Popular Electricity
In Plain English

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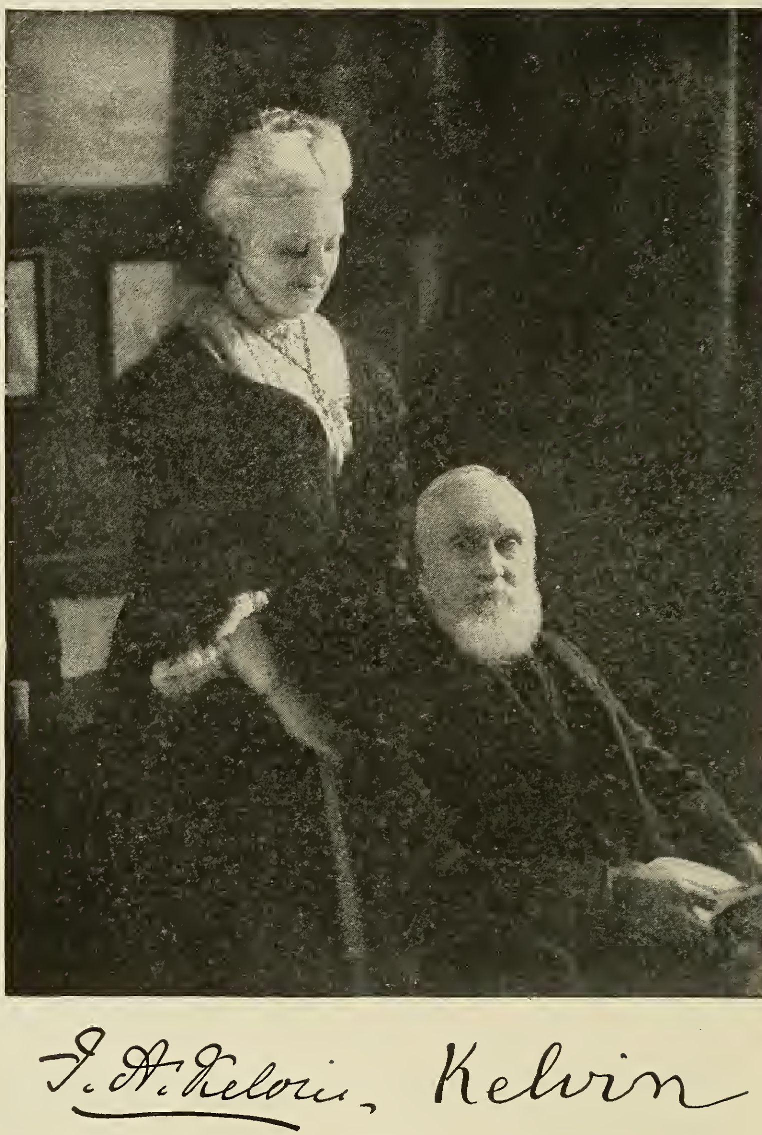
Interesting Glimpses of Kelvin

By T. COMMERFORD MARTIN

Two interesting books have just been given to the world dealing with the career and character of the late Lord Kelvin, so much better known to the world as Sir William Thomson, that a distinguished European savant once wrote indignantly to London to inquire who the man Kelvin was that had the audacity to claim so many of the things done by Thomson. It is one of the misfortunes of the English peerage system that many great men are thus made to lead a kind of "double life" in history; for after a few hundred years it is difficult to remember to whom the changed appellations belong. In Kelvin's case, however, although it might have been better if in becoming ennobled as was his great German friend, he had like Helmholtz retained his own surname, it does not seem likely that the world will readily forget the greatest scientist of his century and the great father of the submarine cable art.

One of these biographies is by Prof. Silvanus Thompson and is worthy the perusal of any student of physics. The other is "Lord Kelvin's Early Home," being chiefly the simple, unaffected but very charming reminiscences of his sister, the late Mrs. Elizabeth King, throwing vivid flashes of light upon the youth of the great scientist. As the son of a professor of no mean attainment, it was not unnatural that William Thomson should have manifested precocity and even genius. Mention is made of the after-dinner study of the globes in the professor's home, and of arithmetic. "William was scarcely four when he began to take some part in these cheerful after-dinner lessons, and from the very first he showed the wonderful mental capacity with which he was endowed." A little prodigy is sometimes a little prig, but it is pleasant to learn that Thomson was very natural as well as intellectual, and there is one amusing story of the mere infant being found one day seated before a looking glass and remarking complacently to himself: "P'itty blue eyes Willie Thomson got!" There is much in the two books to show that Thomson was, in fact, one of the marvels of the time in his astounding precocity, very much like the mathematical genius that has of late been enjoying the applause of the pundits of Harvard. In 1834, when only ten, he is described as working upon electrical apparatus, and shortly after that he entered the University of Glasgow as a student. Within a year he had won two prizes and by the time he was twelve secured another prize for translating Lucian's brilliant satires: "Dialogues of The Gods," and for parsing completely the first three dialogues. Imagine a Japanese boy of twelve doing the same with three of Skakespeare's plays, and we form a relative idea of the feat.

People began to get interested. When he was fifteen Thomson was a prize man in natural philosophy, and a year later had the class prize in astronomy, and a university medal for an essay on "The Figure of The Earth." Taking a trip to Germany with his father, he smuggles into his box a celebrated French book on heat, and at Frankfort goes surreptitiously down to the cellar to read it, for fear his father might object. At seventeen he goes up to Cambridge Uni-



[1906]

By Courtesy of the MacMillan Company

versity, and soon begins to contribute to its "Mathematical Journal," his articles placing him in line with the greatest mathematicians and physicists of the period. Graduating with highest honors at twenty-one, he becomes professor at Glasgow in natural philosophy at twenty-two, and gets into touch with Helmholtz, Faraday and the other intellectual leaders of the day. All this was certainly "going some," and he kept up the pace not only through the fifty years of his notable professorship but up to the very time of his death in 1907. He wrote and delivered during that fruitful life some 300 papers, addresses, etc., on all the great physical questions, particularly those relating to the nature of the solar system and to electricity and magnetism—many of them of the first importance. He was engaged in controversy meanwhile with such men as Huxley, but always held his own, and a little more. Added to this were his numerous inventions and his great conquest of the science and art of submarine telegraphy. Westminster Abbey contains the remains of many great English worthies; but certainly no finer genius is there enshrined than Kelvin.

Prof. Thompson devotes wisely a large part of his biography to the story of the Atlantic cable. It is ever fresh and exciting, and as here narrated the part of the plain college professor in pushing to success the daring plans of Cyrus Field and his associates is seen to be of the most vital nature. In 1855, telegraphy on land was not very far advanced, and in this country still awaited the touch of Edison, then only eight years old. Even when the pioneers were able to get laid their primitive cables, they did not know how to work them. The popular plan was to jam into them all the current that could be got from big batteries and strong induction coils; and if dynamos had been handy in those days they would assuredly have been hitched on to furnish even heavier doses. No wonder the fragile cables gave up the ghost! William Thomson was the homeopathist who showed that delicate currents too weak for human sensation would do the work, and the cables were saved. There was endless research and invention in all this, but not satisfied he brought in two kinds of instruments to record the "talking." His mirror galvanometer gave the pulsing signals in little flashes of light; and then he supplemented that with the siphon recorder which writes the message out on tape in tiny hills and valleys that the expert operator reads at a glance. These two wonderful advances made the art practicable, helped bring into being the extensive modern cable systems of the world, and incidentally made a number of millionaires, of whom Sir William himself was deservedly one.

He who did this was able to appreciate all the more such inventions as Edison's incandescent lamp, Bell's telephone, Westinghouse's air brake—and he did. Every visit to this country was a source of inspiration to him, and he loved to take back with him some new example of American ingenuity. He was deeply interested, moreover, in the utilization of Niagara, and was stout in defense of those who, believing in the conservation policy discovered much later by President Roosevelt, did their best to prevent such waste of needed energy from going on for ever.

There are many human touches in Prof. Thompson's handsome volumes. Kelvin is shown as fond of music, and as playing the cornet in the college band. He took up rowing at Cambridge for the exercise, and won the silver sculls. When he got money at last, he indulged his taste for sailing and bought a staunch seagoing yacht, the "Lalla Rookh," which in the long summer vacation he would navigate himself, turning it into a floating laboratory, and sometimes leaving his guests to flop around on the wet decks by themselves when he happened in a hurry to note some wave effect or think out some formula and would take a hurried header down below to record it in one of his everlasting little green note books. With regard to the work he did in his mariner's compass, finding the position of a ship at sea, the nature of the tides, etc., Prof. Thompson quotes the following incident related to him: "I don't know," said a sailor in the distant seas of the East, "who this Thomson may be, but every sailor ought to pray for him every night."

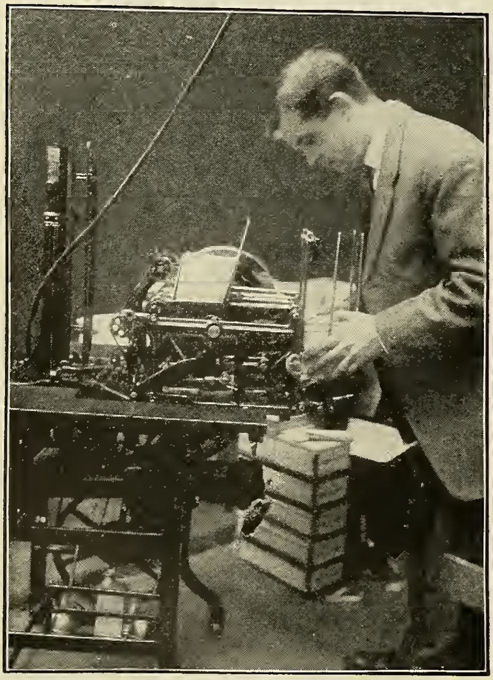
Many of the stories and incidents refer to Kelvin's work as a teacher. He appears to have been a great teacher, but not in the strict pedagogic sense. He was not exactly ideal for the handling of large clasess, but was a great intellectual stimulus to the students who could appreciate what he was driving at and who were willing to follow up his line of thought and experiment. His consumption of chalk at the blackboard was enormous, in working out the equations, but he did insist on proving all things and loved to take a share himself. Helmholtz tells how "Thomson's experiment did for my new hat."—The eager investigator threw a metal disk into rotation and hit it with a hammer, treatment which the disk resented so much that it flew in one direction while the iron foot on which it was revolving went off in another, ripping up the savant's hat and pretty nearly braining him. Another amusing picture is that of the Paris Electrical Congress of 1881 where there was manifested a strong feeling in favor of abandoning the British Association's unit of resistance, the ohm, in favor of Siemens's unit, the column of mercury, one meter long. "The debate grew warm. One who was present has narrated the unforgettable scene of comedy of Thomson and Helmholtz disputing hotly in French which each pronounced *more suo*, to the edification of the representatives of other nationalities." It may be noted in passing that his house was the first in Scotland to be lighted by electricity. Altogether in these books we enjoy a splendid and vivid picture of a great genius, and of the greatest electrician in England for at least fifty years.

Governmental Test of Office Devices

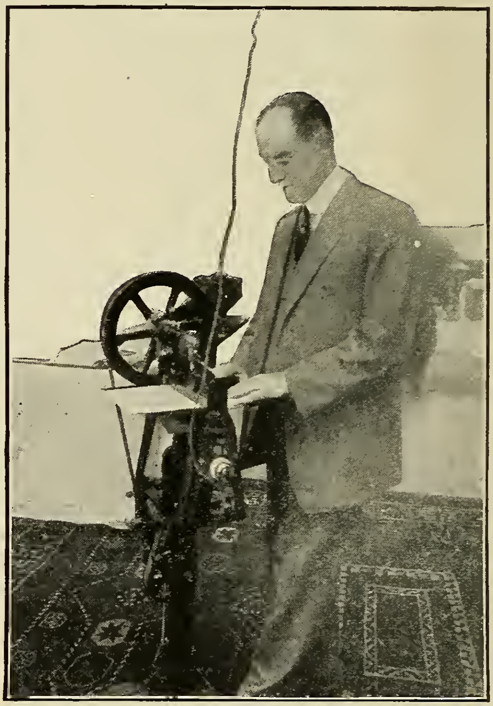
By WALDON FAWCETT

There has recently been held under the auspices of the national government at Washington, D. C., a unique test and demonstration of no little significance to the electrical interests of the country. This event which was conducted by Federal officials acting wholly disinterestedly in the cause of general progress, consisted, primarily, of an exhibit of labor-saving devices suitable for office work and was held in the Treasury Building. There were more than 70 different exhibits, many of them of most elaborate character.

Participating in this practical "try-out" of modern office aids and business equipment were not only all the well-known firms manufacturing such utilities but many inventors and newcomers among electricians and manufacturers who presented novelties of recent inception. Moreover, the magnet



NEW MODEL ADDRESSOGRAPH



POSTAGE STAMP PERFORATOR

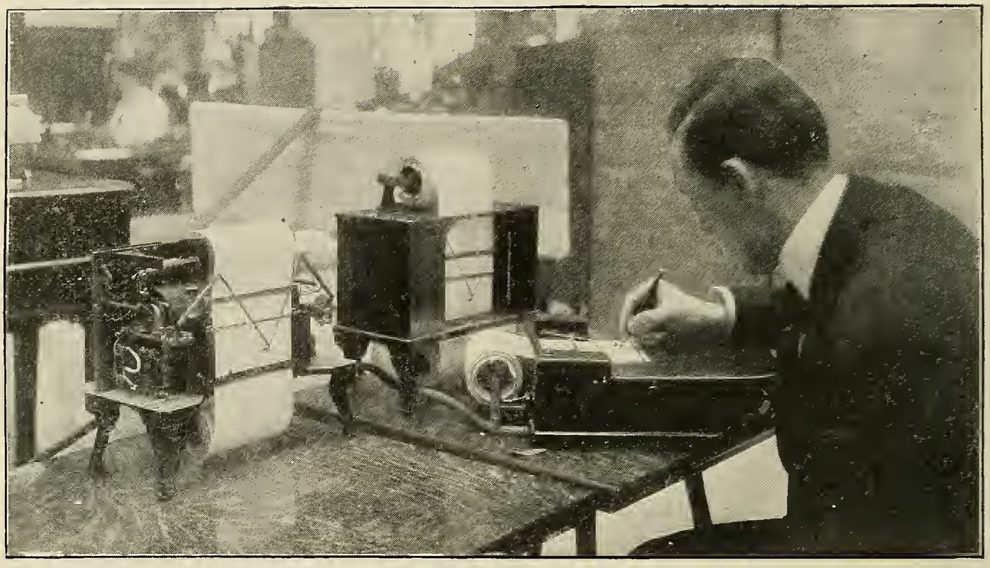
of prospective heavy government contracts served to induce the first public demonstrations of a number of mechanical and electrical marvels which have never been exploited at any of the "business shows" or electrical expositions held in our larger cities of late years. The contemplation of new business, as mentioned, was due to the fact that this whole exhibition was planned as means to the end of modernizing the

FLEXOTYPE FOR DUPLICATING TYPEWRITTEN SHEETS

equipment of our government offices. Heads of bureaus, chiefs of divisions, and in fact all officers and clerks of the various departments in Washington and Uncle Sam's "branch offices" throughout the country were invited to familiarize themselves with the devices shown and to make recommendations for the adoption of any that might seem to give promise of promoting economy or efficiency.

A number of circumstances and considerations rendered notable and significant this new departure on the part of the government. However, probably the most impressive object lesson afforded by this competition concerned the rapid and tremendous growth of the use of electricity for power purposes of all kinds, in the up-to-date business office. Reference is not made, of course, to the indispensables such as electric lights, electric fans, electric elevators, etc. All such are established institutions, although improvements are continually making their appearance. Rather does the newer development contemplate the displacing of hand power by electricity in all the functions of recording dictation, writing letters, reproducing typewriting, folding letters and circulars, addressing and sealing envelopes, and all the other functions of office routine. With examples of the various classes of machines, shown at the Treasury, in operation in a well-fitted office, very little human brawn will be required to dispatch business, and to do it, too, in far less space than would be required under the old methods.

Persons who have kept at all in touch with the trend of the times have noted in recent years the strong tendency to have electricity supplant all other forms of power as the universal source of energy for office activities in all branches of the work-a-day world. What has not been generally appreciated, however, even by electricians themselves is that there is no field where this new function of electricity has been so welcome or where it finds such boundless opportunities awaiting it as in the government offices. For one thing Uncle Sam has plenty of electricity and to spare—manufacturing his own current for most of his big business establishments at the seat of government—and consequently there is never any question regarding available current. Secondly, the national government has need of electrical helpers in the discharge of office routine



SHOWING THE SENDING AND RECEIVING PARTS OF THE TELAUTOGRAPH

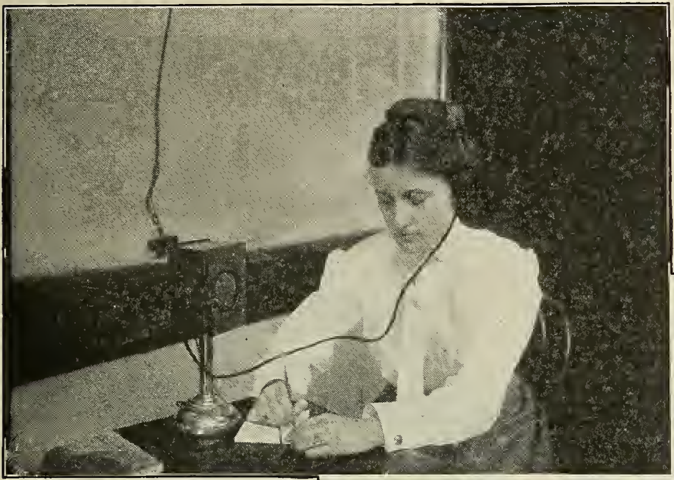
because Uncle Sam does business on so much larger scale than the average private institution. With upward of 30,000 employees (in Washington alone) to be kept constantly in touch with one another; with dozens of different mailing lists, some of them containing as high as 50,000 names to be handled daily or weekly, and with other chores of corresponding proportions it goes without saying that the central government needs something much speedier than hand labor if desks are to be kept cleared for action.

Consequently the government officials who planned the recent exhibition of office appliances rather specialized on electrical toilers. No charge was made, of course, for exhibit space and electric current at 110 volts or 220 volts direct was furnished free to all exhibitors who would make use of it. Many of the new inventions or new models of old appliances which were displayed were designed especially for electrical operation but equally interesting were the object lessons afforded as to what may be accomplished by harnessing the magic current to equipment, such as some of the smaller desk devices, which until a few years ago were never thought of as adapted to other than hand power manipulation.

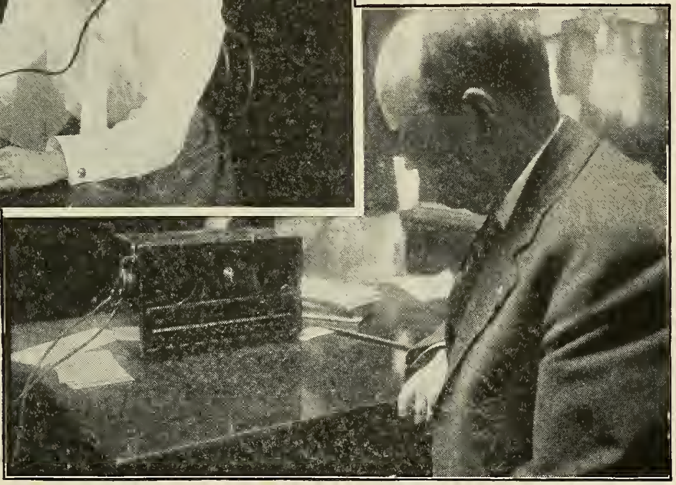
A distinctive feature of the governmental demonstration as reflecting electrical progress was the evidence of the advantages of "electric drive" for all manner of typewriter reproducing, manifolding and office printing outfits, indexing and addressing machines, etc. Only a few years ago this important new class of time-saving and labor-saving office equipment provided for nothing but hand operation. Now all the new models of such machines, as shown for the first time at the Treasury display, are motor driven, motors ranging in power from $\frac{1}{8}$ to 1-16 horsepower being employed in a majority of instances.

DICTATING TO THE DICTAPHONE

Electrical operation, combined with automatic feed, also made practicable through the introduction of electrical power, has enabled great increases in the speed and consequently in the capacity of machines of this class. For instance a new model addressograph, equipped with automatic envelope and card feed, which was tested at the Treasury, maintained a speed of two addresses per second for "runs" of considerable length. This machine fed envelopes and cards ranging all the way from five to 10 inches, in their greatest dimension, with uniformly satisfactory results, the adjustments for the different sizes and weights being made on an average of less than on minute for each such change. An interesting feature was the evidence afforded that the shape of the flap on an envelope did not affect the successful operation of the machine, the envelopes in this new model not being carried to the printing position by the flap. The electrical feed mechanism in this machine is rotary in its movement.



TAKING DICTATION FROM THE DICTOGRAPH



TALKING INTO THE DICTOGRAPH

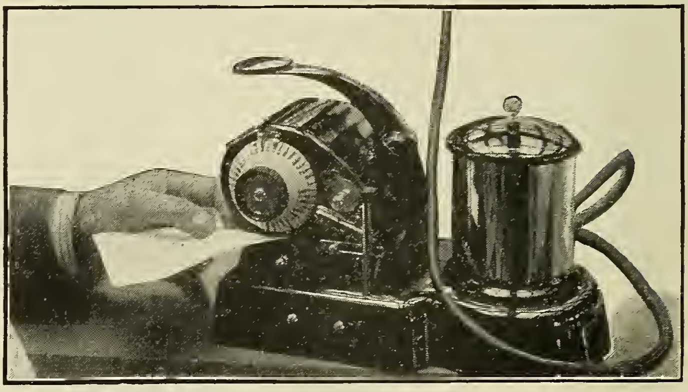
Some of the newly perfected motor-driven rapid addressing machines which were "tried out" before the government officials featured not only an automatic envelope feed but also an automatic wrapper cutter attachment, actuated by electricity. That electrical operation has been reduced to a perfect stage is eloquently proven by the fact that machines of this type are being used nowadays for sending out premium notices to insurance policy holders and other like notices which must be selected for printing according to date. Under the new scheme all the cards or stencils are put into the magazine of the machine and the apparatus set in operation, whereupon this wonderful toiler automatically picks out the cards that should be printed and allows the others to go through without making any impressions. This automatic selection is accomplished by means of different notches on the frames of the cards or stencils which cause them to be separated according to months or by any other system of classification desired.

Worthy co-workers of the new and improved patterns of addressing and mailing machines are the electrical letter folding machines and the electric envelope sealing machines. The former are especially marvelous in their well-nigh human capabilities. The new electrically operated folders demonstrated at the government test, and each operated by a motor of one-sixteenth horsepower, attested their ability to fold letters, bulletins and other printed or typewritten documents in note, letter and legal sizes into standard folds for large and small size envelopes. Tests were made on thin, medium, heavy, smooth and rough papers. Sheets are fed automatically, folded singly and stacked consecutively ready for insertion into the envelopes and at a speed about eight times as fast as experts can fold by hand.

No class of office equipment has been the subject during recent years of such specialization as that embracing the various forms of printing, manifolding and duplicating apparatus for reproducing typewriting, etc. Uncle Sam has been a powerful incentive to the development of this class of apparatus because one or another of these office adjuncts are used for the production of all the governmental form letters, bulletins, etc., that are not issued from a regular printing press. A few years ago in all governmental offices, as in all private business establishments, there were to be seen nothing but the hand-operated machines of this class, and in many a Federal office two, three or even four men gave up practically their entire time to the work involved. Now a long step forward has been taken with the introduction of the electrically operated duplicators, and the recent educational event in Washington witnessed the successful conduct of motor-driven mimeographs, writer presses, printographs and all the other members of this large family.

It has long been recognized that motor drive if introduced successfully would contribute tremendously to the economy of office printing and duplicating apparatus. The trouble has been in many of the attempts made in this direction that infallibility of feeding could not be depended upon and any slip-up in this respect spelled disaster. The best of operators would skip a sheet occasionally and when the cylinder of the machine turned without a sheet feeding the imprint would be received on the platen and each succeeding sheet blurred or offset on the back, requiring the cleaning of the platen. With the latest type of machines, however—for instance, the motor-driven flexotype—the machine automatically detects the failure of the operator to feed the sheet and instantly lowers the platen in time to prevent the offset.

Electrical operation has meant greater speed because a duplicating apparatus can be run at a better gait, with evenness and uniformity of operation, than would be possible with hand power and, furthermore, power operation combined with the safeguard above described makes practicable two-handed feeding. As high as 8000 letters per hour were printed by one of these machines under test. Even these improvements will be overshadowed a few weeks hence when an electrically operated automatic paper feed is to be introduced for use in conjunction with such machines. It will feed from the bottom of an eight-inch stack of paper and this new operation, alike to all the others involved in the action of the machine, will be carried out by the power furnished from a one-eighth horsepower motor, operating on either direct or alternating current.



PROTECTOGRAPH FOR PERFORATING CHECKS

The government demonstration embraced another modern invention for the reproduction of writing but of a character widely dissimilar to those above mentioned. This is the telautograph, an electrical device which enables the transmission instantaneously to a distance of handwriting of any kind. The equipment of the station as installed at the United States Treasury consisted of a transmitter and receiver associated together so that messages could be either sent to or received from the other end of the line. The telautograph which operates on well known and reliable electrical principles is self-registering. It makes two records, one for the sender and one for the person addressed, the latter, if absent, finding the message on his return. Two instruments may be used for a simple private line between two points or a number of instruments at various points may be connected to a switchboard to send and receive messages in a manner similar to the operation of telephones through a central exchange. One transmitter may be connected to operate a number of receivers simultaneously in series, the same message going to all, or one transmitter may be used in connection with any one of a number of receivers by means of a rotary or cam switch, distributing the messages as required.

The telautograph did not, on this recent occasion, have its first introduction to the government officials for it has already been adopted by the United States Army for the coast defense artillery service and by the Navy Department for use on the warships. The line wires for the telautograph are installed according to the rules which are followed in telephone line construction. For exterior service two line wires are required between stations. For interior service there is used a special type of instrument that requires three wires. Operating current is taken from the ordinary direct current electric lighting mains, or if only alternating current can be obtained a motor generator is used to convert it to direct current.

New models of electrical apparatus for voice reproduction and transmission had prominent place.

Conspicuous among the number was the new model dictaphone. This form of business phonograph has, in its essential characteristics, been familiar to the public for some time past but the new model has a number of improvements, among the added features being a resistance coil enabling the use of either direct or alternating current. The cylinder of the new machine will run for twelve minutes instead of only eight minutes as formerly, and in the tests it was demonstrated that as high as 3,300 words can be recorded upon a single cylinder.

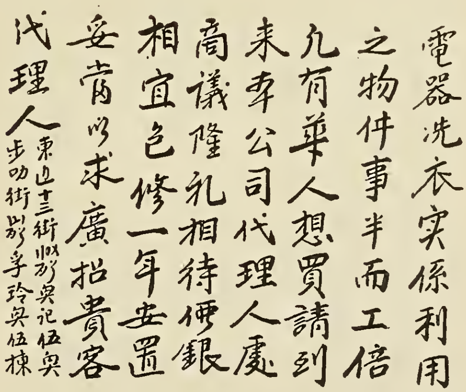
At the governmental event there was given for the first time under such circumstances a complete demonstration of the dictagraph, the vehicle of electrical communication which has been hailed as the successor of the telephone. A master station was established in one of the rooms in the basement of the Treasury while at a substation in another room some distance away sat a stenographer who received and repeated dictation at varying speeds.

A novelty of the display was an electrically operated postage stamp perforator for perforating postage stamps with letters, numerals or other marks or devices for identification purposes—an effective preventative of theft by dishonest employees.

As noted above, too, there was an illustration of the extent to which electrical operation has lately been adopted for minor office devices. For instance there is the new electrically operated protectograph, the function of which is to offer a safeguard against the "raising" of bank checks. Electrical operation will be advantageous in large business establishments and government offices where great numbers of checks are prepared.

The Progressive Chinee

Hing Kee, a Chinese laundry man in the City of New York, had been induced by the New York Edison Company to buy an electric washing machine. After he had used it a while he became highly enthusiastic about it and wrote the company the following letter.


電器洗衣實係利用
之物件事半而工倍
凡有華人想買請到
來本公司代理人處
商議隆礼相待便銀
相宜色修一年安置
妥當以求廣招貴客
代理人

And here is the translation:

Dear Sirs:

My electric washing machine you make run by electric is very good and saves me lot of money. I have it in over three months and it never stops. We get more business for we can wash quicker and cleaner. Send me man about new electric light I see in the stores.

Hing Kee,
204 E. 13th St.

Chinamen are said to be heathens. Are they?

Current From—Where?

BY EDGAR FRANKLIN

CHAPTER V.

THE MAYOR INQUIRES

Now, there is something about a pistol bullet, flattening little more than a foot above one's head, which convinces the average man that he is in the wrong—temporarily, at any rate. Hardly anyone will stop and argue the question with you, if you demonstrate clearly a firm determination to allow the passing of spring breezes through his anatomy.

Race seemed not to differ from the average man; for he gripped Dunbar's arm and whispered, so rapidly that the words fell over one another:

"Don't stop! Go on! Keep low down, Bill! He can't see! Run like the devil when we're clear of the building!"

And Mr. Race set the example.

With the least possible commotion, he hugged the brick wall and—travelled. Sometimes running low, sometimes ploughing along on all fours, he cleared the wall with Dunbar at his heels, just as a second shot crashed out behind. Doors were opening—they heard the creak of a shutter hinge—the landscape just behind grew lighter for a few seconds—and a third shot followed them.

And they ran.

There was a barbed wire fence to expect. They met it, head on. They found poles and went over, monkey fashion; and without a pause they plunged ahead through the rough fields.

Later, when drops of perspiration were fairly streaming behind and breath was coming hard, luck sent them stumbling straight into the main road at the far side of town, and in the distance they caught the faint twinkle of an outlying street lamp and there, at last, they slowed to a walk and listened.

The annoyed cluck of an awakened chicken was the solitary sound to meet their ears; and Race heaved a choking sigh of relief.

"Well—either we've outrun them or they didn't chase us far," he panted.

Dunbar, leaning against a tree, could not speak for a moment; then:

"Did you——see it all——too?"

"I saw it."

"I—I don't mean so much the plant itself. I've been expecting to find that all afternoon, somehow. But—did you see how it was laid out?"

"Huh?" asked Mr. Race, as his handkerchief started on a new mopping tour.

"Why, he's *built the place so as to leave plenty of room for the stuff we've bought for our station.* Ten feet from that big unit he's left the floor all unfinished, so that there won't even be any bother setting up our engines when he gets them."

"Are you indicating that he's even getting ready to fit our own engine beds in his infernal place?"

"Certainly. It's clear as daylight, isn't it—the whole business? Bowers has us where he wants us. He's put up a good spacious building. He's set up a generator big enough to do all the lighting, at least. He's left room to absorb our stuff and be ready to handle the power end for two or three years to come as well."

Mr. Race stared at the distant lamp for nearly a minute.

"Let's go home, Bill," he said at last. "This night air's bad for you."

On their way to business next morning, Race left Dunbar, some two blocks from the office, to pursue his way alone.

When the president himself put in an appearance, it was with Mr. Keller.

Mr. Keller seemed entirely calm and unhurried this morning. His keen little eyes were a trifle keener than usual as he found a chair; his lean neck seemed more angular as it thrust his lean face forward to an angle of constant attention; and he patted down his little old fashioned black tie and straightened his impeccable collar.

Race dropped wearily into his own place and sighed:

"I've told Keller the main facts."

The attorney nodded.

"As I understand it, Mr. Dunbar and Mr. Race, you visited Bowers' new factory at an early hour this morning—you discovered it to be an electric power plant—and while peeking through a shutter, a watchman shot at you and you escaped."

The pair nodded. Mr. Carey lit a cigar and sat silent.

"From what little I heard yesterday and from what Mr. Race told me as we came here, the conclusion seems pretty obvious. Bowers has his plans entirely cut and dried, to keep you out of the business until your time limit has passed and then secure a franchise for himself and start business in earnest."

"But Mayor Wendell——" Dunbar began.

Keller's long, keen, dry stare stopped him.

"Upon my word of honor, gentlemen, I know practically nothing about politics in our city. But I presume they are much like politics in other cities."

"Which means——"

"Anything you like to have it mean," Keller smiled. "Now that we are, to all intents, certain of the situation, what are we going to do about it?"

"Well, that's what you're here to tell us," Race said, vigorously.

"What do you *want* to do?"

"Put that Bowers plant straight out of business."

"Naturally. Why not get a few pounds of dynamite and make another evening call?" smiled the lawyer. "Don't let that excitable nature run away with you, Mr. Race." He settled back in his chair. "There are laws here as elsewhere, and we'll have to be governed by them. Now, in the very first place, are you positive of your ability to make good on the first of July?"

"No," said Race, frankly.

"That's the saddest feature in the very beginning. As to Bowers—do you know any law that forbids him building a power plant or a dozen of them, so long as he remains within the law and attends to his own business? Is there anything to prevent his constructing a line of central stations from here to Jericho, so that he pays his bills and annoys no one?"

"No. I suppose not."

"Take another tack. Do you want to have a warrant issued, go back tonight with an officer, and arrest the man?"

"There might be something in that."

"Then again, there might not. They tell me Bowers has signs all over his property, forbidding trespass of any sort. It is possible, in the present condition of affairs, that Bowers might choose to raise a time about it. At any rate—will you gain anything?"

"I presume that we'd advertise the fact that we're worried to death, all over town!" suggested Carey.

"Benefit to be gained thereby?"

"Hardly!" snapped Race.

"Has Bowers—or anyone else—ever interfered with your lines or your equipment?"

"No. Except that armature——"

"That's a matter for the railroad, I'm afraid. You've no actual evidence that it wasn't an accident?"

"No."

Keller leaned forward, until his thin elbow rested on the president's desk.

"To call a thing a case, a Court demands real proof, gentlemen. You haven't one iota of that, have you? You—I—all four of us *know* now just what is going on. If we had known it all three or four months ago—if we'd had time to get a couple of good detectives here, to gather real evidence and real witnesses—I'd guarantee, without knowing one of the inside details, to give Mr. Bowers and whoever may be his associates and accomplices, such a thorough airing in court that they'd seek the sea-coast for a change of climate. And what's more, they'd stay there."

"Well, that's the talk!" Race exclaimed.

"And it is only talk," said Keller. "It's too late now, as I understand matters. Before we'd get a chance to have the case heard, provided evidence walked straight in here, June would be over. What's more, assuming we could force our way straight in now, all three of you would have to be present, which would leave business here pretty near a standstill, eh?"

"Yes."

"And be doubtful of outcome at the best," concluded Mr. Keller.

For a little time, he looked over the gloomy trio; then he arose slowly.

"Gentlemen, you believe that I have—that I am—advising for the best interests of this company?"

"Certainly," said its president.

"Then you have one course to travel and only one. Deliver the goods on time or quit good losers." He picked up his hat. "My place is not to inquire into your financial standing. With sufficient money at your command, I presume you could rush in a wholly new equipment for your plant. Doubtless it would be expensive.

Doubtless, also, it would be more expensive to burn seven-dollar coal. But in the course of time, we can unquestionably force these Stelton people to a proper price."

"How long?" Carey inquired quickly.

"I have no idea whatever. They're in a strong position, evidently, and there are probably resources behind them.

I'm sorry. I'm sorrier than I can say. I could snow you under with legal expenses —to no end. Try to be cheerful. Keep up the impression that everything is lovely, to the last moment, if you want to, up to the last second. But if you have to quit—well, do it with a grin and die game," said Mr. Keller, mournfully. "Good day."

There was no undue clatter of joyful talk as the door closed behind.

For a minute or so, all three stared at the floor, as if the corpse of their company lay there at rest. Then, for the same idea was in three heads, two pairs of eyes met Mr. Carey's—and he shook his head sadly.

"If I were certain that it was worth the risk—certain that we could buy coal properly within a reasonable time—certain that, having once started, we could go on without incessant opposition and trouble, and eventually put the proposition on a paying basis, however small, I would gladly raise the money now and do it. As it is, I cannot."

Neither of the younger men spoke. When Mr. Carey had had his say, there was nothing to be added.

"If it appears that you have both lost all you have put in, I shall make it up to you," said Carey, with a slight smile. "I was the one who suggested the thing in the first instance."

"We don't want you to do it!" Race cried, almost wrathfully. "We don't want to—to just drop out of the procession and cry for our money back because we couldn't keep up. We've undertaken the job of lighting this benighted burg, and by the living——"

"Shut up!" said Dunbar politely.

"Hey?"

"More company!" announced the engineer. And as he squinted at the approaching pair through the glass door, he straightened up with a jerk and produced a contented smile that was neither more nor less than miraculous. "I'll be drawn and quartered if it isn't the Mayor and the president of the microscopic Board of Aldermen!"

The guiding spirits of the electric company were growing hardened to rapid changes of countenance. Possibly one second later, they were smiling and chatting; and when the street door opened, they looked up, surprised, and rose to greet the visitors.

Mr. Wendell, Mayor of Bronton, was a nice little old man, with sharp little red eyes and long white beard. He had grown up with Bronton; he had been Chief of Police when the town found need of a uniformed force; except for Link, the retired miner, he had been essentially the only candidate at Bronton's first mayoralty election.

As for Schwartz, of the aldermanic body, he was the biggest butcher in Bronton and had been for years. He was a man of importance, wholly out of place in any official capacity short of the Governor's chair—and he knew it well.

Greetings were exchanged—and the electric trio wondered actively as both exalted visitors settled in their chairs with an air of real business.

"We have—um—called to look things over," Mr. Wendell set down as a fact.

"Sorter see how you're gettin' on, y' know," supplemented Mr. Schwartz.

"You are welcome, gentlemen—certainly very welcome indeed," beamed Mr. Race.

"Um—yes. Thanks," said the Mayor. "Everything in proper running order, I presume?"

"Got your lines all up in fine shape, ain't you?" bawled the president of the Board, with almost weird heartiness.

"Our line construction is complete all over the city—every one of our consumers, under yearly contract and otherwise, has had his wiring inspected and approved—lamps are all ready to be installed, down at the central station. Yes!"

"Um—that central station, Mr. Race," the Mayor looked at him with keen interest, "is that all ready to start up?"

"He means, could you go down there now, light up the fires and illuminate the city tonight!" Schwartz added.

"Essentially so—essentially so," said the president of the company, happily. "Of course, we couldn't precisely fulfill Mr. Schwartz's expectations. There are always finishing touches to be put on."

"I see." The Mayor nodded. "I sent a man down there yesterday to look things over, and one of your men chased him off the place."

"We do not encourage visitors at present, Mr. Mayor," Race laughed, airily. "We are going to give the city a surprise—and on the first of July and afterward, the entire public of Bronton will be welcome to view as perfect a central station as money and modern methods can provide."

It sounded extremely well. The Mayor allowed the briefest glance to wander in the direction of his companion.

"Then you can assure us beyond any shadow of doubt, that everything will be in perfect working order on time.?"

"I can," said Mr. Race, blandly. It was quite the truth; he could have assured them with equal ease that the planets were about to form a trust and travel hereafter in a sort of celestial combine.

"And even if something unavoidable should turn up to delay us for a day or two," Carey put in, "the city would no doubt grant us a reasonable extension of time?"

