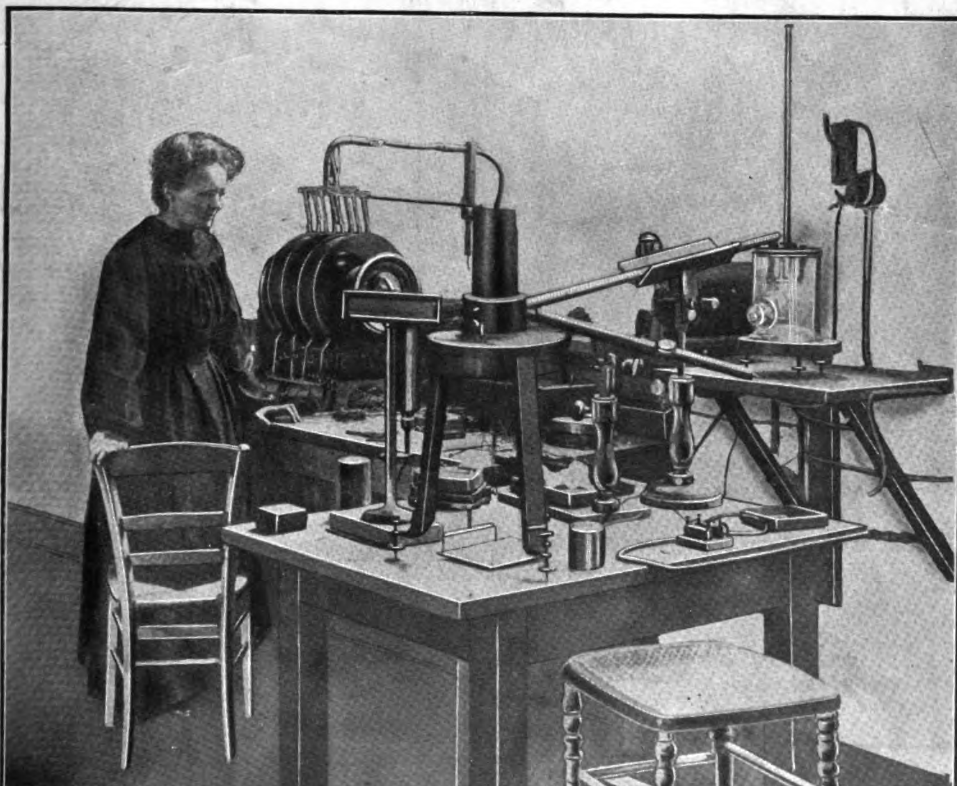
MADAM CURIE—THE WOMAN

POPULAR ELECTRICITY MAGAZINE

IN PLAIN ENGLISH
(NON TECHNICAL)



MADAM CURIE IN HER LABORATORY

See Page 1.

Vol. IV MAY, 1911 No. 1

A MAGAZINE FOR EVERYBODY

10 Cents

POPULAR ELECTRICITY
IN PLAIN ENGLISH
HENRY WALTER YOUNG, Editor

Vol. IV May, 1911 No. 1

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ISSUED MONTHLY BY POPULAR ELECTRICITY PUBLISHING CO., Commercial Bldg., Chicago, Ill.
YEARLY SUBSCRIPTION, $1.00: CANADIAN, $1.35; FOREIGN, $1.50; SINGLE COPY, 10 CENTS

No additional copies will be sent after expiration of subscription except upon renewal.

Entered as Second Class Matter April 14, 1908, at the Post Office at Chicago. Under Act of March 3, 1879.

MADAM CURIE, WHO, WITH HER HUSBAND, DISCOVERED RADIUM. HER DARING THEORIES SHE KEEPS BETWEEN THE NEAT PAGES OF HER NOTE BOOKS AND IN HER WONDERFUL BRAIN, WAITING FOR THE TIME WHEN SHE CAN PROVE THEM TRUE.

Popular Electricity
In Plain English

VOL. IV MAY 1911 No. 1

Madame Curie the Woman

By LAURA CROZER

It is the greatest pity that so gentle and unassuming a person as Madame Curie should have been the victim of the recent squabble in the French Academy which resulted in a decision to admit no women. Madame Curie's name was proposed by her friends, and though she herself would never have sought the honor she has been refused, the experience must have been a bitter one.

But Madame Curie is no stranger to injustice, for she grew up in Russian Poland, and every corridor of the University of Warsaw where her father was an ill-paid professor of chemistry, bore a sign-post pointing to Siberia. Her mother was dead, and at an age when other little girls were playing with dolls, Marie Skladowska was learning the uses of test tubes and retorts in her father's laboratory in order to save the salary of an assistant.

As she grew older she studied in other departments of the University, and began to feel the burning patriotism that inspired all the students even in the shadow of the sign-posts, those grim reminders of the fate that had overtaken many of their kind.

So Marie resolved to devote her life to the service of the country, and in order that she might be more worthy of that service she was eager to travel. At last a position as governess in a Russian family traveling through southern Europe offered itself, and she accepted gladly. Every penny of her meagre salary was saved, for she was determined to go on with her studies in chemistry, and her father could teach her nothing more.

Two years later found her in the Latin Quarter in Paris, in a garret so cold that the milk left before her door froze in its bottle, but enrolled as pupil at the Municipal School. She could not afford the fees of the University, though she allowed herself so little food that her entire expenditures were less than ten cents a day. For whether she had food or not, there must be money for books if she was to go on with her studies.

But such burning earnestness could not go unnoticed, and the young professor, observing the originality of her experiments and her profound knowledge of chemistry, made her his assistant.

For a time they worked together, and in the course of their explorations into the unmapped fields they became fast friends. Finally Professor Curie asked his brilliant assistant to be his wife.

Her answer was characteristic, for she fled back to Warsaw, the zeal of the scientist lost in the personal shyness of the woman. And at the thought of permanently leaving her country, all her love for it had flamed up anew. She lacked the beauty and magnetism of many Polish girls, for days spent over unwholesome gases had given her a pale complexion and lustreless hair. But under the plain gown was a heart filled with all the burning patriotism of a Modjeska.

So she wrote M. Curie that she had long ago decided to devote her life to science and the good of her country, and did not feel that she could change that decision. But his answer was such an attractive picture of the work that they might accomplish together, and so vibrant with his own loneliness that she relented, and two weeks later they were married.

Many a gifted young couple have started out to spend their lives in united work, but they have lacked the courage to give up everything else as the Curies did. At first they took a tiny cottage at Sceaux, nine miles from Paris, but they lost so much time going back and forth to the city that they moved to the Rue de la Glaciere, near the School of Physics and its laboratories. This was a great advantage, for by this time Madame Curie's ability was so far recognized that she was permitted to use these laboratories, a privilege never before granted to a woman.

There was little to eat but plenty of happiness in the cottage, for the husband and wife shared each other's every interest. After a time a little daughter, Irene, came to add another bond, and for her sake they moved again, this time to a vine-covered cottage in the Rue Kellerman, which had a tiny garden.

But so remote and unfashionable was the neighborhood so far from the gay life and changing fashions of Paris, that when the influx of visitors began the Paris cabmen could hardly find it. Given over to scattered tenements and tiny cottages many of them sadly tumble-down, with wide open spaces on which the carpets of Paris were daily beaten, it was a refuge for Russian students of the furtive and revolutionary order.

The cottage was divided by a hall in which there was a stove that did duty for the entire house. In front were the dining room and the little salon furnished with two couches, which often accommodated friends or stranded students. On the mantle was a lamp and beside it two easy chairs. A few cane-seated chairs completed the furnishings. In the back part of the house were the bedrooms and the kitchen.

Madame Curie was a busy woman, and though unlike the traditional intellectual genius she is a good cook and very neat, she has no leisure for housekeeping. So the little menage was presided over by a stout bonne, literally a "good woman," the typical devoted, capable French servant, who did the cooking and washing and took care of the baby. Such a servant is beyond the experience, or even the dream of an American housewife, and perhaps some of Madame Curie's success in her laboratory was due to her freedom from household cares.

She worked every day looking after the chemical experiments, while Professor Curie and his pupils devoted themselves to problems of physics. In the face of discouragement and poverty they worked on until 1898, when one day Madame Curie showed her husband a substance she had succeeded in segregating from pitchblende, an oxide of uranium which comes from a single mine in Bohemia. It is very expensive, and the amount she had used had emptied her slender purse, but the substance she had found was so wonderful that Professor Curie gave up all his other experiments to help her. Between them they managed to extract a single gram, which glowed in the dark, and gave off heat without growing cooler or smaller.

In April they made public the discovery of radium and the scientific world seethed with excitement. Then came the knowledge that this wonderful new substance was effectual in curing disease. The announcement that it was a cure for cancer brought a wave of popular interest, and honors poured in upon the Curies from every country but their own.

In May, 1903, the Royal Institute of Great Britain invited them to lecture, and there they received their first public applause under the kindly auspices of the venerable Lord Kelvin, who was as appreciative as he was learned. The Royal Society gave them the Davey gold medal, and Sweden followed with the Nobel prize. At last France came forward with the Legion of Honor for M. Curie, which he refused "because it had no connection with his work."

It is not so stated, but it is not hard to imagine that M. Curie was unwilling to receive a decoration which took no account of his wife's part in the work. It seems quite probable in view of the fact that Madame Curie, with his approval, accepted the $12,000 Osiris prize, which lifted the little family to financial security.

But M. Curie did not go without a decoration. The day after he had refused the ribbon of the Legion of Honor, the Curies with their neighbors and intimate friends, the Perrins, took dinner at the Villa Robinson, a charming nook on the banks of the Seine outside Paris. It is named after the immortal Swiss Family, since its tables, like theirs, are spread up among the branches of the trees, and reached by spiral stairways inside the trunks.

After they had finished their dinner and were enjoying the view of the river, little Irene scrambled down the steps, and came back with a red geranium in her hand. Very gravely she climbed to her father's lap, and put it in his buttonhole.

"Now," she announced, "you are decorated with my legion of honor!"

"And this one," he replied as gravely, "I shall not refuse."

Shortly afterward came the invitation to lecture at the Sorbonne, the great Paris University which draws students from all over the world for post-graduate work.

But fame had a less pleasant side, for the quiet little home began to be invaded by the curious public, which wondered what sort of a woman a great scientist might be. Madame Curie deeply disliked this prying into her private life, and she did not care for the social honors that were thrust upon her. The daughter of the poor professor, the struggling student, and the busy scientist had had neither time for gaiety nor money to spend on clothes. So it happened that the black silk gown she wore to the dinner that President and Madame Loubet gave for her and her husband was the first she had ever had cut decollette.

The Curies had refused to lecture before royalty, pleading lack of time, but when the Shah of Persia visited Paris, they consented to exhibit their radium to him as a special favor to the government.

The bit of radium was in a glass jar, and when the room was darkened and it glowed forth, the Shah became frightened, and in his excitement upset the table. The Curies were very much afraid their precious radium had been lost, for this single gram was worth more than $30,000 and had been obtained with infinite labor. Conscience stricken over the trouble he had made, the Shah pulled off all his diamond rings and offered them in payment.

But the radium was finally rescued unharmed, and the lecture went on. The Shah was so delighted with it that he insisted upon pinning his orders upon Mrs. Curie's gown. She was greatly embarrassed, for no one could have less use for jewels than this quiet little woman who was trying to preserve the privacy of her home so that she might have strength to go on with her work. But even her laboratory was invaded by reporters.

A second little daughter, Eve, was born in 1906, but the joy over her advent was short-lived, for only a few weeks later Professor Curie was knocked down by a hack while crossing the street, and before he had a chance to rise a wagon going in the opposite direction ran over and killed him.

Scholarly abstraction may have had something to do with the accident, but the fact remains that French traffic laws are still feudal. Vehicles have the right of way, and an appalling carelessness among drivers is the result. The man who is run down, far from having any redress, is arrested for blocking traffic.

Professor Curie was not fifty, and through his death the world lost discoveries that might have benefited mankind in unimagined ways. France lost her most brilliant scientist, and the one who of late years has brought her greatest honor. But Madame Curie's loss was greatest of all, for she lost not only the scientific partner, who had understood and sympathized with every daring theory, and helped her make her dreams a certainty, but the kind and sympathetic husband who had loved her as a woman as deeply as he had admired her as a scientist.

But she had the courage to face her double loss, and go back to her laboratory. There she was rewarded by the discovery of polonium, named after her beloved Poland, and even more wonderful in its properties than radium. So difficult is it to obtain that five tons of pitchblende was used in segregating the small amount that Madame Curie now has.

Resolutely overcoming her shyness she accepted the invitation of the Sorbonne to fill her husband's vacant chair, and became its first woman lecturer. Believing that very few would care to listen to a woman in those sacred halls, she selected a remote classroom which had seats for only about thirty.

What was her amazement to find the whole gay world of Paris flocking to her lectures! Butterfly women of fashion and even royalty came, for Madame Loubet was accompanied by the King and Queen of Portugal.

But Madame Curie is more than a dreamer. Her daring theories she keeps between the neat pages of her note books, and in her wonderful brain, waiting for the time that she can prove them. She has been much hampered in her recent experiments by the scarcity of radium, for its use in medicine has sent the price up into the thousands for a fraction of an ounce, and threatened to exhaust the available supply.

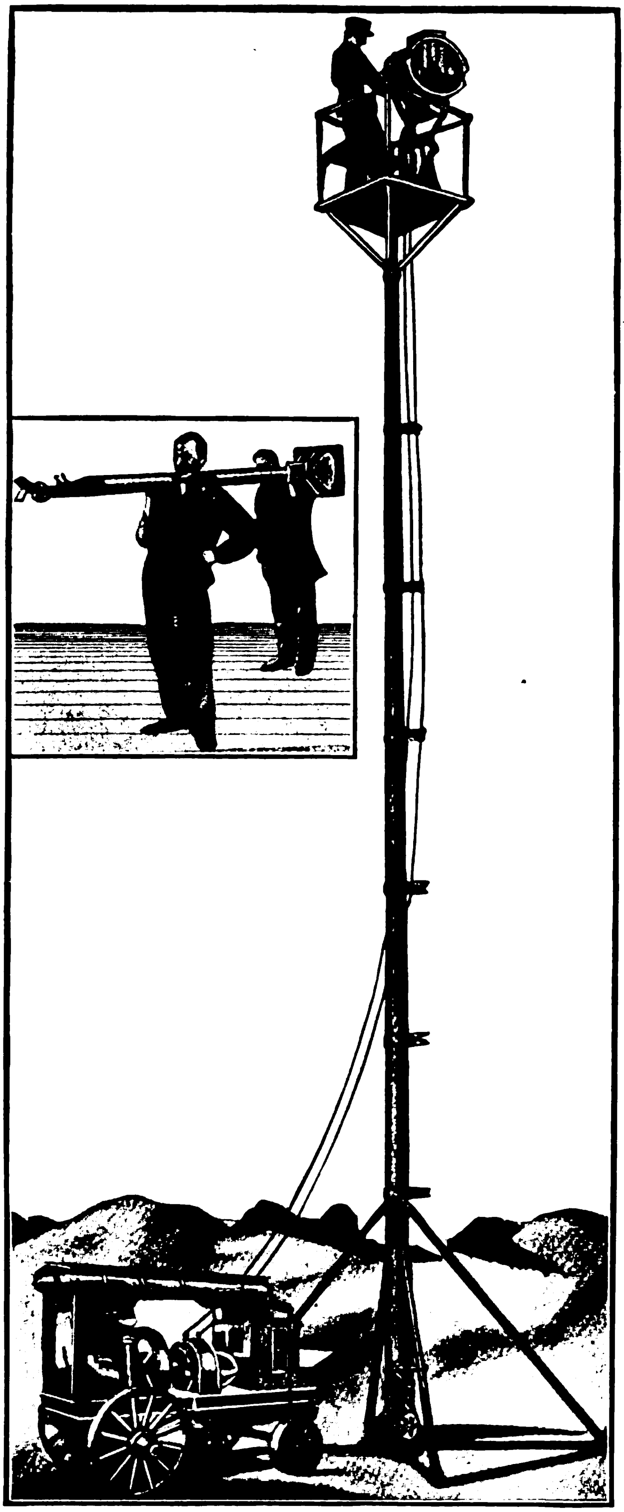
But if her mind is in her laboratory, her heart is still in the vine-covered cottage, where a cousin who came from Poland to take charge of the little girls and M. Curie's father, now past 80, keep her company.

Here at night she folds the hands that have dared to search out the components of the sun, and bends the mind that has opened new avenues to medicine, to telling the hero-tales of far-away Poland to the little girls. In the warmth of their arms she finds strength and courage to go on for another day.

And if she thinks of the French Academy at all, she has only to remember the traditional fate of the prophet in his country.

Collapsible Towers For Searchlights

In any coming wars, the use of both electric searchlights and wireless telegraphy are sure to play an important part. For both purposes the most puzzling problem has been that of erecting a tall enough pole or tower for effective service. The Germans seem to have solved even this problem by adopting the collapsible towers invented by Karl Nitsche, consisting of telescoping tubes which are slid upon one another by simply turning a crank. Our illustration shows a 160-foot wireless mast collapsed so that two men can carry it, also another, an 80-foot mast, with complete searchlight equipment.



Five Epoch-Making Electrical Inventions

By ELMER E. BURNS

II. THE ELECTRIC RAILWAY

The practical working electric motor and the electric railway are so closely connected that an account of one must include some mention of the other. The practical motor dates from the discovery of the reversibility of the dynamo; that is, that a dynamo can be run as a motor, and that current from a dynamo can be used to run another exactly similar machine as a motor. Credit for this discovery must be given to Thomas Davenport of Brandon, Vermont. He obtained his patent in 1837. He also applied in 1836 a miniature motor to the operation of a tiny electric car on a circular track 24 inches in diameter. This was operated by batteries and contained the germ of the idea of electric traction.

So thoroughly was the idea of the reversibility of the dynamo fixed in the minds of electrical workers in the early history of electric power that the motor was known as a "receiving dynamo"; that is, a dynamo that receives the electric current and converts it into power.

This discovery was closely connected with another made almost simultaneously by Varley and Wheatstone in England, and Siemens in Germany. It was discovered by these men that a dynamo retains some magnetism when at rest and that it will furnish an electric current without the use of batteries. Until this discovery was made it was thought necessary to use batteries to furnish current for the field coils of the dynamo. These two discoveries and the invention of a practical armature or "bobbin," as it was then called, placed the motor on a working basis.

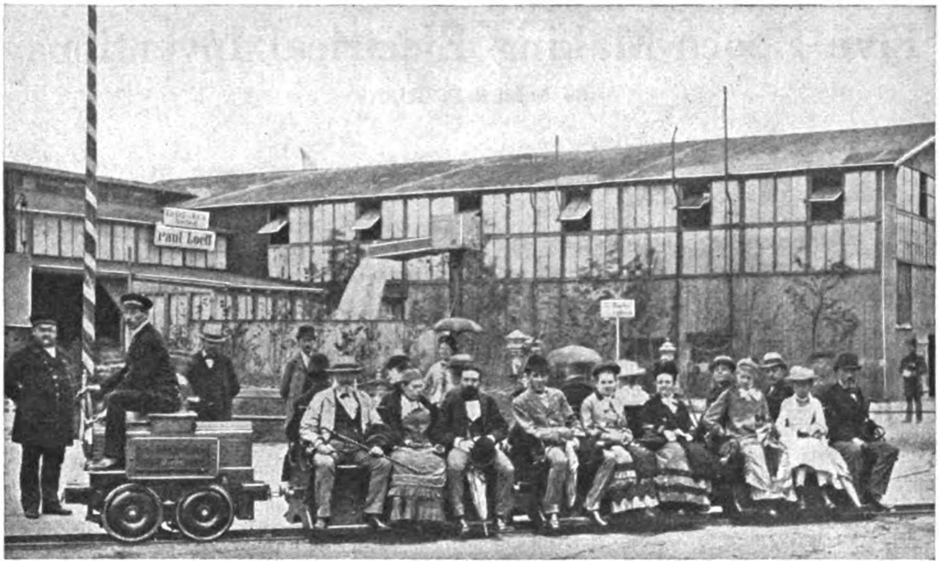
The first aim of the early inventors of motors was transportation by means of electricity. Before the discoveries that have been mentioned were made, motors run by batteries were used for transportation. The motor boat is not a new invention for in 1837 Sturgeon propelled a boat by means of a motor using batteries. He also propelled a small car in the same way. But like Davenport, Sturgeon was far ahead of his time.

About 1850 Professor Page constructed an electric locomotive which traveled from Washington to Bladensburg, a distance of five miles on the Baltimore and Ohio Railroad, attaining a speed of nineteen miles an hour. Professor Page secured an appropriation from Congress to aid in his experiments, but nothing came of this work because he was using batteries carried by the locomotive. The plan was abandoned because of excessive cost of operation. The practical working dynamo and motor had not then been invented.

In 1847, Mr. Lilly and Dr. Colton of Pittsburg invented an electric locomotive and railway, constructing only a working model. In this railway the rails were used to carry the current. This invention has been made the basis by some of claiming for America the honor of inventing the electric railway, but it failed of any practical outcome.

The electric railway as we know it today dates from 1879. In that year there was exhibited at the Industrial Exposition in Berlin an electric locomotive, the invention of Doctor Siemens. This locomotive was small, it is true, and presented an absurd appearance with the motorman sitting astride the machine; but it involved the essential principles of the modern electric locomotive. The track was circular and about 1,000 feet in length. The locomotive drew three small cars, each carrying six passengers. The locomotive was simply a dynamo mounted on wheels and made to run as a motor, the armature shaft, of course, being geared to the wheels. The current was generated by a dynamo exactly like the motor, the armature of this dynamo being turned by a steam engine. The third rail system was used, the third rail being placed in the middle of the track.

In the following year, Edison built an electric locomotive and railway at Menlo



ELECTRIC LOCOMOTIVE EXHIBITED IN 1879 AT THE INDUSTRIAL EXPOSITION IN BERLIN

Park, New Jersey. Edison employed no trolley wire or third rail, but used the two rails of the track as conductors. The rails were not insulated, yet the loss of current was not more than five per cent even when the track was wet. The wheels, of course, were insulated so that the current could not flow through the axle, but must pass through the coils of the motor. The motor mounted on a truck and connected by friction gearing to the axle of the wheels formed the locomotive. This locomotive was large enough for real work, and in the following two years actually carried a great many passengers over the mile track at Menlo Park. This railway was built on the natural ground with no grading and with some rather sharp curves, and thus demonstrated the practicability of the electric railway.

This railway was not, however, regarded as a commercial proposition. It was not intended as such, but only as a demonstration. As was said at the time: It "was designed to test the applicability of the electric current to this purpose, and to develop a railway system suitable for plantations, large farms, and for mining districts," and, the writer added, "perhaps it is not entirely visionary to expect that our street and elevated railways may at no very distant day be successfully operated by electricity."

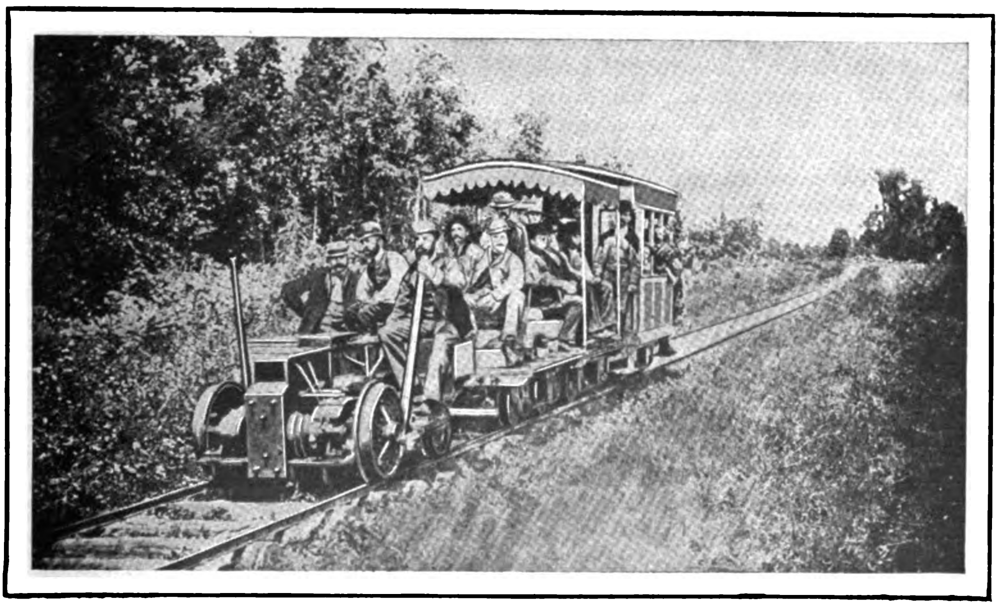
On May 21, 1879, the year in which Edison built his first experimental railway, Stephen D. Field filed a caveat for a patent on an electric railway, which embodied the idea of taking current from a stationary source of power by means of an overhead contact, the forerunner of the modern trolley. This patent was afterwards granted and the interests of Edison and Field were in litigation for a number of years. The case was finally decided in favor of Field. The Field system was put into practical operation in Chicago in 1883, an elevated electric road being built for the Chicago Railway Exposition. This road demonstrated the practicability of electric power for elevated roads and was the forerunner of the elevated road of today.

In 1882, Edison built a second electric railway running from his laboratories at Menlo Park to Pumptown, a distance of nearly three miles. There was no trolley wire or third rail, but the rails of the track with the motor coils formed the circuit. The rails were insulated from the ties by giving them two coats of Japan, baking them in an oven, and then placing them on pads of muslin impregnated with tar. The locomotive with its cab for the engineer and its cowcatcher had very much the appearance of a steam locomotive. This road, though it carried freight and passengers, was also a private road. It was not opened to the public for traffic. In fact, it did not connect points between which there was public traffic.

The first electric road in the world that was used for public traffic was that established at Lichterfeld, a suburb of Berlin, in 1881. The building of this road by the firm of Siemens and Halske was prompted largely by a spirit of patriotism. Inquiries had come from all parts of the world in regard to the little railway of Dr. Siemens. Electric roads were being projected in other countries. They purposed that Germany should have the honor of establishing the first commercial electric railway.

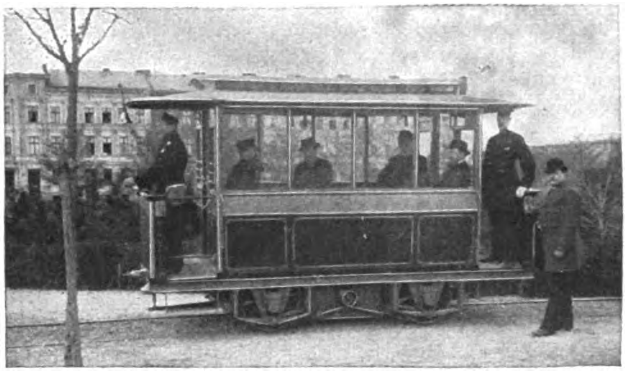
This railway connected the station of Lichterfeld on the Anhalt Railway, one of the largest trunk lines of Germany, with the Government Military School of Greater Lichterfeld. Its length was one and one-half miles. It replaced an omnibus line. It was opened on the 16th of May, 1881, and was used from that time on for public traffic. It used a standard gauge track that had been used by a temporary steam road in transporting material for the buildings of the Military School. The rails were used to conduct the current without special insulation. Of course there was some loss of current by leakage, but not enough to prevent the successful operation of the road. A horse-car seating 26 persons was used. A motor of five and one-half horsepower was mounted underneath and geared to the axle. A central station dynamo of the same construction as the motor was installed. The need of the overhead wire and the trolley was recognized at this time and this device was employed in the second road built by Siemens and Halske.

The difficulty of answering the question: "Who built the first electric railway?" can readily be seen. The answer depends on what is meant by the first electric railway. If we mean the first model able to propel itself by the action of an electric motor, then we must give Davenport the credit, with Sturgeon a close second. It seems best, however, to pass over all models made before the invention of the modern dynamo and motor. Even then the question is difficult. The first experimental railway using a self-exciting dynamo and a motor of similar construction was that built by Siemens in 1879. This was a miniature affair, however, too small for practical use. The first electric railway built on a sufficiently large scale for general use was that built by Edison in 1880. It was this road that first



FIRST EDISON ELECTRIC LOCOMOTIVE

proved that the electric railway is practicable for the actual conditions of traffic. The first road, however, that was actually opened to the public for traffic was that of Siemens and Halske in Lichterfeld, opened in 1881.



FIRST COMMERCIAL ELECTRIC RAILWAY—OLD HORSE CAR CONVERTED TO ELECTRIC

The first electric railway opened for public use in America began operation in Cleveland, Ohio, July 26, 1884. A peculiar feature of the early electric roads in this country resulted from the fact that they succeeded the cable lines. The cable system was peculiarly American, the horse-car being the principal means of city transportation in European countries, while the cable-car was coming into general use in this country. So it happened that underground conductors were used on the early electric roads, the conduits of the cable lines being used for the underground rails of the electric lines. A grip similar to the grip of the cable-car was used to control a roller contact with the underground rail. This was the plan followed in the operation of the Cleveland road. This road was a mile in length and was part of the system of the East Cleveland Street Railroad Company.

A system of considerable importance was that invented by Leo Daft, which was tested at Saratoga, New York, in 1883. It was a third rail system employing a low tension current. The locomotive was ten feet long and weighed ten tons. It made eight miles an hour up a grade of 93 feet to the mile. The Daft system had been tested earlier in the year 1883 on an experimental railway built at Greenville, New Jersey.

The first commercial electric railway on an extended scale in this country, that is, the first complete electrification of the street railway lines of a city, was that established by Frank Sprague in Richmond, Virginia, in 1887. This road was a trolley system comprising thirteen miles of track. Three 125 horsepower engines were used to run the generators. The road was carried over steep grades and its successful operation proved that the problem of rapid transit was being solved by the use of electricity. We shall mention one illustration of the severe tests applied on the Sprague line. Twenty-two cars were "banked" on a section of the line calculated for only four cars. The potential was raised to 500 volts. At a signal the 22 motormen started their cars at once. The potential dropped to 200 volts, then gradually rose, and soon all the cars were running at full speed. This test showed that the generator could be made practically self-regulating.

The leading system, however, among early American electric roads was the Van Depoele. It was put into operation in Toronto in 1884 and introduced into the United States in 1886, when it was put into use in South Bend, Indiana. Overhead wires were used, the track completing the circuit. Each car had a speed regulator resembling the controller now used. This regulator consisted of a small cylinder containing coils. A crank handle was used to regulate the speed and the numbered notches showed the rate at which the car was traveling. The highest speed allowed by the regulator was eight miles an hour. In 1887 the Van Depoele system was in operation in eight cities in the United States and had more miles of track than all other systems put together. But it is to be remembered, however, that these installations only represented partial electrifications of existing horse-car lines, the first complete electrification being in Richmond, as above stated.

Edison had in a crude way anticipated the controller. In his first railway he had difficulty at first in starting his locomotive. When he turned on the current the motor armature burned out. This happened a number of times and then he brought out a number of resistance boxes from the laboratory and connected them in the circuit. Then the motor could be safely started and as it gained speed the resistance coils one by one plugged out of circuit. These resistance boxes were scattered about on the floor of the car and under the seats and were soon found to be very much in the way. He, therefore, wound some extra coils on the motor field magnet, which could be plugged out of circuit as required.

We have noted that batteries were used in the first experiments in electric locomotion. The dynamo followed the battery and as a result only direct current was thought of. The alternating current dynamo and motor, though in reality simpler in construction than the direct current, are a comparatively recent development. Thus it is in inventions. Men begin with the complex and proceed to the simpler forms.

The rapid growth of the electric railway began about 1890. In 1888 there were but thirteen electric roads in the United States. In 1891 there were 400.

Piping Steam 700 Yards

This picture was taken on a cold winter morning up in the town of Virginia, Minnesota. In the distance is the plant of the Virginia and Rainy Lake Lumber Company where wood and wood refuse is so plentiful that it is often burned in screened cupolas, two of which are shown, to get rid of it, and therein lies one reason for the iron pipe seen resting on posts around the edge of the pond. Down this way 2,100 feet from the lumber mill boiler house, but not in view, is the city lighting plant. The growing town taxes the capacity of the lighting plant, so to help out, the eight-inch pipe line was built and steam under a pressure of from 80 to 145 pounds is passed through it from the lumber mill boilers to the lighting plant, and there, after being used to run a Corliss engine and pumps it operates a low pressure turbine as exhaust steam.

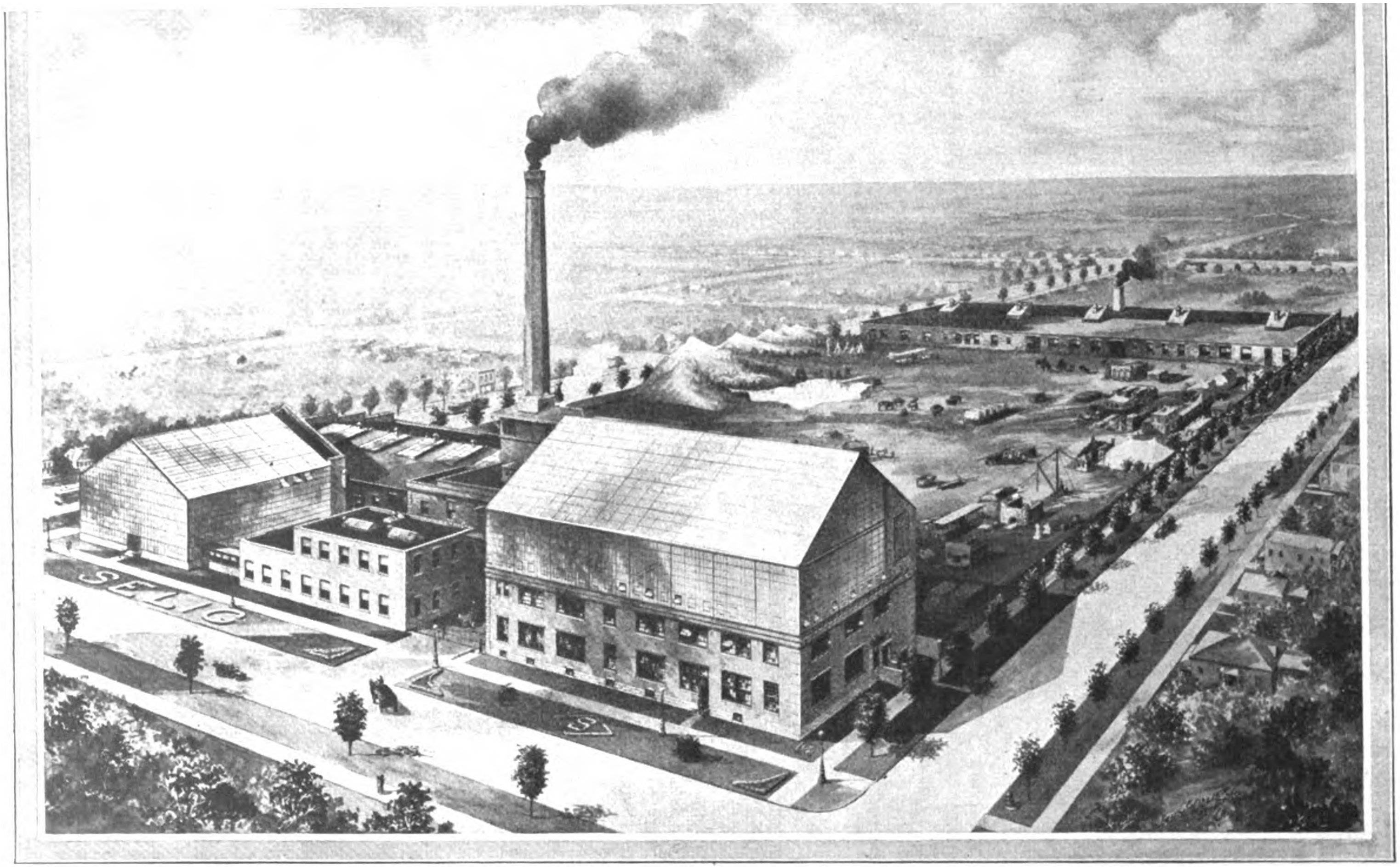
The pipe will deliver as high as 800 horsepower. Loss of heat is prevented by covering the pipe with magnesia insulation and

PART OF THE 2100-FOOT PIPE LINE

canvas and during winter weather snow lies on it without melting. In the coldest weather the quantity of water from the steam which condenses in the pipe is less than ten gallons per hour.

Searchlight in Judging Fogs

The use of the electric searchlight on lake steamers is almost universal, and any one who has been on board during a summer evening trip is familiar with the use of the light to follow the objects along the shore or bring to view some nearby craft. On a foggy night, however, the light is of special value. At such a time the beam seems to come abruptly to an end if the light is pointed upward. It does this instead of gradually fading away into nothing, as when pointed horizontally on a uniformly foggy night. This thing is rather puzzling to one first seeing it, but the reason is evident after a little thought. Where the end of the beam seems to be is the place the fog ends, for the beam cannot be visible to us unless there are small particles in its path to reflect light. This fact is of great help to sailors in judging of the weather, for they can tell by throwing the light horizontally whether or not the fog is universal.



A MODERN PLANT WHERE MOVING PICTURE FILMS ARE MADE

The Making of Moving Pictures

If the moving picture theatres of this country today were placed side by side they would make a line 40 miles long. Were the moving picture seeing portion of the population uniformly distributed among the rest of the people, every twenty-third person you would meet in traveling about would have attended a moving picture show that day.

Last evening you paid a nickel at one of these places and for it saw the salmon fishing industry of the Northwest as vividly as if you had personally visited the region. The next set of pictures carried you through the portrayal of a story in which jealousy, love and hate and the plotting that goes with it gave your mind a turn at motives and happenings in human life. A third film told you with all the vividness of reality, a story of history—perhaps of long ago, maybe of things that occurred but yesterday and will tomorrow form a part of the world's story.

Behind this rapidly growing amusement business as one of its helpers is electricity. Pictures that may be put on by using appropriate stage settings are prepared in a "studio" as it is called. This studio is really a glass house, for its walls and roof are made of glass set in an angle iron framework so that plenty of light may be had. Even then dozens of mercury arc lamps are suspended from the roof so that the certainty of obtaining good results is assured. Stage carpenters and scene painters have arranged the setting and proper surroundings at one end of the studio. At the other end stands a camera containing a fresh film. The preparation of the actors has been completed by numerous rehearsals under the care of a stage director until each person is ready to respond to his cue. With all this done the lights are switched on and the camera operator begins turning the crank of his machine, taking one picture after another at the rate of from ten to twenty per second, each being one inch wide by three-quarters of an inch high.

Without going into detail let us follow this film for a time. Most of the films are quite long and so are developed on a drum upon which as much as 400 feet may be handled. The drum is made of wooden slats put together in the form of a cylinder. Upon this the film is wound with the sensitive surface outward. The drum, the lower part of which when in place is below the surface of the developing solution, is now revolved by a small electric motor. After being developed the film is reeled onto a second slat drum of wood which is covered with cheese cloth. This drum is also motor driven and is constantly turned until the film is dry, to prevent drops of water from collecting on any lower part of a film, as they would do with the film at rest, and leave marks. Sometimes the film is run back and forth from one drum to another in developing, passing through the developing tank between the drums. Electric motors are the motive power here.

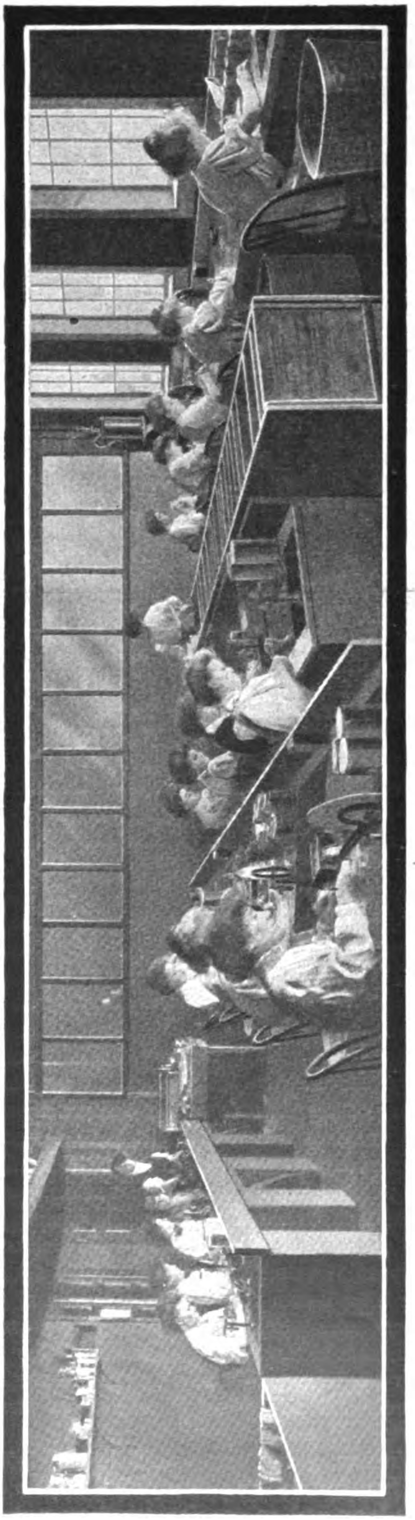
When dry the negative film is inspected for faults before it is used for printing the hundreds of other films which are made from it for the use of the moving picture theatres. To print say 400 feet of film or make 6400 pictures something besides hand power must be employed. A small motor controlled by a hand switch feeds the negative and an undeveloped positive film through together at exactly the same speed, in front of a lamp, the operator keeping watch of the work through a red glass. This work is done, of course, in a dark room. The positive film is now placed on motor-driven drums for developing and drying, just as with the negative. After inspection the positive goes to the finishing room where the parts are again inspected, spliced together, the standard film length being 1,000 feet, then reeled up and placed in a metal box and stored in the vault at the factory or in some exchange until sent out.

