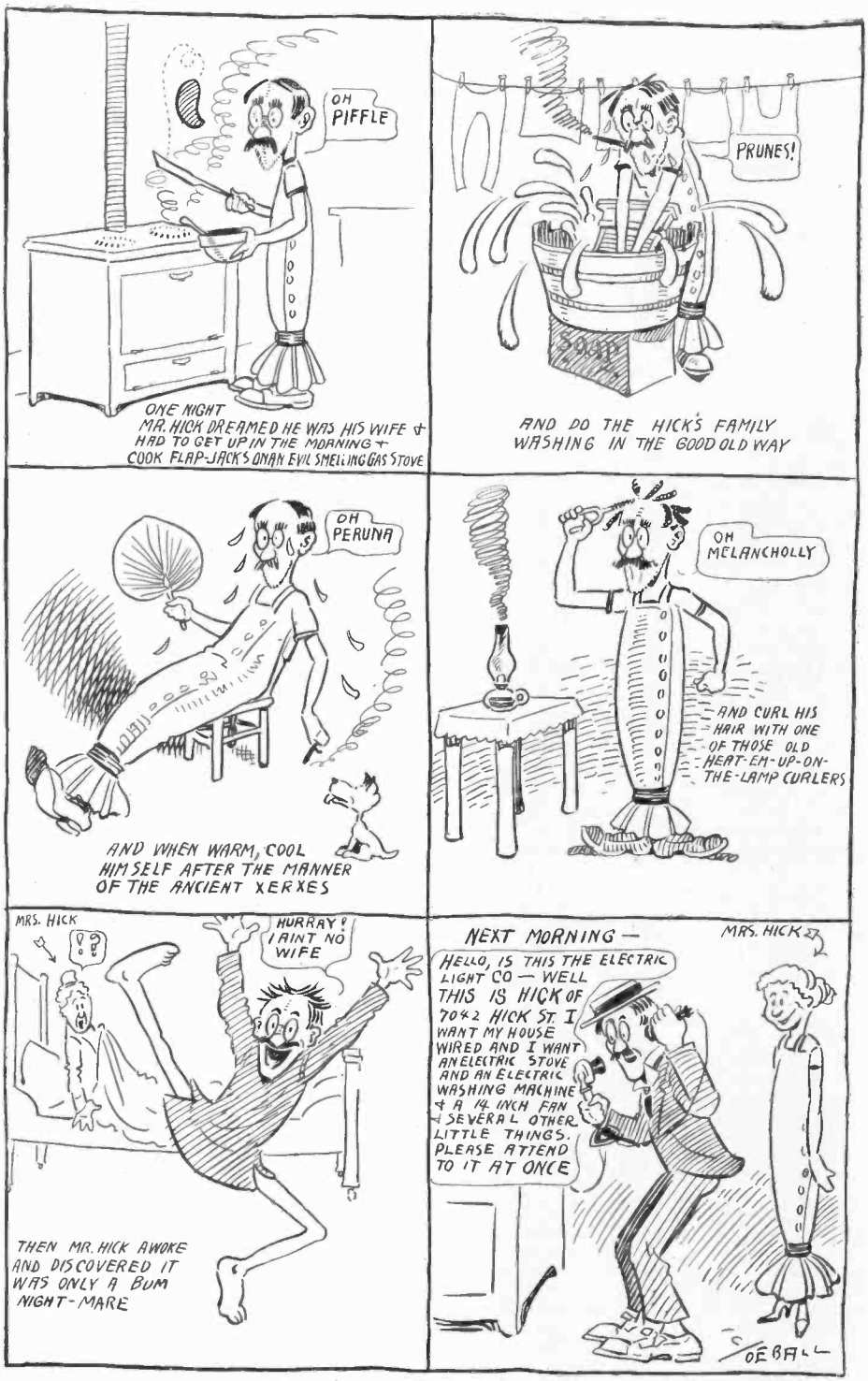
* * *

The late Justice Brewer was with a party of New York friends on a fishing trip in the Adirondacks, and around the camp fire one evening the talk naturally ran on big fish. When it came his turn the jurist began, uncertain as to how he was going to come out:

"We were fishing one time on the Grand Banks for—er—for——"

"Whales," somebody suggested.