With a start, the elderly Mayor faced him. His eyes bulged a little and he blinked them back before he said:

"No! That's just it! The city wouldn't!"

CHAPTER VI.

STRAIGHT TO THE WOODS

Mr. Carey scowled.

Mr. Race, whom little less than dynamite could have startled now, maintained his smile without great effort. After all, the gentle edict of the Mayor seemed to put a neat, workmanlike finish on the situation; it was the last, shining nail to be driven into the lid of their electric coffin, and without it, the obsequies would hardly have been complete.

"The city—wouldn't?" escaped him rather stammeringly, however.

"No, sir! The city would not," repeated her Mayor.

"Y' see, we held a special meetin' to consider it!" said Schwartz, who was the tactful, secretive politician personified. "We voted unanimous that we couldn't give you no more time if things weren't ready on the first."

Slowly, Race sat down before his desk; and if his eye appeared wholly calm and genial at first glance, a closer study might have revealed a dancing, ugly fire somewhere within.

"Just *why*," he said, "did you find it necessary to call the Board together to consider us?"

"Be—because," said Mr. Wendell, stiffly, "because the matter was deemed worthy of especial consideration."

"*Why?*" persisted the president.

The Mayor pursed his lips, crossed his legs and expanded his official chest.

"There have been rumors, Mr. Race, that you had little or no chance of starting up your plant on time."

"Where did they come from? Who told you that?" Race asked, with his easy smile.

"Personally, I may say—directly, that is—no one has spoken to me in the matter, save——"

"Well—save what?" the president shot in, as the Mayor cleared his throat.

"Save—um—in an official capacity, reporting to me."

"Hearsay evidence?"

"Um—well, yes."

"Did you send anyone to get hearsay evidence against us?" Mr. Race asked, politely.

"Why—God bless my soul! We—certainly not!"

"Then, if it isn't impertinent, may I ask again why it was necessary to call a special meeting to consider hearsay evidence."

Mr. Wendell was not quite accustomed to being cross-examined. Indeed, he had been Bronton's star Prominent Citizen for so many years that this kind of heresy staggered him.

"Now listen to me a moment," Race continued, "before this electric business ever saw one cent of our investment, I went to you personally—I talked to you and to the Board. I showed you that we stood ready to furnish the city with light and power at a rate cheaper than any other city of this size that you can quote. I didn't ask one thing of you, save that you give us the sole right to make electricity here for public consumption. I expected to pay pretty well for that franchise. You wouldn't hear of it. You were all too devilish grateful that somebody'd taken enough interest in your ten-cent town to light it," Race's voice was rising. "I thought you might stick on our getting our poles up last fall, rather than risk a delay this spring, if the ground thawed out late. And you said, both of you, that, even if we had a late spring, a month or so one way or the other wouldn't make any difference. *Do you remember that?*"

"No!" said the Mayor of Bronton, as his face turned a vivid red.

"I don't remember nothin' like that, either," Mr. Schwartz blustered. "Maybe somebody said it in joke. I dunno. Anyway, you ain't got it in writing? No!"

"I haven't it in writing——no!" sneered Race. "What I'm trying to dig out of you is this: *why* are the highest authorities of this great city getting excited *now* and calling special meetings and sending their Mayor to inform us that we've got to produce on the second—when we've been promising just that all along?"

"You see, it's like this," said the alderman. "You people didn't pay nothing for that charter. Now, there's other people that are willing——"

Mr. Wendell popped to his feet.

"It is—um—not necessary to go into details, Mr. Schwartz," he exclaimed. "I think we have done our duty here. We have Mr. Race's assurance that——"

"You have Mr. Race's assurance that we *know*——"

And there he stopped. No new sunshine had lighted their pathway since Keller's departure; it might be as well to keep a close mouth and "die game."

The visitors waited interestedly for a moment. There seemed to be nothing more to come, for Race was smiling again—and the queer little meeting broke up suddenly as Schwartz jammed on his hat.

"They understand it all right, Mr. Wendell," he remarked.

"We understand it perfectly," said Race, as he opened the door with a profound bow. "We appreciate the honor of this visit, too. Come and see us again."

He closed the door and faced his associates with a sour grin.

"Now, I wonder," he said, "when it comes to finishing the job altogether, whether they'll hire thugs to kill us, or merely have us arrested?"

"The last remnant of hope's gone—that's sure," said Dunbar, from his particular gloom-cloud.

"It certainly is," sighed Mr. Carey. "I'd thought of making an appeal for another month, myself. Now——"

There was no need to finish the sentence. The elder man sat back and smoked in silence—and Race took to studying him intently, with a queer little smile.

"Mr. Carey," he said at last, "do you remember, when Bill and I were about three years old and we all lived back East, how you used to argue with me and try to convince me that I could or could not do this thing or that?"

"Yes?"

"Well, do you remember that big mongrel pup of mine and the time that you tried to convince me that I couldn't get across the little pond on his back, and that we'd both be drowned?"

"Yes." Mr. Carey laughed a little. "The pup was very nearly extinct when the operation was over."

"So is this company very nearly extinct. But the doggie got across and lived to a ripe old age, if you remember."

Mr. Race rose, stretched and remarked irrelevantly:

"I'm going for a ride in our exquisite four-hundred-dollar racing machine."

"Whereabouts?" Dunbar asked, in some surprise.

"I'm going to find a spot where there's no house—no electric light poles—no sign of civilization," said the president, savagely. "I don't know where it is, but I'm going to find it and sit down and bite my nails and cuss myself back to a normal temperature. Coming, Bill?"

"I might as well," said Dunbar, disgustedly.

Silently, they rolled through the town, Race beaming on everything in sight. They came upon Bowers, seated on the veranda of the new Brontonvale Inn. Mr. Bowers started and stared. Mr. Race waved him a sunny greeting, stopped the machine, climbed briskly to the top of their nearest pole, made a thorough and wholly senseless inspection of the cross arms, and, returning to earth with a nod of satisfaction, bowled on again, chatting merrily with Dunbar.

They reached their forlorn, powerless power-house at last and stopped, and Dunbar dropped down, while Race sat still and stared at the big hills beyond, piling higher and higher, thick with timber.

"And all those belong to Uncle Dick, who never tried to make electricity," observed the president. "Your uncle is a wise man, Bill."

"And bought them almost for nothing," Dunbar muttered thoughtfully. "That was five years before we moved here—after the forest fires—when people said that timber would never be worth ten cents an acre. How like sin they've grown up in sixteen years!"

RACE SAT STILL AND STARED AT THE BIG HILLS BEYOND, PILING HIGHER AND HIGHER, THICK WITH TIMBER

"I didn't know 'em personally sixteen years ago," said Race, "but I'll wander up to them now. They're Mr. Carey's private property, aren't they?"

"Near two miles straight ahead and half a mile down the tracks," said Dunbar.

"Altitudinous, green and calm," concluded Race. "Are you coming, William? Going to stay around the power-house, eh?" He stepped down from the machine. "Well, if you feel just like it you can leave the machine here, Bill, because I'm going for a long, long tramp. I'm going to commune with Nature to beat the cars and I don't know when I'll be back. I don't want any lunch. Good bye."

* * *

The City Hall clock was booming out half past two.

Dunbar, back from lunch, was folding up his plans and blue-prints of the central station, with sad and methodical care—when a chorus of wild yells down street brought him hastily to the window.

A meteorite had landed in front of their office! A meteorite that bore some resemblance to their little auto, until the dust cloud caught up and enveloped it and——

Dusty, hatless, pouring perspiration, with eyes wild as the wildest maniac, Mr. Race entered with a crash that shattered the pane.

"Damn the glass!" choked he, at Mr. Dunbar. "How much cash have we in the bank, Bill?"

"Over three thou——"

"Draw three thousand and have it here ready for me inside of five minutes!" shouted the president of the company as he whizzed out—banged into the car—disappeared!

For seconds, Dunbar and his uncle stared after him, rigid. Then, without a premonitory symptom, Race's craziness seemed to infect his partner, for he jerked their check book into position, scribbled a blank and ran bareheaded for the bank.

He was hardly within the office again when the meteorite returned and banged to a standstill before the door. Mr. Race did not walk in; he pranced in, with a suit case in one hand, and he pranced straight at Carey.

"Can you raise ten thousand dollars cash inside of a week and have it banked here?"

"Of course. I——"

"Do it!" commanded Race, as he whirled on Dunbar. "Gimme the money! Gimme all the plans of that power-house! Quick!"

"What——"

Mr. Race snatched the roll of bills from his hands and rammed it into his trousers pocket. His wild eyes noted the plans on the desk and he grabbed them, crushed them, tore open his bag and hurled them in.

"Is it all here? All the machinery part?" he demanded fiercely, as he slammed the lock of the case.

"Yes, the whole thing——"

"Come with me and bring the car back!" Mr. Race vociferated as he leaped the steps and into his seat. "Hurry up! Hurry up there, you——"

But Dunbar was in his place, gasping for breath—and the automobile pitched headlong for the center of the street.

It was the sort of ride one rarely remembers clearly. Dunbar, later, could recall only that, from somewhere in his neighborhood, came a yell of: "I'll make that three-forty-two to the express, if I kill every man, woman and child in this——"

Then there came a blood-curdling whirl at the station platform—and Race and his bag seemed to hurtle through space—and land somehow on the back platform of a moving train.

(To be concluded.)

Elementary Electricity

By PROF. EDWIN J. HOUSTON, PH. D. (Princeton)

CHAPTER XXVII.—INCANDESCENT ELECTRIC LAMPS. (CONTINUED.)

Incandescent electric lamps assume a variety of forms according to the character of the work they are intended to perform. They differ either in the size and length of the filaments; in the amount or character of the light emitted; in the character of this light; in their life or duration, as well as in their efficiency or the relation existing between the amount of useful light produced and the amount of energy expended.

But none of the above mentioned differences alter the general construction of the lamp as described in the preceding chapter. Up to a comparatively recent date they all consisted of a carbon filament suitably supported inside a lamp globe or chamber in which a high vacuum is maintained.

The character of the light emitted varies markedly with the temperature of the filament. The higher the temperature the more nearly does the emitted light resemble in its color values that of ordinary daylight. When a beam of daylight is passed through a prism, all the colors of the rainbow are produced. This is not true, however, with the light of the ordinary incandescent electric lamp. When examined by a prism it is found that this light contains an excess of red, orange and yellow rays, and a deficiency of the indigo, blue and violet rays.

It is only white bodies that are capable of throwing off all the colors of the rainbow. A red body can only throw off red rays or at least rays near the reds of the solar spectrum. A blue body can only throw off blue rays or rays near the blues. A red body appears red when placed in sunlight because it throws off the reds or colors near them, and absorbs all the other colors; a blue body appears blue because it only throws off the blues and absorbs the other colors.

Consequently, colored bodies illumined by light that does not contain all the colors of sunlight, can only appear in their proper daylight colors, that is, the colors they possess when illumined by daylight, when the artificial light contains all such colors.

Since the light of the incandescent electric lamp contains an abundance of red, orange and yellow rays it is capable of so illumining red, orange or yellow-colored objects as to cause them to appear the same as they would when illumined by sunlight. If, however, an attempt is made to illumine blue or violet-colored bodies by the light of the incandescent lamp, the color effect produced will differ markedly from what would be produced by illumination in daylight.

It is, therefore, a matter of considerable importance that the light emitted by any artificial source, such as the incandescent electric lamp, should have, as nearly as possible, the same color values, or, as they are called, daylight values, as that of sunlight.

Consequently, as is generally the case, where the lamps are employed for the illumination of colored bodies under conditions in which it is necessary that they shall possess the same appearance as they would present when illumined by daylight, it is necessary to employ high temperatures, and this means a decrease in the useful life of the lamp.

When placed in positions where it is difficult to reach them, as on the ceilings of high rooms, an advantage is ensured by purposely employing a smaller pressure and current thus decreasing the number of necessary lamp renewals.

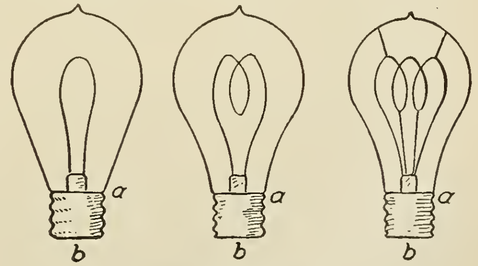


FIG. 171. COMPLETED LAMPS WITH BASE ATTACHED

The tendency at the present day for purposes of general illumination is to use long lamp filaments. This is easily done in the case of the squirted filaments that are now generally made. These assume a variety of forms three of which are represented in Fig. 171. It will be observed that all of these have the shape of a horseshoe. The lamp represented at the left hand side of the above figure has the form of a simple horseshoe. That represented in the middle of this figure has the shape of a horseshoe with a single loop, and that on the right-hand side a horseshoe with two loops. In order to prevent the breaking of a looped filament by vibration, it has been found advisable in practice to provide the filament with what is known as an anchor wire, a wire attached to the top of the glass mount, and the center of the filament loop. In the case of the double loop filament two separate anchor wires are sometimes used, attached at points on top of the filament and sides of the lamp globe as shown in the above figure.

But the increase in the amount of light obtained by an increase in the length of the lamp filament is not the only advantage ensured. An incandescent electric lamp emits more light in certain directions than in others. Generally speaking, the simple horseshoe filament lamp emits the greatest amount of light at the bend of the horseshoe, in the direction of its length.

Since electric lamps are generally employed with the bulb or lamp chamber pointing downwards it is desirable that the amount of light thrown in this direction shall be as great as possible. Now, in the case of the ordinary sixteen candle power horseshoe carbon filament lamp it can be

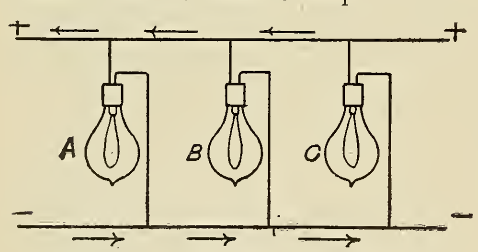


FIG. 172. LAMPS IN PARALLEL

shown that, approximately, an amount of light represented by six of these candles is thrown downwards from the top of the filament and the remaining ten in other direction. When the filament is provided with a single curl an amount of light equal to seven candles, and when provided with a double curl, an amount equal to ten candle powers is thrown downwards.

Generally speaking, incandescent lamps are placed on the lighting mains in buildings in multiple or parallel, as shown in Fig. 172. These mains are what are known as constant-potential mains because they are maintained at a constant voltage pressure or difference of potential. Frequently, however, in order to permit a lamp of a lower voltage to be employed on a high voltage main the lamps are connected in series groups to the

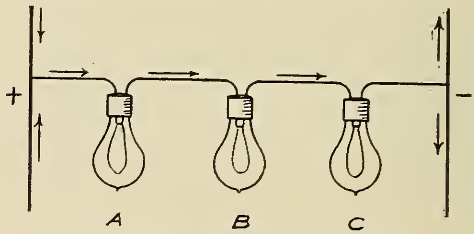


FIG. 173. LAMPS IN SERIES

multiple mains as shown in Fig. 173. In this case, the current, instead of passing from the mains in parallel through the three lamps (A), (B) and (C), passes through them in series. This series connection is convenient with lamps designed for use in a candelabra. In lamps of this character although fairly lengthy filaments are used, yet the resistance is comparatively low.

It is evident that by making the lamp bulb of different colored glass, or by coloring it with a suitable transparent paint, lights of various colors can be readily obtained.

Incandescent lamps, capable of being operated by the comparatively low pressures, produced by a small voltaic or storage battery, are known as battery lamps. These lamps are generally so designed as to produce small candle powers. They are generally designed for use in electric signs and are intended to be placed in series of two, three or four across 100 to 120-volt mains, or in multiple series across 50 to 60-volt mains. Usually they are of low candle power capable of producing, say, one-half a candle, one, two, three, four and six candles. The pressure required to be applied to the terminals of the half candle power lamp varies from three to five volts, and the current from 1 to 0.6 ampere. The one candle power lamp requires from four to six volts, and from 1.4 to 0.9 ampere. The two candle power lamp from four to seven volts, and from 2 to 0.1 amperes. The three candle power lamps require a pressure of from five to seven volts, and a current of from 2.5 to 1.75 amperes. The four candle power lamp requires a pressure of from seven to nine volts, and a current of from

2.5 to 1.75 amperes. The six candle power lamp requires a pressure of from nine to twelve volts, and a current of from 2.75 to two amperes.

The fact that small candle power lamps can be operated by a battery small enough to be readily carried in one's pocket, renders it possible to employ miniature electric lamps, or as they are sometimes called electric jewelry, on one's body. Such lamps are employed for stick pins and are especially common in producing various effects on the stage. In the latter case, however, instead of a single lamp being used, a number of separate lamps are connected in series in a single circuit across the lighting mains.

Small lamps are also employed for the illumination of parts of the human body, such as the throat, the ear, the nostrils, or other parts that are readily entered by its natural cavities. Lamps of this character are generally employed at high temperatures and therefore produce considerable light and consequently have a short life.

Electric lamps are sometimes employed on bicycles and by miners. Lamps for these purposes, however, do not differ essentially from other battery lamps.

High candle power electric incandescent lamps have been devised for special use as a luminous source in magic lanterns. As shown in Fig. 174, a peculiar shape is given to the carbon incandescing filament in order to concentrate the light roughly at the focus of the condensing lenses of the lantern. The best results are obtained by giving the filament a spiral conical shape, since in this way the light is concentrated in a comparatively small area.

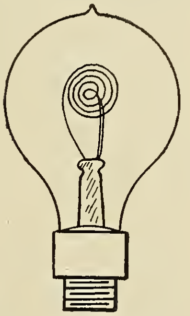


FIG. 174. SPIRAL FILAMENT LAMP

Incandescent electric lamps are sometimes used in what are known as lamp banks for rheostats or variable resistances. By providing suitable receptacles, the mere screwing of the lamps in place connects them in series with the other lamps. While almost any ordinary electric lamp is suitable for this use, yet lamps known as resistance lamps are especially prepared for this purpose in which a comparatively great length of a thick filament is placed in the lamp chamber connected in series. In the electric resistance lamp shown in Fig. 175 three separate filaments are connected with one another in series as shown.

Where especially high candle powers are required what are known as low-voltage lamps are used. These lamps differ from others simply in the fact that they employ heavy filaments. They are made to furnish from 100 to 150 candle power or over of light when so desired, and can be made to operate with a current of from six to nine amperes and a pressure of about 50 volts.

FIG. 175 RESISTANCE LAMP

A very common use for incandescent electric lamps is for electric signs. Lamps for such purposes are generally connected in series. The lamp bulbs are made either of clear or colored glass arranged in groups having the shape of the letters to be represented. They are either mounted on a single board covered with white or other colored paint which is brightly illumined when the lamps are in operation, or on wooden supports cut to the outline of the letters that the group of lamps is intended to represent. By painting such supports striking effects are obtained by the brightly illumined wooden letters provided at the center with the bright surfaces of the incandescing lamps. Of course as is sometimes done the ordinary incandescent lamps are employed for this work, connecting them in multiple.

Electric incandescent lamps are now universally employed for the lighting of street-railway or trolley cars. The current required for their operation is taken directly from the trolley circuit. In such cases the filaments are designed so as to be able to use the trolley pressure, which is generally in the neighborhood of 500 volts. This is done by connecting a number of lamps in series across the main to ensure the desired current strength.

Since the vibrations of an ordinary street railway car are marked, where, as is generally the case, loop filaments are employed, it is necessary to employ anchor wires to prevent the filaments from being broken.

The attachment of anchor wires for double and single loops has already been described.

In what are known as double-filament electric lamps two separate filaments are placed in the same lamp chamber. One of the uses to which a double filament lamp can be put, consists of a device by means of which it is possible to vary the quantity of light the lamp is capable of producing. This device embodies a switch arranged so as to produce the maximum quantity of light by connecting the two filaments in parallel and smaller amounts of light by connecting them in series or by cutting out one of the filaments.

Another method, sometimes adopted for turning down an incandescent lamp so as to obtain a smaller amount of light, is by the introduction of resistance into the lamp circuit. Such a method is far from economical, since too large a percentage of electric energy is expended in the useless production of non-luminous radiation. A lamp of this character is known as the Edison night lamp. Here, the filament is provided with an electric resistance so placed in the base of the lamp that the turning of the small screw introduces the resistance into, or removes it from, the lamp circuit, as may be desired.

The length of life of an incandescent electric lamp depends primarily on the care taken in its construction, and the extent to which it is possible to maintain a vacuum in the lamp chamber. But it does not depend only on these circumstances. Any lamp can readily be caused to emit a greater quantity of light by supplying it with a greater amount of electric energy, and the extent of its useful life depends on the amount of this energy. By increasing this energy a lamp that is capable of producing either sixteen or thirty-two candle power when producing the larger quantity of light is subject to a marked decrease in its length of life. Such a lamp when constructed to produce sixteen candle power under conditions in which its life will have a value of 800 hours, might have its life reduced to 200 hours or even less by using an excessive amount of energy.

Another form of lamp the chamber of which contains two separate filaments is called a twin filament lamp in order to distinguish it from a double filament lamp. The twin filament lamp is employed in places where it is a matter of considerable importance that the light shall not be accidentally extinguished, since such a failure might occasion considerable damage. This is the case in the lighting of the side lights, headlights, stern light, and signal lights of ships. By the use of a twin filament lamp the separate filaments can be so connected to the lamp circuits that should one fail the other may continue burning. The same result is sometimes reached by the employment of two separate lamps.

A general belief exists that it is true economy to use an electric incandescent lamp as long as its filament remains unbroken. This is a great mistake. While such a lamp will continue to give light yet the amount of this light is so small, that it would be far more economical to purposely break the lamp, or remove it from the circuit as soon as its loss of efficiency has reached a certain point known generally as its smashing point.

One of the many interesting stories to be found in that great book known as the Arabian Nights Entertainments, relates the manner in which the wicked African magician succeeded in obtaining Aladdin's magic lamp by offering to exchange new lamps for old lamps. At first sight such an exchange naturally strikes one as extremely foolish, yet the General Electric Company advises central station managers to offer as soon as their lamps show a certain fall in efficiency, to replace them by new lamps.

In a circular letter the company alludes to the necessity that exists for frequent lamp renewals; that this necessity exists regardless of the cost of power and whether the new lamps are charged for or furnished free; that no matter how excellent the construction and operation of the lighting plant may be, it is impossible to furnish satisfactory light unless all dim lamps are periodically removed from the circuits.

Generally speaking, it is evident that the removal of the dim lamps can not be left to the customer. Consequently, such renewals must be made without charge, or at a merely nominal charge, by the lighting company. The decrease in the cost of incandescent lamps has reached such a point that it should be possible for all stations to furnish free lamp renewals at but slight expense. The advice in the company's letter in this respect is as follows:

"With free renewals, one of the following methods should be adopted:

"1. Periodically remove all lamps from the circuits one to four times per year, according to conditions, and replace them by new ones. Photometer the lamps removed and save those measuring above a prescribed limit (say 13 candle-power) for use at high voltage points, or locations where reduced candle-power is of slight importance. Scrap the remaining lamps.

"2. Give a new lamp in exchange for an old one, for, say, every three dollars worth of current supplied, or for any fixed amount determined by the meter rates and conditions.

"The second plan is an excellent one, in that it offers a bonus for the use of current and regulates renewals on the correct basis of number of hours of lamp service: It can be profitably adopted wherever meters are in use. A station attendant should visit customers quarterly and install the number of new lamps due each, removing and returning to the station an equal number of old lamps.

"In cases where lamps must be charged for, some measures should be adopted to induce customers to renew their dim lamps: as, otherwise, dim lamps will be continued in service as long as they will burn.

"A good method is to offer new lamps in exchange for dim ones (not burned out) at a reduction in price of one-quarter or one-half cost. A customer, for example, would save by paying, say, half-price for the renewal of a dim lamp, instead of waiting and paying full price when the lamp burns out.

"Another method is to offer lamps for renewals at less than cost, say 15 cents each, and reserve the right to say when lamps shall be renewed. Such a plan works well, as no customer can justly complain when the company renews lamps at less than cost.

"The price of lamps to the customer in any case should be made as low as possible —cost price or below cost—for the reason that profit on the sale of lamps is secondary in importance to the sale of current and improvement in quality of lighting service."

The failure of an incandescent electric lamp to produce the quantity of light for which it was constructed, is due to many causes. Perhaps the commonest cause is found in the fact that in various ways the carbon filament undergoes a gradual disintegration, that results in a decrease in diameter and a consequent increase in electric resistance.

If the resistance of an electric lamp is increased and no increase is made in the voltage applied to the lamp terminals, the current supplied to the filament will be so cut down that the lamp will give off a much smaller quantity of light than otherwise. This is one of the commonest causes of the decrease in the amount of light emitted.

Another cause is to be found in the blackening of the lamp bulb due to the deposition on the inner walls of the lamp chamber, of the carbon that has been disintegrated, by the breaking down of the filament.

(To be Continued.)

Are Dynamos Understood?

How far the popular understanding of electrical terms and electrical devices has advanced during the last two decades may be inferred from an interview in regard to the principles of dynamo-electric machinery, held a little over twenty years ago. It was given to a correspondent of the New York World by Prof. Moses G. Farmer who was the first in this country to make sucessful experiments with electric lights, being the inventor of one of the earliest types of arc lamps. Said Prof. Farmer:

"The electricity for the purpose of illumination is produced by the movement of coils of copper wire in the neighborhood of magnets. Electricity is developed in condition whenever it is moved across the lines of force streaming from a magnet. The electricity is more powerful the more rapid this motion; more powerful the longer the wire and more powerful the greater the intensity of magnetism in the magnet. These are the fundamental facts that underlie the construction of all magneto-electric machines. *Any more technical description of the process of producing electricity would scarcely be understood by the general reader.*"

That satisfied the public of his time. But today who that pretends to have any education would be put off in that way? Now the progressive man and his bright sons all revel every month in a great variety of detailed information on such matters, for the intelligent reader of today understands many times more about electrical devices than was dreamt of by the experimenter whose most noted work dates back some fifty years.

The Non-magnetic Yacht Carnegie

The Department of Terrestrial Magnetism of the Carnegie Institute of Washington, D. C., has undertaken the gigantic task of making a magnetic survey of the world and to accomplish it within the next fifteen years. The results are to be published in the form of magnetic charts, from which the navigators of the world may read at a glance the error of the compass in any particular spot which is due to the action of the forces of nature. The work will not be a national one, but will prove a boon to mankind and thus subserve the avowed object of the Carnegie Institute: "to contribute something of definite value to man." This work was commenced in the Pacific Ocean in 1905, when the Institute chartered the brigantine "*Galilee*" of San Francisco. Sufficient data was obtained by this experiment to convince the bureau that the work was worth doing well, and it was decided to construct a vessel built, as far as possible, of non-magnetic materials and designed with special reference to the facilities for taking magnetic observations under any and all conditions of sea and weather.

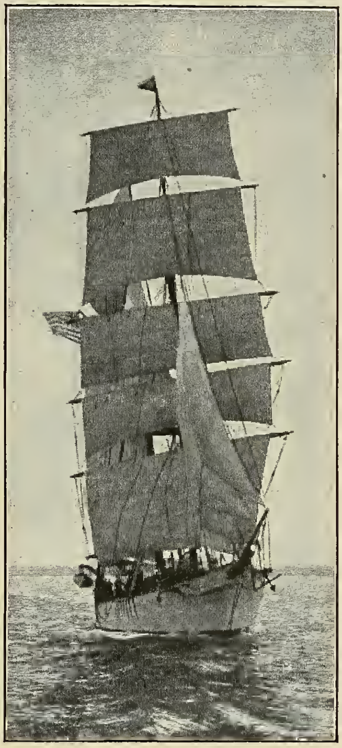
Constructed throughout of non-magnetic materials and designed especially for a floating observatory in which to do the marine work of the magnetic survey of the world, the non-magnetic brigantine "*Carnegie*"—the first of her kind—has just completed her first season's work in exploring the magnetic field of the North Atlantic Ocean.

The *Carnegie* was designed by Mr. Henry J. Gielow of New York, architect of the German Kaiser's yacht "*Meteor*," and was built by the Tebo Yacht Basin Company of Brooklyn. She is essentially a brigantine of 568 tons displacement, 155 feet six inches over all; length on load water line 128 feet four inches; beam, moulded 33 feet; depth of hold 12 feet nine inches; mean draft 12 feet seven inches. Her lines are fair and easy, running in an unbroken sweep from stem to stern, showing great strength and seagoing qualities.

THE CREW OF THE CARNEGIE

The hull is constructed according to the standards of the American Bureau of Shipping, combining the grace of a yacht with the staying qualities of a cargo vessel. The keel, frames, knees, stern post and deadwood are of white oak; the deck beams, planking and ceiling are of yellow pine; and the deck is of comb-grained Oregon pine. All fastenings are of locust treenails, copper and Tobin bronze bolts and composition spikes, all through bolts being riveted over rings both inside and out. All metal deck fittings and the metal work on spars and rigging are of bronze, copper or gunmetal.

She spreads 12,900 square feet of canvas. Her spar plan measures 122 feet from fore truck to water line and 210 feet from bowsprit cap to after end of main boom. She measures 48 feet from head booms to cut-water; cutwater to foremast 35 feet; from fore to mainmast 48 feet. The rigging is of Russian hemp.


THE CARNEGIE UNDER FULL SAIL

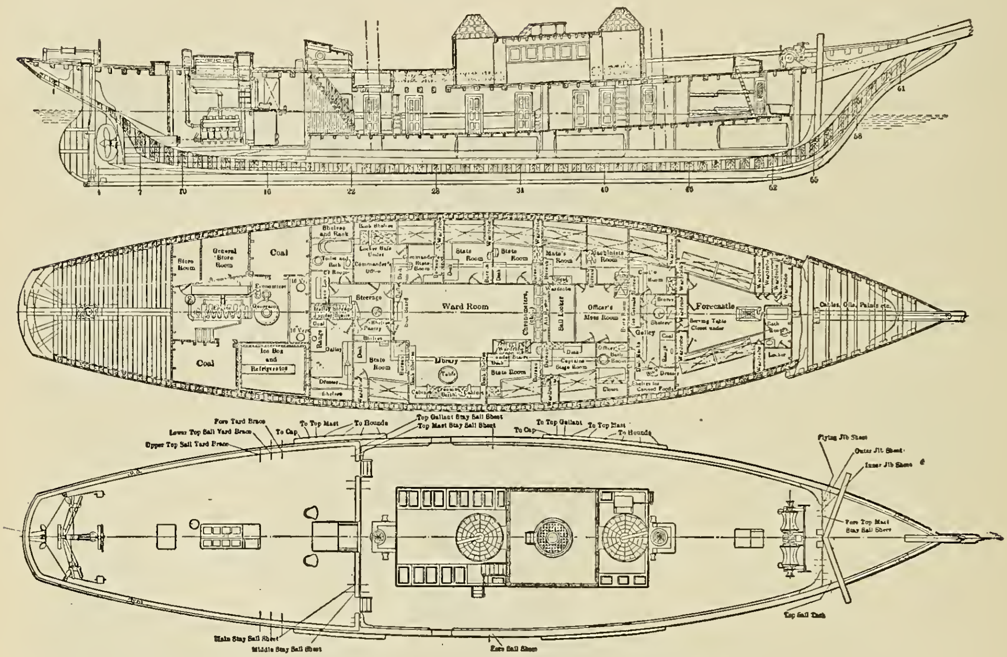
Auxiliary to her sail power, the *Carnegie* is equipped with a four-cylinder, Craig internal combustion engine of 150 horse power, which alone is capable of giving her headway at the rate of six knots an hour. The necessity of some auxiliary power independent of the wind for close handling, accurately placing the vessel on a given magnetic heading and for use in calm weather or head winds is apparent. Additional interest is attached to the installation of this machinery in the *Carnegie* from the fact that all parts of the engine except the cast-iron pistons and the steel cams necessary for operating the valves are made of non-magnetic material.

Consideration of the available fuel for such a motor resulted in the elimination of gasolene and oil, not only on account of cost, but also because they would be quite unavailable in the zones to be covered by the *Carnegie*, as well as being unsafe in the quantities that would have to be stored for the long cruises which are contemplated. A careful investigation showed that a gas producer for marine purposes could be built which would generate a gas suitable for use in an internal combustion engine from bituminous or anthracite coal, coke, wood or charcoal, and that such a plant could be constructed almost entirely of non-magnetic materials. In the actual accomplishment of this feat the *Carnegie* is again a pioneer, in that she is the first vessel of any size in which producer gas has been utilized for propulsion. The cruising radius of the *Carnegie* at six knots an hour on 25 tons of coal is 2,000 miles.

Of especial interest in her construction are the vessel's observatories where the bearings of celestial bodies are taken and the compass declination and dip and the intensity of the earth's horizontal force are measured. The standard compass is set up in the chart room directly below the bridge compass, and two others are located on the main deck under glass-covered domes forward and abaft the standard. At these two stations observations can be made in any sort of weather, the observers being under cover of the domes.

In all forms of compass azimuth circles hitherto used the bearing of a celestial body had to be taken from whatever point the card in its oscillations to and fro as the vessel rolled had momentarily reached. In the *Carnegie's* work, however, a special form of "marine collimating compass" invented and constructed by the Department of Terrestrial Magnetism is used. The basis of the instrument is an eight-inch Ritchie liquid compass with card removed, and an optical collimating system with scale introduced. This enables the observer to note the arc of motion of the magnet while sighting on the sun or star, hence knowing precisely to what part of the arc the stellar azimuth applies. The angle is next determined between the circle setting and some mark, or the true meridian, and the declination is finally deduced.

The non-magnetic character of the *Carnegie* was found to exceed the most sanguine expectations when she was swung for compass deviations in Gardiner's Bay, Long Island, just before she started to sea last August. On arrival at Falmouth, England, her compass errors were again tested out with most satisfactory results and were found to agree exactlv with the observations taken on shore at the Falmouth Magnetic Observatory.



SECTION AND PLANS OF THE CARNEGIE

During the voyage across the Altantic Ocean the vessel was hove to at intervals and the magnetic elements of different localities determined by a series of careful observations. The efficiency of the new instruments was effectually established on this voyage, for although gale after gale was encountered, observations were taken with regularity on every day save one. From Falmouth the little vessel carried her work down the European coast to Funchal, Madeira, about 300 miles off the African coast, and from there she re-crossed the Atlantic, arriving at Hamilton, Bermuda, January 7.

After re-occupying the Bermuda stations and again testing out the ship's instruments, sail was set on the 28th for New York. On the run up the coast the *Carnegie* had ample opportunity to display her remarkable seagoing qualities. She encountered nearly three weeks of very stormy weather in the Gulf Stream and was five times driven across the lattitude of Cape Hatteras by the same weather which swamped the unfortunate Naval Tug *Nina*. One of her crew was thrown from the topsail yard as the vessel took a violent lurch, but saved himself by clinging to the rigging. Another was swept overboard by a boarding sea, but was hauled back by a staysail sheet. After vainly trying to make the port of New York, the little vessel was obliged to lay a course for Montauk Point, and, on the 15th of February, sailed into Long Island Sound.

The results of the *Carnegie's* work for the season show that the charts used to navigate the North Atlantic Ocean are in error along the transatlantic steamship routes by from 1 to $1\frac{1}{2}$ degrees, and, when published, will not only enable navigators to lay their courses so as to save time and distance, but to feel sure that they are not likely to be set down on the Sable Island shore and lose their ships.

Electrical Securities

By "CONTANGO"

HYDROELECTRIC PLANTS AND THEIR FUTURE—IRRIGATION UNDERTAKINGS AND THEIR CONNECTION THEREWITH IN THE WEST—THE SECURITIES OF SUCH ENTERPRISES IN THEIR RELATION TO THE PUBLIC.

The next form of electrical development to be taken up is the hydroelectric plant, that is to say, the use of water power for producing electrical energy which may be used right at hand, as in the case of a small installation or as is more usually the case distributed far afield by means of transmission lines extending many hundreds of miles. It is with the public service plant of such kind that this article will briefly deal from the point of view of its securities.

The use of water powers, great and small, is now being developed east, west, south and north wherever they may be found in the least degree accessible, and the natural tendency is towards a combined management covering large areas. To a certain extent the hydroelectric plant goes hand in hand with the irrigation project. The most notable example of such a combination is the Roosevelt dam at Roosevelt, Arizona, a government undertaking just completed, and practically the largest of its kind in the world. By controlling the water in a very narrow and very deep gorge at this point, a vast territory has been turned from desert into a most productive and fertile region, while the large water power obtained is producing energy for towns and villages throughout the entire district. It may then be noted that once established the future of such a system is ultimately only limited by the amount of power that can be furnished. There is in point of fact no waste and if the affair is conducted in a business-like way there should be no difficulty in bringing in handsome returns on the capital outlay. Naturally financial experts, bankers and the like look with particular favor on securities of such companies. The cost of maintenance is comparatively small and the ability to generate current at low cost correspondingly great. As a final word Frank A. Vanderlip, the well known banker of New York, may again be quoted on this latest phase of the generation, distribution and sale of electricity:

"If a layman might venture an opinion it would be that the next era of distinct development in the electric lighting field will come as the result of the utilization of the great water powers of the country, and the progress that the technical experts will make in long distance transmission. With great power stations located in the heart of the coal districts on the one hand, or drawing their energy from the great power plants on the other, the problem of cheap production would seem to be pretty well solved. If current thus produced can be economically distributed over a very large area, as indeed it is now being in many sections, the way will be open to securing the economies of a concentrated management and the advantages of large corporate issues of securities, and such combination should result in a large profit to the business venture and in a high degree of efficiency and satisfaction to the stockholders."

In other words, by the development of the hydroelectric plant will come more perfect centralization of the whole business of distributing electric current.

The largest and most efficient hydroelectric plants of the day in this country are those at Niagara Falls. They demonstrate excellently the practice of selling and distributing electricity in bulk—selling at a wholesale price to users of power far and near. It will have already been grasped by the readers of these articles that the production and sale of electricity as a commodity in large quantities, that is on a wholesale scale, is one of the greatest commercial assets of the times, and when its source is from an almost unlimited water power it may readily be seen that the possibilities are enormous. Now while Niagara is by far the greatest producer of power, it was not until the value of long distance transmission of energy in bulk had been proved in the West and Mexico that the water power from the Falls reached its greatest value. The Niagara Falls Hydraulic Power and

Manufacturing Company started the ball rolling in a small way in 1895, and now there are five important companies distributing electricity in bulk to far distant places and selling to countless manufacturing plants in Niagara Falls, in Buffalo, and throughout the district surrounding the Falls.

Engineers for years looked longingly at the tremendous power in the Falls. It was estimated that theoretically there was 7,500,000 horsepower capable of development. The power was there, but to use it economically and in commensurate quantity—that was the question. Then came the development in the use of electricity for factories and railways and in electrochemical processes, and the perfecting of economical long distance transmission systems. Today electricity is distributed in bulk from the Falls to Toronto, Syracuse, Tonawanda, Buffalo and numberless lesser towns. Within the last year or two the progress made with this bulk distribution has been wonderful and today something like 575,000 horsepower are derived from the Falls. The principle is the simplest—water power operating turbo-generators. It is now in use through the country.

In the South, for example, there is the great hydroelectric plant at Hale's Bar on the Tennessee River, 33 miles below Chattanooga. This is one of the largest in the country aside from Niagara. There is an installation of about 50,000 horsepower at Hale's Bar.

