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ELEMENTARY ELECTRICITY.

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CHAPTER VI.—THERMAL OR HEATING EFFECTS OF ELECTRIC DISCHARGES.

One of the most important generalizations ever made in physical science is the doctrine of the conservation of energy, or, as it is sometimes called, the doctrine of the indestructibility of energy. Briefly stated, this doctrine is to the effect that the total quantity of the energy in the universe is unalterable, so that when energy disappears in one form, it must appear in another form.

By energy is meant the power of doing work. Work is done by the action of various natural forces acting on matter. The amount of work done can be measured by the force that does the work multiplied by the distance through which it acts. For example, the work done when a weight of one pound is raised through a vertical distance of one foot is equal to a force of one pound multiplied by a distance of one vertical foot through which the force acts or is equal to one foot-pound.

In a similar manner, in order to raise a weight of 100 pounds through the vertical distance of one foot an expenditure of 100 foot-pounds of work is necessary.

In accordance with the doctrine of the conservation of energy, since the total amount of energy in the universe can neither be increased or decreased, the energy or the power of doing work that is expended in any case is drawn from the constant stock of energy already existing in the universe. When 100 pounds were raised through the vertical distance of one foot, an amount of energy equal to 100 foot-pounds was expended. The total store of the energy of the universe has not in this case, nor in any of the phenomena that are constantly going on around us, been either decreased or increased. The energy has been transferred from one place to another, or from one form to another form of energy.

But when the 100 pound weight was raised through a vertical distance of one foot, it seems as if an amount of energy equal to 100 foot-pounds has disappeared. The question that, therefore, arises is what has become of the one foot-pound, or the 100 foot-pounds, of energy thus expended?

Suppose, when the weight of 100 pounds has been raised through a distance of one foot, say by means of a cord or rope passing over a pulley, that the 100 pound weight is supported at a distance of one foot above the surface of the earth. Let us suppose in this case that the work was done by the muscular energy of the arm of a man. As far as this man is concerned, an amount of energy capable of doing 100 foot-pounds of work has been expended. The man no longer possesses this energy. Apparently it has been blotted out of existence. But this annihilation is apparent, not real. It is as impossible to annihilate energy as it is to create it.

Energy is capable of existing in two different conditions; namely, as kinetic or working energy and as potential or stored energy. While the muscular force of the man is being expended in actually doing work, or raising the 100 pound weight, it is in a condition called kinetic energy. When the weight is held in position at a distance of one foot above the earth, it is producing a stress or pull on the rope and is in the condition of what may be called stored or potential energy, or energy that possesses the potency or the power of doing work. If the rope or cord is suddenly cut or loosed, the weight will descend and during this descent will do an amount of kinetic energy or actual work equal precisely to the 100 pounds of work that were expended in raising it to a distance of 100 feet from the ground.

The same thing is true of all physical phenomena. Take, for example, a lump of coal weighing 100 pounds. If this amount of coal is raised vertically through the distance of one foot, a hundred foot-pounds of work will have been stored in it as potential energy; this amount of energy, and no more, will be given out if the coal is permitted to fall.

But the atoms of carbon of which the lump of coal is composed have also been raised or separated from the atoms of oxygen with which they were originally combined, when they existed as carbonic acid gas in the atmosphere of the carboniferous age, the geological time when the coal was produced. A certain store of energy, drawn from the sun, has been expended in separating the atoms of carbon from the atoms of oxygen. A certain amount of potential energy has been stored in the carbon atoms, and when they are again permitted to fall towards the oxygen atoms, so as to unite with them, as they are when the coal is burned, the potential energy stored in the separated atoms again becomes kinetic. In a similar manner all the chemical elements possess a store of chemical potential energy differing in amount in a given weight, say one pound, of the different chemical elements, but always the same in the same element.

It is the chemical potential energy that is stored up in the elements forming our food that become liberated when the food is consumed, and forms the source of the store or stock of muscular force that a man or any other animal is capable of exerting.

As will be seen the doctrine of the conservation of energy is necessarily connected with another equally important doctrine known as the correlation of energy. Energy is indestructible. It is capable of existing in many different forms, such as sound, heat, light, electricity, magnetism, mechanical force, etc. It disappears in any one form only to reappear in another form. When coal or any other combustible material is burned in air, its chemical potential energy, or its power of combining with oxygen, disappears and reappears in a kinetic form as heat or thermal energy.

The quantity of heat produced by the combustion of a certain quantity of coal in air is therefore fixed and definite. The amount of chemical potential energy liberated when a given quantity of coal is burned in air, is exactly equal to the amount of energy expended by the sun in decomposing the carbonic acid gas in the earth's geological atmosphere, or in raising a given quantity of carbon atoms above the oxygen atoms. When these atoms again fall together, or when the coal is burned in the air, exactly this amount of chemical potential energy again becomes kinetic.

If the heat produced by the combustion of coal takes place under the boiler of a steam engine, and mechanical work is done by the engine through any suitable machine, it will be found that a definite quantitative relation exists between the amount of heat expended by the engine and the amount of mechanical work done by the machine the engine is driving.

Heat may be produced by the burning of metallic zinc in air, and the heat so produced employed for doing mechanical work. Or the chemical potential energy of the zinc may be employed as in the voltaic cell for the production of electric energy. Here the amount of electric energy produced bears a definite quantitative relation to the amount of chemical potential energy stored in the zinc.

If heat produced in any manner is permitted to fall on the face of an electroreceptive device, known as the thermoelectric pile, such as shown in Fig. 42 ("Electricity and Magnetism," Guillemin), heat energy is converted into electric energy. The electricity so produced may be converted partially into magnetism and so deflect the needle of a galvanometer placed in the circuit of the thermo-pile at the right hand of the figure or it may be caused to produce any other electric effects. In either case, there will be found a definite quantitative relation existing between the heat energy expended when the heat falls on the face of the pile, or in the magnetic energy produced in the field of the conductor on the passage of electricity through the coils of the galvanometer.

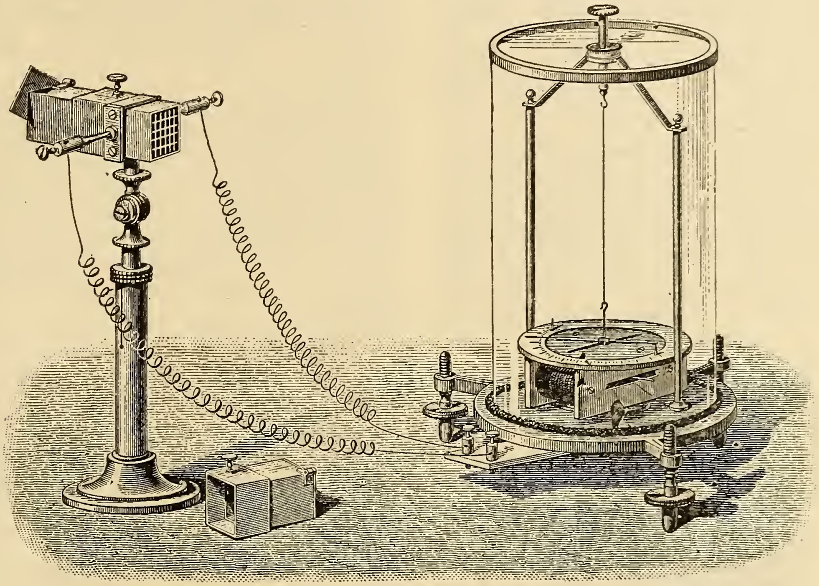


FIG. 42. THERMO-ELECTRIC PILE.

When light energy is permitted to fall on the face of a device known as a selenium, or photo-electric cell, shown in Fig. 43 ("Electricity in Everyday Life," Houston), a portion of the luminous energy is converted into electric energy. Here again a definite relation exists between the amount of luminous energy absorbed and the amount of energy existing in the electricity produced. During its passage through an arc or incandescent lamp, electricity may produce luminous effects accompanied by heat, but a definite and quantitative relation exists between the amount of energy absorbed during its passage through the lamp and the amount of luminous energy that appears in the light produced.

A certain amount of mechanical force is expended in driving a dynamo-electric machine. Even if the dynamo were perfect in its action and no loss occurred by friction against its bearings by air churnings or in many other ways, the amount of energy produced in the shape of electric energy would always bear a fixed and quantitative relation to the amount of electric energy existing in the electricity it produces.

It is practically never the case that all

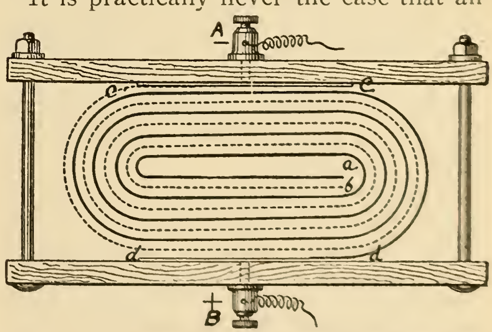


FIG. 43. SELENIUM OR PHOTO-ELECTRIC CELL.

the energy in one form is converted into energy in one other form. Some of the energy is almost invariably converted into heat, that, lost by radiation or conduction, becomes non-available to man. The luminous energy that falls on the surface of the thermo-electric pile is not all converted into electric energy. A very large proportion is converted into heat and dissipated or lost by radiation or conduction. Not all the mechanical energy that drives a dynamo is converted into electrical energy. Much is lost to the circuit as heat developed by friction, by the churning or air currents, by the production of parasitic or Foucault currents produced in the iron cores of the armature or field magnets.

Not all the electric energy that passes through an arc or incandescent lamp is converted into luminous energy. By far the greater proportion is converted into heat, and is therefore lost so far as artificial illumination is concerned. And the same is true of all other conversions of energy in one form to another.

A great deal of the mystery that exists in the minds of many concerning electricity will at once disappear when it is understood that, like all other natural forces, electricity is only one of the many forms in which energy is capable of manifesting itself. Like all other forms of energy electric energy, or the power electricity possesses of doing work, is fixed and determinate. An electric source is able under given conditions to produce a certain quantity of electricity and this quantity only. No matter what may be its construction, the amount of electricity a voltaic cell is capable of producing is limited to the quantity of chemical potential energy liberated by the combustion of its zinc in the acids of the cell; and here, as in all other cases, losses occur by which a fairly considerable portion of the energy is uselessly expended as heat and fails to appear as electric energy in the circuit of the cell.

When electricity is caused to flow between any two points in a circuit the amount of work it can perform is equal to the amount of electricity that passes multiplied by what is called the difference of potential through which the electricity falls or moves.

When work is done on a quantity of water by forcing it into a reservoir at a higher level than that from which the water has been raised, the amount of work done can be measured in foot-pounds by the quantity of water in pounds so raised, multiplied by the difference in level through which it is raised in feet. While it is not our intention to suggest that electricity is a fluid, yet it possesses many of the properties of a fluid, so that the amount of work electricity is capable of doing depends on the quantity of electricity moved as well as on the difference of the electric level or potential through which it has been raised.