The reel of pictures next sees the light again when some moving picture machine operator places it in position on his machine in front of an electric arc for reproduction on the screen. The universal distribution of electricity and the ease and safety with which it can be used make it one of the pillars so to speak of the moving picture show business for it not only helps to reproduce the pictures, but also illuminates both the interior and the exterior of the theatre.

Moving picture making had its beginning in France in 1893 and in Chicago in 1898. At first only the simplest kind of pictures were attempted at as small cost as possible and many of our readers will remember seeing moving pictures first exhibited in vaudeville houses at the end of the performance. But in ten years a great advance has been made and besides being an inexpensive form of entertainment they have become a source of education, and from the year 1906 moving picture shows have spread over the country like wild fire. As a result hundreds of thousands of dollars have been invested in the production of pictures.

It will interest our readers to go through one of these picture producing plants and look at things as we find them. Chicago people are strong supporters of the moving picture shows. There are 600 such theatres in the city and 50 vaudeville houses exhibiting them at their performances. A conservative estimate places the number of people who daily attend these shows at 150,000. Yet we are quite safe in assuming that few outside of show owners and people living in the immediate neighborhood are aware that out on the Northwest Side of Chicago is the largest studio and factory in the world for moving picture production, and to it we will pay a visit. The illustration on page 10 conveys some idea of the space and money invested by the Selig Polyscope Company. The plant occupies almost an entire block and a similar plant is in operation in Los Angeles, California.

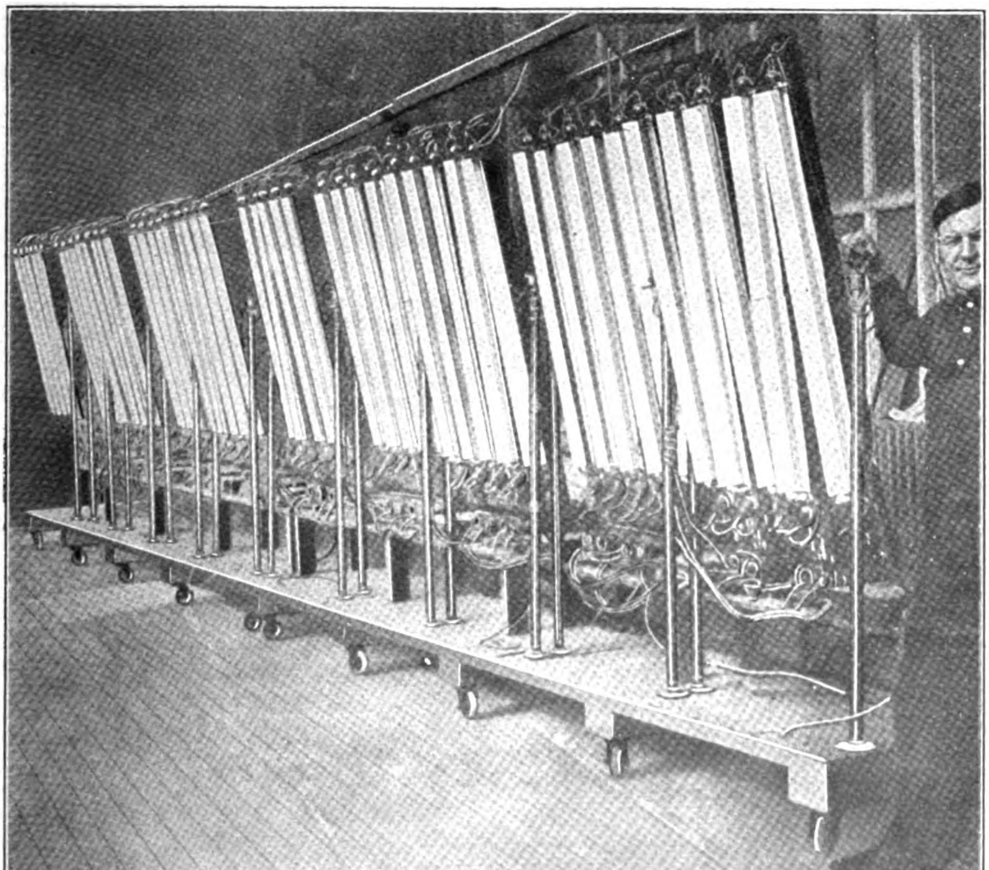
It was noon on a rather warm day in summer and the employes were just quitting for their noon luncheon. "Cosmopolitan" is the word to describe the hungry crowd that poured out of the gates of the plant and scattered to the various restaurants. This day noon a group of Roman citizens attired in loose robes and sandals sauntered forth, not with the slow dignity expected of such personages, but with the alacrity of a true American business man making for a quick lunch counter. The gladiators who had fought so bravely and died in the arena before the assembled multitude sat down at the same table. The rest of the Roman citizens in their Roman clothes sat down at other tables and discussed the latest aeroplane flight or prize fight according to their



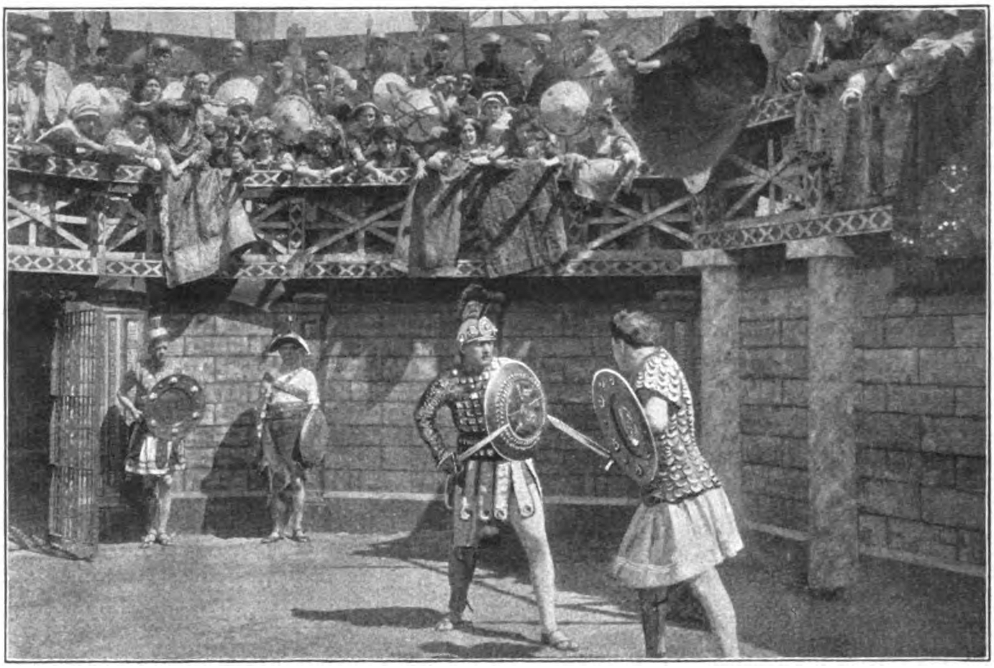
VIEW IN A ROOM WHERE MOVING PICTURE FILMS ARE FINISHED several tastes. But what a change! The man who played the part of Roman Emperor tells the waiter to hurry up with the pork roast, the court fool never cracks a smile, while a little red-headed midget of a waitress calls down the "head of the Roman army" for tipping over the cranberry sauce on a clean tablecloth. Cosmopolitan place this! Yes, tomorrow these Romans will give place to a band of gypsies, and so on.

But let us follow the players back to their work. They are producing the story of Justinian and Theodora, by Elbert and Alice Hubbard. The work is being done out of doors. In the picture Justinian, nephew of Justin I the Emperor, is fighting Rechizard, a cousin. Both are in love with Theodora, a daughter of the "Master of the Bears," or keeper of the animals in the amphitheatre and a girl of unusual talent and sterling character. But leaving the story to the reader who perhaps by this time has seen it in a picture theatre, we call attention to the number of people, 44, in this one scene. And the men and women engaged in this work are not "pick-ups," but people of recognized ability from the theatrical world commanding salaries of from $30 for small parts up to several hundred per week in the leading roles. The cost of a single scene like the one just mentioned may run into several hundred dollars and comprise only a small part of the film.

But let us continue our survey. In one portion of the grounds is a miniature lake, in a basin of concrete. Here may be produced a story of Venice where the taxicab is replaced by the gondola. A little farther away is a pen containing a number of deer and next to it are kept three camels. The stables contain several mustang ponies or



MERCURY VAPOR ARC LAMPS USED IN THE STUDIO FOR ILLUMINATING STAGE SETTINGS



REPRODUCING ON PICTURE FILMS ELBERT HUBBARD'S "JUSTINIAN AND THEODORA"

bronchos with the necessary trappings to fit out and produce a Western picture. There are also several prairie schooners such as the old "forty-niners" used in rushing to the gold fields of California. Nearby is an old stage coach, not built to look like an old timer, but the real thing. Ten field pieces for use in war scenes stand under a shed, and last but not least a modern aeroplane rounds out the accessories that an up-to-the-minute moving picture producer must have at hand. In fact, it is a by-word among the small boys and even their elders "out by Seligs" that if you have something you don't want Mr. Selig will take it and find a use for it. As the property man remarked, "It's fierce when you need something and haven't got it, for it holds up the whole works."

And this brings us to one of the most interesting parts of the plant, the property room. What cannot be found there is not worth mentioning. Everything from wearing apparel of the 14th Century to Chinese chop sticks, and even the fittings of a modern business man's office, including the telephone. All the trappings of a certain period are kept together and by a system of cataloging every thing is noted and put where it can be found when needed.

Then there is the designer who prepares the costumes for use of the actors and this apparel must be correct as to the dress of the period to be represented. History, old cuts and fashion plates are part of the designer's library for he is compelled to change the styles more often than the modern tailor and dressmaker.

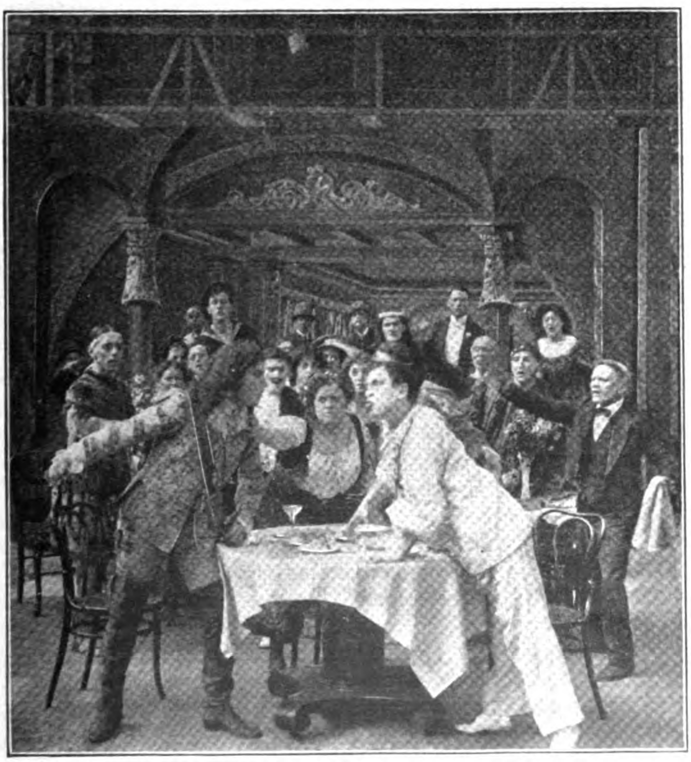
There are many things about the making of moving pictures that the millions of people who see them in the shows would like to know. How does the picture producer get the ideas, stories, scenes, etc.? Many of the producers pay for manuscripts or scenarios as they are called outlining or giving in full a motion picture play. Such producers send outlines of how they wish the material prepared for the kind of pictures they make. Some makers employ the best story writers. At present at least ten prominent writers are in the employ of Chicago manufacturers. Their work requires a skill which it is asserted is superior to that employed in the writing of stories because they have to depend to such a large extent upon the details of movement and expression in their scenes rather than on conversation. When a historical scene is to be depicted they study the literature of the day and then depict accurately scenes that will give as nearly a faithful representation as possible. Hand in hand with the writers come the directors of the pictures who are of the highest artistic ability. These men have been the producers of drama, musical comedies and other productions which require special talent. They take the work of the authors and practically dramatize it. Some of the actors in the scenes which are daily thrown on the canvas are put through many rehearsals before a satisfactory effect is produced.

The camera men also must be adepts in their special line. They must have a perfect understanding of atmospheric conditions and must know exactly the intensity of the light in which they are operating. They are supplied with instruments to determine this. The camera man is in some cases too, a traveler. His company may send him to foreign countries to get pictures of important events or maybe into the dangerous jungle to secure some rare pictures of animal life.

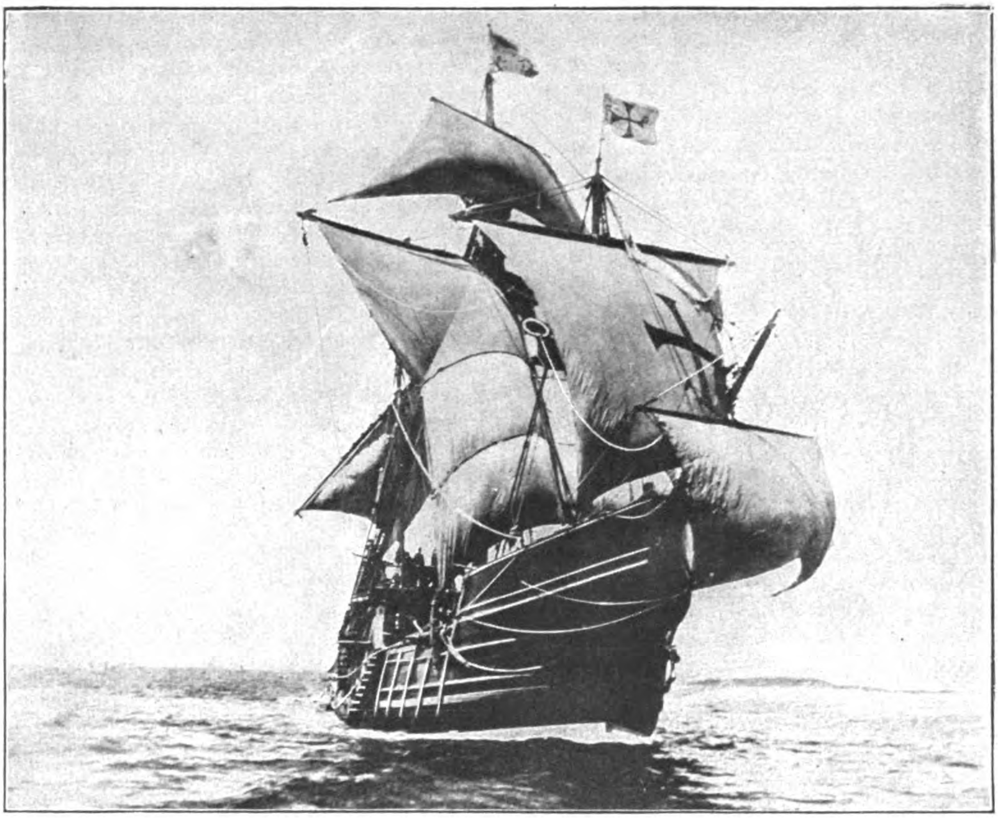
To what hazards the actors and camera men will go to produce real sensations was illustrated at a $350,000 fire on the northwest corner of Third and Broadway Streets, Los Angeles, California, during the month of February. While the blaze was at its height, Thomas Sanchis, an actor with the Polyscope Motion Picture Company, clad in regulation fireman's regalia carried Miss Bessie Hart, another member of the company, down a ladder from the third story of the building, while a moving picture machine stationed on the top of a building across the street caught upon its swiftly moving film the "heroism" of the deed.

And this story about the making of moving pictures ought not to end without something about their world-wide effect. In commenting upon their educational value a prominent minister says: "Over the door of every picture house in the country might well be the title 'The Dime Civilizer,' 'The Nickel College' or the 'Moving Picture University.'"

The decision of the Supreme Court affirming the right of the Mayor to censor the films and pictures exhibited in all theatres can not fail to gratify those of us who believe that the five-cent moving picture shows are possibilities for a great deal of good in the cummunity. These novel places of amusement have undoubtedly filled a popular need. Otherwise their marvelous increase in variety and number is inexplicable. That they are a paying venture merely confirms the fact that there is a demand for just the kind of entertainment they provide. Nor is it difficult to understand wherein the peculiar attraction of these cinematographic displays lies. They do more than fill an idle hour. But did they even do only this they would have to be given credentials as purveyors of legitimate amusement.



STAGE SETTING FOR THE FILM "HALLROOM BOYS"



ONE OF THE THREE SPANISH CARAVELS NOW IN JACKSON PARK LAGOON, CHICAGO, BROUGHT TO THIS COUNTRY FOR THE WORLD'S COLUMBIAN EXPOSITION IN 1893. THIS IS TO BE FITTED UP AND USED TO REPRODUCE "THE COMING OF COLUMBUS"

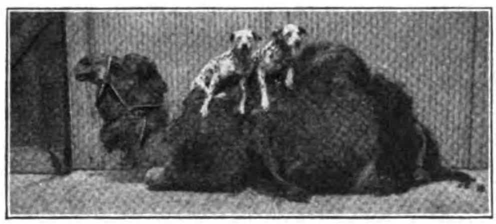
Hours unemployed are the devil's opportunity. A well known proverb has taught us to know and remember this.

Even now the discovery has been made and amply verified that the five and ten-cent theatre with its cinematographic plays is a most powerful rival of the saloon. The saloon has often been defended on the score that it is the poor man's club. There is a strong basis for the plea. But the experience of recent days in connection with the introduction of these picture theatres indicates that the best method of counteracting the attraction of the saloon as a place of recreation for the clubless is to provide amusement for them at a price which is within the reach of the ordinary patrons of the drinking resort. Saloon keepers have reported that their transient trade has fallen off in districts well supplied with these shows. They have come to stay and efforts should be made to lift their exhibits to highest planes of instruction.

The educational value of travel is recognized. As the German song has it, they to whom God desires to show favor are permitted to see his wide world. Contact with the people and races of distant lands is the most efficient antidote to national pride and arrogance. It is the counter-irritant to narrow prejudice.

The value of the new theatre as a supplement to the courses in history and geography given in the public school cannot be overestimated. It has been the ambition of modern pedagogy to make instruction vital. Textbooks are poor apologies for vital knowledge. In all well appointed schools the screen and lantern have been welcomed as powerful helpers. Yet the school hours are few and the subjects many and varied. Even the lantern slide lacks the element of interest which motion alone can supply. For this reason the moving picture show promises to be a most valuable adjunct to the school.

Tomorrow our fleet may return from a long voyage. Sicily devastated by earthquake still calls for sympathy. These and many more happenings fill the columns of the newspapers. Their descriptions convey information, but for all that they are deprived of the breath of life. The moving picture, on the other hand, invites us to cheer the pageant or to shudder at the catastrophe as though we had been standing in the very street over which the procession passed or which the disaster overturned. It supplements the account in the newspaper. It vivifies it. It brings home the essential unity of all dwellers on earth. It brings history and geography to the very door of the house in which we live.



From Out the Leyden Jar

In ten years, or since May 8, 1900, 17,000 men have been picked over to get the few less than 3,000 who make up the uniformed portion of the surface car operators in St. Louis, Mo.

* * *

About 700 electric vehicles are now in use in various cities and towns of the Pacific States. The largest number is in Los Angeles, where there are between 350 and 400 pleasure vehicles.

* * *

The torch of the Goddess of Liberty in New York harbor is being equipped with a 40,000-candlepower illumination in place of the old circle of twelve arc-lights, whose combined power, though equal to 12,000 candles, failed to give the desired radiance.

* * *

Contracts have been recently given for about eighteen miles further work on the tri-borough rapid transit subway of New York City at a cost of about $60,000,000, the section for which contracts were executed in November, 1909, being well advanced in construction. The whole subway system will aggregate 44.2 miles and will cost close to $100,000,000.

A considerable increase in the number of waterfalls utilized for industrial purposes in Sweden took place in 1910, as is shown by the fact that 21 new hydro-electric works were completed in the course of the year, representing a total of 111,280 horsepower.

* * *

The electrical conductivity of copper iodide, like that of selenium, is sensitive to light, being increased gradually by exposure. Blue light is much more effective than red. With short exposures, the effect is proportional to the intensity of illumination, but this is not true for long exposures. The effect is greater in specimens having high resistance. High temperature is favorable to the action when the exposure is short.

* * *

Dry-cleaning establishments, where gasoline, naphtha, benzine or other volatile oils are used to clean clothing or other fabrics, are regulated in Chicago by a recently adopted ordinance. One provision of the law requires that every building used for a dry-cleaning plant shall be lighted by incandescent lamps having keyless sockets and protected by vapor-tight outer globes. No open light or flame of any kind is allowed.

A Personal Appreciation of Thomas A. Edison

By JOSEPH E. HINDS

Two venerable Grand Army men sat on a bench in Tournament Park at Pasadena, California, on the second day of January of this year, watching the flower-bedecked floats of the gorgeous pageant of the Tournament of Roses pass in review, when one said to the other:

"Where are you from?"

"I'm from Ohio."

"Is that so? So am I; what part?"

"Milan; I drove the coach between Sandusky and Milan 50 to 60 years ago; many a time I've whipped the youngsters off the back step going up the hill, and one of the worst among them was young Tom Edison. He was a troublesome boy then, but he has got to be some man now, I can tell you."

The name of Edison interested me at once and I ventured to ask:

"What is your name, please? I am an old friend of Mr. Edison."

"My name is Rice and Tom will remember me if you tell him what I have just said."

EDISON WHEN A YOUNG MAN

And "Tom" will, I am sure, for he never forgets anything or anybody.

When I first met Thomas A. Edison, in the fall of 1880, he was a healthy, vigorous, active man, full of tireless energy and indomitable purpose. When I met him again, in the summer of 1910, 30 years later, he was a healthy, vigorous, active man, full of tireless energy and indomitable purpose. This is not mere tautology but is a statement of fact. Aside from the whitened hair and his one physical defect, his hearing, there is no outward appearance of any change; his senses are still as acute, his movements as lithe and active, his ambitions and his interest in life are still as keen as when he was on the sunny side of 30. I asked him how he had maintained his vitality and energy so well while so many men who have done nothing in comparison with what he has accomplished have broken down, mentally and physically, from overwork. After a moment's reflection he gave his views on the subject. Every young woman would do well to work this into a "motto" and send it to brother or some young friend to hang on the wall of his college room or wherever it may always be within his range or vision, for it is as strong and forceful a sermon as was ever preached to young men. He said:

"Well, I don't drink; I don't eat much; I get plenty of sleep; and I don't worry."

Now, "plenty of sleep," from his point of view, may mean an hour's nap in his chair or two or three hours on the little cot bed which stands in one of the alcoves of his great library in the works at Orange, and this at any interval of time and at any hour of the day or night. How he does it nobody knows, but he has tired out everyone who has ever been associated with him. "Brain-fag" seems to have been forgotten when the elements that form his personality were put together.

Accompanied by a mutual friend I went out to Orange one day last summer to call on Edison. Entering the library we found him seated at a table with two other men who were apparently at odds over some problem and had come to him for a solution. There was a look of profound study and concentration on his face and he seemed lost to everything but the matter under consideration, but on his attention being called to our presence he arose from the table and came over smiling. My companion said:

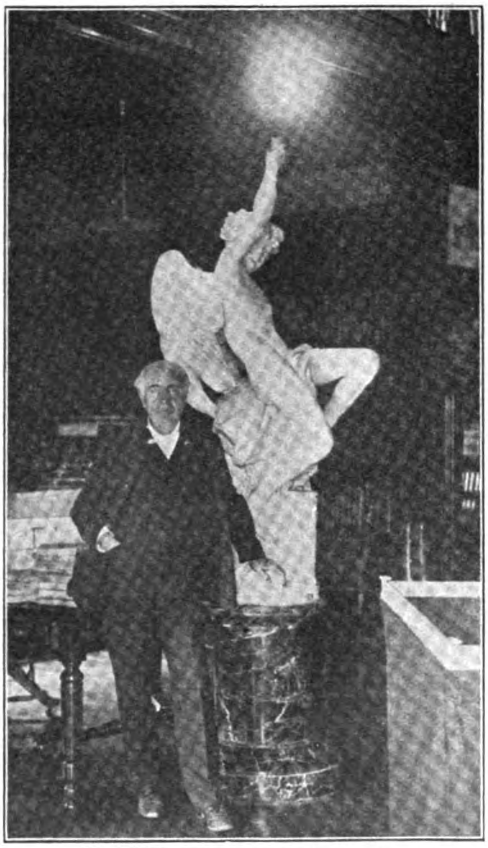
"Here is an old friend come to see you; do you recognize him?"

He looked at me intently for a moment, then reached out his hand, called me by name and greeted me with the greatest cordiality. I had not spoken to him or had any communication with him in 25 years, yet his recognition was instantaneous.

"The passage of time has not troubled you much," I said, jocularly. "You are as young and handsome as ever you were."

Then a change came over the man. The mature, serious minded man, the great scientist and philosopher, the "wizard," whose name is known to almost every civilized man and woman on earth, seemed to disappear and in his place stood an awkward country boy, with a winning smile on his lips and a merry twinkle in his eye. Placing the tips of his right hand fingers over his heart, he ducked his head, scraped his foot along the floor, as though he was about to recite "Casabianca," and said, with an air of mock gravity:

"Oh, sir; you flatter me."



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RECENT PICTURE OF MR. EDISON IN HIS LIBRARY

I think the real secret of Edison's vitality is his intense optimism, his never-failing store of good nature and his infinite patience. It does not seem to disturb him to be called from a search of the infinite or a study of the abstruse to listen to the latest funny story, and his hearty, wholesome laugh is worth going miles to hear. His dominating characteristic is the intensely practical view he takes of everything. While driving through Yellowstone Park two years ago I caught a passing glimpse of him but had no opportunity to speak to him. When I saw him later I asked him what he thought of the wonders of the Park and the great geysers; he said, with what seemed to be a blush of apology:

"Isn't it wonderful? My family enjoyed the sights, but I kept busy figuring out how I could utilize all that power that is going to waste."

Has he any fads or longings for recreation apart from his work? I do not know. Nearly every man has some yearning for a few days of hunting, fishing, golf, riding, tramping or something to relieve the tedium of continuous work and to offset the monotony of the "everlasting, demnition grind," but with him a change of occupation seems to mean recreation. Returning from a pleasure trip some time ago he was asked how he had liked the country he had visited. He answered: "I guess it was very nice, but I didn't pay much attention to it. You know that new phonograph hasn't suited me at all. Well, I got it all figured out while I was away and it is all right now."

Probably the only person in the world who does not consider Edison a most original genius and very much out of the ordinary is the man himself. Here is a good illustration of the point. Seated one night in his library, enjoying a quiet smoke with a few friends, he said: "People insist upon calling me an inventor, but I am not an inventor. I can take an idea and pound and hammer at it day and night until I prove it either a success or a failure, that is all."

Along about 1884, Edison, who was then a widower, moved his thousands of models and instruments from Menlo Park to a great loft on the east side of New York City. Here I called on him and found that he was enjoying some sort of vacation or rest after several years of close application and ceaseless labor. He wore a long linen "duster" that reached the floor; it was loosely cut, but he seemed very proud of it and walked up and down before us several times showing it off like a dressmaker's model, saying: "What do you think of my new coat? My little daughter made it; yes, made it all with her own hands."

"What are you up to nowadays?" I asked. "What are you doing?"

"Nothing much," he replied. "But see what you think of this."

He took me to an odd-looking telephone instrument on the wall and said:

"You know I don't hear very well and an ordinary telephone is not of much use to me. Now turn this little crank slowly at first, then increase the speed and watch the result." Then, speaking into the instrument, he said:

"Billy, here's a man wants to hear you sing."

Turning the crank slowly I heard a tenor voice singing, "Way Down Upon the Suwanee River." Increasing the speed the voice grew louder, until it could be heard all over the great room. Then I asked "Billy": "Where are you?" thinking that he was in the opposite corner or on the floor below. He answered:

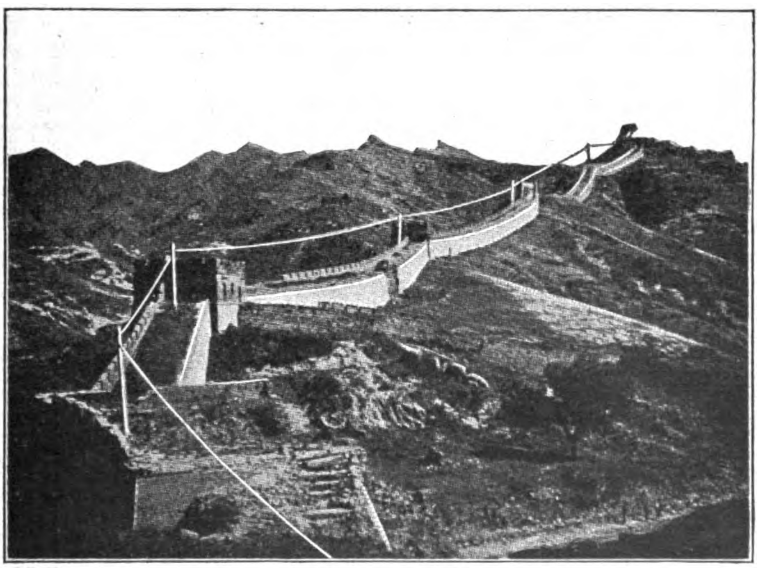
"I'm in the Old South Church, on Washington Street, Boston."

This would surprise no one at the present time, but when I heard the statement you could have knocked me down with a feather, as we used to say in the old times.

The electric lighting proposition prior to 1880 did not seem a very promising one to a layman. About the first results had been shown at the Centennial Exposition at Philadelphia in 1876, and the flaring arc lights were afterwards used in open spaces and large halls, but the light was so intense and the shadows so black that the effect was far from satisfactory. Then Edison took up the problem of the subdivision of the electric current and the incandescent lamp, something that would take the place of the ordinary gas burner for local use. There were many imitators and followers who were all left behind in the race, and while failure was predicted almost everywhere and a certain high authority in England "pledged a reputation hitherto formidable to the assertion that the successful subdivision of the electric current, so as to effect a popular revolution in the lighting of houses and factories, was a mere chimera and that efforts in that direction were doomed to final, necessary and ignominious failure," Edison was a Yankee and from Ohio, and so he "simply went ahead and did it."

If, as the result of his life's work, he had given us nothing but the electric light, his name would go down into history as one of the greatest benefactors of the race, but he has enriched every field to which he has turned his many-sided mind. When the incandescent light first made its appearance there were few people who believed that it would ever come into general use or become a rival of gas or oil as an illuminant, but that it would always remain the rich man's luxury. Today, in some places, the generation of the current is so inexpensive that it is the cheapest artificial light ever known, and is within the reach of everyone. On the Pacific coast, in some localities, the "juice" is sold as low as two and three-fourth cents per kilowatt hour to ordinary consumers, and it is stated that under favorable conditions current can be and is produced and sold at one-half cent per kilowatt hour. When it is remembered that electric current at four cents per kilowatt hour is about equal to gas at $1.00 per thousand a comparison can be easily made. As to the universality of the light; an Arctic explorer says that the dreary waiting through the long night was made endurable by the presence of electric lights in the shelter hut on the shore, fed from the ship frozen in the sea nearly a mile away, and that when the connection was broken by the shifting ice it seemed that the very light of life had gone out for them. The falls of the Amazon, of the Congo, of the Yukon, the waste waters of the earth everywhere are generating the energy that shall carry out the orders of the man who said only 30 years ago: "Let there be (electric) light."

As we were leaving the works in the early evening of the day of my visit we stepped into the library to say good-bye, perhaps for the last time, to the great man who had honored me with the appellation, "My old friend," as I was soon leaving for my far-away Western home. The room was deserted, save for the presence of one man, who was writing by a window, in the gathering dusk. The day workmen had departed and the night shift was coming in. We asked for Mr. Edison, but the secretary shook his head and pointed to the upper galleries. We understood his meaning; the master mind of the centuries had retired for study and contemplation and must not be disturbed. I left with regret but filled with speculation as to what that portentious hour might mean for generations yet to come.



THE OLD AND THE NEW

In the last decade a new China has been born. The oldest of the world's peoples is now the infant, as measured by the standards of modern achievement. Everywhere there are evidences of the great awakening. What, for instance, could be more significant of this movement than the great wall of China topped by a modern telegraph line. Yet there it stands, this wonder of the world, each stone a monument to bleeding slavery in ages past; and on its crest a wire of iron pulsating with a new message to an old world.

Electric Block Signaling

By SIMON DEUTSCH

PART VI

Until within the last seven or eight years, single track lines, with one or two exceptions, made but little use of automatic block signals, because of the complications peculiar to properly safeguarding trains operating on single track. Whereas it is necessary to protect only against rear-end collisions on double track, it is necessary to protect against both rear-end and head-on collisions on single track, which requires the

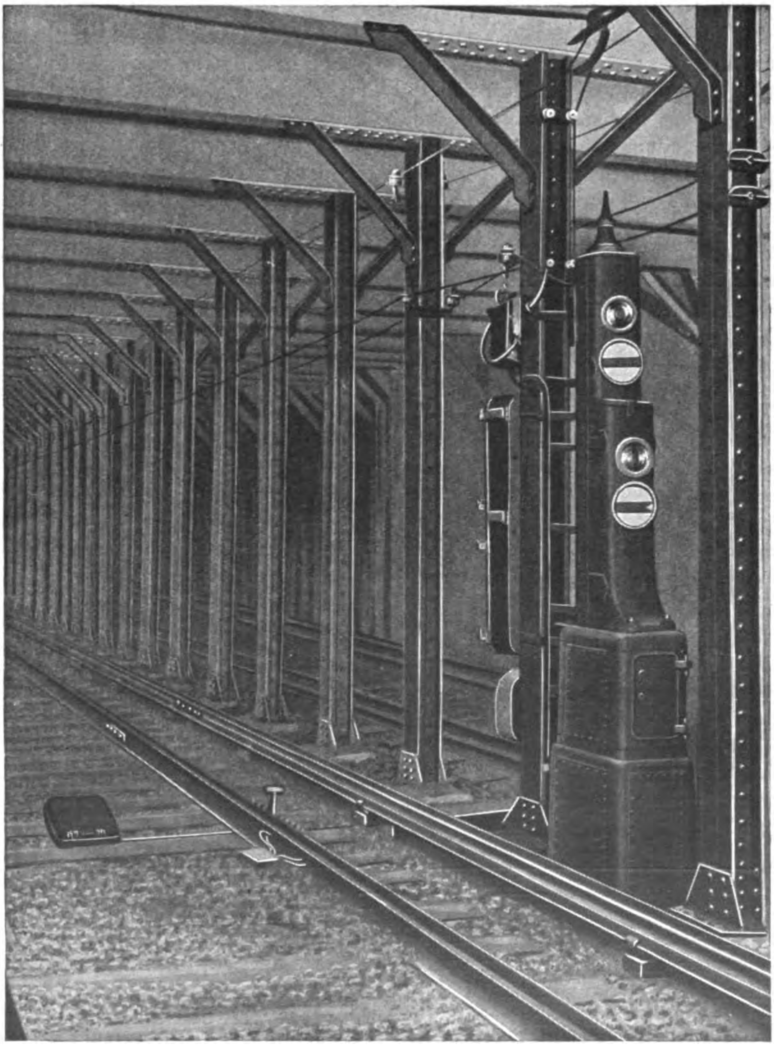


FIG. 22. ELECTRO-PNEUMATIC SIGNAL IN NEW YORK SUBWAY

extension of controlling circuits so that each of the trains approaching the other can set signals to "Stop," far enough in advance, to insure both trains receiving the "Stop" indication before meeting.

Finding a signal at "Stop," a train operating on double track waits at the signal for a short period of time, as prescribed by the operating rules, and then slowly proceeds under control, although the signal still shows "Stop." Under like conditions on single track, one flagman is sent ahead and another one to the rear, to flag any approaching or following train. The train then very slowly follows the flagman until it has passed beyond the danger zone. In spite of the fact that considerable delay is thus caused, and that other difficulties

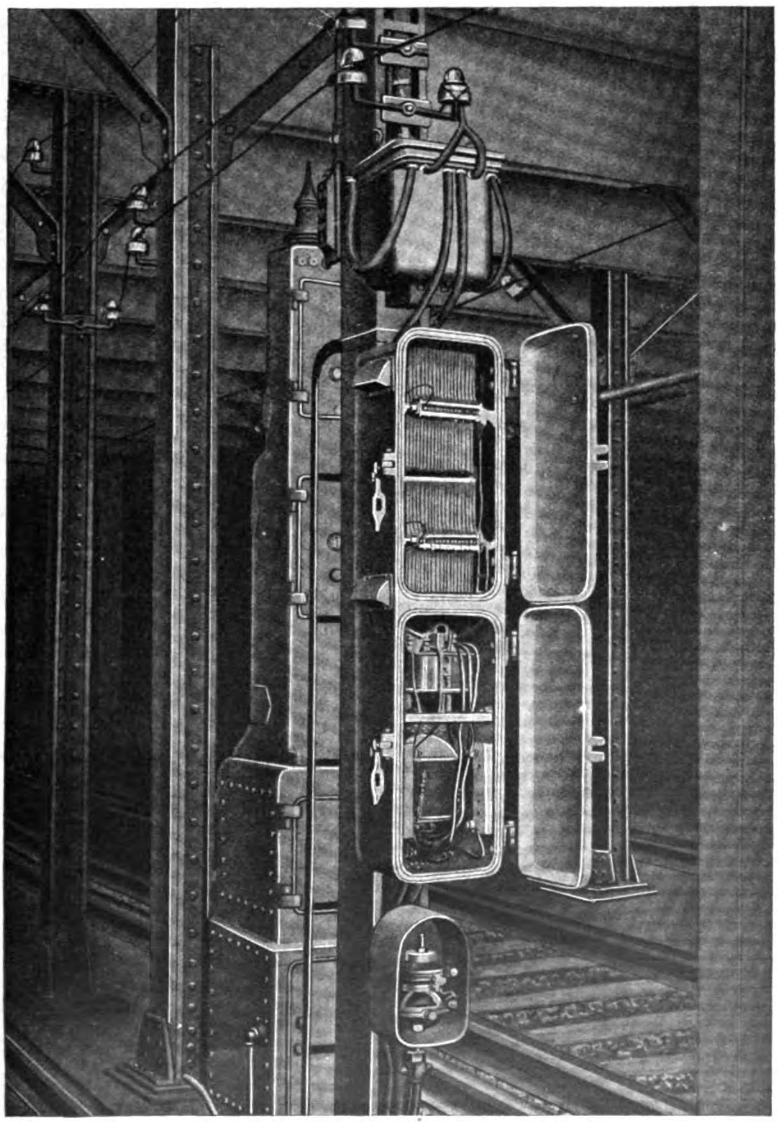


FIG. 23. REAR VIEW OF SUBWAY SIGNAL EQUIPMENT

must be overcome, the amount of signal installations on single track has been surprisingly large within the last few years.

Automatic signals reach a stage of highest perfection in such installations as those in the New York subway, where automatic stops are provided to guard against carelessness, and physical or mental disability on the part of the train crew.

Not being exposed to the elements, an installation of apparatus of this kind in a tunnel is ideal, but used on surface lines would enormously increase the cost of maintenance and cause an appreciable reduction in traffic capacity, for which reason the automatic stop has not as yet been adopted except for special conditions.

It has no doubt been noted that steam railroad conditions make possible the installation of track circuits in a comparatively simple manner. Both rails being mounted on wooden ties and thus insulated from each other simplifies the application of a low voltage track circuit.

On electric roads this becomes more complicated, due to the fact that the rails are generally electrically joined together, and used as a return for the power circuit. Further, when the track rails have the additional duty of conducting current for propulsion purposes, the enormous demands thrown on certain sections of the road at times, will so disturb normal conditions as to make impractical most forms of direct current track circuits.

It therefore is necessary to have the track circuit on electric roads of such characteristics as to be practical and reliable under these conditions. Alternating current possesses the required characteristics and is used with success on electric roads, of which the New York subway is one. The track relays used for controlling the signal circuits are of such construction as to respond to alternating current only, of proper voltage, phase and frequency.