Or turning to such a central point as Chicago it will be found that the waters of a river of a very modest size into which the waters from the drainage canal discharge are utilized for power development at Joliet, Ill., and points below that city, while the Sanitary District, the corporate body operating the drainage canal also has a hydroelectric plant at Lockport at a point where the drainage channel's waters pass into the Desplaines River.

The financing of the hydroelectric central station plant is on precisely the lines of other large central station undertakings, only there is this advantage that the ability to produce at lowest cost gives corresponding ability to furnish current at lowest rates and therefore the field is more quickly covered and the public more readily uses electric, in preference to any other form of power. It is very evident then that the securities of a well thought out, well situated hydroelectric company are justly entitled to the confidence of the public and the financial world as being among the most substantial and solid form of property known.

As to the combination of irrigation and hydroelectric or the simple irrigation company—such securities have the position of a mortgage on the property of the users. That is to say, the average irrigation bond of which a great many issues are now being offered, particularly throughout the West, is guaranteed by the land holdings of the users of the water. The water itself creates the value of the land, and the mortgage on that land is the security given the company selling the water, therefore the bonds of such a company which are bought by the public have back of them these land mortgages.

The supplying of water for irrigation purposes is a form of public service of its own kind, differing materially from the service of transportation, light or power. Without the water the land is to all intents and purposes nonexistent, but with light, power and transportation it is another matter. This position makes for the irrigation bond, a special form and security of its own.

But the securities of all public service or utility corporations should rightly be regarded as of the highest value, for the simple reason that they are based on the sale of public necessities, the use of which extends and grows year by year. The villages, towns and cities of the United States are growing at a tremendous pace, the arid spaces of the country are fast being brought into cultivation and when the tale of the new census, just taken, shall have been told, there will be found one of the most convincing arguments as to the solidity and tangibility of investments in all these public undertakings. The general use of electricity has only just about started. Take the growth in the population of any city or state in the years to come and consider what the then necessities must be. To meet such demands of the future, even year by year, must mean a constant and ever increasing expansion in the business of supplying them, and those who have the present sagacity and courage to invest in the securities of concerns whose business is meeting the public needs have an assured present and guaranteed future of profitable return not presented, with the same degree of absolute certainty, in other forms of securities.

Sufficient advice has already been given as to the necessity for dealing with bond-houses and financial agents of known reputation and integrity, and where there is time and inclination, for personal investigation into the character of the management, of all such companies. The man at the head of such an undertaking of trained experience who has proved his works by results is naturally most to be depended on, for he has a very personal interest in the success of all he undertakes.

Perhaps the most remarkable example of results from irrigation known to the business world today is found, not in this country at all, but in far away Egypt, where the operation of the Assouan dam, confining the head waters of the Nile, has proved the salvation of that country. This was a government enterprise and by its completion the ruler of that country and his family and Egyptian landholders generally have been placed among the rich men of the world. In the United States it is good to say that the people who benefit most by irrigation enterprises are the plain people. Not only those who take up the land but the people at large who have the faith to invest their money in such enterprises. Yet even so their opportunity has still to stand the test of time, whereas the electrical undertaking can now at this time stand on its proved merits.

(To be Concluded)

High Speeds and Signals

In 1901 on the Berlin-Zossen (Germany) military railway an electric car reached a speed of 115 to 125 miles per hour.

Now a mechanically operated railroad signal cannot be depended upon to act with reliability at a longer distance than 2000 feet from the operator. If with a train velocity of 60 miles the signals are disposed at 2500 feet from the block tower to give time to the engineer to stop before entering the block ahead, a velocity of 115 miles requires for the same purpose the signals to be 6600 feet from the tower, a distance which renders their operation very difficult if not impossible.

One hundred and fifteen miles per hour means 168.6 feet per second, and if we suppose that in clear weather the signals can be seen 1600 or 1700 feet before reaching them, the engineer has nine or ten seconds in which to realize the conditions of the block ahead and act accordingly. Now if the weather is foggy this time must be reduced and in some cases the engineer may have from two to three seconds in which to decide if he can run ahead safely or if he must stop.

This high speed question may be discussed from many other points of view—but actually 125 miles per hour is only to be reached safely on a special right of way, with specially ballasted track and at a very high cost.

A "Magic Mirror"

Suppose you saw a little framed mirror at a conveniently tempting height in a show window and you stopped to look at yourself —for who of either sex would resist the temptation? Then suppose your reflection suddenly vanished while an advertisement appeared in its place: would you not be surprised? And if your image reappeared shortly, would you not stay and wait again and again for the interesting change to repeat itself?

"MAGIC MIRROR"

That is exactly the effect produced by a novel type of electric sign in which the advertisement, or a part of it, is placed back of the thin film of silver on a mirror. The latter reflects just like an ordinary looking glass as long as the light shining on it is more intense than that behind it. But if a strong light is lit behind it, the reflection will vanish and the advertising matter will show right through the thin film of silver as shown in the picture. An ordinary sign flasher turns on the hidden electric light, thus effecting the changes in the "magic mirror" much to the amazement of any who happen to come upon the mirror when the light behind the same is turned off.

Talks With the Judge

A "HEATED" DISCUSSION

"Although I don't believe you could put me down as a Bowser, as far as self-conceit goes," said the Judge as he clung to his strap and looked longingly at the full seats, "still, I give myself credit for being mighty careful and far-sighted for an advertising man."

"You are quite right," I said, "your look of profound wisdom would have prevented any one from trying to sell you a lightning rod even in the halcyon days."

He looked at me gloomily for a moment and then continued: "My wife is set on having a lot of electrical things to cook with—the whole blooming outfit, range, percolator, disk stove, cereal cookers, chafing dishes and (sic) a shaving water heater for me, and I don't know what all. Now I am one of the best husbands a woman ever entrapped, and I propose to let her have about what she wants, but before I get these things I am going to know something about them. As we sway from side to side in this car I want you to give me a little dissertation on electrical heat. How can electricity make heat when it also runs refrigerating machines?"

"When we rounded that last curve, Judge," I replied, "and you flew outward on that strap with a force that made it give out a plaintive creak, you almost burned your hand against the leather didn't you? At least it was a trifle warmer. That heat you say was caused by friction. Well, frictional heat is nothing more than the manifestation of a whole lot of energy expended in a small space—in this case the little area between your hand and the strap."

"Electricity is a form of energy and when you concentrate that energy in a very small space it is bound to manifest itself in the form of heat. Take for instance the incandescent lamp. Current flows to it along a wire from the main circuit through the filament and back through another circuit wire. The circuit wires are comparatively large and offer very little resistance to the flow of current and no noticeable amount of heat is generated in them. It is the same as if you were to move a heavy book across a large smooth surface—no perceptible heat would be generated. Let that book pass over the head of a match so that all the energy were concentrated at the little point of sulphur and enough heat would be generated to light the match. In the incandescent lamp when the current comes to the little hair-like filament it is forced through by the pressure behind it. The energy required to force the current through is about six one-hundredths of a horse power, all concentrated in that little filament, so of course the latter gets very hot—white hot.

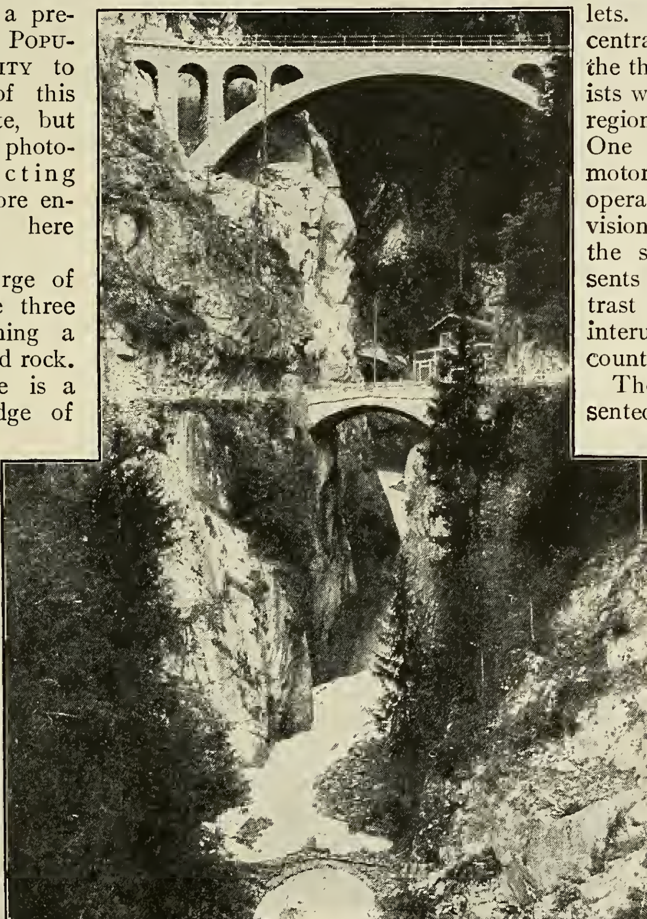
"This same principle is embodied in all electric heating and cooking utensils. They contain what is known as a 'heating element.' This is located somewhere within the utensil. It is made in various forms, sometimes removable, and always consists of a fine wire or metal ribbon which presents a high resistance to the current which is passed through it. Then as in the case of the lamp filament the energy expended is turned into heat and the temperature of the heating element and the utensil is raised.

"The particular advantage of the use of electric utensils lies in the fact that the heat is all generated at the point where it is to be utilized. There is almost no waste of energy as the heat all goes into the heating or cooking process and does not have a chance to be radiated to the surrounding atmosphere as in the case of a cook stove where there are twenty or more square feet of surface giving off heat to the air."

Some Railways of France and Norway

Connecting points of interest along the borders of France is the electric railway operating between Martigny and Chatelard. Never in the history of electric railroading has a line penetrated a region more beautiful, more impressive in the grandeur of mountain scenes which burst into view at every turn. Reference was made in a previous issue of POPULAR ELECTRICITY to the beauties of this mountain route, but some later photographs, depicting scenes even more enchanting, are here presented.

Over the gorge of the Triege are three viaducts spanning a cleft in the solid rock. The lower one is a mere foot bridge of stone—an unassuming little arch built nobody knows how many years or perhaps centuries ago. The middle bridge is a stone arch by which the wagon road crosses the chasm. Above the others is the Triege Viaduct of the electric line with a main arch spanning a distance of over a hundred feet.

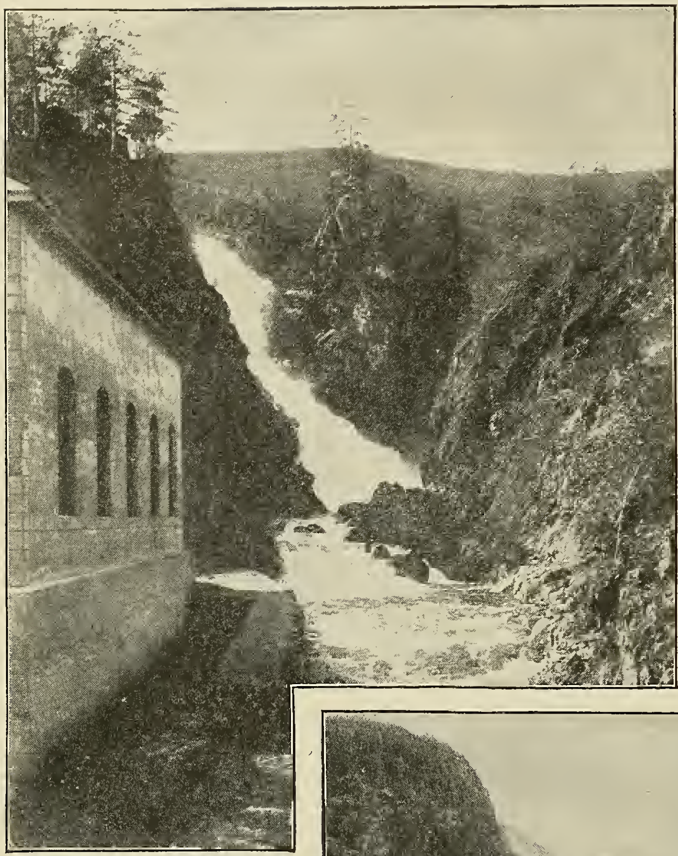


THE TRIEGE BRIDGE

A little farther along is the "Viaduct des Torrents," near Finhaut. The combination of the most wild and rugged mountain scenery and the pleasant warmth of a sheltered valley furnishes at this point a contrast wonderfully pleasing. Looking miles away between the mountains in the foreground may be seen famous "Glacier du Trient" suspended as it were from the steep slopes of the mountain.

It is hard to imagine a more picturesque spot than the station at the little village of Les Marecottes, which is nothing more than a small group of chalets. It is one of the central attractions of the thousands of tourists who come to this region every summer. One of the four-motor cars which operate over this division is shown at the station and presents a marked contrast to the type of interurban seen in this country.

The scenes presented to the traveler who rides on an electric railway in Norway are totally different from those of sunny France; no less picturesque, however, and no less satisfying. Norway is a land of wild and rugged mountains, a land of plentiful water-power and the descendants of the Vikings are rapidly making use of this form of energy for purposes of transportation. The Skienald water fall, with its power station seen at the left in the picture on the following page is but one of scores of examples of the harnessing of brawling upland streams of Norway to produce electric current for



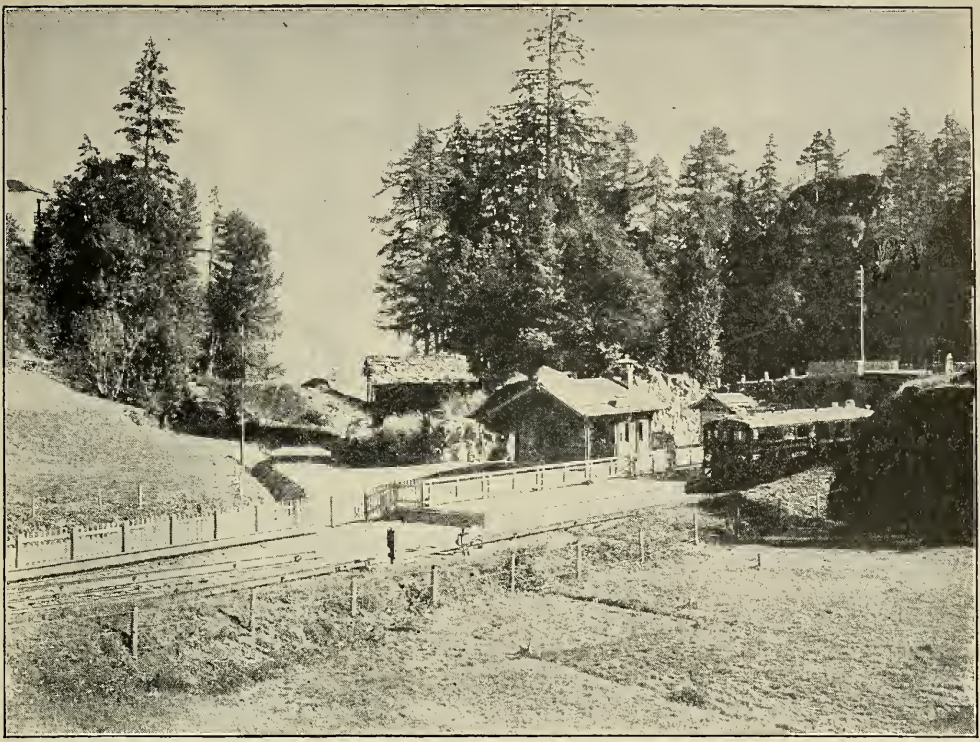
SKIENALD WATER FALL AND POWER STATION

Electric locomotives are employed to draw the trains as will be seen by the view of the train on the bridge over the Svorka Canal. The closed-in appearance of the locomotive, like a box car, in much different from that of electric locomotives seen in this country and indicates that the engineer is in need of adequate protection from the frigid climate. These locomotives weigh 20 tons each, and the nominal rating of only 80 horse power for the two motors makes possible a speed of only about ten miles an hour. But then, perhaps the people of Norway are not in such a hurry as they are in this country.

railways and industrial purposes.

The Thamshavn-Lokken electric railway in operation between the mines at these two cities on the Orkedald Fjord is the first line to be operated in Norway on what is known as the single phase system. It extends inland nearly 20 miles, skirting the River Orkla as far as Svorkmo. From this point it rises rapidly to the Lokken copper mines which are among the most important of the vast mining interests in Norway.

FINHAUT BRIDGE AND GLACIER DU TRENT



MARECOTTES STATION OF THE MARTIGNY-CHATELARD ELECTRIC RAILWAY

THE THAMSHAVN-LOKKEN ELECTRIC RAILWAY

Episodes in Electrical Invention

Mr. Charles A. Brown, one of Chicago's prominent patent attorneys, familiar with early electrical patent contentions which have now become historic, recently addressed the Electric Club of Chicago on the subject "Episodes in Electrical Invention and Patent Litigation."

Among other things Mr. Brown mentioned Mr. Edison's early work in connection with the telegraph. Edison devoted his attention to a system of duplexing which he patented and which to all intents and purposes was identical with the system used today. At the same time an inventor by the name of Stearns devised a system along somewhat similar lines. When Mr. Edison was asked as to the difference between the two duplexing systems he replied, laconically, "Mine works."

The Edison patent was sold to the Western Union. As a matter of policy it was thought best at the time to put forward a co-inventor and a man by the name of Prescott was selected. Edison was to receive $100,000 and Prescott as co-inventor was to receive $100,000, said $100,000 given to Prescott to return to the strong box of the company. But politics went wrong and Prescott calmly pocketed the $100,000 and it never went to building telegraph lines.

Field in his early telegraph work invented what he called an "expert relay." Today it is known as a "neutral relay." Such a relay embodies an armature of soft iron which is not magnetized, as distinguished from a polarized armature. When asked to describe his relay Field humorously replied: "An expert relay has a tongue adapted to lie on either side with equal ability according to influences."

The greatest patent case ever fought in the courts was that to determine who was the inventor of the telephone. On the same day Alexander Graham Bell and Elisha Gray filed in the United States Patent office almost identical descriptions of a method of transmitting human speech electrically over wires. So far they may have been said to have had equal rights. But Bell looked direct to the transmission of human speech whereas Gray in the beginning in his own mind, and upon the advice of his friends, never believed that the device would work to that end and sought to apply it to multiplex telegraphy. The thing drifted on. Bell worked doggedly at the telephone idea and at last brought it to a practicable stage. Then Gray waked up to what he had been losing in working on the telegraph application. Then came the lawsuit which was fought for years in the courts, Bell being finally given the credit of the invention principally from the fact that he had first fully grasped its significance and developed the idea.

Thomas A. Watson, a mechanic who worked in Bell's shop was the first man in the world to hear a word spoken over a telephone. Money was scarce with Bell in those days and he induced Watson to accept a little stock in part payment for his services. Today that little block of stock is worth just $6,000,000.

In the famous litigation between Edison and Brush regarding the compound wound dynamo there were 7000 pages of typewritten testimony taken. Both had worked out practically the same scheme of placing two windings on the field magnets but Brush didn't know that by so doing the machine could be made self regulating as to the voltage. He simply described his system as a device to prevent reversal of polarity of the dynamo. Edison, however, knew of the regulating principle. Brush went so far as to deny that the compound winding could be used to regulate voltage. But the other side had rigged up a dynamo with the two windings in place and demonstrated by taking off and adding on lamps to a circuit fed by the dynamo that it would so regulate and the lamps would burn at proper brilliancy no matter what the load; so Brush lost the suit.

Graveyard of the Atlantic

How much electricity is doing and in the future will do to save and prolong human life can not be given in figures. What has been accomplished by wireless telegraphy in saving ships and passengers is fresh in our minds. The "graveyard" of the Atlantic is said by sailors to be located off Cape Hatteras and is known as the Diamond Shoals. To warn ships of the danger when near these, two huge megaphones will be used, the diaphragms of which will be operated by electricity just as is the electric automobile horn. Tests show that the sound from these devices is able to penetrate fog and be heard for miles.

Where Electricity Stands in the Practice of Medicine

By NOBLE M. EBERHART, A. M., M. S., M. D.

CHAPTER VII.—GALVANISM AND FARADISM

We are inclined to overlook the medical value of the galvanic and faradic currents in view of the great popularity of some of the newer electrical methods. The galvanic current is a "chemical" current and it does some things which none of the other currents do and some which it does better than the others. For instance, it is the current necessary in electrolysis; lights diagnostic and therapeutic lamps; heats the blade of the electro-cautery, etc. Do not lose sight of the fact that its effects are chemical effects and that the prime essential to keep in mind is the difference in the action of its poles; for "polarity is everything."

In contrast to this the action of the faradic or induced current is mechanical; it possesses no chemical properties, and polarity is an indifferent matter.

Reverting to the primary wet cell of the galvanic battery the positive pole is the end of the copper element outside of the solution and the negative, the zinc element. To those who are not familiar with this fact I will give the method I use in my classes of enabling students to remember it.

The letter P, standing for positive, occurs only in copper and N, standing for

HARD RUBBER NEEDLE HOLDER

negative, only in zinc, so by spelling the words with a p and an n capitalized we have the letters for the corresponding poles, thus: coPper, ziNc.

The polar effects of galvanism depend upon the attraction which the poles have for elements of the opposite polarity, thus the positive pole attracts oxygen, which is, itself, negative, and since oxygen is a necessary element in acids, the positive pole has therefore an acid reaction.

The characteristics of the two poles are herewith summarized, and by contrasting their properties and keeping them well in mind, the physician will have no difficulty in selecting the suitable pole for the purpose sought, and it will serve as a therapeutic guide.

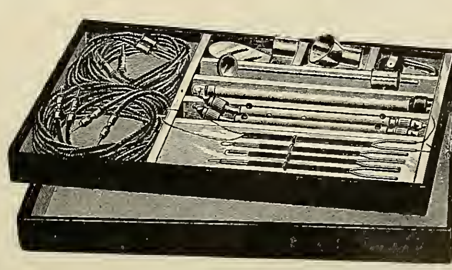
Positive Pole	*Negative Pole*
Acid	Alkaline
Corrodes	Attracts hydrogen
Oxygen found at this pole	Does not corrode
Contracts blood-vessels	Dilates blood-vessels
Coagulates albumen	Does not coagulate albumen
Stops bleeding	Increases bleeding
Soothing	Irritating
Relieves pain	Increases sensitiveness
Hardens tissues	Softens and liquefies tissues
Acts as an acid caustic	An alkaline caustic
Leaves a firm unyielding scar	Soft pliable scar

In the electrolysis (electric analysis) of water the negative oxygen is attracted to the

FIBER CAUTERY HOLDER

positive pole of the battery while the hydrogen which is positive is drawn to the negative pole. Thus, the fluid is electrically separated or analyzed.

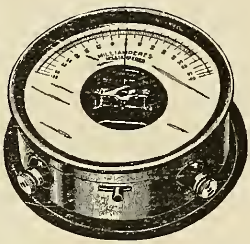
Electrolysis in medicine is applied principally to the removal of superfluous hair, moles, warts and other small growths. For this purpose the negative pole is employed because it forms an alkaline caustic and because the slight scar produced is soft and pliable.



CAUTERY ILLUMINATOR SET

A simple experiment to show the comparative action of the poles may be made by attaching a steel needle to the positive pole and plunging it into a piece of raw meat. After the current has been passed (say one of 10–15 milliamperes) for a moment it will be found on attempting to withdraw the needle that it sticks in the meat; that there is a dark area around it and the needle itself is corroded or oxidized. There also will be found a deposit of the oxide of the metal composing the needle in the tissues surrounding it. When the negative pole is attached the needle comes out easily and is not blackened or corroded.

In measuring the current an instrument called a milli-amperemeter is used, which measures the current in thousandths of an ampere.



MILLI-AMPEREMETER

In removing the superfluous hair, the needle is attached to the negative pole, using a special needle holder. Some of these have a switch in the handle with which to turn on the current. The positive pole is connected to a large pad, moistened in salt water and in contact with the upper part of the back, the patient lying on it, or it may be placed at some other indifferent point, as on the breast with the patient's hand lying on it.

The needle is passed down alongside of the hair shaft into the root or follicle. This is an average of about 1-16 of an inch. A current of from two to five milliamperes is then allowed to pass for possibly 20 seconds, when the current is turned off and a gentle pull given to the hair. If it has been destroyed it will pull out easily, if not, turn the current on for a short time again, as hairs occasionally curve abruptly in a different direction from that which they take at the surface. A reasonable percentage of them will not be destroyed, and finally the caustic produced by the current burns the shaft through but does not kill the root and the hair will ultimately return. The bubbles which arise about the needle are produced by the hydrogen gas evolved. After the treatment is over a little peroxide or simple antiseptic solution should be applied to the skin.

Physicians usually employ the current derived through a wall plate, affording both galvanism and faradism. Dry or wet cell batteries may be used with equal success. Space forbids discussing many of these points. In removing moles, warts, or small growths the needle is attached to the negative pole and the growth transfixed through its base, on a level with the skin, by the needle. A current of five milliamperes (occasionally up to 20 or 30 in large growths), is employed and passes for 30 to 60 seconds, and then the needle is passed through at right angles and the process repeated. Sometimes I have found it convenient to withdraw the needle almost to the point of entrance and then thrust it back in another direction. Thus without turning off the current I still am able to transfix the whole base of the growth.

The object is to destroy the blood supply to the growth and thereby cause it to shrivel up. The growth whitens out as the current passes, but later turns dark. I seldom make a second application under five days, should a second one be required. Growths that have a small stem or pedicle to them are removed usually by one application, but flat growths with a wide base may require several applications before their blood supply is entirely obliterated.

Cataphoresis or as it is frequently called, phoresis, is the carrying of substances into the tissues by means of the electrical current. This also depends upon the attraction or repulsion which the poles possess, for the various elements. A solution is placed on a sponge or a small electrode made by covering the metal electrode with absorbent cotton and after immersion in the solution, frequently with gold-beaters' skin.

If this is attached to the positive pole as the current passes, all positive elements will be repelled from it and drawn through the tissues toward the negative pole. The converse is true if the solution is on the negative electrode.

If we wish to carry a certain substance into the tissues we must consider the pole to which that particular substance will be attracted. For example in using a saturated solution of potassium iodide in treating goiter, our object is to drive the iodine into the goiter. Now the potassium is electropositive and will travel toward or remain at the negative pole, while the iodine, being negative, travels toward the positive pole. Therefore, to utilize the iodine the solution is placed on the sponge attached to the negative pole. As the solution is broken up, the positive potassium remains at the negative pole while the negative iodine travels through the tissues toward the positive pole.

Cocaine solutions are used from the positive pole, for local anesthesia. Massey destroys cancers by treating with a zinc electrode amalgamated with mercury. The electrode used is the positive and it is introduced or plunged into the tissues.

It is well to remember, then, that oxygen, chlorine, iodine and acids are electro-negative, while hydrogen, alkalies, and most metals are positive.

A simple method of determining the poles of the battery is by immersing both in a glass of water containing a little salt. Bubbles (hydrogen) gather at the negative pole.

A few therapeutic applications of galvanism are enumerated. Others, which the physician will readily understand, have been omitted in this discussion.

NEURALGIAS

Apply positive pole over painful spot; negative to spinal origin of nerve or to an indifferent point, and allow the current to pass from three to five minutes, of a strength of one to five milli-amperes.

CONGESTIVE HEADACHES

Apply positive pole over the forehead and negative to the back of the neck. One to five milli-amperes, three to five minutes

GOITER

Negative sponge electrode moistened in saturated solution potassium iodide placed on one side of the goiter; positive sponge on the other side. Two to five milli-amperes, five to ten minutes.

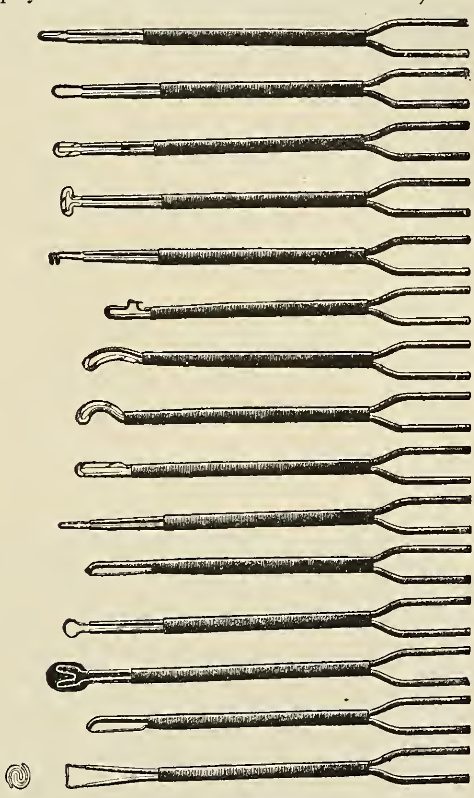
ARTICULAR RHEUMATISM

Solution of lithium citrate on sponge attached to the positive pole, over joint, negative on abdomen or some indifferent point; twenty milli-amperes, ten minutes.

Diagnostic lamps are made in many styles and sizes. Some are used to reflect light into the mouth, nose, ear, etc., while others are so small that they may be introduced into the various cavities of the body. Still others are used to show by the degree in which the light penetrates or shines through the tissues (transillumination) the presence or absence of a diseased condition, and finally we have the high candle-power lights used for the heat or chemical effects they produce when shining on a diseased surface. All of this must be left for consideration later in a separate chapter.

In using the electro-cautery there are platinum blades and points of sundry styles and sizes. I have employed the electro-cautery successfully not only in the minor conditions in which the cautery is indicated, but in operations of a major or semi-major character.

A point of the greatest importance is the degree of heat to which the cautery blade or point is subjected. It is at first a dull red; then a bright red and finally a white heat, as the current is increased. The white heat will cause the blade to cut through the tissues as smoothly as a knife, but as it does not stop the amount of bleeding it really has no advantage over the knife and is more clumsy, hence unsuitable for the physicians' use. On the other hand, the



CAUTERY ELECTRODES

blade showing a red heat, cuts slowly, but seals up the bleeding vessels on either side and thus leaves practically a bloodless field of operation. It is this which gives it its great value. Also, in sealing up these blood vessels and lymphatics there is no opportunity offered for the entrance of septic or malignant matter.

If the skin be incised by this form of cautery the adjacent sides will heal together as readily as after an incision made by a knife, and furthermore, because there is no loss of serum or especial damage to the tissues there is practically no swelling of the cauterized wound.

As the blade comes in contact with the tissues it cools down quickly and it is desirable to remove it every few seconds until it glows again, when it is re-applied.

The electro-cautery is especially valuable in nasal surgery, in orificial surgery, etc. It is employed frequently to destroy as much as possible of a cancer or other malignant growth which is so situated that complete surgical removal is impossible or inadvisable.

The faradic current shows practically no difference between the effect of its poles because it is an alternating current and the poles change too quickly for chemical effects to be manifested. I am referring now to chemical effects only. As regards the physiological properties of the two poles there is a perceptible difference between the positive and negative pole and the negative pole is more irritating because the negative wave is more abrupt, being the wave that occurs with the breaking of the current.

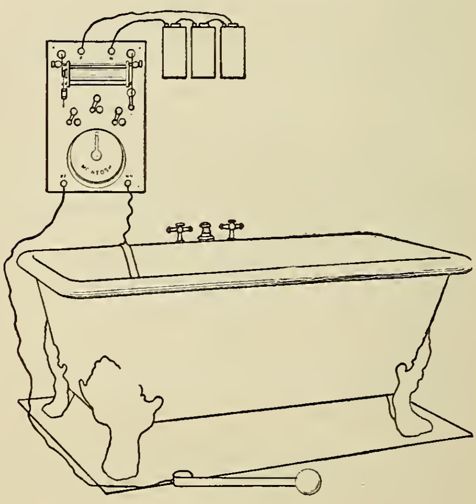
The faradic current possesses absolutely no electrolytic properties and cannot be used to remove superfluous hair, growths, etc. Ludicrous letters are often received from physicians who state that they have been unsuccessful in following the directions given for removing small growths with their battery and on further investigation it is found that they have been trying to do so with the faradic battery.

The feature which gives this current its true value is its ability to cause muscular contractions with each make or break of the current. The result of these contractions is the exercise of the muscular tissues and consequent improvement in all of the various bodily processes. There is an increased oxidation of the tissues and an increased elimination of the poisons or waste products. Therefore, we think of the faradic current as a "massage" current, and find that in common with the high frequency and sinusoidal currents it increases metabolism or cellular activity, and is indicated in all conditions where increased nutrition either locally or generally is desired.

There is a method of applying the current called general faradization, which is accomplished by placing the feet upon a plate connected to one pole of the battery and a moistened sponge electrode attached to the other pole, moving back and forth over different parts of the body, usually dwelling for from one to three minutes over the head, neck, back, abdomen and extremities. The patient may sit on the plate instead of placing it under the feet, if so desired.

The galvanic and faradic currents may be combined and thus the advantage of both currents made use of. The method of doing this is the connecting of the negative pole of the galvanic current to the positive pole of the faradic battery.

One method of administering faradic currents and which also may be employed for sinusoidal or galvanic currents, is by means of the electric bath. In giving this the poles of the battery end in good sized copper plates, one of which is placed at the



ELECTRIC BATH

head and the other at the foot of a porcelain bathtub, partly filled with water. Ordinarily the feet touch the lower plate, but the other plate is kept from contact with the head or shoulders by interposing a cushion or other obstacle. The size of the plate used for the head is usually about 12 by 16 inches; the other possibly 10 by 12 inches. Another way is by means of special electrodes as shown in the diagram.

The patient is placed in the bathtub before the current is turned on; when it is allowed to pass for a varied length of time according to the case, the strength of current being governed by the toleration of the patient. This form of faradic bath may be given with the ordinary home battery.

(To be continued.)

ELECTRIC POWER BOAT THAT MAKES 24 MILES AN HOUR

Speed and Pleasure with Electric Boats

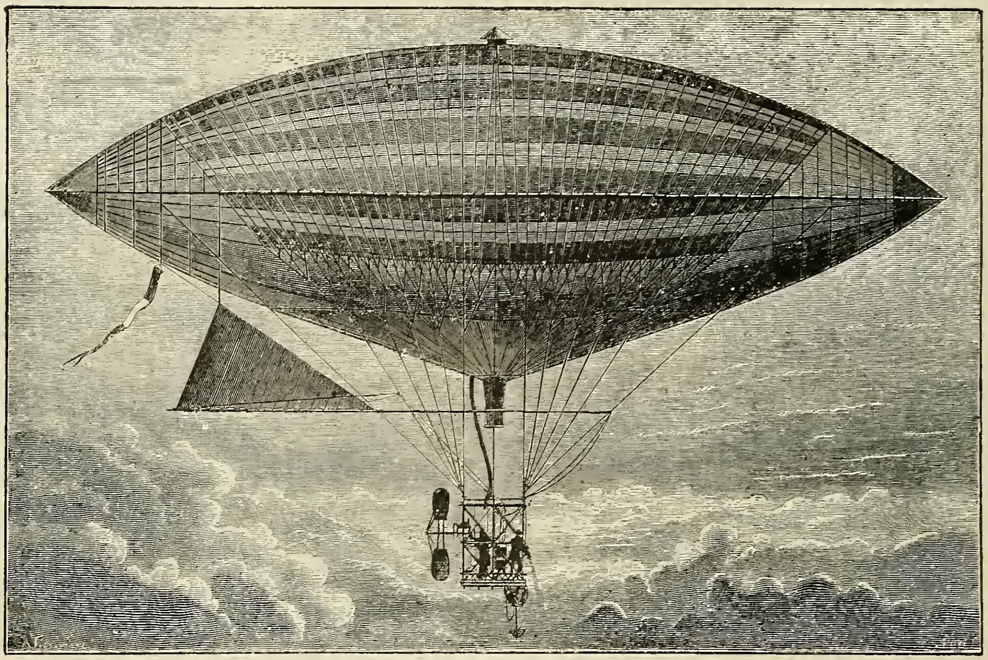
The use of electricity as a means of propelling pleasure boats or launches is a matter of common knowledge. But it will no doubt be a surprise to many, especially those who are enthusiastic over high-speed boats, to know that power boats capable of making 24 miles an hour are now being run by storage batteries and a motor driven propeller. One of these high speed boats making fast time on Lake George, New York, is shown in one of the illustrations, the boat being 40 feet long and carrying a 70 horse-power.

Electric pleasure boats are also becoming more popular every year. The one shown seats 40 passengers and for its purpose is built, in contrast to that of the high speed boats, for making only six or seven miles an hour.

The cost of current to run a 30-foot boat is placed at about four cents an hour by the Electric Launch Company, Bayonne, New Jersey. The furnishings are almost equal to those in a small modern home, while electric light is used in the cabin and for the headlight.

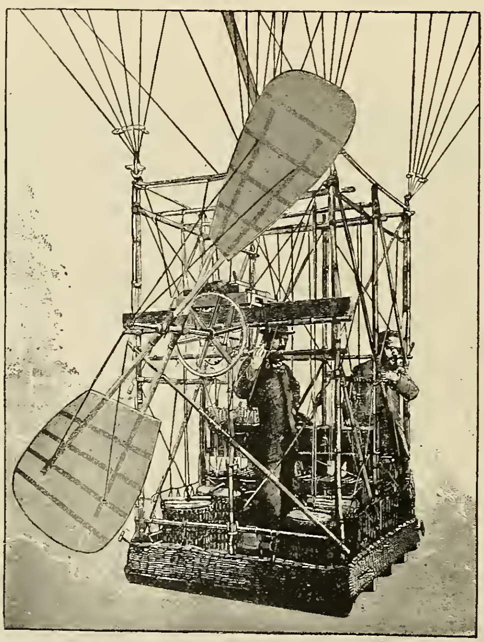
ELECTRIC PLEASURE LAUNCH, CAPACITY 40 PEOPLE

First Electrically Propelled Balloon



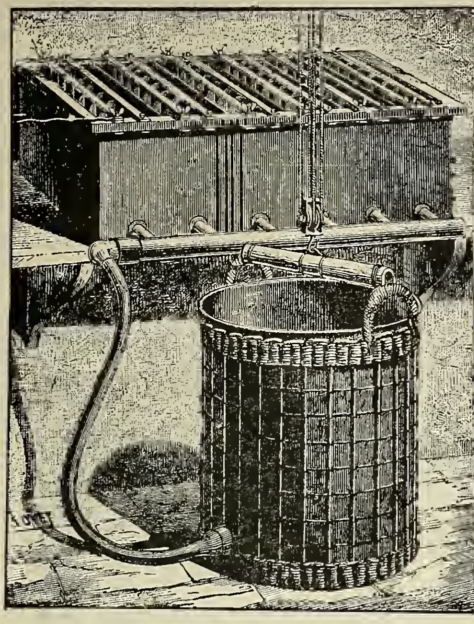
ELECTRICALLY PROPELLED BALLOON OF THE TISSANDIER BROTHERS

The continued successful flights of the dirigible balloons designed and piloted by Count von Zeppelin recalls the much earlier French effort in that direction, the first in which electricity furnished the motive power. Remarkable as it may seem, this was over a quarter of a century ago, long before the invention of the storage battery, hence the source of current had to be primary batteries. In 1881, one of the features of the Exhibition of Electricity in Paris was a small dirigible electric balloon designed by Gaston Tissandier, who was then (as he is still) editor of the clever French scientific weekly "La Nature."