The unit of quantity of a water current may be taken as a cubic foot or a cubic inch. In electricity the practical unit of quantity is a certain quantity of electricity called a coulomb. In measuring this quantity of electricity reference must be had to certain other electrical units; i. e., the ampere, the volt and the ohm.

The ampere is the name given to a practical unit of electric current and is such a rate of electric flow as is capable of transmitting a quantity of electricity equal to one coulomb per second. A current of electricity equal to one ampere will flow through a circuit whose resistance is one ohm, when acted on by an electromotive force or pressure of one volt. An ampere is approximately such a current of electricity that is capable of depositing 1.118 milligrammes of silver per second from a specially prepared solution of silver nitrate.

The volt or practical unit of electromotive force is an electromotive force or pressure that is capable of causing the flow of an electric current of one ampere through a circuit, the electric resistance of which is equal to one ohm.

The ohm is the practical unit of electric resistance. It is the resistance that would limit the flow of electricity under an electromotive force of one volt to a current of one ampere or to a discharge of one coulomb per second. It is equal to the resistance of a column of pure mercury one square millimetre in area of cross section and 104.9 centimetres in length.

A coulomb is the practical unit of electric quantity. It is the quantity of electricity that would pass in one second through a circuit carrying a current of one ampere.

Electric energy can be measured in terms of electric power or rate of doing work. A careful distinction should be made between work or the product of force by the distance through which the force acts, and power or rate of doing work. As we have already seen, the unit of work is called the foot-pound. The unit of power or rate of doing work, or, as it is sometimes called, the unit of activity is equal to the foot-pound per second, or foot-pound second.

The amount of work electricity is capable of doing is equal to the quantity of electricity that flows multiplied by the difference of level or potential through which it flows. This is the volt-coulomb or joule. The amount of electric activity or work per second is equal to the volt-ampere or the watt.

The volt-ampère or watt is equal to the power developed when 44.25 foot-pounds of work are done per minute, or 0.7375 foot-pounds per second.

If the ampere is replaced by the symbol C, and the watt by the symbol E, then C multiplied by E, or CE equals the volt-ampere or the watt.

A definite quantity of energy must be expended in order to raise the temperature of a pound of water or of any other kind of material through a given difference of temperature. The quantity or amount of this energy is capable of being expressed in foot-pounds. It can be shown that in order to raise the temperature of one pound of water through one degree of the Fahrenheit thermometer scale, an amount of work must be done equal to 778 foot-pounds or the work required to raise 778 pounds through the vertical distance of one foot.

The joule, or the unit of electric work, is capable of being expressed in foot-pounds, and is equal to 0.738 foot-pounds, or about the amount of work required to raise one pound through a vertical distance of nine inches. In order, then, to raise the temperature of one pound of water through one degree Fahrenheit, requires the expenditure of .778 foot-pound divided by 0.738 or 1.055 joules.

Therefore, when an electric discharge passes through a circuit, and heat is produced, the amount of heat a certain quantity of electricity is capable of producing is perfectly definite. To raise the temperature of one pound of water through one degree Fahrenheit, requires either the expenditure of 778 foot-pounds, or of 1.055 joules. In a similar manner, to raise the temperature of one pound of copper wire, or of any other metallic wire through a given number of degrees, requires the expenditure of a definite amount of electric energy.

Now, when an electric current is passed through a conductor and raises its temperature a certain number of degrees, if this temperature is to be maintained constant, a certain constant expenditure of energy is necessary. In other words, there must be expended a certain number of foot-pounds per second; i. e., 0.738 foot-pound per second or joules per second, or watts.

In order to measure the amount of heat that is produced in any conductor, or in any piece of electrical apparatus in a given time, a device known as an electric calorimeter is employed. This device, as represented in Fig. 44 (Houston's Dictionary of Electrical Words, Terms, and Phrases), consists of a vessel capable of holding a certain quantity of water, say one pound, and provided with a thermometer (T). The electric discharge or current passes through a coil of wire that is immersed in a given quantity of water and the amount of heat produced is determined by the increase in temperature. The amount of heat produced is proportional to the resistance of the conductor, and to the time the current is passing. When the resistance of the circuit remains the same, it is proportional to the square of the current strength.

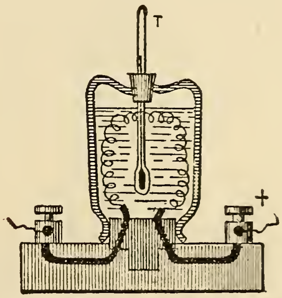


FIG. 44. ELECTRIC CALORIMETER.

The passage of an electric discharge through air results in an increase in the temperature of the air. This can be shown by means of an apparatus known as Kinnersley's electric thermometer consisting as represented in Fig. 45 (Guillemin), of a vessel consisting of two vertical glass tubes communicating with each other, and filled with water. The larger tube is closed at the top and is provided with two smooth metallic balls separated from one another by an air space as shown. The smaller tube is open at the top. Under ordinary circumstances the level of the liquid is the same in both tubes, but on the passage of an electric discharge between the balls, the air is expanded, and, exerting a pressure on the surface of the liquid in the large tube, causes it to mount higher in the small tube. Sometimes the amount of this pressure is sufficiently great to throw some of the liquid out of the small tube.

Another way in which the increase in temperature of the air caused by the passage of an electric discharge can be shown is the device known as the electric mortar. This apparatus is represented

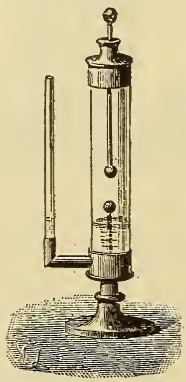


FIG. 45. KINNERSLEY'S ELECTRIC THERMOMETER.

in Fig. 46 (Guillemin). On the passage of an electric discharge between two polished balls placed within the mortar, such an expansion of the air occurs that a violent expulsion of the ball is caused. This may be increased by placing a few drops of ether inside the cannon. On the passage of the sparks an explosive mixture of ether vapor and air is ignited thus greatly increasing the force with which the ball is thrown out of the mortar.

While the amount of heat produced in any circuit by the passage of an electric discharge depends on the amount of electricity passing, yet the difference of temperature which a given amount of electrical activity is capable of producing depends on a variety of circumstances such as the dimensions of the circuit, the capacity of the circuit for heat and electric resistance of the material of the circuit per unit of length.

If the wire or conductor through which an electric discharge is passing is sufficiently thin and small, the wire may be raised to a temperature sufficiently high to become luminous.

The conductor may even be sufficiently

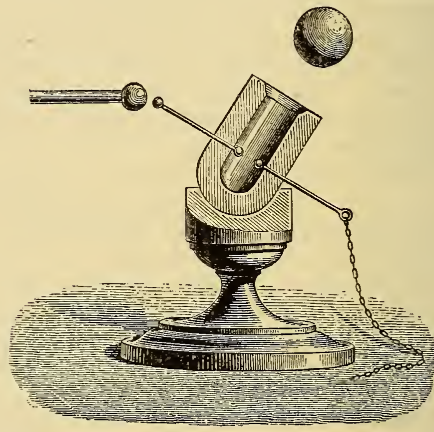


FIG. 46. THE ELECTRIC MORTAR.

heated to volatilize or pass off as vapor. Instances of this are seen in the case of arc and incandescent electric lamps. Advantage is taken of the ease with which a metal is volatilized by an electric discharge for the production of what is known as an electric silhouette, where

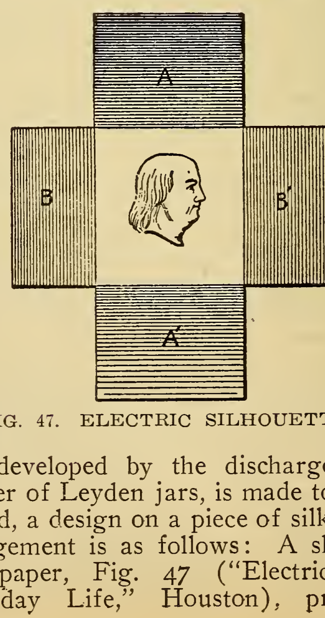


FIG. 47. ELECTRIC SILHOUETTE.

heat developed by the discharge of a number of Leyden jars, is made to print, in gold, a design on a piece of silk. The arrangement is as follows: A sheet of stiff paper, Fig. 47 ("Electricity in Everyday Life," Houston), provided with suitable outlines and perforation, to form, say a portrait of Franklin, is placed on a piece of white silk. A sheet of gold leaf is then placed on the paper and strips of tinfoil (A A′) and (B B′), are placed as shown. The pieces (A A′) are folded down and over the picture, and then the whole placed in a press and tightly brought together. If now the terminals of a Leyden jar or battery are placed in connection with the projecting edges of (B B′), the passage of a discharge through the gold volatilizes it, producing through the perforations of the paper a dark purplish stain of metallic gold on the surface of the silk.

But besides the cases above mentioned the passage of an electric discharge instead of producing such high temperatures that the conductors become highly luminous, may only produce a small degree of heat, as in various electric heaters, or the heating effects are limited to such a dull incandescence as readily permits metals to be forged or welded. These specific devices, however, will be afterwards described.

(To be continued.)

UNIQUE ELECTRIC BUG TRAP.

An electric bug trap is being employed by the Saxon authorities in Germany to fight the caterpillar plague which is having such a disastrous effect on the forests.

The contrivance consists of two large and powerful arc light reflectors placed over a deep receptacle provided with powerful exhaust fans. The device has been erected on top of the municipal electric plant. At night two great streams of light are thrown from the reflectors on the wooded mountain sides half a mile distant.

The results have been astonishing. The moths—which lay the eggs from which the caterpillars come—drawn by the brilliancy come fluttering in thousands along the broad rays of light. When they get within a certain distance of the reflectors the exhaust fans take up their work, and, with powerful currents of air, swirl the bugs down into the receptacle.

On the first night three tons of moths were caught. It has been decided to build another trap on the Rathaus tower, and the fight will be continued.

TELEGRAPH POLES OF STONE.

In Bolivia between the city of La Paz, the capital, and the town of Oruro, the terminus of the railway connecting it with the sea port of Antofagasta, there still may be seen the remains of what was probably the most original telegraph line ever erected, says the London Electrical Review.

In this part of Bolivia there are no growing trees, and wood is so difficult to procure that even the ordinary household furniture of the natives is invariably

STONE TELEGRAPH POLE.

made, not of wood, but of dried mud.

It is, therefore, not surprising that when the war broke out in 1889 between Chile and Bolivia, and the need for a telegraph line between the two places mentioned became urgent, that, as all communication with any sea port was cut off, this material was used to construct pillars to take the place of ordinary posts for supporting the wire, with the addition of old bottles as insulators.