The small amount of space available in the subway does not permit the ordinary type of semaphore blade signals to be used and therefore colored glasses mounted in slides are used. These glasses are moved

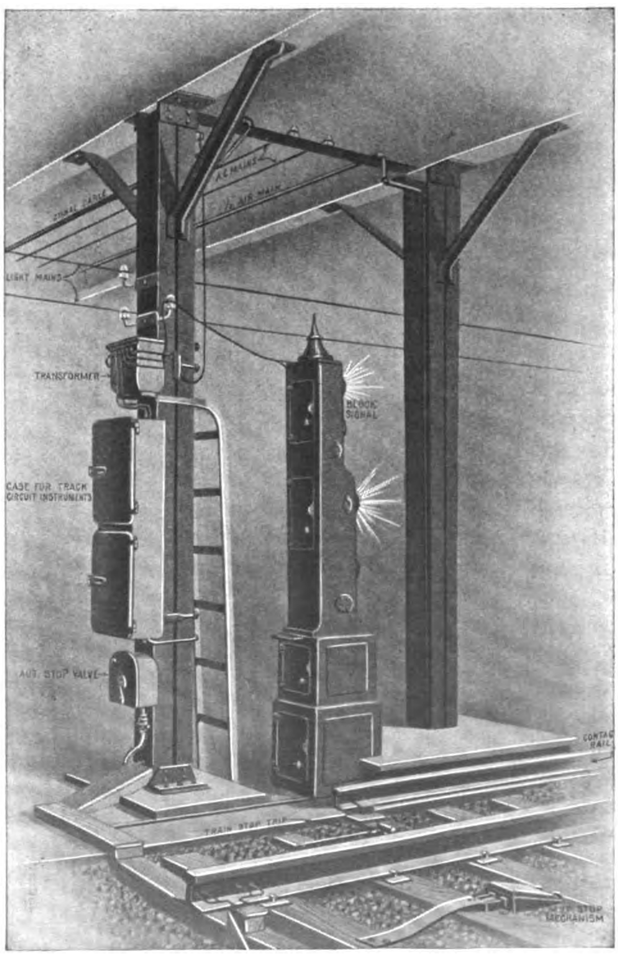


FIG. 24. SIGNALS AT "CLEAR." AUTOMATIC STOP IN CORRESPONDING NON-INTERFERING POSITION

in front of or away from incandescent lamps by compressed air, all of the signals, automatic train stops and interlocking being of the electro-pneumatic type; that is, air is used as the moving force, and electricity for the control of same, through electro-magnetically operated valves. Red is used as "Danger," yellow as "Caution," and green as "Clear." Below each light signal in the same case, are miniature semaphore arm signals as shown by Fig. 22, all signals here showing "Danger" and the automatic stop being in proper position to set the air brakes of any train disregarding its signal. Fig. 23 shows a rear view of the signal equipment, with case holding the resistance grids, relay, electric valve for stop, etc., open. Fig. 24 shows a similar view with the cases closed, signals at "Clear" and the automatic stop in a corresponding non-interfering position.

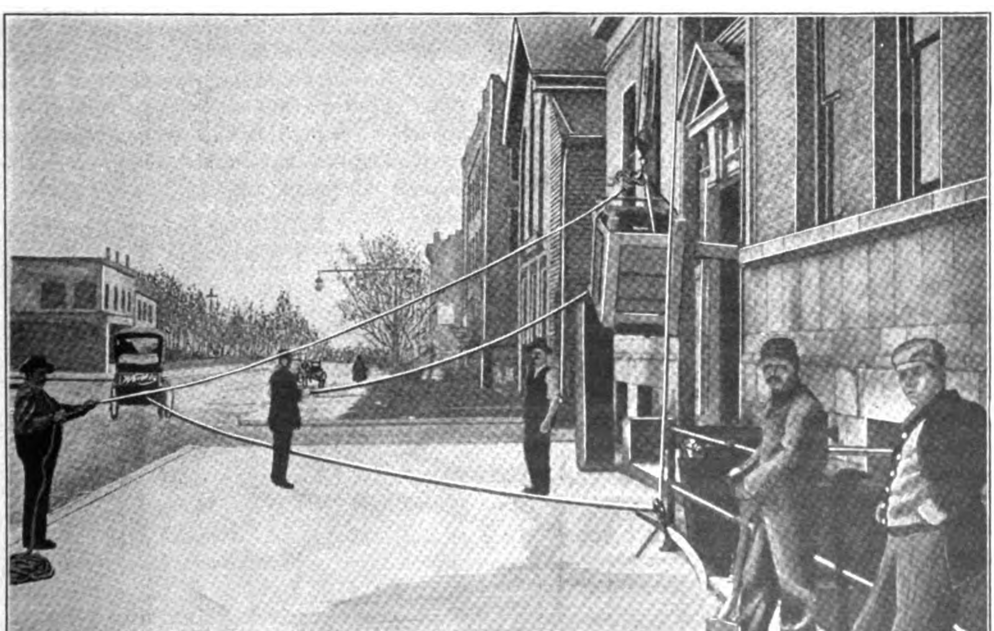
Block signaling, however, in itself is not complete or satisfactory without interlocking. Although even incomplete signaling has proved highly profitable, the need of overcoming the dangers due to fog and imperfect hand signaling in switching yards or at large terminals, the expense of keeping switchmen at detached switches, the making of unnecessary stops at grade crossings all tended to create a sentiment among railroad officials favorable to the development of hand and power interlocking.

In the next and last article of this series, the author will give a brief outline of the history and development of interlocking, the important position it holds in the field of railroad signaling, and the manner in which automatic block signals and interlocking go hand in hand towards the safeguarding of the traveling public.

(To be Concluded.)

Hoisting With an Electric Wagon

A certain hardware concern in Indianapolis has occasion at times to hoist safes, ranges, castings, etc., to the upper floors of tall buildings. For delivery they use a Waverly electric wagon which they soon learned to put to another use. Instead of waiting for the slow process of hoisting by a hand windlass the car is attached to a long rope leading from the block and tackle. When the power is applied the car moves rapidly down the street, hoisting the weight as rapidly as the car moves to the proper floor. The picture shows the car hoisting a 500-pound casting.



HOISTING WITH AN ELECTRIC WAGON

Did you ever have your word hotly disputed when you were absolutely sure that you were right, but knew you couldn't prove it at the time? For several years I served as wireless telegraph operator on a number of ocean steamers, and I am going to relate to you a few incidents where I handled mysterious and unsatisfactory messages—and got the blame therefor.

On such trips, and indeed on any American vessel where the apparatus is American and the operator an American, the wireless room is the "hang out" for nearly everybody. They come up to see the wireless work, to chat with the wireless operator and be sociable. One of the operator's duties is to entertain his callers. It is demanded of him that he be courteous to one and all. Some people he is glad to see. Others are not so welcome.

On one cruise with 350 passengers I figured roughly that each one asked the wireless man ten questions a day—3,500 times 31 equals 108,500, the number of questions I answered, not impolitely, in a month.

The wireless man is nearly always the most popular man aboard the ship. His position makes him so, and if his personality is genial he can maintain his popularity. He has "inside information" and "outside information." He knows what is going on ashore and what is going on aboard the ship. He is the editor of the ship's newspaper. By his versatility in the columns, he can make the entire ship's company happy or gloomy.

The Haughty Beauty and the Mysterious Message

Once on a large tourist steamer, returning from a month's cruise in the tropics there were some 350 passengers who had been enjoying themselves in the southern balmy climes while at home their kin struggled to keep warm. Among these jolly people was a very pretty young lady, but haughty. Her mother had less beauty, but more haughtiness. If they were having a good time they didn't tell anybody about it. On the passenger list they appeared as "Mrs. J. Paul Jennings and daughter."

The ship was due in New York the next day, when through the air from Manhattan Beach Station, 235 miles away, came a message addressed thus:

"No. 3 DF FG BO 13 paid and paid,
Worcester, Mass........
To Jennings
S. S. ***.......... at sea.
"Will meet you Kiss you Hug you at the dock in the morning.
615 p. m. (no sig)."

Naturally I supposed the message to be for Miss Jennings. I handed her the message. She receipted with a smileless "thanks."

Returning to the wireless room a few minutes later, I discovered Miss Jennings, reinforced with another of the gentle sex, awaiting my arrival. She was puzzled. She didn't believe the message, and was for the moment undecided whether to be just mildly indignant or plumb mad. For a starter she must have concluded to be merely vexed. She very formally requested me to kindly interpret the message. Where was the signature? I took it and read it over, and gravely told her that I reckoned it meant she was going to be met, kissed and hugged at the dock in the morning. That was what I would infer from the text. She blushed, and I could tell that she was getting indignant. Just mildly so. Again she wished to know who sent the message. I was beginning to tell her that he must have forgotten to sign his name, that messages frequently came that way, when her auxiliary crashed in and said that she and Miss Jennings believed that I was playing a trick on them. That if such was the case they demanded to know by what right I ever presumed to do such a thing? What proof had they that the message was bona fide?


Her Auxiliary Crashed In

Then I added, "We shall see in the morning." Whereupon Miss Jennings became real mad. I handed her my card saying that when she discovered that I was right, she could telegraph her apology. She tore the card in two, tossed it on the floor, assuring me that I would hear from her later, but I never have. I didn't even get to see the "dock" scene.

Now the point is: How easy it would have been to obtain proof if the lady had had some knowledge of wireless telegraphy.

Wireless Wins Against Appearances

Once, returning from Porto Rico, and being only two days out of New York, we received a wireless storm warning, assuring all vessels of a northwester of extraordinary severity. We were then about 200 miles off the coast of North Carolina, in Cape Hatteras territory, and, strange to say, the sea was smooth, the moon and stars shone brightly, and gentle southern breezes were blowing.

It was incredible to believe that a few hundred miles north of us raged a storm. The warning I had received from Cape Henry, Va. Captain took it and studied it, glanced out at the elements, shook his head and said, "Wireless, there must be some mistake here. Of course I don't doubt you, but it's impossible for us to have this weather and there be a storm this side of New York and we not feel it."

I went back to the wireless room, wondering too how it were possible. Presently I copied the same warning from Brooklyn Navy Yard. Then I ran up and gave it to the captain, who took it, and asked me where I got it.

To make a long story short, we passed the night without any signs of a storm, and next morning. the captain came up and said: "Wireless, I guess that storm theory has passed." He sat down while I answered a ship I heard calling various other ships. This ship was south bound and had left New York the day before. He was anxious to talk with a north bound ship so as to make arrangements to transfer his pilot, who had been unable to leave the ship the night before. on account of the severe storm. I answered him at nine a. m. and his captain and mine chatted awhile and figured out that by changing each course they would meet around two p. m. and we would take the pilot. We only had a few passengers and the word soon got to them that we were to meet this ship around two p. m. and they displayed great interest in the proceedings. They watched the horizon faithfully, and at two o'clock when the ship failed to show up they came around to see me, and some unbelievers wanted to know where that ship was. I was afraid that the ship would pass under the horizon and out of sight. But about two-thirty she showed up, and I shot over a quick message for them to go to our windward, which they did, and lowered their boat and brought over the pilot, who was mighty glad to get with us, instead of fetching up in the West Indies. He told us that one pilot was drowned the night before near Sandy Hook during the gale.


Watched the Horizon Faithfully

Growing Rubber in Mexico

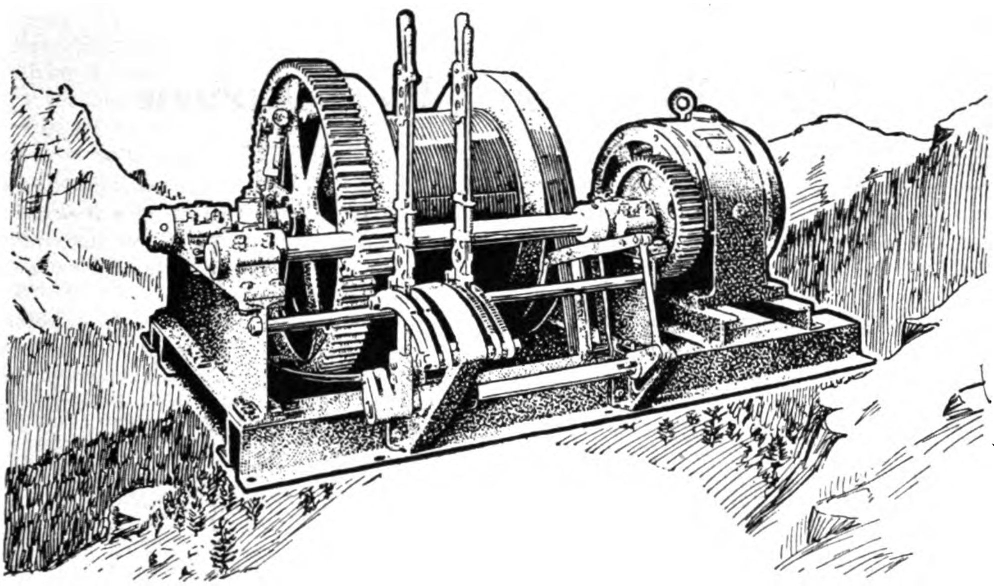
Among the foreign interests which may excuse, if not justify, the intervention of other governments in the turmoils of Mexico, are those of the rubber plantations. For, while a variety of rubber tree (the Castilloa Elastica) is native to tropical Mexico and has been utilized there for some decades, the tapping of such trees by the natives has been done in crude ways and with a recklessness which too often killed the most promising trees. Here, as in all lines of plant or tree raising, it takes a careful and systematic rearing and treating of the plants to make them steadily productive.

Considerable outside capital has gone into rubber plantations in southern Mexico where the native variety responds readily to systematic cultivation, reaching a surprising height even in the first two or three years. With the sixth or seventh year the tapping begins and is done by natives carefully instructed and watched so that they will not overdo the slashing and thereby injure the trees. When cared for in this way, trees only eight or ten years old are said to average a yield of enough sap every three months to make about two ounces of dry rubber, worth about 10 cents an ounce. The output gradually increases to six or eight times this amount as the tree ages.

Much of the recent impulse given to the raising of rubber on this continent has come from the automobile industry, but this had been preceded by the demands of electrical manufacturers who have been using rubber in steadily increasing amounts for insulating wires and cables. No really adequate substitute for rubber has yet been brought out and if the troubles in Mexico should result in opening more of the suitable lands to the cultivation of rubber trees, the prices of insulations a decade hence may be considerably influenced by the Mexican turmoil of 1911.

INSPECTOR ON HIS ROUNDS

THE RUBBER HARVEST



Crawling Cables

When the old cable cars that used to go lumbering along some of Chicago's best streets were done away with, it was decided to take advantage of the so-called cable slot for laying the new electric power cables. Clay conduit was placed in the trench and the cables drawn through from manhole to manhole.

Then there was a delay of some months before the power was ready to be transmitted. When at last the workmen opened the manhole at one end of the line the end of the cable was nowhere to be seen. The foreman who had charge of laying the cables was called in. He asserted that he had drawn the cable through the clay conduit.

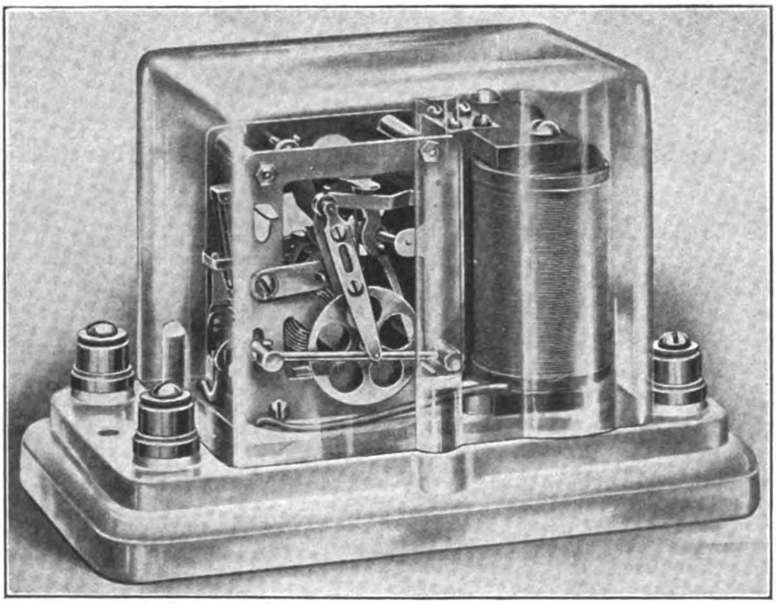
The party proceeded to the next manhole. Here several feet of cable was found. The cable had "crawled" in the direction in which the cars overhead were moving. It was promptly pulled back into place and connected at the manholes. To insure against further crawling an iron anchor was clamped to the cable in each manhole. But so great was the wave motion in the ground from the passage of the cars above that the lead casing was stripped from the cable at the anchor grip and other means had to be provided before the cable ceased indulging its crawling proclivities.

Mule Back Motor Transporting

While the advantages of electric power are being more and more appreciated by mine operators, the difficulties of getting the machinery to the rather inaccessible locations are often hard to overcome. Particularly is this true with direct-connected pieces of apparatus, which for most purposes are made with a single massive casting for the frame work. To meet such conditions, a Denver firm is now building electric mine hoists with a frame built up of steel parts which can be taken up the mountain-trails piece by piece. In this way the whole machine can be transported on pack mules.

Train Dispatching By Telephone

We are prone to think of the train dispatcher as a man of remarkable memory and wonderful eo-ordination of wits and nimble fingers who sits in the midst of his web like a spider and flashes the Morse code signals out to his subordinates over a maze of telegraph wires. Without detracting one whit from the admiration which is due the train dispatcher, it is well to remember that all train dispatching is not done nowadays by means of dots and dashes sent out over a telegraph line. A revolutionary development has been under way in railway operation, during the last five years; namely, the substitution of the telephone for the telegraph. This development has been made possible by the perfecting of one little electrical device called a selector.



THE SELECTOR

The selector is the one device by which the electric circuit of any one of a number of audible or visible signals or other electromechanical devices associated with a telegraph, telephone or other electric line may be controlled from a distant point, without affecting any of the other devices associated with the same line. This is the apparatus under which over 35,000 miles of railway are now being operated.

Primarily a telegraph device, the selector, began to attract attention in the early days of the telephone. In the days when the aggravating party line, with its four to twelve subscribers on a single pair of wires, was more common in large cities than it is now, the selector was intended to secure individual or discriminating calling. But this rich field was soon restricted when single party lines became standard practice among the telephone companies. So application of the selector along with the telephone, was diverted to a field where the telegraph had been supreme since 1850.

From the beginning of the use of the telegraph for train dispatching, it has been recognized that one of its greatest weaknesses and limitations lay in the means of signaling the operator at the point with which communication was desired. The call by the Morse sounder must of necessity be repeated until the office called is raised. Moreover, this call is heard in every office in the circuit and while calling is in progress no other business can be transacted over the line. The bell signal was recognized as the most economical and satisfactory method of calling, but it was not thought feasible to ring a bell at the desired office without producing the same action at all the offices on the same circuit.

Now, with the advent of the little selector, the selective calling system applied to the telegraph gives a distinctive, individual and insistent call at the desired station, has no operative effect at any other station in the circuit and provides for a continuous call, while clearing the line for other business.

There are in the market several patterns of selectors. They may be broadly classified as mechanical and electro-mechanical selectors. All are designed to serve the same purpose, but they vary in electrical and mechanical principles, in details of construction and in efficiency of service.

That selected for description, the Gill, is an electro-mechanical device. It may be carried in the top of a silk hat. As shown in one of the cuts, the mechanism is mounted on a porcelain base and enclosed by a transparent glass cover hermetically sealed. Its essential features are a combination wheel and a time wheel, suitably governed by a magnet, levers and detents. As a combination lock will open only to its own key or knob setting, so the selector can be operated only by electrical impulses of the predetermined number and sequence. The combination wheel differs in its teeth cutting in every selector in a circuit, and while a calling impulse sent over the line actuates every selector, yet it will not go to the *contact position* and operate to call an office, unless the individual combination of that particular selector is made.

In other words, the function of the selector is to discriminate and select from among the calls going over the circuit those apply-

THE FIRST TELEPHONE TRAIN DISPATCHER

ing to its particular station, to turn over the work of calling the operator or agent to a bell which may be rung by the main line current or by the local battery and thus to secure an answer back to the dispatcher, calling, giving assurance that his call has been received. But a single call is necessary with the selector system and the signal bell may be arranged to ring continuously.

So much for selective calling which is the important function of the selector. Now let us see how it works in conjunction with the telephone. In September, 1907, the New York Central road installed and put in service between Albany and Fonda, N. Y. the first telephone train dispatching circuit equipped for selective calling. The selector used was that shown in the first illustration. The second picture is of historical interest as it shows the first installation for selective telephone train dispatching ever made.

The physical difference between the telephone and the telegraph systems are the use of two copper wires in place of one iron wire and telephone and selective calling apparatus in place of telegraphic apparatus. The operating differences are that orders are transmitted by speech instead of by Morse code and the stations are called selectively and distinctly instead of by telegraphic-sounder. The orders are issued orally by the dispatcher to the operator or operators word by word, in some cases words and figures being spelled letter by letter in order to insure accuracy. The dispatcher writes the order in his book as he dictates it to the operators, thus regulating the speed to such a rate as to enable the order to be readily copied by the operators. The same form of order is used as heretofore and operators receiving the orders repeat them to the dispatcher for checking, as under telegraph dispatching.

The sending of the proper combination of electrical impulses by the dispatcher for actuating the selector of any particular station may be made by a telegraph key, but is preferably accomplished by an individual calling key, consisting of a simple train of gears operating a circuit-breaker somewhat similar to the familiar district messenger call box. The keys make the call with absolute regularity, in a maximum of eight seconds for the longest call used. The dispatcher through his receiver can hear the bell ring at the station called or in telegraph service receives an answer back, repeating the number of the station called and thus signifying that the call has been received.

In addition to telephoning and operating the selectors over a telephone line, a through telegraph circuit may be obtained over the same wires without interfering with either the telephone conversation or the operation of the selector. In other words, during a telephone conversation the bell at another station may be rung and a telegraph message be sent between the terminal stations, all occurring simultaneously and without interference with any of the three kinds of service.

Telephone train dispatching provides a means of utilizing in the railroad service the knowledge and training of employees who may have become incapacitated for continued service in train operation, but who are still able to operate a telephone.

Coasting on Electric Cars

The word "coasting" reminds most people of a long hill covered with snow, and the bright red sled they got for Christmas about the time they were ten years old. If you told them that motormen on street cars are taught very carefully how to coast, they would think you were joking, and if you further told them that automatic instruments watch the motorman to see how much coasting he is doing, they would probably smile and tell you to inform Sweeney of the fact.

When a street car is coasting it is not using any power. Power costs money. The more coasting a car does, the cheaper it can be run. By knowing just when to shut off the "juice" a motorman can cover the most possible distance with the least possible power. If he shuts off too soon, he has to speed the car up again, and it takes more power to accelerate a car than it does to keep it going. If he shuts off too late, he must use the brakes, and that, too, takes power. Of course he must not coast so much that the car falls behind its schedule.

The automatic instrument that is placed on the car is called an ampere-hour meter. It records the amount of current entering the motors in ampere-hours. That is, if a current of 20 amperes flows into the motors for one hour, or a current of 40 amperes for half an hour, the instrument records 20 ampere-hours.

As the Lightning Speaks

By XENO W. PUTNAM

"Two points to larboard."

The Cyclone shook her stout sides like a dripping hog, then shoved her nose spitefully into the next sea ahead before she lifted.

Templeton, the wireless operator, pressed his face against the glass and tried to peer through the spray into the blackness beyond.

"What is the old man thinking of, anyway, driving that little girl of his into the teeth of a gale like this? She'll marry the man she has chosen in the end—if the Presco's ribs are as stout as her young commander's nerve."

"Look at that!"

"That" was only a mountain among foothills; a discarded relic of the storm. It made the Cyclone stagger, though, when it struck her aslant and heeled her half upon her side before the man at the wheel brought her back to her job again; then the laboring screws raced like a pair of released schoolboys as she presently slid over the crest and turned them heavenward.

Again the impatient call rang out, "Two points to larboard." The Cyclone was evidently drifting into the shore current and falling away from her course towards the rocks. The oil-cloaked figure muttered as the helm was shifted and they raced ahead in chase of the recreant lovers.

"Before I'd do that—" continued the operator, eyeing the figure on the bridge in grim disapproval, "I'd sure give them—ah!"

There was a warning quiver in the receptor and Templeton's interest was centered upon his work. Some one, from out those miles of raging waters and darkness, was calling the Cyclone. In an instant his fingers became hammers, throwing sparks into the night.

"Cyclone! Cyclone!" came the call in frantic haste again. "Call Cyclone!"

"How do they know that the Cyclone is out here," grumbled the operator, nursing his key, "unless it's the Presco calling, and if it is, they're trying to trick us. I'll fool them a little on who has picked them up."

"Who are you; what is wanted?" he called back.

"Cyclone! Answer, Cyclone!" kept coming out of the darkness.

"Confound you, answer yourself," roared Templeton's spark, in a burst of rage. "Who are you, or shut up?"

A smashing blow from the sea against the Cyclone's sturdy ribs keeled her far over and threw the operator sprawling against the opposite wall, in the midst of the sputtering answer; but he gathered himself up promptly and swung into his place in time to catch:

"Tell Cyclone to steer clear of Devil's Light. The lantern is down. Find Cyclone. Keep her away."

"Aha! So that's the game they are trying to work, and give us the slip in the storm. If the old man knew the trick he'd be wanting to send them a round robin from the gun-deck—and serve them right." Then he flashed out.

"Why don't *you* find her, idiot, and tell her yourself?"

"I tell you we've struck," came back to him. "We are hard on the reef and hardly good for a half hour. We are going to pieces now and can't last long. Have been calling Cyclone to warn her but haven't picked her up yet. Find her and warn her back."

A wave of sudden uncertainty swept over Templeton. "Who are you, anyway?" he called.

"The Presco. Commanding officer, Proctor; destination, the ocean bottom, now. Devil's Light was out. We struck here half an hour ago. Water is boiling through these reefs. Don't try to reach us. Hunt Cyclone up and keep her out of the danger."

Again the Cyclone reeled back as a giant wave delivered a crushing blow against her and a rush of salt spray burst over the operator's head as though it meant to suffocate him. The oil-cloaked figure on the bridge had left its post and Templeton, as he wheeled inquiringly toward the sliding door, faced the captain, breathless and dripping.

"Who have you picked up in this storm?"

the commanding officer asked as he slid the door into place.

Templeton was already in the midst of a message to the night.

"Have you no boats? Can you last till we reach you?"

"No!" came the answer. "We're going to pieces now; can't last ten minutes, probably. Cut out the help for us and find Cyclone."

"I'm sure you're lying, now," answered Templeton, bluntly. "This is the Cyclone and I know the Presco had good boats. You're trying to trick us away from you, and so give us the slip; but it don't go."

"Then for God's sake keep away from Devil's Light!" came the frantic call. "We're telling the truth; keep away! The lantern is down. Do you get us?"

"Where are your boats?" persisted Templeton, half wavering in his own mind.

"They left us soon as we struck. They were all good; I think they will ride out the storm."

"And the girl; the rest of the crew?"

"With the boats. They took her along by force, though she fought hard to stay."

"You must be Proctor himself, then, or she wouldn't have wanted to stay. How many are with you?"

"No one. The boats are safe, I think. They can weather it to the bay all right and will be surely seen in the morning."

"Never mind the boats. Why did *you* stay?"

"And leave Captain Richards to ram the Cyclone into this death-trap same as we did? Not on your life!"

"'Twould serve him right," Templeton's spark roared back, as he glanced defiantly at his superior officer. "Maybe it would have rammed a little sense into his skull."

"I'd like to be there punching your's for that. Say, comrade, cut it out just now. It hurts, you know. He's her father and he always treated me white. I see things different now when things are not just a summer picnic out here. I hated to treat him as I did, but I wanted the girl. Just tell him that for me, old fellow, will you, and ask him if he won't give me credit on account for staying here to warn him away."

"Well, you've lost the girl now, but we're going to get you, yet."

"No! No! Keep back! You will only strike a reef and I can't last till you come. Keep back!"

"We're coming anyway. Keep on calling us. Presco! Proctor! Answer, Presco! Where are you?"

Templeton looked at his captain with a feeling of sudden horror and then hammered out calls until his fingers ached; but the night gave back no answer.

Another staggering wave sent the captain flying to the bridge. "Let me know at once if you pick them up again," he ordered as he drew back the slide and disappeared into the blinding spray. From the bridge he was presently hurling orders into the interior of the ship until the laboring engines caused it to tremble more from the strain of the flying shafts within than from the hammering that it was getting by the waves.

"Cyclone! Cyclone!" Templeton caught up the story again out of the night and, quivering with excitement, prepared to transcribe it for his chief. "Quick, Cyclone; we're breaking up! For God's sake, save us if you can! The girl didn't leave. She's here."

"The girl! What do you mean?"

"The captain's daughter. Do you get us? I ordered them to take her with the boats by force and then came up here to warn the Cyclone. I know they tried and she resisted; and she must have given them the slip. She did not let me know that she was here, but I caught a glimpse of her a moment ago. Come! Come! If you can."

Templeton hurled a desperate message to the bridge that sent the captain flying down the hatchway with an avalanche of personally delivered orders; then he called back:

"We're coming, and we're going to save you both."

Again the Cyclone struggled and wallowed deep in the side of an attacking wave, but finally righted, breathing hard through her twin stacks, and sending a great cloud of unconsumed coal-dust skyward. Templeton gathered up his disturbed equilibrium and caught the message that followed, in its midst.

"——and don't give her up, even if the Presco is gone. We have a motor boat on board; the one she and I came off in yesterday. It's small, but stout. I'll put her in that, if the worst comes, and launch her toward you. It may last till you meet her;

anyway 'twill be another chance. Worst is, I'll have to lash her in. She's loyal to me and I cannot make her go except by force."

"Go with her, idiot. What do you want to send her out alone for in this storm? Presco! Proctor! If you've got a boat along, use it for both of you and stick together. Don't send the girl off alone."

"I can't help her by going, and it would swamp the boat. It's only good for one, in a storm like this. She's got to have all the chance there is. It may carry her through alone. I'll stay here and guide you with our own headlight as long as I have one. There goes our name-plate and about 30 feet of good back door. It's about good-bye now, I guess. Keep a sharp lookout for Kittie; I will launch her at once; the Presco is going to pieces fast. Quick as you pick her up keep off to larboard; the reefs are as thick as shark's teeth, here; and sharper than needles."

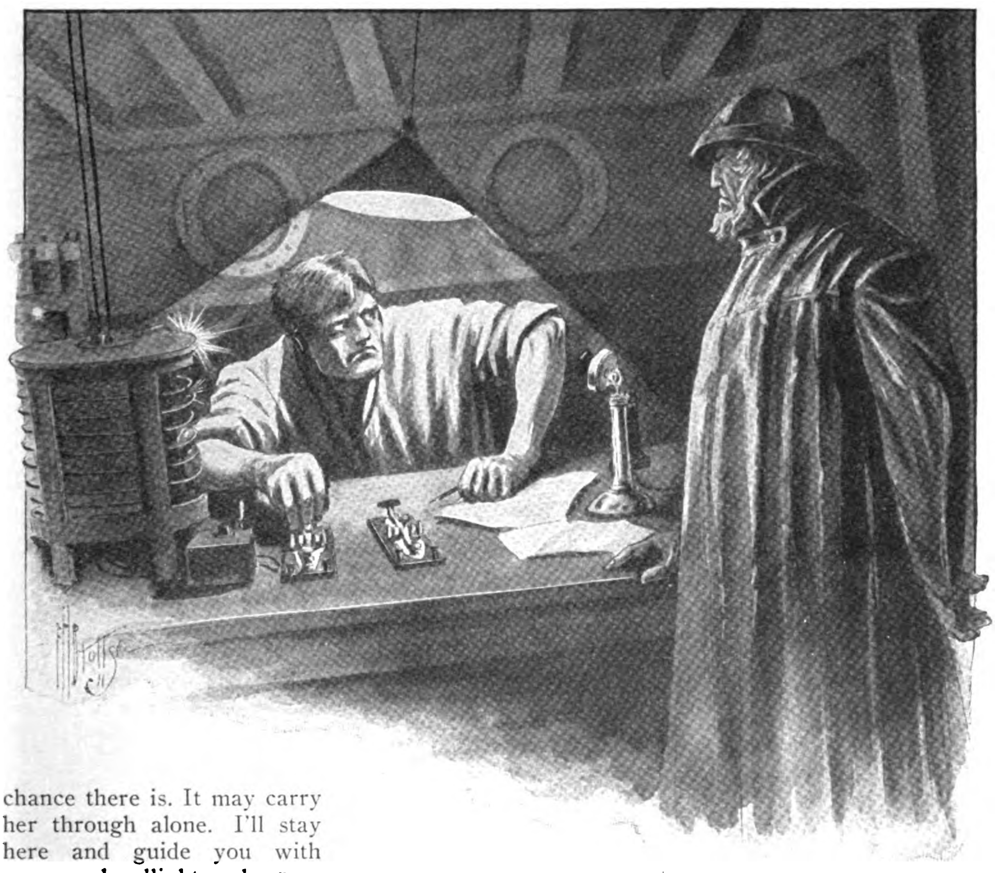
Templeton cut him off impatiently, with the roar of his own message:

"We can begin to see your headlight. Are you good for fifteen minutes more?"

"No! We won't stand more than another wave or two. I'll launch the girl at once, then keep the dynamos running as long as I can. Tell Captain Richards I'm sorry for the trouble that I made him and after awhile tell Kittie that I asked her to forgive me for using force in sending her away at the last."

Templeton spoke a few hurried words with the captain, now standing at his side; then he threw himself upon his key as though he meant to drive it bodily through the storm.

"Wait, Presco! Proctor! This is from Captain Richards. He says, 'Tell those two children of mine to stick together, whatever comes. Tell them that there is a good



"Who Have You Picked Up in This Storm?"

fifteen minutes' run between us yet and that we are going to cover it in ten or blow up the Cyclone.' Do you get me? Answer!"

"Yes, I get you; but I am not Proctor. This is from Kittie. Jack has gone below to hunt me out and launch me. Gave him the slip. He doesn't dream I understand the code. I do, and I stay here, right on this job. Tell daddy good-bye for me. Tell him I'm not afraid at all; not since Jack picked the Cyclone up and warned him away from here. Would have been awful to gone off in boats and let him strike this rock. Tell daddy——there goes our mast. Goo——"

The spray piled up in blinding drifts upon the Cyclone's decks as she wallowed from trough to trough. When it cleared away, in a moment's lull, the two men peered anxiously through the glass ahead and got no reassurance. The light was gone. "Presco! Presco! Answer!" Templeton bellowed the call repeatedly, but the Presco's resonator was silent.

Captain Richards returned to the bridge—an unbending figure gazing along the glare of the Cyclone's searchlight, but alert to every detail of his surroundings. Every shadow was a thing of interest to him; every fleck of drifting foam the possibility of an approaching boat. He watched them all with rigid attention, without seeming to lift his gaze for an instant from the point ahead toward which he was steaming; without once forgetting the details of his duties that lay behind. His oil-dressed coat, smooth and dripping, slapped spitefully about his legs like heavy yellow banners.

The ship was outstripping the storm, and lessening the billows that lay between her and the helpless Presco in rapid succession, one by one. And every triumph brought her nearer to that channel into which it seemed as though no ship could ever pass and survive.

Captain Richards gloried in that fact; there was something bracing in it. In his blind anger he had driven these two before him into an awful danger, with vengeance in his heart. Now that their necessity was extreme this reckless dash to their assistance, this determination to drag them away from death or to share it with them, to defy the worst that the sea could do, brought into his heart a new religion of tenderness.

Below the stokers toiled at the furnaces. They knew the story and accepted the possibilities of their own fate. Their faces were streaming, their muscular bodies, nearly stripped, were covered with curious maps done in carbon and indicating in some measure the violent nature of the strain, as they poured in coal until the white-hot grates were nearly choked. From the engine room, near by, a great shaft of shining steel drank in this white-hot energy at one end and gave it out at the other where the screws were wrestling with the sea.

The waters hissed under the Cyclone's prow, then scurried along her sides in sullen anger at their failure to retard her. They piled up in great hills and sprang down at her from above, determined to overwhelm her, to crush her with their weight. She threw them aside in playful haste, as though they were toys, and arose majestically upon their swell, her course unchanged, her speed hardly disturbed. She was riding the waves now, instead of climbing against them, and she managed to outstrip them two to one.

Already the outlines of the disabled lighthouse arose, grim and somber, out of the whirl of furious waters that it guarded. The Cyclone's searchlight picked it up and, shifting along the foam-crested line, made out a darker object at the extreme end of the reef, lifting and falling with each passing wave. The angry billows dashed themselves to pieces across this grim mystery of the deep, this invisible menace; then gathering up again, began a new career of destruction, furious at the repulse.

On board, the crew were at their posts, their faces white and tense and their jaws set hard. With them it was a battle to the death, and no man among them knew a qualm of fear. A few stood near the captain, the coils of rope they held glistening in the shifting rays of the searchlight. At the furnaces the hardy stokers rested, their work perhaps done, perhaps just in its beginning; their faces wearing the mask of indifference that only men who face death without fear can assume. The head engineer stood rigid, his hand on the reversing levers, his eye upon the indicator and every nerve alert for the voice of the bell.

Suddenly the bell rang sharply. The reverse lever shot to the limit of its arc and the engines churned the sea to a mimic replica of the foam around them—in vain.

The waves were carrying the Cyclone straight upon the reef and her machinery availed no more against the current than a watch against the flight of time. For one dreadful moment the oil-cloaked figure seemed to hesitate in uncertain confusion; then the searchlight revealed two people clinging to each other on the Presco's wreck and looking, self-forgetful, on the awful danger of the approaching ship; and out of that oil-cloaked figure the *man* arose supreme to the necessities of the *occasion*.

For a moment the vessel seemed to hang motionless, on the very brink of destruction, as though the sea, assured of its prey, was willing to enjoy a brief respite before completing its triumph. Then a greater wave than any that had passed came rushing up and the stern face of the commanding officer was lighted by a smile of absolute confidence. The great swell lifted all this pigmy turmoil on its mighty bosom and wiped out every evidence of the confusion, as it passed, in the sweeping magnitude of its own prowess.

"Full speed ahead!" thundered the captain, and the helmsman brought the wheel short over as he hurled the message down the wire. In another instant the ship leaped forward and drove, along with the avalanche of water on the crest of which it rode, full at the reef.

"Ready with your lines."

The men on deck crouched under gathered sinews, like tigers preparing to spring. An instant the Cyclone hung in mid-air above the reef, as though dreading the shock.

"Cast your lines!" thundered the captain, and a dozen whizzing coils shot across the remnant of the Presco's hull to its two occupants just as the mountain of water swept under her keel and, lifting her clear, whirled her to pieces in the angry waters. The lines went true, for they were flung by sailors' hands to comrades in danger. Any one of them would have reached its mark.

For a moment these two victims of the storm stood motionless side by side, sharply outlined, against the ragged cloudbank by the piercing searchlight; then, as the ropes hissed over them, the man, with spider-like agility, wound coil upon coil of the nearest one about his body and, seizing the woman in his arms, sprang clear of the lifting wreck into the heaving froth. As the line hung slack they were tossed and driven about, a helpless atom in the midst of the moving waters. Then the line tightened and they felt themselves being drawn swiftly, steadily forward, out of the water, up—up—over the vessel's side, until they were dropped chilled and nearly senseless on the Cyclone's dock, while the ship itself, riding upon the extreme crest of the wave, slid over the reef, its stout keel barely scraping the barrier as it passed.

Templeton, looking down from his perch above, glanced at his watch and muttered under his breath:

"You did it, old man, with a couple of minutes' margin. 'Twas only eight minutes from the time you sent that message till you rescued them both, and took the Cyclone in safety over the reef."

Electric Lights on Phantom Circuits

The residents of Courtenay, N. D., were somewhat startled during the recent installation of a new telephone switchboard by the North Western Telephone Exchange Company, to see the men at work evenings under electric lights.

Courtenay has no electric light plant but is on a heavily loaded long distance telephone lead where plenty of circuits are available and the current was furnished from Fargo, N. D., a distance of 100 miles, over these circuits without interruption to the regular telephone traffic.

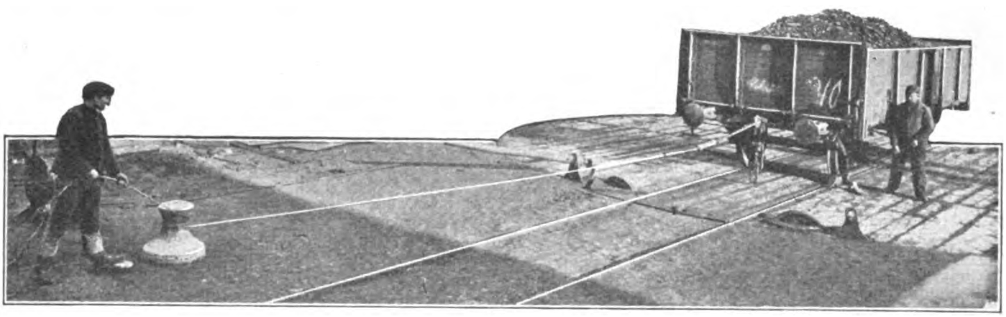
To explain just how this was done would require a lot of technical language which would not mean much to most people. Suffice it to say, however, that the performance was made possible by means of what telephone men call phantom circuits. When two complete metallic circuits are strung between two points engineers have figured out a simple way of connecting so that a third talking circuit may be obtained from the four wires without interfering with conversations on the original circuits. This is called a "phantom circuit."