CAR OF THE TISSANDIER BALLOON

Having developed a bichromate of potash pile which promised to be more powerful in proportion to its weight than the battery used in this small balloon, M. Tissandier and his brother Albert, (who had meanwhile started a balloon factory at Auteuil) built a much larger dirigible balloon, measuring 36 feet in diameter and 110 feet from tip to tip. The balloon proper was of the double pointed shape developed by Dupuy de Lome in 1872 and was filled with hydrogen gas. The motor was of the



BATTERY USED ON TISSANDIER BALLOON

Siemens type, wound to run at a maximum of 1800 revolutions per minute and connected to the propeller through a 1 to 10 gear. Current was furnished by 24 bichromate of potash batteries arranged in four groups, each of which was connected by a flexible tube to a light hard-rubber pail which contained the liquid. When this pail was raised by means of a block and tackle, the liquid entered the battery and started the current. The 24 cells were connected in series and controlled by means of a mercury commutator.

At the very first ascension the two Tissandiers remained up over Paris for an hour and a quarter, and while they were limited in their evolutions by an incomplete control of the rudder, they found the motive power fully equal to the air currents which they encountered. Indeed, Gaston Tissandier promptly reported in "La Nature" (to which we are indebted for our detail cuts of the car and the battery) that "electricity furnishes a balloon with one of the most favorable of motors, the management of which in the car is extremely easy." He also adds what some of our contemporaries have waited a quarter of a century to demonstrate: "Aerial navigation will not be created all at once, for it necessitates numerous trials, multiple efforts and a perseverance that is proof against anything."

This historic ascent of the first electrically guided balloon occurred on October 8, 1883, and seems to have been appreciated by the leading periodicals of that time, to one of which ("L'Illustration") we owe our illustration of the Tissandier balloon.

Recorders on the Berlin Cars

Since 1908 the Berlin traction companies have equipped their cars with an electric recorder which consists of a clock which is automatically started or stopped every time the motors are started or stopped.

The motormen have, as everywhere else, a certain fixed time to complete a round trip. This time is determined experimentally. Those recording instruments make is possible to observe if the normal loss in time due to stops is exceeded or not. The results of those observations are noted on the crew record cards—and if for a certain period of time they are unfavorable the crew is detailed off to a new period of training. If after that there is no improvement the men are discharged.

For 3000 conductors the control service is looked after by 13 employees and the clocks cost $10.00 each. Nevertheless the resulting economy is considerable.

It was found out, however, that soon after the device was installed the cars began to come in ahead of time and it was possible to increase the average speed by about 10 per cent and so it was found necessary to buy 80 new cars, which increased number of cars required the employment of 300 more men. But the resulting service was better.

More, the repair cost of motors and brakes has decreased about 20 or 30 per cent.

Tunnel from Sweden to Denmark

A project is on foot to build a tunnel between the Southern extremity of Amajer Island in Denmark and Schonne in Sweden. The length of the tunnel would be about 20 miles. It would contain two tracks; the power for running the trains would be electricity, and the tunnel would be built with great iron sections that would be deposited on the bottom of the sea. The tunnel would be used for the transportation of freight and passengers.

Brilliant Flaming Arcs

The first installation in the Northwest of 18-ampere flaming arc lamps was made in front of the National Guard Armory at Minneapolis, for service during the first annual electrical show held by the Northwestern Electrical Association, March 26th, to April 2nd, 1910.

One of the difficult problems to be solved by the Association was the illumination of the exterior of the Armory and its grounds. After giving the matter due consideration as to the best methods of illumination, it was decided to install the new 18-ampere General Electric flaming arc lamp.

As an experiment, two of these lamps were placed at the top of a fifty-foot pole, approximately 75 feet in front of the Armory. Much to the surprise of those interested these two lamps not only gave a brilliant golden light, sufficient to illuminate the entire building and street in front, but proved to be the best possible advertisement for the electrical show. As the lamps swung high in the air, they resembled two miniature suns, attracting considerable attention for a great distance in all directions.

TWO FLAMING ARCS LIGHT THE WHOLE FRONT OF THE MINNEAPOLIS ARMORY

The Early Days in Texas

One ring of the bell: "Short of ice;" two rings: "Need more beer."

Such was the signal code used in an enterprising Texas town long before the prohibition wave struck that section, and indeed long before the telephone was generally introduced. At that time most of the saloons in the town were controlled by a brewer who tried to save expense by carrying only a limited supply of both beer and ice at each place. By having his headquarters connected with each saloon through an ordinary annunciator call system he was able to keep in touch with the urgent needs at each point. The saving in ice alone is said to have paid for the installing of the system in a single summer, but with the general introduction of telephones it was outclassed some years later. However, the method was typical of the many uses of even a simple electrical annunciator.

Who Will "Invest" Him?

That the Japanese are interested in the new electrical developments, and have an eye for a good money-making proposition, is evidenced by the following letter. Perhaps someone with a little money to invest would like to go into the lecturing business in Japan:.

EDITOR POPULAR ELECTRICITY:

I am afraid to ask you these questions, but allow me to inquire you. I have an ambition on electrical business. I am a Japanese boy who have an interest in electricity. Well, few years ago when our country first time saw the telephone, we were surprised to see it (we saw the telephone instrument by the traveling telephone show man) and he operates instruments everywhere he went (especially in school) and he made about $20 to $35 every day by operating instruments and he made his fortune with his pair of telephone instruments.

Now I would like to be a one of traveling man with the wireless telegraph instrument. There is no one traveled yet with the sample wireless instrument, so I would like to go to Japan with pair of instrument but I can't devote all my expense in this present time so I would like to know if there is someone would invest me in business. Few months ago I wrote to Manhattan Electrical Supply Co. and Mr. J. J. Duck, Ohio, but they can't do anything but give the percent if I would take order for their Company.

Please let me know where I can find the man who would invest me on this business.

Yours very truly,
THOMAS UCHIYAMADA.
Care The Escalante,
Ash Fork, Ariz.

P. S. I am the student of the I. C. S. Electrical Engineering.

Electric Traction on Bavarian Roads

From an official report published on the eventual electrification of the Bavarian railroad the amount of power necessary for the transformation would be about 600,000 horse-power.

There is enough hydraulic power in the country to permit of the electrification, which would be particularly convenient in the southern part of the country where the traffic is comparatively light and where most of the waterfalls are situated. In the northern part for economical electrical operation the traffic should be twice as heavy as it is in the southern part. The expense for the three lines to be equipped first is counted to be about 8,000,000 marks. The speed of express trains is to be 50 miles per hour and single phase alternating current is to be used.

The Montefiore Prize

The Administrative Council of the Association of Electrical Engineers connected with the Montefiore Electrical Institute in Liége, Belgium have announced the giving of a prize which will bear the name of "Fondation George Montefiore Levi." Thirty thousand dollars invested in three per cent Belgian bonds furnishes the means for offering a triennial prize which amounts to $4,000 and which will be available for the first time in 1911. This money is to be given for the best original work on the progress, advancement and application of electricity in modern life. The papers will be passed upon by a body of judges consisting of ten electrical engineers, five Belgians and five foreigners, presided over by the president of the Institute. The papers may be in either French or English, printed or written. Each manuscript must bear an assumed name and also a sealed envelope in which the writer on a card gives his real name and address. Contributions must be in on or before March 11, 1911, and should be addressed to the secretary of the Fondation, George Montefiori Levi, 31 Rue St. Gilles, Liége, Belgium.

THE AERIAL BURGLAR

The field of usefulness of the lightning rod is to be presently extended.

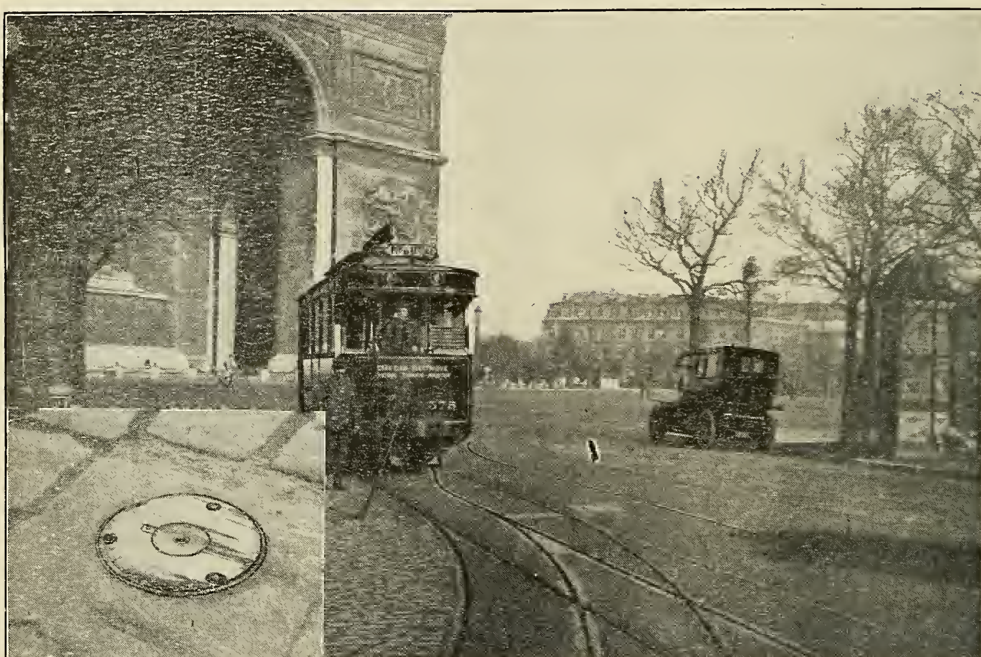
Under-running Trolleys in Paris

By EMILE RUEGG

It is unquestionably a fact that trolley wires spoil the good looks of any elegant city. Paris knows it, too. But can we do without them? The picture proves that the Parisian is able to do so. The scene represented is at the Etoile, one of the most beautiful places of the picturesque city. Here the Thomson-Houston system has found the largest application.

In the centre between the two rails we find a slot about $1\frac{1}{2}$ inches wide and rather deep (about one yard). Instead of having a trolley upon the roof of the electric cars reaching up to the wires, we find here a trolley reaching down into the slot where it takes the current below the surface of the earth. This system is the most perfect one of its kind and hardly ever gives rise to any disturbances or irregularities.

The small view shows a current tap of peculiar shape. Such plugs are buried at regular distances from each other in the pavement between the two rails in some parts of Paris. The electric cars are long and carry three slides which glide constantly upon the pavement, from time to time making connection with these plugs. The distances between these plugs are measured very exactly so that some of the slides are always upon plugs which is essential for a regular current supply.



UNDER-RUNNING TROLLEY CAR AND TYPE OF CONTACT BUTTON USED IN PARIS

The loss of current in this system is quite considerable, it is said, especially during rainy weather and in winter when the humidity acts as a conductor. The plugs are well insulated from the ground but losses occur just the same, caused by moisture.

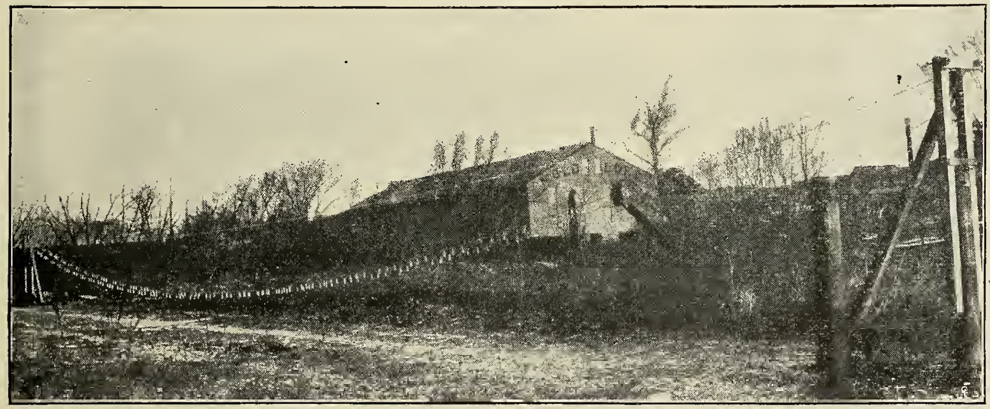
It is also a peculiarity of this system that during night time there may be seen tremendous flashes like lightning. This is especially true during rainy weather or when some sand or stone causes the slide below to be lifted from the plugs, thus interrupting the current. Many a horse has been frightened by such sparks and accidents have occasionally been reported. The newspapers also reported occasional accidents to horses during rainy weather, which have been caused by a contact of the hoofs of the horse and the iron wheels of the wagons, etc. But such accidents are fortunately but very seldom and happen perhaps every one or two years. Pedestrians are not harmed because to step on one of the plugs will not permit of a shock and they are too far apart to enable one to touch two of them at the same time.

The cars carry a trolley pole in addition to the "under-running trolley." While the cars are running in the city the trolley is hooked down, but as soon as they leave the city walls behind them, the trolleys are set upon the trolley wires above and without a moment's delay may run under another system. There are, however, many suburban electric cars which run in the city as well as also in the country on such plugs only.

Testing Copper-Clad Steel Wire

When selecting wire for carrying electric current, the mechanical strength as well as the conductivity must be considered. Although copper wire is a better conductor than iron and steel wire, the latter is much used for telegraph and telephone purposes because the copper wire lacks tensile strength, a copper wire large enough to stand the strain on long spans costing too much on account of the increased size of wire necessary.

To secure both conductivity and strength a steel wire covered with a coating of copper is now made by welding molten copper on a billet of steel. The bar is then subjected to a process of rolling similar to that used in making steel and copper wire and comes out copper-clad steel wire. To test this wire two poles are set some distance apart. In the illustration a No. 10 hard-drawn copper wire and a No. 12 copper-clad steel wire are suspended side by side between the posts and weighted uniformly by pieces of lead, the total weight on each wire being 109 pounds. The sag is measured from a third wire drawn between the posts the test being carried in some cases to the breaking point of the wires.



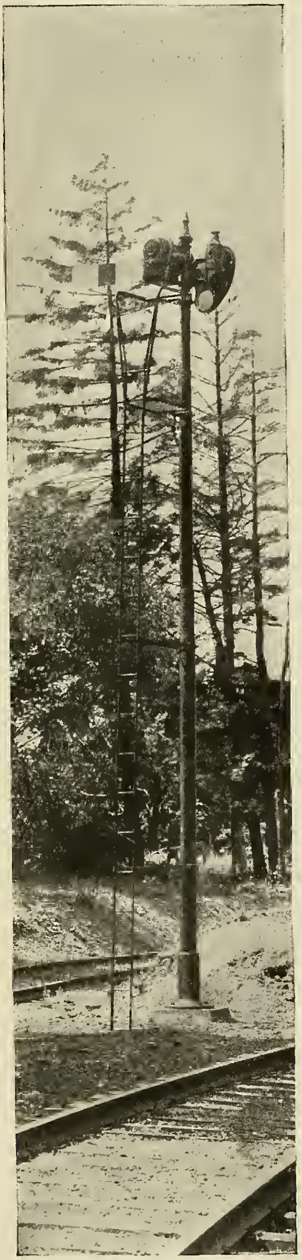
THE WIRE IS PUT UNDER TENSION BY HANGING ON LEAD WEIGHTS

Batteries Large and Small

Nowadays when we light our way at night on country paths with pocket size batteries, it is interesting to look back at some of the experimental batteries of exactly two centuries ago, when various investigators were using batteries of enormous size without even dreaming of producing light from the same. Several experimenters of that period reported their using batteries composed of at least twenty cells, each cell having a pair of zinc and copper plates and the plates themselves being two feet wide and four feet high. The favorite solution at that time was a diluted mixture of nitric and sulphuric acids, which must have consumed the plates rapidly. But the more remarkable point was the size of the plates and therefore of the cells, some of which held over a hundred gallons of solution. Think what a supply of energy we would have today if we were to fill the same size of tank or jar with the modern high-ampere dry cells as used for our portable flashlights!

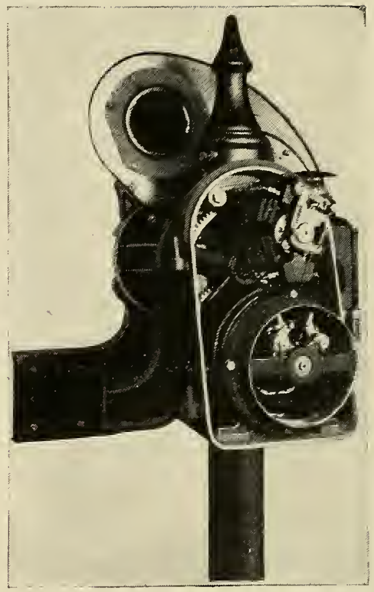
The Electric Semaphore

"Stop, Look and Listen!" are words signifying danger to those who cross railroad tracks guarded by a crossing signal. To the locomotive engineer who must cross the track of another road or run into the railway station of a big city where trains are arriving and leaving every hour of the day and night the arm attached to the top of the pole as shown in the picture spells "stop" when in its horizontal position and "clear" when it swings up to a vertical position.



ELECTRIC SEMAPHORES GUARD THE WAY

In the little iron case on the pole is a motor, the wires of which run down the pole and to a watch tower, where, by the simple operation of closing a switch, the motor is started and swings the semaphore into the proper position ready to deliver its message. On many railroads these signals are still operated by hand from a system of levers in the signal tower and metal rods along the track to the signal pole, but the illustration shows the same thing accomplished by the electrical equipment of the General Railway Signal Company.



THE INTERIOR OF AN ELECTRIC SEMAPHORE

Three Centuries of Electric Bells

What is probably the earliest available reference to an electric bell is found in a rare volume to which the catalog of the British Museum assigns the date of 1600, though it more likely was issued some ten years later. It was published in Nuremberg, the famous toy center of Germany, by Janus de Sunde under the title: "Secret, Magic and Natural Arts of Communication." In this book de Sunde tells of a wonder worker as calling up a friend by ringing a bell through the means of a bar magnet—in other words, he vaguely describes a magnetically operated bell.

Another of the secret and magical means of communication described by the same author consists of needles moved by bar magnets so as to indicate letters by one or more strokes of the needles to the right and the left—a simple needle telegraph. Thus we find among the mysteriously magical of three hundred years ago the basis of the magnetic boys' play of more recent years. Fifty years later another philosopher of Nuremberg described a bell in which the clapper was moved by the armature of a magnet.

Insulating Materials

VULCANIZED FIBRE

The very extensive use of this material is due more to its mechanical properties and to its easy shaping in all required forms than to its insulating qualities. This material is nothing more than wooden fibres which, treated by some chemical agents, dissolve and are solidified by drying after being submitted to a very high pressure.

The manufacture of this insulating fibre requires the right kind of wood, very accurate workmanship in making the paste, in drying and in its compression. Particular attention is also paid to the humidity in the surrounding atmosphere and its temperature, and powerful machinery is required.

To obtain it in workable quantities and conditions it is necessary to have recourse to American manufacturers. Germany has tried to manufacture it, or just as good a substitute, but has now given up hope of ever succeeding. It is put on the market in sheets 44 by 66 inches. The thickness varies from thousandth of an inch to one inch and a half, in rods or in tubes.

The color (black, red or gray) does not involve any difference in the properties, and the price is satisfactorily low.

But while this substance has high mechanical resistance to vibration, is not sensibly affected by acids or solvents and oily matters and can be easily worked, its dielectric strength is not high and it is very sensitive to humidity and can give trouble by absorbing water up to 10 per cent of its own weight. It is true that it regains some of its good properties by drying, but the drying process must be natural and the fibre must not be exposed to a high temperature—otherwise it will lose its elasticity.

The proper precaution to take is to use a very high grade waterproof varnish to protect the fibre.

The fibre is a poor conductor of the heat and burns with difficulty and also under operation gets better the older it is.

WOOD

Wood, especially when hard and seasoned in a dry place, owing to its comparatively low price, its abundance, and the ease with which it is worked, is used very largely in electric machinery, i. e., from bases for electric bells to the largest three-phase motors. In theory the price should not be considered at all when looking for some scientifically perfect insulating material. Practically, the price is one of the most important factors, and this gives wood a preference except where it cannot absolutely be used, as in case of high electric tension.

Often wood is used for the bulk of the insulating device, to give it strength, and is lined with porcelain, asbestos, etc., in holes where electric conductors go through.

Wood is highly hygroscopic and when wet loses all its dielectric power. Its texture is not uniform, and burns easily, and its dielectric power is not high.

To obviate this the wood used is very hard and dry, is coated with varnish or impregnated with preserving matter. But if for this purpose the usual solution of paraffine or vegetable resin is used there is an increase in the possibility of fire. It is preferable to use a good varnish which will preserve the wood from water and will not increase the danger by heat or short circuit.

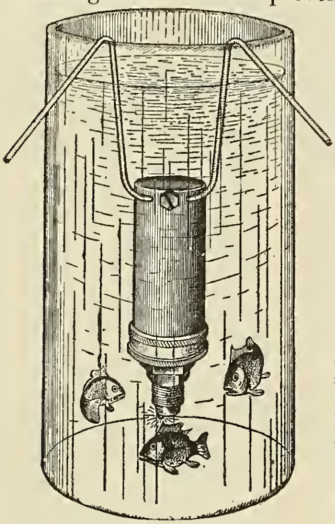
When wood comes in contact continuously with heavy oil the danger of humidity decreases, moreover the wood will enjoy the advantages of being continuously in contact with a substance which is by itself a good insulator. without any increase in its combustibility. So wood can be used without inconvenience in oil switches and in certain parts of transformers. Wood cellulose is moreover largely the foundation for the manufacture of many other insulating materials like fibre-insulating paper, etc.

Tungsten Lights Up First

Have you ever noticed how much more quickly a tungsten lamp lights up after the current is turned on than does a carbon lamp? This effect is due to the difference between the hot and the cold resistance of the two filaments. A piece of tungsten wire having a resistance of one ohm at 0°C increases its resistance to seven ohms at 1000°C. In the carbon lamp the resistance of the filament cold is twice as great as when it is at an incandescent heat. Now if we apply Ohm's law, $C=\frac{E}{R}$, with these two conditions in mind and remember that the heating effect is proportional to the current squared, we see that the heat generated in a tungsten lamp when first lighted is very great, while in a carbon it is correspondingly small at the start.

It Sparks Under Water

Nothing so quickly tells on the action of an induction coil used for ignition as the presence of moisture in its windings. The water soaks through the insulation, short-circuiting the coils and preventing a spark, and to repair a coil so damaged requires the services of an experienced workman.

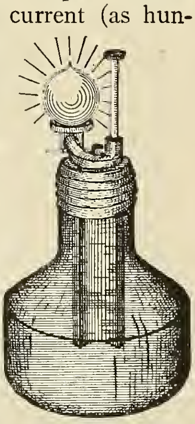


COIL AND PLUG OPERATING UNDER WATER

The illustration shows a Perfex ignitor consisting of a coil and spark plug combined operating under water, as exhibited at a recent motor-boat show. Operation under such conditions speaks well for the quality of the insulation used in the coil.

Return to Battery Lamp

Thirty years ago the experimenter's favorite source of electric current (as hundreds of our readers can testify) was a battery in which carbon and zinc electrodes were used with a solution of bichromate of potassium and dilute sulphuric acid. Such a battery gives a fairly steady current for 15 or 20 minutes and could be used on a play scale even for temporarily lighting low voltage miniature lamps. In recent years the development of tungsten and other metallic filament lamps has made the lighting power of such a battery thrice as great as before, so that instead of the toy miniature lamps we can now light lamps of practical sizes with the same. Besides, the voltage of these bichromate batteries is considerably higher than that of the dry batteries used in the flashlights now on the market both here and abroad.

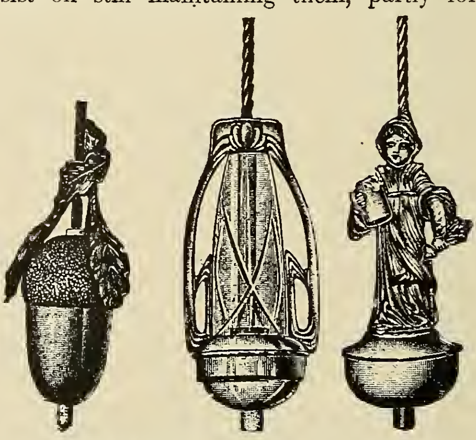


NOVEL BATTERY LAMP

It therefore is not surprising that a revised form of this familiar bichromate battery should be offered on the European market for temporary or intermittent lighting, such as may be needed in a sickroom, closet or cellar. In this commercial form the lamp is fastened directly to the screw cover of the jar, while the zinc is lowered into the liquid by merely depressing the top of a sliding rod which normally holds the zinc out of the solution. The latter is made by adding clear water to a chromic salt which is sold in packages to users of the battery. Each filling is said to last about fifteen hours with intermittent use of the battery; that is, if the light is used fifteen minutes daily. The battery should run about two months before the liquid needs renewing. The same battery lamp is also said to make a convenient ruby lantern for photographer's uses when a ruby globe is placed over the lamp.

Ornamental Pendant Pushes

Centuries of use have made the old fashioned bell pulls such a familiar part of European interiors that many people insist on still maintaining them, partly for

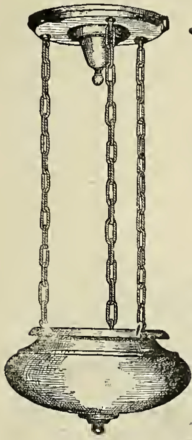


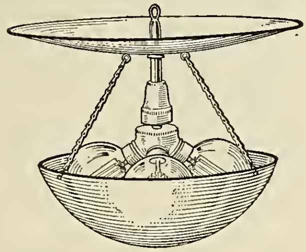
ORNAMENTAL PENDANT PUSHES

their artistic effect. This is particularly true of hotels and inns which like to keep up their time honored appearance. In these we still find bell pulls, but instead of the clumsy cords and tassels of fifty years ago, we now have dainty flexible cords with ornamental forms of what we generally call pendant or pear-shaped pushes. Some of these imitate fruits or nuts, such as apples, pears or acorns. Another has a sparkling glass column set in a gilded metal framework, while still another has a miniature figure of a maid of Munich.

Hiding the Lamps

The old adage about not hiding one's light under a bushel seems to be set at naught by the developments of recent years, for a





large variety of interiors are nowadays lit by lamps which themselves are hidden from view. By projecting the light to the ceiling and letting that diffuse the light, we get rid of the direct glare of the lamps, so we are practically getting our illumination from lamps hid under a bushel.

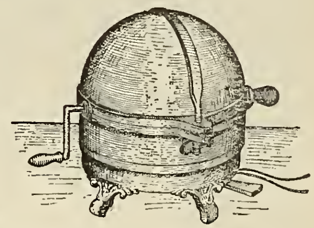
Where such a method of lighting is applicable, the present problem narrows itself down practically to a choice of the reflecting and concealing fixture, which may be highly artistic or decidedly homespun. For instance, two such indirect lighting fixtures were recently advertised in the same month's issue of a European and an American technical journal. Both designs are here reproduced, leaving each reader to make his own comments.

Electricity from the River Jordan

It may seem sacrilegious but nevertheless a company is being formed to build a light and power plant at the falls of the Jordan between Meron and Lake Gallilee. The river at this point makes a descent of 700 feet and it is planned to build the plant large enough to supply all of the large towns of Palestine.

Old Coffee Roaster Resurrected

As long as coffee is "green" or unroasted, the oils in the beans preserve its freshness so that it will keep not only through the long voyage from Guatemala or Brazil, but also for months and even years after reaching the northern countries. Roasting the beans removes these preservative oils, hence the roasted coffee loses rapidly in strength and flavor unless kept from exposure to the air. The average dealer gets his supply only once or twice a month, and it may have been roasted for weeks before being shipped to him, so the consumer often suffers from the flat taste of the old coffee.



Having had this experience once too often, a shrewd German with a fondness for a good cup of "Bliemchen Kaffee" decided to roast his own hereafter. So he resurrected a neat little coffee roaster which his grandmother had tucked away in the attic years ago. This he fastened to an electric hot-plate, so that the heat of the plate would gradually roast the beans in the drum, which is slowly turned by hand. A Yankee probably would have fastened this to an electric toaster, but toast is not a German dish.

Instrument to Detect Gas Leakage

An Italian professor has invented a very simple instrument adapted to any locality to detect gas leakages. It is very strong and makes an electric bell ring long before sufficient gas has accumulated to endanger people by fire or suffocation.

The gas molecules to get into the surrounding atmosphere have to pass through the sides of a small porcelain cylinder which contains air at a normal pressure. These gas molecules enter the chamber much more quickly than the inside air can escape and make place for them. This is due to the "osmotic" properties of the gas.

The pressure inside is so increased that a small column of mercury is moved and closes a circuit setting a bell to ringing. The bell is kept ringing also after the normal pressure is restored inside the cylinder by a special disposition of the circuit.

Statuary Authenticity Determined by X-Rays

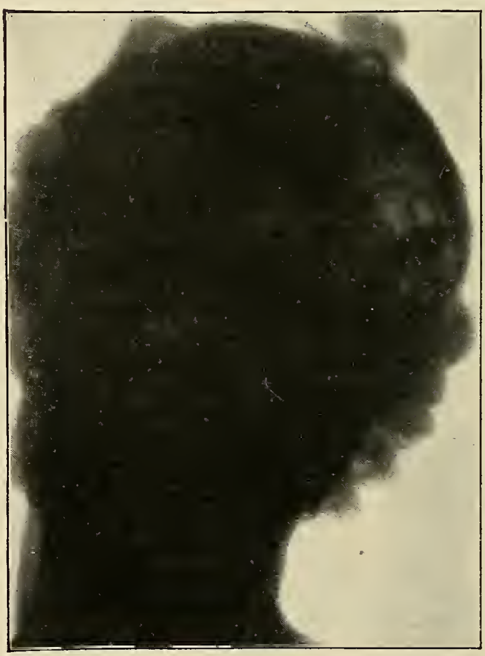
By DR. ALFRED GRADENWITZ

Dr. Bode, director of the Royal Museum at Berlin, purchased in England, a short time ago, a wax bust called "Flora," supposed to be a production of Leonardo da Vinci (XVI Century). Immediately afterwards the authenticity of this bust was questioned by an English art expert, and *The Times* published a letter from a Southampton antiquarian and auctioneer, Mr. Cooksey, in which the writer declared that an English sculptor, Mr. R. C. Lucas, who died in 1883, was the author of the work. This sensational assertion did not fail to have its effect, and new proofs of the recent origin of the bust were sought for and found every day, which naturally induced the purchaser, who believed in the authenticity of the bust, to search for counterproofs.

THE "FLORA" OF LEONARDO DA VINCI

Though the artistic value of the wax bust itself, which has been placed at the Emperor Frederick Museum, cannot be affected in any way by the issue of this discussion, the different methods used for ascertaining the age of the bust are of more than passing interest, as all the resources of modern engineering were drawn upon in this connection.

The principal reason for considering Lucas as the author of the work was a photograph said to have been taken by the sculptor in his studio from a wax bust, and which bears the following inscription written in pencil by Lucas himself: "The 'Flora' of Leonardo da Vinci." This photograph showed a female figure, draped in a shawl and dressed in a light garb, which, apart from the hands, that are wanting in the wax bust, bore a striking likeness to the latter. Dr. Bode compared this photograph with some pictures taken from the bust he had purchased and came to the conclusion that the busts represented in the respective photographs could not possibly be identical, some striking differences being visible at first sight.



X-RAY PHOTOGRAPH SHOWED THAT THE HEAD WAS STUFFED

However, in spite of this visual evidence an accurate photographic measuring process enabled Dr. Miethe to obtain a perfect coincidence of the Lucas picture and the recent photographs. In view of the absolute identity of measurements in all parts of the bust, Dr. Miethe pronounced himself in favor of the English hypothesis.

SPECIAL INSTRUMENTS FOR MELTING THE WAX

Needless to say, those of the other party were not satisfied with this negative result, and called in the aid of chemical analysis. The melting point of some wax samples taken from various portions of the bust was determined and found to be somewhat lower than that of the usual wax as used by modern artists. Other chemical factors failed to yield any definite evidence.

The most sanguine hopes however were attached to the use of X-rays for examining the structure of the bust. In fact, some persons, among whom was the son of the supposed author, affirmed that Lucas, in order to save some material, had practised the strange habit of filling up his wax figures with old rags, pieces of clothing, etc. Now, as X-rays enable substances of different densities in the interior of an object to be distinguished on the photographic plate, an X-ray examination of the bust was made.

This interesting operation was carried out on November 13th, last, in the photographic studio of the Museum, in the presence of a committee composed of the foremost Berlin art experts.

One of the X-ray pictures so obtained is illustrated herewith. It shows without any doubt that the interior of the bust does contain substances of different densities, and the same result was obtained by visual X-ray inspection. In order further to investigate the nature of the material contained in the bust, the committee had an electrical manufacturer construct a special electrical instrument for melting an opening into the wax, without marring the appearance of the bust. This instrument, as shown in the picture, was somewhat on the principle of the electric cauterizing instrument used by dentists and surgeons.

After thus melting some holes into the bust, the experimenters succeeded in removing some tissue samples, which were submitted for further examination to special experts. In order to leave no doubt as to the possible origin of the fabric, a sample was even sent to London, where the officials of a museum found them to belong to the Victorian Age.

In spite of this apparent evidence in favor of the recent origin of the bust, those who believe in the opposite hypothesis are still left the possibility of considering Lucas not as the author but as the restorer of this masterpiece.

The New York and Paris Subways

The New York and Paris subway systems are of about the same length (31 miles) in two cities of about the same population. The Paris subway is a double track system, the New York four track one with two express tracks. Paris has many branch lines, New York one main line and very few branches.

The average speed of trains in Paris is about 12 miles per hour and the maximum 36. The corresponding values for New York are 15 miles for local and 25 miles for express trains, and a maximum speed of 40 miles.

The average distance between stations in Paris is about three miles, against four miles for local and several miles for express service in New York.

The fares are three cents and five cents, with transfers, in Paris, and five cents and no transfers in New York.

The following figures give an idea of the traffic intensity:

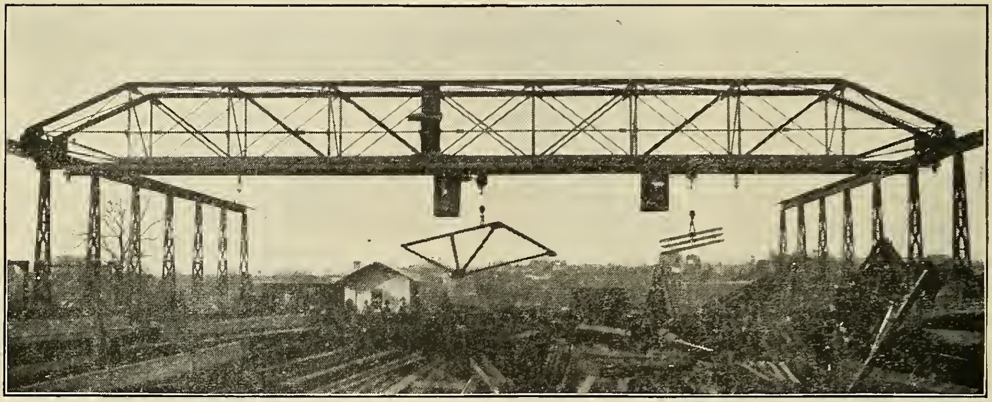
	New York	Paris
Number of cars	837	951
Total seating capacity per car	52	28
Total car kilometers (3280 ft.) in millions of km.	70	56
Total of passengers in millions	200	282
Passengers per track mile	2	2.9
Passengers per car mile	2.85	5.1

The difference in the figures is easily explained by the fact that the distribution of the population is more uniform in Paris than in New York and the distances are shorter.

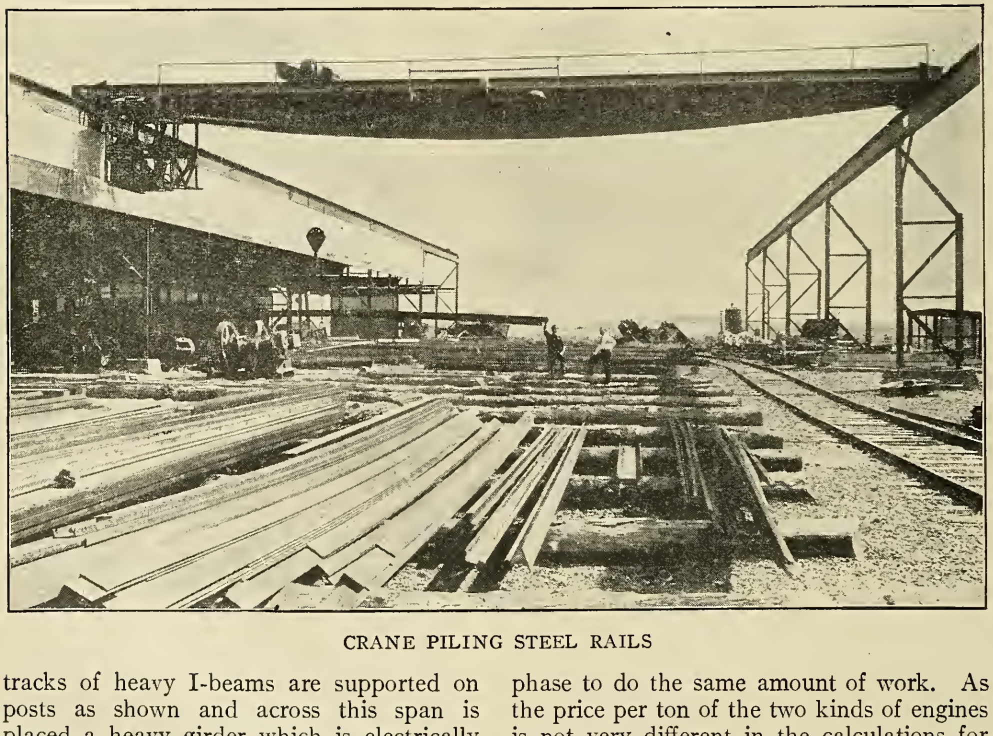
The Work of the Crane

To handle the tons and tons of metal in the form of beams and girders stored in the structural steel yards of today would be an impossible task were it not for lifting cranes.

Electrically driven traveling hoists capable of lifting tons are much used for this purpose and hasten the loading and unloading of cars and long hauling wagons. Parallel tracks of heavy I-beams are supported on posts as shown and across this span is placed a heavy girder which is electrically propelled back and forth while the load lifted is carried from one place to another.



TRAVELING BRIDGE CRANE IN A STRUCTURAL STEEL YARD



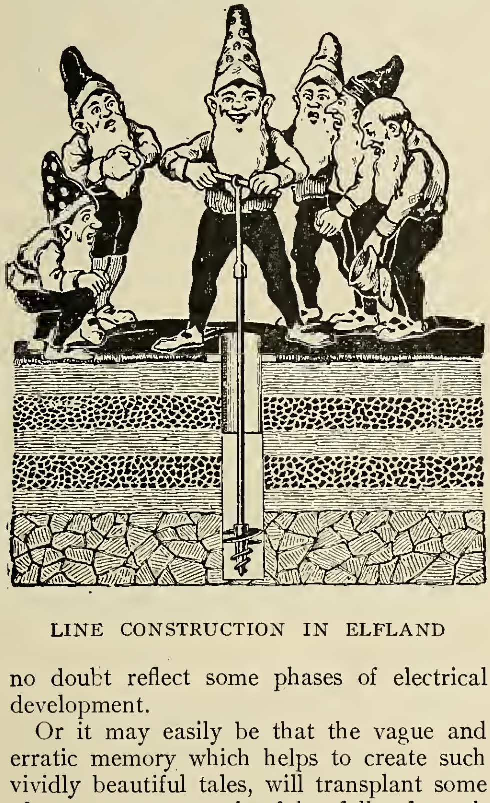
CRANE PILING STEEL RAILS

Power of Electric Locomotives

From the latest experiments in Italy on the state electric railways it has been established that a three-phase electric locomotive can pull 5.45 times its own weight, while a single-phase locomotive can only pull a train of 2.7 times its weight. Other conditions being equal it takes a single-phase locomotive twice as heavy as a three-phase to do the same amount of work. As the price per ton of the two kinds of engines is not very different in the calculations for electric operation of railroads this will prove quite an important factor.