These pillars were substantially built on stone foundations, and measured about five feet square at the base, with a height of about 15 feet. They were placed at intervals of about 350, and thus held the wire at a height sufficient to clear the only animals of the country, the llama and the donkey.

The total length of the line was 156 miles, and it rendered useful service for some years before being replaced.

ELECTRICITY IN COAL MINING.

PART 1.—MINE LOCOMOTIVES.

As coal becomes more scarce, and with a steadily increasing demand, mining methods must be constantly improved in order to meet the requirements of profitable production. As in the case of a multitude of other industries, electricity has come to the aid of the mine owner, increasing output and economy. The days of the mine mule are numbered for his place has already been taken by the "electric mule" in a majority of the large mines, and the application of electricity to mine haulage is rapidly increasing among the smaller properties.

MINE LOCOMOTIVE AT THE END OF A TRACK SECTION.

Mining locomotives as a type are the outcome of the peculiar conditions prevailing in the mine. Low down and massive, they are designed to economize head room to the last degree, for with a thin vein, say four feet in thickness, it is important that as little excavating as possible be done in the rock above and below the vein.

Mine locomotives derive their power from an overhead trolley the current being returned through the track rails as in the case of the ordinary street car system.

Instead of being supported by poles, the trolley wires are carried by specially insulated hangers which are fastened to the overhead timbers or directly to the mine roof, and the manufacture of these hangers and the other accessories of the trolley equipment constitutes a considerable industry in itself.

The locomotives shown in the accompanying illustrations are known as the rack rail type, built on the Goodman system. Level track haulage is comparatively easy, involving merely the overcoming of train and track resistances, which amount to very small percentages of the train weight. Up-grade haulage is difficult work, because in addition to the resistances met in hauling

MINE LOCOMOTIVE AND A TRIP OF LOADS.

MINE LOCOMOTIVE DESCENDING A STEEP GRADE.

on level tracks, there is introduced the work of lifting the whole train weight, more or less gradually, according to the pitch of the grade.

In moving up grade with the rack rail type of locomotive no dependence is placed on the tractive effort of the locomotive, that is, its ability to stick to the rail through its weight. The pull is exerted through a cog wheel under the locomotive which engages the teeth of a rack fastened on the floor of the mine, between the rails. The cog wheel is driven by the motors and the machine literally climbs up the rack, dragging its train of cars behind. Where there is no grade the rack is dispensed with and the locomotive proceeds by its tractive effort alone.

The operator of a mine locomotive sits on a low seat at the rear, his head reaches above the top only enough to give him a clear view ahead, and he operates the locomotive by means of a controller similar to a street car controller.

The advantage of electric haulage over mules lies in greater speed and heavier loads attainable and in the economy of operation. Electricity is at the same time available for the operation of pumps, and for lighting, drilling and operating coal cutting machines. The power is generated at the surface and is there available for operating crushers, tipples, etc.; so that, a complete electrical equipment is practically a necessity in the attainment of the most economical results. Often there are a large number of mines owned by a single company and situated in a comparatively small area. Here a single power plant may be built, and the current transmitted at high tension to the different mines, there to be transformed down to working voltage, this scheme still further reducing the cost of power, through the greater efficiency of the large plant over several small ones.

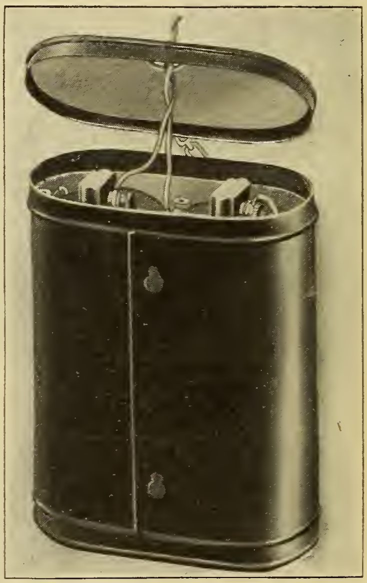
THE JAPANESE TELEGRAPH CODE.

The Morse Signals used in telegrams written in the Japanese characters are fifty in number, in addition to those representing figures, and the signs of punctuation, etc., says a writer in St. Martin's LeGrand. These signals are partly composed of those representing the Morse alphabet, and partly of additional combinations of dots and dashes.

Telegraphically speaking, about 3.65 Japanese letters are equivalent to one word in English, which on an average consists of 4.67 Morse letters, and therefore one Japanese Morse signal corresponds to 1.28 international Morse signal. It may be perhaps interesting here to note how Japan is related telegraphically to foreign countries. Of the whole number of foreign messages forwarded or received, and which amount to some 800,000 a year at present, about forty per cent are credited to Korea, twenty-eight per cent to China, nine per cent to England, seven per cent to the United States, four per cent to France, two per cent to Russia and four per cent to all other countries.

A NEAT BATTERY BOX.

It is oftentimes the case that the dry batteries used with local battery telephones, door bells, etc., are put in "any old place" where they are frequently knocked over, the connections tangled

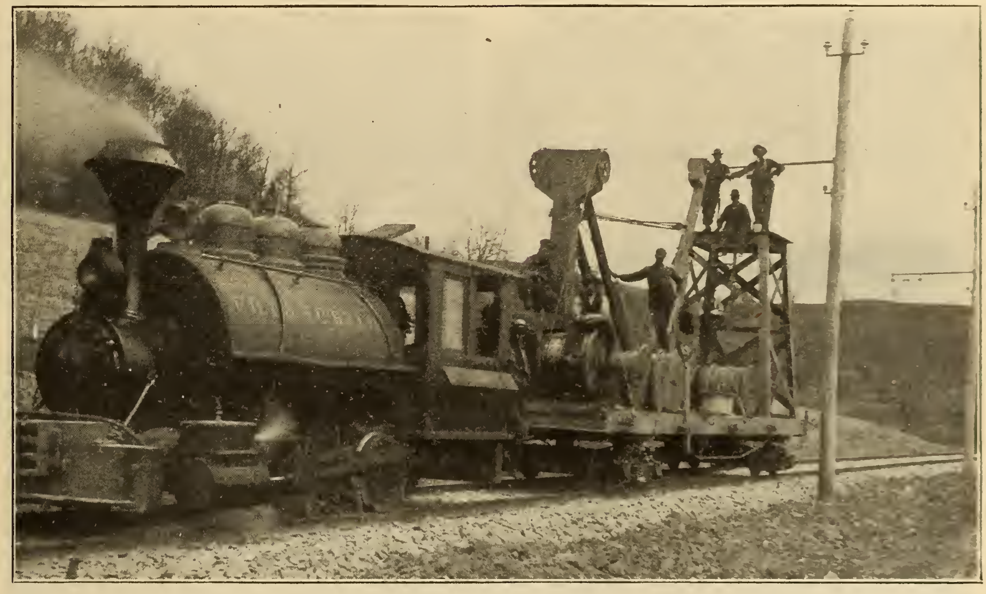


A NEAT BATTERY BOX.

or broken and where they present at best an unsightly appearance. Along comes a man with an idea, however, which takes form in the Paragon battery box shown in the illustration. This is the invention of F. W. Pardee, Cambridge building, Chicago. It is made to hold two dry battery cells snugly with a cover for the top and provided with openings at the top and bottom through which the battery leads are passed. The box is made of sheet steel, finished in black Japan and lined inside with insulating fiber which protects the sides of the box and edges of the openings. The cover is attached to the box by a nickel plated chain. It can be fastened in any convenient place and may be attached to a wall, desk or any desired surface.

STRINGING DOUBLE TROLLEY WIRE.

For stringing trolley wire on the Pittsburg, Harmony, Butler & New Castle Railway, now under construction, Chief Engineer Harry Ethredge designed a special work car which shows some interesting features. The road was built with double trolley wire. At one end of the flat car were erected supports for holding two reels of wire. A timber brake gave the proper tension and the wires passed up over two 20-inch sheaves on a 15-foot mast just back of the reels. From there they passed over two 10-inch sheaves on a movable boom. The spacing of the sheaves at the mast was 42 inches and at the boom 13 inches, so that the wires came together at the proper angle for the 8-inch spacing where they were tied. The idea of the movable boom was to follow curves accurately and to keep the strain of shifting the wires off from the shoulders of the men and bring the wires to the position desired. In stringing the overhead, the trolley was first tied loosely to the cars and later pulled up and secured to Figure 8 clinch ears. With this arrangement it was possible to string about three miles of double trolley per day.—Electric Traction Weekly.



STRINGING DOUBLE TROLLEY WIRE.

GLASS TELEGRAPH POLES.

Europe is now beginning to use glass telegraph poles; and patents have been granted in Germany and the United States, for a machine to be used in their manufacture. The poles are said to be especially valuable in countries where wooden poles are quickly destroyed by insects or by climate. The Imperial Post Department of Germany, it is said, has already ordered that these poles be used in its telegraph or telephone lines. The poles will be more sightly than the present wooden affairs, and in countries where the timber is nearly exhausted, they will lessen somewhat the great drain upon the rapidly vanishing forests.

TREMENDOUS HEAT DEVELOPED BY LIGHTNING.

The remarkable heating effect of a lightning discharge was exemplified recently near Ben Hur, Ark. Lightning struck and completely destroyed fully a quarter of a mile of wire and, aside from a few small partially melted pieces, not a trace of the wire could be found. Evidently the intense heat had vaporized the metal. The small pieces found were only a few inches in length and were twisted into every shape imaginable. Several were welded together as if done by a blow torch.

NEW AUTOMATIC TRANSPORTATION SYSTEM.

Fancy a little car that travels silently and diligently on an overhead track that meanders from house to house through the country, leaving a package here, accepting another there, ringing the doorbell of the recipient, and in short showing almost human intelligence. Such is the conception of a Buffalo man, Mr. William C. Carr, inventor of a new electric system of transportation which is motored carriers will be sent out with the mail and the parcels for the farmers living along the route traversed by the system.

The carrier travels at the rate of 25 to 30 miles an hour. When it approaches a station, it slows down automatically and leaves a mail box containing the farmer's mail locked in a station in front of his house, rings an electric signal in the building, picks up the box containing the out-going mail deposited by the

FIG. 1. NEW AUTOMATIC TRANSPORTATION SYSTEM.

designed not only to serve the purpose of a mail and package delivery system for rural districts but also, when built on a sufficiently large scale to carry the bulkier products of the farm, to deliver coal, etc.

This new automatic transportation system, as proposed for rural districts, comprises a series of Y-shaped metal or concrete poles supporting a double steel track which is elevated from 12 to 20 feet above the ground, excepting at the several stations in front of farmers' houses, where the track will be lowered to a convenient height. These lines will run in loops from a central station where

farmer, and proceeds on its way, acquiring at once its speed of 30 miles an hour.

The processes of delivery and collection are both accomplished automatically, and the progress of the carrier along its route is noted by an indicator in the central office, which shows the exact location of the carrier while making its rounds. One man may operate as many of these loops as are required from one central station.