Four physical circuits combined give two phantoms, which pass through Courtenay. These two phantoms were made more "ghostly" by being themselves "phantomed" and it was over this circuit that the current at 220 volts was furnished for the lights. As all circuits were perfectly balanced no noise was caused on any of the telephone lines.—Maurice E. Young.

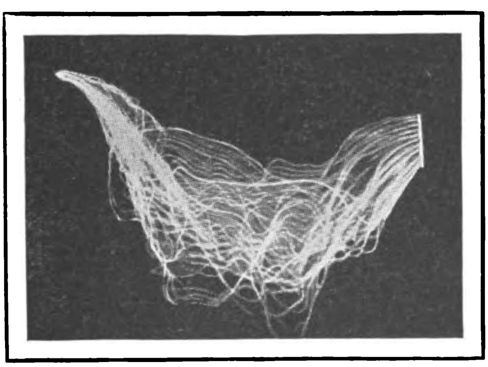
Timing Cameras by Artificial Lightning

Owing to the strong air currents produced by the heat of the discharges, lightning flashes even when following each other in quick succession between the same two points take different paths. Very often a number of such flashes passing between highly charged clouds will follow each other so quickly that the eye will not distinguish the time interval and several of these successive flashes may be mistaken for simultaneous ramifications or divisions of a single one.

On a camera plate, the impressions are retained even longer than on the retina of the eye, hence if we try to photograph a series of sparks passing between the terminals of a large induction coil, we can secure a clear reproduction of as many as 30 or 40 distinct flashes. Now if the current interrupter which causes the high voltage sparks to be formed works at a known speed, the number of separate sparks depicted on the plate will depend on the length of time that the shutter was open. Hence we have in the induction outfit as used for X-ray work an interesting means of ascertaining how near the estimated open time of a shutter with a given adjustment comes to the actual time of exposure. Indeed, the camera builder who checks his calculations by this method may be justified in advertising his shutters as "tested by lightning."



HAULING A CAR ONTO A TURN TABLE



THE EXPOSURE WILL SHOW A NUMBER OF DISCHARGES

Moving Cars with Electric Capstans

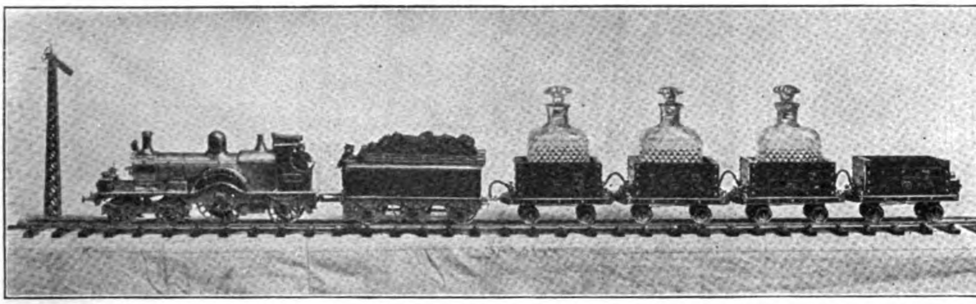
Have you ever seen three or four perspiring men with as many crow bars moving a freight car with much effort at a speed that would make a snail blush? They do it differently in Germany. They use an electric capstan and a cable.

A capstan is simply a barrel shaped piece to wind in the cable, and the car has got to come.

Two speeds can be obtained by having two diameters on the capstan. The motor is controlled by the foot through the pedal which can be seen in the picture.

The capstans are built in all sizes. The largest develop about 15 horsepower and are used for hauling heavy trains and warping large ships fast to the docks.

In order to have a line which will not be interfered with by snowstorms and blizzards in winter, an elevated electric road will be built between Montezuma and Keystone, Summit County, Colorado. The road will be twelve miles long and will cost $250,000. The road is intended to serve the mines near it.



THE AFTER-DINNER EXPRESS

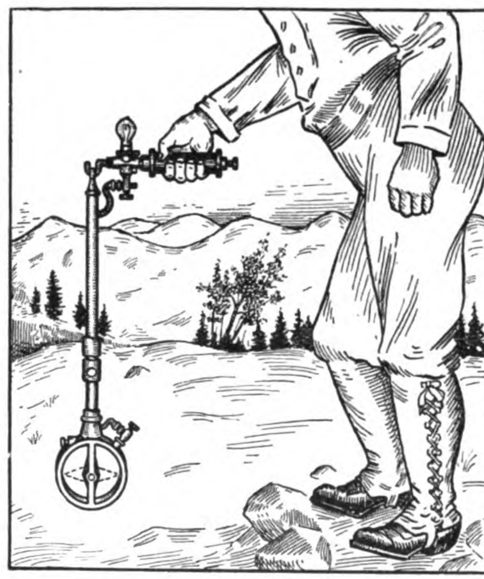
The After-dinner Express

It is, of course, no uncommon thing to have one's wine and cigars delivered to one's door by mechanical means, but a railroad service for conveying the wherewithal for smoking and drinking from one end of the dining-table to the other is a decided novelty A large English engineering firm has recently turned out a model of a Great Western Railroad train for a wealthy client, which whisks the whisky and cigars round the table from guest to guest in a moment.

The train, which is five feet six inches in length, is driven by electricity, and is controlled from a switch operated at the head of the table. The host can start, stop, or accelerate the train at will. The act of lifting a decanter also stops the train, and when the decanter is replaced it moves on again. The locomotive, and all the fittings and mountings, including even the rails, are silver-plated.

Prospecting with a Dip Needle Flasher

Those familiar with iron, nickel and other magnetic ores know that the so-caled "magnetic North Pole" of the earth is not the only place where a compass needle will point downward. If free to move vertically, the needle will set itself upright whenever it is brought over a mass of magnetic material, even though the latter is deeply buried. The so-called "dip-needles" as made for this purpose have located ore in many places, but watching the needle while carrying it is a tiresome task. A Michigan inventor has therefore arranged a needle so that when it dips to a given extent it will close a battery circuit and light a little flash lamp. This enables the user to go along at a brisk walk without paying attention to the needle which will flash forth its signal as soon as he passes over a magnetic mass. Then by



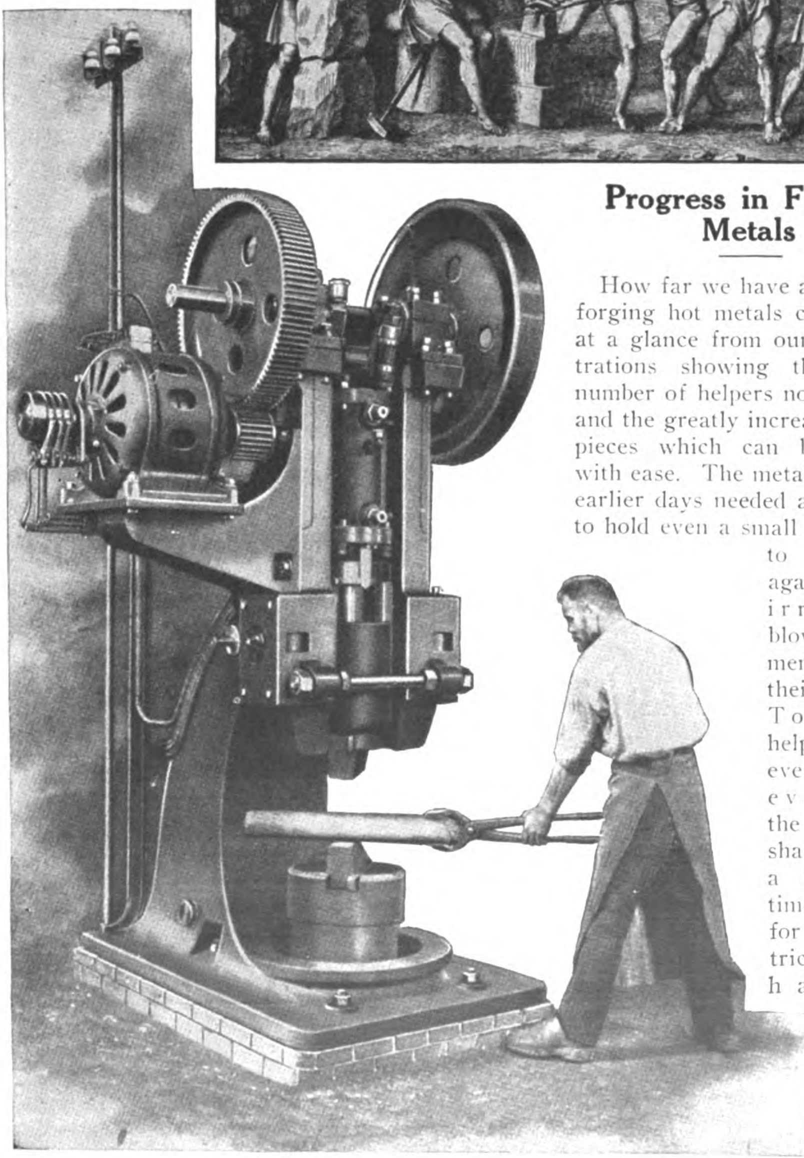
THE DIP NEEDLE FLASHER

going in various directions he can easily find out how extensive a stretch of land is underlain by the hidden ore, after which he can take the device to pieces so as to carry it in a small grip.

A 40,000-volt electric transmission line is now being built from the lower plant of the Copper Queen smelter at Douglas, Arizona, to El Tigre, Mexico, 65 miles distant. The question of whether electricity was subject to duty was raised and the decision reached that it should be classed as on the free list.

Progress in Forging Metals

How far we have advanced in forging hot metals can be seen at a glance from our two illustrations showing the smaller number of helpers now required and the greatly increased size of pieces which can be handled with ease. The metal worker of earlier days needed an assistant to hold even a small piece so as to steady it against the irregular blows of two men swinging their sledges. Today, no helper whatever is needed, even though the piece being shaped weighs a hundred times as much, for the electric power hammer knows no swerving.



The Pupin Coil

By R. M. WINANS

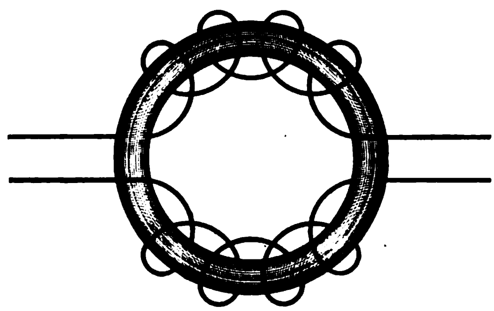
Among the patents held by the American Telephone and Telegraph Company, one of the greatest value and interest is the contrivance by which Professor M. I. Pupin of Columbia overcame a serious obstacle to long-distance telephoning whenever the wires are placed underground instead of overhead. The device is known as Pupin's coil. It consists simply of a coil or circular core of iron wire around which the message-conducting copper wire is wound. The coils are placed at intervals of one to one and a quarter miles.

Necessity was the mother of this invention, as it is said to be of all inventions. In 1904 all poles were ordered down in New York City and the telephone company found

UNDERGROUND WORK WHICH MADE NECESSARY THE PUPIN COIL

itself stalled in its long-distance work because the wires would not work satisfactorily in the subway. However, the company managed, in the face of strong official protest, to retain enough overhead wires for long-distance purposes and eventually Professor Pupin, to whose attention the difficulty had been brought, came to its rescue.

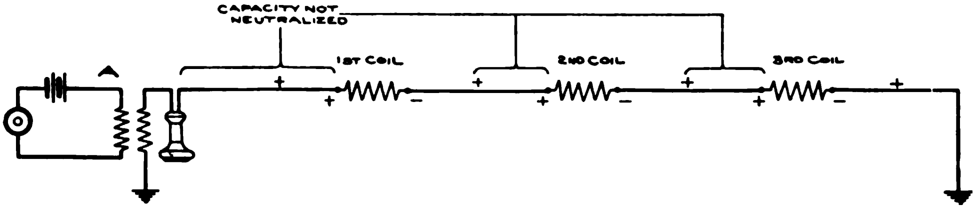
The trouble was this: The electrical energy used in operating a telephone diaphragm is marvelously small and the fluctuations in this current which bring about a variation in the magnetic qualities of the



THE PUPIN COIL

telephone receiver are so minute as to be almost unmeasurable except by a telephone diaphragm, one of the most delicate electrical measuring instruments known. When the wires are strung out in the open on poles there are few factors to disturb the transmission of these tiny fluctuations. When, however, the wires are enclosed in a cable and placed underground in conduits or tunnels a great disturbing factor immediately arises, known to engineers as "capacity effect." This capacity effect is hard to explain in everyday English. Crudely stated. the telephone wires, with their coverings, under these conditions, "soak up current," so to speak, partly due to the close proximity to the earth. The telephonic current, therefore, in passing through an underground cable must, in addition to its regular work, be constantly charging the cable, representing a waste of energy. Thus the minute fluctuations in the current are "worn down," and lost, and instead of words coming from the receiver we hear mere noises. No results can be obtained on underground wires over ten miles in length unless some artificial means is employed to overcome the capacity of the line.

Fortunately there is an antidote for capacity, you might term it a counter-irritant in this case. It is what is known to engineers as "induction." In this case there is no everyday term to make its meaning clear to the layman, although it may be explained as similar to the property of inertia in matter. This inductive effect may be obtained by inserting coils in the circuit, and suffice it to say that a certain amount of capacity effect may be exactly neutralized by a given amount of inductive effect, induction and capacity being antagonistic to each other.



HOW PUPIN COILS ARE INSERTED IN A LONG-DISTANCE LINE

This principle Pupin employed in his famous "Pupin coils." These are inserted in the wires of the telephone circuit at intervals of about a mile, throughout the underground portion. The simple diagrams herewith show the general relation of these coils to the rest of the circuit.

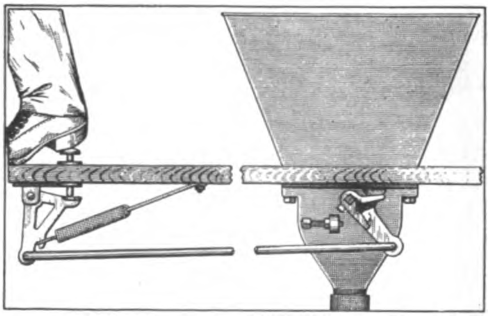
Not the least wonderful thing about the Pupin coil is the manner in which the problem was attacked and solved by the inventor. Professor Pupin arrived at his results through purely mathematical reasoning, although it took months of experimenting on his part to place his demonstration on a practical basis. During this time he occupied a house at Babylon, Long Island, in which were strung the wires necessary for his experiments. Telephoning in the cellar to his assistant in the room above, the Professor sent his voice traveling over 600 miles of wire.

The Pupin coil is installed in all long-distance underground lines — between New York and New Haven (now being extended to Boston); between New York and Philadelphia (now being extended to Washington), and between Chicago and Milwaukee. It may not be long before we see a subway telephone system between New York and Chicago, or even San Francisco.

Overhead wires, being some 40 feet from the ground, are not subject to "capacity" in anything like the same degree as wires in a conduit. So the long-distance wires between Chicago and New York have not heretofore been "loaded" with Pupin coils. But disturbances have even been noticed at times in these overhead wires, and the company is now "loading" them.

When the Rails Are Slippery

"Where does the sand come from?" asked a youngster one winter morning as he watched the fire fly from under the helpless, revolving wheels of a street car trying to climb a grade at the approach to a bridge. A rubber hose coming from somewhere up in the body of the car near the motorman's platform kept dropping a small stream of sand upon the icy rails just in front of the car wheels.



MECHANISM OF A TRACK SANDER

The upper end of this hose is attached to a hopper or box of sand and as is made plain in the illustration the motorman has only to step on a foot-pin coming up through the platform. This action operates a lever, opens up a hole in the bottom of the sand box allowing sand to come to the rescue of the balky car. The shutter mechanism of the Dumpit sand box has a sort of blade attached to it to break up any lumps of sand.

Poles by the Million

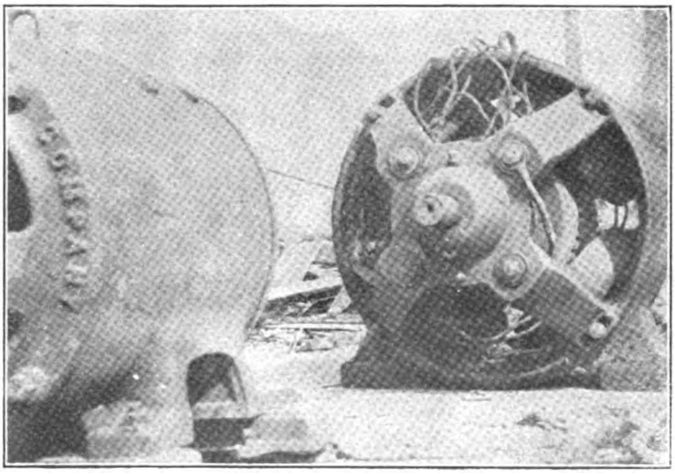
In the year 1909, according to census report, there were 3,738,740 poles bought by telephone, telegraph, electric railway and allied industries. These cost the consumers $7,073,826. It will be surprising to many, who have been under the impression that the cedar of this country has been pretty well exhausted, to learn by this report that by far the greatest number of poles are still cut from this wood. The number of cedar poles used in 1909 was 2,439,825; chestnut, the nearest competitor, had only 608,066 to its credit.

A great variety of woods are used for poles, including oak, pine, cypress, juniper, Douglas fir, redwood, spruce, locust, osage, orange and tamarack, but there is nothing like cedar when it comes to lasting qualities under all conditions of climate.

Life of Electrical Apparatus

Electrical apparatus is generally considered to be less rugged than some other classes of machinery, but the accompanying illustration and the explanation show through what severe ordeals it may sometimes pass without serious damage.

Two Bullock motors were taken from the ruins of the Los Angeles *Times* Building, after the explosion and fire which recently destroyed this building. The motors were removed from the basement where they were lying in five feet of water. The presses to which they were attached were completely destroyed and had no value except as scrap iron. The motors, however, were not badly damaged and were practically the only article of value saved from the ruins. In the adjustment of losses made by the Fire Underwriters' Association, 99 per cent of the total insurance was allowed, which is evidence that electrical machinery of today is nearly indestructible.



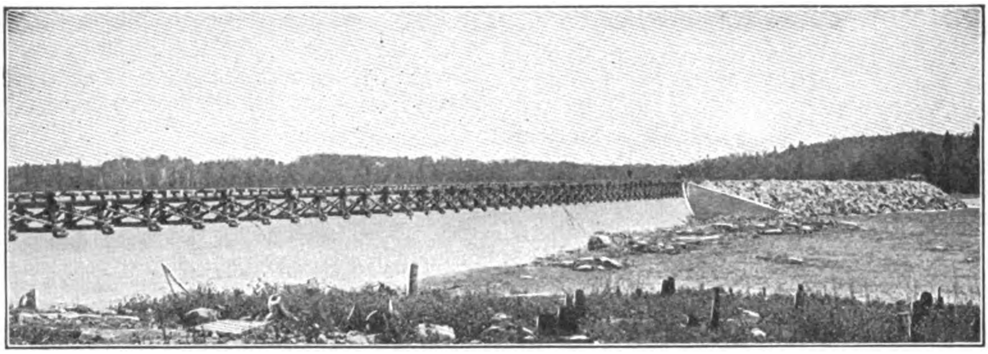
MOTORS THAT WENT THROUGH A FIRE WITHOUT SERIOUS DAMAGE

Storage Battery Locomotive

In and about iron and steel works the difficulties arising from the use of overhead trolleys or third-rail conductors have, in many cases, acted to keep in service the clumsy steam locomotive for operating the cars of the industrial railways serving the various departments and shops of the plants. The Germans, however, overcome this objection, and use electricity by employing storage battery locomotives. One of their leading types is shown in the picture.

STORAGE BATTERY LOCOMOTIVE

This locomotive is constructed with the battery mounted on top in a sort of crate.



POWER DAM AT WINNIPEG

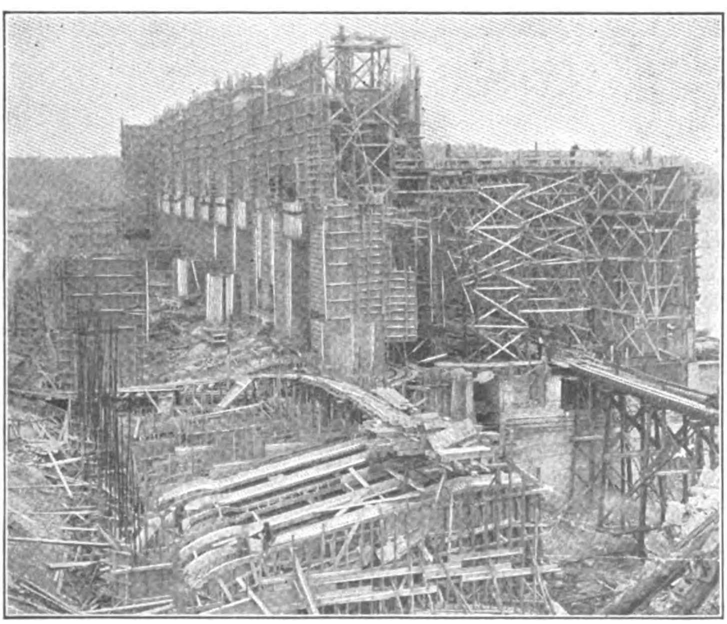
Power of the Prairie

By GEO. M. HALL

Winnipeg, the capital city of the province of Manitoba, is a place chiefly known to the people of the United States because of the rush it has made up the ladder of civic growth. In 1870 Winnipeg was 215 people more than a mere name; today, there are 200,000 within five miles of the City Hall.

Prompted by the remarkable growth of its industries, particularly in the direction of manufacturing undertakings, the people of Winnipeg some time ago voted for a by-law looking toward the building of a municipal electric power plant on the Winnipeg River, and appropriated the sum of $3,250,000 for the purpose. So promptly has the purpose of the law been put into effect that next summer the plant will be put into commission. Its capacity will be 60,000 horse-power.

The plant is located at Point du Bois, on the Winnipeg River, 77 miles from the city. The natural fall of the river at this point is 32 feet and this fall has been increased to 47 feet by building a dam. The construction of this dam, 2,850 feet long and with a maximum height of 45 feet, gives the plant a storage reservoir with an area of 60,000 acres, and as the Winnipeg River drains an area of 50,000 square miles at this point, it is not likely that the capacity of the reservoir will ever be much impaired by shortage of water.



WINNIPEG'S POWER PLANT IN COURSE OF CONSTRUCTION

Seventy-five million gallons of water will pass through each of the water turbines and gen-

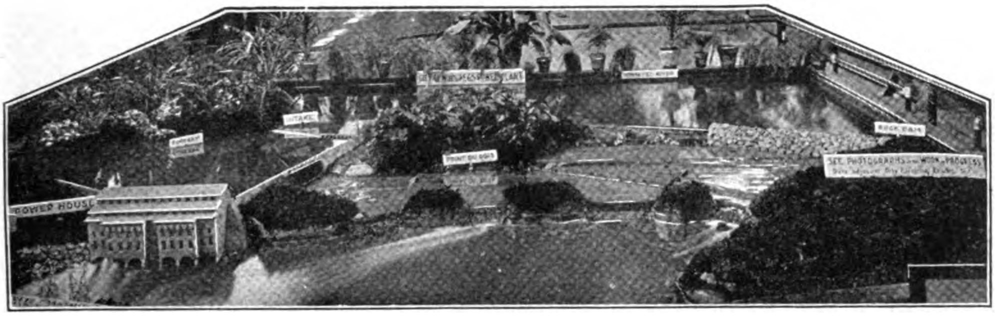


EXHIBIT SHOWING THE LAY-OUT OF THE WINNIPEG POWER PLANT

erators every 24 hours for the development of the first 20,000 horsepower. The transmission right of way to Winnipeg from the power plant is 77 miles long and 100 feet wide. Along this way, a double line of towers will be completed, carrying 2,200,000 pounds of steel construction. Power will be transmitted at 60,000 volts on two independent circuits by five-eighths-inch aluminum cable. The 60,000 horsepower that will be developed with the final installation under the plan as now being worked out, is capable of being increased to 100,000 horsepower and even the first installation of 20,000 horsepower will put Winnipeg in line for the patronage of seekers after cheap power, light, and heat, as far as heat is used from electrical devices, thus far.

The Mercury Vapor Lamp

By ALBERT WALTON

The mercury vapor lamp contains no red rays. One's face, the stripes of a flag, or any other surface is red in proportion as it reflects the red rays of whatever light is thrown upon it and absorbs all the other rays. If there are no red rays in the light which illuminates it and it absorbs all others obviously no light is reflected and the red pigment appears black. This explanation has been made so often that many people understand why it is that the vapor lamp makes one look so hideous when standing in its light. Still the majority do not yet quite understand what the light is or how it is made, though the peculiar, long, tubelike lamps have been on the market for a number of years. Therefore a few words of explanation will do no harm.

The lamp is extremely simple as may be seen by even a superficial examination—a two-foot glass tube an inch in diameter with a bulb holding a pool of mercury at one end, a wire running through the glass into the mercury and another wire running through the glass to a small metal plate at the other end. All the air is pumped from the tube and it is sealed to hold the resulting vacuum just as in the incandescent lamp. Were no mercury present electricity would pass through the vacuum and cause the weird and fitful glow of the Crooks or X-ray tube. To do this the electric pressure would need to be high and the light would be too faint and unsteady to be commercially useful. Introducing the mercury obviates these two difficulties, for a vapor is created reducing the resistance to such an extent that ordinary house voltages can maintain a current across considerable spaces while at the same time having the fortunate property of giving forth a steady glow of great brilliancy.

It may seem a trifle strange to think of mercury vaporizing, but this is what occurs. We are accustomed to think of water vapor, or steam, forming at the "boiling point" or 212 degrees Fahrenheit, but seldom append the necessary qualification "at normal atmospheric pressure." Mountain climbers find that at high altitudes it forms steam at so much lower temperatures, owing to reduced air pressures, that sufficient heat cannot be put into the water to cook their potatoes. If the pressure is similarly reduced with any other liquid the vapor is correspondingly more easily formed.

Even with this condition of very low pressure imposed, the vapor of the mercury in the tube is not sufficient to allow the current to flow when the voltage is put across the cold tube by turning on the switch. For this reason the tube is arranged on a hinge so that it may be tilted enough to cause the liquid to run from the bulb toward the other end. A long, thin, partially broken stream of mercury is formed reaching the entire length of the glass, and the short gaps are then easily jumped by the current, the passing of electricity instantly vaporizing more of the mercury and filling the tube with sufficient vapor to permit the lamp to be returned to its normal inclined position, the globules of mercury running back to the bulb. The vapor continues to carry the current whose very continuation insures the maintenance of sufficient vapor to allow it to pass freely from end to end of the tube. The mercury in the bulb may be seen to "boil" gently and the temperature of the tube is noticeably above that of the surrounding air.

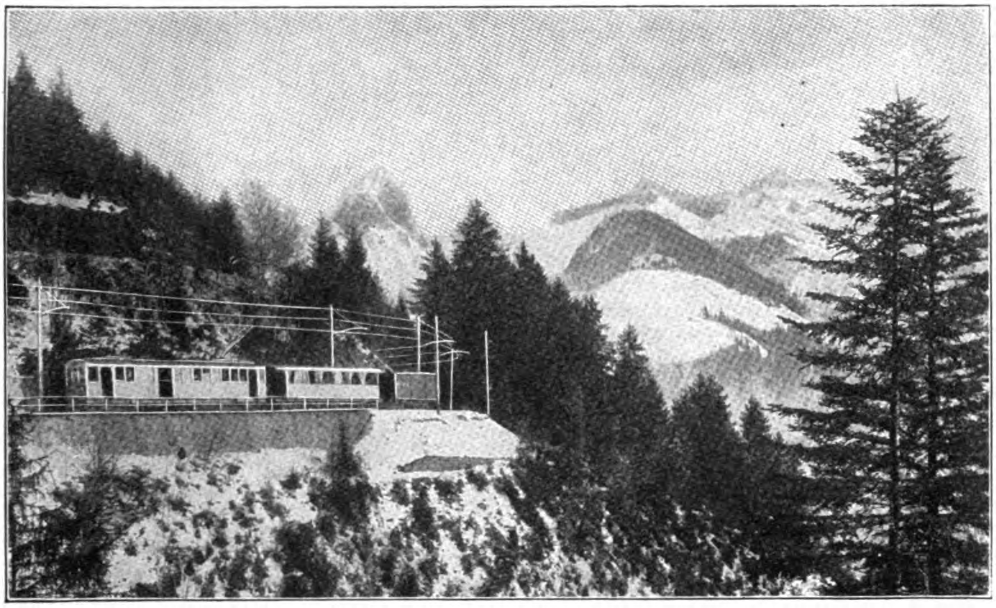
That true vaporizing is going on may be observed by noticing the condensation into little drops on all parts of the inner surface of the glass which is exposed to the cooler air. These drops accumulate into globules that free themselves from the surface and run back down the incline to the bulb to be again vaporized as before. Obviously the mercury must vaporize at least as fast as it condenses or the vapor would fall below the point at which current could pass. If then the heat generated in the lamp could be carried away faster than the current supplies it we would expect the lamp to go out. And this has frequently occurred in the colder climates where the lamp has been used outdoors. On very cold nights when the wind is blowing the lamps cannot be kept burning, the light actually being "frozen out" of existence! This can, however, be prevented by enclosing the regular tube in another to shield it from this chilling effect.

Since it is often desirable to install the lamps in high, inaccessible places it is not always convenient to go to each lamp to tilt it up for starting each night or after each interruption of the current, should such occur. The lamps are therefore arranged to tilt automatically by suitable magnets and to return to the proper angle for burning as soon as the vapor starts. There are also types of lamps that start without tilting, an arrangement of magnets and transformers mounted above the lamp causing a very high voltage to be impressed momentarily across the terminals to break down the resistance of the cold lamp and set the current flowing, after which the normal voltage is instantly resumed automatically.

Alpine Scenes from Trolley Windows

Along the borders of Lake Geneva, piercing the black-bearded forests of the Swiss Alps, and mounting to their snowy sum-

STATION AT LES AVANTS



THROUGH 40 MILES OF IMPOSING SCENERY

mits, winds the steel path of the Montreux-Oberland-Bernois Electric Railway, through 40 miles of probably the most imposing scenery in all Switzerland. Sometimes sunk deep between towering, snow-clotted mountains, sometimes tunneling through them, sometimes girdling their peaks, this Alpine railway presents not a few ingenius feats of electrical engineering.

To build the first section of the road, from Montbovon to Montreux, though a matter of only 14 miles, is said to have cost over a million dollars. It is on this first section of the road that the heaviest grades occur. For several miles there is a continuous grade averaging over five per cent, while occasionally it reaches seven per cent. Construction plans also necessitated sharp curves in this region, many of them having a radius of but a little over 130 feet.

The second section of the road, from Montreux to Zweisimmen, covers a distance of 25 miles and was built at a cost of a million and a half. At Zweisimmen connections are made with the steam railway for Interlaaken and Spiez.

The most precipitous ascent of the mountains occurs between Montreux and Les Avants. Within the distance of only about six miles between the two stations a rise of nearly 1,900 feet is accomplished. Montreux is but 1,300 feet above sea level, while Les Avants claims to be 3,200 feet.

There are two tunnels on the first section of the railway, one over 600 feet in length, the other about 500 feet, with a nine-arch viaduct near Montreux and three large curve viaducts besides several small viaducts below Les Avants.

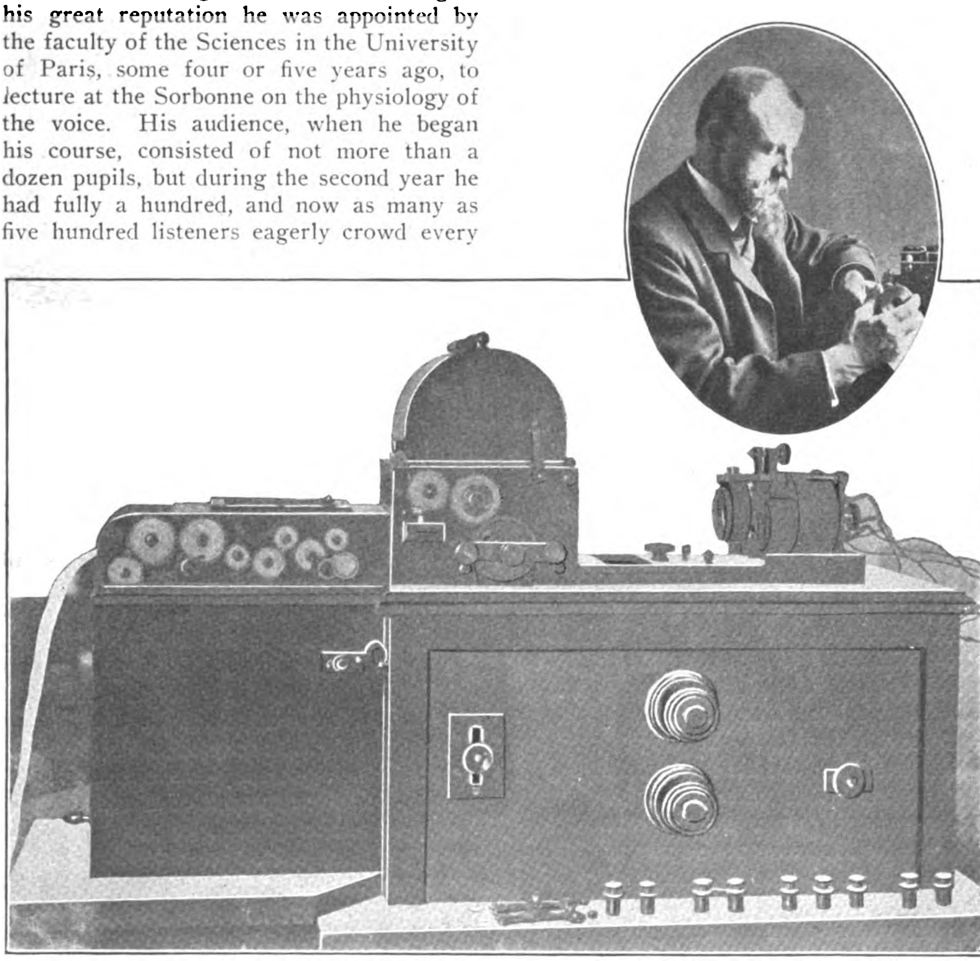
Up over this picturesque route climb the motor cars with their odd-looking bow trolleys so largely used in European countries and so seldom seen here in the United States. Each of the four motors on the trolley car, which generally draws two trailers, develops 65 horsepower and enables the trains to attain a speed of ten or twelve miles an hour on the up-grades. On the down-grades the speed is increased to 25 miles an hour.

A complete train weighs about 60 tons, and rolling down a mountain under the impetus of 120,000 pounds would be more than a pleasant diversion were it not understood that every precaution is taken to make possible the almost instant stopping of the train. Both air brakes and electro-magnetic brakes are fitted to the cars, and the train may be brought to a standstill, from full speed, within a distance of 20 feet. Any automobile driver would love his car for accomplishing such a feat.

Photographing the Voice by Electricity

By FREDERIC LEES

Marage—a name which is respected in the highest scientific circles of Paris and London—is a doctor of medicine and a doctor of science. He is a specialist in all matters concerning the voice, and owing to his great reputation he was appointed by the faculty of the Sciences in the University of Paris, some four or five years ago, to lecture at the Sorbonne on the physiology of the voice. His audience, when he began his course, consisted of not more than a dozen pupils, but during the second year he had fully a hundred, and now as many as five hundred listeners eagerly crowd every Saturday during the winter months, into the ampitheatre where he holds forth on the subject of the marvelous mechanism of the human organs of speech and song. All the well-known teachers of singing, such as M. Melchissédec, of the Opera, are there with their pupils, and all display great interest in and I have no doubt derive great profit from the remarks of the learned lecturer. Every Sunday, too, during December, January and February, many of these students of singing take part in the *travaux pratiques* with which Dr. Marage supplements his lectures. After having explained the theoretical part of the physiology of the voice, he devotes his attention to the practical side of the question and puts his pupils through respiratory exercises and takes rec-



DR. MARAGE AND HIS WONDERFUL APPARATUS FOR PHOTOGRAPHING VOICE WAVES ords of their voices by means of his marvelous apparatus which photographs the voice.

One day I asked him if he would please explain the mechanism of this apparatus which photographs the voice, and which is calculated to render invaluable services to students of singing?

"Certainly. This new machine is based on the principle of the Pollak and Virag

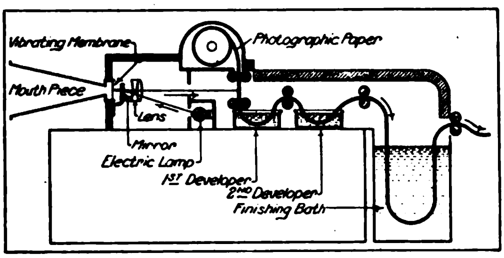
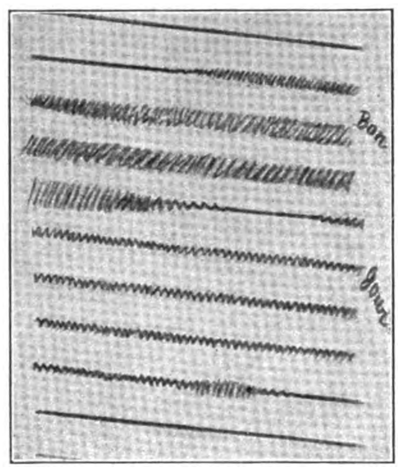


DIAGRAM OF THE MARAGE APPARATUS

telegraph apparatus, which photographs with unerring accuracy, and at a distance of several hundreds of miles, a written message. In modifying this ingenious machine, I have suppressed the transmitter and replaced it by a microphone connected with one only of the receiving telephones, that which controls the vertical movements of the mirror which writes the message on a band of photographic paper. What happens when a pupil of singing sings into the mouthpiece of my apparatus? The mirror is set in motion and a ray of light, which comes from a little electric lamp, acts like a sort of luminous pencil, on the band of bromide paper which you here see moving over a roller with great rapidity. As the voice waves play upon the sensitive diaphragm of the microphone the mirror is tipped ever so little upon the impact of each voice wave. This causes the ray of light to play up and down in a vertical plane. Then there is a mechanism for moving the lens directing this ray so that the latter will travel across the paper strip.

"The paper then passes, you will observe, into a bath of developer, afterwards into a fixing bath; and thus I obtain a faithful record of a singer's voice. Thanks to this record, I am able to observe the following facts: I. The duration of each note, by counting the number of lines on which vibrations are inscribed. If there are three lines, then the note has lasted three-quarters of a second; if there are four lines, it has lasted a second, since each line represents a quarter of a second. II. The time that has elapsed between the singing of each note, a perfectly straight line on the record showing that there have been no vibrations to photograph. III. The homogeneousness of the sounds by examining the regularity of the vibrations. IV. The correctness of the notes by counting the number of vibrations on each line and multiplying them by four. In this way the number of vibrations per second can be obtained. Now, these four elements are precisely those which govern the method of every capable teacher of singing, and to be able to demonstrate photographically the weaknesses of a pupil's voice is a most valuable aid in teaching the art of singing."

A marvellous machine, indeed, and one



BON JOUR (GOOD-DAY) AS REPRESENTED BY WAVE PICTURES

that ought to be adopted at the Conservatory!" I exclaimed.

"Yes; but I fear we are too much bound down to routine ever to do that," replied Dr. Marage. "The Conservatory ought certainly to have a department where the physiology of the voice is treated by a scientist, but it is only in such new countries as the United States that such advanced ideas as this will be accepted. If ever one of your great American millionaires gives a sum of money to found a new college of singing I would strongly advise those who have the disposal of it not to forget that the first thing for learners of singing to do is to study physiology as we do in Paris.