"No," said the Justice, "we were baiting with whales."


OH PIFFLE
ONE NIGHT MR. HICK DREAMED HE WAS HIS WIFE & HAD TO GET UP IN THE MORNING + COOK FLAP-JACKS ONAN EVIL SMELLING GAS STOVE
PRUNES!
SOAP
AND DO THE HICK'S FAMILY WASHING IN THE GOOD OLD WAY
OH PERUNA
AND WHEN WARM, COOL HIM SELF AFTER THE MANNER OF THE ANCIENT XERXES
OH MELANCHOLLY
AND CURL HIS HAIR WITH ONE OF THOSE OLD HEAT-EM-UP-ON-THE-LAMP CURLERS
MRS. HICK
?!
HURRAY! I AINT NO WIFE
THEN MR. HICK AWOKE AND DISCOVERED IT WAS ONLY A BUM NIGHT-MARE
NEXT MORNING —
MRS. HICK
HELLO, IS THIS THE ELECTRIC LIGHT CO — WELL THIS IS HICK OF 704 2 HICK ST. I WANT MY HOUSE WIRED AND I WANT AN ELECTRIC STOVE AND AN ELECTRIC WASHING MACHINE + A 14 INCH FAN + SEVERAL OTHER LITTLE THINGS. PLEASE ATTEND TO IT AT ONCE
© OE BALL

COMMON ELECTRICAL TERMS DEFINED

In this age of electricity everyone should be versed in its phraseology. By studying this page from month to month a working knowledge of the most commonly employed electrical terms may be obtained.

CENTER OF DISTRIBUTION.—The point or panel to which a main feeder is connected and from which branch circuits through fuses and switches are taken off.

CENTRAL STATION.—The plant containing engines, dynamos and other apparatus necessary to supply a certain territory with electricity.

CHARACTERISTIC CURVE.—The indicator diagram of a steam engine may be termed its characteristic curve. In a dynamo or a motor it is a curve showing the relation between the speed and voltage or between any two other factors as the current and voltage.

The curve is made by laying off a horizontal line to represent one set of units, as amperes, and a vertical line to represent the other set, as volts. Then for a certain point on the vertical line the amperes will by test have a certain value on the horizontal line which determines one point. A curve traced through several such points is a characteristic curve.

CHARACTERISTIC, EXTERNAL.—Applied to the curve representing the relation between the volts at the terminals of a dynamo and the current flowing in the external circuit.

CHARACTERISTIC, INTERNAL.—A curve showing the relation between the volts and amperes in the shunt coil of a dynamo.

CHARGE.—Used with several meanings in its electrical sense (1) The quantity of electricity present on the surface of a body or conductor. (2) Applied to the electrostatic charge given a condenser. (3) Signifying the recharging of a storage battery.

CHARGE, BOUND.—A charge of electricity held upon the surface of a body by the presence of a neighboring charge of the opposite kind.

CHARGE, FREE.—A charge of electricity carried upon the surface of an insulated body in such a condition that it will pass to earth if the body is connected to ground.

CHARGE, RESIDUAL.—After a Leyden jar has been discharged in the usual way and left standing for a few minutes, a second discharge of less amount can be obtained from it. The second discharge is termed residual, and according to theory is explained as being derived from the dielectric or glass which, while holding the charge is under tension or a distortion of its molecules.

CHATTERTON'S COMPOUND.—A cement used in splicing telegraph cables and fastening together sheets of gutta percha. It consists by weight of Stockholm tar, one part; gutta percha, three parts; resin, one part.

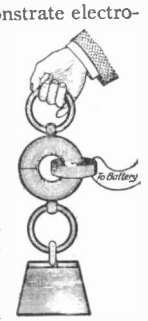
CHEMICAL ELECTRIC METER.—A meter consisting of an electrolyte containing two electrodes. When current is passed through the meter, one electrode loses in weight and the other gains by deposit, as in the process of electroplating. The electrodes are weighed at intervals, the one checking the other, the current that has passed being porportional to the loss in weight of one plate or to the gain in weight in the other. The Edison chemical meter is a notable example of this type.