The cost for power for sending a carrier around a 25 mile loop is but a few cents. Snow, ice and severe weather will not hamper the operation of the carrier.

The point of contact between the car and the rail—where the power is taken—is underneath in an inverted V-shaped groove which affords protection from the elements.

In connection with this rural system of transportation, a telephone service may be installed, and telephones may be provided for the farmers along the route.

The operating company can furnish electric energy to the farmer for running his farm machinery and illuminating his house. The farmer may telephone over the company's service to the central station for a special car to bring in his farm produce, and he may also have delivered to him merchandise from the city stores.

An actual line in operation is shown in Fig. 1. This line was built for demonstration purposes and shows the system as applied to mail collection and delivery. When a farmer has any mail to be delivered to the postoffice it is placed in a sheet iron box and mounted on a suitable stand so that the carrier in passing over picks it up on the horizontal prongs or arms. Mail to be delivered to the farmer is placed in a similar box and by means of a simple device is automatically dropped at the proper station.

It is also proposed to use the system for underground work in the delivery of mail matter and packages in the larger cities to take the place of pneumatic tube systems. Fig. 2 illustrates the method proposed. This system contemplates the construction of concrete tubes with a two-rail track mounted on the inside upon which the motor operated carriers will run and be controlled as in the overhead system.

Many are of the opinion that the automatic transportation system will prove of great value in many fields besides mail and package delivery. For instance, in the wheat belts of the west and Canada private systems might be installed on the immense tracts and the grain transported to the central granary at a very small cost. The same applies to the great sugar plantations of the south.

In the coal section it could be applied to the transportation of the mined product from distant galleries to the mouth of the mine, now requiring thousands of mules and drivers.

A feature of interest to electric central stations is the possibility of furnishing cheap electric lights, heat and power in every farm house along the route through the rural sections. Tapping the rails, a farmer can enjoy electric lighting in his house, electric heat in his cook stove, and electric machinery.

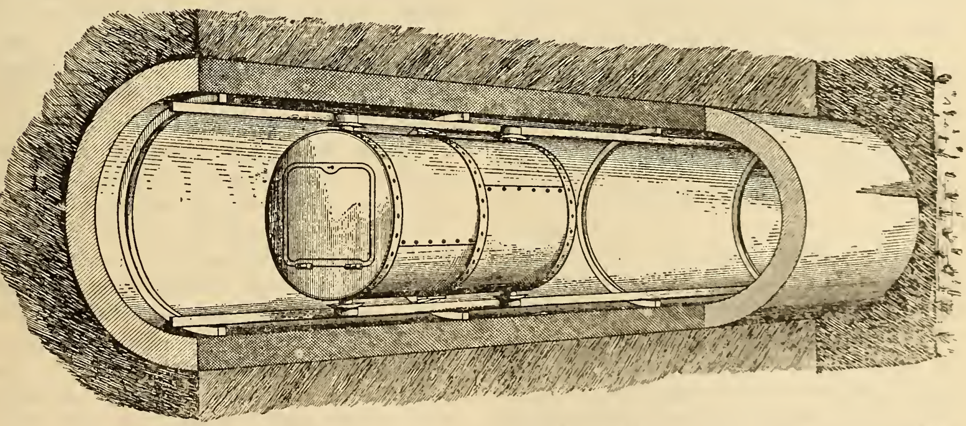


FIG. 2. AUTOMATIC TRANSPORTATION SYSTEM AS APPLIED TO UNDERGROUND TUBES.

ELECTRIC POWER FROM PEAT.

Steps are now being taken toward the erection of a large electric power plant in County Kildare, Ireland, near the city of Dublin. This plant will utilize peat moss for fuel, the peat to be taken from the Bog of Allen. A power development of 15,000 horsepower is contemplated, this power to be made available by high tension transmission over an area of 847 square miles. Engineers say there is sufficient peat in the bog to supply fuel for 50 years.

FAVORITE MARKS FOR THUNDERBOLTS.

Professor E. J. Houston, well known authority on electrical phenomena, and author of the serial on "Elementary Electricity" which appears from month to month in this magazine, contributed an article to the Philadelphia North American upon the subject of lightning and some of its favorite marks. The following paragraphs from this article present Professor Houston's views on the subject in an interesting manner:

It is now generally believed that most lightning discharges or thunderstorms are due to an electric charge produced in the air by the evaporation of moisture. Like all charges, those existing in moist air are spread out over the surface of the particles or minute drops of water that form the clouds. When the cloud particles are condensed as raindrops, a marked decrease in area occurs, so that the density of the electric charges increases. In other words, an increase occurs in the depth of the electric fluid constituting the charge. In this way it is now generally believed that the high potential of the lightning flash can be explained.

If the above theory be true, then it would follow that thunderstorms and lightning flashes should be found principally in those parts of the earth where the condensation of the charged vapor rapidly follows its formation. If too long a time occurs between vaporization and the condensation the electricity charged on the vapor particles will be dissipated or dispersed through the air. If, on the contrary, the condensation rapidly follows the evaporation, then we have all the conditions necessary for powerful lightning flashes.

This theory accords fairly well with the fact. The most severe thunderstorms occur within the tropics during those seasons of the year corresponding to the times of the rainfall. In a belt of land lying on either side of the equator and on the side, according to position of the sun, when the sun is overhead, severe thunderstorms are of daily occurrence. They always accompany the rainfall. Now, since in these regions the vapor that is formed during the morning hours is condensed during the afternoon hours, the conditions for the formation of heavy lightning flashes must be those above given.

There are conditions in which a person may be placed that will especially render him likely to be struck by a lightning discharge. A disruptive discharge, that is, a lightning flash, never occurs between a cloud and the earth until an opposite charge is produced by induction on some body on the earth. A flagpole would receive by induction on its upper end a negative charge from a positively charged cloud floating over it. An accumulation of electricity occurs both on the part of the cloud underneath the pole and on the end of the pole. If the difference of these charges is sufficiently great, the air between the cloud and the pole will be disrupted or broken and a lightning flash will pass. Consequently, it is the highest objects that are more likely to receive discharges.

There are certain especially dangerous positions for persons to assume. I can conceive of nothing more dangerous than a man marching with a gun over his shoulder, whether it is supplied with a bayonet or not, though more so with a bayonet, either during a thunderstorm or slightly before it, when the air is charged with electricity. Such a man becomes a veritable walking lightning rod of the most dangerous type. The upper point of his gun or bayonet receives a charge which invites a discharge from the cloud, but no means have been provided for the passage of this discharge to the ground. This must almost invariably result in the man's death.

In a similar manner the carrying of a sword is also highly dangerous, because here again the discharge being invited, and having no means for a safe escape to the ground, will probably result in the man's death.

In a similar manner I do not think it advisable to permit the steel-ribbed leggins to be employed, since these would act as lightning rods. Fortunately, however, they extend only a short distance below the man's knees, still they are dangerous. I noticed in this morning's paper a statement objecting to the possible danger of steel leggins, on the plea that the mass of metal in these leggins was so slight. It is by no means the mass of the conductor that constitutes the danger, but the position of this mass.

In a similar manner any uniform mass of metal, or, better, any area of metal worn about the head, either as a cuirass or as the regimental mark, forms a positive source of danger.

Surprise is sometimes expressed at what are styled the wonderful narrow escapes from death by thunderbolts. There are well known cases on record where persons have been apparently struck by lightning discharge and hurled bodily a distance of fifteen or twenty feet through the air, and yet found with no other injury than probably the bruises which would naturally be produced by such unceremonious handling. At times, however, all their clothes have been removed, completely ripped from their bodies, even the boots and shoes torn from their feet, and yet without any other injury. A surprise is expressed because of absence of death. It would seem that such discharges should undoubtedly have caused instant death.

I think it can be safely said that in such cases there was no actual passage of electricity through the bodies. The fact that watches, penknives, bunches of keys found on the bodies of these persons have apparently been fused by a lightning flash is no contradiction.

The explanation is, I think, simple. A lightning discharge does not consist of a single rush of electricity between the cloud and the object on the earth. There is first a rush from the cloud to the earth. Then a somewhat less powerful rush in the opposite direction from the earth to the cloud; then another rush from the cloud to the earth, and the reverse, these alternate rushes taking place with rapidly decreasing intensity for a comparatively few times. In other words, the lightning flash is oscillatory or rapidly alternating in direction.

Now, it is a well known fact that alternating electric currents such as are to-day employed on a large scale for the lighting of arc and incandescent electric lamps and the driving of motors can readily set up, by a process known as induction, a powerful electric current in all masses of metal which may happen to be in the neighborhood of the flash. It is not necessary that these masses of metal be actually placed in metallic contact with the discharge. In fact, the induced currents are set up better if the masses are carefully insulated from the discharge.

Now, here is probably the explanation of the melting of metals in the bodies of persons that may or may not have been unceremoniously disrobed by lightning flashes. The passage of a lightning discharge anywhere in their neighborhood —it may either be only a few hundred feet or several hundred feet from them —sets up induced currents in all masses of metals in the neighborhood. It is these induced currents that fuse the watch or the bunch of keys, or the sword or even the nails in the shoes.

Similar effects have been observed on looking glasses or in the gilt furniture of a salon. An electric discharge striking in the neighborhood of the house produces currents sufficiently great to volatilize these gilt coverings or the gilding on the back of a looking glass.

And now as to the ripping off of the boots or shoes, or what might be called electric disrobement. As is well known, thunder accompanying lightning is due to the sudden rushing of the wind into the vacuous space caused by the intense heat of the discharge, either through the air or through drops of water in the air. It is this thundered wind, as I think it might be called, rushing into the neighborhood of the space through which the lightning discharge has passed that tears or rips the clothes from a person, or causes the shoes and boots to be unripped by the expansion of the air between the body and the boots, and this would be all the easier if the metal pegs have been previously removed by induced currents. In this way the wonder, like all physical wonders, disappears as soon as it is thoroughly understood. It is not the actual electric discharge that has struck the person, but only an induced discharge.

ELECTRICITY IN MEDICINE.

BY OTTO JUETTNER, M. D., PH. D.

Part VI.

Our discussion concerning the different uses of electricity in the study and treatment of diseases would not be complete without some reference to the electric light (incandescent and arc) as a serviceable instrument in the hands of the modern physician.