ELECTRIC CURRENT AT WORK

NEW DEVICES FOR APPLYING ELECTRICITY

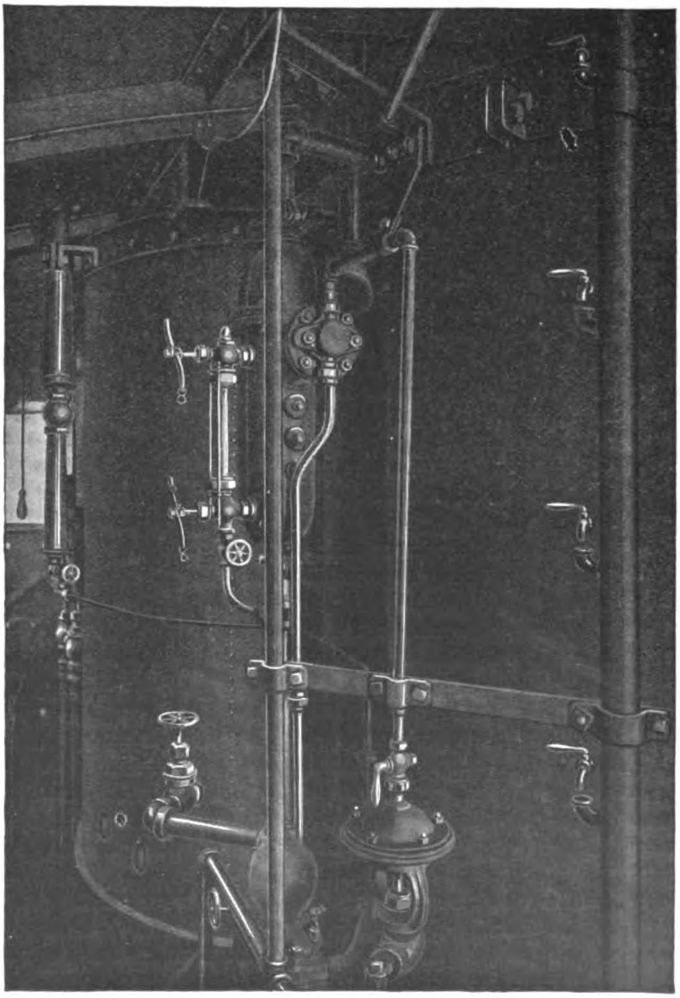
Electric Boiler for Train Heating

When the New York Central electrified its New York Terminal it did away with smoke and steam. But steam is a rather desirable thing when the mercury in the thermometer sneaks down into the bulb. All the passenger trains were fitted for steam heating.

Of course the electrical engineers could furnish electric heaters easily enough, but electric heaters are expensive propositions, when they heat the train through only about one-twentieth of its run. It seemed to be cheaper to use electricity to make steam, and this was what they did.

The electric "boiler" is much like the common fire-tube boiler, in that the heat is generated in the tubes around which the water passes. The tubes are vertical. The heating "elements" consist of cores of insulating material wound with wire of high heat-resisting qualities. These are slipped into brass tubes lined with porcelain. These tubes are then placed in the tubes of the boiler, which are iron pipes two inches in diameter. The space between the iron tubes and the brass tubes is filled with fine sand.

The whole equipment occupies a floor space about five feet by eight feet on the locomotive. It will evaporate 800 pounds of water per hour.



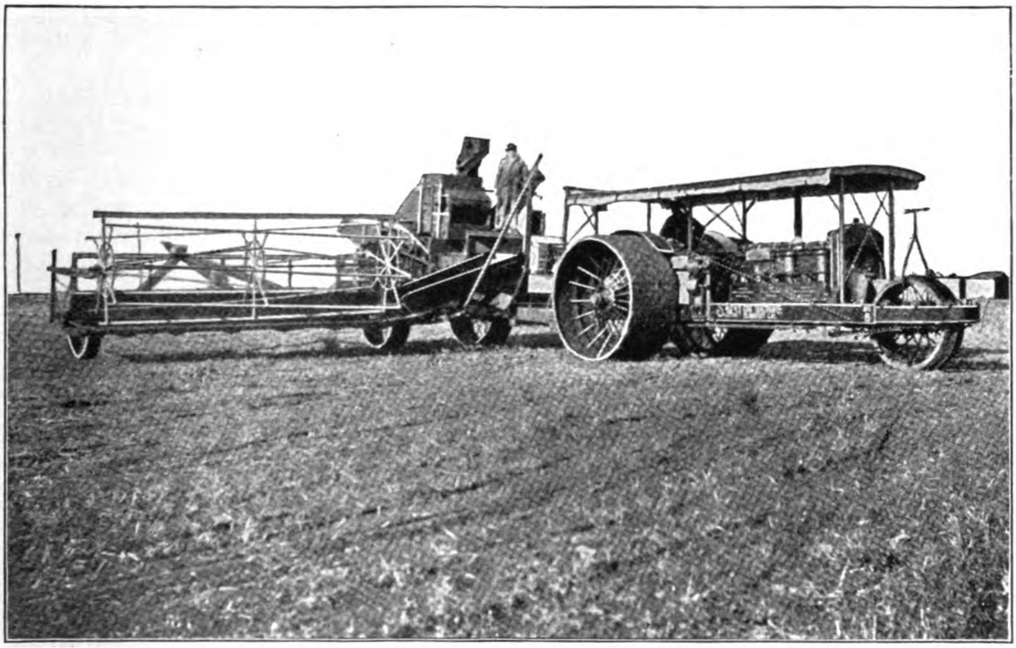
ELECTRIC BOILER WHICH HEATS A TRAIN

St. Paul, Minn., will use a novel scheme for advertising itself. Moving pictures of the residence districts and beauty spots will be taken, and these sent out over the country by the hotel and restaurant men.

Electric Harvester and Thresher

On the great wheat farms of the West it is a familiar sight to see a gasoline or steam engine drawing the combined harvesting and threshing machines which are necessary in wholesale farming operations. Ordinarily the engines simply drag the harvesters over the ground, the mechanism of the latter being operated by means of gears and chains from the harvester wheels. This has always resulted in an unsteady motion of the separator or threshing machine which forms part of the outfit, due to the unevenness of the ground causing a jerky and intermittent motion of the drive wheels. This unsteady motion means a great loss of grain.

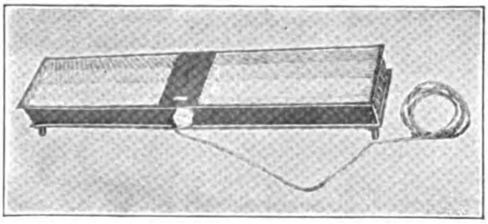
An electrical harvester has been designed to overcome this difficulty. It consists of a gas tractor of the type shown in the illustration carrying a dynamo or electric generator. This supplies the necessary current for operating an electric motor mounted on the back of the separator, and driving the latter. In this way the driving of the separator and of the harvester, also, if desired, is made independent of the harvester wheels.



ELECTRIC HARVESTER AND THRESHER

Drying Beer Vats

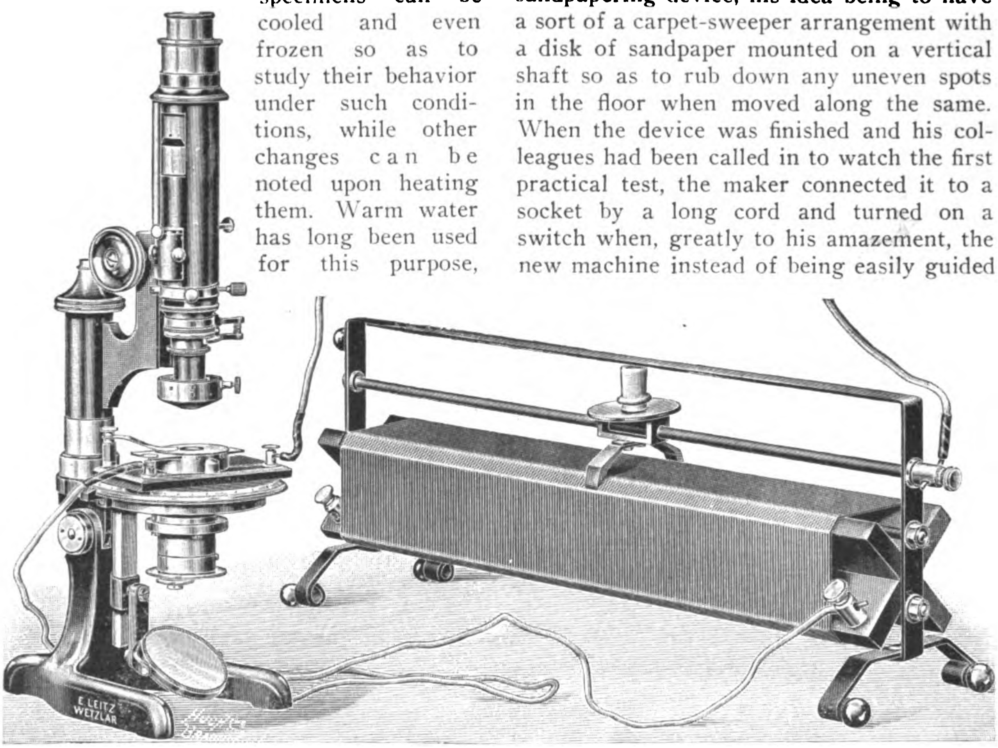
At the end of certain periods of beer and ale aging, it is necessary that the vats be thoroughly varnished and dried. The cleanest and most sanitary method of drying suggests the use of some such "Radiant" drier as shown here. The incandescent heating filament is enclosed in tough glass tubes which are well protected by coarse mesh screen, which effectually eliminates any danger of breakage. The lightness in weight of the electric vat drier, one of the essential features of all electric heating devices, together with its portability, constitute the strongest arguments in its favor, wherever current at the ordinary lighting voltages is available.



BEER VAT DRIER

Heating Microscope Specimens

Most of the studies made by microscopists have been on specimens maintained at ordinary room temperatures, but much has also been added to our fund of scientific knowledge by examining the objects at other temperatures. By using liquid air, the specimens can be cooled and even frozen so as to study their behavior under such conditions, while other changes can be noted upon heating them. Warm water has long been used for this purpose,



ELECTRICAL HEATER FOR MICROSCOPE SPECIMENS

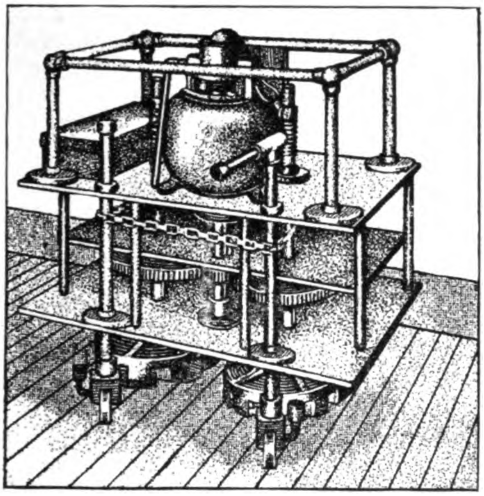
but is quite limited as to the heat to be obtained from it; while steam would be hard to regulate even if available, which is not often the case.

Now a German scientist, Dr. Jentsch, has designed an electric oven which can be placed on the platform of any microscope, being held in position by spring clips. For low temperatures the needed current may be obtained from a battery, while for higher heats it is taken from the lighting circuits, the current being regulated by a sliding contact on a wire rheostat. In this way temperatures as high as 1,500° Fahrenheit may be obtained, thus allowing test specimens to be studied under the action of high heats. To avoid damaging the objective lens of the microscope this is surrounded by an air jacket which is said to be so effective that even with the specimen heated to 900° the lens is hardly warmed.

Waltzing Floor Polishers and Others

A machinery builder had designed a floor-sandpapering device, his idea being to have a sort of a carpet-sweeper arrangement with a disk of sandpaper mounted on a vertical shaft so as to rub down any uneven spots in the floor when moved along the same. When the device was finished and his colleagues had been called in to watch the first practical test, the maker connected it to a socket by a long cord and turned on a switch when, greatly to his amazement, the new machine instead of being easily guided by him, insisted on twisting itself round and round, turning the inventor with it. Whereupon one of the spectators started humming "Waltz me around again, Willie," while the others held their sides with laughter.

The explanation was simple, for the small but powerful electric motor insisted on turning something and when the quickly rotating disk struck rough spots on the floor it was easier for it to twist the handle of the machine than to grind off these projections. Of course this amusing trouble was soon cured, partly by running the motor at a different speed, as the designer had underestimated the amount of work which it would try to do if given a chance. Since that time a number of successful wood floor



ELECTRIC FLOOR POLISHER

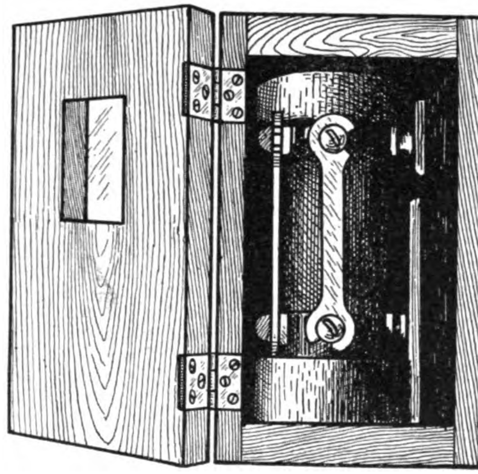
surfacers have been earning profits for contractors and lately the same principle has been applied to the leveling and polishing of mosaic floors. For, no matter how carefully the individual pieces of stone comprising a mosaic floor are planned for uniform height, irregularities in the floor under them and in the cement holding them will make them uneven after the cement hardens. To level them by a hand is a slow task requiring strong men, while even a child can guide the electric floor surfaces shown in the illustration. This has an electric motor rotating two disks in opposite directions, thus overcoming any tendency to waltz.

Keeping the Current Flowing

Fuses are protective devices. They are put into electrical circuits to break them if the current gets too strong. They are made of material that fuses, or "blows," when the current exceeds a certain value.

Most fuses are built into "plugs." When the fuse blows you put in a new plug. But what are you going to do if you have no plug? This question does not bother much in a city, but on an electric lighted railway train crossing the wilds of New Mexico it is rather serious. Owing to the peculiar conditions fuses on trains are prone to "blow."

To help at such times the device shown in the picture was invented. It is called a snap switch multiple fuse, which is a long name for a simple thing. It consists of a cylinder with copper ends connected by four fuses. The upper cylinder is split into four segments and so arranged that the copper contact rests on only one of them at any time. Each segment is connected to the

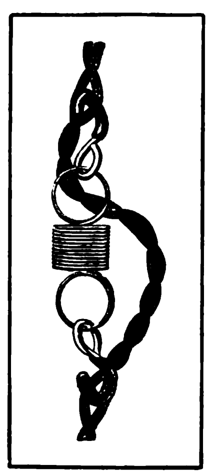


SNAP SWITCH MULTIPLE FUSE

lower cylinder by a fuse. The current flows through this fuse. If it gets too strong, and "blows" the fuse, all you have to do is to turn the switch at the bottom, which brings the next segment into place.

A Simple Anti-vibrator

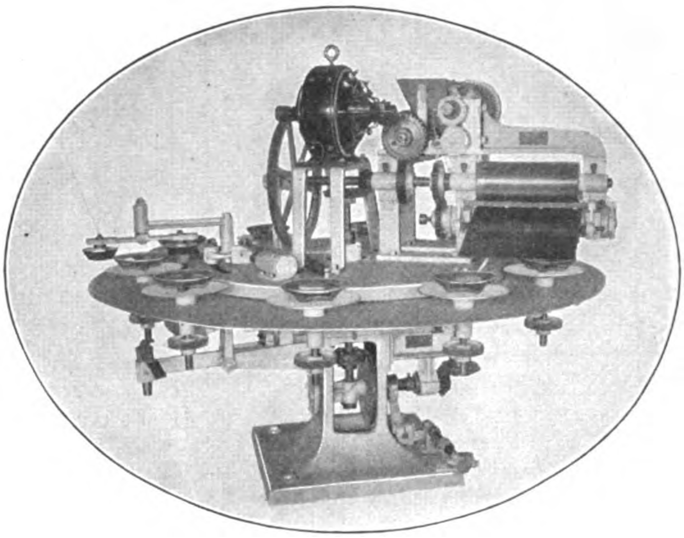
In factory buildings the jars caused by the pounding of punch-presses or the sudden dropping of heavy materials on the floor above are apt to be too severe for the filaments of incandescent lamps suspended from the ceiling, just as they also are for the mantels of gas burners. With the latter, the necessity of having gas-tight joints in the piping makes it impractical to cushion the fixtures, but with electric lamps this can easily be done. With lamps hung on drop cords, one of the simplest ways consists in hooking the ends of a light spiral spring into the cord.



ANTI-VIBRATOR

A Sanitary Pie Machine

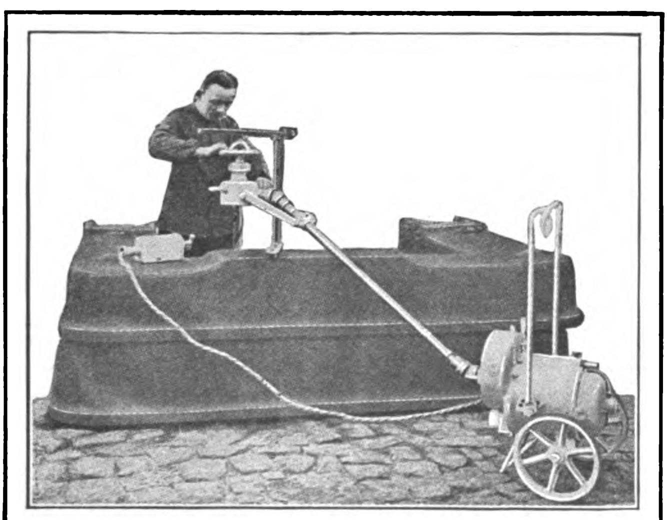
When it comes to quantity pie-making, in rather crowded quarters with ordinary bakers' helpers instead of the trim housewife, most of us would prefer to have as few hands as possible touch the dough. In most modern pie bakeries this happy condition exists. Mixing and kneading machines prepare the dough and cut it into lumps of just the right size for a single pie crust, which lumps are dropped one by one into the hopper of a pie machine. Each lump passes between rollers in two different directions, thereby flattening it into a disk a trifle larger in diameter than the needed pie crust. The disk of dough thus formed slides down over one of the ten pie tins on a revolving table, and when it comes to the other side a baker pours a ladle full of filling on it. Then when it passes under the rollers a second time, another disk of dough drops on it, forming the upper crust. This is pressed down tight by the roller shown at the left hand edge in the illustration, which also trims off the projecting edge of the crusts, leaving the pie ready for the oven. With such a machine, three men can make from 500 to 600 pies an hour.



SANITARY PIE MACHINE

A small electric motor perched at the top of the machine supplies the power. Such a pie machine is said to pay for itself even with an output of only 1,000 pies per day.

Go-carts for Electric Motors



BRINGING THE DRILL TO THE WORK

The practice of having a married man place the pride of his heart in a go-cart so as to wheel it about much more easily than he could otherwise move it, is far older than our use of electric power. Having long ago learned how to utilize electricity as a source of power for whole shops, the more progressive manufacturers have in recent years been coupling individual motors direct to the machine tools used for shaping all sorts of light pieces. Now some are going still further, by taking both the tool and the motor to the work so as to avoid moving heavy pieces. The illustration shows how this is sometimes done by mounting the motor on a go-cart from which a jointed shaft transmits the power to the drill or other tool, the current being regulated by the switch shown in front of the workman.

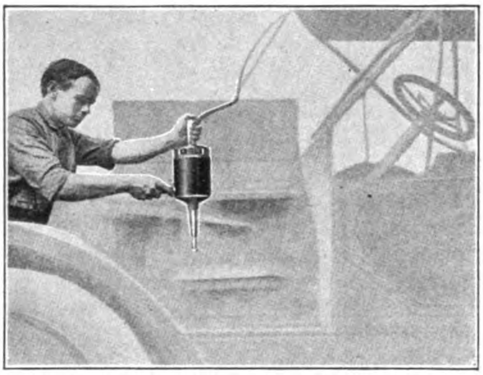
The Modern Spinning Wheel

Almost a complete revolution has been brought about in the textile industry, in the last few years, by the introduction of motor drive. This is partly accounted for by the presence of abundant water power in the great textile districts of New England, which is easily converted into electricity, the most flexible and economical form of energy. But even without the water power the innovation would have come about sooner or later owing to the simplification of machinery, greater cleanliness and better light, which are characteristic of the motor operated factory.

The picture herewith shows a group of spinning machines in the Brighton Mills, Passaic, New Jersey. Each spinner is operated by its own individual motor and it is not hard for the imagination to contrast this picture with the one which would have been shown had the machines all been driven by belts from overhead shafting. With the new method in effect there is less waste of energy, greater safety to operatives and instant control of every machine.

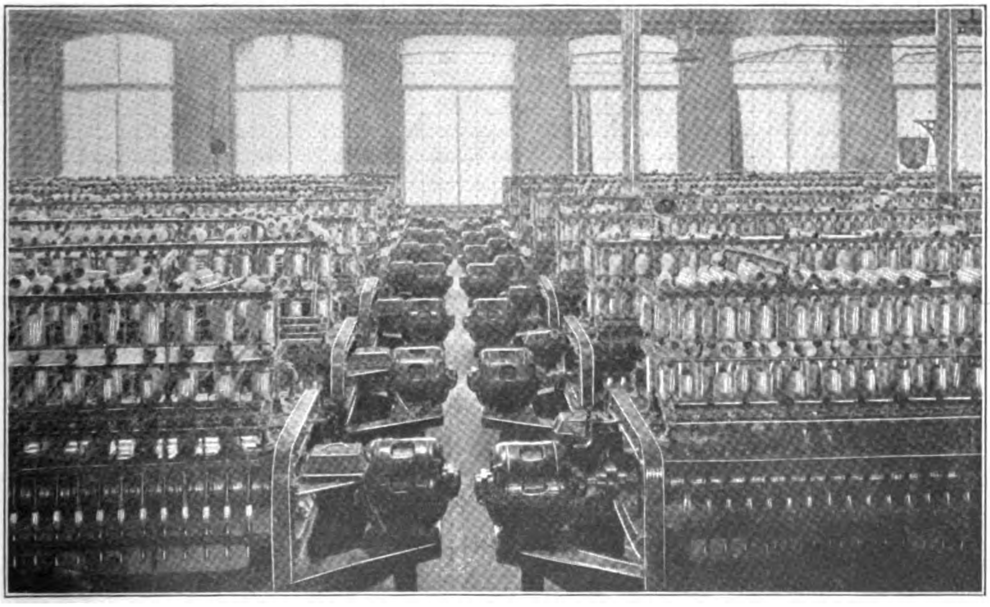
Regrinding Auto Engines Valves

Among the many automobile troubles from which the electrics are happily free, is the difficulty of keeping the engine valves in proper working order. Owing to the gradual and irregular wear on these valves,



REGRINDING VALVES

the seats against which they close have to be reground occasionally, which means a slow and expensive piece of repairing when the engine has to be taken apart for this



A LINE OF SPINNING MACHINES DRIVEN BY INDUCTION MOTORS.

purpose. In this, as in other parts of his work, the progressive repair man is learning that electrical devices can save a great deal of time for him and thus enable him to satisfy his customers without tying up their automobiles for days at a time. Now if a valve leaks, he does not always need to take the engine out of the auto, or even to remove the bonnet, but can regrind the valve seat with an electrically driven grinder which, while light enough to be easily handled, still is heavy enough to have its own weight furnish the pressure needed for the grinding.

Electric Hammer Drill

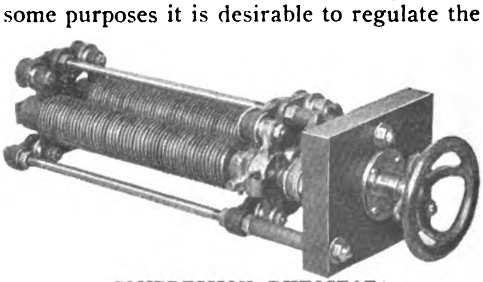
An electric drill, for rock, concrete and similar work, that will operate on the reciprocating or hammer principle like the ordinary pneumatic drill has long been sought. One that seems to have solved the problem is called the Electro-magnetic hammer, the term hammer being used to avoid confusing the device with the usual form of electric twist drill which has been used for steel, iron and woodwork for many years. It is not only a great time saver over hand-drilling but is also convenient, as it takes current, at the usual lighting voltage, through a cord and plug. Direct current is required for its operation.

ELECTRIC HAMMER DRILL

The equipment, here shown "on the job," consists of a small motor housed in the upper part of the device and requiring the same amount of current as three 32-candle-power lamps. In the lower part of the device is a magnet coil which the motor, by means of bevel gears, pulls back and forth in a sleeve. A solenoid plunger tries to follow this coil and stay inside its magnetic field and in so doing jumps back and forth at the rate of 1,500 times per minute, striking the hammer head located at the nose-piece. The magnetic field which the plunger tries to follow acts as a sort of cushion for the plunger. Current from the motor leads energizes the magnet coil.

Compression Rheostat

The ordinary rheostat used in starting motors consists of a series of resistance coils. By moving the handle of the rheostat from one contact to another these coils are one by one cut out of the circuit. The ordinary rheostat has from six to twelve of these coils, which makes it possible to vary the resistance by that many steps. But it must be varied by one of those steps. For some purposes it is desirable to regulate the



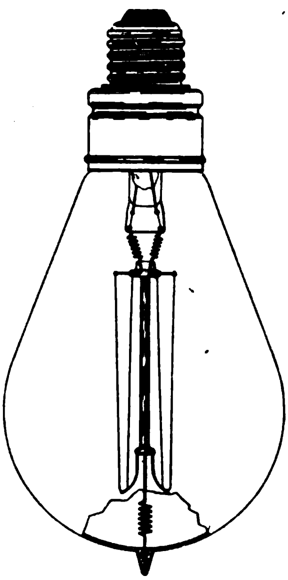
COMPRESSION RHEOSTAT

resistance more closely than this. It is very advantageous to be able to do so in charging storage batteries, for instance.

The rheostat shown accomplishes this result, but in an entirely different way. It is composed of two piles of carbon disks, through which the current passes. The more closely these disks are pressed together, the less resistance they oppose to the passage of the current. By means of the screw (on the right) any desired pressure may be placed on the piles. The gradations of resistance which it is possible to get with this rheostat are therefore infinitely fine.

To Prevent Breaking of Filament

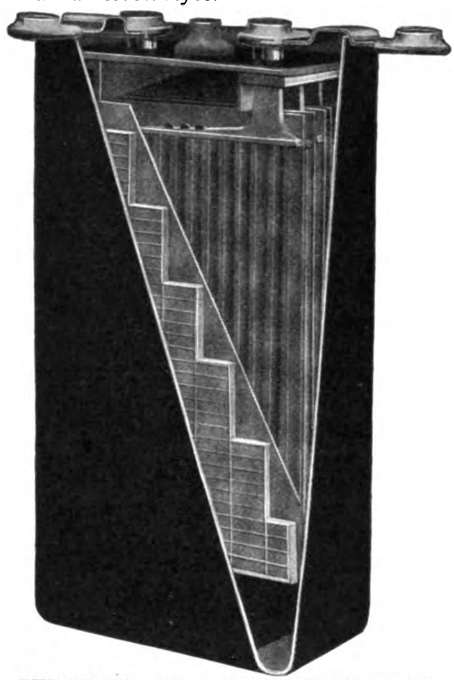
One of the obstacles met with in the introduction of the high efficiency lamps of which the tungsten is a type is the ease with which the filaments break, their cross-section being small. Lamps are sometimes roughly handled and often placed in fixtures where subject to vibration. A patent on a means to protect the filament from shocks and vibration has been issued to Elihu Thomson of Swampscott, Massachusetts. The filaments are mounted on a framework as shown, this frame being supported by spiral wire springs which carry the current and also allow the frame to oscillate back and forth within the bulb and relieve the filaments from any sudden shock.



LAMP FILAMENT HUNG BY SPRINGS

The Inside of a Storage Battery

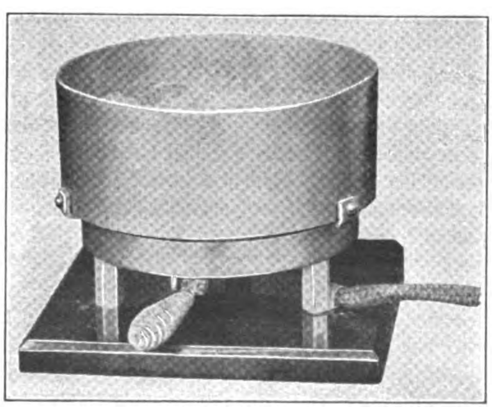
This picture shows what the inside of a storage battery cell looks like, the cell being one of the new "Ironclad Exide" kind made particularly for electric vehicles. The plate with the vertical ridges is the positive one. Each vertical rod is surrounded with active material which is protected and held firmly in place by a hard rubber tube. Separated from each positive plate by a thin, flat wood separator is the negative plate, the one with the cross lines in the picture. These plates are then hung in the battery jar and connected as shown, the jar being filled up with the usual electrolyte.



THE INSIDE OF A STORAGE BATTERY

For the Plumber

The electric lead melting pot will reduce 15 pounds of lead to a liquid state in a few minutes. The flaring, noisy jet of the gasoline torch is happily eliminated and though the electric melter is not suitable for use in old-fashioned houses, it is fast becoming the rule, with the present use of electricity, that wherever a plumber is ever needed there electric current will also be found.



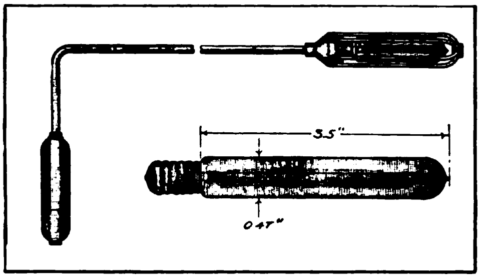
LEAD MELTING POT

FOR PRACTICAL ELECTRICAL WORKERS

HOW TO MAKE AND OPERATE ELECTRICAL DEVICES

Electric Lamp for Wine-cellars

An English inventor, Frederich Hughes of London, has produced an electric search-light for use in wine-cellars, that is a great improvement in the matter of neatness, absence of odor, and general reliability, and much better than the old lamps with a bowl used for testing beer-barrels, and other vessels for containing malted and spirituous liquors. This new cellar lamp consists prin-



ELECTRIC LAMP FOR EXAMINING WINE BARRELS

cipally of a strong electric incandescent lamp, of special form, on the end of a long bent pole-like handle. This lamp is of such slight diameter that it will readily pass through a bung-hole only five-eighths inch in diameter.

The advantages of this device over the old style are readily seen. If a wax-candle or a gas flame is brought into contact with the cold inner wall of a barrel, there is at once formed a slight deposit of soot, which may not be apparent, but which sooner or later either bleaches or colors the liquid in the barrel.

In the case of gas the danger is that the products of combustion in combination with the carbonic acid already in the barrel will hide from the sense of smell any unpleasant odor that may be therein; so that a cask may be considered clean when in reality it is foul.

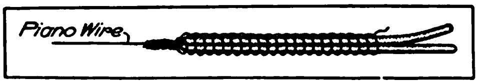
With the new lamp the test may be as prolonged and as thorough as desired, without the lamp causing odor.

As the heat developed by this lamp is but slight, the apparatus may be used for lighting barrels containing readily inflammable or explosive substances, whether liquid or gaseous, without any danger of fire or explosion. But a still more valuable quality is, that at the end of the pole-like handle, beyond the lamp, there may be attached a rounded or oval mirror, which, when lightly pressed against the wall or bottom of the receptacle, may by means of a hinge-like arrangement be made to take a horizontal position, and thus enable a very accurate examination of the interior.

Lamps of this type are also desirable for examining boiler-tubes, etc.

Difficult Wiring Job Made Easy

Some time ago I had a chandelier to rewire which had three 90-degree bends from inlet to outlet. After working about two hours I hit upon the following method.



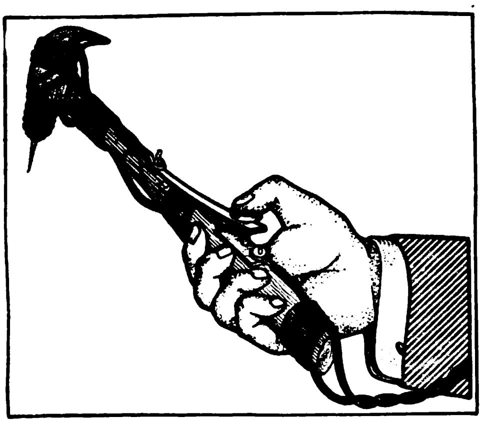
DEVICE FOR WIRING

The chandelier in question had a very small bore through which the wires had to go. There was just room enough for the two wires and not a particle to spare. I first took a piece of fixture wire and doubled it so as to have a closed end on one end of the wire, the entire length of the doubled wire being a little more than the length required in the fixture. I then procured a small shot, about No. 10, or as large as would go through the fixture. I cut the shot half way through with a knife blade and then inserted a piece of smooth thread, squeezing the shot on the thread securely.

The shot was now placed in the highest point of the fixture and allowed to come to the lower outlet. By rapping the fixture with the hand it passed through quickly. After the shot came out where it was desired, a stronger piece of thread was drawn through, strong enough to pull in a piece of piano wire, about No. 24 B. & S. gauge. One end of the piano wire was now hooked to the closed loop end of the fixture wire as shown. With about No. 32 iron wire the hook of the piano wire was wrapped closely so it would not unhook. After the hook on the piano wire had been wrapped the winding was continued on the fixture wire for a few inches making the turns about 1/16 inch apart. This winding on the fixture wire gives the fixture wire a slippery surface as it acts as a sort of flexible metal cover. A little oil rubbed over the whole thing before pulling in will help. With a pair of pliers the wire was drawn through and at the same time pushed into the fixture at the other end.—HARRY FALTERMAYER.

An Electro-magnetic Tack Hammer

I have a handy electro-magnetic tack hammer made as follows: Wind a layer of tape on the hammer head fastening this tape



ELECTRO-MAGNETIC TACK HAMMER

with glue. Over this as shown wrap several turns of No. 18 or 20 magnet wire. A steel spring and thumb contact are used to open and close the electric circuit. In finishing it would be well to dip the hammer in some melted paraffine wax to make the wire retain its shape and to preserve the insulation. It will operate nicely on one or two dry cells. To get the right number of turns will require a little experimenting. Start with a dozen turns and if sufficient magnetization is not obtained increase one or two turns at a time till the required number is reached. This hammer is handier than the permanent magnet type because you can pick up tacks and drop them again at will.

The Model Visitor

To the layman the electric power plant is a world of wonders. Whether stray "lines of force" or some other strange energy takes possession of some of his kind when visiting such places is uncertain. In proof that all is not as it should be a station operator suggests from experience the following rules for visitors:

Come in the station and ask some fool questions. All the operator has to do is to answer them.

Ask where the boilers are located and whether we use coal or wood.

Spit on the floor. The operator has nothing to do but follow you around with a bucket of water and a mop and clean up after you.

Throw cigar stumps and cigarettes on the floor. It is too much trouble to throw them out of the door.

If you see the machine sparking, tell the operator about it. He is not liable to know it.

Ask the operator if he doesn't get a little sleep at night. That is what the company is paying him for. If he does sleep, he will surely tell you.

Ask him what hours he works; then tell him you would not work such hours.

Ask the operator how much money the company is paying him. He has no private affairs.

Tell him several of your latest and most foolish jokes. He has nothing to do but to listen to them.

Make this your habitual loafing place. It was constructed by the company for your special convenience.

Be as careless as possible while here. There is no danger. We only carry 15,000 volts.

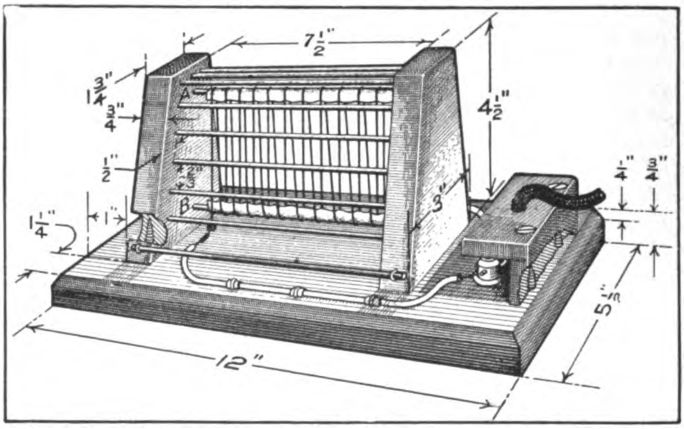
When you have complied with all these rules and asked a few more foolish questions, you may consider yourself a model visitor.

To Make an Electric Toaster

The electric toaster shown in the cut is now in daily use and is not hard to make. The frame work consisting of the base and the two uprights may be made either of hardwood or asbestos board. If constructed of the former, the portion of the base under the coil, and the inside surfaces of the two uprights should be covered with a 1/8 inch sheet of well made asbestos paper, or thin asbestos board may be substituted for this lining. Asbestos board is to be preferred, and this material in almost any degree of hardness may be purchased. It can be worked and will hold wood screws. The cut gives all dimensions needed to work to shape the wood or asbestos board.

After preparing the base and uprights, drill fifteen holes 1/4 inch deep into the inside face of each upright to support the No. 6 wires shown. The wires (A) and (B) wrapped with asbestos paper serve as stretchers upon which to wind the resistance wire, the holes for these wires being 3/4 inch from the top and bottom respectively of the uprights. For the wires that form the "cage" about the heater coil and support the toast, use fifteen pieces of No. 6 iron wire each eight inches long. The screws that hold the uprights in position should be countersunk on the underside of the base. The binding posts should now be set in position and their protecting covering containing the reinforced cord left until everything else is done.

To assemble, secure one upright in position using 1 1/2-inch wood screws. Place the other upright where it belongs without fastening it and put in place stretcher wires (A) and (B). Upon these put asbestos paper as shown and with the assistance of a helper begin winding on the heater coil. Use 80 feet of eighteen per cent No. 22 German silver wire. Wind the successive turns of wire so that they do not touch each other and fasten at each end with a turn or two of No. 16 copper wire. This done, have your helper hold (A) and (B) while you tip the unfastened upright out and insert the wires of the cage. Then fasten the upright in place. The wire from the binding posts to the coil may be what is known as under-



ELECTRIC TOASTER

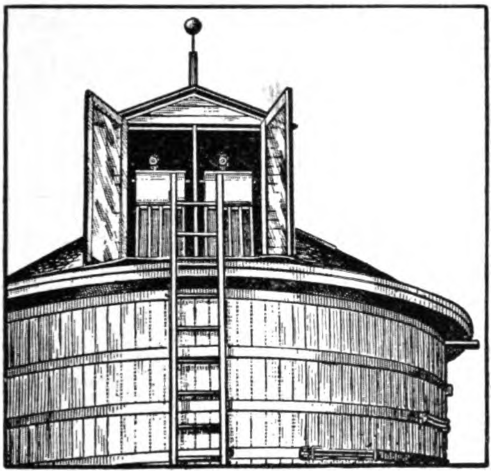
writers' wire or asbestos covered wire No. 14 and is held in place by double headed tacks containing an insulation at the head. These may be found at electrical supply houses. Now connect the reinforced cord and terminals to the binding screws and fasten the cover in place. On 110 volts this toaster will take four amperes.—L. H. Hardin.

Curing Boiler Scale by Electricity

All waters coming from wells contain more or less mineral salts in solution. In most cases these salts are carbonates of calcium and magnesium. Well water is therefore called "hard" and the more salts it carries the "harder" it is. Rain water on the other hand is called "soft."

When the water is evaporated these salts are left behind. When the evaporation takes place in a tubular boiler they form a crystalline crust over the inside of the pipes. This crust is what is called boiler scale. Boiler scale is a bad thing not only because it impedes the circulation of the water but also because it is a poor conductor of heat and does not readily transfer the heat from the fire to the water.

To get rid of this scale it is necessary either to clean the boilers frequently or to



THE "LUMINATOR"

treat the water with chemicals which will keep the mineral salts from being precipitated in a hard crystalline form. Lately another method has been invented which makes use of very slight electric currents

This method consists of allowing the water to run over aluminum plates of special dimensions and with corrugations of a particular size according to the kind of impurities contained in the water. The passage of the water induces a slight current of electricity which renders the salts in the water amorphous. That is to say, they no longer crystallize, but are thrown down in the boiler as a fine powder which may readily be blown out by steam. The water must be used within seven days after treatment and the apparatus acts to the best advantage when it is placed facing north or south and open to the air. The inventor of this apparatus calls it a "luminator."

Vacant Pews and the Telephone

Another use of the telephone has been discovered by a progressive Milwaukee pastor. This minister's church attracts people from all parts of the city and often the ushers are in doubt as to whether certain pews will be available.

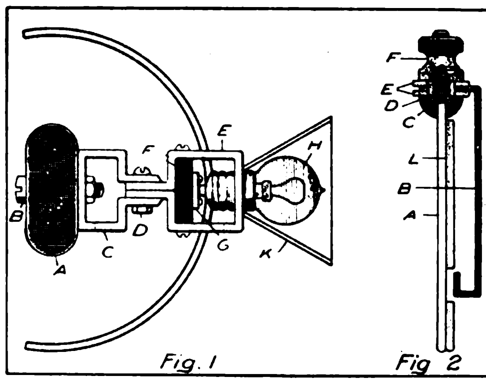
The minister wracked his brains for a long time and finally hit upon the idea of using the telephone. So he arranged with his congregation that when they do not expect to use their pews they will telephone on Saturday and thus the ushers will have a complete list of pews which can be used for the accommodation of non-members.

Flashlight to Mount on Dry Cell

A large flashlight or night lamp can be made for a total cost of about 50 cents. It is made by fastening a simple bulb holder and push button to an ordinary dry cell, and both may be detached and placed on a new cell in a half minute when the old cell is worn out.

As will be seen from Fig 1, which shows a top view of flashlight, the socket which holds a 1½ volt tungsten miniature lamp bulb, is hinged at (D), so that when it is used as a night lamp, it may be adjusted to cast its light in any direction.