Line Construction in Elfland

Every age develops its share of folklore, though some generations may pass before this becomes current enough to be classic. The fairy tales so ably gathered for the benefit of our grandparents and of all succeeding times by Grimm, Andersen and Hauff relate to folk with much simpler customs and surroundings than we have today. Our own times and habits will play their part in the folklore of another century, and will



LINE CONSTRUCTION IN ELFLAND

no doubt reflect some phases of electrical development.

Or it may easily be that the vague and erratic memory which helps to create such vividly beautiful tales, will transplant some of our customs to the fairy folk of much older times, so that the same fascinating people will occur in new roles. One artist has already been embued with this idea. He has let his fancy roam to the time when Elfland has felt the wave of electrical progress and when the little gnomes or elfmen have started to erect pole lines from the water falls way up in the wooded mountains to their capital on the little knoll by the sea.

Will they use single phase or three-phase transmission? Ah, how prosaic we are! The artist, like the moulders of the word-pictures in our fairy tales, sees the more artistic points. What matter how the circuits run, or what rate of alternations is adopted, when flashes like this appeal to him: "And the other gnomes crowded around him, for no more had he touched his magic auger to the ground but it bored itself deep and straight into the earth, just where the first pole was to be set."

Electric Engines on Italian Railroads

Following is some data on the 40 electric engines that the Italian State Railroads are going to use on their new electric lines.

The engines have two motors fed by a three-phase current of 3000 volts, 15 cycles. The motors have eight poles and connected in series run at a speed of 112.5 revolutions per minute, giving the trains a velocity of 14 miles per hour. Connected in parallel, with a speed of 225 revolutions per minute, the train velocity is 28 miles per hour.

The total length of the engine is 31 feet four inches between bumpers. The distance between the rail and trolley contact is 19 feet eight inches, and between the rail and roof, 13 feet. The trolley contact can be lowered to a distance of 14 feet from the rail to take care of the different heights of the trolley wire. There are five pairs of driving wheels 40 inches in diameter and the total weight of the engine is 165,000 pounds with ballast.

The total horse-power is about 2000, at 300 amperes. For the operating conditions this was required for two engines to be able to pull a train of 840,000 pounds net weight at a speed not to exceed 28 miles per hour on a grade of 35 per 1000 and with curves of 1350 feet radius.

The motor temperature after an hour run at 117 amperes and 3000 volts does not exceed by more than 75° C. the temperature of the surrounding atmosphere.

The continuous run tests were especially fitted to the peculiarly mountainous country and very thorough. An 84,000 pound train had to be started and brought up to a velocity of 14 miles per hour 30 times per hour on a three per 1000 grade with curves not to exceed 600 feet radius without any of the engine parts getting out of order by heating.

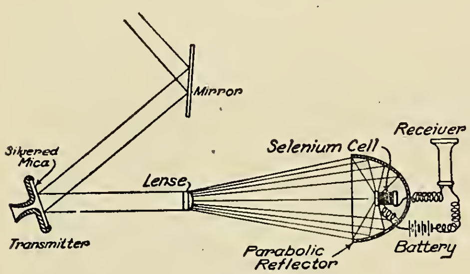
The trolley contact is made up of two bronze cylinders on ball bearings and a steel axis. The trolley is kept in place by a spring actuated by compressed air. If the air pressure in this mechanism is released from the engine cab the trolley pole falls by its own weight.

The net weight of the locomotive being 67 tons, the horse power per ton is about 30, which gives a fair idea of the advantages in regard to power per ton weight of this electric locomotive over a correspondingly powerful steam engine.

It is to be noted that all Italian electric railroads use alternating high tension current with overhead conductors and that the third rail system has been used very little.

First Wireless Telephone

In 1879, long before the day of the Hertzian wave and modern wireless telegraphy, Alexander Graham Bell devised and operated a "wireless telephone." Starting with Clerk Maxwell's electro-magnetic theory of light, he undertook to impress phonetic disturbances upon the light waves and reproduce them in a telephone receiver by means of a bit of selenium, which has the remarkable property of changing its resistance to an electric current when under the influence of



FIRST WIRELESS TELEPHONE

light. A cell made of two narrow strips of annealed selenium attached to a block of brass alters its resistance from 300 to 150 ohms when brought from darkness into the sunlight.

A beam of bright light was directed upon the surface of a silvered mica diaphragm which reflected it to a parobolic mirror at the receiving station. Here the light was again reflected by the inner surface of the mirror so that it converged through a lens upon a small selenium cell at the focus of the mirror, and in series with a battery and the telephone receiver.

As the voice waves of the sender impinged upon the silvered diaphragm it vibrated to and fro, altering the amount of reflected light according as it became convex or concave toward the receiver. With each variation of the intensity of the transmitted light the selenuim cell or "detector" offered a corresponding variation in its resistance to the receiver current; and since each variation of current causes a sound in the telephone, the voice of the sender was accurately reproduced.

At first the apparatus was called a "photophone," but it was afterwards found that when a black solution of iodine in carbon bisulphide was placed in the path of the beam of light the instrument would still work, for though the solution is quite opaque to all light visible to the eye the long, invisible infra-red rays pass through unhindered. From this circumstance the name was changed to "radio-phone."

Of course with the old arrangement speech could not be transmitted over any considerable distance, but that is because the wave length used was too short to penetrate many obstacles and too refrangible to maintain its individuality in the presence of interference.

Tungsten Not a New Metal

While the metal tungsten has been used only during the last few years as a material for making incandescent lamp filaments, it is not in itself a new article. Indeed it is practically as old as this republic of ours, for it was in 1781 that Joseph and Fausto d'Elhujar discussed the properties of tungsten in a Spanish treatise.

Even at that time they recognized its unusual density and hence unusual weight, which make the name tung-sten (heavy stone) so appropriate. For instance, a bar of tungsten of a given size will weigh about two and a half times as much as a similar bar of iron or steel. This implies that the particles composing the metal tungsten must be packed much more closely together than those forming iron or steel. Is it a wonder then that the addition of tungsten to steel makes it harder and more tenacious so as to adapt it to tools for use at higher speeds? This so-called "tungsten steel" was first made in Germany fifty years ago and embodied the chief use of tungsten until the latter proved itself to be the most suitable of all known materials for making lamp filaments of high efficiency.

FOR PRACTICAL ELECTRICAL WORKERS

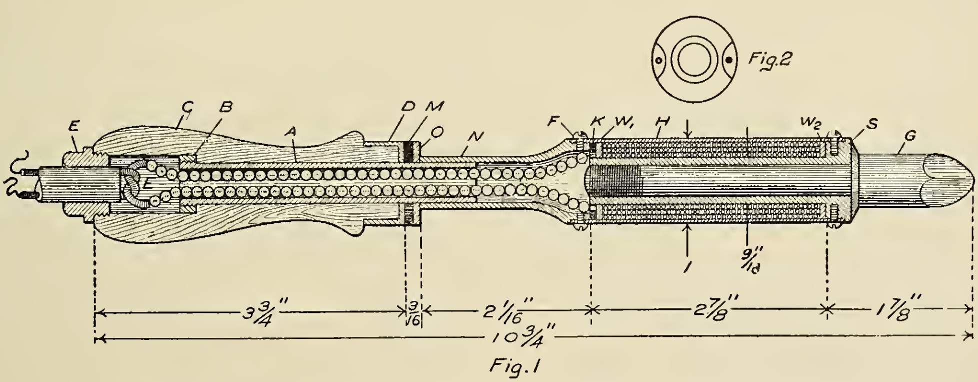
HOW TO MAKE AND OPERATE ELECTRICAL DEVICES

Electric Soldering Iron

Numerous inquiries have been sent in asking about the construction of electric soldering irons. As much money and time have been spent by manufacturers in this field with more and often less satisfactory results, and as such a device is somewhat more complicated than the amateur would care to undertake, we have not heretofore given space to this matter. However, a subscriber sends in this sketch and description of an iron which he states operates very satisfactorily on either 110 volts direct or alternating. The more essential features are here given, from which by referring to the illustration, details can be worked out by the builder.

Provide a brass tube (A), $\frac{1}{2}$ inch outside diameter, $\frac{3}{8}$ inch inside, and threaded at both ends. One end of this tube is screwed into a nut (B) in the hard maple handle (C). The open space at the left of this nut affords room for the knot which serves to anchor the heater cord. A smooth steel bushing (E) forms the outlet at the handle, and a brass ferrule (D) is fitted over this handle at the other end. At the right, the brass tube (A) is screwed into a neck of steel (N) shouldered at (F). The coil spool (S) is threaded at the left end, and into it is screwed the soldering copper (G) which has a flange as a shoulder. A 1-32 inch brass shell (H) protects the heating coil. Mica washers (M) held in place by a steel washer (O) assist in keeping the heat from reaching the handle. The wires from the coil are brought out through holes drilled in the mica, the iron washer being cut away as shown in Fig. 2.

In winding the heating coil, first insulate the spool (S) by wrapping it with a layer of sheet mica, and also with two mica washers (W_1W_2), (W_1) being reinforced by an iron washer (K). Then wind on 70 turns of bare No. 28 IA IA resistance wire, separating each turn from the last a distance equal to the diameter of the wire. Over this wrap another layer of mica, and upon it wind a second layer of resistance wire. Six layers of wire should thus be put on, and the final coil insulated from the brass shell (H) by mica. Glass beads are strung on the bare wires from the coil to the cord in the handle. Our correspondent says that in from five to ten minutes after current is turned on the iron is ready for use.



SHOWING THE CONSTRUCTION OF AN ELECTRIC SOLDERING IRON

Electric Stove and Toaster

Quite a number have asked how to make a small electric stove or toaster. Although it would be difficult to make one of these devices which would be as efficient and long-lived as the commercial types which have required years of experiment to develop, by exercising a little care and ingenuity one can be made which will work fairly well.

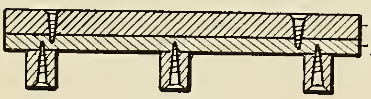


FIG. 1

One of the readers of Popular Electricity has written in and explained how he turned the trick, which may be of interest to others. Here is how he went to work:

The first thing to do is to get a piece of asbestos board one-half inch thick and cut out a circle 12 inches in diameter. This is the part (A), Fig. 1. To the bottom of this screw three one-inch porcelain insulators for feet.

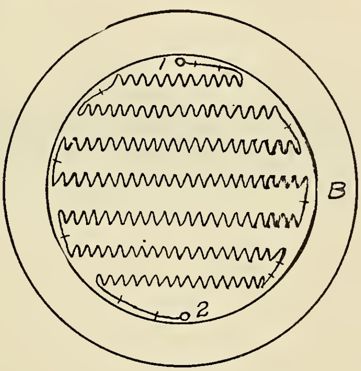


FIG. 2

From a piece of ¾-inch asbestos cut a ring (B) Figs. 1 and 2, 12 inches in outside diameter and nine inches inside diameter. Screw this down on (A) with three or four screws.

Get about No. 19 German silver wire and wind it on the blade of a table knife, taking it off as you wind.

To find out when you have the right amount stretch the wire out on some bricks and join the electric circuit wires to each end, and if the wire (German silver) does not get red move one of the circuit wires along down the loose coil till the latter gets red hot. If it gets red quickly move the circuit wire back till the coil comes up to a red heat slowly, then you will have the correct amount.

However before doing this be sure to anneal the heater wire by passing it through a flame till it gets red hot, this makes the wire softer.

To put the wire in the heater start from one side, Fig. 2, and nail the wire down to (2) by small copper staples so that the wire will not work loose and make short circuits. Carry it back and forth as shown. Fasten the two ends to binding posts (1) and (2),

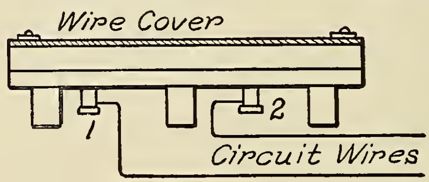


FIG. 3

going through to the bottom. To these posts connect the two terminals of your circuit as shown in Fig. 3.

The last step is very easy, get a piece of wire netting, made of No. 16 wire, and also made without solder, cut this to fit the top of the stove, screwing it down over (B), with small washers to keep it firm.

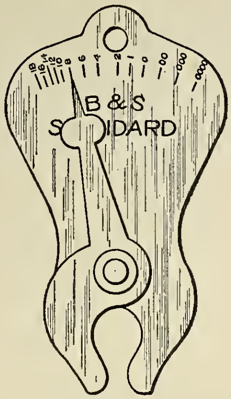
Instead of the German silver wire you might use some of the well known resistance wires, such as "Nichrome," for instance, using about No. 21 or 22. This is known as non-oxidizing and will not burn out as quickly.

The Door Bell Circuit

The article that appeared on page 59 of the May issue on how to operate a bell from a lighting circuit by means of a lamp in series with the bell has been justly criticized from the point of view of the possible danger of fire. Of course while the lamp is intact and if the wiring is done in a manner to enable it safely to carry the 110-volt current no harm would result. But some might get the impression from the article that ordinary bell wiring could be used, which would be highly dangerous.

Vest Pocket Wire Gauge

A convenient pocket or key ring wire gauge is here illustrated, the pointer being pivoted so as to swing over a scale as the



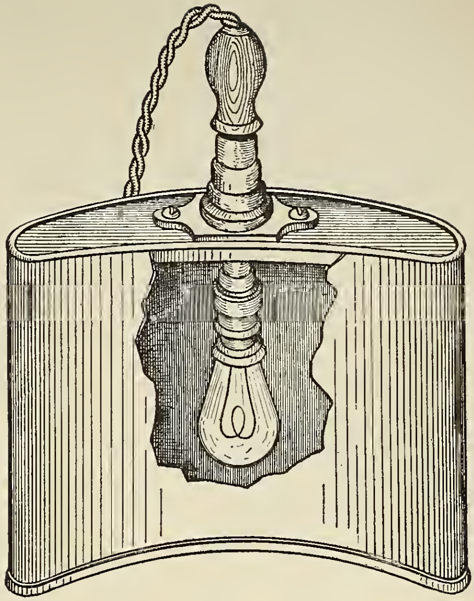
WIRE GAUGE

device is applied to the wire. The pointer stops at the proper point to give in direct reading the size B. and S. gauge of any wire from No. 0000 to 18 inclusive. The scale is made of hardened finished steel.

How to Make a Warming Pan

When Dickens, in one of Mr. Pickwick's celebrated speeches, laid emphasis on warming pans, he little dreamt that even these might some day be classed among electrical devices, yet such is the case. Any mechanic can make a simple type such as we are picturing, which consists of a flat and preferably curved tin case with an opening at one end through which an ordinary incandescent lamp can be introduced. The opening is closed by a flange bolted to the end, which flange supports both the lamp socket and the receptacle for an attachment plug through which the patient can disconnect the device from the circuit without reaching for a switch.

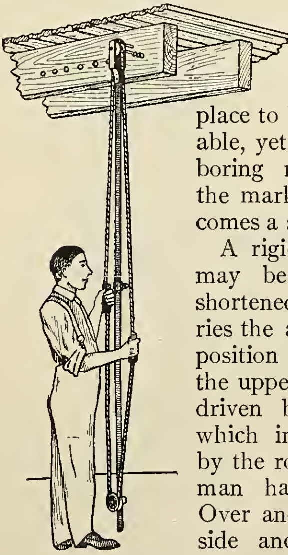
Of course this arrangement is neither as convenient nor as adaptable as the more recent heating pads made of resistance material imbedded in a flexible mat or webbing, but it is easily made by any mechanic and has proven helpful in many forms of stomach troubles. Indeed it is one of the electrical appliances for which the summer with its severe strains on our digestive apparatus brings no less a demand than does the winter.



ELECTRIC WARMING PAN

Wiring Through Joists

Here is a job in electrical wiring that often comes up; that is, to run wires parallel with a ceiling and through the floor joists. Anyone who has ever tried knows that this is about the most awkward place to bore holes imaginable, yet with the standard boring machine now on the market the boring becomes a simple matter.



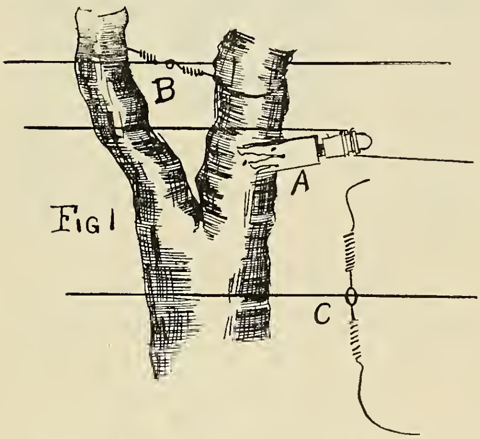
BORING MACHINE

A rigid standard, which may be lengthened or shortened as desired, carries the auger or bit in a position at right angles at the upper end. The bit is driven by a little pulley which in turn is revolved by the rope belt which the man has in his hands. Over and over, down one side and up the other, goes the belt and the hole is bored quickly and no step ladder needed.

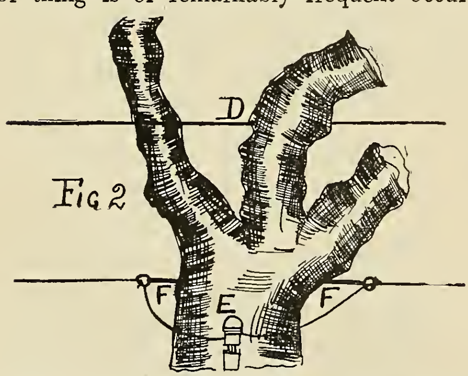
Results of Imperfect Wiring

By GEORGE RICE

Recently I saw a workman nail his insulator firmly to a tree, adjoining a building into which the wires were to carry electrical current. I observed that the tree swayed to and fro. I wanted to remark about it to the workman, but he seemed to be in a hurry. Not long after I had occasion to pass that way and the insulator was hang-

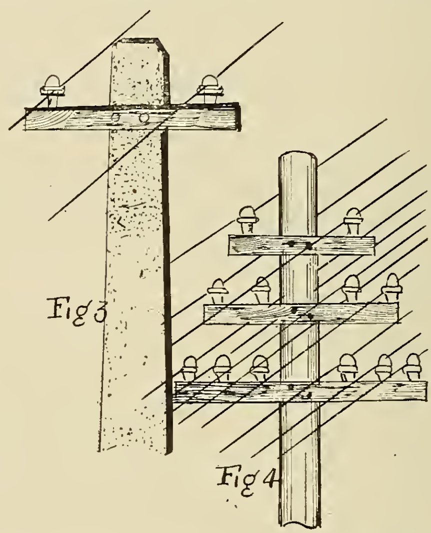


ing loose as at (A) Fig. 1. The motion of the wind in swaying the tree back and forth had pulled the fastenings out. This sort of thing is of remarkably frequent occur-



rence. You can find similar examples about manufacturing plants where electrical wires are installed by workmen of the plant. Sometimes green electrical helpers do this way.

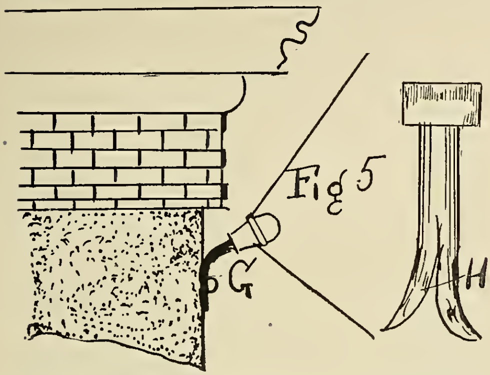
Then again we find wires so securely attached to projecting parts of buildings that the vibrating motion is exceedingly detrimental. In one case a workman attached the wire to a bell tower. The tower swayed a little, as it was constructed of steel. The vibrations soon tore the wire fixing free. Then the same man went to work and attached stronger fastenings. These again ripped out and finally he rigged an ingenious system of fastening by which vibrations could be allowed for. He fixed up special fastening wires, something like the plan shown in Fig. 1 at (C). The steel spiral wire was wound on a metal spindle in a turning lathe. A number of such pieces were made



and carried in stock for convenience. The wire carrying the electrical current passed through the eye in the spirally wound wire support as shown, the spirals being connected to insulators. A device like this can be employed readily on trees as at (B) in Fig. 1. In this way, the tree may rock and sway as much as it likes and the spiral coils will give in the one direction, while the strand slipping through the wire gives freedom in a longitudinal direction.

The other day I saw a man put a bore straight through a tree as at (D) Fig. 2. He inserted a wire through this hole. It seemed to be an odd manner of doing the job to me; While I never learned the consequences, I am convinced that it is better to adopt the scheme presented in the same view, consisting of the driving of two ring pins one each side of the tree as at (FF). Then secure your insulator as at (E) and attach the wires to the ring pins as shown. Thereby the tree can move back and forth with the wind without ripping down your fastenings.

I see that they are utilizing cement poles. Fig. 3 is a drawing of one. Some of the poles are made in round form, closely resembling the common pole in shape. Other poles are hollow and some are flat. The



Portland cement is mixed with sand and water and you can, if you desire, watch the workmen mould the poles in long wooden flasks, in a simple and quick way. Then the flasks are opened and the long stretch of cement is allowed to harden in the sun. The pole is watched closely during the hardening operation to make sure that it settles out straight, as a warped cement pole would be rejected.

Then there are the steel poles with cross arms as in Fig. 4. I refer to this steel pole because of an incident. Steel poles have many merits as all know. But in this instance the steel pole failed in its work, due to carelessness of the workmen.

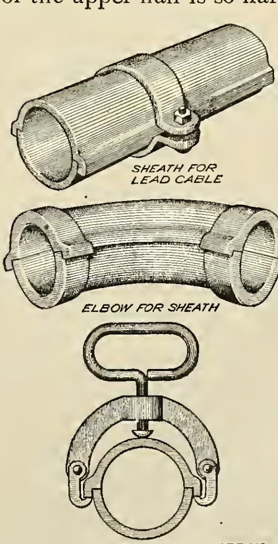
The pole was set up in a soft bottom. It settled and swung to one side. The usual bracing did not help matters. The pole kept going. Then the workmen excavated the ground on the off side of the pole, relieving the pressure of earth on that side. Next a block and tackle was rigged to pull the pole up straight. As fast as the pole straightened under the pull, sand was packed on the inside. Then the base of the pole was filled in with cement and the pole hardened in place perfectly upright.

I often observe insulators torn from cement and brick walls of buildings. A certain party made his fastenings to walls with split pins like (H), Fig. 5. The same figure shows one of the pins driven at (G). Now then, sometimes the expanding point of the pin would cling and hold and then again it would not. Considerable of this man's work pulled off. Finally he used a threaded bolt in places and in other places bolts with fastening nuts on the inner end, thereby making sure of a strong joint.

Protecting Lead Cables

In underground circuits the buried cable is usually covered with a lead casing which protects the insulation from the damaging effects of any chemicals pervading the soil. When used in this way, the lead serves its purpose admirably so long as it is not damaged by an accidental cut from a pick or shovel. To guard against such a mechanical damaging of the lead, underground cables are sometimes protected by a trough or sheathing which may be of wood, clay or iron.

One form of such protecting sheath is made of cast iron of a somewhat better grade than that used for the so-called "soil pipes" of the plumbers, and is made in two sections so that the cable can be laid in the lower half before the cover is slipped over it. The upper and lower parts are laid "staggering" so as not to have their joints come opposite each other, and the spread of the upper half is so narrow that it pinches the under part and makes a tight joint. This cover part is driven into place with wooden mallets. To remove it, the over-lapping lips are first sprung outward by special screw clamps as shown in one of the cuts. Both parts are tarred or asphalted before being laid, so as to guard against their rusting, and are commonly made in lengths of 20 to 25 feet. The weight of



LEAD-CABLE SHEATHS

the cover and the spring grip of the overlapping parts is sufficient to keep them tightly together, but for severe conditions a steel clamp may be placed around the whole sheath. For turns, similarly split elbows are used with ends large enough to slip over both of the connected sections.

Telephone Magnets in the Making

By Frank L. Whitaker

Though the bit of steel, which, properly shaped comprises a telephone generator magnet, looks insignificant in itself, it requires a lot of skill and patience to bring it into its proper state, so that it may perform the intended function. And not only this but that it may be able to retain its proper state or strength almost indefinitely. This retentiveness lies in the grade of steel used in the make-up of the magnet. Commercial or American steel is most commonly used as it is very easily worked and not at all expensive. Magnets made from this steel must be carefully tempered otherwise the result will be anything but satisfactory.

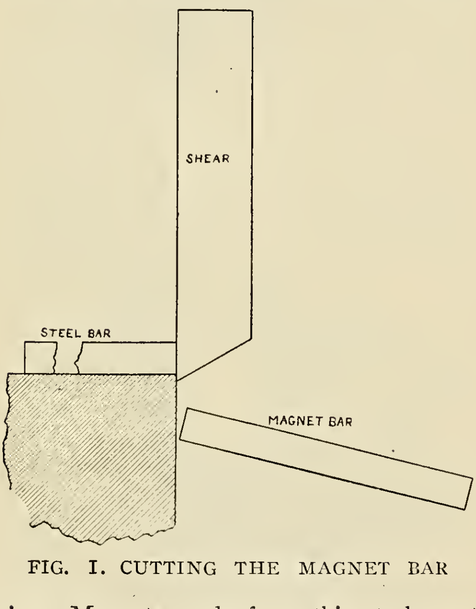


FIG. I. CUTTING THE MAGNET BAR

Thousands of dollars are wasted each year in the telephone business just from this one thing and it goes without saying that a little study along these lines will be of benefit to many in almost any branch of the electrical business in which permanent magnets are used. I do not see any reason why good workmen in telephone exchanges or elsewhere should not be able to take old apparatus which has been discarded for loss of magnetism, retemper and remagnetize the magnets therein just the same as the workman in the factory does.

Probably the following brief outline will throw some light on the subject. Fig. 1 is an illustration showing the first operation used in the construction of a telephone generator magnet. Steel of the right width and thickness is procured from the manufacturers, so it does not have to go through any forging or drawing after it reaches the maker of telephones. A bar is first heated to a light color and placed in a jig under a heavy shear as shown, which descending rapidly cuts off each piece the required length. These are immediately thrown back into the fire and reheated for the next operation which is illustrated in Fig. 2. Here is shown what may be termed the forming die and punch. The magnet bar when again brought to the proper temperature is placed in a jig which exactly centers it across the forming part of the die ready for the downward stroke of the punch which is shown in Fig 3 where it is just entering the die, taking the magnet bar with it. Fig. 4 shows the finished stroke, the magnet bar now being

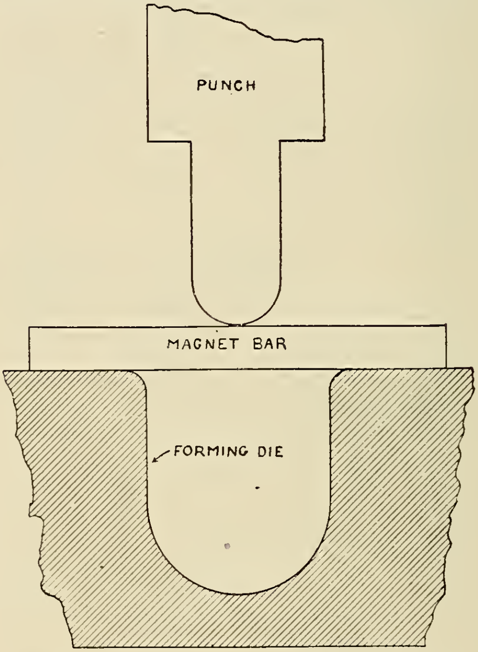


FIG. 2. THE FORMING DIE AND PUNCH

brought to the desired shape. For the sake of clearness the cuts show each operation separately, and while it is a slow process it is a very good one. Many manufacturers, however, cut and form their magnet bars in one operation, one heating and one handling being all that is necessary to complete the shape.

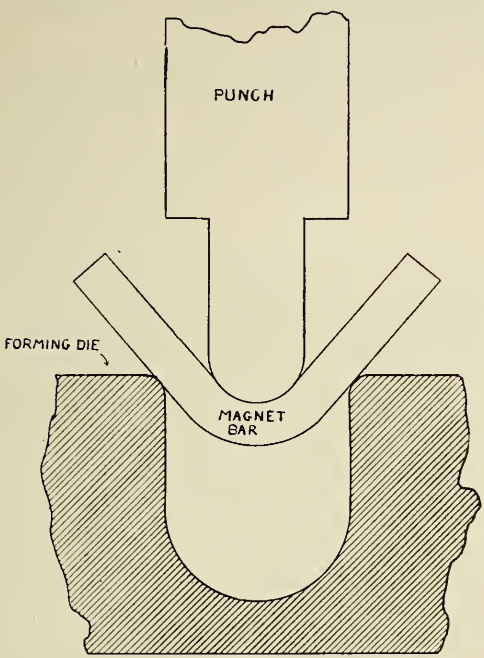


FIG. 3. ENTERING THE DIE

Next comes the most important part of magnet making—tempering—and herein lies the secret of successful apparatus, for if the temper be poor likewise will be the magnetism. The magnet bar after having been formed as shown in the illustration is put back into the fire and again brought to a light color. It is then immediately plunged into a bath of water which chills it very quickly and which causes it to become very hard and brittle. It will be well to explain here how this tempering process can vary enough to cause trouble in the finished magnet. As stated above, the temper determines the quality of the magnet, so the heating and chilling of the steel must be perfect in every detail. Most of us have watched a blacksmith tempering his tools and know how little he seems to be concerned about the piece he is working. To an onlooker it would seem that he merely heats the steel and puts it into the water tub, but nevertheless he knows exactly what color to heat it to and how it should be manipulated in the water. Experience and practice enable him to do this apparently without thinking, and perfectly to meet the requirements of his tools. As stated, magnets must be very hard and brittle but there is a limit to this, as a piece of this steel heated to a whiteness and plunged into cold water will come out cracked and worthless on account of the surface cooling and contracting too rapidly.

The best method for tempering any steel for this purpose is to find out how much heat it will stand and then adjust the heat source to that temperature. Ordinarily this is very hard to do—but experience, again, will finally result in perfect magnets every time.

Factories usually have a gas furnace which can be adjusted to the proper heat. Sometimes in making magnets in large quantities the temperature in the furnace falls just enough to render the temper too "soft" after it falls into the water. The workman who has grown tired from a hard day's work does not notice it and so goes on tempering just the same, not knowing that the work he is doing may mean dollars loss to the company later on. Experience is a good thing but it must be experience supplemented with constant carefulness in every stage of the process.

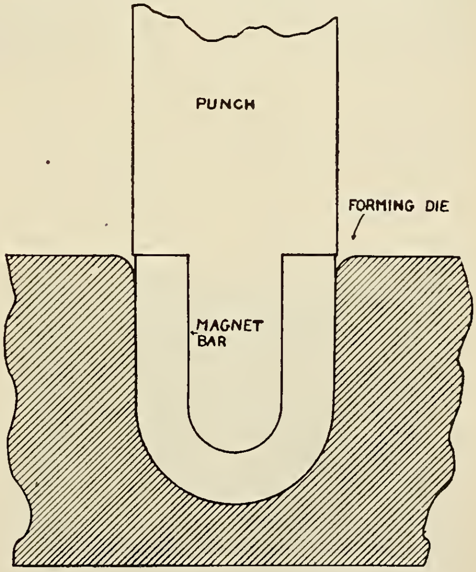


FIG. 4. THE END OF THE STROKE

The water used in tempering should be moderately cool as the metal requires a certain suddenness in chilling to bring about the desired results. Large numbers of bars tempered in the same tub will often get the water too hot for first class work. Heavy magnets do not temper as perfectly as light ones, as the center does not cool rapidly enough. This is why compound magnets are found in some makes of instruments.

When the hardest temper that it is possible to obtain in the steel has been reached the finished bars are ready to be charged with magnetism, or, to use the common term, "magnetized." This is a simple operation and is shown in Fig. 5. The magnetizing power comes from the two cores of an electro-magnet which are wound with a suitable size of copper wire, the ends of which are shown connecting with a switch and battery. Closing the switch at (X) causes battery current to flow through the windings of the two coils and the two cores become heavily charged with magnetism. At (Y) the magnetic circuit is broken, until the magnet bar is placed in position as shown. The magnetism now completes its path through the steel resting on the pole pieces. If the current flow from the battery is great enough

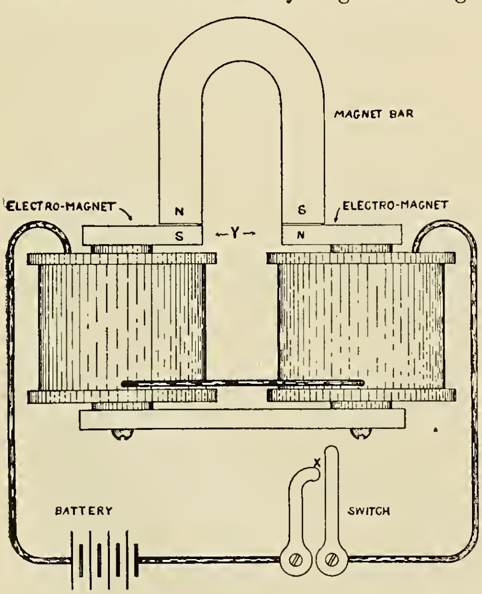


FIG. 5. MAGNETIZING THE BAR

the bar becomes heavily charged and is now a magnet, for when the switch is thrown open enough magnetism will be found remaining in the piece to enable it to pick up several times its own weight. This is called saturating a magnet. The perfect temper in the magnet retains the magnetism, provided the magnetizing force is strong enough to fully charge it. It would seem that if a magnet could be undercharged that it could be overcharged, but such is not the case as the steel absorbs a charge up to a certain point only. A very good illustration of this is a sponge absorbing water. It will soak it up until it gets full, after which it cannot take any more.

Some magnets have a greater capacity of saturation, especially those made from an imported grade of steel called "tungsten." This steel is very expensive and is not used extensively on this account. Its power of retaining magnetism is excellent. Manufacturers of high grade automobile magnetos use this steel altogether in the making of their machines. Makers of telephone apparatus use it but very little as the demand for a strictly high grade magnet is not pressing. Commercial steel magnets will lose some of their magnetism in a very short time no matter how well they have been created, and after several years service it is not a bad idea to have them remagnetized. Care should be taken when this is done to see that the magnetizing force is sufficient to demagnetize the magnet and to charge it in the opposite direction. This is done by placing like poles of the magnet against like poles of the electro-magnet and cutting in the battery for an instant.

The time required to fully charge any magnet is a period just long enough to obtain a good fat spark at the switch points, not over one second in any instance, as no amount of soaking would render the magnet any better.

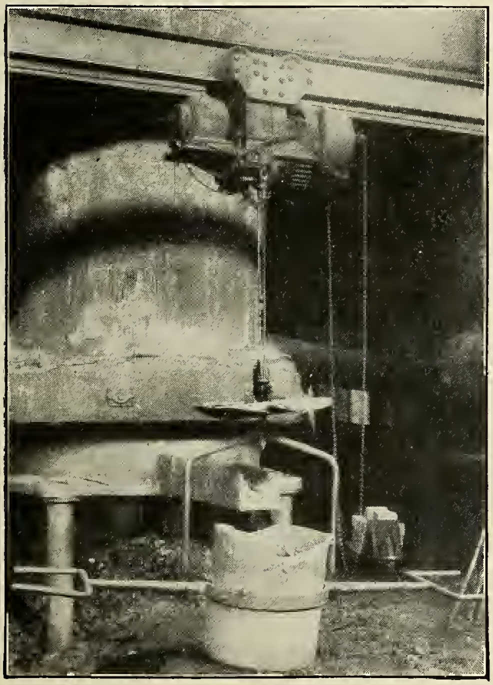
When placing magnets back on the pole pieces of a generator it is probably needless to say that care should be taken to see that all of the north poles are side by side before putting them in position. This may be determined when the magnets are in contact with each other and not sticking together. Some makers of generators make a slight punch mark on one side of each magnet and like poles may be determined in this way. In remagnetizing care should be taken to see that each one is charged in the same relative position. Magnets when taken from their working position should be handled very carefully as the magnetism is easily destroyed. They should not be brought near any heavily magnetized apparatus unless a soft bar of iron is placed across the poles.

ELECTRIC CURRENT AT WORK

NEW DEVICES FOR APPLYING ELECTRICITY

Electric Crane in the Foundry

You recall vividly your first visit to a foundry while they were "taking off a heat" or "pouring," the white molten metal throwing off sparks as it flowed from the mouth



"TAKING OFF A HEAT"

of the furnace into a clay ladle, while two workmen stood ready to grasp the iron pronged handles and hurry their load to the moulders. At each flask the metal was poured out into funnel shaped holes to run down into the space shaped out to form a casting. Many accidents have occurred where workmen bearing the ladle have tripped and fallen, spilling the hot metal and burning themselves and others.

The picture shows one of these ladles arranged so as to be lifted and carried by an electric crane, the handles of the ladles being used only to tip the ladle and pour out the metal. The crane travels back and forth along a track on a swinging I-beam, the motor being controlled by the two chains at the right. Very heavy castings and ladles are handled in this way with safety and little labor.

The Making of Ozone

It is maintained by scientists that an ozonizer for the production of purified air should be so constructed that the air drawn in by the machine shall pass through the electric glow in a comparatively brief period, thereby treating a large volume of air rather than overtreating a small volume. This principle is embodied in the Vohr ozonizer.

This ingenious apparatus is the invention of a well-known electro-chemist. The ozone is produced by a rapidly revolving fan, which is an electrode, placed within a glass dialectric of circular shape. The apparatus can be operated from an ordinary electric light.

AN OZONIZER

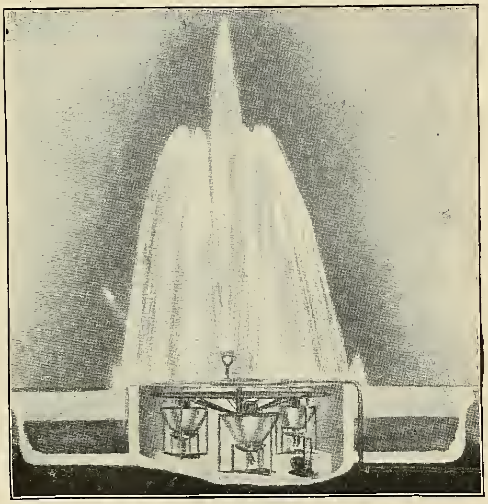
It has only one unit of production. The apparatus can be regulated to produce ozone in just the quantities necessary to give the proper air content of ozone, such as Nature produces in her most favorable locations.

Abroad, ozone apparatus is absolutely accepted, and has passed beyond the field of a luxury into that of a necessity. In England many of the leading hotels, offices, public buildings, have ozone apparatus installed. This is also true of Germany, France and Russia. In the United States the field has been somewhat neglected, but unquestionably the interest in this form of air vitalizer is growing.