CHIMES, ELECTRIC.—A device consisting of two suspended bells having a clapper or butten hung between them by a silk thread. One bell is connected to one of the conductors of a static machine while the other bell is insulated therefrom and connected to ground or to the other pole of the machine. When the machine is operated the clapper is attracted to one of the bells where it is loaded with a like charge of electricity, then repelled and attracted to the other bell where similar action takes place, the bells continuing to ring as long as the machine is operated.

CHOKING COIL.—A coil of insulated wire enclosing a laminated iron core. A current passed through such a coil must use some of its energy to build up a magnetic field in the iron. This results in a choking effect on the current, hence the name. Such coils with movable cores are used in theaters and in other places where the lamps must be dimmed for lighting effects. Called also a kicking coil or a reactance coil.

CHRONOGRAPH.—A device for measuring a period of time electrically. A smoked glass cylinder revolves at a uniform speed while a fine point attached to a stylus and electromagnet armature, makes a line upon its surface. A measurement of the space between two disturbances of the electric circuit of the magnet determines the time elapsing between the two interruptions of the circuit.

CIRCLE, MAGIC.—A circle of round iron cut across so as to form two half circles. If a coil of wire be placed on the circle and the faces brought together, a current passed through the coil will cause the two halves to be attracted so strongly as to require considerable force to separate them. The device is used in schools and colleges to demonstrate electromagnetic attraction. (See cut)



CIRCUIT.—A path by means of which an electric current may pass from a given point over a conductor and back to its starting point.

CIRCUIT, BRANCH.—See Branch Circuit.

CIRCUIT-BREAKER.—A term generally applied to a protective apparatus which may be set to automatically open a circuit in case of the flow of a dangerously heavy current.

CIRCUIT, DERIVED.—A circuit connected in parallel to two points of another circuit. A shunt circuit.

CIRCUIT, EXTERNAL.—That part of a circuit which is outside of the source of current supply.

CIRCUIT, GROUNDED.—A circuit in which the earth forms part of the path through which the current passes. Used on single wire telephone and telegraph lines, and on most trolley lines, the negative side of the generator being grounded.

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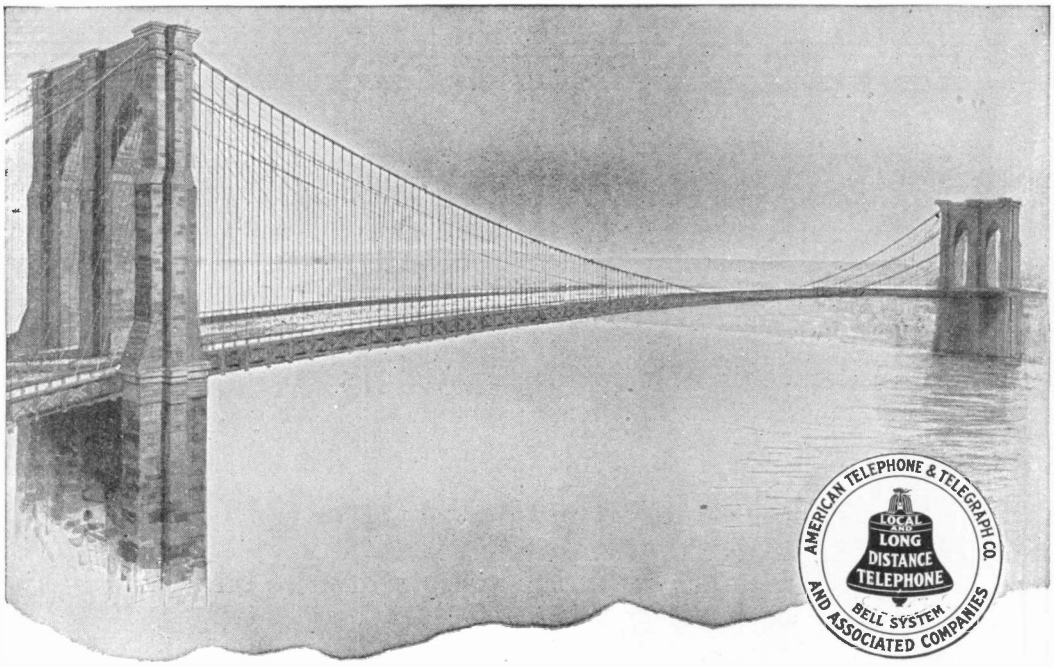