Referring to Fig. 1 (C) is a strip of 1/16-inch sheet brass about ½ inch wide, bent as shown. This is bolted to the battery carbon (A) using its binding screw and nut (B). Another strip (E) of 1/16-inch brass is bent to a similar shape and hinged to piece (C)



DRY CELL AND FLASH LIGHT

with a small machine screw (D). In the center of its face is bored a hole of such a size as to take the miniature (screw) base of the bulb (H); about 5-16 inch. It would perhaps be better to use the female screw of a miniature socket, and solder it to (C). Between the sides of (C) is fastened a small piece of hard leather (F) using wood screws as shown in the figure. This has screwed to its face a small piece of brass (G) ⅛ by ⅜ inches; it must not make metallic contact in any way with (E). A brass or aluminum shade or reflector (K) is soldered to (C).

A push button is made and fastened to the cell in the following manner: Over the binding-post (C), Fig. 2, which is soldered to the zinc cup (A) is slipped a ¼-inch length of small rubber tubing (D) and over this two rubber or fibre washers (E). Between these is placed one end of the U-shaped piece (B) which is of light spring brass ¼-inch wide and about two inches long. It must have a hole in the end large enough to go over the rubber tubing. It is connected to piece (G), Fig 1, by a short length of light flexible cord (not shown); and the binding nut (F) is clamped down on the whole. As will be seen from the cross section view, Fig. 2, of the push button and the foregoing, the binding-post is merely used as a support for the button, they being insulated from each other. Under the free end of (B) a small hole is cut in the pasteboard cover of a battery and the zinc scraped clean. To use as a switch slip a strong rubber band around the cell and over (B) to hold it down.

This contrivance may be used on almost any type, or size of dry cell, and can be used as a steady light for a half hour or more without injury. The standard size, 2½ by 6 inches will give 25 or 30 hours of light altogether.—JAMES P. LEWIS.

Changing Direct Current to Alternating

The following described device I have found most convenient for changing direct current to alternating for experimental and testing purposes. A wooden cylinder two inches in diameter is fitted with a shaft as illustrated in Fig. 1. Upon this are placed

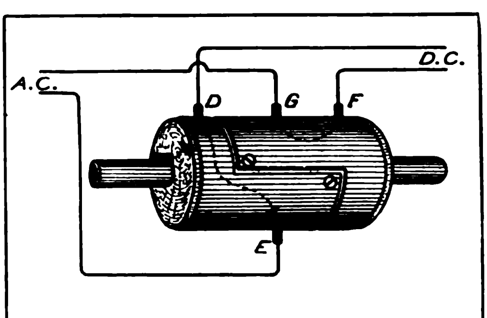


FIG. 1

commutator pieces cut into the shape shown in Fig. 2. These pieces may be made from brass or copper tubing two inches inside diameter or cut from sheeting. Between the two segments an air gap of at least ⅛ inch should be left and filled with mica, as in the commutator of a dynamo or motor. Flat-headed screws hold the segments in place. The length of the cylinder should be about four inches. The brushes may be made of spring brass and set as shown. By means of speed pulleys any ordinary fre-

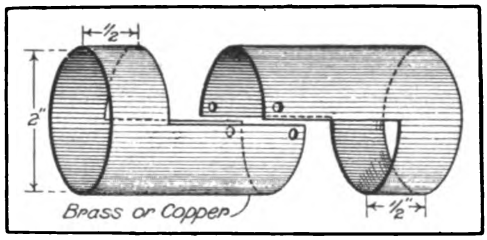
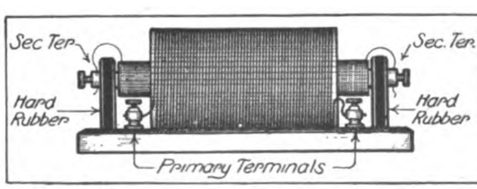


FIG. 2

quency may be obtained, as the current changes direction on the a. c. side every time brushes (G) and (E), which are exactly opposite each other, pass simultaneously from the segment on which they rest to the next one.

A Small Tesla Coil

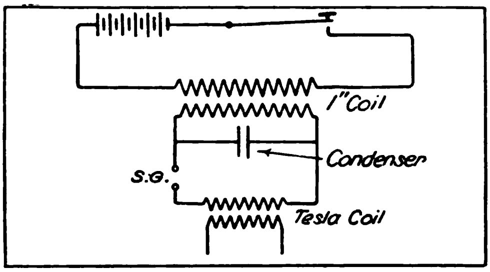
The illustration shows a small Tesla coil which I built at very little expense and which I have used in performing many interesting experiments. For the secondary, wind No. 22 enameled wire on a mailing tube 1½ inches in diameter and eight inches long leaving a blank space of ⅜ inch at each end of the tube. Paint this winding with several good thick coats of shellac. For the primary provide a mailing tube 3 ¾ inches in diameter and six inches long.



SMALL TESLA COIL

Upon this wind 18 turns of fixture wire and shellac thoroughly. Use hard rubber supports on a dry wood base to support the secondary. The primary coil may be secured to the base by shellac. This may be operated in connection with a one-inch coil.

The condenser consists of 26 7 by 5 inch glass plates using 3 by 5 inch tinfoil sheets.



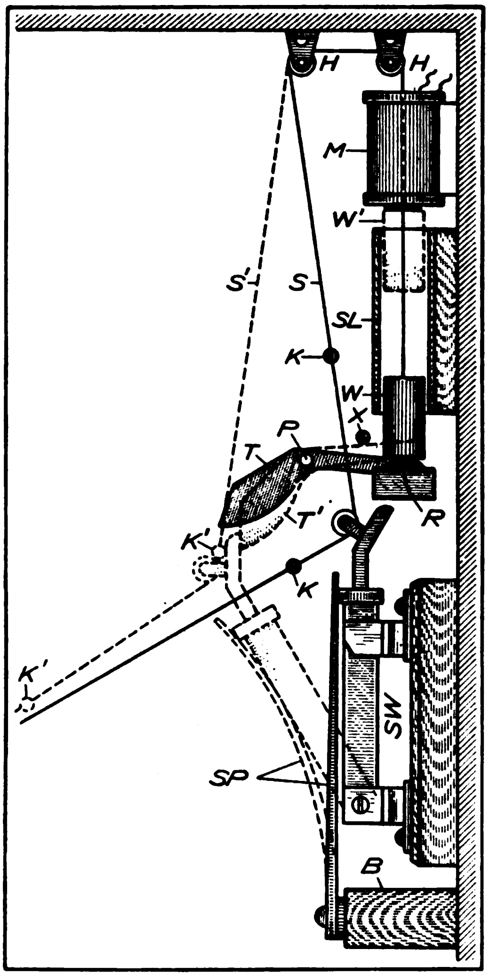
CONNECTIONS OF TESLA COIL

The condenser cuts the spark down to about ⅛ inch but it is very white and "cracky." A zinc gap with an end area 1/16 inch square worked well. With needle points on the Tesla coil spaced three inches, a bright brush envelopes the points. With two wires placed ¾ inch apart and parallel the Tesla coil caused a ladder of brushes to be formed. Other interesting experiments will suggest themselves to the builder.—HAROLD KESSLER.

Alarm System Turns on Lights

In a burglar or fire alarm system the current is flowing through the electromagnets all the time. Any break in the circuit demagnetizes the core of a magnet and releases its armature, the fall of which is used to release clockwork. This clockwork by means of make and break devices sends in an alarm over a second electric circuit.

The application of such a system to the closing of an electric light circuit by a switch is shown in the accompanying illustration. The electromagnet (M) is connected in the burglar or fire alarm circuit. The weight (W) is of soft iron, and is held in contact with the core of coil (M) as long as current flows through (M). When the current is interrupted (W) falls along the wooden guides (S L), strikes the trigger (T) which operating on pivot (P) releases the switch (S W) and the spring (S P) throws the switch in. The weight (W) after releasing the trigger rests upon the rubber (R) which is split to allow (T) to pass down through it. (X) is a stop for the trigger. Strong fish cord may be used to lift the weight (W). Knots (K K) keep the cord from slipping through the pulleys and becoming slack and a small hard rubber or fiber tube through (M) may serve as a passage for it. I placed the outfit in an old telephone box asbestos lined and having a glass door.—C. K. THEOBALD.



ALARM SYSTEM

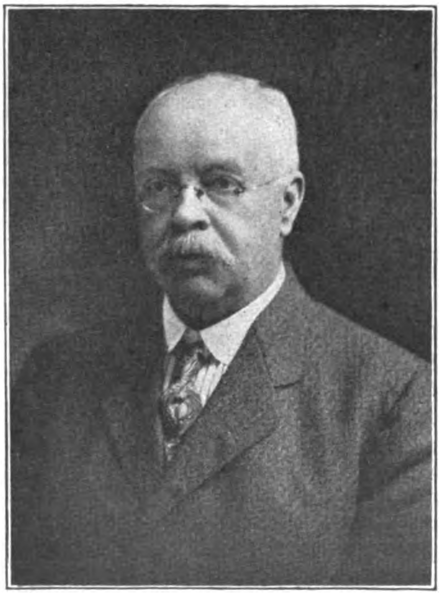
Tent Protects Linemen

Something new in the way of keeping the linemen protected and comfortable while at work on the pole was used during the cold weather of last winter in Knoxville, Tennessee. The telephone companies used a portable canvas tent, which fitted over the cable boxes and wires on telephone poles, effectually protecting the linemen while at work. The tent had four walls and a roof. It could be let down over the top of the pole and could be run from one pole to another by means of a pulley.

Electrical Men of the Times

RALPH WAINWRIGHT POPE

Among the important influences bearing upon the development of the electrical art, is the exchange of ideas, and the concentration of various minds upon a particular subject. An organization of technical men for the reading and discussing of papers is virtually a clearing house for such a purpose. When the American Institute of Electrical Engineers was founded by Dr. Nathaniel S. Keith in 1884 that field was ready, but it became evident that a steady guiding hand was essential to its future welfare. In 1885 Ralph Wainwright Pope was elected its permanent secretary, and it was soon apparent that the man and the job were in complete accord. Today the high standing and prosperous condition of the Institute testify to the value of 25 years of conscientious and intelligent service. Beyond experience in various lines of important work, there could have been at that time no specific training for such a position. The young man of today has before him such a wealth of opportunities, he may have good reason for being perplexed when he either chooses or has suggested to him a career which may at the time seem promising, but eventually proves to be disappointing. Fifty years ago the conditions of education, training and employment were so different from those existing today the comparison is hardly possible.



In 1858 Mr. Pope was a chubby country boy; a graduate from a "little red schoolhouse" in the town of Great Barrington, Mass., where one of the most successful conventions of the Institute was held in 1902. As an assistant to his brother, Franklin Leonard Pope, who was then the local operator of the Hughes printing and telegraph instrument, he had become proficient in that branch of telegraphy, and had also mastered the rudiments of steam railroad work. In the spring of 1859 he was selected by George B. Hunt, assistant superintendent of the Housatonic railroad, to fill a vacancy at the Pittsfield, Mass., station as freight and ticket clerk. This was practically an apprenticeship for a period of one year at $6.50 per month with board in the agent's family. The next year he was transferred to Bridgeport, but in a few months terminated his engagement for the purpose of taking up telegraphy in the service of the American Telegraph Company at Great Barrington. He soon became an expert Morse operator, working in the offices of the same company at New York, New Haven and Providence. Close confinement and night duty threatened a breakdown in his health, which led to his accepting an appointment in April, 1865, with the famous British Columbia exploring party of the Collins Overland Telegraph. Upon the abandonment of this enterprise, owing to the successful laying of the Atlantic cable in 1866, he returned to New York and re-entered commercial telegraphy. He also took up editorial work on the weekly *Telegrapher*, of which his brother Franklin was the editor. In 1873 he was engaged as an inspector with the Gold and Stock Telegraph Company, being subsequently promoted to the office of deputy superintendent. At this period the "ticker" system was a most attractive field for the inventor of printing instruments, as the machines and their transmitters could not be operated at a sufficient speed to meet the requirements of an active market. To obtain the best results skilled and progressive men were necessary. After ten years' service with this company, Mr. Pope was appointed associate editor of the *Electrician and Electrical Engineer,* and while engaged in this work was elected secretary of the American Institute of Electrical Engineers.

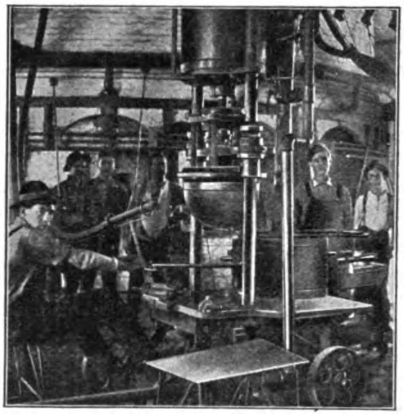
The institute now has about 7,000 members. When it celebrated in 1909 the close of its first quarter of a century, with 6,700 members, *The Electrical World,* discussing the conditions that had surrounded the Society and had built it up, said: "Upon this pleasant anniversary, when congratulations are so eminently in order, and when we may especially felicitate those who took an active share in the creation of this great and powerful organization, it seems peculiarly appropriate to make cordial reference to the services of Mr. Ralph W. Pope, who has been secretary continuously since the annual meeting in May, 1885, when the society was only one year old. This loyal and faithful service to the Institute, unmatched as to official connection with the body, except in one instance, has probably been more effective than any other factor in all this splendid growth."

Making Holophane Globes

Most of us are familiar with the artistic light diffusing globes and reflectors which go under the trade name of Holophane. These are constructed with a system of scientific prisms, vertical on the interior to diffuse the light and horizontal on the exterior to distribute the light. Each of the prisms has a number of faces, there being more than 1,000 carefully calculated prism faces on the largest globes. Holophane reflectors have only external prisms which serve both to direct and diffuse the light.

In order to secure perfect prisms, the globes and reflectors are pressed by means of a plunger in strong and heavy iron molds. The profile of each of the prisms, having been calculated, is drawn out on a very much enlarged scale in order to secure accuracy. The drawing is then reduced and transferred to a steel plate and the profiles cut out by an engraving method. A tempered steel tool is then made corresponding to this engraved plate, accurate to the thousandth part of an inch, and this tool is used in cutting the grooves in the mold in which the glass is pressed.

The mold having been prepared in this manner, the glass specially compounded to



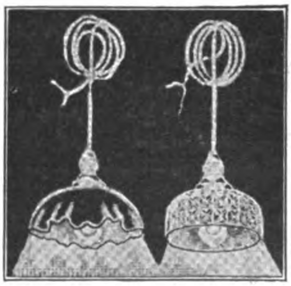
MOLD FOR PRESSING HOLOPHANE GLOBES

secure high optical quality, is formed up by a specially constructed press. A thorough annealing of the glass to embody toughness completes the process.

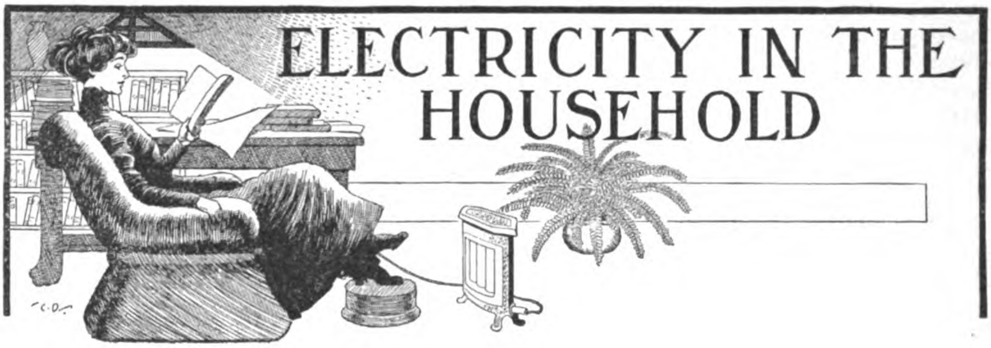
The mold shown in the above illustration weighs 800 pounds; the plunger, 500 pounds. The pressure is 16,000 pounds.

Miniature Drop Lights

In England where the building of models by amateurs is much more common than in this country, the boys not only run their miniature railways and boats, but also wire the doll houses for their sisters. To make this lighting more in harmony with that of real homes, they sometimes suspend the miniature sockets by drop cords, and even use miniature glass shades over the lamps. Our illustration shows two such shades as supplied by a Twickenham firm, one having a silvered interior while the other imitates a cut glass effect.



MINIATURE DROP LIGHTS



Where Art and Science Meet

By T. VERNETTE MORSE

Not long ago a Boston man, noted for his interest in art and the promotion of its principles in the home advised a return of the people to the good old Puritan period, when well defined duties occupied certain days of the week, and the housewife was so strict in enforcing those duties, that every comfort of the household was sacrificed to their accomplishment. He described the picturesque pounding barrel, the rub-a-dub-dub, of the washboard and the remarkable physical exercises brought into play by the twisting and wringing of the clothes. He pictured the snowy white linen upon the line, and dwelt with pride upon the fact that his grandmother had reared a family of ten children, amid the simple conditions of such a life, all of whom had made a success in after years.

Possibly the character of the boys who were made to pound the clothes was stronger and better for the exercise and patience which they were called upon to endure for cleanliness sake, and they may have been able to appreciate more fully the importance of keeping the Sunday linen immaculate, after having had a hand in the transformation process, but the speaker failed to impress his audience with the weary backaches and aching arms that accompanied this picturesque task. One day at the washboard would have given him a different point of view.

Modern machinery may not be picturesque but its a wonderful comfort, and wash-day has lost its terrors, since the introduction of the electric washing machines and ironing appliances.

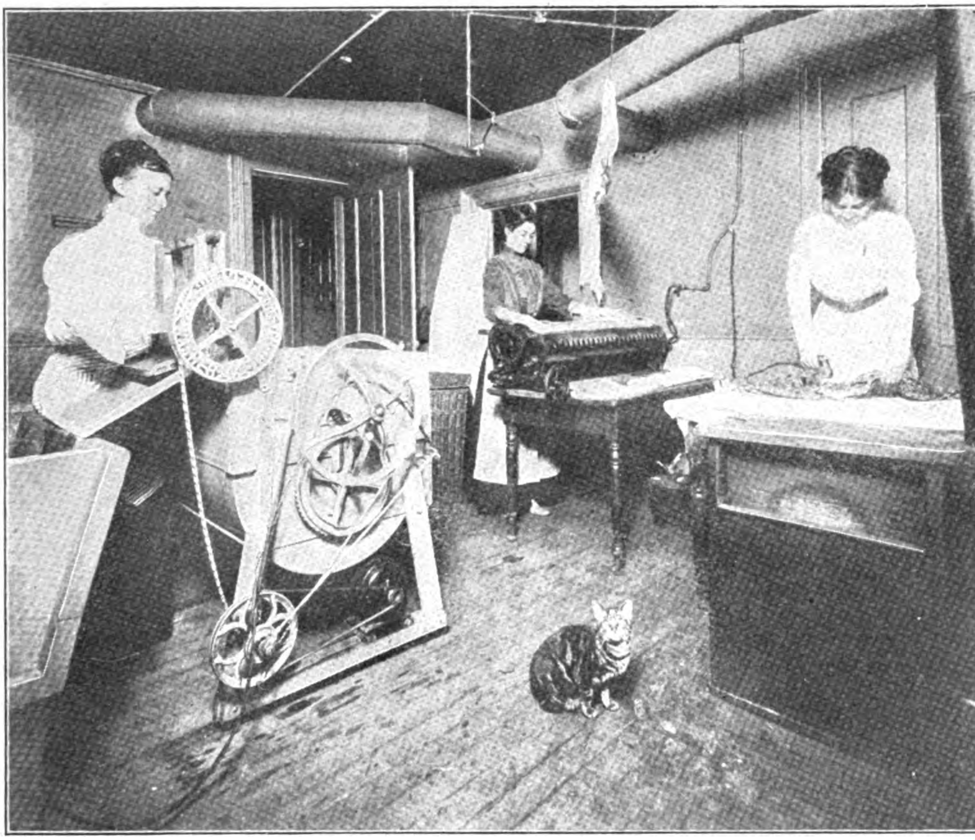
Three times a week the laundry laboratory at the Artcraft Institute is in operation. Modern science has assisted greatly in the care of clothing. The chemical knowledge necessary to remove stains and the proper method for bleaching are important educational features of the laboratory, making it possible to execute the work in such a manner that the finest fabrics and sheerest laces come from the laundry in perfect condition. Bedding which has been so difficult to clean, may with a little care be made fresh and sanitary.

The laboratory is in charge of a competent instructor who carefully sorts the clothing, keeping the fine clothing by itself.

The water in which the clothes are soaked is prepared by adding one cup of strong borax water. This will not injure the finest fabric and loosens the dirt, better than any other chemical.

If it is not convenient to soak the clothes over night, they are placed in the cylinder of the electric washing machine and washed in the cold borax water for fifteen minutes. Wring them from this water, replace them in the cylinder, add the soap, run the hot water over them, turn on the current and wash them 25 minutes longer.

For six months the electric washing machine has been in use in this laboratory. Every kind of clothing from the finest lace to the heaviest bedding and rugs has been laundered. In all of that time, not a single



MODERN MACHINERY MAY NOT BE PICTURESQUE BUT IT IS A WONDERFUL COMFORT

garment has been torn. The clothing is white and clean at no expense of physical exhaustion.

The time saved by the use of an electric washer more than compensates for the expense of installation. It does away with the necessity of hiring a laundress. It allows one to keep the family clothing free from all unsanitary contamination, which is one of the most important features of modern household science.

It is so simple in construction that the most inexperienced woman may learn to use it in a few hours.

Besides the electric washer the laundry is fitted up with an electric ironing machine. All of the heavy sheets, and flat pieces are run through this in a comparatively short time. The hand electric flatiron is used for the hand work, with a smaller electric iron for shirtwaist sleeves and children's fine dresses.

In preparing the soap, shave it fine, place in a pan with one cup of borax water, cover with water, and set it over the fire where the soap will melt. As soon as melted, put it on the clothes in the cylinder and pour on the hot water. Turn on the current. During the few minutes that is required to wash the clothing, the line is put up and the starch prepared.

Thus no time is lost, and by night, if one wishes to work all day, a large washing and ironing is completed.

After the clothing has been thoroughly washed, run through the wringer into cold water. Be sure and have plenty of water so that all suds may be removed. Wring from this water, if it is free from suds, into the bluing water. Dry all white clothes in the sun if possible. Nothing is more sanitary than sun dried clothing.

The principal factors for fine laundry work are plenty of clear fresh water, a good quality of pure soap and borax.

To wash blankets use one pint of melted

soap and two large tablespoonfuls of borax, for every tub of water. This makes a fine suds. Wash the flannels for five minutes in this solution, rinse through two waters. Do not wring flannels; squeeze the water out, and let them drain on the line. Flannels washed in this way will remain soft and pliable.

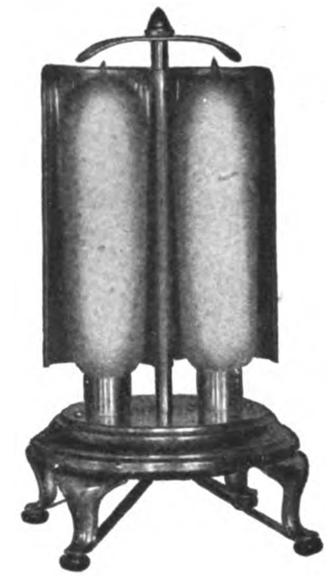
When starching clothes first wet the required amount of starch in cold water, pour on boiling water until it is of the right consistency, allow it to remain over the fire until it becomes perfectly clear. To every quart of starch add a teaspoonful of laundry wax. This gives a fine gloss to the starch and keeps the irons from sticking.

Clothes that are sprinkled with warm water will iron better, than those that are sprinkled with cold water, as the moisture is more evenly distributed through the fabric.

We consider that the modern laundry run by electricity will not only save time, and produce better results than any other method, but experience teaches us that it will pay for itself the first year, and after that period, looking at it from the business standpoint, it is all clear profit.

Radiant Heat from the Lighting Circuit

During a cold, late spring and in the fall there are weeks when some heat is necessary although the regular heating system if put in commission makes the rooms uncomfortably warm. These are the times when an electric radiator "shines" in more senses than one. Here is an illustration of a small twin glower radiator which does not require a specially wired circuit but may be connected to the ordinary lighting circuit.



ELECTRIC RADIANT HEATER

The same "non-oxygen consuming" radiant heat so essential to hygienic conditions not only in the sick-rooms of homes and hospital wards, but also for safeguarding the general health of any household, is available, while extreme lightness of weight permits of the radiator being easily moved from room to room. Thus it can be readily used for increasing the temperature of the bathroom preparatory to the bath, for making the bedroom comfortable in the early morning when the regular heating system has a low tone, and for adding to the comfort of reception halls, libraries, studies, and other rooms, which usually are of temporary occupancy. Furthermore, the absence of carbonic-acid-producing open flames renders its use particularly desirable in rooms containing valuable paintings and beautifully bound books, which rapidly deteriorate when exposed to injurious burnt gases or products of combustion.

Electricity the "Matchless" Light

In his annual report, the Fire Marshal of Ohio states that 538 fires (in 1910) were caused by carelessness with matches, and that 182 of them were due to children playing with matches. The total loss caused thereby was $191,543.

In the State of Minnesota, the total number of fires reported (counting only those in towns having fire departments) was 1,790. Of these, 106 were due to carelessness with matches, and 67 from children playing with matches; while only 23 were ascribed to electric wires.

The Fire Marshal of the State of Ohio contends that fully 10 per cent of the losses in the state every year are due to the "criminal match," as he names it.

The above facts should be good arguments for the electric light solicitor.

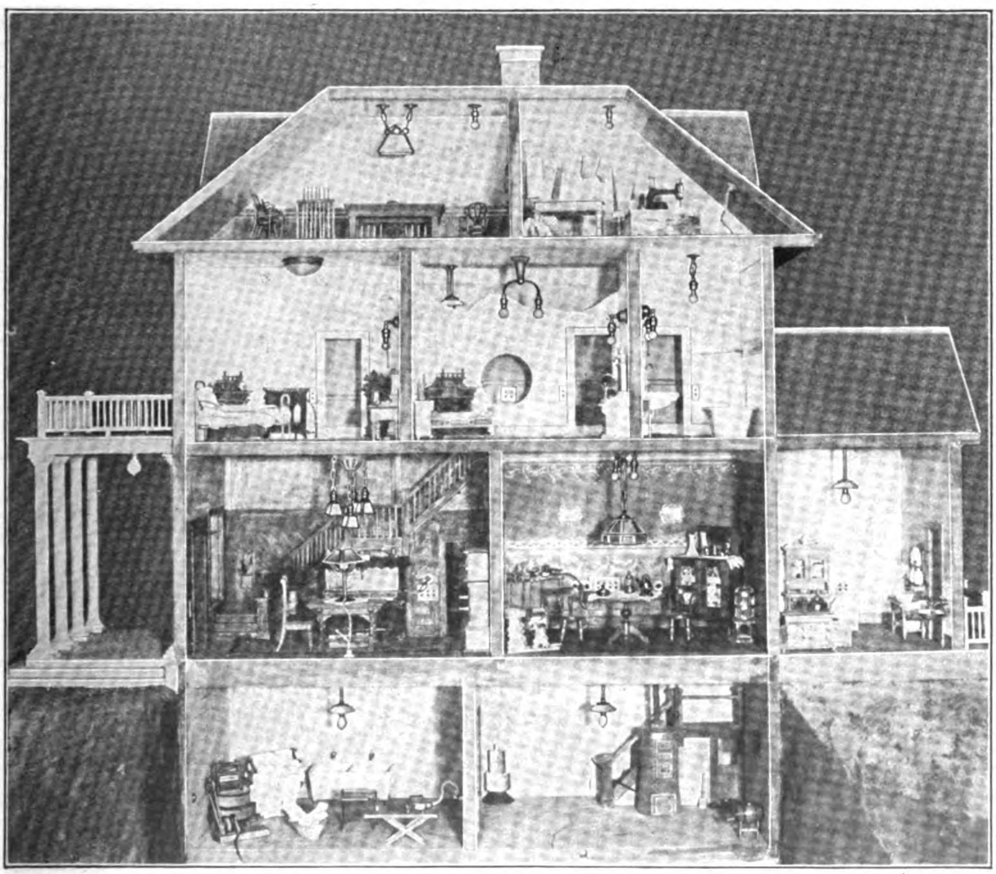
A Model Electrical Home

Electricity is imperative to the advancement of modern home life. It is largely responsible for the degree of success attained by cities and the comfort of citizens. It is, therefore, of the utmost importance that a city should be well lighted, but to be well lighted each individual home should have the proper illumination.

The proper planning of a well-lighted home rests in the true conception of what modern science calls efficient illumination, and a clear understanding of the essential factors necessary to produce artistic effect having constantly in mind economy.

It is just as easy in building to arrange for convenient and efficient lighting and for the necessary outlets for connections to the sewing machine motor, washing machine, electric irons, vacuum cleaner, etc., as it is to allow these things to be put in haphazard. Take for instance the six-room cottage here shown. It will be seen that the electrical work has been carefully planned from cellar to garret.

This picture represents a model cottage which was part of the exhibit of the Minneapolis General Electric Company at the Minneapolis Electrical Show, where it attracted much favorable comment among householders. There are seven rooms beside the basement compartments. Note the convenient and artistic arrangement of the lighting fixtures in the various rooms; how the push button switches are conveniently located; how connections are made for the sewing machine, laundry machinery, table lamp, electric radiator and basement vacuum cleaner. In the kitchen is an electric cabinet. There are also special and convenient lighting fixtures for the bedroom dresser.



A MODEL ELECTRICAL HOME

JUNIOR SECTION

A wholesome, fascinating study is the study of electricity. No boy who spends his spare time and his spare money in making and learning to operate electrical apparatus will go far wrong. This department is for such boys.

Construction of Small Motors and Dynamos

By CHAS. F. FRAASA

CHAPTER V.—FIELD AND ARMATURE WINDINGS

There are various ways of exciting the field magnet of a dynamo. When excited by passing a current external to its armature circuit through the field windings, it is said to be separately excited; when the current is furnished by the armature of the generator itself it is said to be self-excited.

A separate excitation is illustrated in Fig. 21. In this diagram are shown two complete circuits, that are in no way connected. One circuit is composed of the commutator (C), which is connected to the armature windings, though these connections are not shown, the brushes (B), and the load of lamps. The field circuit is composed of the field winding (FW) the battery or other source which supplies the current, and the variable resistance (R) which is included in the circuit to regulate the magnetizing current to the proper value. Since the field is separately excited, the current and consequently the field ampere-turns will remain constant, notwithstanding any variations in the armature output, thus providing a steady magnetic field. With a steady magnetic field the voltage generated by the armature of a separately excited dynamo depends practically upon the speed at which the armature rotates. With a constant speed and field magnetism, the voltage falls off as the amperes delivered increases. This may be accounted for by Ohm's law, the voltage drop being equal to the product of the resistance of the armature times the current.

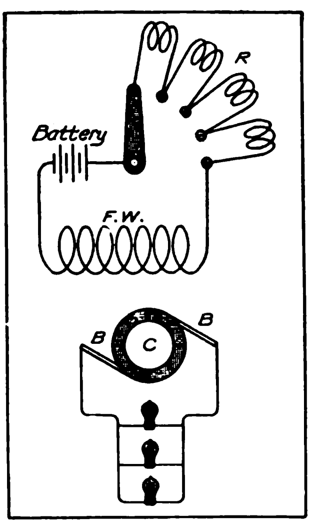


FIG. 21. SEPARATE EXCITATION

The separately excited dynamo has the advantage of making it possible to reduce the expense of construction by using wire of a large diameter, with a correspondingly large exciting current, and fewer turns of wire on the field poles.

Most alternators are separately excited, because if self-excited, any inductive load in the circuit would cause a disturbance in the armature, which would result in a fluctuation in the field magnetism and hence in the output.

The machines, the construction of which is given in these articles are self-excited, the direct current for excitation being furnished from the armature by means of the commutator.

Of self-excited dynamos, the two types will be discussed here: The series and the shunt. In the series-wound dynamo, all the current output at the brushes passes directly through the field winding. In the illustration, Fig. 22, of a series winding the lettering is the same as in Fig. 21. The current generated in the armature passes to the commutator (C), through one brush (B), to the field wire (FW), then to the lamp load, and back to the armature through the brush (B).

Since all the current flows through the field wire in the series dynamo, an increase in current means an increase in field magnetism and consequently an increase in voltage. The voltage therefore fluctuates with the load. For a load requiring a constant voltage, a series dynamo should not be used.

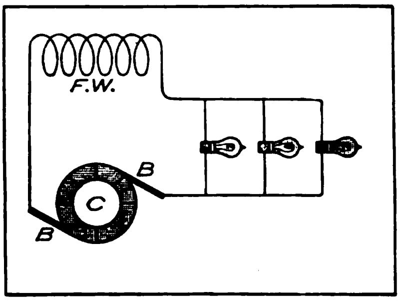


FIG. 22. SERIES EXCITATION

In the shunt wound dynamo, Fig. 23. only a fraction of the current passes through the field, depending upon the voltage and the resistance of the field winding. The current divides at the brushes, part going to the field winding (FW), and part to the lamp load. A variable resistance (R) is provided in the shunt field circuit, and is connected in series with it.

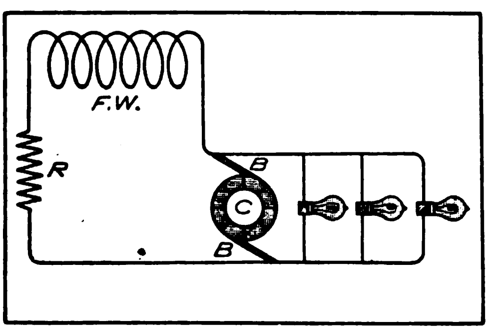


FIG. 23. SHUNT EXCITATION

The amount of heat which a coil of wire can radiate is limited by various factors, and should the coil develop more heat than it can radiate, the temperature will rise and destroy the insulation. To prevent this a certain cross-sectional area, determined by tests, is allowed per unit of current, so that the designer may calculate the size of wire that will carry the given current without overheating. This cross-sectional area is measured in circular mils, as, for instance, allowing 800 circular mils per ampere. The allowance in circular mils per ampere for the field magnet windings varies from about 800 circular mils in a 25 or 50-watt dynamo or motor, to about 1,000 circular mils in one of one kilowatt capacity. In the armature winding where there is a better opportunity for the radiation of heat due to the rotation of the armature, the values are one-half as great; about 400 and 500 circular mils respectively.

The series field winding must be designed to pass the full armature current without an excessive drop in terminal voltage. The shunt winding should be designed to carry only a fraction of the armature current, and therefore its resistance must be high so that it will shunt only a certain amount of current, and must contain also a great many turns in comparison to the series winding. For either a series or shunt field winding of a given model the product of amperes times turns, must be constant, no matter what the voltage or type of winding. The wire should have the proper cross section and there should be the correct number of turns. The necessary data for these windings is given in Tables IX and X. The wire for all the windings should be double cotton covered.

TABLE IX

SERIES FIELD WINDINGS
DIRECT CURRENT. 2-POLE. 1750 R. P. M.

TYPE	VOLTS	NUMBER OF WIRE	NUMBER OF TURNS PER POLE
A	25	16	195
	50	19	390
	110	22	858
B	55	15	250
	110	19	505
C	110	15	310
D	110	11	163

Before applying the windings smooth off the rough corners of the field magnet cores and the inside edge of the yoke with a file. The field should then be insulated by applying two layers of thin muslin well soaked in shellac over the core and the inside of the yoke where the winding will come in contact with it. Be careful to see that there are no bare places where the winding can come in contact with the iron. Then proceed to wind the wire on the poles, being

TABLE X
SHUNT FIELD WINDING

DIRECT CURRENT 2-POLE DYNAMO RUNNING AT 1500 R. P. M.				A. C. OR DOUBLE CURRENT GENERATOR RUNNING AT 1800 R. P. M.		
Type	Volts	No. of Wire	No. of Turns per Pole	No. of Wire	No. of Turns per Pole	D. C. Side Volts
A	25	21	600			
	50	24	1200	28	1952	150
	110	27	2400			
B	55	22	1082			
	110	25	2164	26	2062	150
C	110	24	2169	24	1589	150
D	110	22	1644	21	1142	150

careful to get the correct number of turns on each pole, using the size of wire specified in Table IX or X. Wind on a number of turns, and then shellac the surface of the wire, wind on more wire and shellac again, and repeat until the coil is complete. Apply several heavy coats of shellac to the final surface of the finished coil.

When all the coils are wound, connect them as shown in Fig. 24, so that the current will flow in alternate directions in

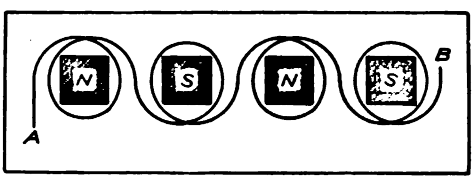


FIG. 24. CONNECTION OF FIELD COILS

adjacent coils, or in the same direction in alternate coils. The two-pole field magnet is represented by the first two poles (N) and (S), Fig. 24, and the winding is also shown, being in opposite directions on the two poles. The ends (A) and (B), of the winding should be brought up to a connection block, which will be described later.

After securing the armature core in place on the shaft by means of the key shown in the construction of the commutator in Chapter IV, the armature should be prepared for winding. Prepare a number of disks of paper equal in diameter to the core, and cut a hole in the center of each disk for passing the shaft through. These disks should be fastened with shellac to both sides of the armature core to a thickness of about 1-16 inch. Now wrap the shaft on both sides of the core for a distance equal to that which the armature winding will occupy when the wires are brought out, and fasten this with shellac, putting enough on the under surface of the strip when winding to cause it to become one solid mass when dry. The armature should then be set aside over night to dry. When dry cut out the paper over the slots with a sharp knife. Carefully file away any projections of the laminations into the slots, and at the ends so that the interior of each slot is very smooth. The slots should now be insulated by two layers

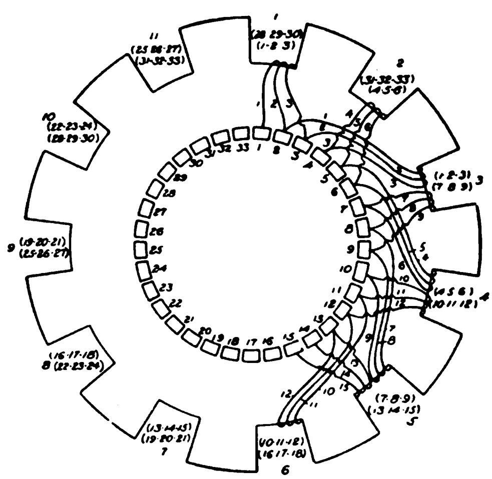


FIG. 25. CONNECTIONS TO THE COMMUTATOR

of thin muslin or tough paper secured in place by a liberal coating of shellac.

Tables XI and XII give data as to the number of turns, size of wire, etc., for the windings of the various sizes of armatures. From these it will be seen that the direct current generator armatures have from eleven to fifteen coils, and consequently have from eleven to fifteen segments on the commutator, which is sufficient for all voltages up to 110, and that the alternating current generators have three times as many coils and segments respectively, since the voltage rises to 155 on the direct current side and the number of poles is doubled, making necessary a brush at each quarter circumference and requiring pratically three times as many segments in the commutator, to maintain the voltage allowance per segment. To use three times as many segments, three times as many coils should be used.

TABLE XI
DIRECT CURRENT DYNAMO ARMATURE DATA FOR TWO POLE FIELD-MAGNETS

	ARMATURE ROTATING AT 1500 TO 1760 REVOLUTIONS PER MINUTE						ARMATURE ROTATING AT 2500 REVOLUTIONS PER MINUTE			
TYPE	VOLTS	NO. WIRE	TURNS PER COIL	COILS NO.	TOTAL TURNS	TURNS PER SLOT	NO. WIRE	TURNS PER COIL	TOTAL TURNS	TURNS PER SLOT
A	110	28	143	11	3146	286	26	95	2090	190
	50	25	65	11	1430	130	23	39	858	78
	25	22	33	11	715	66	20	20	440	80
B	110	25	87	11	1914	174	23	52	1144	104
	55	22	44	11	968	88	20	26	572	52
C	110	22	41	13	1066	82	20	26	676	52
D	110	17	17	15	510	34				

In order to make the armature winding as clear as possible the slot numbers and commutator connections are given below. This will enable the amateur to wind his armature correctly, and will not leave him groping about for a winding.

Because of a difference in the number of armature slots and the number of poles in the field, there is a difference in the windings of the individual armatures, and therefore each is taken up separately.

TABLE XII
ARMATURE WINDINGS FOR A. C. AND DOUBLE-CURRENT GENERATORS FOUR-POLE FIELD, ARMATURE ROTATING AT 1800 R. P. M.