Color Changing Fountains

The cost of delighting the evening crowds by the fascinating color spectacles of an electric fountain like the celebrated Yerkes Fountain at Lincoln Park in Chicago depends on three items: the water supply, the current and carbons, and the cost of attendance. Where each arc lamp requires a man to change the colored glass slides, this cost of attendance alone is a large item of expense. For more modest installations which would be ample for small parks or amusement resorts, the cost of attendance can be almost annulled by using an electric motor to effect the color changes.

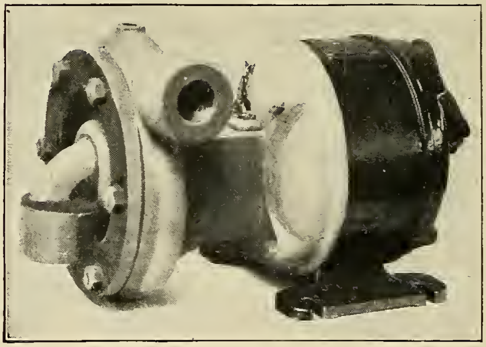
For instance, in the three-light fountain pictured herewith the color screens are mounted in a circular frame geared at its outer edge to the vertical shaft of an electric motor. The space between the three arc lamps allows a larger number of colored glasses to be used, thus producing numerous color combinations, particularly if the number of colored slides is not a multiple of three. Each lamp has a parabolic reflector to project the light upward through the colored glass and through a window of clear glass set in the metal roof which covers the central chamber. An underground passage leading to this chamber allows the electrician to make any needed adjustments and to recarbon the lamps. For a basin 25 to 30 feet in diameter fine effects have been obtained by using three arcs at 40 amperes each. The continually changing color combinations make such a fountain a general source of enjoyment, and the use of a motor-driven color changer reduces the needed attendance to what can be given incidentally by the regular park electrician or trimmer, thus bringing the expense of such an electric charm within easy reach of the average amusement place.



ARRANGEMENT OF LAMPS UNDER THE FOUNTAIN

Electric House Pump

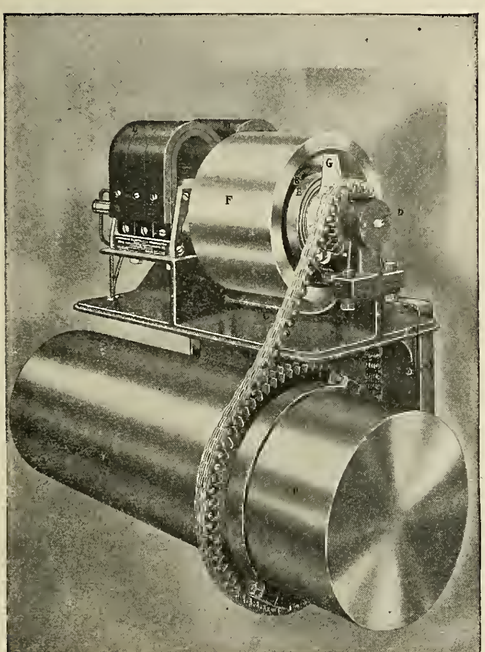
Those who carried water from the "spring" on washday in time past, will be interested in the compact Westinghouse alternating current induction motor and pump shown in this illustration and which is adapted for household pumping equipments. At the right is the motor, and on the left on the same shaft is the pump rated to lift 1000 gallons of water to a height of 50 feet in one hour. The length of the equipment is but one foot. The threaded hole opening toward the reader is the pump discharge outlet and takes a one-inch pipe, while the connection for the intake pipe is shown at the end, projecting downward.



ELECTRIC HOUSE PUMP

To Indicate Propeller Speeds

Suppose the captain of a ship, who is far away from the engine room, wishes to know how many revolutions the propeller is making. The latest method of imparting this information to him is through the Hutchi-

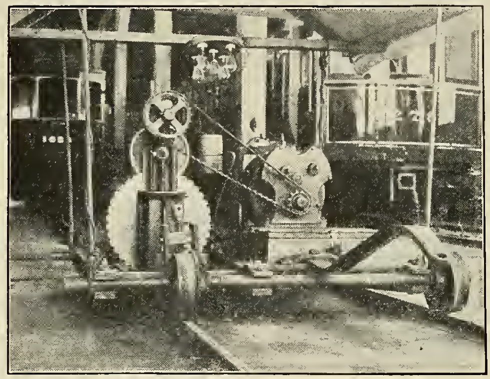


A LITTLE DYNAMO DRIVEN BY THE PROPELLOR SHAFT

son electrical tachometer. A collar carrying cog wheels is clamped to the propeller shaft. This drives, by means of a chain, the sprocket wheel on the shaft of a small magneto, which is one form of an electric dynamo. Now the faster you turn a dynamo the greater will be the voltage or electrical pressure which it will develop. If you connect a voltmeter to the terminals of the machine it will show, say 10 volts for a certain speed, 20 volts for a higher speed and so on up. Therefore, with this magneto driven by the propeller shaft and wires leading up to a voltmeter in the captain's quarters he is able to determine instantly the speed of the propeller. The scale of the voltmeter in this case is marked to indicate speeds instead of volts, for the sake of convenience.

Rail-cutting Saw

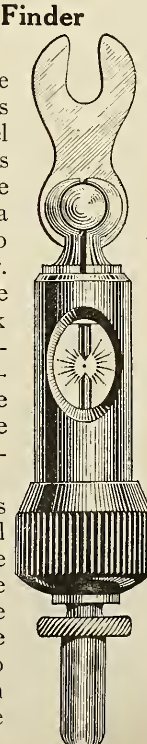
Cutting iron with a saw as shown in the illustration is a somewhat unusual sight to most people. The saw is mounted on a



RAIL CUTTING SAW

pair of trucks and moved from place to place on the street car tracks. When in use the machine is clamped firmly to the rail on either side of the saw and current for the motor is taken from the trolley wire.

Ignition Trouble Finder

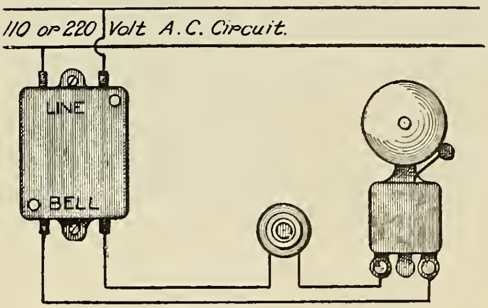


When your automobile creeps along or runs by jerks or misses fire you may feel pretty certain something is wrong with the ignition. The Phelps trouble finder is a small adjustable spark gap enclosed in a glass cover. It shows you, between the two terminals of the spark gap, just how the spark is acting in the cylinder of the engine, and you can determine at a glance whether the trouble is in the plug or somewhere else.

The device, after it has been adjusted to a very small gap is substituted for the spark plug terminal and the terminal is connected to the finder. By adjusting the thumb screw, you are able to see the manner in which spark is really acting inside the cylinder.

A Low-voltage Transformer

Not so very long ago someone hit upon the idea of building a small transformer which would take the 110-volt alternating current used in most dwellings and step it down in pressure to the few volts necessary to operate a door bell, thereby saving the expense and annoyance of batteries. Now there was nothing new about a little transformer, but it was this particular application which made the hit. It was something the people needed and it sold like "hot cakes." Pretty soon there were a lot of manufacturers putting out these little transformers.



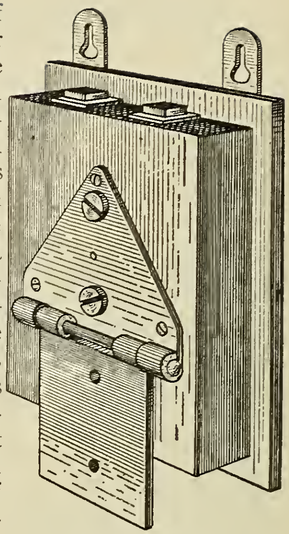
TRANSFORMER ON BELL CIRCUIT

But there are thousands of bells still unrung by the alternating current, so there is room, no doubt, for a new-comer in the field—the K-B low-voltage transformer. The drawing shows the scheme of connecting it up to the circuit. It may also be used to operate fan motors, toy motors, low-voltage lamps and Christmas tree lighting outfits.

Waking the Servants

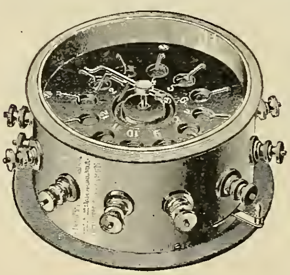
One of the serious problems of modern life, from which the poor man is happily exempt, is that of waking the servant. In many a household this has proven a bothersome task. If an alarm clock is set for the servants, they can easily change its setting to a later hour, or else claim that they did not hear it go off. If a signal bell is rung from a button in some other part of the house, they may likewise claim that the bell did not work.

To overcome this uncertain condition an "answer back" servant call was offered on the European market last winter as a "choice Christmas present for the Hausfrau." Instead of the usual button, the push was in the form of an iron shutter which closes the circuit when raised, whereupon a magnet in the casing holds this shutter in place until the servant presses a button. His doing so momentarily opens the circuit and drops the shutter, thus letting the mistress know that he has been awakened. Of course the answering button in the servant's room is placed where the sleepy one could not reach it without rising.


THE "ANSWER BACK" SERVANT CALL

A Multi-indicator Switch

Nothing equals a visual record for giving the head of any plant a dependable survey of the way any given device has been run, no matter whether the readings indicate temperature, voltage, air-pressure or still other factors. But recording instruments are expensive and when a number of similar devices are being operated at one and the same time, the cost of a separate recorder for each may seem prohibitive.


MULTI-INDICATOR SWITCH

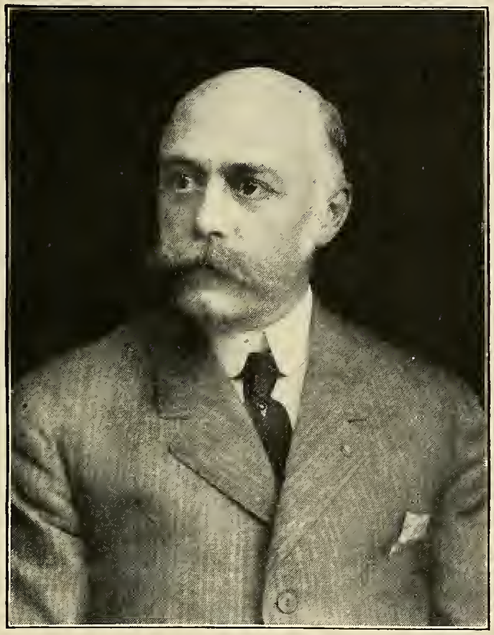
In such a case the next best thing to do is to have a single recording instrument note the readings of all in rotation.

To accomplish this, each instrument is wired to a special mercury switch, which has a contact connecting the central (or recorder) terminal successively with the various instruments. The contact arm is rotated by a simple clockwork.

Electrical Men of the Times

T. COMMERFORD MARTIN

"The irrepressible and irresistible Martin;" so did Andrew Carnegie characterize him when paying tribute to his work which had so largely to do with the success of the great Engineering Societies Building in New York. The words fit the man. Irrepressible, but not domineering, irresistible, by virtue of a peculiarly magnetic and convincing personality—these qualities have assisted Thomas Commerford Martin to a high position in the field of electrical development.



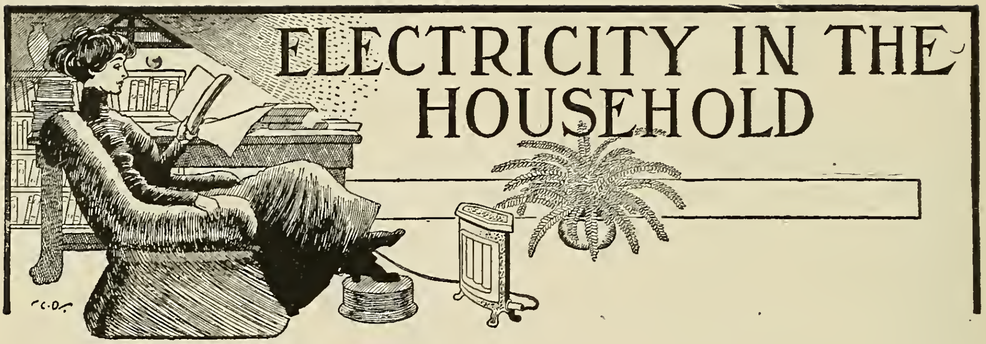
Born in London, England, July 22, 1856, he was educated for the clergy, but his inclinations did not fit him for the work and we find him in 1877, in this country, working in the laboratory of Thomas A. Edison. Here he stayed until 1879 and obtained a technical knowledge of electricity which was the basis of a broad system of self-education which he has ever since pursued.

Being a man of letters and by instinct a journalist, Mr. Martin, in 1883, became editor of the Electrical World. After 10 years he became editor of the Electrical Engineer. Then when these two publications joined forces as the Electrical World and Engineer, he was its editor until about a year ago, when he resigned to become the executive secretary of the National Electric Light Association.

In all those 28 years of service with the publications which so largely through his efforts became to be looked upon as the technical authority in matters pertaining to electricity, Mr. Martin was making friends and winning praise for his untiring work in raising the standard of electrical engineering. His efforts were broadly distributed. He was president of the American Institute of Electrical Engineers, 1887-1888. He served the United States Census Office for many years as special expert, collecting and compiling a vast amount of statistical information relative to the electrical and allied manufacturing industries. He was made an honorary member of the National Electric Light Association and straightway it felt his influence, and his "Progress Report" each year is looked upon as a classic in the literature of the organization. He found time to write books, among them being "The Electric Motor and Its Applications," "Researches of Nikola Tesla" and "A Life of Edison."

Mr. Martin's scholarly attainments are readily manifest in his writings, and he presents moreover that happy and unusual combination of a man who not only writes well but is a graceful and polished speaker. When T. C. Martin addresses any of the gatherings common among the engineering societies, attendance is maximum.

It is more than likely that he will find in his new work with the National Electric Light Association the greatest opportunity of all in which to further the interests of the electrical industry. A marvelous growth has taken place in the field of electric light and power in the last few years and the Association, as one of the factors which have been instrumental in bringing about unified effort on the part of the various interests, has grown apace. The future of the industry is brilliant beyond comparison, and the Association has done well to select a man who by natural ability and associations is so well fitted as Mr. Martin.



ELECTRICITY IN THE HOUSEHOLD

THE AMERICAN ELECTRIC GIRL

[Over a quarter of a century ago, when electricity was comparatively little used and when women had never dreamed of an electric range or a coffee percolator, a poet or near-poet was inspired to pay tribute to the "electric girl" in the following lines which appeared in the *New York Graphic.*]

A maiden fair to see, I know,
Of loveliness the essence;
Him upon whom her arc-lights glow,
She turns to incandescence.

When first we met, a shock I got;
But held on, just to test her;
Alas! I'd left at home, forgot,
My "sole lightning-arrester."

The keenness of her brilliant mind
Makes her o'er others tower;
Who sparks this girl of mine will find
Two thousand candle-power.

Her silken tresses rippling flow,
You ardently admire;
Her small coquetting dynamo
Is wound with "thirty" wire.

Soft as the sweet magneto-bell
Her influence on you switching,
Your watch don't know what time to tell,
Her volt is so bewitching.

Winds of despair and storms of doubt
May struggle to benight her;
Should Fates combine to put her out,
Joy comes with her re-lighter.

Two pretty feet on equal poles,
Nimble and quick denote her
The envy of all rival souls,
Who else has such a motor?

When longing nearer joys to taste
I strive with brave insistence,
Why will you fix about your waist
Shunt-magnets of resistance?

Ah, alternating-current girl,
No praises can be flattery:
Short circuit, dear, and cease to whirl,
Make me your storage-battery.

And, dearest, should you rather not
Accept my offering votive,
Might I most humbly ask you Watt
Was your Electro-motive?

To several circuits hereabout
You are the Central Station:
Would I all others could cut-out,
You lovely installation.

Soft nestled in your armature,
Lulled by your soothing brushes,
Your commutator's drowsy hum
All earth's excitement hushes.

No more my carboned heart would roam,
Sweet girl these wishes grant me,
Reduce your resistance to *one* ohm,
My isolated plant be.

Were I Am-Pere and she Gramme-Ma,
With insulation rounded,
We'd charge some unfrequented star
And live there till we grounded.

The Letters of A Bachelor Girl

BY R. GRACELYN EVERETT

DEAREST EDNA:

Well here I am! If you had told me a month ago that I would go to the city and take a really good position, I should have laughed you to scorn. But such is life. As the rooster said, "An egg today and tomorrow a feather duster."


Madge

My trip was uneventful even though a nice looking young man did sit a little way down the car from me. I was afraid to look at him for fear that he and the others would think me a flirt. I wanted to but I was "askeered."

Madge was at the station and took complete charge of me. She hurried along through the crowd in the station as though it was an every-day occurrence, and poor little me had to hustle to keep up. The crowd reminded me of the county fair at home and I asked her whether anything special was going on and she only laughed. Now I know why. I have become so used to seeing lots of people that now I would not notice it either.

It seems as though the three days that I have been here were not more than three hours, and yet when I think of you and the home folks it seems months since I left, so much has happened in the meantime.

Madge had found a room for me—a dear little one—at a price that just fits my pocketbook, and she took me right up there. It is with some sort of a cousin of hers, and they are simply splendid to me. I spent the first two nights unpacking and winking back a few tears over the family pictures.

The first morning I went without breakfast because I was not familiar with the locality, but I became so faint at the office that Madge insisted on sending the office boy for a malted milk which resuscitated me. That evening I was particular to find a little place, but it is two blocks from my room. Think of it, dear heart, two blocks to breakfast. I nearly starve on the way.

Yesterday it began to rain about noon and all afternoon I was dreading to go home to the hall bed-room and an evening all by myself. The room is all right but I would get lonesome. Strange how lonesome you can be with people all around you. Just as I was planning on a letter home as an evening's entertainment Madge came over and announced, "Tonight you are coming home with me." Needless to say I was more than delighted—I bubbled over with joy all the rest of the afternoon.

At five o'clock the rain was coming down in torrents, but as it showed no signs of letting up we decided to risk a wetting. We got a little damp between the office and the elevated station and at the other end of the line we had two squares to go and ran all


Winking Back a Few Tears

of the way. We splashed through puddles of various depths and were half drowned when we got to her house. We made record time getting out of our wet clothes and into comfortable dry kimonos. It was then that I had my first chance to look around me and marvel at the wisdom of woman.

Madge is almost beautiful in her trim tailored suit, but in a kimono which was a marvel of color harmonies she was as dainty and exquisite as a daughter of fair Japan. The daintiness with which Madge surrounds herself impressed me even more than her pretty clothes.

On a tea table in one corner of the room was a beautiful brass electrical chafing dish and an electrical bread toaster with some dainty china. Of course they took my eye, and as I hovered over them I could not but think what extravagance they were. But Madge has explained and demonstrated how really inexpensive they are in the long run. I snuggled up on the couch and was so cozy and "comfy" that I quite forgot we had not eaten until Madge asked whether I liked clam chowder. I did not know. But the delicious odor that came from the chafing dish caused me hastily to make up my mind. After the chowder, we had grilled sardines on toast—made on an electric toaster while we were grilling the sardines. Bread and butter and jam that Madge had got from home completed our feast.

Dainty and Exquisite as a Daughter of Fair Japan

I had often heard of fixing things to eat in one's room, but it seemed such a bother. With an outfit like this it was a pleasure because of the little trouble involved. Madge is engaged to that dashing young chap from out West whom you met a year ago, and the chafing dish was a gift from him. He had wanted to give her a pearl necklace but she very wisely took the chafing dish in preference.

She is making some beautiful things to go to housekeeping with—stenciled cushions and curtains. She uses dye colors and then sets them by pressing them with her electrical flat iron. Then they can be laundered without fear of the colors running.

She showed me a beautiful gray waist. I think I must have looked envious. Then she laughingly said, "Do you know this is an old white lace waist that I dyed pink after the newness had worn off. Not long ago I dipped it gray to match my suit." The secret is she boils the dye in a little pail by setting it on the flat iron turned upside down, which sets firmly into a holder for that purpose. Really this iron is fine. While the chafing dish is busy, one can boil coffee nicely on the iron.

But I must continue about the dyeing operations for I just know you can make use of this idea. She filled the lavatory with water and poured in dye enough to make the desired shade and miracle of miracles, the waist came out new and lovely. Sprinkling with water in which a little gum-arabic had been dissolved, then pressing, and finally the addition of fresh coral velvet pipings produced a result that was astonishing. Do you wonder that I looked envious?

Before retiring we pressed our skirts and waists, and my waist, which looked hopeless for another day's wear, was so fresh that I then and there decided upon an electric iron as an immediate need.

Madge says many of her jabots and collars she does not trust to the laundress and by pressing them herself they last much longer.

It was late before we got to bed, there were so many things to talk about. I think Madge was sound asleep long before I stopped asking questions.

In the morning while we were dressing Madge put the coffee on the iron, and with toast and eggs we had an ample breakfast.

I was lamenting that, in the excitement of the evening before, I had forgotten to do my hair up on curlers, as I always have to do to make a presentable appearance next day. Madge brought out her electric curling iron. I always said I should never bother to curl my hair on an iron, but now my views are completely changed, for an electrical iron is clean, and the even heat cannot hurt anyone's hair.

A curler I must have, for I know my beauty sleep never could make amends for the faces that kid curlers caused me to make in my sleep.

Upon leaving for the office I took a farewell glance into the pretty room of this wonder girl and made up my mind to have some improvements made in my own quarters immediately. I found what seemed to be extravagance to be real economy, and Madge is far-seeing enough to know this.

I know, dear, you would welcome any advancement like a true suffragette, and these appliances are doing wonders toward making work easier for women. When you come up on that visit you promised to make me I hope to have quite a complete outfit of my own.

I am sending a flat-iron to mother. You know they have a new electrical plant in our little city, and, with the hot weather coming on, it will be a joy to her to have one.

My work is becoming easier as I get better acquainted with it. There are several

She Showed Me a Beautiful Gray Waist

dandy young fellows in our office. One especially, for he has invited Madge and me to go to the opera next Friday. Wasn't that splendid of him? I will write and tell you all about it.

Now, write soon, Edna, and tell me all about your dear self and what you have been doing. There are lots of things I am keeping back, hoping you may make arrangements to come to the city sooner.

Lovingly,

VIVIAN

Planning Home Illumination

To get the best results from your electric current the first wiring of your house should be carefully planned. It is a mistaken idea to stint on the wiring expense, for any outlay here will be amply repaid by reduced consumption later when the current is turned on.

When a house is planned spaces are always provided suitable for the large necessary pieces of furniture, such as table and sideboard in the dining room, stove and sink in the kitchen, beds and dressers, and so on, through the house. All these may then be provided with the proper light by specifying outlets nearby, and it is in this matter that the woman who is planning a house should be especially interested from the point of convenience.

The bedrooms, clothes closets and bathrooms are probably the most neglected portions of the house when providing for outlets for electric lighting and for the use of current for other purposes. In the bedroom usually a one-light fixture is considered satisfactory for general illumination with one wall bracket near the dresser. If one wishes to read in bed a flexible cord and lamp connected to an outlet are frequently hung over the head of the bed. The closets, too often, are without any light, depending upon the reflected light from the bedroom. In the bathroom a high candle power lamp must be burned when it is desired to light the bathroom all night.

Not only from a point of economy, but also from the standpoint of safety and good illumination plenty of lamp outlets are desirable. It is hardly economizing to turn on a lamp of high candle-power at the dresser when an outlet near the bed in which a small candle-power lamp is used with a shade is entirely sufficient to throw plenty of light for reading. The bedside outlet will be found useful also for supplying other devices such as a heating pad, bottle warmer, fan or massage machine. Taking the "cue" from actresses who often carry two tall, slender portable electric lamp fixtures, one for each side of the dresser, to assist in caring for the hair, every woman will appreciate wall light outlets so arranged that the dresser may stand between them.

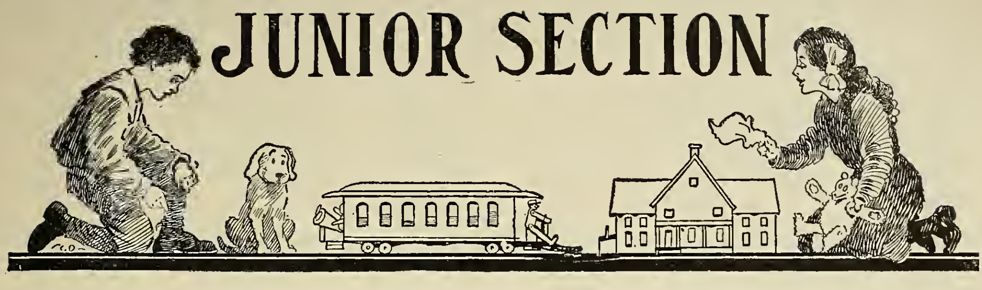
All insurance men know that the free use of good electric wiring is in itself the best kind of insurance and especially is this true in the closets of the house. A fixture arranged here with a pendant chain for turning on and off the light does away with matches, and lighted candles, and assists one in putting dresses, skirts and other clothing away in good order.

Bathrooms are usually finished in light colors so that small candle-power lamps are sufficient here, but at least two or three outlets should be provided for such conveniences as a radiator to take off the chill of the room, small water heater and curling iron.

Heating in the Future

Electricity is an ideal source of heat, as there is absolutely no loss in the change from electricity to heat. It seems practically certain that our coal supply is limited, and will be too costly, and that new and better ways of obtaining the heat so necessary for our lives and comfort must be found in the years yet to come. Steinmetz, the genius of the General Electric Company, says that unless some such discovery is made before many years all the water powers will have to be harnessed to secure electrical energy, and this energy transmitted to various points and turned into heat.

Electric heat can be had on the instant, for electricity travels at the rate of 186,000 miles a second, and in any degree desired, from warmth that is barely perceptible to the touch, to the terrific heat of the electric furnace in which platinum, diamonds and firebrick itself melt and run like water. Electric heat can be carried anywhere about a building and applied just where wanted without serious loss through radiation. Consequently the electric kitchen and the "wooden range" can be operated all day long to cook and bake without raising the temperature of the kitchen to any considerable degree.



A New Game

BY "SPARKS"

Weary and I were sitting on the porch talking electricity and magnetism as we used to do a lot. Thinking I could have some fun with Weary I bet him he couldn't float a needle on water. He took me up for a quarter which was all I happened to have in my house-coat at the time, which was lucky for me. We marched out into the kitchen and got a soup plate of water and I got some needles out of Sal's workbag and then we marched in to the dining room table.

Weary took a piece of tissue paper, wet a needle with kerosene, laid the needle on the tissue paper and the paper on the water. Bye and bye the paper got waterlogged and sank, and sure enough there was the needle floating away just as nice as a chip in the brook. Then he took another needle and oiled it and rolled it off a fork and it floated too. After trying a couple of times to float one from his hand, he got one to go.

Next I took an ordinary dry one and made it float. Soon we got so we could drop them in, careless like, and make them float sometimes, fishing up the sunken ones with my knife which I had magnetized quite strongly.

He said, "Let's make a compass." And I said, "how in the name of silicon are you going to do it?" He said, "Watch," and picked up a needle and my knife, and with the end of the blade that was one of its magnetic poles, he rubbed the needle from the eye to the point and then brought it back to the eye away from the needle and did that several times. He said a physics teacher or anyone who knew a lot about it would say that it was "magnetism by induction."

"Has it anything to do with an induction coil?" I said.

"No!" he replied, kind of snappy, so I shut up.

After we had magnetized the needle we floated it, and sure enough it pointed north and south no matter how we turned it, except when the knife was brought near it when it would sail away sometimes and turn around and sail back again. It would certainly do some funny stunts when we moved the knife.

Then we magnetized another needle the same way and they both did all kinds of funny tricks and finally they both stuck together, as they were both magnets of themselves.

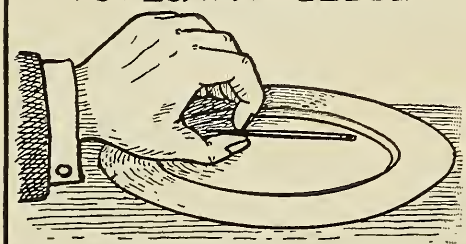
I said to Weary: "Lets' go and get some magnets and develop a game out of this."

He said, "Good idea, Sparks, we're off." So off we went hunting all around my shop for magnets that were suitable for our purpose but as we couldn't find any I decided to dig my wireless phones apart.

We dug out their insides and got three permanent magnets that were the right shape, and two electromagnets that we didn't want. We took the permanents and the diaphragm, because we were wondering if the latter would float. It did, and just as easy as the needle if we were careful.

We each took a needle and floated it and if we moved the magnets above them they would follow as if they were on a string. We dropped the extra magnet under water and then we tried to run each other down with the needles. Well, with our magnets and the one under water, and being magnets themselves, those needles went crazy. I'd start my needle straight for his, but it would

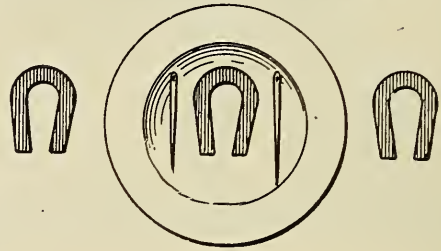
TO FLOAT A NEEDLE



BE SURE IT IS DRY. TAKE IT BETWEEN THE THUMB AND FIRST FINGER. LAY IT GENTLY AND HORIZONTALLY ON THE SURFACE FILM OF THE WATER REMOVE THE THUMB AND FINGER SLOWLY

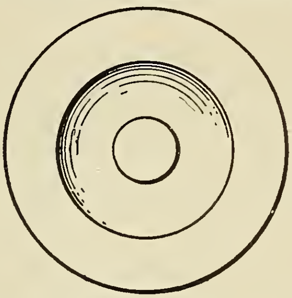
PRACTICE MAKES PERFECT

PARAPHERNALIA



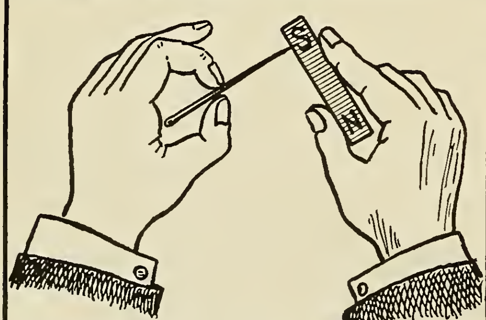
2 OR 3 HORSESHOE -MAGNETS, 2 NEEDLES, AND 1 SOUP PLATE OF WATER

TO FLOAT A DIAPHRAGM



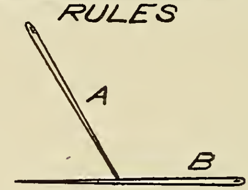
PLACE IT FLAT ON THE SURFACE OF THE WATER IF THE TOP DOESN'T GET WET IT WILL FLOAT

TO MAGNETIZE A NEEDLE



WITH ONE POLE OF A MAGNET RUB THE NEEDLE FROM THE EYE TO THE POINT AND BRING THE MAGNET BACK TO THE EYE AWAY FROM THE NEEDLE, REPEAT.

RULES

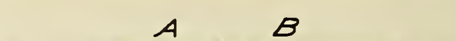


A WINS

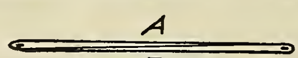
A WINS

A WINS

DRAW



DRAW



DRAW

go daft and turn tail and sprint or else put itself calmly in front of his and wait to be run down. Then again his would be sailing along peaceably when it would stop and turn around over the magnet in the middle and wait.

Then we made the rules which follow:

1. A soup plate of water shall be the sea, with a magnetized needle for each battleship. A magnet may be submerged in the sea if desired.

2. There shall be two players to each sea, each having one ship. They shall also have a magnet, each preferably a horseshoe, to propel the ships by attraction and repulsion only, and *not* by mechanical force.

3. When both players have said "go" the "battle" is on.

4. If the point or bow of one "ship" hits the side or stern of the other, the former wins the "battle." If the bows or sterns collide it is a draw, also if they come together exactly sideways it is again a draw.

5. If a ship sinks after the word "go" it is a victory for the other player.

6. Mechanical pushing or ruffling of the surface of the water forfeits the "battle."

7. After a "draw" or a victory another battle is begun.

8. Each battle won counts a point and the game is of 25 points or any number agreed upon.

Well before we quit Weary and I were as daft over the game as the needles were, and we made up a fancy set with wood boats with magnets on them, and we also got some "sporty" magnets, but we came back to the soup plates and needles because we found that the wood boats were too clumsy.

An Electrical Laboratory for Twenty-Five Dollars

By DAVID P. MORRISON

PART VII

CONSTRUCTION OF CURRENT RHEOSTATS

A rheostat will be needed to connect in series with your storage battery when it is being charged, and the following simple types will be found serviceable.

Assume that you have a single storage cell that has a normal charging rate of five amperes and that you want to charge the cell from a 110-volt direct current circuit. Fig. 59 shows the connections of the cell (B), rheostat (R) and ammeter (A), and the polarity of the battery with respect to the line. Now if 2.5 volts are required to cause a current of five amperes to flow through the cell there remain 110—2.5 or 107.5 volts that must be consumed in causing the five amperes to flow through the rheostat. By a single application of Ohm's Law you can now calculate the value of the resistance that must be placed in the rheostat:

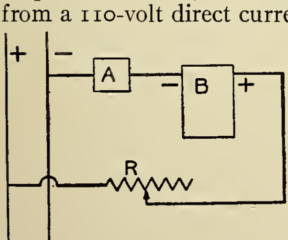


FIG. 59

$$R = \frac{E}{I} = \frac{107.5}{5} = 21.5 \text{ ohms.}$$

To construct such a rheostat you should proceed as follows:—Cut from some $\frac{7}{8}$-inch

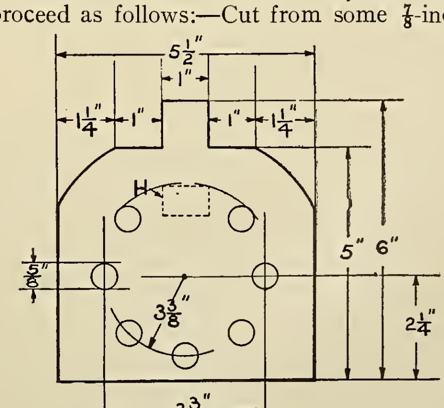


FIG. 60

oak two pieces of dimensions given in Fig. 60 and drill the holes as indicated. Cut two other pieces of dimensions in Fig. 61 from some ¼ or ⅜-inch wood. Now obtain seven round pieces of wood ⅝ inch in diameter and 16 inches long. Wrap around each of these pieces two layers of asbestos paper. This paper should not come nearer than ⅞ inch from the ends of the pieces of wood. One end of all of these pieces can now be glued in the holes of one of the pieces shown in Fig. 60. Slip the two pieces shown in Fig. 61 down inside of the asbestos covered strips and then glue the other ends into the holes in the second end-piece. The two pieces inside of the cage just formed should be so placed that the distance between the two end pieces is divided into three equal parts. A small finishing nail may be driven, and counter sunk through the round wooden rods into these separators after they are put in place to hold them. Cut from some oak a piece

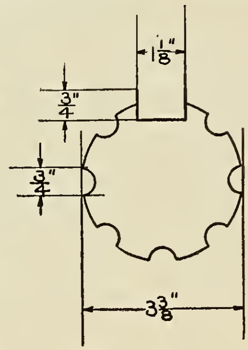


FIG. 61

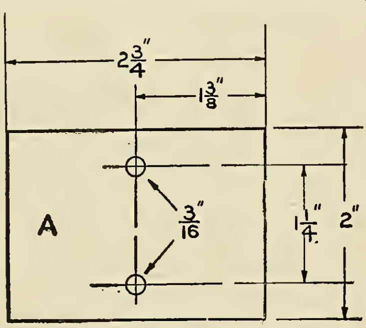


FIG. 62

one inch wide, ⅝ inch thick and 12¼ inches long: Cover this piece with asbestos paper as you did the round pieces except the paper should go to the end of the piece. This piece should be fastened at the point marked (H) Fig. 60, by means of two screws that pass through the end-pieces from the outside.

Now wind on this cage ⅜ of a pound of No. 18 B. & S. "Advance" resistance wire, manufactured by the Driver Harris Wire Co., Harrison, New Jersey. The reason this wire is used is on account of its extremely low temperature coefficient, and its high resistance properties. Fasten one end of the wire around one of the round rods about one inch from the end and solder. Now wind the bare wire around the cage with a

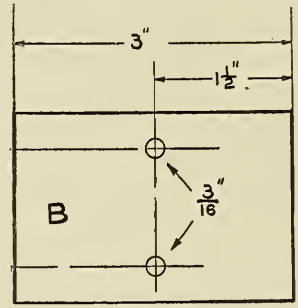


FIG. 63

piece of twine of approximately the same diameter as the wire. When the winding is complete the end should be securely fastened and soldered as in the previous case. Two or three inches of free wire should be allowed at each end for connections.

The sliding contact with which to vary the resistance is the next thing you will want to

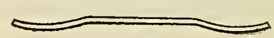


FIG. 64

construct. This should be mounted on the top of the cage and arranged so that it can be moved back and forth over the entire length of the winding. Cut from some hard wood two pieces one inch wide, one inch thick and 14 inches long as supports for the sliding contact. Mount them in the two notches in the top of the end pieces. Place a piece of 1-32-inch brass or copper one inch wide and 14 inches long on one side of one of these pieces so that it will be on the underside when the wooden strip is mounted. Decrease the thickness of the wooden piece an amount equal to the thickness of the brass strip. Now cut from some 1-16-inch brass two pieces (A) and (B) as shown in Figs. 62 and 63 and drill the holes as indicated. Bend (A) into the form shown in Fig. 64. Cut a block of wood with dimensions given in Fig. 65 as a handle to be used in operating the sliding contact, and give it the form shown in Fig.

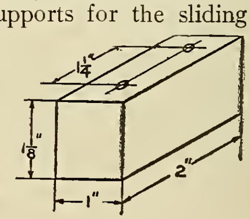


FIG. 65

66. Cut from some 1-16-inch spring brass a piece of dimensions given in Fig. 67 and bend it into the form shown in Fig. 68. These various parts can now be assembled as shown in Fig. 69.

Cut from some one-inch oak a piece six inches wide and 16 inches long foı a base and mount the completed resistance coil with screws that pass through the base from the underside. Three terminals should now be provided by mounting binding posts on the base and making the following connections. Connect two of the posts to the ends of the coil with pieces of No. 14 B. & S. insulated copper wire and the third to the brass strip mounted on the support for the sliding contact. By using three binding posts either end of the coil can be connected in circuit and thus equalize the wear on the wire and slides. It might be well for you to provide fuse connections in the lead from the sliding contact to its binding post.

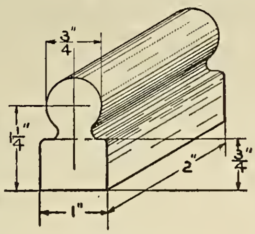


FIG. 66

The current capacity of this rheostat can of course be increased almost indefinitely by

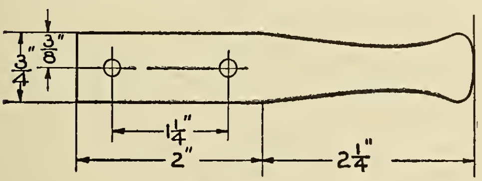


FIG. 67

increasing the size of the wire and the current capacity of the leads and contact spring. If it is desired to have a finer adjustment of the resistance you can use a smaller cage and put on more turns.