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THE BUCKEYE ELECTRIC LAMP CO., City of Mexico

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NEW YORK & OHIO COMPANY, Warren, O.

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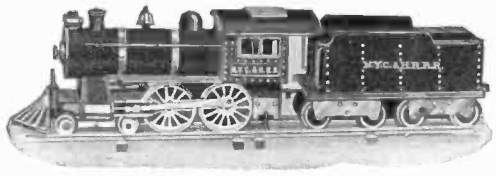
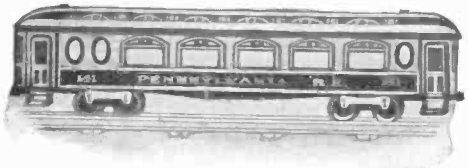


No. 6—Express Locomotive; sheet steel construction; working parts and trimmings highly nickel-plated; length of engine, 13½ in.; height above rails, 5½ in.; the tender measures 9x4x3½ in.; equipped with a four wheel pilot truck, so constructed as to assure perfect action and flexibility; also an electric headlight, with a miniature incandescent bulb; weight, 7 lbs; without track. Each.....**$11.25**



No. 18—Pullman; sheet steel construction; built with vestibules on each end; imitation leaded glass windows, two four-wheeled trucks; interior fitted with seats; beautifully decorated in colors; length, 16 in.; height from tracks, 6½ in.; weight, 2½ lbs. Each **$4.15**

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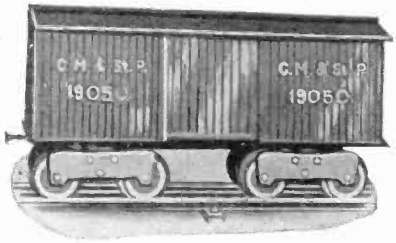

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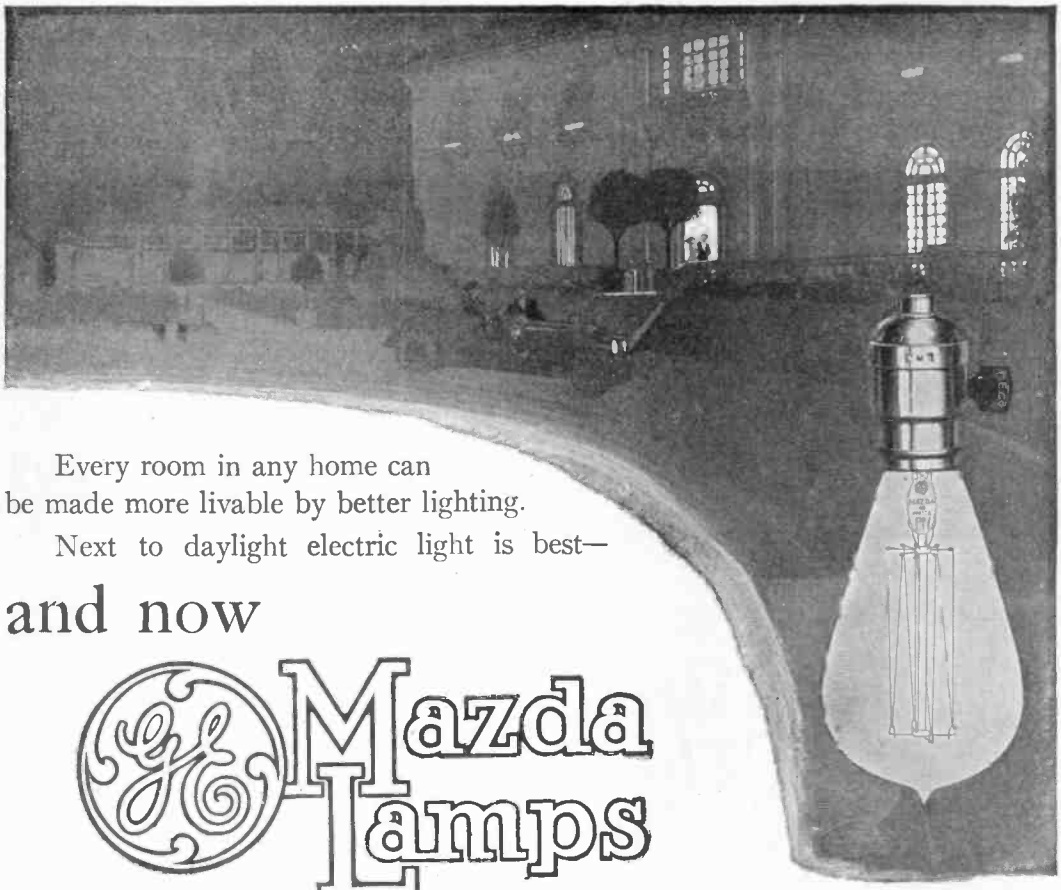