The miniature incandescent globes of one-half to two candle-power which ordinarily are mere toys and as such answer an admirable purpose in lighting up a Christmas tree, are of the greatest value in the recognition and proper study of many diseases. To the specialist who is interested in diseases of certain cavities in the human body that are either entirely inaccessible to the eye or only partially so, these little electric lights are indispensable. They form the essential parts of suitably constructed instruments and are carried into the cavities of the body which are thus laid open to inspection and study. The throat specialist has a little instrument called a "tongue depressor" on the end of which is mounted a little incandescent lamp which lights up the cavity of the mouth. The tongue depressor is held by the left hand of the physician whose right hand is thus left free to make suitable applications or give treatments to afflicted parts. If he wishes to study the appearance of the larynx (throat) and surrounding parts, a small mirror which is properly mounted on the tongue depressor or in some other suitable manner, in introduced into the mouth and reflects the image of parts which are out of the range of vision of the eye. The same holds good in regard to other cavities, for instance the nose, the bladder, the lower bowel, including the canals leading to these cavities. Interesting observations have also been made by causing the patient to swallow a partially incased miniature lamp suspended by a chord. In a dark room the light can be seen through the stomach wall and may aid in clearing up some obscure points in the condition of the patient's stomach. This is called translumination or diaphany of the stomach.

The larger incandescent lamps of 16, 32, 50 and more candle power are of the greatest importance in modern medicine because they furnish dry heat in the simplest and most practical manner. Dr. Minin, of St. Petersburgh, who is surgeon-general of the Russian army, is the originator of treatment by means of incandescent lamps. He uses them in variable candle power and places them in a reflector or hood (Fig. 25) over the part to be treated. Their effect in properly selected cases is truly remarkable. The dry heat produced by these lamps has a tremendously stimulating effect on the skin, and a secondary effect is produced on the circulation of the part treated. Fresh arterial blood is drawn to the part, which is thus regenerated and freed from obnoxious and poisonous matter. Pain is relieved, especially if the light application is preceded by some other stimulating treatment, for instance massage. Dry heat produced by an incandescent lamp will more than take the place of the old-fashioned poultice without the discomfort and filth of the latter. The incandescent lamp (Minin's lamp, as it should be properly called in medicine) is very effective in the treatment of boils and carbuncles. It facilitates and accelerates the formation of matter and draws it to the surface. In the treatment of muscular rheumatism and inflammatory conditions, especially if they are associated with pain, the Minin lamp will often work wonders. In varicose ulcers which are usually seen on the leg and are frequently large, painful and very hard to heal, the Minin lamp renders very good service. It would carry us beyond the confines of our subject to give all the conditions in the treatment of which the Minin lamp may be useful. Much depends on the candle power of the lamp. The penetrating effect is in proportion to the size of the lamp. Ordinarily the 32 or 50 candle power lamp is sufficient. Lamps of gigantic size, of 300 and 500 candle power, are nowadays frequently employed. Their efficacy, if properly used, is truly wonderful.

It may not be amiss to call attention to the fact that the effects of lamps of different color are by no means the same. Red globes have a distinctly irritating effect and cause sweating very promptly. Blue globes produce a soothing and quieting effect and are to be used if the principal object is the relief from pain. Blue light is a sleep producer of great value. The employment of light in medicine is called photo-therapy, while the use of different colors is known as chromo-therapy. It is proper to add that in giving Minin treatments single lamps or clusters, properly mounted in a hood or reflector, are used.

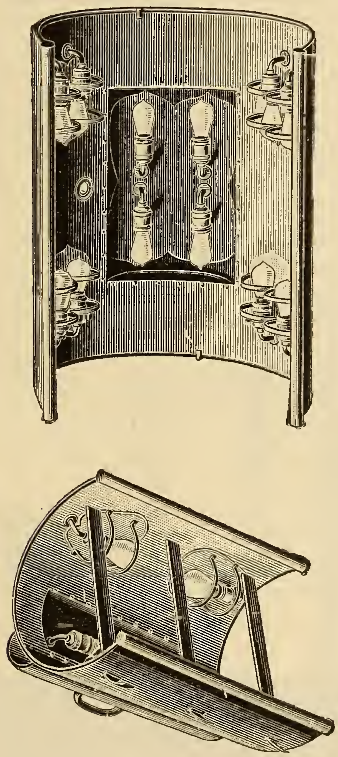


FIG. 25. INCANDESCENT LAMPS FOR LOCAL TREATMENT.

The consideration of the incandescent lamp naturally brings us to the subject of the electric light bath cabinet. In the construction of these cabinets incandescent lamps are used, although, for certain purposes, arc lights are sometimes added. The cabinet may be constructed in such a manner as to enable the patient to lie down and take the treatment. He lies down on a platform nude and is rolled into the cabinet. Some cabinets are made for the patient to sit in. These cabinets have been discarded by the best operators because patients are much more liable to faint when they take the treatment in the sitting position. Of course, in both varieties of cabinets the head of the patient remains out of the cabinet. The interior of the cabinet is studded with incandescent lamps which give forth dry heat and stimulating rays of light. The globes may be white, blue or red. The best effects are produced if the colors are mixed, with the blue predominating. There is no limit to the usefulness of the electric light bath. It is by all odds the best and most modern treatment in all forms of rheumatism, in fact in all conditions requiring powerful elimination through the skin (Bright's disease, etc.).

The electric arc light has recently found a large field of usefulness in the practice of medicine. Its effects are due to the fact that the arc light is spectroscopically sunlight on a small scale. In order to understand what this means, we must remember that the light of the sun is a composition of many different forms of radiating energy. If we allow sunlight to fall through a prism we cause it to be broken up into its component rays or color. This arrangement of colors is known as the "solar spectrum." If sunlight is broken up by myriads of drops of moisture in the atmosphere, each drop representing a little prism, the effect is the rainbow showing the different component parts of the light of the sun. The important point to be remembered is that the spectrum of the sun is practically the same as the spectrum of the electric arc light. The arrangement of colors is approximately the same. This fact makes the light from the electric arc a substitute for sunlight, the difference being in intensity, but not in composition. Therefore we may assume that, in a small way, the arc light will accomplish what the light of the sun is capable of doing.

The seven colors of the spectrum are red, orange, yellow, green, blue, indigo and violet. Besides these seven visible rays there are many invisible forms of radiation that belong to the spectrum and, of course, have no color. Depending on the location of these invisible radiations

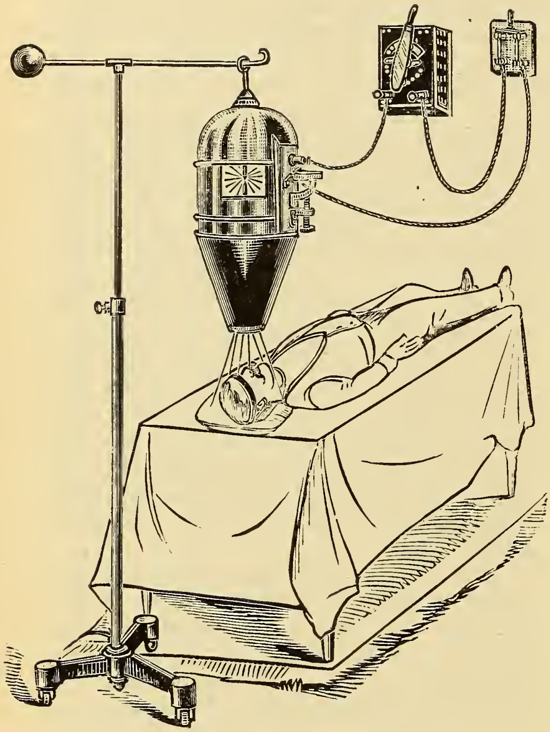


FIG. 26. AN AMERICAN ARC LIGHT TREATMENT.

they are called "infra-red" (if they are on the red end of the spectrum) or "ultra-violet" (if they are situated beyond the violet end). There are three different activities that are contained in sun or arc light. The radiations emanating from the red end, including the invisible infra-red rays, produce heat and are, therefore, known as "thermic" or "calorific" rays. The rays which come from the center of the spectrum, especially from the yellow and green fields, are productive of light pure and simple and are, therefore, called "luminous" rays. The violet end of the spectrum, including the visible blue and indigo but more especially the invisible ultra-violet fields, emit rays that are chemical in their action and, therefore, are known as "chemical" rays. They are frequently called "actinic" rays. They have the power of killing germs and represent the great disinfectant in the domain of nature. It is these actinic rays that give light its great sanitary importance. The tanning of the skin after prolonged exposure to light is due to the action of the actinic rays.

The electric arc light, as we stated before, contains approximately the same spectral composition as sunlight. It is, therefore, available as an artificial substitute for sunlight. We may administer an artificial sunbath to a patient by exposing his nude body to the light from a half a dozen or more arcs. The actinic rays contained in this light stimulate and disinfect the skin. The latter becomes better nourished and, as a result, functionates more actively. In connection with the effects produced by the actinic rays contained in arc light it is important to remember its irritating action on the mucous membrane of the eye. People who work in arc light are prone to suffer from sore and inflamed eyes. The latter should be protected by blue glasses. To get the stimulating effects of the light of an electric arc the incandescent light bath previously referred to is frequently provided with one, two or more arc lights. It is understood that the intensity of its action is in direct proportion to the amperage of the arc light. Fig. 26 shows a method of treatment by arc light.

Everyone knows what a sun glass is. It is a lens which concentrates the light and causes its rays to converge into a focus. A sun glass concentrates all the rays, the thermic, the luminous and the

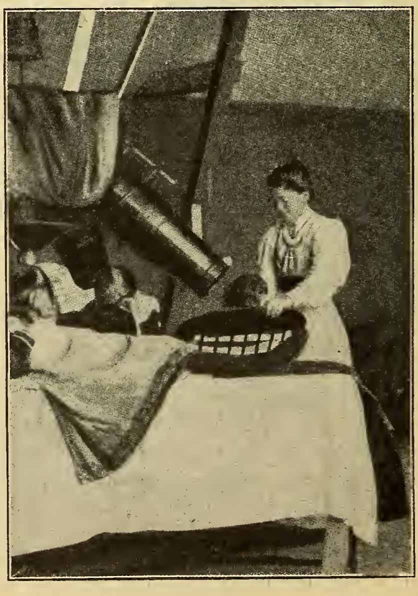


FIG. 27. TREATMENT BY FINSEN LIGHT

actinic. The concentration of the thermic rays causes intense heat. If the concentration takes place on the skin, the result is intense pain. If it were possible to eliminate from a concentration of light the pain producing thermic rays we would still have a concentration of the luminous and actinic (chemical) rays and get the stimulating and germicidal action of the latter without pain or even discomfort. The man who studied this subject and made its practical application possible for the cure of disease became one of the greatest benefactors of the human race, Prof. Finsen, of Copenhagen, who died a few years ago, a comparatively young man.