The following form of rheostat will be found equally as good for the particular case mentioned at the outset and may be easier to construct. This rheostat is to consist of a number of incandescent lamps so arranged with respect to each other that they can be connected or disconnected from the circuit by a special switch to be described. Obtain 12 porcelain lamp sockets and 12 carbon filament 16 candle power lamps. Cut from some one-inch oak a piece five feet long and six inches wide. Now mount the lamp sockets on one end of this board four inches between centers with all the terminals projecting to the right and left as partly shown in Fig. 70. Connect one side of all these sockets together with a No. 14 copper wire, removing the insulation from the wire only at the points it is fastened under the screws.

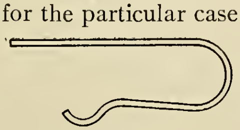


FIG. 68

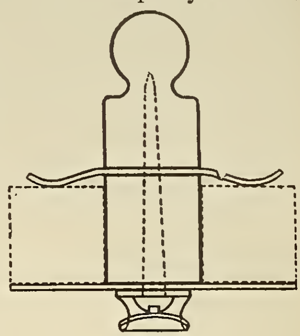


FIG. 69

Now cut from some well-seasoned close grained wood ⅜ inch thick, a piece six inches square. Drill the holes in this piece as indicated in Fig. 71. Procure twelve $1\frac{1}{4}$-inch round-headed brass screws, ⅛ inch in diameter and file off the top of the heads until there is a flat place about 3-16 inch in diameter. Fasten these screws in the ⅛-inch holes in the board with a small nut on the under side, placing brass washers on both sides.

Now cut from some 1-32-inch spring brass a piece as shown in Fig. 72 and slit it as indicated by the dotted lines. Obtain a ⅜-inch brass bolt $1\frac{1}{2}$ inches long, put it through the hole (H) and solder. Now make a small wooden handle as shown in Fig. 73. The fan-shaped piece of brass can now be fastened to the handle with

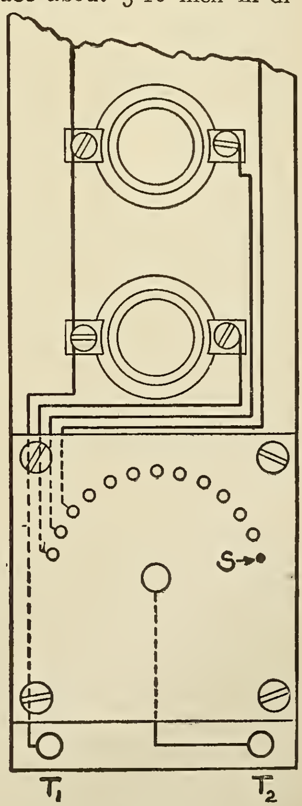


FIG. 70

four small screws. Mount a washer one inch in diameter and $\frac{1}{8}$ inch thick with a hole $\frac{1}{4}$ inch in diameter, in the center of the board with two countersunk flat headed brass screws. This washer is to serve as a bearing for the piece of brass attached to the wooden handle. Bend each of the segments in the fan-shaped piece of brass down a short distance so that they will rest firmly against the tops of the screws when the fan-shaped piece is held down against the washer on the wooden base. A small spring placed on the bolt in the back and held by two lock nuts will aid in maintaining a constant pressure of the fingers. Cut from some $\frac{1}{8}$-inch brass a circular piece as shown in Fig. 74 and mount it on the wooden base so that its upper surface is on the same level as the top of the screw heads. A stop should be placed in the position marked (S) Fig. 70 to prevent the handle being turned completely around.

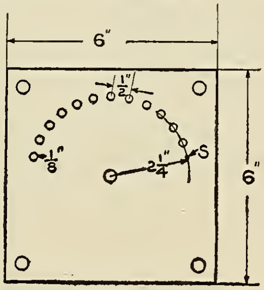


FIG. 71

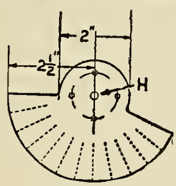


FIG. 72

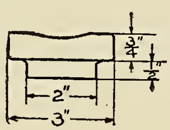


FIG. 73

Now mount this special switch on four short pedestals under the corners, on the same board you mounted with the lamp sockets, and arrange to make the following connections. Two binding posts (T_1) and (T_2) Fig. 70, can be mounted on the main base that will serve as terminals for the rheostat. Connect one of these binding posts to the lead common to all of the lamps. The other binding post should be connected to the bolt in the center of the switch with a flexible lead. The free terminals of the various lamps should now be connected in regular order to the back end of the screws in the special switch base. When all the lamps are in place you can vary the number connected in parallel between the binding posts of the rheostat by simply turning the rheostat handle.

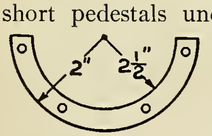


FIG. 74

You no doubt will want to make a rheostat that can be used on your switchboard in connection with your transformer and rectifier in charging and discharging the storage battery. The construction of the switch for this rheostat will differ from the one used with the lamps and it will be so arranged that a more gradual change in resistance can be made than in the previous case. Assume that it is desired to have a rheostat that will give a range of current from one half to five amperes when connected to circuits whose voltages range from a few volts to 50 volts. A convenient way of making such a rheostat would be to connect two in series, one in which the resistance units are relatively large and the other in which the resistance units are relatively small. Fig. 75 shows how such an arrangement should be connected. The total resistance of the small rheostat should be practically the same or a little greater than the resistance of one step in the larger rheostat. With the maximum voltage of 50

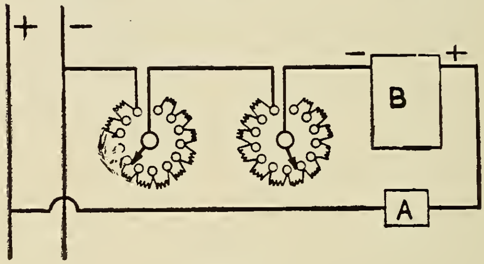


FIG. 75

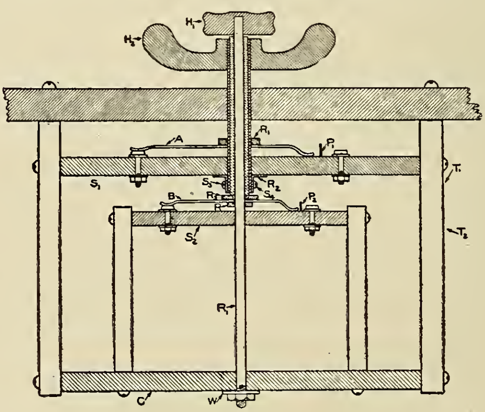


FIG. 76

volts the total rheostat resistance should be 100 ohms to give the minimum current of ½ ampere. This total resistance can consist of 19 five-ohm units in the larger rheostat and 20 one-fourth-ohm units in the smaller rheostat.

Fig. 76 shows a cross section through a switch suitable for operating such a rheostat, and its construction can be accomplished as follows. Cut two pieces, from some ½-inch

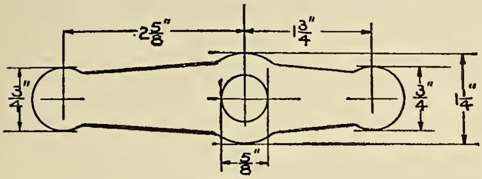


FIG. 77

well-seasoned wood, one 10 inches square and the other six inches square. Draw a 5½-inch circle on the larger board with the stationary point of the compass in the exact centre of the board. Divide this circle into 20 equal parts and drill 20 ⅛-inch holes with these equally spaced points as centres. Draw a four-inch circle on the smaller board and divide it into 20 equal parts, and with these

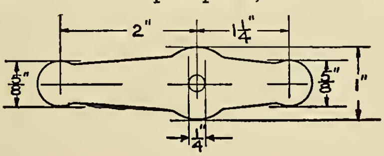


FIG. 78

points as centres drill ⅛-inch holes. Now procure 39 ⅛-inch brass bolts ⅞ or one inch in length. Fasten 20 of these bolts in the holes in the smaller board and 19 of them in the holes in the larger board which leaves one blank spot and the rheostat will be open when the arm (A) is in this particular position. It might be well, however, to fill this space with any kind of a blank screw. Cut a second board 10 inches square from some ½ or ⅝-inch stock to serve as a back for the rheostat. See (C), Fig. 76. This board should have a ¼-inch hole drilled in its centre for the rod (R_1) to pass through. Cut four pieces two inches wide and 4½ inches long from ½-inch oak that are to serve as supports for the switch (S_2). Four more pieces three inches wide and 7⅝ inches long should be cut from some ½ or ⅝-inch oak that are to serve as supports for the switch (S_1). Obtain a piece of ¼-inch brass rod 10¾ inches long. Thread one end of this rod to a distance of about one inch and drill a 3-32-inch hole through it ¼ inch from the opposite end. This rod is to be used in operating the contact arm (B) of the switch (S_2). Cut from some 1-16-inch spring brass two pieces as shown in Figs. 77 and 78 that are to form the arms (A) and (B) of the switches. A brass washer (R), Fig. 76, should be cut from some ⅛-inch brass and soldered to the arm (B) and both of them then soldered to the brass rod so that the lower side of the washer is 5½ inches from the threaded end of the rod. Now fasten this part of the switch in position as shown in Fig. 76. A brass washer (W) should be placed on the end of the rod before the nut is screwed on. It would be best to put a lock nut on the end of the rod in addition to the one shown. These nuts should be run onto the rod until there is quite a little tension in the arm (B), thus assuring a good contact between it and the heads of the screws. Procure an insulating tube, 4⅝ inches long, with an inside diameter a trifle larger than the outside diameter of the brass rod (R_1) and an outside diameter of approximately ½ inch. Next obtain a piece of brass tubing (T) 4½ inches long with about 1-16-inch wall and of such an inside diameter that it will fit snugly around the insulating tube. Now fasten the arm (A) to the brass tube with a brass washer (R_1) as you did the arm (B) to the brass rod. The lower side of the arm (A) should be 1¼ inches from the lower end of the brass tube when they are fastened together. A special washer (R_2) should now be made. Two holes should be drilled in the lower end of the brass tube and threaded so that they will take the screws (S_3) and (S_4). There should be quite a bit of pressure exerted by the arm (A) upon the heads of the screws when it is fastened in place.

Two handles (H_1) and (H_2) as shown in Fig. 76 can be turned from hard wood and mounted on the outer end of the brass rod and tube. A washer (R_3) should be cut from insulated material and put in place, to prevent the brass tube coming in contact with the arm (B). Two small uprights (P_1) and (P_2) should be placed on top of the boards (S_1) and (S_2) to prevent the arms (A) and (B) turning entirely around.

The elements of resistance connected between the screws mounted on the board (S_1) are to each have five ohms resistance. No. 18 B. & S. gauge "Advance" resistance wire has a resistance of .184 ohm per foot so that there will be required five divided by .184, or 27.17 feet. This number of feet is equal to 326 inches. Divide this length of wire into two parts. Wind these pieces around a round piece of wood with the various turns touching each other allowing 1½ inches of free wire at one end and 2½ inches at the other end for connections. Holes may be drilled in the boards (S_1), (S_2), and (C) through which the free ends of these resistance coils can be passed, thus giving an easy means of supporting them. Two coils can now be connected together in series by soldering together the ends that project through the lower side of the board (C). The upper terminals of these coils should now be connected to adjacent screws, the last screw of one element forming the first terminal of the next element and so on.

The elements for the smaller rheostat are to each have a resistance of ¼ ohm and have a total length of 16.3 inches. These lengths of wire should of course be increased a small amount on account of end connections.

Two binding posts should be mounted in some convenient place such as shown by (T_1) and (T_2). Connect (T_1) to one end of the series of resistance in the smaller rheostat. Then arm (B) can be connected by a flexible lead to one terminal of the resistances in the larger rheostat and the arm (A) by a flexible lead to the terminal (T_2). When these two rheostats are to be used in series as just described there is no need of the insulating tube that separates (A) from (B). The rheostat was made in this way so you can split it up and use either separately if desired.

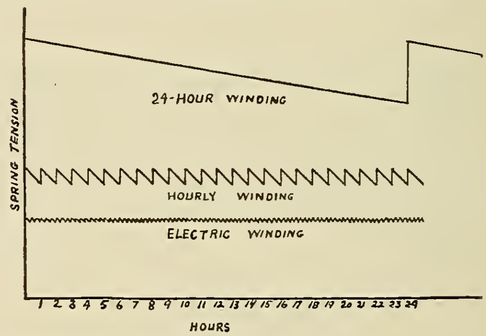
A hole should be drilled in the front of your switchboard of such a size that it will allow the brass tube to easily pass through. The rheostat can then be fastened rigidly to the board with four large screws.

The rheostats described here may not be suited to the particular circuit you want to use them in but the general plan of construction will be the same. A small booklet containing tables giving the resistance of different size wires of different kinds of materials and their change in resistance with a given change in temperature can be obtained from the Driver-Harris Company. These tables will be found very convenient in selecting the size and kind of wire to use in your rheostat.

(To be continued.)

Electric Clocks as Timekeepers

Can electrically wound clocks keep better time than those wound by hand, the rest of the mechanism being the same? The question is an important one, for in the long run the device that is more nearly right in principle will come out ahead. In our hand-wound clocks the rate of movement is controlled by an escapement which is moved either by a spring or by a pendulum. Changing the tension of this spring, or the length of the pendulum, alters the speed of the escapement and therefore the rate at which the hands move over the dial. As long as this adjustment of the balance spring or pendulum is kept the same, we



FREQUENT WINDING MEANS MORE UNIFORM SPRING TENSION

generally assume that the clock will run at a uniform speed, yet this is not entirely true. For while the swing of the escapement may have a fixed time, the speed at which this escapement catches and releases will vary with the pressure of the teeth against the same. This pressure depends on the tension of the main spring and is many times greater when the clock is fully wound than when it is almost run down, so that the escapement in a 24-hour clock will act with more snap during the first twelve hours.

The difference is not great, but it explains why two clocks which may read alike each evening will differ by a half minute or minute at other times of the day. Now, if we reduce the difference in spring tension before and after winding, we will lessen this variation in the hourly speed of the clock. A glance at the diagram will show how winding the clock every hour would reduce the change in spring tension. Electrically wound clocks go still further when they wind the spring several hundred times each hour.

POPULAR ELECTRICITY WIRELESS CLUB

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

Determination of Wave Length

How can I determine the wave length of my equipment? What is the formula? These and other questions of like import are continually being asked by readers of this department. Invariably we have answered the amateur by telling him to get in tune with some station of known wave length and thereby determine his own. There are of course wave meters which may be used for the purpose, but they are expensive and generally not available except to the commercial station.

Still, there are no doubt many who may think that our customary answer is an evasion of the question—an easy way of putting them off. So for once we are going to sidestep the "popular" idea of our magazine and delve a little into the technicalities. If you want the formula here it is. Those who understand higher mathematics may make use of it. To those who do not we simply say: "Do not ask us to explain." We do not conduct a correspondence school in mathematics.

$$W = 3.1416 \times 2 \times 2\, V \sqrt{LC}$$

in which ....

W=wave length in meters

V=velocity of light, or 300,000,000 meters per second

L=inductance in henrys

C=capacity in farads

Both capacity, C, and inductance, L, enter into the equation and except in simple circuits are difficult to calculate. The capacity of a straight vertical wire of length l and diameter d well above the earth and away from other conductors is in micro-micro-farads found from the equation,

$$C = \frac{1}{4.1454 \log \left(\frac{2l}{d}\right)}$$

When brought near to other wires and connected to them, the above value will be modified. The capacities of the connected condensers must also be considered, but this will depend on how the condensers are connected, which varies in different systems.

Stefan's formula for self inductance is:

$$L = 4\pi n^2 a \left\{ \log_e \frac{8a}{\sqrt{b^2 + c^2}} \left(1 + \frac{3b^2 + c^2}{96a^2}\right) - y_1 + \frac{b^2}{16a^2} y_2 \right.$$

where L=inductance in micro-henrys after being divided by 1000.

a=mean radius of the coil

n=number of turns

b=over-all breadth of the coil

c=depth of the coil

y_1 and y_2=constants depending on the ratio of the quantities b and c (always dividing the smaller by the larger). For example, suppose b=2cm. and c=1 cm.

$\frac{c}{b} = \frac{1}{2} = .5$ By reference to previously determined table of constants, for the value .5, y_1=.796 and y_2=.3066

This formula is quite exact for square wire insulated by a covering of little thickness, but requires correction in the case of round insulated wire. This correction consists of three parts and is represented by

$$\Delta L = 4\pi\, n\, a \left(\log_e \frac{D}{d} + 0.13806 + A \right)$$

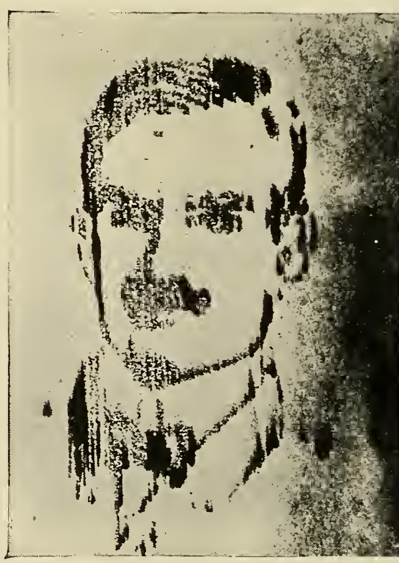
where Δ L is the correction in L (in micro-henrys after dividing by 1000), a and n are radius and number of turns as before, D and d are diameters of wire plus insulation and bare wire, respectively, and A is a constant depending upon the number of turns of wire in the coil. (The correction 0.13806 is the increase in the self-inductance of the separate turns because the wire is round instead of square, $\log_e \frac{D}{d}$ is the increase because the wire is smaller than the square wire assumed in the formula, A is the correction due to the difference in the mutual inductance of the separate turns on one another, being more for round wire than for square.) For wireless telegraphy coils the correction, A, is small and may be disregarded.

Transmission of Photographs by Wireless

We have often wished that we could see the party to whom we are talking over the telephone. From the present outlook there is a possibility that our hopes along this line may be realized, for a Mississippi inventor has recently perfected a new system for transmitting photographs by wireless, making it possible for us to talk over the wireless telephone and then see the face of the party to whom we were talking gradually traced on the recording cylinder of a phonographic looking instrument.

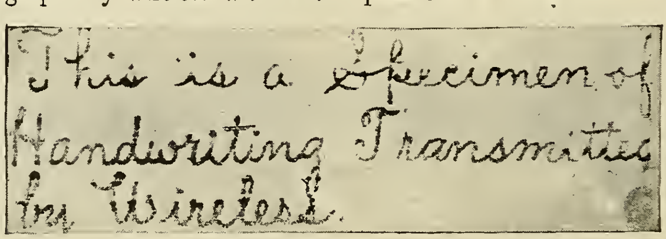
V. H. LAUGHTER

Victor H. Laughter, the inventor of this system, is well known to the readers of Popular Electricity through his many contributions to the subject of wireless. Mr. Laughter, who has over twenty pending wireless patents, has been experimenting for a number of years along this line.



Transmission of photographs by wireless with Mr. Laughter's system has been carried out up to the present in an experimental way, although he thinks that his method can be made practicable. The principle of transmitting photographs by wire or wirelessly is very simple, and not original with Mr. Laughter, but the many obstacles in the way of small details to be perfected have received careful study and much experiment on his part.

The inventor refuses to give a detailed description of the set owing to the patent situation. He writes, however, that instead of sending out a wave from a spark coil or transformer to correspond with the varying portions of the photograph being transmitted, a generator of a continuous wave is utilized and this



wave is varied and thrown in and out of the regular current to correspond with the photograph. At the receiving end a special type of coherer is used and for printing the photograph a method both electro-chemical and photographic is employed.

The inventor found it next to impossible to send photographs with the old type spark sending set and coherer, owing to the periodic character of the spark and the slow working action of the coherer. He informs us that the set he is now employing is used in conjunction with his wireless telephone system and to talk over the wireless telephone, then run off a photograph of the distant party makes a very interesting exhibition.

The illustrations herewith were furnished by Mr. Laughter as examples of the work he has done in this line.

This system can also be applied to wire use and it is expected that it will come into use for newspaper work. To be able to transmit a photograph from city to city, of some noteworthy event a few moments after it actually happens would certainly prove a great help to the newspapers.

A High-Power Wireless Equipment

By ALFRED P. MORGAN

PART III.—INDUCTION COIL SECONDARY; KEY

The secondary sections are 50 in number. They measure 12 inches outside diameter and three-sixteenths of an inch thick. The hole in the center through which the insulating tube passes is five inches in diameter. About 15 pounds of No. 28 B. & S. gauge silk-covered wire is required to wind the 50 sections. A sectional view showing the general arrangement of core; primary, insulation and secondary is given in Fig. 19.

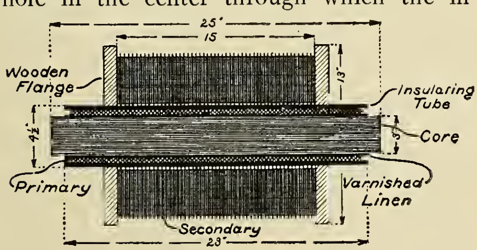


FIG. 19. ARRANGEMENT OF CORE AND WINDINGS

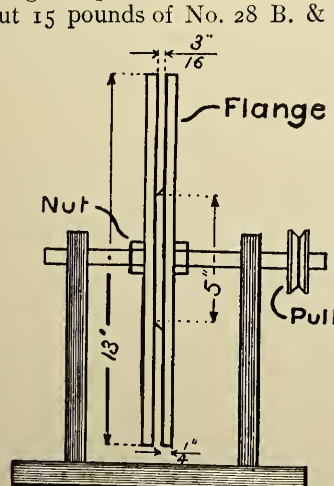


FIG. 20. SECTION FORMER

They are formed on a winder similar to that illustrated in Fig. 20.

The flanges are 13 inches in diameter and ¼ inch thick. The core is 3-16 inch thick and five inches in diameter. The parts of the winder are preferably made of brass.

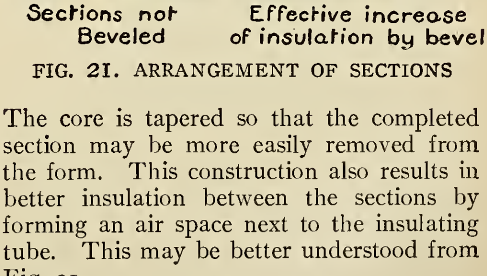


FIG. 21. ARRANGEMENT OF SECTIONS

The core is tapered so that the completed section may be more easily removed from the form. This construction also results in better insulation between the sections by forming an air space next to the insulating tube. This may be better understood from Fig. 21.

The flanges are held tightly against the core by means of two nuts which screw on the shaft. The shaft may be either placed in a lathe chuck or else fitted with a pulley and the form revolved by attaching a belt which runs to the driving wheel of a sewing machine. Those who possess a small workshop may find the suggestion illustrated in

Fig. 22 of permanent value and useful for other purposes than coil winding.

An old bicycle is adapted in the manner shown and should require no other explanation than that afforded by the illustration.

The base and uprights of the winder are made of wood and may be of almost any convenient size. The bearings are short lengths of brass tubing into which the shaft will fit.

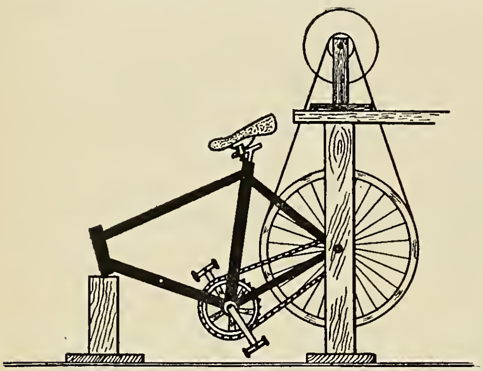


FIG. 22. SIMPLE WINDING MACHINE

The wire is fed slowly and evenly into the winder until the section is 12 inches in diameter. Use a great deal of care not to pass in any kinks or snarls. The wire must be very carefully watched for breaks. Oftentimes the wire itself is broken but is held together by the insulation. It is a good plan therefore to test each section for continuity by placing it in series with a battery and a telephone receiver. If broken, the section should be discarded or else unwound and mended. The splice should be soldered using resin as the flux.

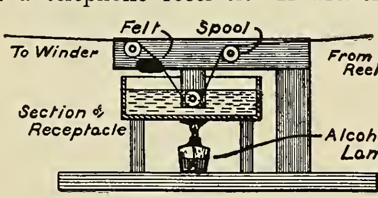


FIG. 23. IMPREGNATING THE INSULATION

The wire is passed through a bath of melted beeswax and resin before it is wound into a section. This operation not only increases the insulation of the wire but the resulting section is mechanically stronger as well, and will not fall apart when removed from the form. The wax must be kept fairly hot and the form revolved rapidly so that the wire is wound in before the wax has had time to cool and become solidified.

Fig. 23 illustrates an arrangement for impregnating the insulation. The wire passes from the reel over a small pulley and down into the bath, then under a pulley and out over another. Before passing over this third pulley it rubs against a piece of felt which removes the surplus wax. The piece of felt requires frequent scraping or renewal.

A square cracker tin contains the wax mixture and is supported at its four corners so that an alcohol lamp may be placed underneath as a source of heat. The pulleys are simply ordinary spools turning about a round headed screw and having a small washer placed at either end so as to eliminate friction.

The separators between the secondary sections are circular disks of blotting paper, 12½ inches in diameter and having a hole five inches in diameter cut in the center. A template of sheet metal of the same size is first made and then laid on the blotting paper so that the separators may be cut out by scoring around the edges with a sharp pen knife. The separators are impregnated by soaking them in a hot mixture of beeswax and resin. They are then hung up and allowed to dry before using.

The secondary is assembled by slipping alternately a completed section and then two separating disks over the primary and insulating tube. The method of connecting the sections is indicated in Fig. 24. The direction of winding of every alternate section is not necessarily reversed as the arrows at first seem to indicate but they are merely turned around as shown by the bevel.

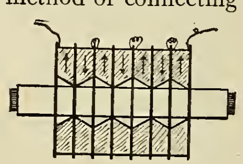


FIG. 24. METHOD OF CONNECTING SECTIONS

When the complete secondary is assembled two wooden flanges 13 inches in diameter are forced over the insulating tube until they come tightly against the ends of the secondary.

The ends of the insulating tube of the coil illustrated in Fig. 25 were threaded and fitted with hard rubber flanges which screw against the wooden flanges and hold them tightly against the secondary, but this construction is no doubt rather difficult for amateur coil builders to imitate and impossible with an insulating tube composed of several layers.

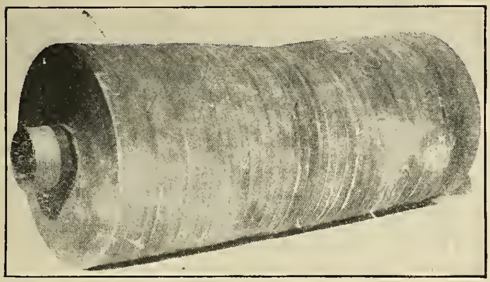


FIG. 25. COMPLETED SECONDARY

After assembling, the whole coil is placed in a metal receptacle which contains a quantity of the mixture of beeswax and resin used for impregnating the sections. The container should be built up in the shape of a cylinder out of sheet tin, and of a size just large enough to admit the coil so that there will be no necessity to use a large amount of the wax. The wax is kept hot by a gentle heat and the coil allowed to become thoroughly "soaked."

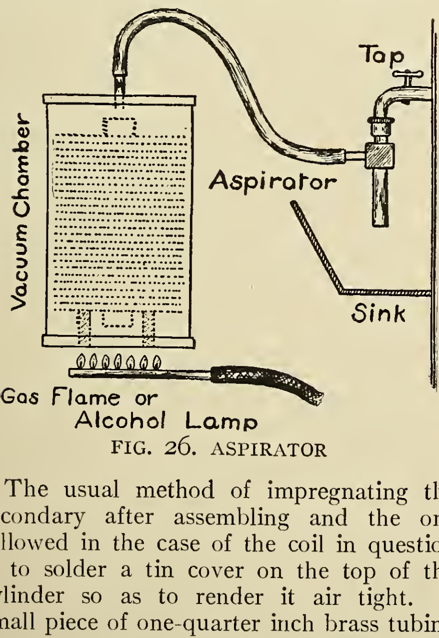


FIG. 26. ASPIRATOR

The usual method of impregnating the secondary after assembling and the one followed in the case of the coil in question is to solder a tin cover on the top of the cylinder so as to render it air tight. A small piece of one-quarter inch brass tubing is soldered in the top and connected with a rubber hose to an aspirator on the water faucet as shown in Fig. 26. When the aspirator is set in operation it will exhaust the air from the receptacle and cause any air bubbles in the coil to expand and pass out. When the atmosphere is readmitted the pressure will force the hot wax into all the interstices.

After soaking in the hot wax for a while and under atmospheric pressure the receptacle is opened and the coil removed. If the primary and insulating tube are covered with a layer of ordinary insulating tape previous to immersing in the wax, they will be protected and not become covered with the compound. The tape is removed after the coil is taken out of the receptacle. After cooling the secondary is given several coats of wax by painting it on hot with a brush. It is then covered with a layer of tape which protects the sections and separators from mechanical injury and in case the coil is set in a solid mass of insulating compound when mounted, is easier to remove if ever necessary.

One of the best and simplest ways in which to mount the coil is to place it in a rectangular wooden box fitted with a cover. The case should measure 27 by 15 by 15 inches inside dimensions. The ends of the primary rest on two wooden supports which raise the secondary up clear of the bottom of the case. The primary terminals lead to two large binding posts on the end of the case. The terminals of the secondary are connected to insulating pillars on the top of the case.

The insulating pillars are made, as in

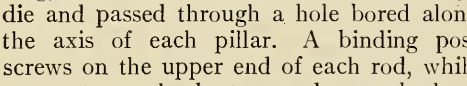


FIG. 27. INSULATING PILLAR

Fig. 27, of $\frac{3}{4}$ inch hard rubber rods, four inches long. A $\frac{1}{8}$ inch brass rod, $5\frac{1}{2}$ inches long, is threaded at both ends with an 8-32 die and passed through a hole bored along the axis of each pillar. A binding post screws on the upper end of each rod, while two nuts on the bottom end serve both to secure the pillar and also the secondary terminal.

Small grooves may be turned in the pillars to improve their appearance and also to increase the effective insulating surface.

KEY

The telegraph key of a modern wireless equipment is a somewhat important factor since the ease with which it may be manipulated will largely determine the time and current energy consumed in transmitting a message.

The ordinary Morse telegraph key is not large enough to conduct or break the current required by a large coil or transformer without becoming overheated. However a wireless key must not be of such a size that it is awkward to operate but rather be designed so that the weaknesses of a small key are avoided. This is accomplished by providing auxiliary conductors which relieve the bearings of the key from carrying the current and by shunting a condenser across the contacts or placing them in a magnetic field to prevent arcing.

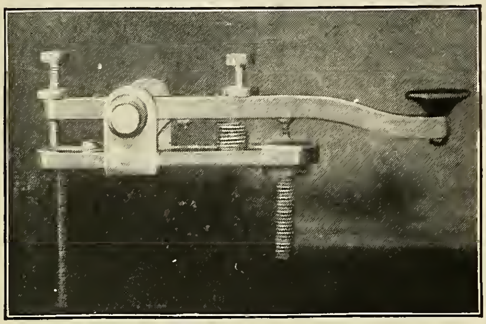


FIG. 28. KEY

Fig. 28 illustrates a key which is easily constructed and entirely practical, it being the form adopted by one of the large commercial companies.

The lever is seven inches long and is formed from a piece of square brass $\frac{3}{8}$ by $\frac{3}{8}$ inch, by bending one end in a double curve so as to bring the key knob nearer the surface of the operating table and render it less awkward to manipulate than if it were straight.

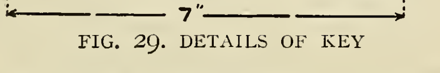


FIG. 29. DETAILS OF KEY

Fig. 29 is a detail drawing of this key. Six holes, (A), (B), (C), (D), (E) and (F) are located and bored in the positions indicated in the illustration. (A) and (D) pass all the way through the lever and are threaded with a 10-24 tap to receive a thumbscrew having a similar thread. (F) also passes all the way through but is not threaded. A 10-24 brass machine screw $\frac{1}{2}$ inch long under the head passes through this hole and screws into the under side of an ordinary key knob. The hole (B) is 3-16 inch in diameter and passes through the lever at right angles to the sides, $1\frac{11}{16}$ inches forward of the rear end. A piece of 3-16 inch round brass, $1\frac{1}{4}$ inches long and pointed at both ends passes through this hole and forms the pivots of the key. The holes (C) and (E) are bored $\frac{1}{4}$ inch deep. The former is threaded with a 10-24 tap, while the other is threaded with a 5-16 inch tap having 20 threads to the inch to receive the contact stub.

The base, Fig. 30, is five inches long, $2\frac{5}{8}$ inches wide and $\frac{1}{4}$ inch thick. The plan and elevation may be best comprehended from the illustration. A wooden pattern, 1-16 inch larger all around than the dimensions here given is made and a casting in brass procured from a foundry. Smooth the pattern with sand paper and give it a coat of shellac.

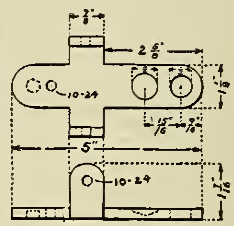


FIG. 30. KEY BASE

The rough casting is finished up to the shape and dimensions indicated by filing or grinding on an emery wheel. Two holes are bored on the center lines of the uprights, 7-16 inch below the top and threaded with a 10-24 tap to fit the bearing screws. On the center line of the base $\frac{1}{2}$ inch from the rear a hole is bored 3-16 inch deep and threaded to fit a 5-16 inch brass rod $2\frac{1}{2}$ inches long and having 18 threads to the inch. This rod forms the rear leg of the key and serves both to fasten the key on the operating bench and also as a means to make connections.

A $\frac{1}{2}$ inch hole passes through the forward part of the base $\frac{1}{2}$ inch back from the edge. This hole is purposely made large so that the under contact may be moved about to bring it into perfect alignment with that on the lever.

A shallow recess is formed with the point of a $\frac{5}{8}$ inch twist drill, $1\frac{1}{2}$ inches back from the front edge of the base and on the center line. This recess prevents any lateral movement of the spiral spring.

One inch forward of the rear edge and on the center line of the base, a hole is drilled through and threaded with a 10-24 tap. A 10-24 machine screw $\frac{1}{4}$ inch long under the head fits into this hole.

A strip of No. 25 hard spring brass Fig., 31, 5-16 inch wide and $2\frac{1}{4}$ inches long serves both as an auxilliary and also to conduct part of the current passing from the base to the lever. The upper end is clamped

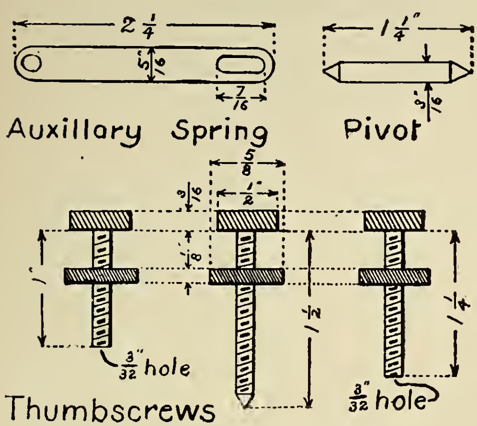


FIG. 31. KEY ACCESSORIES

by the screw fitting into the hole (C) in the lever. The hole in the lower end is elongated as in the illustration so that the tension is adjustable. The lower end clamps under a small machine screw in the base.

The spiral spring is formed of seven turns of No. 16 hard brass wire and is $\frac{1}{2}$ inch in

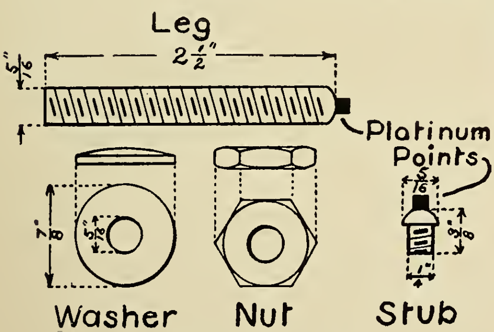


FIG. 32. CONTACTS

diameter. The upper end is bent upwards at right angles and fits into a hole in the lower end of the adjusting screw.

Four thumbscrews, Fig. 31, are required and an equal number of knurled lock nuts. All have a 10-24 thread. The bearing screws are $1\frac{1}{4}$ inches long under the head and have a 3-32 inch hole bored in the ends to receive the pointed ends of the lever pivot. The rear adjusting screw which regulates the play of the key is pointed and is $1\frac{1}{2}$ inches long. The other screw governing the tension of the spiral spring is $\frac{1}{2}$ inch shorter and has a small hole bored in the lower end.

The contacts, shown in Fig. 32, and their adjustment deserve careful attention. They must be heavy, perfectly flat across the contact surface, in perfect alignment and of proper material. The points of the key in question are $\frac{1}{8}$ inch in diameter, 3-16 inch long and are platinum-iridium. Silver is sometimes used but the first metal is preferable. The upper contact is set in a small brass stub $\frac{3}{8}$ inch long and 5-16 inch in

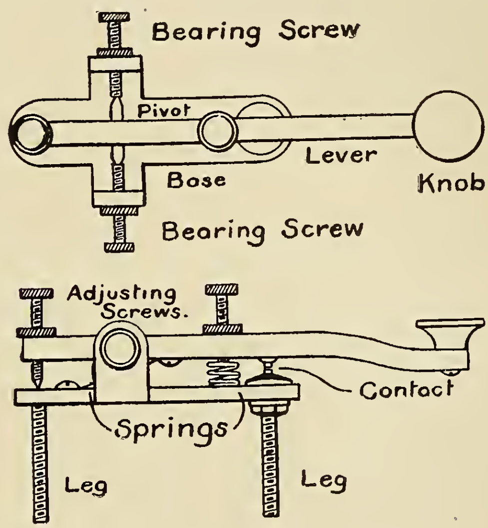


FIG. 33. METHOD OF ASSEMBLING

diameter, which screws into the hole (E) in the lever. The lower contact is set in the upper end of the front leg. The contact points are driven into place and held by friction. The leg is $2\frac{1}{2}$ inches long, 5-16 inch in diameter and is threaded with a die having 18 turns to the inch. A similarly threaded washer, $\frac{7}{8}$ inch in diameter, $\frac{1}{8}$ inch thick, is placed on the upper side of the base and screwed on the upper part of the leg. A mica washer of the same diameter must be placed between the washer and the base.

The leg is clamped on the under side by means of a large hexagonal nut the dimensions of which are indicated in Fig. 33. A mica washer is also placed between the nut and the base, but a metal washer must be interposed between the nut and the mica to prevent damage to the latter when the nut is tightened. The large hole in the base through which the leg passes permits the point to be moved around until it comes directly under that on the lever. The points must be filed until they are perfectly square across and make contact over their entire surface, otherwise there will be trouble from fusing of the surfaces.