TYPE	NO. WIRE	NO. COILS	TURNS PER COIL	TOTAL TURNS	TURNS PER SLOT
A	31	33	48	3168	288
B	28	33	30	1980	180
C	25	39	15	1170	90
D	20	45	7	630	42

For the winding of the eleven-coil armature for a two-pole field, number the slots successively from one to eleven, Fig. 25. Leaving the next turn up to slot No. 2. Leave long enough to reach the commutator connecting screw, wind the required number of turns of coil 1 in slots 1 and 6; then bring the next turn up to slot No. 2. Leave a loop in the wire long enough to reach the commutator, and coil 2 in slots 2 and 7; coil 3 in slots 3 and 8; coil 4 in slots 4 and 9; coil 5 in slots 5 and 10; coil 6 on top of coil 1 slot 6 and in slot 11; coil 7 on coils 2 slot 7, and 1 slot 1; coil 8 on coil 3 in slots 3 and 8; coil 4 in slots 4 slot 9, and coil 3 slot 3; 10 on coil 5 slot 5 and 4 slot 4; and finally coil 11 on coil 6 slot 11, and on coil 5 slot 5, leaving a loop after each coil before proceeding to wind the next.

The end of coil 11 should be brought around to the beginning of coil 1, and twisted to form a loop, after connecting the ends. Connect this loop to the adjacent commutator segment, and then all the others in the order of their winding. This forms a series winding, the current flowing in two paths between the brushes which are diagonally opposite, the paths being as follows. Taking the circuit as the one brush rests on segment 1 and the other on segment 6 and 7, (1) starting at the brush on segment 1, to coils No. 1-2-3-4-5-6 to the other brush, and (2) going in the opposite direction, coils 11-10-9-8-7, from segment 1 to the other brush.

Numbering the slots in the same order, the thirteen-slot armature is wound as follows: coil 1, slots 1 and 7; coil 2, slots 2 and 8; coil 3, slots 3 and 9; coil 4, slots 4 and 10; coil 5 slots 5 and 11; coil 6, slots 6 and 12; coil 7 on top of coil 1, slot 7 and in slot 13; coil 8, on top of coil 2, slot 8, and coil 1, slot 1; coil 9 on top of coil 3, slot 9, and coil 2, slot 2; coil 10 on top of coil 4, slot 10, and coil 3 slot 3; coil 11 on top of coils 5 slot 11 and 4 slot 4; coil 12 on top of coils 6 slot 12; and 5 slot 5; coil 13 on top of coils 7, slot 13 and 6, slot 6. The commutator connections should be made as before. Starting at segment 1, the paths through the armature are: (1) coils 13-12-11-10-9-8 to opposite brush, (2) around the core in the opposite direction, 1-2-3-4-5-6-7 to opposite brush.

The fifteen-slot armature for a two-pole field is wound as follows: After numbering the slots, wind coil 1 of the required number of turns in slots 1 and 8; coil 2 in slots 2 and 9; coil 3, slots 3 and 10; coil 4, slots 4 and 11; coil 5, slots 5 and 12; coil 6, slots 6 and 13; coil 7, slots 7 and 14; coil 8, on top of coil 1 slot 8 and in slot 15; coil 9 on coils 2 slot 9, and 1 slot 1; coil 10 on coils 3 slot 10, and 2 slot 2; coil 11 on coils 4 slot 11 and 3 slot 3; 12 on coils 5 slot 12 and 4 slot 4; coil 13 on coils 6 slot 13, and 5 slot 5; coil 14 on coils 7 slot 14, and 6 slot 6; coil 15 on coils 8 slot 15 and 7 slot 7. The connections should be made as before, the loops being connected to the screw on the commutator after being scraped bare.

Owing to the alternating current or double current generators having four poles, and therefore requiring four brushes, the windings must necessarily be different. The armature coils for these armatures span only about one quarter of the circumference of the armature, and each coil begins and ends in adjacent segments; the end of one coil and the beginning of the next are connected to the segment adjacent to the one the beginning of the first is connected to, this being the order of connection around the commutator.

The span of the eleven-coil eleven-slot armature is 1 to 3, or the first three coils are wound in slots 1 and 3; coils 4, 5 and 6 in slots 2 and 4; continuing until in the third slot, coils 7, 8 and 9 are wound upon 1, 2 and 3, and finally in the tenth and eleventh slots, the coils are wound on the coils in slots 10 and 11, and 1 and 2 respectively.

Connect the beginning of coil 1 to segment 1 and the end to segment 2; the beginning of coil 2 to segment 2 and the end to segment 3, and continue connecting in this order until the connections are complete. To be sure of getting the proper wires when connecting, tag the beginning and end of each coil, giving the coil number, and some mark for distinguishing between the beginning and end of a coil.

The thirteen-slot armature coils also have a span of 1 to 3, and the winding and connection is the same as in the eleven-slot armature except that there are more coils and segments.

The fifteen-slot armature coils have a spread of 1 to 4, and are wound as follows: coils 1, 2 and 3, slots 1 and 4; coils 4, 5 and 6, slots 2 and 5; coils 7, 8 and 9, slots 3 and 6; coils 10, 11 and 12, on coils 1, 2 and 3, slot 4 and in slot 7, continuing around the armature in the same order till all the slots are full. The connections are the same as before.

Assume that the commutator is rotated till segment 1 comes under one of the four brushes. Letter this brush (A), and the others (B), (C) and (D) in a clockwise order around the commutator. Between these brushes there will be four paths through the armature. Assuming that the (A) and (C) brushes—which are diametrically opposite—are negative brushes, the current will flow in two paths in the armature windings from (A) to (B) and (D), and from (C) to (B) and (D).

In the eleven-slot armature for the four-pole field, the paths are: (1) From brush (A) to coils 1-2-3-4-5-6-7-8 to brush (B); (2) from brush (A) to coils 33-32-31-30-29-28-27-26 to brush (D); (3) from brush (C) to coils 18-19-20-21-22-23-24-25 to brush (D); (4) from brush (C) to coils 16-15-14-13-12-11-10-9 to brush (B).

The paths in the thirteen-slot armature are: (1) From brush (A) to coils 39-38-37-36-35-34-33-32-31-30 to brush (D); (2) from brush (A) to coils 1-2-3-4-5-6-7-8-9-10 to brush (B); (3) from brush (C) to coils 21-22-23-24-25-26-27-28-29 to brush (D); (4) from brush (C) to coils 19-18-17-16-15-14-13-12-11 to brush (B).

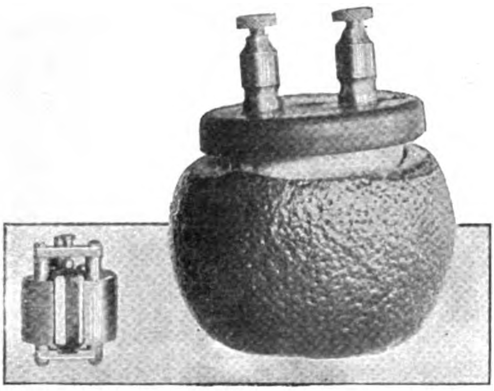
In the fifteen-slot armature the paths are: (1) From brush (A) to coils 45-44-43-42-41-40-39-38-37-36-35 to brush (D); (2) from brush (A) to coils 1-2-3-4-5-6-7-8-9-10-11 to brush (B); (3) from brush (C) to coils 24-25-26-27-28-29-30-31-32-33-34 to brush (D); (4) from brush (C) to coils 22-21-20-19-18-17-16-15-14-13-12 to brush (B).

The above data on the paths through the armature is valuable for use in winding and connecting, and later when testing, may be used to trace connections for errors.

(To be Continued.)

Power Plant in an Orange

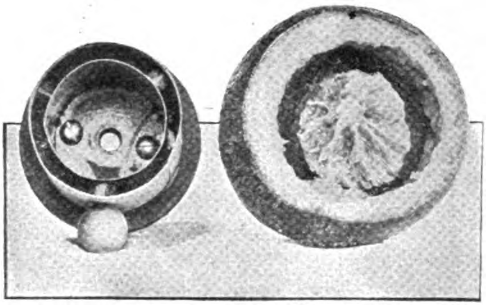
This astonishing little battery and motor were actually made to operate merely by the action of the orange juice on the battery plates which were pressed down into the pulp. The two metallic elements of th battery are arranged concentrically as shown in one view, the juice of the orange filling up the space between them and acting on the plates as an electrolyte.



ORANGE BATTERY AND ITS MOTOR

Of course the voltage and amperage derived from such an orange battery is very small, but in this case were sufficient to operate the tiny electric motor shown in the cut. This latter is an interesting little machine, one of the smallest of its kind ever constructed, but complete with armature, fields and commutator.

It would naturally be supposed that a lemon would work even better than the



"INSIDES" OF THE ORANGE BATTERY

orange in making a battery, but this was found not to be the case. The acid of the lemon, though "stronger" to the taste does not have as great an effect on the battery plates.

THE YOUNG EDISONS' CLUB

Under this heading will be published letters from readers of the Junior Department. These letters should describe briefly and accurately your experiences in the making and operation of electrical devices and in the performing of electrical experiments. See how good an "engineering report" you can make of your investigations.

The Young Edisons' Club:

On the afternoon and night of March 7, amateur wireless boys in and around San Jose, Cal., heard, for the first time, a game of chess played by amateurs by means of wireless.

About three o'clock in the afternoon Eugene Wilson, operating for Edwin Walter at Herrold's Wireless School, and Ernest Moores, operating for Freeman Burbank, at the former's home, about one mile distant, began to exchange the moves for the players. The players knew every square and every man on the board by a letter or two. Almost all of the other amateurs in San Jose were very much puzzled to hear "check" and "mate" exchanged and did not find out until the following day what was going on. About seven o'clock the operators and players stopped to eat and at 7:30 p. m. went on with the game. The game did not end until 10:30 p. m., when the players finished. Operator Wilson then announced that Mr. Walter had won the game. A total of 37 moves was made throughout the entire time and the operators and the players were glad to retire.

Much enthusiasm was created about this game and there will be more games at greater distances in the near future.

San Jose, Cal. L. T. F.

The Young Edisons' Club:

As I just completed a test of the crowfoot battery, I am going to let the readers of POPULAR ELECTRICITY profit by my study. I find that the crowfoot or gravity cell is one of the most troublesome to keep working right. I will give you an outline of how to take care of them, as I have found.

I cleaned my jars out thoroughly, placed the copper in the bottom of the jar, and sifted the blue vitriol so as not to get any fine powder in the jar. I put in about two pounds of vitriol, so that it was evenly distributed on the copper. Next I put in the zinc plate, filled the jar with water up to about ¾ of an inch of the top, and poured on eight ounces of oil. If the cell is to be used on a high-resistance wound apparatus or a transmitter coil it would be best to use the oil. The harder the cell is to be worked the heavier the oil should be.

I also find that a cell will work better if it has a half blue line; that is, if the copper is half copperized and the other half a pretty blue. If the cell is not worked hard enough it will become blue all over (that is, the copper plate). If the cell is worked too hard it will become copperized.

I find that a cell that is kept in service on a total resistance of 100 ohms will hold from a ½ to ¾-inch blue line.

Odebolt, Ia. R. S. KRAUSE.

The Young Edisons' Club:

In making the "electric fortune teller," described in the October, 1910, number of POPULAR ELECTRICITY, I got a great deal more amusement from it by fastening a piece of tinfoil on the handles. Then I wound some very small silk covered wire in with the insulated lamp cord and connecting it with the tinfoil on the handles. The other end I connected to a small induction coil such as is used for shocking purposes. This done, I connected it up so that when the right nail was reached the person asking the question received a shock.

GRANT V. HOPE.

311 E. Water St., Austin, Minn.

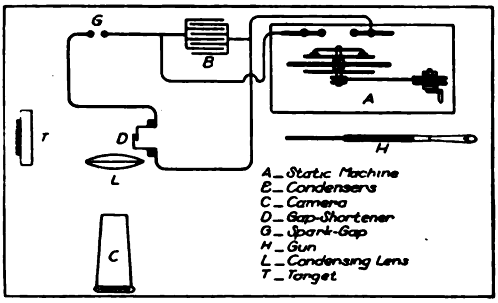
Photographing Projectiles by Electricity

By LOYLE D. DOBBS

The photographing of projectiles in flight may appear to be a difficult task; but with the proper apparatus and with electricity to help, it is not impossible. The pictures which are shown here were taken by Norman Barden and Loyle Dobbs, in the dark-room of East High School of Minneapolis. The boys made their own apparatus and after experimenting for two months, succeeded in getting some good negatives. Anyone with a little patience may get as good, and even better results.

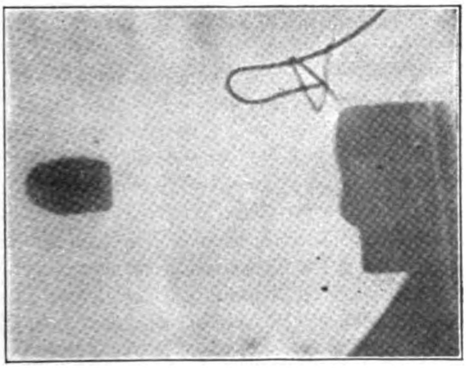
The apparatus together with the young experimenters is shown on this page, and

YOUNG EXPERIMENTERS AND THEIR APPARATUS FOR PHOTOGRAPHING BULLETS the apparatus was arranged as follows: A static machine and a battery of Leyden jars were connected in parallel. Then the condensers, spark-gap and gap shortener were placed in series. A condensing lens was placed opposite the spark-gap, so that the



ARRANGEMENT OF BULLET PHOTOGRAPHING OUTFIT

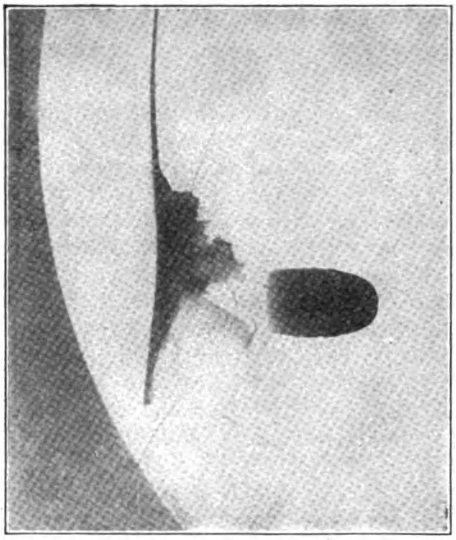
gap was at the focal length from the lens. Then a camera was placed opposite the lens. The camera has no lens, since the photographs are shadow pictures. The gap shortener is made by arranging two



A .32 CALIBER BULLET JUST LEAVING THE REVOLVER

strips of copper foil upon a frame. These strips are separated about ½ inch.

When the condensers are fully charged, and the rifle is discharged, the bullet strikes the first strip of copper and pushes it against the second strip, thus shortening the gap and allowing the spark to jump across the spark-gap. This spark produces the light by which the photograph is taken. The camera is made of thin boards and painted with dead black paint upon the inside. A plate-holder is placed at the back of the camera. The rifle should be far enough away to keep the powder particles from interfering with the pictures. The bullets used were .22 and .32 calibre. The .32 calibre were shot from a revolver which was held about two inches from the gap shortener. The bullets pass directly behind the condensing lens. One of the photographs shows a .32 calibre bullet just leaving the muzzle of the revolver. A back-stop must



A .32 CALIBER BULLET GOING THROUGH A PIECE OF CARDBOARD

be provided to keep the bullets from penetrating the wall. The one used was made by placing a piece of boiler-plate behind a piece of 2 ½ inch plank.

All of the work must be done in a dark-room, since the shutter of the camera is open before the gun is discharged, and the plates should be developed as soon as they are exposed. Very sensitive plates were used because the spark does not produce a very large amount of actinic light. The plates which gave the best results were Lumier Sigma's and were 5 by 7 inches. Care must be taken to avoid accidents while working in the dark-room since the light is very dim. When one stops to consider the tremendous speed of a projectile, it seems that electricity is the only possible means for photographing one in flight.

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.

History of the Wireless Telephone

By LINDLEY PYLE, A. M.

Lord Kelvin, said, "The life and soul of science is its practical application." The work of Hertz found practical application in wireless telegraphy and wireless telephony. The first mentioned has been before the public for fifteen years, and has been developed to such an extent that commercial wireless messages are now exchanged regularly between Glace Bay, Nova Scotia, and Clifden, Ireland. Practical wireless telephony has been developed only within the last five years and it would seem worth while to present, briefly and in non-technical terms, its underlying principles.

Telegraphy demands merely a means of transmitting signals according to a certain code, while telephony requires that this transferring of energy take place in exact accordance and agreement with the rapidly varying energy-content of vibrations of the air set up by the human voice. The further demand is made that, at the receiving point, that this ever-changing flow of energy through the transmitting medium be presented to the listening ear-drum by the impact of air particles whose oscillations duplicate those at the original source of sound. Shake a cord tied to a distant stake and thus disturb the stake—that is telegraphy; transmit spoken words through that cord—that is telephony. The appearance of the telephone in the commercial world (1876) more than 30 years after the advent of the telegraph (1844) thus finds a ready explanation in the more exacting demands of telephonic communication.

Modern science regards the electric current as a stream of minute particles, charged with negative electricity, each particle of mass about 1-1800 that of the hydrogen atom. The conducting wire guides this stream and directs the flow of energy. How is the energy transmitted in wireless communication? To illustrate, let a boy stand at the edge of a pond and throw pebbles into the water at his feet. A system of waves is set up involving the handing on of energy from point to point in the medium (water) until the waves impinge upon some obstacle (the opposite shore), lose their motion, and deliver up their energy. Across the so-called void of space comes to us the light of the stars and the heat of the sun, not as projected particles, but, conclusively shown over a century ago, as wave motions in some invisible, intangible medium which fills all space and permeates all matter—the ether. Here is the wireless transmission of energy on a stupendous scale. The incandescent light bulb is exhausted of air, yet the filament within pours forth a flood of radiation, carried by the ether in the vacuum, in the very glass of the envelope, and in the external air. Material bodies are saturated and immersed in this limitless ocean of ether in much the same way as pieces of sponge scattered through a quantity of gelatin. Just as the gelatin may be agitated and set aquiver, so may the ether be set aquiver and made to distribute energy to distant points. Luminous bodies, by their extremely rapid atomic vibrations, may set up as many as 250,000 ether waves per inch, which travel through space at the amazing speed of 186,000 miles a second.

It is of interest to note that telephonic communication has actually been carried on over a beam of light-waves issuing from a search-light, and directed upon receiving apparatus three or four miles distant. It should be borne in mind that ordinary matter only, and not the ether, carries sound-waves proper; and further, that ether only, and not the air, carries the waves of light and heat. Now the energy of short ether-waves is rapidly absorbed by ordinary matter. Water vapor forms an efficient screen against the light and heat of the sun. A beam of light carries but a short distance through fog. Long distance telephony with the short waves is therefore impracticable. But what of ether-waves measuring thousands of feet from crest to crest instead of mere thousandths of an inch? Is it possible to generate such waves?

In 1865, Maxwell, an English physicist, predicted from theoretical conditions that it should be possible to set up ether disturbances by electrical methods. In 1888, the German physicist, Hertz, succeeded in so doing, and showed not only that the velocity of these electro-magnetic waves is the same as that of light waves, but that the identical experiments may be performed with them as with light waves. The conclusion is that light and heat are themselves electro-magnetic in nature.

The longest heat waves thus far measured are 1-300 of an inch in length; the shortest waves set up electrically measure 1-8 of an inch in length. Electro-magnetic waves of length a mile or more will penetrate brick walls and banks of fog as readily as does light a window-pane. They will carry through three thousand miles of space enough energy to work a delicate receiving apparatus.

The electrical device whereby the ether is set aquiver is of interest. As long ago as 1842, the American, Henry, showed experimentally that the discharge of a condenser is oscillatory in character. A condenser, in briefest terms, consists of two parallel metallic plates separated by a thin layer of air, glass, mica, or other insulating substance. Henry demonstrated that if two such plates be charged to different potentials by an electric machine, and then connected by a wire, that the electric spark of discharge from plate to plate is not uni-directional but oscillatory. In modern terms it has been found that the electrons, originally stored up on one plate, surge to and from the other plate in much the same manner as water surges between a filled compartment of a box and an adjacent empty one when the dividing partition is quickly removed. The electrical surgings take place with enormous rapidity, varying from a few thousand a second up to hundreds of millions, depending upon the size of the plates and the nature of the connecting wire. Lord Kelvin, in 1853, showed how the frequency of oscillation could be determined mathematically, the electrical constants of the apparatus being known; and five years later Feddersen, by examining in a revolving mirror the image of the condenser spark, gave visual proof of its oscillatory nature.

It has been stated that Maxwell predicted from theory how such electrical oscillations should create ether waves, and how Hertz gave the experimental verification. But ether disturbances set up by single spark discharges, while usable for telegraphy, are not at all adapted to telephony. The energy of the discharge is quickly dissipated, and the surgings die away so rapidly that only a few, perhaps a dozen, waves are set up in the etheric medium. Another group of waves is sent forth only after the relatively long time interval required to recharge the condenser. If the ether is to carry not merely signals but articulate speech, its waves must carry upon their backs, so to speak, modifications in form which occur as rapidly and continuously as the vibrations set up on the air by the human voice. Evidently there must be no long gaps in the train of waves. It would give an effect like stopping one's ears at intervals with his fingers while listening to music. A voice singing or speaking in the pitch of the musical note "A" sets up 435 air waves a second but it must be understood that there are present, due to the resonance of the mouth and nasal cavities, many vibrations of higher frequencies which determine the quality of that particular voice. The higher frequencies may amount to 1,500 or 2,000 a second and, consequently, spark discharges must occur with at least that frequency. For really good results, 10,000 discharges a second are required. Wireless telegraphy had reached an advanced stage of development before wireless telephony had found the means of generating electrically sustained and continuous oscillations in the ether.

In 1892, an American, Elihu Thomson, patented a device intended to fulfill this want. In 1900, it was improved upon by the

Englishmen, Duddell, and termed, "The singing arc." In barest outline it may be said that the two plates of a condenser are connected through a coil of wire to the two carbons of an arc light. Duddell noted that under proper conditions the arc gave out a musical note when connected to a direct current dynamo. Space does not permit a description of how the burning arc itself may actually send forth speech. Suffice it to say that under the improvements of Poulsen, Fessenden, Lee de Forest, and others, using water-cooled electrodes instead of carbons, and burning the arc in various compressed gases, it is possible to set up through the condenser and its coils of wire, continuous and powerful oscillatory currents, with frequencies up to a million a second, and sustained for any desired length of time.

By an electrical device known as a transformer, these oscillations may be communicated to a vertical wire termed the aerial, which is connected through a carbon-granule telephone transmitter to the earth. According to the present-day theory, any change of motion of the electrons, whether by acceleration, retardation, or change of direction, involves the generation of ether disturbances. The oscillatory currents induced in the aerial pour in all directions a continuous stream of waves which may be modulated by the resistance of the telephone transmitter varying under the pressure of the sound waves of spoken words.

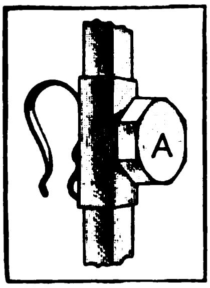
At the receiving end, the energy of these ether waves, darting through space at their tremendous speed, yet following the curvature of the earth, must be caught and made to set up sound waves reproducing the speech at the sending station. It is required that the receiving apparatus be sufficiently rapid in action and that it respond in exact proportion to the quantity of energy received. There are several such receivers available, the very simplest, perhaps, being the silicon detector. It consists merely of a pointed brass screw resting against a small crystal of silicon. An aerial wire at the receiving station is connected to the earth through this contact of brass and silicon. The two wires leading to a telephone receiver are connected respectively to the brass screw and the silicon crystal. The ether waves, cutting across the aerial wire, set up therein oscillatory currents similar to those at the sending station. It has been found that electricity will cross the contact of brass and silicon with enormously greater ease in one direction than in the other. The contact plays the part of a valve which diverts through the telephone receiver those oscillatory currents against which the valve closes. It is found that the reproduction of speech is as perfect as in wire transmission.

Fessenden of this country began transmitting speech with perfect clearness in the summer of 1906. At that time he succeeded in relaying messages from the wire lines to the wireless, and vice versa. In place of the arc, he is now using high frequency dynamos of special design for direct generation of oscillatory currents of 80,000 and 100,000 frequency.

No detailed mention can be made of the work of Fessenden, Lee de Forest, Poulsen, and Majorana, all of whom have carried on wireless telephony over distances of 300 miles or more. It is confidently predicted that Paris and New York will be in telephonic communication within two years. But with all the public enthusiasm attendant upon a great commercial achievement, forget not to honor the quiet man— a Henry, or a Hertz—who toils long and patiently in his laboratory to lay bare the ultimate secrets of things.

Tuning Coil Slider from Typewriter Key

From the keyboard of an old Oliver No. 3 typewriter I took the key top which

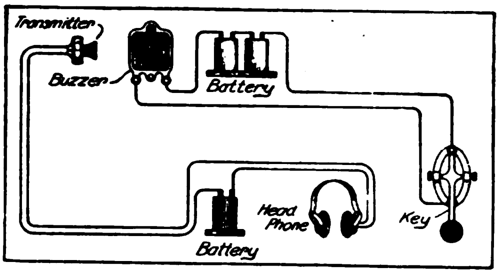


TUNING COIL SLIDER

has a brass bushing built into such a form that it can be soldered to the tube on the slider rod of a tuning coil. The letter "A" very conveniently indicated the "aerial" and "G" the "ground" slider.—E. MUELLNER.

Teaching Yourself the Wireless Code

The arrangement shown in the drawing is very helpful to amateurs who are learning the wireless code. The idea is to operate the key as if sending a message. The buzzer, which is placed at such a distance away



THE CODE TEACHING SYSTEM

as to be out of hearing, has a telephone transmitter near it. This transmitter gathers up the dots and dashes from the buzzer and causes the head phones to repeat to you your own message much as it would sound if coming in over an aerial. By locating the buzzer near to or far from the mouthpiece of the transmitter the signals may be made loud or faint in the head phones.—E. Muellner.

Aerials of Aluminum Wire

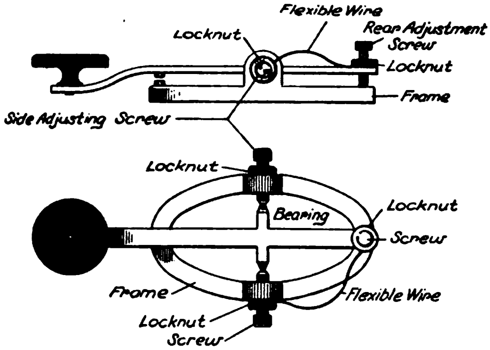
Since aluminum wire is used in the aerials of a large percentage of the wireless experimenters, it may be well to compare the qualities of this material with those of copper. Kent gives aluminum a specific gravity of 2.67, and copper has a specific gravity of 8.85. In other words, a given volume of copper is 3.3 times as heavy as the same volume of aluminum. An aluminum wire of a given weight would therefore be 3.3 times as long as a copper wire of the same weight and diameter. Aluminum has the advantage of lightness, and it has sufficient strength for a small aerial. With aluminum wire at 60 cents per pound and copper wire at 30 cents per pound, the aluminum would also be the cheaper.

Aluminum wire 98.5 per cent pure has only 55 per cent the electrical conductivity of copper. This is a serious disadvantage where efficiency of the station is a matter of importance. Moreover, after an aluminum wire aerial has been exposed to the weather for three or four months a coating of aluminum oxide is formed on the surface of the wire. This oxide is an electrical insulator, and after a time will begin to form between the wires where they are spliced, unless they are soldered at these points, which is not generally the case. It will be noticed that both the transmitting and receiving radius will be considerably diminished at about this time.

An aluminum wire aerial is satisfactory for small stations where high efficiency is not so much an object as low cost, but where high efficiency is desired, copper or some alloy of copper having a high electrical conductivity and strength is to be recommended, though the initial cost is greater.

Doctoring a Wireless Key

While working with my wireless sending outfit the bearings of the key became very



WIRELESS KEY

hot. I took a short piece of flexible copper wire and connected one end of it under the side lock-nut of the adjustment screw, the other end under the lock-nut of the rear adjustment screw. This relieved the bearings from carrying current and the key worked satisfactorily.

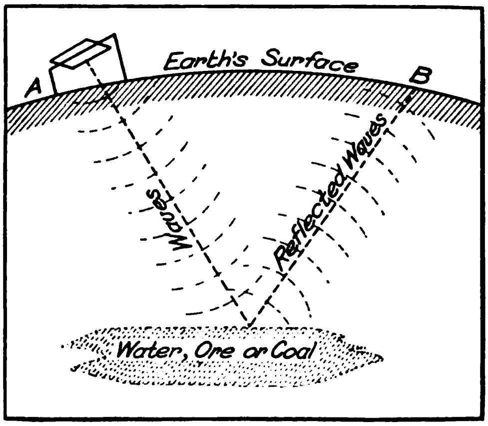
B. Francis Dashiell.

Hears "Skeeter" Spark

On the night of Jan. 9 the writer was operating an amateur station in this city and after listening to Pensacola and Key West, Florida, was surprised to hear the "skeeter" spark "NAX" which is Colon, Panama. As the distance is about 3,000 miles, and partly overland, I think it is a pretty good record.—Julius Abercrombie, St. Joseph.

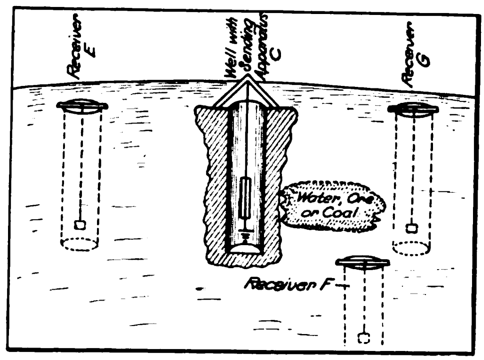
Wireless Earth Exploring

The peristent efforts made through many centuries towards finding a successful "divining rod" only show the general eagerness of men to explore what is beneath them without digging or boring into the earth. In this connection two scientists, Loewy and Leimbach have made the ingenious suggestion that wireless waves be used in exploring the interior of the earth so as to locate the metal core, (if this exists as some physicists claim) and also to show the whereabouts of coal and water. They propose to go about this in two ways, both equally simple. The first is based on the well established principle that the propagation of wireless waves from long antennæ is most intense at right angles to these antennæ, so that the waves from inclined antennæ will enter the earth as shown at (A) in our diagram and will penetrate the rock soil and sand until they strike, water, ore or coal. Then the waves will be reflected, just as light is reflected by a mirror and will strike the surface at a point (B), this being the point at which a portable detector shows the strongest waves. The distance from (A) to (B) will depend on the depth at which the waves strike the opaque medium which reflects them, hence by exploring the surface with a detector to find the point (B) (where the waves passing through the air are reinforced by those reflected from within the earth) and measuring the distance from (A) to (B) it will be easy to estimate the depth of the hidden materials.



EARTH EXPLORING BY REFLECTED WAVES

The other plan, is suggested for use where coal, ore or water are hidden at a moderate depth. In this case the two Austrians suggest that holes be bored at various points and the terminals of wireless apparatus lowered into the same so as to send messages through the earth from one hole to the others. Thus, if the antennæ of a wireless outfit at (C) are lowered into a deep well, the waves would be detected by coherers lowered into other wells at (E) and (F) as long as the intervening soil is free from material which is opaque or semi-opaque to the wireless waves. But if a deposit of coal or ore, or a subterranean lake is between the sending well and a receiving well, such as (G), then the latter will be shut off from the waves. This ingenious method has the added advantage that if the holes are far apart the curvature of the earth increases the depth between the wells far beyond the depth to which the wireless terminals are lowered. Tests already made in a European mine imply that such a method of exploring the earth is feasible and its use for locating underground bodies of water alone may prove of immense value. For instance, a systematic boring and testing of holes at widely scattered points in deserts or in semi-arid countries may enable us to locate the hidden waters, thereby gradually opening immense tracts of waste lands to cultivation.



LOCATING ORE BY SIGNALS THROUGH THE EARTH

Detector Cups

The following "kink" I have found useful in building a detector. After carefully removing the copper caps from the ends of a burned out cartridge fuse these caps may be used as the cups of a mineral or crystal detector.—James Butler.

A High-Power Wireless Equipment

By ALFRED P. MORGAN

PART XIII.—A LOOSE COUPLED TUNING COIL.

A loose coupler or transforming tuner is, as the name implies, a tuning coil consisting of a primary and secondary, so that the detector circuit is indirectly coupled to the antennae.

The primary coil is included in the aerial circuit, and the secondary, which slides in and out of the primary, is made part of the detector circuit. If the primary and secondary coils are very close together, the circuits are said to be *closely coupled.* If they are far apart, they are said to be *loosely coupled.*

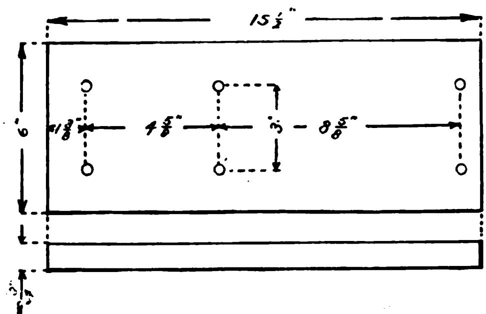


FIG. 141. THE BASE

The wave sent out from a transmitter is usually made up of two waves of different lengths. The variation in the length of these two waves is dependable upon a factor known as the *coefficient of coupling* of the transmitter. It is almost impossible to clearly explain this phenomena without the use of mathematics, and since this text has not been so complicated in the past I must ask my readers to take the statement as it stands.

The effect of the two different wave lengths emitted by a single transmitter is to make selective tuning difficult. For instance, when a nearby station is sending, in order to avoid interference at the receiving station *two* waves must be tuned out.

By sliding the secondary of the transforming tuner in or out of the primary the coupling is varied and it is so possible to make the coefficient of coupling of the receptor identical with that of any station it is desirable to receive.

A decrease in the coefficient of coupling of the receptor brings with it an increase in the sharpness of resonance, but the resonance is obtained at a loss of energy.

A "loose coupler" is one of the most valuable adjuncts to a well-equipped wireless station. It is easily made and is well worth the time and labor spent in its construction.

The base of the instrument is an oblong piece of mahogany 15½ inches long, six inches wide, and ¾ inch thick. Several holes are bored and counter sunk to receive the 8-32 machine screws which hold the various parts to the base. The location of these holes is shown in Fig. 141.

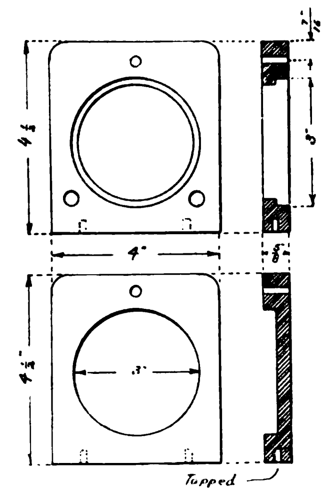


FIG. 142. HARD RUBBER PRIMARY HEADS

The heads of the primary (Fig. 142) are both hard rubber. They are cut out of ⅝-inch sheet with a saw. They are four inches wide and 4½ inches high. After the edges are squared up they are chucked in a lath and a hole 2¾ inches in diameter turned out in one. The center of the hole should be located ¼ inch below the center of the head. The hole is enlarged to a diameter of three inches to a depth of 1/16 inch on one face. A three-inch hole is turned in a corresponding position to a depth of 5/16 inch in the other head. The upper corners of both heads are rounded off so as to give them a neater appearance. A 5/32-inch hole is bored through each head on the center line, 7/16 inch from the top, to receive the slider rod.

-The latter is a piece of ¼-inch square brass rod, six inches long. The ends are turned down and threaded with an 8-32 die. (Fig. 145.)

The bottoms of the two heads are bored and threaded with a 10-32 tap, so that they may be securely fastened in position by screws passing through the base.

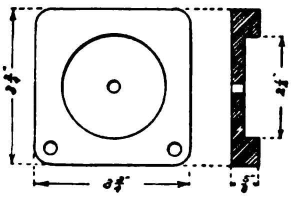


FIG. 143. HARD RUBBER SECONDARY HEADS

The head of the secondary coil (Fig. 143) is a piece of hard rubber 3¾ inches square, and ⅝ inch thick. A hole 2½ inches in diameter is turned in the center to a depth of 5/16 inch. The corners are rounded off to improve the appearance.

The primary winding is composed of a single layer of No. 20 B. & S. gauge enamel covered wire wound over a hard rubber tube 4⅝ inches long and three inches in diameter. The thickness of the wall is ⅛

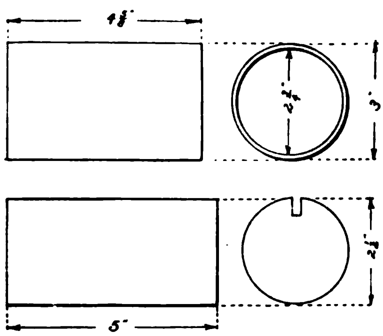


FIG. 144. THE CORES

inch (see Fig. 144). The winding itself is 3¼ inches long. The ends of the tube should fit snugly into the heads.

The secondary is wound over a cylinder of hard wood 2½ inches in diameter and five inches long, as shown in the lower half of Fig. 144. A slot 3/16 inch wide and ½ inch deep is milled in the face of the cylinder farthest from the head, and is led back through along its entire length.

The secondary winding is composed of a single layer of No. 26 B. & S. gauge brass wire wound in a single layer. Two wires are wound on together and then one wire unwound. This results in each turn being separated from the adjacent turns by a space equal to the diameter of the wire itself. Care must be taken to wind the wire very carefully and tightly, so that there is no danger of its becoming loose.

The cylinder is attached to the head by means of a small wood screw passing through the head. A hole 5/32 inch in diameter is bored through the head opposite the slot in the cylinder.

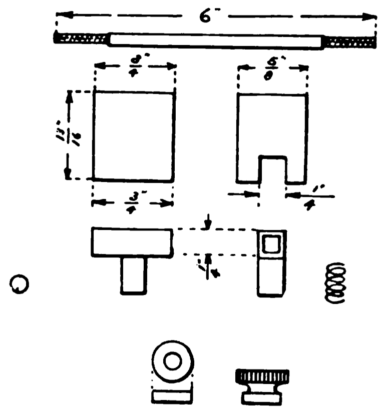


FIG. 145. DETAILS OF SLIDER

The number of turns in the secondary is variable by means of a slider moving back and forth in the slot in the cylinder. The slider is shown in detail in Fig. 149. A strip of thin spring brass 5/32 inch wide is bent into a loop and soldered to one end of a 5/32-inch brass rod. A small semi-circular piece of brass is soldered to the top of the loop so that when it is drawn back and forth in the slot it will make contact against the under side of the wire. The outside end of the rod is threaded and fitted with a molded composition knob.

Two holes are bored through the hard rubber head of the secondary coil, into which a piece of thin-walled brass tubing having an internal diameter of ¼ inch will fit. Two pieces of tubing, each 1½ inches long, are forced into the holes. They should fit snugly so that they will not easily pull out.

The end of the secondary at the end a hole bored lengthwise of the cylinder and connected to one of the tubes by soldering. The other tube is connected to a small strip of spring brass which rubs against the slider rod. The spring brass strip is fastened against the face of the cylinder, which goes against the head and is then bent down at right angles so that it lies in the groove, as shown in the illustration.

The secondary slides on two ¼-inch brass rods, ten inches long, which will pass.

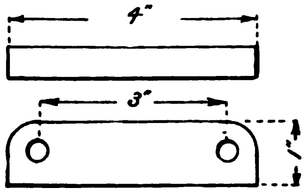


FIG. 146. SUPPORT FOR GUIDE RODS

The rods are supported at one end by the head of the primary. They pass through two holes near the bottom corners of the latter. They are prevented from pulling out by two hexagonal brass nuts. The other ends of the rods are set in two holes bored in a strip of hard rubber four inches long, one inch thick, and one inch wide (Fig. 146). The rods at this end are turned down and threaded with an 8-32 die so that they may be fitted with a knurled nut and a washer as a binding post.

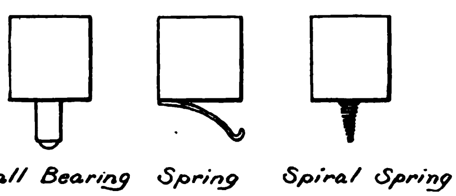


FIG. 147. THREE VARIETIES OF SLIDERS

The rubber strip is fastened in position by two 8-32 machine screws passing through the base.

A small knurled composition knob is fastened to the head of the secondary so that the latter may be conveniently slid in and out of the primary.

After all the hard rubber parts have been cut to size and bored they should be polished. The polishing may be done in a buffing wheel charged with tripoli powder.

The slider making contact with the primary is supported on the square brass rod fastened between the two heads.

There are several types of sliders in vogue on tuning coils, as shown in Fig. 147, any one of which is suitable for a loose complex. The ball-bearing slider is made by soldering a piece of small brass tubing ⅜ inch long to the center of one face of a piece of square brass tubing ¾ inch long, which will slide over the square rod. A ball-bearing is placed in the tube with a small spiral brass spring above it so that it is pressed gently downwards against the wire.