Finsen constructed an apparatus consisting of a powerful arc light (Fig. 27), the light of which was collected by a large lens and allowed to fall through a sheet of clear water. In this way the light was cooled because the heat rays were absorbed by the water. The light when it reached the surface to be treated was cold and represented a strong concentration of luminous and chemical rays. Finsen used this form of light with wonderful effect in the treatment of germ diseases of the skin. Finsen light, therefore, is sunlight or light from an electric arc minus heat rays. In a recent modification of the Finsen lamp ("Dermo" lamp, (Fig. 28) the light is cooled by cold water circulating in the electrodes which are hollow and not made of carbon but of steel. The construction of the "Dermo" lamp is, from a mechanical point of view, very ingenious. In the accompanying illustration the lamp is shown mounted on a bracket, together with the rubber tubes for carrying supply and waste water to and from the lamp. (h) is the handle of the current controller (n); (i) is the current switch, (k) is the fuse box. The wires from (l_2) rep-

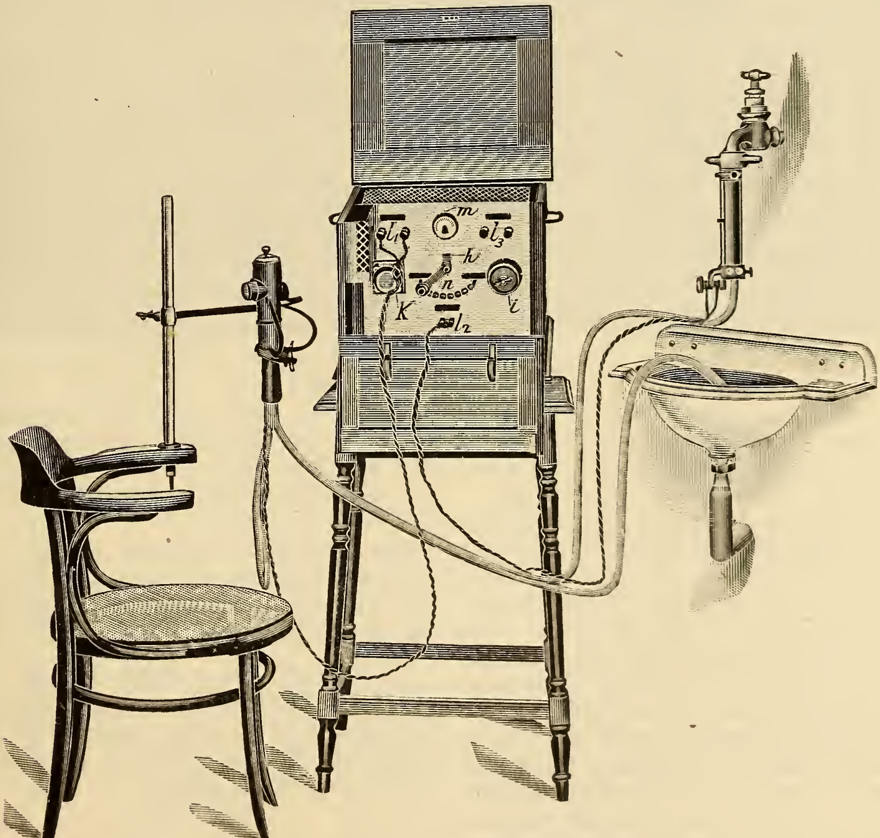


FIG. 28. "THE DERMO" ARC LIGHT.

resent a loop in the circuit to prevent the formation of an arc in the lamp unless the water is flowing. The pressure of the water distends the rubber tube and by an ingenious arrangement completes the circuit.

Fig. 29 shows the Finsen device for concentrating solar rays.

A SUMMARY.

In conclusion let us recapitulate briefly what can be accomplished in the art and

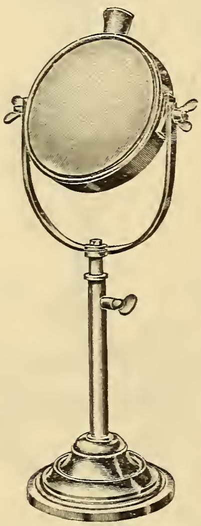


FIG. 29. FINSEN'S DEVICE FOR CONCENTRATING SOLAR RAYS.

science of medicine by the legitimate use of electricity in its various forms.

GALVANISM.—The positive pole counteracts imflammation and, by lessening the blood pressure, relieves pain. The negative pole increases the blood pressure and irritates. It causes chemical changes in the tissues by its affinity for hydrogen. In this way it acts as an absorbent and a destructive agent in the treatment of warts, growths, superfluous hair, strictures, etc. General galvanization is a useful tonic. The galvanic current is used to carry medicinal substances into the body.

FARADISM.—The faradic current is a tonic for and regulator of muscle tissue. It contracts and relaxes muscles and in this way improves their quality and blood supply. It is useful in certain forms of paralysis or impairment due to faulty nutrition of muscular tissue.

STATIC ELECTRICITY.—It is a powerful tonic and antispasmodic. The positive current lessens blood pressure and is, therefore, indicated in all conditions produced by an increase in the blood pressure. Congestions are counteracted by the positive pole. Pain due to congestion is relieved by it. The negative pole increases blood pressure and in this way is adapted in the treatment of all conditions which are characterized by lack of nutrition. Negative static currents stimulate and regenerate by drawing fresh blood to the part treated.

HIGH FREQUENCY CURRENTS.—General applications are tonic in their action. Local applications are gently stimulating and germicidal. To improve the complexion, there is no better agent than the high frequency current. It is by far the best curative agent in the treatment of skin diseases, especially dry, chronic eczema.

ROENTGEN RAYS.—They are useful in transluminating the body and studying the conditions of hard tissues (fractures, dislocations) and in locating foreign bodies, especially metallic substances (needles, bullets, etc.). Roentgen rays relieve pain. They may be used in the treatment of certain forms of skin cancer and skin disease.

INCANDESCENT GLOBES.—They produce dry heat and in this way stimulate the skin, regenerate the blood supply of the cuticle and relieve pain.

ARC LIGHT.—It contains a large supply of chemical rays and is applicable to the treatment of skin applications that are due to lack of vitality in the skin or to the presence of germs.

(The End.)

REFRIGERATOR CARS FOR ELECTRIC ROADS.

An air-cooled refrigerator car has been put in operation on the Milwaukee Northern Interurban electric road from Cedarburg, Wis. The car is the invention of F. W. Walker, engineer of the Milwaukee Northern road and is 53 feet long, and has a capacity of 225 cans of milk. The company will handle all the milk delivered into Milwaukee from this territory for many large dealers.

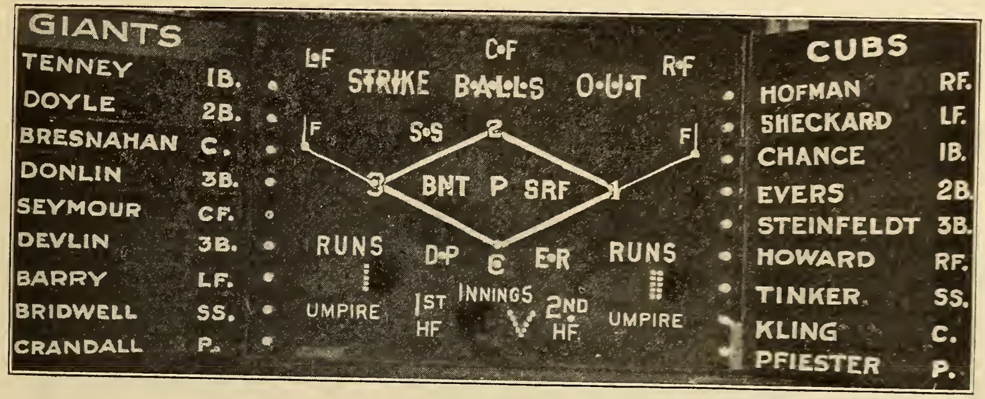
FOLLOWING A BALL GAME BY THE ELECTRIC BULLETIN BOARD.

Twenty thousand baseball "fans" shouted until they were hoarse over the progress of a ball game as indicated by a few little colored electric lamps. On the occasion of the great Chicago National League series the last week in August, when the Cubs won three straight from the New York Giants, excited crowds of baseball enthusiasts followed with wrapt attention the successive plays which were indicated on the two electric bulletin boards of the Chicago Tribune; one on the Tribune Building and one at Washington Street and Michigan Avenue.

The picture shows one of these boards and the method of signaling employed. The line-up of the two teams is lettered on the sides of the board, with a lamp opposite each name. When a player comes to the bat his particular lamp lights, the colored globe showing in the daylight. When the ball is pitched to him the fact that it is either a strike or a ball or a foul is indicated by lamps provided for the purpose. If he drives the ball to center field, for instance, the lamp there lights. If he is out, the lighting of the proper lamps indicates the fact, and where out. If it is a safe hit the lamp on first base lights. If he continues on around, the lamps at the various bases indicate his progress.

Judging from the enthusiasm and noise, watching the bulletin board is almost as good as seeing the real game.

The bulletin board is operated from a little keyboard at the rear. On this keyboard are mounted ordinary snap switches in the same relative positions as the lamps on the bulletin board. Each switch controls its respective lamp. As the operator receives his information by telephone or telegraph, direct from the field, he instantly snaps on the proper switch to indicate each play as it is made.



ELECTRIC BULLETIN BOARD.

ELECTRICITY THE LIFE OF VEGETABLES.

That electricity is the life principle of vegetables is said to have been proven by the use of a sensitive galvanometer with which the presence of electric current in the cells of fruits has been detected.

Some believe that all fruits, whether of solid flesh, like the apple, or composed of a number of cells, contain what corresponds to the positive and negative plates of a storage battery. For instance, in the apple the fleshy part constitutes the positive and the core divided or insulated from the flesh by a thin skin is the negative cell, the respective terminals being the flower end of the fruit and the stalk. In the orange, on the other hand, the successive divisions form alternately positive and negative cells, insulated from one another by the skin walls, while the whole is completely insulated on the outside by the peel or rind.

To substantiate his theory one investigator secured an extremely sensitive Kelvin galvanometer, the magnetic reflecting indicator of which is so light as to be suspended by a single strand of a spider's web. By means of this apparatus the scientist was able to deflect the needle from one side to the other, according to the connection of the stalk or flower ends of the fruit with the instrument. That such movement was not attributable to chemical agency is borne out by the fact that by reversing the terminals of the fruit reversal of the direction of flow of current was obtained. Again, such deflections were not merely temporary. They lasted until either the insulation of the fruit was broken down or decay had set in.

TRANSMITTING AND TRANSFORMING HIGH TENSION CURRENT.

Frequently nowadays we hear of new electric power undertakings where waterfalls generate electricity which is transmitted in some cases to distances of over a hundred miles, even two hundred miles, before it is utilized for industrial purposes. Most people are conversant in a general way with the methods of generating the current by turbine driven dynamos but the methods employed in transmitting and distributing the current involve apparatus and equipment new to the majority.

In the first place, the electric current cannot be transmitted over great distances at the voltage at which it is generated, that is, economically. The reason for this is simple. Suppose it is desired to transmit 1,000 horsepower 100 miles. This might be done by using almost any voltage above that required to overcome the resistance of the wires, but if a low voltage were used, say 5,000 volts, much larger wires would be required than with a high voltage. Exactly the same principle applies as in transmitting a given quantity of water through a pipe. A thousand barrels of water might be transmitted through a pipe in a given time but the size of the pipe required to do the work would vary inversely with the pressure employed in forcing the water through. As copper wire is expensive, it therefore becomes necessary in transmitting electricity long distances to use a very high pressure in order to keep the size of the wires down to economical limits.