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1 12-ft. covered Suction Hose
1 Book and Wall Brush
1 10-in. Drapery Tool
1 3-in. Suction Tool
1 Felt-Faced Floor Tool
1 Adjustable Wall Brush
1 30-ft. Electrical Cord
1 Complete Hair Drying Attachment

—for which I agree to pay to your order, $1.00 herewith, and $6.00 on the first day of each of the next 12 consecutive months. Title to be given me when full amount is paid.

Name.....

Address.....

SMALL MOTORS FOR ALL PURPOSES

We manufacture motors (both alternating and direct current) for every small power purpose. We build them in sizes from one-hundredth horse-power up.

Regardless of what mechanical appliance you wish to operate, we can supply you with a Fort Wayne motor particularly adapted to your requirements.

No one motor ever built can run all kinds of devices equally well, so we have developed a variety of types to meet all conditions. For years we have been making the motors used on the leading vacuum cleaners, water pumps, meat grinders, washing machines, vibrators, etc. Tell us what you want to run and we will advise you what kind of a motor it will need and how much it will cost to buy and operate it.

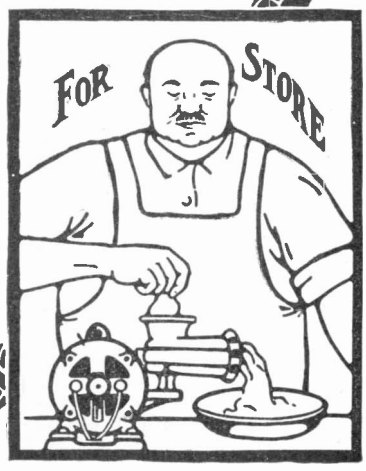
Our new bulletin 1122 contains descriptions and illustrations of some twenty applications which have saved time and money for Manufacturers, Merchants, Doctors, Dentists, Housewives, etc. We want to mail you a copy—FREE. It will pay you to send for this bulletin and read it before you buy motors of any kind.

Fort Wayne Electric Works

"Wood" Systems

1603 Broadway
Fort Wayne, Ind.

Branch Offices:
Most Large Cities



FLEXILYTE—THE PORTABLE ELECTRIC LIGHT

just as useful in the home as it is while traveling.

See if this is what you have been waiting for—a portable, flexible light, new and original—fully protected by United States and foreign patents.