The bearing screws should be just loose enough to permit the lever to move easily without side play. The tension of the springs and the amount of movement given to the lever are matters of individual taste.

A one-half micro-farad condenser connected directly across the contacts will absorb any sparking which takes place on a direct current circuit.

Connections are established to the legs of the key by means of two large hexagonal nuts on each.

(To be Continued.)

Effect of Sunlight on Transmission

Considerable attention has been directed of late to the effect of sunlight on the transmission of Hertzian waves. A writer in Electrotechnische Zeitschrift, in commenting on this subject, points out that the stronger the sunshine the less the conductivity of ether to the Hertzian waves, so that it is incorrect to speak of a wireless telegraph station as having any definite range; for one which has a large radius of communication in northern latitudes would have a much smaller radius in the warm climate of the tropics.

This would be particularly noticeable on vessels sailing north and south, and he suggests that it would be desirable to prepare a "radio-topographical" map, giving the relative conductivity of the ether at different latitudes.

Wireless from Coast to Coast

A new wireless company, formed by combining several companies now doing business in the United States, has been capitalized at $5,000,000, and will be known as the Continental Wireless Telephone and Telegraph Company.

The object of the company is to establish a coast to coast wireless transmission. The officers include Thomas E. Clark of Detroit, General Manager; Walter W. Massie of Providence, Rhode Island, Vice President, and A. Frederick Collins, Technical Director.

Rockland County (N. Y.) Wireless Association

On April 16 the Rockland County Wireless Association was formed. A system of by-laws was voted upon and the following officers chosen: President, W. F. Crosby; Vice President, E. B. Van Houten; Secretary, C. Tucker; Corresponding Secretary, V. N. Giles. The object of the Association is to help wireless amateurs and to prevent interference with commercial and Government stations. Meetings are held once a month. Anyone living in Rockland County and wishing to join will kindly write to Vincent Giles, South Broadway, Nyack, N. Y.

Safeguarding Airships by Wireless

The early attempts to equip dirigible balloons with wireless telegraph apparatus were made primarily with a view to receiving information from the same while aloft. Now it is dawning on those interested in military airships that the proposition may also be reversed, by using the wireless to advise the balloonist of approaching storms or danger of any kind. With the enormous cost of the aerial crafts such a means of safeguarding the same may easily pay for the whole wireless outfit and this protective feature will undoubtedly stimulate the more general equipping of the airships used for military purposes with wireless receiving apparatus.

Newspaper Establishes Wireless Station

A South American newspaper, La Prensa of Buenos Ayres, has had installed as a part of its system a wireless telegraph station. The hundredth anniversary of Argentine Republic will be celebrated this year by an exposition which opened May 25th and one of the purposes of the station is to keep the newspaper offices in constant wireless communication with the exposition grounds.

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.

Sending and Receiving Radii

It becomes necessary again to call the attention of those who take advantage of the wireless queries department, to the necessity of definitely stating *all* the conditions when asking questions regarding sending and receiving radii. It should be self-evident to most of you that it is next to impossible for us to advise over what distance you can receive with a certain set unless we know what kind and how large a station is sending at the other end, and what the nature of the space is between the two stations, whether hilly or level land, or water. Moreover, we cannot intelligently decide how far you can send with any particular transmitting outfit unless we know all about the receiving station, and the space between the stations.

In asking questions on this subject it will be necessary for you to cover all of the above mentioned points, as well as to state definitely what instruments are used in each station, as one-half kilowatt transformer or two-inch coil, straight coil tuner or variable coupling tuner, etc., and also the height above earth, length, and number of wires of the aerials. The shape of the aerials is also very important.

For example, a one-inch spark coil connected to the aerial of a commercial station is very different from the same coil connected to an amateur's 40 or 50-foot one, as regards transmitting distance to a particular station. We have known such a coil connected to a 100-foot aerial consisting of four parallel wires, top of aerial 90 feet above earth, to transmit to a commercial station over a distance of 12 miles, but we have also known of experimenters using a similar coil who could nor cover a distance of one mile. There might be many reasons for the difference in sending radii of these two stations, but if we are to decide how far such a coil will transmit, we will have to know all about both the sending and the receiving station, as we have pointed out above.

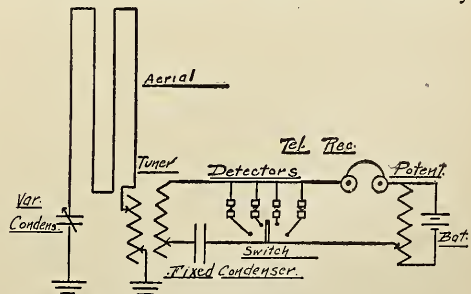
Every instrument in a wireless station has some effect on the radii of transmission and reception. For example, a 75-ohm telephone receiver will not give as good results with an electrolytic detector as will a 1000-ohm receiver, both receivers being of the same make. Other detectors require receivers of different resistances, depending on the detector itself. Moreover, the cheap telephone receivers cannot be compared with the better makes, in regard to sensitive qualities. We have had signals come in clearly with the better receivers, and yet be entirely imperceptible in cheap receivers. The make of receiver as well as the other instruments should be given in asking these questions.

We therefore urge you to follow carefully the above instructions, as otherwise we cannot give satisfactory answers.

Connections for Sensitive Receiving

Questions.—(A) Please give diagram for connecting a variable receiving transformer, two slides on primary and one on secondary; a variable condenser of the tubular type; a fixed condenser of tinfoil and paraffin paper; a pair of 75-ohm receivers (Mesco); four detectors (perikon, electrolytic, carborundum and silicon). I wish to use each of the latter by use of a four-point switch so that the perikon, electrolytic, and carborundum shall be connected with battery and potentiometer, while the silicon shall be connected without the potentiometer and battery. I will use a loop aerial consisting of four wires suspended between two houses, 250 feet apart, one end 60 feet high and the other 70 feet. (B) How may I improve this receiving set? (C) With a one-inch coil how far ought I be able to transmit, assuming sensitive equipment at distant station? (D) Will condensers improve my sending radius?—T. C. C., Jersey City, N. J.

Answers.—(A) See diagram. To connect the silicon detector without the battery,



RECEIVING CONNECTIONS

merely move the slider of the potentiometer down to the end of the resistance rod corresponding to no voltage.

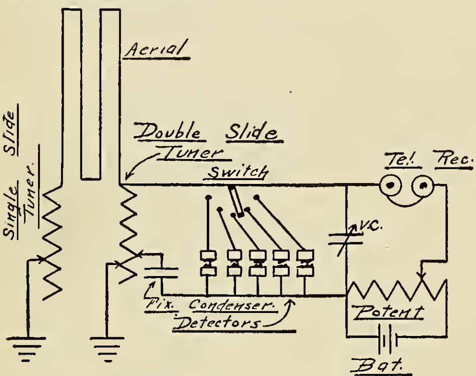
(B) To improve the set, put a single slide tuning coil in place of the fixed condenser, as shown in answer to J. G. W. in this issue.

(C) From two to fifteen miles under ordinary weather conditions, and over water or fairly level land.

(D) A small condenser, such as a ½ pint Leyden jar, connected across the spark gap, will probably improve transmission.

Connecting Instruments

Question.—Please give me a diagram showing the best way to connect up the following wireless instruments: One double slide tuning coil; 1 single-slide tuning coil; silicon, molybdenite, carborundum, microphone, ferron and electrolytic detectors; 1 fixed condenser; 1 variable condenser and 1 potentiometer; 1000-ohm head-phone receiver. How far can I receive with the above outfit and a 6-wire aerial 100 feet long and 95 feet high?—J. G. W., San Francisco, Cal.



RECEIVING CONNECTIONS

Answer.—See diagram. You should be able to receive from high power stations a maximum distance of about 800 miles under ordinary conditions of weather.

Noise in Receiver; Silicon Detector

Questions.—(A) As I move the slider on my receiving tuning coil I hear ticks in my receiver, although my aerial is disconnected. Should this be the case? (B) Are two silicon detectors better than one?—J. S., Plymouth, Wis.

Answers.—(A) If you do not use a condenser in series with your detector and tuning coil. The cause of the sound is loose contact between the sliders and the wire of the coil. If you use a condenser in series with the detector and the coil, the cause of the sound is probably the same as in the above case, but is due to the discharge of the condenser each time the slider touches the wire. The sliders should always make contact with the wire of the coil. (B) No.

Aerial

Questions.—(A) Could I use an aerial 25 feet high and 20 feet long with telegraph wires about 20 feet distant? Would they affect the instruments and if so how could I stop the trouble? (B) Can an aerial be placed between two buildings about 10 feet from the top?—E. J. T., Chicago, Ill.

Answers.—(A) The telegraph wires will diminish the distance of transmission and reception to a certain extent in their direction, but will not otherwise affect your station. The only way to prevent this is to remove the telegraph wires.

(B) Yes, but it will give much better results if placed above the buildings.

Tantalum and Mercury Detectors; Aerial Wire

Questions.—(A) Is a detector made of tantalum wire and mercury as sensitive as the electrolytic? If not, will it do in place of the latter in most cases? (B) Is No. 16 B. & S. gauge bare copper wire too small for aerials?—B. A. E., Roseburg, Ore.

Answers.—(A) The tantalum detector is not considered as sensitive as the electrolytic, but over comparatively short distances the signals are reproduced in the telephones quite loudly, and the detector is satisfactory for all around work.

(B) No. 16 B. & S. copper wire may be used for the aerial of a small station. A larger wire is, however, to be preferred.

Microphone Detector; Ferron Detector

Questions.—(A) What is a microphone detector? (B) What is a ferron detector?—C. C., Fennimore, Wis.

Answers.—(A) A microphone detector consists of a steel needle supported by two sharp edges of carbon.

(B) A ferron detector consists of a metal point so arranged that its pressure on a crystal of iron pyrites can be varied. We expect to publish an article on this detector in the near future.

Tuning Coil for High Resistance Receiver

Questions.—(A) I have a 3010-ohm, head-piece receiver. Please give dimensions for a tuning coil to be used with same which will receive up to 1000 miles? (B) Please give wiring diagrams of these instruments with a silicon detector. (C) Give directions for making the tuning coil.—A. A., Indianapolis, Ind.

Answers.—We refer you to an article on "A Variable Coupling Tuning Coil," in the January, 1910, issue, which answers your questions fully.

QUESTIONS AND ANSWERS

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

Milli-Ampere

Question.—What is a milli-ampere?—G. E. L., Phillipsburg, Kansas.

Answer.—The prefix "milli" signifies "one-thousandth part." A milli-ampere is the thousandth part of one ampere (.001).

Grounding Transformers and Generators; High Voltage Insulation

Questions.—(A) Should a dynamo or a transformer be grounded? (B) Should wires carrying 2300 volts and running through a town be insulated if they are on the top of a 40-foot pole? J. H., Richfield, Idaho.

Answers.—(A) Regarding generators the National Code reads: "Must when operating at a potential in excess of 550 volts, have their base frames permanently and effectively grounded. Must, when operating at a potential of 550 volts or less, be thoroughly insulated from the ground wherever feasible. Wooden base frames used for this purpose, and wooden floors which are depended upon for insulation where, for any reason, it is necessary to omit the base frames, must be kept filled to prevent absorption of moisture, and must be kept clean and dry. Where frame insulation is impracticable, the inspection department having jurisdiction may in writing permit its omission, in which case the frame must be permanently and effectively grounded." The Code forbids the installation of transformers in buildings other than central or sub-stations unless by permission of the inspection department concerned. When installed in central or sub-stations, casings of all transformers must be permanently and effectively grounded. Transformers used to supply current to switchboard instruments only need not be grounded provided they are thoroughly insulated.

(B) These wires may be bare but should be supported on petticoat insulators.

Connecting Cells of Battery

Questions.—(A) When cells are connected in series what is the voltage and current? (B) When connected in parallel what is the voltage and current? (C) When connected in multiple-series how figure the voltage and current? (D) I have 7 gravity cells in series and each one tests one volt. Why will not 7 cells test 7 volts? (E) About what is the amperage and voltage of a gravity cell?—O. W. Y., Kennedy, Minn.

Answers.—(A) If cells are connected in series the voltage is that of one cell multiplied by the number of cells, and the current will be governed by Ohm's law:

$$\text{Current} = \frac{\text{Electromotive Force}}{\text{Resistance}},$$

Resistance being whatever there may be in the circuit.

(B) If cells are connected in parallel the voltage is that of one cell, and the current capacity is increased, the cells thus arranged representing one large cell having a very small internal resistance.

(C) Cells connected in multiple-series give the voltage of one of the series sets, and represent a cell, as far as current output is concerned, having a plate area as many times larger than a single cell as there are series sets.

(D) They should show seven volts unless you are using connections between cells that cause a voltage drop, or are taking measurements at the terminals of the circuit, in which case a drop along these wires would have to be allowed for.

(E) One volt and a little less than one-half an ampere.

Connecting Generators; Horse Power

Questions.—(A) Will more than two generators operate in parallel? (B) Explain how they should be connected. (C) Will A. C. generators of the same voltage and frequency operate in parallel if they are of different make? (D) Do generators working in parallel have to be of the same size and run at the same speed? (E) How is the horsepower figured for driving generators?—J. S., Kansas City, Mo.

Answers.—(A) Yes, if each machine is raised in voltage to the bus-bar pressure before closing the switch connecting the generator leads to the bus-bars.

(B) Compound wound machines are usual for this purpose, the positive lead of each being connected to the positive bus, and the negative lead to the negative bus. In addition an equalizer as large as the machine leads should connect the series coil of one machine to the series coil of the next at the brushes and so on.

(C) Alternators running together so that their outputs may be combined must run at such speeds that their frequencies are the same. They must run "in phase" or "in step." The machines may be of any make so long as the above is adhered to.

(D) No. They divide the load automatically if all are run at the same voltage.

(E) A generator is rated on the name-plate at its output under normal conditions of speed and regulation. Taking this rating, an additional allowance of from 25 per cent in small dynamos up to 5 per cent in large ones must be made to get the necessary power that must be put into the machine under normal load.

Electrical Inspection

Question.—If a building were wired for electric lights according to written specifications without having the wiring shown on plans, and these wires were concealed, would the insurance inspector require the floors to be taken up and the walls opened in places for the purpose of ascertaining whether or not the work was propely done?—H. L. M., Clarksville, Va.

Answer.—The specifications for the installation of any electric wiring are satisfactory to the insurance inspector when these specifiactions comply with the rules of the National Code which is the standard of the underwriters for such construction. However, the inspector will not concern himself about such parts of the specifications as have to do with installing the wires in this or that way so long as the Code rules are not violated. The inspector should not accept any concealed work unless installed under his supervision, or without having such openings made in the floors and walls as will enable him to know whether the work is standard or not. As a rule contractors who desire approval of a job notify the inspector when the work is begun, and it is then the inspector's duty to follow up the job until completed, examining all concealed work when "roughed in."

Alternator Exciter; Fuses

Questions.—(A) Please explain how an exciter works in connection with an alternator. (B) Suppose a set of feeders runs to a point, where a pair of branch wires are tapped off with fuses. If these latter wires get short circuited, would it blow both fuses out, or only one? (C) Would there be any danger of getting a shock if only one fuse blew out?—C. R., Boonville, Mo.

Answers.—(A) The exciter of a alternator is a direct current dynamo. It is sometimes belted to the main shaft of the alternator or run by a motor. The two wires from the exciter run to the fields of the alternator, and in series with one of these wires may be a rheostat for regulating the current through the alternator field coils. Besides this a rheostat in the field of the exciter itself regulates the exciter voltage.

(B) Fuses for protecting electrical circuits are built to "blow" and open the circuit when they carry over ten per cent more than their rating. With a fuse rated to carry 30 amperes, a time limit of 30 seconds is permissible before this fuse opens the circuit on a 50 per cent overload. On a fuse rated to carry 600 amperes, a period of 10 minutes is allowable before it should blow on 50 per cent overload. Under these requirements in tests, it can be seen that a slight difference in construction, a better contact in the fuse block on one side of the line than on the other, and the carrying capacity are factors which might vary so as to cause one fuse to blow, opening the short circuit before the second fuse became hot enough to blow out.

(C) Yes, if the fuse on the negative side only opened the positive side would still be alive.

ON POLYPHASE SUBJECTS

National Electric Light Convention

Twenty-five years ago a small group of men who were interested in the then infant electrical industry met in Chicago and organized the National Electric Light Association. As a result of this first meeting there were recorded 71 members. The idea of the association was probably that of George S. Bowen of Elgin, Ill. The first president was J. Frank Morrison. The thirty-third convention of the association has just been held in St. Louis, May 23d to 27th. That it was the thirty-third is due to the fact that the conventions were held twice a year in the beginning. At the first convention there were a few over 50 present. At the last over 2,500 delegates were registered.

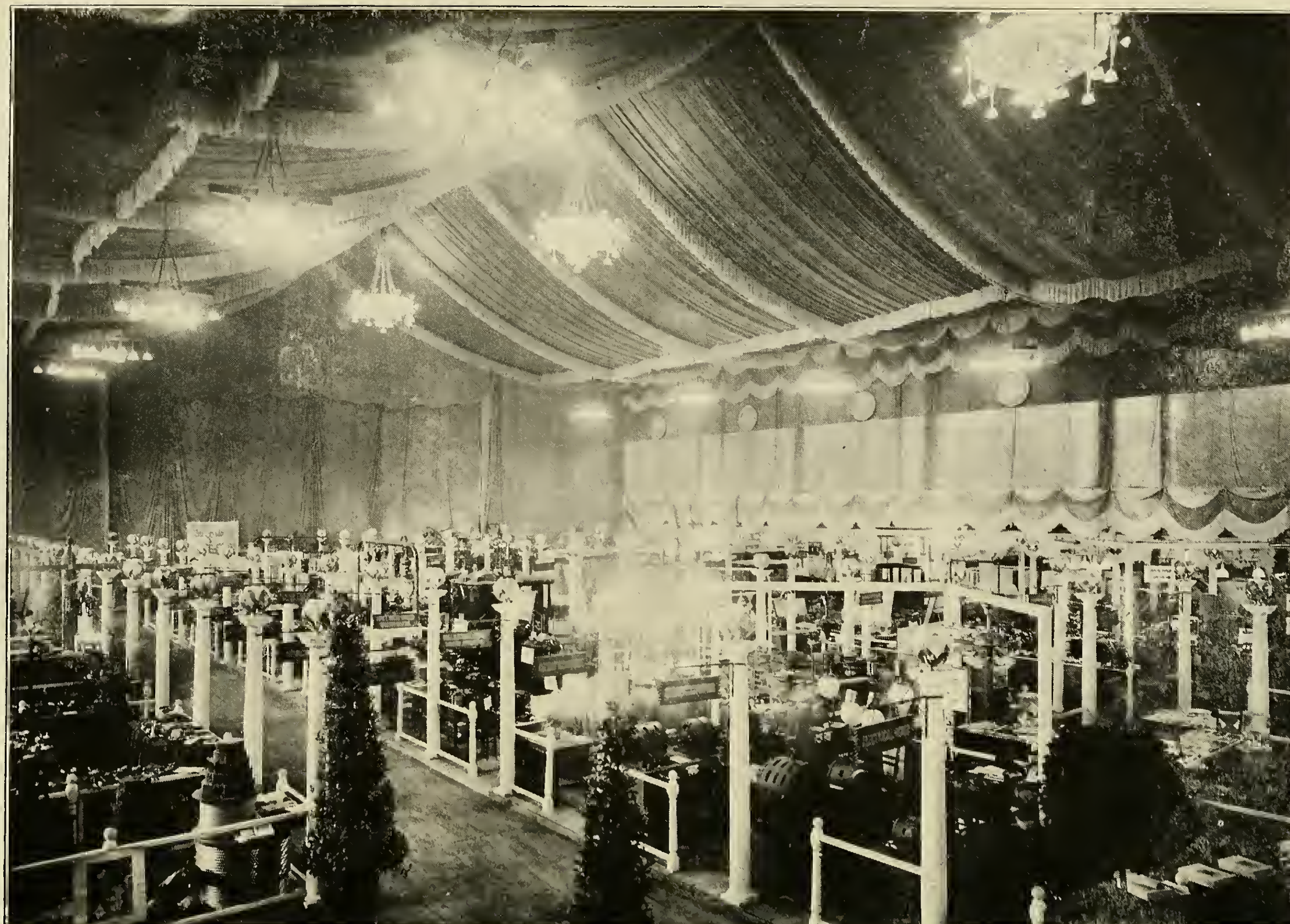
To-day the National Electric Light Association stands as the largest and most representative organization of electric light and power interests in the world. Allied with it are the principal manufacturers of electrical apparatus whose exhibits lend to the convention the air of a great exposition, a bare idea of which is gained from the illustration on the next page. The members flock to the convention from all over the United States, Canada, Mexico, and our island possessions. They come to listen to and participate in the discussions of papers read by the best talent in the engineering, management, accounting and business departments of the profession; they study the newest and most improved electrical equipment there on exhibit; they meet old friends and business acquaintances; they many of them bring their wives and families, who are entertained by an endless round of receptions, excursions, theaters, etc. Altogether it is a week of combined work and festivity, which an electric light man will plan on for a year ahead, even if he has to "pass up" everything else.

The scene of the convention this year was the fine concrete-steel Coliseum in St. Louis, with ground dimensions of 200 by 300 feet. The main hall contained the exhibits. At one end of the hall is a vast stage, recently used by the Metropolitan Opera Company. This was partitioned off from the main hall by a fireproof curtain, forming a great amphitheater where the principal meetings for the reading and discussion of papers were held. Other meeting rooms in various parts of the great building were utilized by other sections so that there were as many as three or four meetings being held at once. This year a daily paper was issued at the convention, of from 16 to 24 pages, which detailed the life and heart of the convention day by day.

On the evening of the 25th, an anniversary meeting was held, among the speakers being Elmer A. Sperry, one of the organizers of the association; Samuel Insull, past president, and known as the dean of the electric lighting profession; President Frank W. Frueauff; W. W. Freeman, chairman ot the public policy committee; T. C. Martin, executive secretary, and Frank M. Tait, secretary and treasurer.

Interesting and amusing incidents of the early days of electric lighting were related by Mr. Sperry. "There was abundant evidence," he said, "that many of us were willing to assume great risks at that time. Mr. Ridley, the Boston representative, told us how he lighted up a queen of light in some Boston theater; he told us she had a number of incandescent lamps in her hand and three or four on her head. He said, 'We took a loop from the arc light circuit and brought it down on the stage; these six or seven incandescent lamps took the full force of the current.' One can but wonder what would have happened to the queen had these lamps not taken the full force of the current.

"There was a strong feeling on the part of many that the series-parallel distribution for incandescent lamps would prove superior



MANUFACTURERS' EXHIBITS IN THE COLISEUM, ST. LOUIS, DURING THE NATIONAL ELECTRIC LIGHT CONVENTION to the multiple system owing to the vast amount of copper required in the latter.

"The first convention reflected very strongly the great controversy that was going on at this time between the telephone people and the arc light people. In many centers each had franchises. Complaint was made that the telephone people had wires strung on both sides of the street, and no place was left for the lighting poles and wires without too close proximity of the sets of wires producing serious induction. A committee was appointed on this matter, and in its report are to be found excellent suggestions and wise counsel.

"Think of these earnest fellows struggling with high-tension currents with no better insulation than "undertaker's wires," as it was familiarly called at that time. One speaker started his remarks with the comment that he did not mean to advertise any wire man; another man had difficulty with the insulation 'between the rubber covering and the wire.'

"In the discussion of motors, opinions were divided as to what efficiency should be expected. Many could not understand how it was that as between two similar machines, one being operated as generator and the other as motor, the efficiency could rise above 50 per cent, inasmuch as it was apparent that half of the total resistance was in the generator and half in the motor. There were some contemporary writings on this subject by Edward Weston that gave force to these remarks. I was deeply interested in this question of the motor at that time, but my talk is not recorded and posterity owes the reporter much. The only record that exists reads as follows: 'Mr. Sperry went into quite a lengthy discussion on this subject which, being all technical language, and being uttered by him very rapidly, was not understood by the reporter.' "

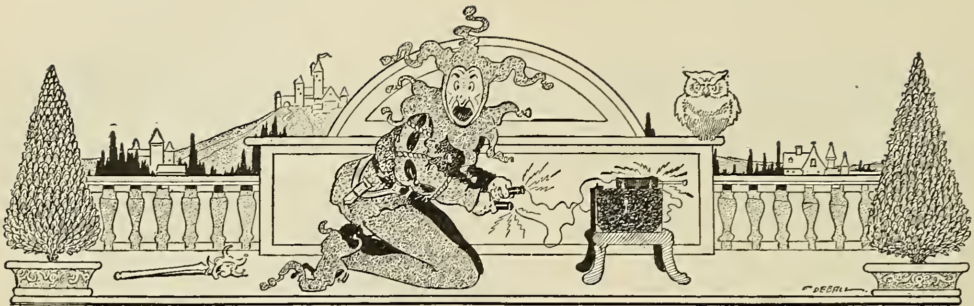
Speaking of the commercial aspects of the business Mr. Insull said:

"How far the commercial development of the business has been forced by the work of the engineers or how far the necessities of the salesmen and the business managers forced the technical development it is difficult to say, but the fact remains that as the possibilities of economical investment and economical production have increased, the business obtained and the energy distributed have increased by leaps and bounds, so that it is no uncommon occurrence for a central-station company to double its output every three to four years.

"In the early days of the development of the central-station business, say for the first ten years of its existence, from 1881 to 1891, the customers of the central-station companies looked upon our product as more or less of a luxury. Partly owing to a lack of knowledge of the conditions governing the relation of cost and selling price and partly owing to the difficulty of getting our customers to make the necessary investment to connect with our system, our service was used rather as a luxury, or an advertising proposition than as a necessity."

"It was not until the early nineties that any of the managers of the large central-station properties of the country appreciated the fact that if they desired to place their business on the basis of a general public necessity it was necessary for them to rearrange their rates on such a plan as would give the long time consumer, the man who used the central-station company's investment most steadily during the year, the lowest possible price; and the recognition of the necessity of meeting this condition may possibly have had as much to do with reducing the cost as have the wonderful work of the inventors and the marvelous skill of the engineers."

"It matters not by what name you may call it,—whether you speak of it as the improvement of your load factor, whether you speak of it as creating a day load,—the fundamental reason for the success of the business in which we are engaged is as much an appreciation of the proper method of selling our product as the opportunity to use the many brilliant inventions which have been made by the great technical minds of our time."



SHORT CIRCUITS

A little Swede boy presented himself before the schoolma'am, who asked his name. "Yonny Olson," he replied. "How old are you?" asked the teacher. "Ay not know hold ay bane." "Well, when were you born?" continued the teacher, who nearly fainted at the reply "Ay not born at all; ay got stepmutter."

* * *

"I thank you for the flowers you sent," she said,
And she smiled and blushed and dropped her head,
"I'm sorry for the words I spoke last night;
Your sending the flowers proved that you were right.
Forgive me."
He forgave her.
And as they walked and talked beneath the bowers,
He wondered who in hell sent her those flowers.

* * *

An editor had died and was, of course, directed to ascend to the Abode of the Just. But during the ascent the editor's journalistic curiosity asserted itself, and he said:

"Is it permitted for one to have a look at—er—the other place?"

"Certainly," was the gracious reply, and accordingly a descent to the other place was made. Here the editor found much to interest him. He scurried about and was soon lost to view.

His angelic escort got worried at last and began a systematic search for his charge. He found him at last seated before a furnace fanning himself and gazing at the people in the fire. On the floor of the furnace was a plate saying: "Delinquent Subscribers."

"Come," said the angel to the editor, "we must be going."

"You go on," the editor answered, without lifting his eyes. "I'm not coming. This is heaven enough for me."

* * *

The schoolhouse had just gone up in smoke, and the taxpayers in the crowd looked at one another and groaned.

A small boy, upon approaching the smouldering ruin, burst into uproarious grief.

"Does it grieve you so to lose your school?" asked a sympathetic bystander.

"T'ain't that," howled the boy, "but I left a nickel in my desk, and I'll never be able to find it in all that muss."

* * *

Mrs. Jones and her neighbor, Mrs. White, were talking over the back yard fence and neither of them could solve the identity of the new neighbors who had just moved in. Presently they saw the garbage man approaching and knowing him to be an unfailing source of information asked, "Jake, who are the new people who have just moved in?" "I don't know, mum," replied Jake, "but they have the swellest swill in the block."

* * *

Anxious Suitor—But, sir, I thrill at your daughter's slightest touch.

Practical Father—Young man, I find her slightest touch is usually for a hundred dollars.

(A serious accident, in one prolonged, agonizing stanza.)

Of recent date, I met a skate, who left the state in '98. His name was Nate,—his surname, Tate.

I'd really hate to perpetrate the rhymes of "ate" that fitted Nate; inebriate, degenerate, profligate and turtle bate,—At any rate you'd hesitate to advocate the cause of Tate.

The hour was late, when in walked Tate and calmly sate beside my grate. To irritate he took one straight, then didn't wait to thus relate:

"I had a date at Golden Gate to meet my Fate,—her name was Kate; no words of 'ate' are adequate to illustrate this girl sedate. Affectionate, compassionate—it makes my pate coagulate to contemplate. At any rate I got there straight and met my mate at 7:08. En tete-a-tete. (the lunch was great,) we sat and ate, and something fat-al in that bate got next to Kate and sealed her fate. It sent her straight—C. O. D. freight, a candidate to the pearly gate,—"

Here, to abate this tale of Kate, I grabbed a plate and threw it straight, then chased this Tate from my estate.

* * *

The village cornetist, who made his living as a barber, was massaging a patron's face.

"That's a peculiar way of massaging the nose," remarked the man in the chair. "Some New York method?"

"That? Oh, no, I was just practising the fingering of the Second Hungarian Rhapsody."

* * *

Prosecuting Attorney—Your Honor, the bull pup has gone and chawed up the court Bible.

Judge—Well, make the witness kiss the bull pup, then. We can't adjourn court for a week just to hunt up a new Bible.

* * *

"The country is going to the dogs!" shouted the agitator at a street meeting.

"Quit your snarling, then, and wait for your share!" said a spectator who sized the speaker up.

* * *

The train was drawing into Baltimore. The porter approached a Son of Jove, saying, "Shall Ah brush yo' off, Sah?" "No," was the reply, "I prefer to get off in the usual way."

* * *

"Thar's a sign up there, daddy, what says, 'Don't blow out the gas'."

"Well, who blowed it out? I jest hit it a lick with my britches an' I haun't seen nothin' er it sense."

* * *

"Mama, do all angels fly?"

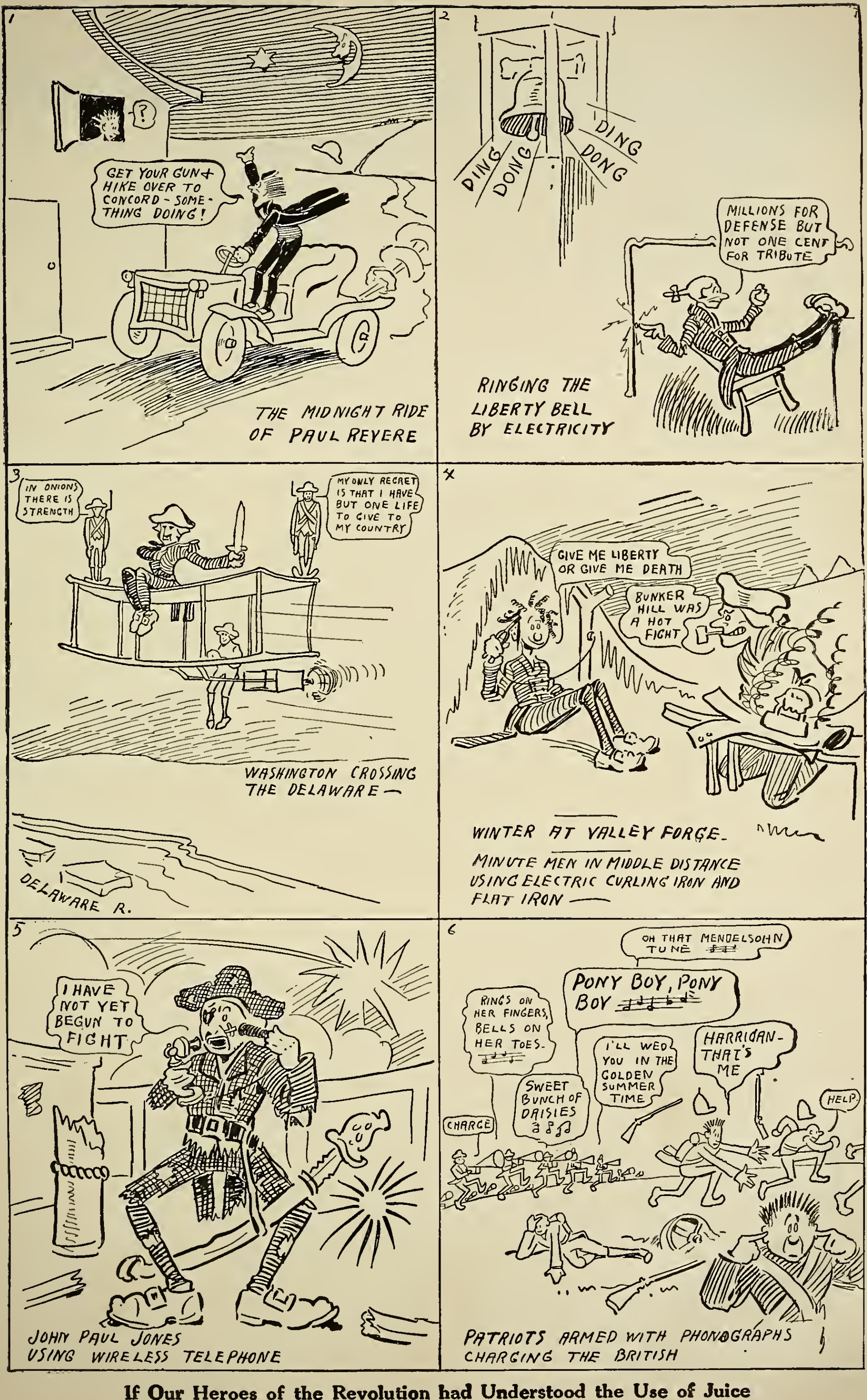
"Yes, Willie, why do you ask?"

"Cause I heard dad call the hired girl an angel the other day. Will she fly, too?"

"Yes, Willie, tomorrow."

* * *

"Mary," said the lady of the house, "I want you to go and see how old Mrs. Jones is." Mary went and after she returned the lady asked: "Well, did you find out how old Mrs. Jones is?" "Yes, ma'am; she says she'll be 60 years old next February, if it's any of your business."



If Our Heroes of the Revolution had Understood the Use of Juice

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.

ATMOSPHERIC ELECTRICITY.—Static electricity present in the atmosphere. The cause is not well understood. Atmospheric electricity varies greatly in amount and often changes very quickly from positive to negative or from negative to positive during a thunder storm. The cause for the great increase in the potential finally resulting in a lightning discharge is attributed to the change in the capacity of a cloud by the formation of large rain drops from particles of vapor, also from the friction between the cloud and air.

ATTACHMENT PLUG.—A device to which flexible or other wires may be connected so as to plug into a receptacle and thus supply current to portable lamps, motors, etc.

ATTRACTION.—The tendency of a body charged with static electricity of one polarity to approach or be drawn to another body oppositely charged, known as electrostatic attraction. Also shown between bodies capable of being magnetized, classified at electromagnetic or magnetic attraction.

AURORA.—Rays and bands of light seen in the northern and southern skies at night. Considered by some scientists to be due to the electric discharges in a thin or rarefied air similar to the display obtained in a Geissler tube.

B

B. W. G.—An abbreviation for "Birmingham Wire Gauge."

BACK ELECTROMOTIVE FORCE.—When a motor is in operation the wires of its armature are turning in a magnetic field the same as in the case of a dynamo. Therefore they generate an electromotive force or voltage, as in the case of the dynamo. This electromotive force is opposite to that impressed upon the motor from the outside source and opposes it—hence the name back electromotive-force.

BALANCED LOAD.—An equal distribution of the load on a two- or three-phase system, or between two generators, or on the two sides of a three-wire Edison system, or over five-wire distribution mains.

BANK OF LAMPS.—A number of lamps so connected that they may be thrown on a circuit as a load. Used frequently in electrical testing laboratories.

BANK OF TRANSFORMERS.—Applied to any group of transformers connected together to step up or step down the voltage.

BATH, ELECTROPLATING.—The solution in the vat in which articles are placed while being plated.

BATH, ELECTRO-THERAPEUTIC.—The application of an electric treatment to the body or to a portion of the body of a patient by means of suitable positive and negative electrodes. Called also an electric bath.

BATH, STRIPPING.—A term applied to the solution in which any electroplated article is placed for the purpose of removing this plating. It is the process of electroplating reversed.

BATTERY.—A term commonly applied to a combination of a number of cells for the production of electrical energy. Used also to designate a single cell for producing electrical energy. Applied to Leyden jars when two or more are connected together. Represented by the symbol:

BATTERY, ALUMINUM.—A battery having aluminum for the negative plate and aluminum sulphate for the electrolyte. Its E. M. F. is .2 volt.

BATTERY, BICHROMATE.—A battery consisting of a zinc plate for the positive element suspended between two carbon plates forming the negative element. The electrolyte is a solution of potassium bichromate, 1 part; sulphuric acid, 3 parts; water, 9 parts. Electromotive force, 2.1 volts. For open or closed circuit work. The plates should be removed from the solution when not in use.

BATTERY, BUNSEN.—A type of two fluid cell consisting of a bar of carbon immersed in strong nitric acid contained in a porous cup, this cup being placed in a glass jar containing water, 20 parts; sulphuric acid, 1 part, and a cylindrical plate of zinc. Potassium bichromate is sometimes substituted for the nitric acid which gives off disagreeable fumes. Electromotive force of this cell, 1.8 to 1.9 volts; internal resistance, .08 to .11 ohm. This battery is adapted for experimental work, but is expensive and requires frequent attention. May be used on either open or closed circuit work.

BATTERY, CADMIUM.—A battery set up like the gravity cell and consisting of a cadmium plate for the negative element, zinc for the positive and sulphate of cadmium for the solution. Electromotive force .3 volt.

BATTERY, CLOSED CIRCUIT.—A battery which may be kept on a circuit requiring a steady current without serious polarization.

BATTERY, DRY.—A battery in which the solution is replaced by some form of material which holds the exciting fluid by absorbing it.

BATTERY, FULLER'S.—Battery consists of a cone-shaped piece of amalgamated zinc within a porous cup. The zinc is connected to an insulated copper wire and a little mercury is placed in the cup. In other respects similar to the Bunsen cell (see Battery, Bunsen) except that the mercury renders it unnecessary to remove the plates from the solution when not in use. Sometimes referred to as the mercury bichromate battery. Electromotive force, 2.14 volts; internal resistance, .5 to .7 ohm.

BATTERY, LECLANCHE.—Consists of a glass jar in which is placed a zinc rod and a strong solution of sal-ammoniac. In this solution is placed a porous cup containing a carbon slab surrounded by small pieces of carbon and manganese dioxide. Over the top of this is spread hot pitch only a few small air holes being left. The cell is not ready for use until time enough has elapsed, usually ten or twelve hours, to allow the solution to soak into the porous cup. Electromotive force, 1.48 volts; internal resistance, 1.13 to 1.15 ohms. Adapted to open circuit work such as door bells, electric gas lighting, etc.