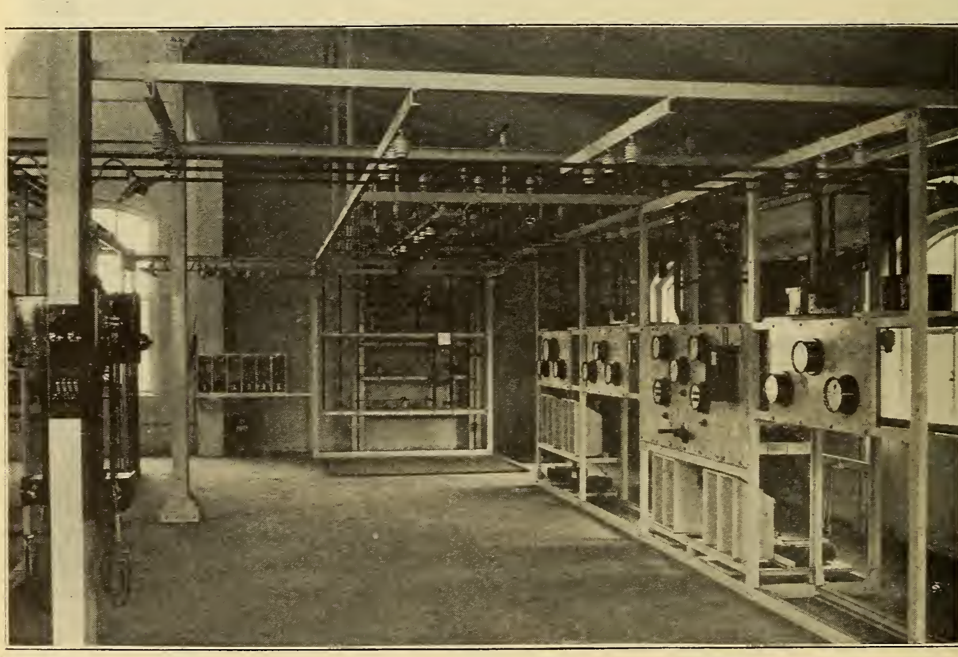


FIG. 1. SWITCHING APPARATUS IN TRANSFORMER STATION.

As dynamos are most economically built to develop 5,000 to 10,000 volts, which is not high enough to force the current over long distances it becomes necessary to use what are known as transformers to raise the voltage of the current. It will be interesting to many to see what these transformers look like. In Fig. 1 are to be seen four of them as installed in a large power house in Norway near Kyykelsrud. These transformers, which stand 10 or 12 feet high are simply oil filled cases containing two great coils of wire, the coils being wound one over the other and insulated from each other. One coil containing a few turns is connected to the dynamo, the other, containing many turns is connected to the transmission line. In this case the voltage is raised from 25,000 to 50,000.

Current from this Norwegian plant is transmitted about 50 miles to the city of Christiania. The frontispiece in this issue shows the transmission line which carries this enormous voltage. It is very substantially built, and neatly, so as to be an ornament to the landscape.

After the current has been transmitted

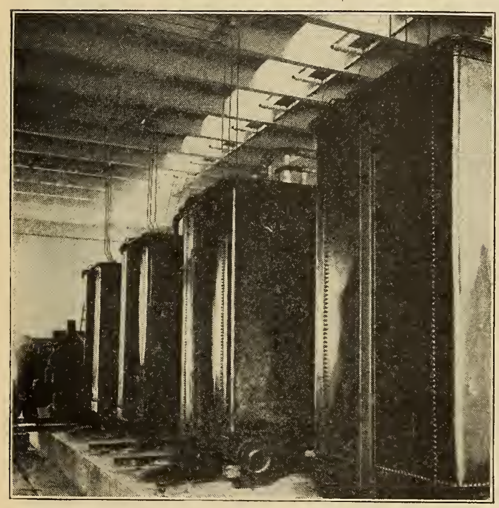


FIG. 2. OIL-COOLED TRANSFORMERS.

at high voltage from the point of generation to the locality where it is to be used it arrives at a little lower voltage than it started out, owing to the line loss, but still much too high to be used with safety by the consumer. It must therefore be stepped down in voltage again by another set of transformers similar to those employed to raise it at the generating station. To handle the high voltage current in this step-down transformer station with safety, and to subdivide it for the different distribution lines, more apparatus, such as switches, measuring instruments, etc., are required. Fig. 2 shows this apparatus in the step-down transformer station. Everything is arranged with neatness and symmetry, for it is essential that with this high voltage current there be no confusion of wires and conductors and that everything be as convenient as possible for the operator in manipulating his various switches and directing the current out over the various lines in the city.

ZAMBESI POWER PLANT ASSURED.

Financial arrangements have been completed for the construction of the great power plant, which has been contemplated for several years, at Victoria Falls on the Zambesi River in Africa. A new syndicate has been formed in London, with a capital of $15,000,000, which practically controls the power possibilities in South Africa.

As to the exact available power of the falls, this is a matter of scientific calculation. The engineers claim that they have a possibility of 35,000,000 horsepower.

One of the remarkable features of the falls is the mighty gorge into which the floods pour. This gorge is over 40 miles long, and the water within it falls so rapidly that an enormous power can be developed outside the falls themselves. Within 15 miles there is a fall of 700 feet; and a thousand-foot fall could be made within about 20 miles. Indeed, it is said that a canal, which would cost comparatively little to construct, could be so made that it would develop one million horse power. This is almost four times as much as the total horsepower now used in the Transvaal.

As to the utilization of the power to be developed by Victoria Falls, it will comprise the greater part of South-central Africa. Victoria Falls is just about 600 miles from Beira on the India Ocean. It is a little more than 600 miles from Johannesburg, and a like distance away from the great copper mountains of the Kongo Free State. Within that radius would come more than a thousand miles of the Cape to Cairo Railroad, all of the two thousand miles of the railroads of Rhodesia and a large portion of the mines of the Transvaal. It would comprise hundreds of small gold mines in Rhodesia and the great deposits of iron which lie between the Zambesi and the Kongo Free State. The ore from these mines may be turned into pig iron by the power from the falls.

FREIGHT TUNNELS UNDER THE STREETS OF CHICAGO

Many people who are residents of Chicago are still unaware that 40 feet below the surface of its principal business streets there is an elaborate system of tunnels which now reach an aggregate length of over 56 miles. Within what is known as the loop district of the city, said to contain more human beings than any other equal area on the face of the earth, these tunnels have been laborously excavated under every street. Lateral tunnels are now being extended out to the North, West and South Sides.

CHICAGO FREIGHT TUNNELS.

The tunnel system is owned and operated by the Illinois Tunnel Company, and it was built for the transportation of merchandise back and forth between the railway terminals and the business places within the district.

A tour through the tunnel system is extremely interesting, for there, far below the surface of the street, is an electric railway system operated by electric locomotives, no sounds from which ever reach the throngs of people moving on the street above.

The tunnels themselves are virtually concrete tubes, oval in cross section, with a flat bottom for the railway track. The standard single tubes are seven feet six inches in height by six feet wide. In constructing the tunnels the concrete lining was put in place as fast as the excavation progressed.

The tubes, as already stated, are situated under every street in the down town district, and laterals are dug to the basements of many of the large stores and office buildings. At the present time there are over 90 such connections made. This is where the usefullness of the system becomes apparent. Coal may be brought from the freight yards and deposited direct from the tunnel cars in the boiler rooms of the buildings, that is, where the basements are excavated to the depth of the tunnels, which is the case with most of the newer buildings. In the older buildings a shaft is dug down to the tunnel and elevators provided for lifting the cars and their contents into the buildings. Merchandise of all kinds may be hauled from the business places to the depots with great facility, and the large retail stores will make use of the extensions to the North, West and South Sides to send goods to wagon delivery stations located at points on these extensions.

The cars are drawn, several in a train, by electric locomotives which take current from an overhead trolley wire which is strung through the tunnels on special insulated hangers attached directly to the roof, the construction being similar to that used in mines where electric haulage is employed. The locomotive is low and compact, the trolley pole beng mounted on a pedestal support on top. Current after passing through the motors returns to the station through the track rails as in surface railway systems.

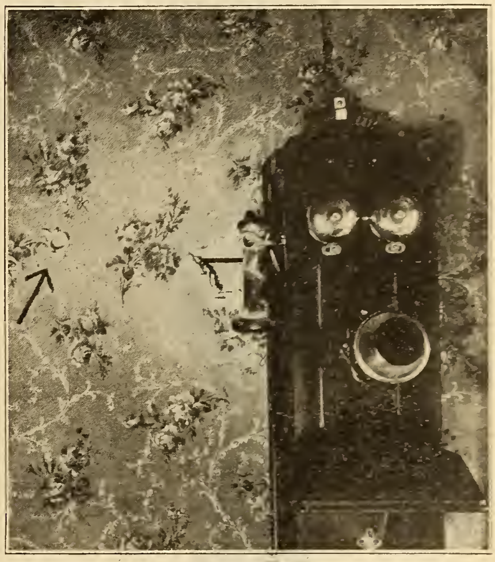
A very important work accomplished by the tunnel system is the removal of debris from wrecked buildings and from the site of building excavations. It is interesting to watch the process of destruction of a brick or stone structure which is being removed to make room for one of a larger and more modern character. After the interior parts of value have been removed, the work of destruction proceeds from the top downward, and bricks, mortar, plaster and all refuse are

FREIGHT TUNNEL LOCOMOTIVE.

thrown down through shafts which have been dug to the tunnels below. Gradually the building disappears, literally into the bowels of the earth, and the refuse is drawn away through the tunnels to the shore of Lake Michigan, where it is used as filling in Grant Park.

FREAK LIGHTNING STROKE.

During a severe electrical storm in Franklin, N. H., a bolt of lightning entered a house through the telephone wires. After burning out the fuses, the charge passed through the wall into a room, leaving some peculiar marks of its progress. Several holes were pierced in



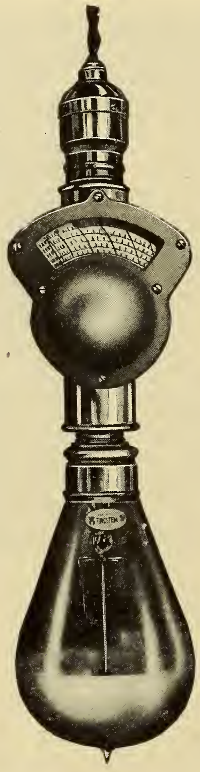
RESULTS OF A FREAK LIGHTNING STROKE.

the plastering, and one of these, indicated by the arrow, was almost perfectly round, as if a hot iron had been thrust through a plate of butter. The plaster around the holes was pulverized to a fine powder.