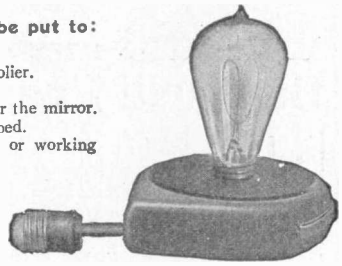
The case, as shown in the picture, contains 15 feet of cord, which you can pull out and fasten at **any desired length**, on any current with any incandescent lamp.

There is an attachment plug at one end of the lamp cord which you put into the fixture—into the Flexilyte you put the lamp which you have taken from the fixture. Then you lead the Flexilyte to any part of the room where you want the light concentrated.

Here are some of the people who are using the Flexilyte: traveling-men, house-managers, doctors, trained nurses, dentists, house-owners, shop-managers, actors, actresses, college students, apartment-owners, flat-dwellers, musicians, draftsmen and engineers.

These are a few of the practical uses it can be put to:

Reading in bed.
Reading or writing in a room dimly lighted by an electrolier.
Rummaging in a closet.
For shaving in a room where the lights are nowhere near the mirror.
For hunting collar-buttons that have jumped under the bed.
For concentrating light while doing mechanical drawing or working over plans.
For concentrating on fine mechanical work, such as in the optical or jewelry business.
For throwing light on the music rack of a piano.
For any occupation, pastime or amusement where light is an essential.



Every live Electrical Dealer, Department Store, Jeweler and Optician is selling these Flexilytes now. Get one at once and save eye-strain and the thousand and one annoyances to which you are being put all the time, because you cannot get the light just where you want it.

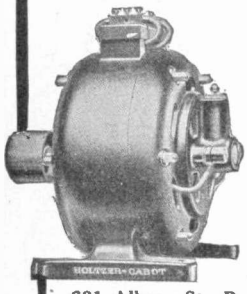
If your dealer has not got Flexilytes in stock yet, we will send direct, express prepaid, on receipt of the list price, $5.00.

Don't put off, act now.

L. A. WILLIAMSON CO.

79 MILK STREET **BOSTON, MASS.**

Motors for all Purposes—1-20 to 1-2 H. P. Single Phase



Holtzer-Cabot Motors are made for all kinds of purposes—washing machines, vacuum cleaners, adding machines, ozone machines. Any mechanical appliance requiring motors from 1-20 to 1-2 H. P. are absolutely perfect when carrying

Holtzer-Cabot Motors

We make a specialty of single phase alternating current motors and build them from manufacturers' designs and on specifications.

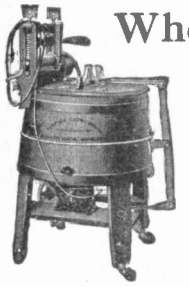
Absolutely perfect in workmanship and electrical design.

We will send you our catalogue 330-D immediately for the asking.

THE HOLTZER-CABOT ELECTRIC CO.

621 Albany St., Boston, Mass. **6161-65 S. State St., Chicago, Ill.**

When You Buy

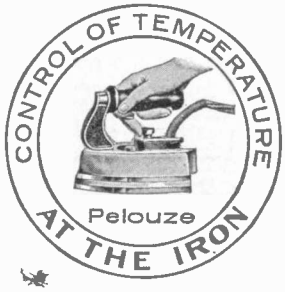


Why pay more than we ask for an electric washer? Our prices are reasonable, our machine is the most complete regardless of price.

Send today for booklet of information.

Automatic Electric Washer Co.
Box 100, Newton, Iowa

Pelouze Electric Iron



Consumes less current than other irons

The only Electric Iron in which the current and temperature can be controlled at the iron.

The Iron that Guarantees Satisfaction.

No Fire No Dirt No Odor

Every Iron Guaranteed

4 lb. $5.00 — 6½ lb. $5.00 — 9 lb. $7.00 — 20 lb. $12.50

For Sale by Leading Dealers

PELOUZE ELECTRIC HEATER CO.
232 East Ohio St., CHICAGO, ILL.