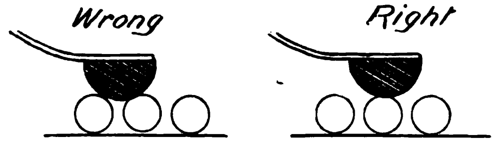


FIG. 148. ENLARGED VIEW OF SLIDER MAKING CONTACT

The second form of slider is a small strip of spring brass soldered to the square brass tube and bent downwards so that it rubs against the wire. The last is a spiral spring formed over a cone and soldered with the point downwards to the under face of the square tube. The lower end of the spring terminates in a small piece of brass rod, rounded at its lower extremity.

The sliders are provided with a hard rubber block so that they are easily grasped and moved.

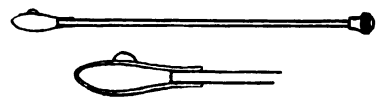


FIG. 149. SECONDARY SLIDER

The block is 13/16 inch high, ¾ inch wide and ⅝ inch thick. A square groove is cut out of the lower face of such a size that it will fit snugly over the square brass tube and not pull off easily. It may be fastened in place with cement.

The enamel is scraped off the wire in a long, narrow strip immediately under the slider so that it will make a good electrical contact with the wire.

When adjusting the sliders when the loose coupler is in use always see that contact is made with one wire only, as in the illustration. If the contact falls against two wires it will short circuit that turn (see Fig. 148). This will result in considerable loss of energy and greatly weaken the effect of the incoming signals.

The ends of the primary coil are connected to two binding posts mounted on the base. The whole coil assembled is shown in Fig. 150.

The simplest receiving circuit is shown in Fig. 151. The aerial is connected to the slider on the primary coil and the earth to one end of the coil. The secondary is

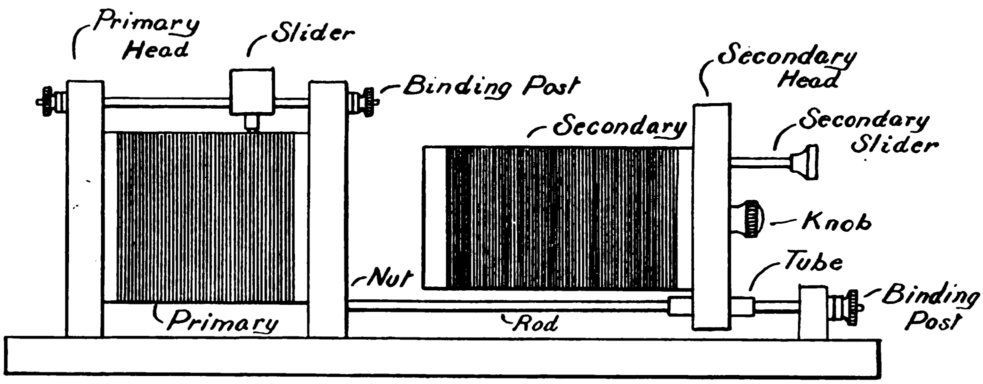


FIG. 150. SIDE VIEW OF LOOSE COUPLER

placed in series with the detector and condenser by connecting to the building posts on the ends of the rods which the secondary slides over.

There are several other useful circuits employing a variable condenser which will be shown in the next article upon "Variable Condensers."

It may perhaps be well to state here for the benefit of any of my readers who possibly may contemplate using a double slider on the primary that such construction is of no advantage and that a single-slide loose

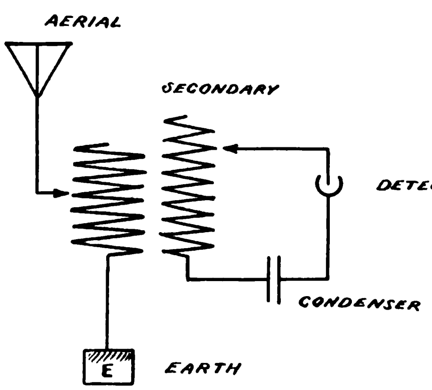


FIG. 151. CIRCUIT DIAGRAM

coupler is capable of better work than the same instrument fitted with two layers on the primary.

For the benefit of those who may perhaps wish to experiment and investigate the effects of variances in the coupling, I suggest that they place an ordinary single-slide, close-coupled tuning coil in series with the primary of the loose coupler, as shown in Fig. 152. This not only adapts the receptor to receiving longer waves, but also makes it possible to tune the loose coupler with-

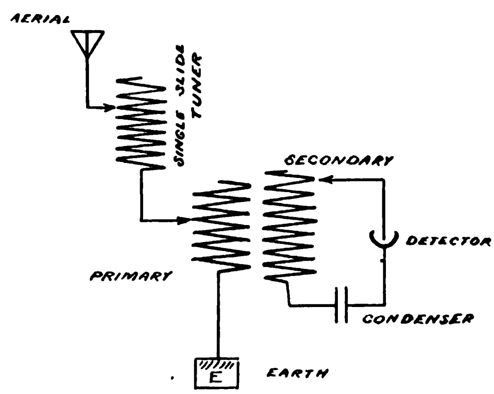


FIG. 152. LOADING COIL IN CIRCUIT

out varying the coupling between the primary and secondary.

(To be Continued.)

Waynesburg (Pa.) College Wireless Club

A wireless telegraph club has been formed at Waynesburg College, Pennsylvania, for the scientific study of the wireless telegraph. The following are the officers of the club:

Prof. C. W. Frietage, president; John Meighn, secretary and treasurer; James D. Thomas, chief engineer. Two stations are in operation, one at the college, the other at the home of Mr. Thomas.

Amateur Experimental Wireless Association

The Amateur Experimental Wireless Association has been formed in Spokane, Wash. The officers are David Kirk, president; Lewis Kobie, secretary and treasurer, and Cornelius Hobbs, vice-president and librarian.

Roslindale (Mass.) Wireless Association

The Roslindale Wireless Association, Roslindale, Mass., invites those in the vicinity interested in wireless to join the club. The following are the officers: O. Gilus, president; E. T. McKay, treasurer; Fred C. Fruth, secretary. Address the Secretary at 962 South Street.

Winnipeg (Manitoba) Wireless Association

At the recent organization of the Winnipeg Wireless Association the following officers were elected: Alex. Polson, president; Stewart Scorer, vice-president; Howard Pratt, secretary and treasurer. The object of the society is to assist its members in the study of wireless telegraphy. Club meetings are held the last Friday of each month. Communications should be addressed to the Secretary, Suite 5, Columbia Block, Winnipeg, Manitoba.

Chicago Association to Revise Call Letters

As a result of the injudicious selection and the duplication of calls among the many wireless amateurs of Chicago, the Chicago Wireless Association has appointed a committee to revise the list of call letters and have them printed in comprehensive form to include all amateur wireless stations in Chicago and vicinity.

Officers of the association request that owners of such stations which are equipped with transmitting sets send at once to E. Mullner, 6603 Langley Ave., president of the association, complete information as to their full names, addresses, station equipment, capacity, kind of transmitting apparatus, and longest distance over which they have established communication under ordinary conditions.

Guilford County (N. C.) Wireless Association

At a meeting of the wireless amateurs of Guilford County, North Carolina, March 3, a wireless association starting off with 25 members was formed. The officers are: Adger Forney, president; Herman Cone, vice-president; Robins Tilden, treasurer; Ralph Lewis, secretary. A "query committee" of three members was appointed. The object of the association is to bring together for mutual help all persons in the County interested in wireless and to prevent interference with government and commercial stations. Applications for membership may be addressed to Robins Tilden, Edgeworth St., Greensboro, N. C.

Wireless Association of Easton, Pa.

A wireless club has been formed in Easton, Pa., to be known as the Wireless Association of Easton. Its purpose is the study of wireless telegraphy and telephony among amateurs. The officers are: W. Ballentine, president; John Q. Adams, vice-president; Weikel Jordan, treasurer; E. J. Sortore, recording secretary; James Smith, Jr., 123 North Main street, Phillipsburg, N. J., corresponding secretary. The club would like to communicate with all other clubs organized for the same purpose. Address all correspondence to corresponding secretary.

Manchester (N. H.) Radio Club

On January 18, 1911, the Manchester Radio Club, an amateur wireless association, was organized in Manchester, N. H., with a membership of fourteen. The following officers were elected: Earl McKewin, president; Clarence Richardson, vice-president; Earle Freeman, secretary and treasurer. The object of the club is to further the art of wireless communication.

Address the Secretary, 759 Pine St. The Radio Club will be glad to hear from other wireless clubs.

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.

Data on Wireless Equipment

Questions.—(A) What is meant by "wave length in wireless telegraphy? (B) What is the difference in the action of a tuning coil and a variable condenser? (C) Is a carborundum detector more sensitive than a silicon, both being used without a battery or potentiometer? (D) How far apart should the strands on a three-wire aerial be? (E) Please explain the principle of an oscillation transformer and its advantages. (F) Please give data on a helix to be used on a one-inch or a two-inch spark coil? (G) Would it be better for me to buy a one-inch or a two-inch coil than to make one, as regards efficiency, cost and trouble in assembling? (H) Would a fusible cutout, connected in series with the aerial and instruments, be a safeguard against lightning? (I) Would a 15-ampere D. T. S. P. switch be heavy enough, arranged to ground the aerial? (J) What is the smallest wire to run to the outside ground?—F. L. C., Plainfield, N. J.

Answers. — (A) When the aerial is charged by the coil or transformer an electrical disturbance is created in the space around the aerial. This disturbance has traveled a certain distance when a second disturbance is created. This distance is the wave length.

(B) The tuning coil is a device to vary inductance, and the purpose of a variable condenser is to vary capacity. Inductance retards the current flow with respect to the impressed voltage. Capacity advances current with respect to voltage. Wave length is dependent upon both inductance and capacity.

(C) No definite answer can be given to this question, for no two pieces of carborundum are alike in sensitiveness. In general, however, silicon will be found to be more sensitive.

(D) The farther apart, the better. A separation of three or four feet gives good results.

(E) In the tuning coil the inductance and capacity of one or more circuits can be varied, and in the case of the two or the three slide types, almost independently of each other. In the loose coupled tuning coil, or oscillation transformer, we have the additional advantage of being able to vary the mutual inductance between the two circuits. This allows closer tuning.

(F) Diameter, eight inches. Wire, No. 6 copper or aluminum. Ten turns, spaced 1½ inches.

(G) Yes, much better.

(H) No, it would be of no use at all, for by the time the fuse had blown there would be enough energy in the aerial to cause an arc across the gap between the fuse terminals.

(I) After using such a switch for three years, we have found it safe, but the Fire Underwriters require a 100-ampere switch.

(J) The Fire Underwriters require a wire not smaller than a No. 6 copper.

Wireless Transformer; Leyden Jar; Grounding

Questions.—(A) How far could I send with the open core transformer described in the December, 1910, issue, using 110 volts A. C., in connection with an aerial 60 feet high and 60 feet long, consisting of four wires? (B) Could an ordinary telegraph key be used for this transformer if shunted by a large Leyden jar? (C) Of what does a Leyden jar consist? (D) How is connection made with the ground in automobile sending sets? In aeroplane sets? (E) Describe the condenser and helix for the above transformer.—J. H. B., Troy, O.

Answers.—(A) Up to about 50 miles over water or level land, to commercial wireless stations, under ordinary weather conditions.

(B) Such a key would not last very long, as the current passing through it would be too great.

(C) A Leyden jar consists of a glass jar coated inside and outside with tinfoil, to within two or three inches of the top. A metal chain serves to make connection with the inner coating, and a metal plate upon which the jar may be placed affords good connection with the outer coating.

(D) In automobile sets a chain may be dragged on the road. In aeroplane equipments a "capacity ground" is used, consisting of a wire dropped behind the machine. This wire does not touch the earth, but nevertheless serves as a ground, although not a very good one.

(E) A good condenser and helix are described in the articles entitled "A High Power Wireless Equipment," in the September and October, 1910, issues, to which we refer you.

Lamps in Aerial; Arc at Gap

Questions.—(A) I have an aerial of one No. 6 wire, 500 feet long, the highest point being 300 feet above the surrounding country. There is 40 feet of wire fencing at the upper end of this wire. I have no hot wire ammeter, and therefore use lamps as a radiation indicator. My transformer has a variable capacity from ¼ to 4 K. W. When the transformer is operating at 2 K. W., I can light five 80-watt lamps in multiple in the aerial circuit; but with the lamps in series, I can light twenty of them. Under the first condition it seems that I am radiating 400 watts, but in the second instance a radiation of 1,600 watts seems apparent. Which is it? (B) How far could I expect to send with this outfit? (C) When I use more than 2 K. W. on the transformer, an arc forms at the gap. Is this due to insufficient capacity in the secondary circuit?—F. D., Bristol, Tenn.

Answers.—(A) The ordinary method of rating lamps in watts is to multiply the volts required to light the lamp to full brilliancy by the number of amperes flowing through the lamp when so lighted. This is based upon a direct current voltage, or a commercial alternating current, which is generally almost a pure sine curve. In such an alternating current the current is almost in phase with the voltage, and the product of the effective volts by the effective amperes gives the wattage of the lamp.

In dealing with the currents sent out through an aerial, we have a voltage which is far from being in phase with the current. For this reason it is impossible to take as the number of watts developed the product of the amperes flowing (upon which the lighting of the lamps is dependent) by the apparent voltage drop across the lamp.

The energy radiated by your system is probably between the values which seem apparent, but it would not be safe to assume any definite figure.

(B) An average of from 150 to 250 miles over water at night, under ordinary weather conditions.

(C) Yes.

Adjusting a Loose Coupled Tuner

Questions.—(A) Is there any method by which any turn of wire on the secondary of a loose coupled tuner can be touched by a slider, without taking the slider off the rod and reversing it, no matter how far the secondary is inside the primary? (B) Is there any advantage in using such a device?—H. N., Toronto, Ont., Can.

Answers.—(A) The only method which we know is to arrange the slider of the secondary to move inside the core of this winding, and to cut a slot in the core so that the slider makes contact with the wire on the side nearest the core.

(B) Such a device is not necessary, for it will be found that in nearly all cases when it is necessary to have the secondary entirely within the primary, all the turns of the secondary winding will be needed. It is always well, however, to provide for adjustments in all wireless instruments, and the method of construction described above will be found very satisfactory.

Rotary Spark Gap

Question.—What is a rotary spark gap, and what is its purpose?—H. C. S., River Forest, Ill.

Answer.—A rotary spark gap consists of a disk of insulating material, having metallic points around its circumference, and a stationary metal plug or ball, so located that the points pass close to it. The points are connected by a wire and form one spark gap terminal. The plug or ball is the other terminal of the gap. The disk is rotated by a motor, and consequently the distance between the points and the plug is varied.

The purpose of this type of gap is to allow the aerial to fully discharge before it is again charged when a point passes near to the plug.

Getting Rid of Inductive Effects

Question.—How can the induction picked up by an aerial from electric light circuits be eliminated?—W. D. B., Dexter, Mich.

Answer.—The use of a double slide, three slide, or loose coupled tuning coil, or any system using a condenser, will help. Another way is to connect a variable condenser across the aerial and ground.

Kind of Wire on Tuning Coil

Question.—Can the loose coupled tuning coil described in the January, 1910, issue be wound with cotton covered wire instead of enameled?—E. T. W., Chicago, Ill.

Answer.—Yes, although the maximum wave length to which the tuner will respond will be shortened slightly.

Cannot Call Operator

Question.—Is there an instrument for calling a wireless operator to his post?—C. M. M., Lewiston, Idaho.

Answer.—There is no satisfactory instrument in use at the present time to call an operator when he is not at his instruments.

QUESTIONS AND ANSWERS

Rules:—Questions must be addressed to the "Question and Answer Department" and contain nothing for other departments. Full name and address of the writer must be given; only three questions may be sent at one time; 2-cent stamp must be enclosed for answer by mail. No attention will be paid to questions which do not comply with these rules.

Rules for Asking Questions

Attention is hereby called to some slight changes in the rules applying to the Questions and Answers Department, as printed above. Those expecting to make use of this department will please read over the rules carefully and govern themselves accordingly. No attention will be paid to correspondence which does not comply with all the rules.

Short Circuited Coil in Dynamo

Questions.—(A) How may a short circuited coil in a generator be located? (B) How will the generator act while running if such trouble exists? (C) How would you deal with a short circuited coil in a generator that cannot be stopped long enough to make extensive repairs?—L. E. P., North Brookfield, Mass.

Answers.—(A) On stopping the machine the coil may often be found by running the hand over the armature, the defective coil having a much higher temperature than the others. The insulation on this coil may have a baked or burned appearance.

(B) The armature will become hotter than ordinarily, there may be flashing at the commutator, flickering of the lights and a smell of baking varnish or very hot insulation.

(C) Where the taulty coil cannot be put in good shape at once each turn of the short-circuited coil may be cut in two and the two commutator bars between which the coil is connected may be connected by a wire soldered to each.

Transformer Losses; Electrical Inspection

Questions.—(A) When the lights on the secondary of a step-down transformer are not turned on is there any current loss in the transformer? (B) Must all electrical wiring be inspected or is it only a matter concerning the insurance company?—I. W. T., Mankato, Minn.

Answers.—(A) What is called the iron or core loss, due to hysteresis or eddy currents, is practically the same in any given transformer, at all loads, and is going on at no load. The primary coil of the transformer is always connected across the line and some current, according to the resistance of the primary winding, will flow through it all the time, thus subjecting it to periodic magnetization, demagnetization and magnetization again, and so on as the current alternates. This core loss depends upon the frequency, range through which the flux passes, the quality of the iron, the volume of the core and the thickness of the laminations or sheets making up the core.

(B) This depends upon the locality. In small towns this matter receives little or no attention. In medium sized and large cities inspection is required not only by insurance interests, but by the cities themselves. Some states have a state inspection bureau from which inspectors travel all over the state, calling attention to poorly installed electrical equipments. All wiring should be installed in accordance with the rules of the National Electrical Code, copies of which may be obtained from the nearest underwriter or fire prevention bureau.

Wiring Formula

Question.—What formula may I use to determine wire sizes for output from dynamos of various capacities?—C. S. Lentz, Oregon.

Answer.—Use the formula:

$$C.\,M. = \frac{I \times L \times 10.8}{V}$$

where C. M. = circular mils cross-section of wire.

I = current in amperes.

L = total length of wire.

and V = drop in volts allowable.

I and L are known and V must be decided upon.

Requisites and Validity of Re-issued Patents

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

EVIDENCE OF IDENTITY.—The granting of a re-issue is *prima facie* evidence that the inventions claimed in the original and re-issued patents are the same, but although entitled to great weight it is not conclusive. Ordinarily the question of identity is purely one of construction of the specifications and descriptions in the original and re-issued patents. Parol evidence is inadmissible to enlarge the scope and nature of the invention beyond what was described, suggested, or substantially indicated in the original specifications, drawings, or model. The Court is confined to the records in the patent office. The original patent must be introduced in evidence in all cases where the question of identity is in issue. The specifications of the original and re-issued patents are the best means by which to determine whether or not the two patents are for the same invention. But the drawings and model are to be considered in connection with the specifications. A change in the drawings upon re-issue, or additional drawings, may be evidence that the inventions are not the same. But it has been held that no presumption arises from the fact that claims made in a re-issued patent are not found in the original, that such claims were not intended to be made in the original. Differences in the claims and description are not inconsistent with the identity of the inventions designed to be covered by the two patents, as the very purpose of a surrender and re-issue is to correct the specifications and claims. Expert testimony is admissible to determine the meaning of technical terms or words of art, and to point out differences between the original and re-issued patents.

REQUISITES AND VALIDITY OF RE-ISSUED PATENTS.—The validity of re-issued patents depends upon the same considerations as govern the validity of original patents, and in addition the requirements as to re-issued patents already discussed must be observed. The *prima facie* presumption is in favor of the validity of the re-issue. The re-issued patent need not recite the facts upon which its re-issuance was based. The invalidity of new claims in the re-issue does not impair the validity of original claims repeated and separately stated in the re-issued patent. Fraud may render a re-issue void or at least voidable. But re-issued patents cannot be collaterally attacked for fraud in obtaining the re-issue.

CONCLUSIVENESS AND EFFECT OF DECISIONS OF PATENT OFFICE.—There is much conflict and confusion in the decisions, and it is impossible to reconcile all that has been said and decided upon this subject. Many cases, some of which are comparatively recent ones, have laid down the rule that re-issued patents are conclusive of their own validity, and that the decision of the commissioner is not re-examinable in court in a collateral proceeding, such as a suit for infringement, unless it is apparent on the face of the patent that he exceeded his jurisdiction, or it may be said as a matter of legal construction that the two patents are not for the same invention. But this rule has never been wholly acceptable to the courts; and certainly cases may be found reviewing the decision of the commissioner upon every one of the questions upon which it has been supposed to be conclusive. The true rule seems to be that the re-issue is merely *prima facie* evidence of the facts authorizing the re-issue, and while the decision of the commissioner is entitled to great weight, and should not lightly be disturbed, yet it is not absolutely conclusive upon the courts, and this is the rule expressly declared in some cases. The commissioner's decision is not conclusive as to his own jurisdiction to grant the re-issue.

OPERATION AND EFFECT OF SURRENDER AND RE-ISSUE.—The statute expressly provides that the surrender shall take effect only upon the issue of the amended patent. Where the re-issue is refused the original patent remains in full force. But where the re-issue is granted, the original patent is deemed abandoned and is of no further force or effect even if the re-issue is subsequently declared void by the court. The re-issue is to be substituted for the original as the evidence of the patentee's title and of the nature and object of his invention, and relates back as a continuous proceeding to the date of the original application, except in respect to infringement prior to its issuance. Existing contracts concerning a patent apply equally to it after surrender and re-issue. The application may be withdrawn or abandoned at any time before the re-issue is granted, and in such case the original will remain in full force. The patent office has no authority to reject or cancel any of the claims of the original patent where no re-issue is granted.

Hens Lay for Tungsten Light

A Canadian has made some interesting tests as to the effect of electric light upon hens. He placed four 40-watt tungsten lamps in his hen house, burning them from four o'clock in the afternoon to one o'clock in the morning. This gave the hens plenty of time to pick their food during the short days of the winter months. They would eat and roost all day and lay at night. As an experiment he replaced the tungsten lamps with four sixteen-candle-power carbon lamps. Although these lamps were burned the same number of hours as the other type of lamp the hens went on a strike until the tungstens were again used. He believes that the color and quantity of light of the tungstens, almost like daylight, had the right effect and proved the hen quite a discriminating creature. Further he states that the experiment proved profitable with current at seventeen cents a kilowatt hour.

Electrical Advertising by Air Ship

The great airship of the Parseval Air Transportation Company appeared recently over Berlin, Germany, and passed over the main streets unusually close to the ground. On each side of the huge bag were stretched large canvases of glittering stuff, on which appeared in great letters of light the words "Prosit Neujahr," meaning "Happy New Year." The ship had just returned from its gas-charging station at Bitterfield, about 150 miles from Berlin, and the display caused a great sensation. The ship took its course to the royal castle, circumnavigated that and other important buildings, and finally returned to its station at Johannisthal. The lighting was accomplished by an electric generator in the car, taking sufficient power from the airship engine to produce electricity for two searchlights, one on each side. The outlines of the car were marked by incandescent lamps of various colors. This method of advertising is patented by the Air Transportation Company, Charlottenburg, Germany.

Telephone for Life Saving Station

A telephone is to be installed at the United States life saving station, which guards the Ohio Falls at the Louisville, Ky., wharf, and which is the only inland life-saving station in the United States. Captain "Billy" Devan, of the life saving station, is now making arrangements with the authorities at Washington whereby the service may be established.

A Rival for Para Rubber

Prof. John R. Allen of the University of Michigan has discovered in the Territory of Tepic, Mexico, a new rubber tree. The tree resembles a horse-chestnut and bears nuts like that tree, these nuts being covered with nettles which make gloves necessary in handling them. The trees are tapped and the sap which oozes out in a coagulated form is washed and sent to market. The gum very closely resembles Para rubber, but is said to be more readily prepared, thus costing less.

Water-power in Switzerland

Owing to abundant waterpower, the use of electricity, even in small villages and on farms, is greatly increasing throughout Switzerland. The use of candles is therefore gradually decreasing. Heretofore the candle has been the general illuminant in the small, Swiss homes. There are still about 2,000,000 pounds of candles produced in the Swiss candle factories every year. Cheap electricity is, however, producing a sudden change, from the primitive to the modern mode of lighting.

ON POLYPHASE SUBJECTS

Readers Should be Writers

This number is the beginning of a new volume. POPULAR ELECTRICITY magazine is now in its fourth year. A birthday, of course, offers an excuse for the editor to ramble off into ecstacies about past achievements of the magazine and advance felicitations about wonderful things to come. We will forget all that, however, and discuss a subject having we hope, a more direct bearing on the future betterment of the magazine.

You who are old subscribers may have noticed that each issue for a year back has contained 96 pages or over of reading matter, You probably do not know that in that time we printed 1100 articles which required 1450 cuts for their embellishment. These figures show that even in one field like electricity there is a great diversity of subjects to be covered. We aim to do this by printing a great many short, snappy articles, each with a good, live picture or two. These, of course, are in addition to a number of more pretentious articles, one fiction story and two or three serials of a practical nature in each issue.

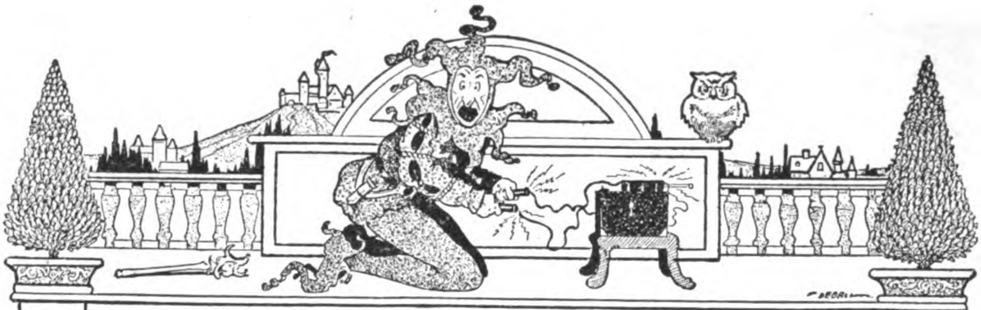
You may have questioned where all this material comes from, and that is just the point we are getting at. It comes from a great many different sources, but one of the most important is a list of contributors which we have been building up in the last three years. As the magazine grows this list of contributors must grow with it, consequently we are always on the lookout for writers who can help to make the magazine interesting.

Right among our own subscribers and among the news-stand patrons there are hundreds who are in a position to furnish us with exactly the right kind of material for these short illustrated articles. Our readers are scattered not only all over the United States but in every civilized country of the globe, and we want each and every one to consider himself a unit in a great flying squadron to collect interesting facts and interesting pictures about electricity and its workings all over the world. It isn't difficult if you see an interesting thing and understand it to sit down and in straightforward simple English to tell what you know about it. In these days when the camera is everywhere it isn't hard to get a picture of anything, anywhere at any time. If you haven't a camera yourself your friend has or else a professional artist is handy. We pay well for material which is usable and there is no more fascinating work in the world than "writing for a magazine."

What kind of material do we want? As stated above we can't get too many of the short articles that have the right element of interest and the "go" to them. If 200 words and a picture tell a good live story we like it better than a long article, with a lot of pictures, that is liable to "drag."

A few words and a picture of a telegraph line on the great Wall of China; how bananas are ripened and made palatable by electric heat; an aeroplane in flight with an electrical "speedometer" attached; an odd old electric vehicle of '89; giant skull made to do odd tricks by electricity; artistic shadow dancing; electric cableway "caught in the act" of dumping its load; electrical method of advertising shoe polish; the cruiser who scours the timber lands for telephone and electric light poles—these are a few examples from recent issues showing what we are after in the way of short articles.

Remember, in sending in a manuscript that the editor's hand instinctively singles out first the neat, flat package and that his eye lingers most carefully on the nicely typewritten page and the good clear photographs. Thus "properly introduced" we are ready to do business with any writer among our tens of thousands of readers. **The magazine is part yours. You read it. Now help to improve it.**



SHORT CIRCUITS

A little four-year-old, on being taken to the circus for the first time by her big brother, spying the monkeys, cried: "Oh, Johnny, Johnny, look at the little dogs that look like us!"

* * *

"Madam," he began, "I have here a can opener which can't be beat. Candidly, it can open any can that can be opened by any can opener, and if you can show me a can, I can—"

"Can it, or I'll call out the canine," cried the woman cantankerously, and the canvasser cancelled all further attempts and cantered away toward Canterbury whistling a canzonet.

* * *

There was a young lady of Brighton,
Who went on the stage as a trighton;
She exclaimed in a pause
Of thunderous applause:
"Oh, heavens! I've only one tight on."

* * *

A month or so after Nat Willis's recent marriage, Mrs. Wills, nee La Belle Titcomb, the bareback rider, was in the kitchen overseeing the breakfast preparations. "Nat," she called to her husband. No answer. "Nat!" she repeated. Again no answer. Five times, five no-answers. Entering the dining-room, Mrs. Wills saw her husband at table, absorbedly reading a copy of the New York Journal.

"My Gawd!" she sighed. "To think that I married a bookworm!"

* * *

A teacher asked her scholars to give a sentence using the word disarrange. An Italian boy submitted this: "My mudder she gotta da coal range. My fadder get up in da morning, make da fire he say, 'Damma dis a range!'"

* * *

At a Denver hotel a woman went into one of the telephone booths and sat down. It is not possible to get a telephone number from the booth—the girl at the board has to call it. The girl went to the booth, "Did you want a telephone number?" she asked of the woman. "No," replied the woman, "I'm just waiting for this elevator to go up."

* * *

"Lend a hand, Hiram, and help ketch the selectman's pig."

"Let the selectman ketch his own pig. I'm out of politics for good."

* * *

An American and a Highlander were walking one day on the top of one of the Scotch mountains, when the Scotchman, wishing to impress his boastful "cousin," produced a famous echo to be heard in that place. When the echo returned clearly after nearly four minutes, the proud Scotchman, turning to the Yankee, exclaimed: "There, mon, ye canna show anything like that in your country." To which the other replied: "I guess we can better that some, stranger. Why, in my shooting lodge in the Rockies, when I go to bed I just lean out of my window and call out: 'Time to get up! Wake up!' and eight hours afterward the echo comes back and wakes me."

* * *

"What do you think of my acting?" asked the would-be Hamlet.

"That wasn't acting," replied the friend. "That was misbehavior."

The minister was shaking hands with a new member of his congregation, a girl fresh from Sweden, and said, cordially: "I would like to know your address, so I can call on you."

"Oh," said the girl, innocently, "I haf a man."

* * *

An Irishman witnessed the burning of a saloon in which his credit was good and knowing one of the firemen he exclaimed, "Mike, if you love me, play on the slate."

* * *

A Chink by the name of Ching Ling
Fell off a street car—bing! bing!
The con turned his head,
To the passengers said:
"The car's lost a washer.—Ding! Ding!"

* * *

My wife used to be an actress. She got twenty-five dollars a week for saying just one line—"Hip-Hip-Hooray!" Just think—twenty-five dollars for two hips and a hooray. Five dollars for the hooray.

* * *

Jones is the luckiest man you ever saw—he's always falling into property. On his way home from the club last night he fell into the cellar of a new twenty-story office building.

* * *

Assistant—Here's a man who says he never knew his 'phone to ring through mistake, never had the operator to tell him, "Line busy;" never was disconnected, nor ever had a friend to tell him, "I called and your line was busy;" what shall I do with it?

Editor—Why put it in "Current Fiction," of course.

* * *

Tommy: "The doctor brought the baby."

Freddy: "It looks just like ma's been shopping by telephone again."

* * *

Little Miss Muffet,
She sat on a tuffet,
Inside of her big limousine.
When the motor back-fired,
It made her feel tired,
So she bought an electric machine.

* * *

The elderly stranger, by invitation of the superintendent, was addressing the Sunday school. "How many can tell me," he asked, "which is the longest chapter in the Bible?"

Many hands went up.

"This little boy may answer," he said, pointing his finger at an urchin in one of the seats near the front. "Which is the longest chapter in the Bible?"

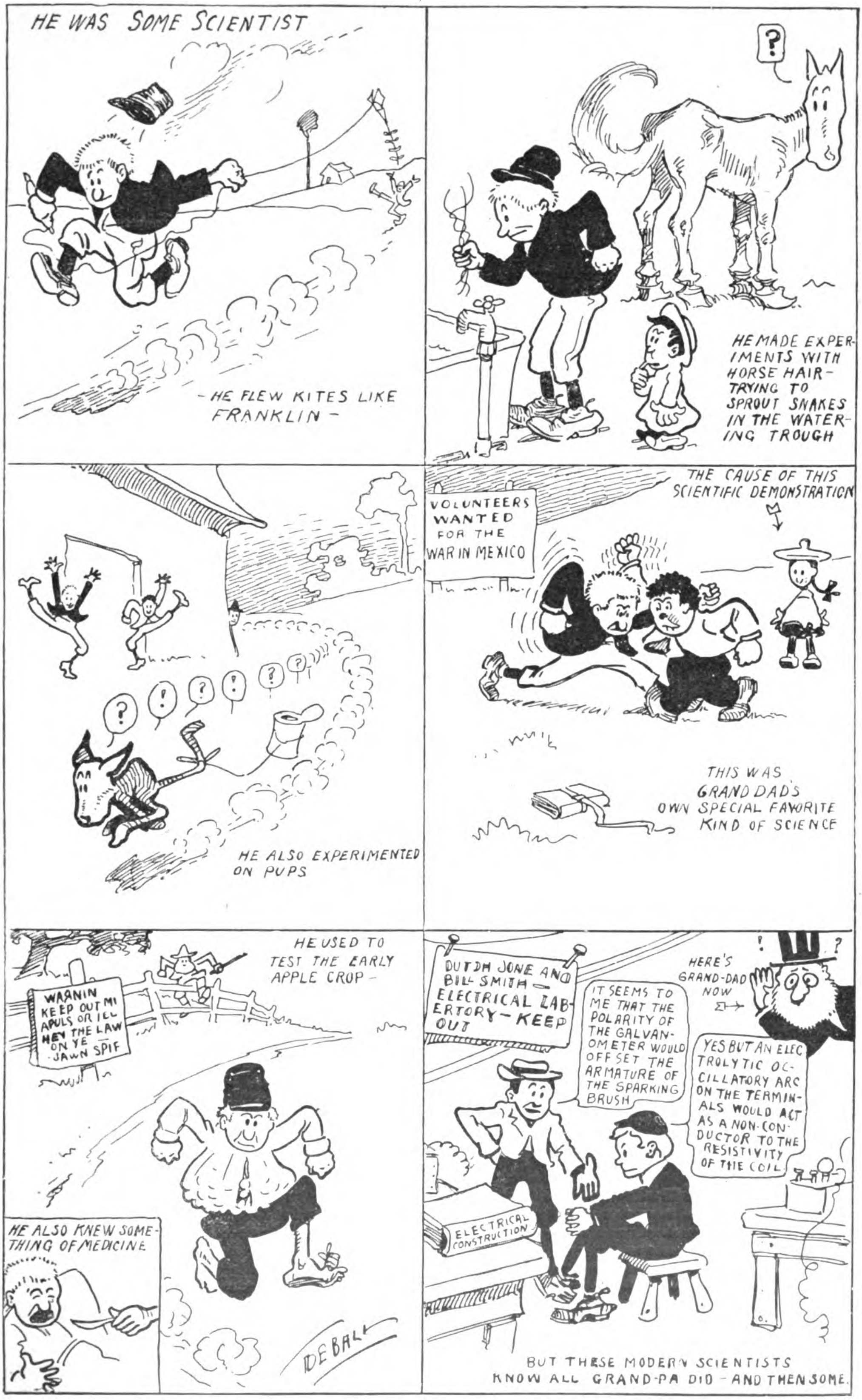
"Psalm double one nine!" shouted Tommy Tucker.

* * *

"Do you ever read Popular Electricity?"

"Oh—speaking of Electricity—that makes me think."

"Really, Mr. Lapleigh, isn't it wonderful what Electricity can do?"


HE WAS SOME SCIENTIST
- HE FLEW KITES LIKE FRANKLIN -
?
HE MADE EXPERIMENTS WITH HORSE HAIR - TRYING TO SPROUT SNAKES IN THE WATERING TROUGH
HE ALSO EXPERIMENTED ON PUPS
VOLUNTEERS WANTED FOR THE WAR IN MEXICO
THE CAUSE OF THIS SCIENTIFIC DEMONSTRATION
THIS WAS GRAND DAD'S OWN SPECIAL FAVORITE KIND OF SCIENCE
HE USED TO TEST THE EARLY APPLE CROP -
WARNIN KEEP OUT MI APULS OR ILL HEV THE LAW ON YE - JAWN SPIF
HE ALSO KNEW SOMETHING OF MEDICINE
DE BALL
DUTCH JONE AND BILL SMITH - ELECTRICAL LABERTORY - KEEP OUT
HERE'S GRAND-DAD NOW
IT SEEMS TO ME THAT THE POLARITY OF THE GALVANOMETER WOULD OFFSET THE ARMATURE OF THE SPARKING BRUSH
YES BUT AN ELECTROLYTIC OCCILLATORY ARC ON THE TERMINALS WOULD ACT AS A NON-CONDUCTOR TO THE RESISTIVITY OF THE COIL
ELECTRICAL CONSTRUCTION
BUT THESE MODERN SCIENTISTS KNOW ALL GRAND-PA DID - AND THEN SOME.

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.

CURRENT DENSITY.—The current in amperes compared to the cross-sectional area of a conducting wire or cable. This area is usually expressed in circular mils. Also used in electroplating to specify the number of amperes per square foot of the surface to be plated that should be applied to give the best results.

CURRENT GENERATOR.—A device for transforming mechanical energy into electrical, as a dynamo or magneto.

CURRENT INTENSITY.—Current strength, defined as the quantity of electricity passed by such current in a given time. The practical unit is the ampere.

CURRENT REVERSER.—A switch or other device for reversing the direction of flow of current in a conductor.

CURRENT TAP.—An adapter fitted to a lamp socket so that current may be taken by a flexible cord from it without interfering with the operation of the lamp.

CURVE OF SATURATION OF MAGNETIC CIRCUIT.—Magnetic lines of force are induced in a piece of iron by passing current through a wire coil wound around the iron. These magnetic lines are proportionate to the strength of the current flowing and the number of turns in the coil. If we plot a curve in which the ordinates represent number of lines of force and abscissas number of ampere turns, this curve is called the curve of saturation of the magnetic circuit.

CUT-IN.—Used as a verb means to connect any electric appliance, mechanism or conductor into circuit. Used also as a noun.

CUT-OUT.—The reverse of Cut-in, when used as a verb. An appliance for removing any apparatus from a circuit as a fuse, circuit-breaker, etc.

CUT-OUT, AUTOMATIC.—A mechanism for automatically shunting an arc or other lamp out of circuit when it ceases to work properly.

CUT-OUT, MAGNETIC.—A coil of wire so arranged with a core which is drawn up as the current strength through the coil increases. This operates to open a switch and thus of the circuit.

CUT-OUT, SAFETY.—A block of porcelain or other base carrying a safety fuse, which melts and breaks the circuit before the wire connected to it is dangerously heated.

CYCLE OF ALTERNATION.—In an alternating current, the current flows in first one direction and then in the opposite direction a certain number of times per second. A cycle or period of alternation represents the interval elapsed during a complete double reversal of the current. Starting at zero, for instance, the current would rise to maximum value in one direction, die down to zero, rise to maximum value in the opposite direction and then die down to zero. This would constitute one alternation or cycle.

CYCLE OF MAGNETIZATION.—This represents a period of positive and negative magnetization brought about by a magnetizing force such as an electric current, beginning at a fixed value, generally zero, rising to a maximum, and then returning to the original basis. Cycles of magnetization apply especially to transformer cores and similar apparatus used in connection with alternating current.

DAMPER.—A device to retard the motion of some part of an electrical device as for instance the copper frame on which the wire in a galvanometer is coiled, which acts to damp the oscillations of the needle. Also used to designate the tube of brass or copper placed between the primary and secondary of an induction coil to diminish the current and potential of the secondary.

DAMPING.—Preventing the indicator of an electrical measuring instrument from oscillating.

DASH-POT.—A cylinder and piston loosely fitting in same, which constitutes a familiar mechanical arrangement for retarding motion or cushioning the parts of a machine. Used in electrical apparatus and instruments for damping.

DEADBEAT.—A term applied to electrical measuring or indicating instruments in which the needle or pointer comes to rest quickly, permitting quick reading.

DANIELL'S CELL.—A standard voltaic cell of which many forms are used. It consists of a zinc-copper—copper-sulphate couple.

DEAD EARTH OR DEAD GROUND.—A fault in a telegraph, telephone or signal circuit in which the wire is thoroughly connected to the earth.

DEAD-TURNS.—In the winding of an armature a certain percentage—about 20 per cent—are termed "dead-turns," as they pass virtually out of the magnetic field and do not concur in the production of electro-motive force.

DEATH, ELECTRICAL.—Death resulting from a discharge of electricity through the animal system is not fully understood; that is, exact conditions requisite for fatal results have not been determined. High electromotive force is essential, though the term "high" is relative; a pulsating or alternating current is most dangerous; amperage or quantity of current also has a bearing, though the quantity may be very small, a fraction of an ampere, and still cause death. In electrocution a voltage of 1,500 to 2,000 volts is used; the current is alternating.