Cutler-Hammer Electric Iron
The Iron for Practical People

CUTLER-HAMMER

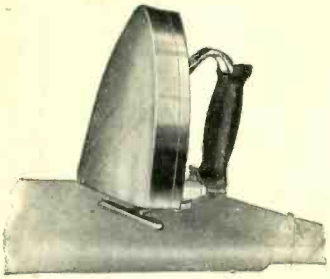
ELECTRIC Heating Devices

will solve your Christmas Gift Problem

They possess many new features and include some new developments in the electric heating field.

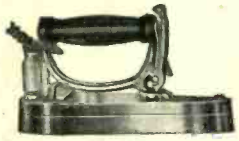
Curling Iron Heater

Cutler-Hammer Portable Water Heaters made in two styles areattractively ornamented and finished and with our line of five types of Instataneous Water Heaters offer greater conveniences than any electric heating device yet developed.



Household Iron
Made in 5, 6 and 7 pound sizes

Cutler-Hammer Electric Irons, Disc Stoves, Curling Iron Heaters, Chafing Dishes, Radiators, Shaving Mugs are most acceptable as gifts.



Sleeve Iron
3-pound—detachable handle
Convenient for Travelers

Portable Water Heater
Two Styles, 3 and 4 q.. sizes
Hot Water in 45 seconds

A 32-page Booklet

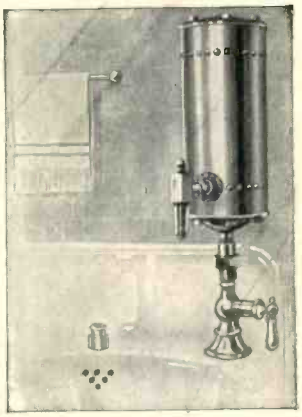
containing descriptions and illustrations of our entire line has just been published.

Send us your address and we will mail you a copy.

Radiator
Made in three sizes

Shaving Mug

Disc Stove



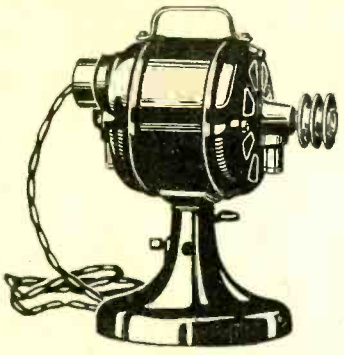
Lavatory Type
Instantaneous Water Heater
Hot Water in 15 seconds

The Cutler-Hammer Mfg. Co.

Milwaukee, Wisconsin

NEW YORK: Hudson Terminal (50 Church Street) CHICAGO: Monadnock Block PITTSBURG: Farmers' Bank Building BOSTON: 176 Federal Street PHILADELPHIA: 1207 Commonwealth Trust Building CLEVELAND: 1108 Schofield Building PACIFIC COAST AGENTS: Otis & Squires, 155 New Montgomery Street, SAN FRANCISCO

New This Christmas— A Splendid Gift For Man, Woman or Boy



EVERY woman who keeps house will have a dozen uses for this perfect little motor. Every man who has a garage or work shop will want one; so will every boy who is mechanically inclined.

It runs the sewing machine. (This is worth its price). It polishes silver—grinds knives and tools—cleans faucets and automobile trimmings—blows away cooking odors—ventilates—forces heat out of the register or radiator—runs a boy's lathe or any small machine.

Simple attachments change it from one kind of motor to another; costs less than one cent an hour to operate.

The Westinghouse General Utility Motor

is a real motor, not a toy. Built as strongly for its work as the sturdy Westinghouse motor that runs the electric trolley car, and by the same organization known everywhere for the correct design and honest construction of electrical apparatus for all purposes. This motor will last for years and need no attention beyond an occasional oiling. Price of motor $18.25. Attachments are inexpensive and may be added to the outfit as desired.

Your lighting company or dealer will show you the motor and its different applications. Send us your name on a post card and we will mail you booklet telling what it does. Send for folders describing many other electrical devices suitable for Christmas presents. Address—Westinghouse Department of Publicity, East Pittsburg, Pa.

Westinghouse Electric & Mfg. Company

Pittsburg, Pa.

Offices in 40 American Cities