There are no cities of any note in the Japanese Empire that do not possess a system of electric cars, omnibuses, or motor cars, and almost every important place or pleasure resort in the country is connected with the main cities by one of the means of locomotion mentioned, so that the capital invested in such unundertakings has reached an enormous amount. There are eight electric lines running, with an aggregate capital of $18,530,000 gold. Adding smaller companies and several enterprises not yet opened, the aggregate capital of all the lines—those in operation or about to be operated—reaches a grand total of over $50,000,000, with a mileage of 545.

LAMP TESTING WATT INDICATOR.

A practical demonstration of the wonderful efficiency of the new metallic filament incandescent lamps will often aid in their introduction among users of electric lamps to whom seeing is believing. A small instrument known as a lamp testing watt indicator shown in the accompanying cut gives a practical dem-



LAMP TESTING WATT INDICATOR.

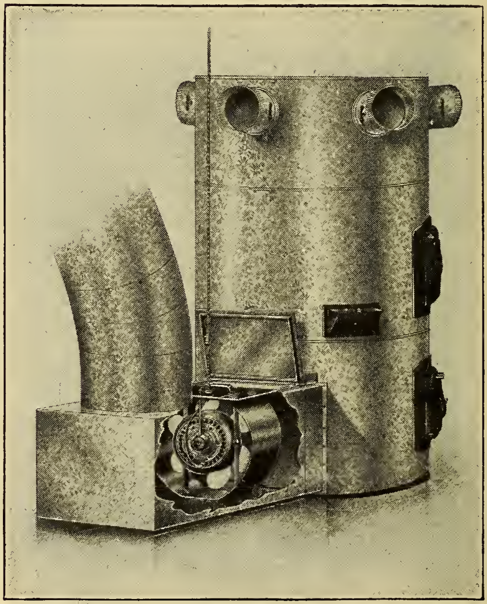
onstration of the relative watt consumption of metallic and carbon filament lamps. This instrument is intended for use with Edison base lamps, but can be provided with an adapter permitting its use with either a Thomson-Houston or Westinghouse socket or lamp base. The instrument is of the portable type and can be carried in the pocket.

To use the instrument, the plug is screwed into a lamp socket and the lamp to be tested is inserted in the receptacle at the bottom of the instrument. The pointer will then indicate the watts consumed by the lamp. The plug end of the instrument is equipped with a spring contact end, permitting an extra turn so that the scale may always be in view.

ELECTRIC BLOWER FOR FURNACES.

The need is apparent for some aid to the natural draft in hot air furnaces used for heating residences, as the natural air currents from the furnace fail to properly heat one or two rooms in almost every house. Even when the maximum heating power of the ordinary furnace is secured, there are almost always certain rooms which cannot be kept comfortably warm.

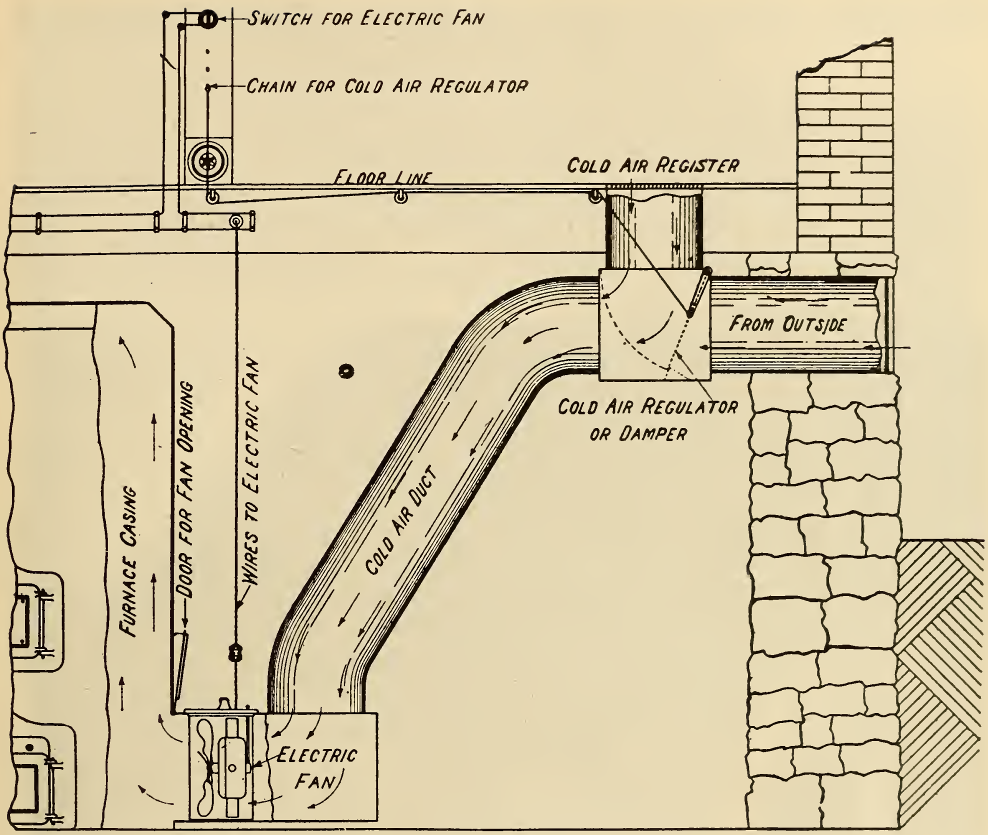
The expedient has often been tried successfully of using an ordinary electric disk fan as a furnace blower with a noticeable improvement in the distribution of heat, but the best results cannot be obtained with fans of the ordinary type. A special furnace blower has,



ELECTRIC FURNACE BLOWER.

however, been developed, which is shown in the illustrations herewith.

This electric blower consists of a special Emerson motor equipped with six blade quiet fan, and mounted substantially in a sheet iron casing with cover and handle. As shown in the engraving, the blower outfit is placed in the cold air box of the furnace, fitting into an opening about nine by 15 inches in the top of the box. The action of the fan forces increased quantities of cold



METHOD OF INSTALLING ELECTRIC FURNACE BLOWER.

air into the air chamber of the furnace to be heated by contact with the surface of the furnace body, and assists the natural tendency of the heated air to rise through the radiating pipes to the rooms above.

The outfit may be connected by attachment plugs to any convenient electric light socket in the cellar. However, it is recommended that special wiring be installed for the motor as shown in the diagram, providing for starting and stopping the motor from an indicating switch in the hall or room above. If this plan of installation is followed, the maximum results in increased comfort and economical distribution of heat will be secured.

ELECTRIC FROST FORETELLER.

Scientific fruit raising in the larger orchards of the irrigated belt in the Far Northwest has been benefited by an invention, the credit of which is thought to belong to some unknown Chinaman. This is the electric frost foreteller. A little thermometer is set to declare itself on the safe side of the frost line, and when the releasing limit is reached, the mercury in the tube closes an electric circuit, ringing a bell in the orchardist's bedroom. The next step is a hasty visit to the orchard where are located at intervals covered pots filled with crude petroleum. To each of these he touches a match or torch. A dense smudge then envelops the trees and the danger is over; the lids are put back and the fires go out. An inspector of these orchards says the smudge pots will keep the orchards eight degrees warmer than those not supplied with them, and they have frequently been brought safely through cold nights that have ruined the products of adjoining ranches.

SIXTEEN THOUSAND HORSEPOWER FROM A MOUNTAIN STREAM.

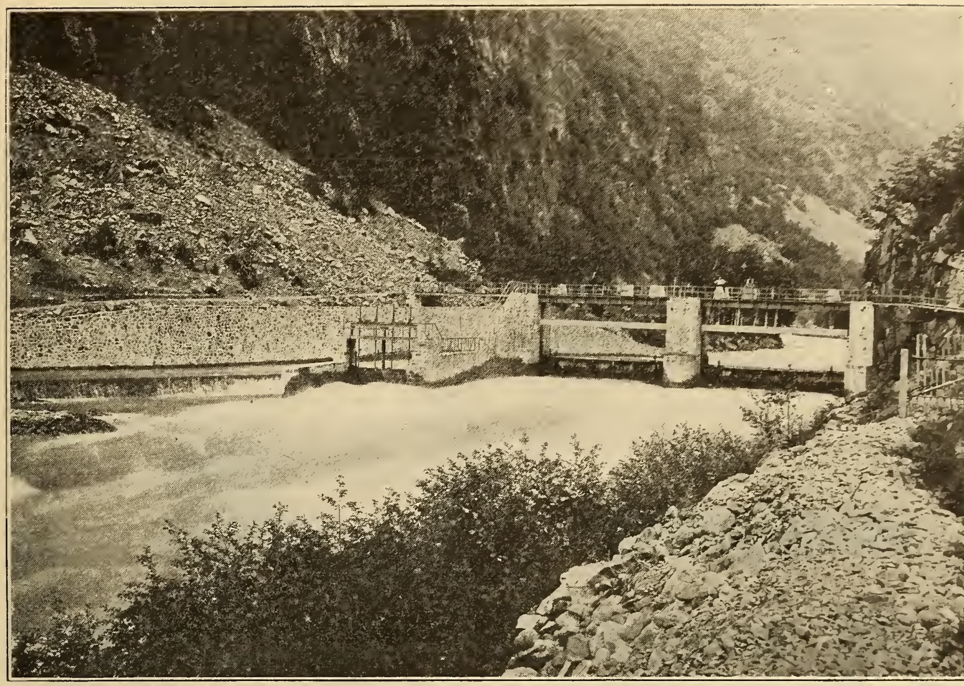
The peculiar spectacle of water carried through a mountain side to drive the turbines of an electric power plant is presented by an hydroelectric installation near the village of Schiliene. France. Water is carried through the mountain side by a penstock over 10 feet in diameter, as shown in one of the pictures. This penstock delivers enough water to the turbines to generate 8,000 horsepower. Provision is also made for another penstock of the same capacity so that the power house will have ultimately eight groups of turbines and electrical generators of 2,000 horsepower each.

Away up in the mountains a small stream has been damned to furnish a continuous supply of water. One of the illustrations shows the head gates and controlling works. Water is taken from the controlling works and carried by a canal to the head of the penstock; then it takes its long plunge down the dark tunnel through the mountain and is hurled with tremendous force against the blades of the turbines. The head of water is 183 feet and the pressure at the foot of the penstock, correspondingly high, so that, as compared with low-head water power developments, the quantity of water required is small.

SCHILIENE WATER POWER ELECTRIC PLANT.

The four direct connected dynamos or generators in the power house are all provided with flywheels between the hydraulic turbine and the generator, which is of the alternating current type, the connection being made by a flexible coupling on the side of the flywheel nearest the generator. The machines operate at a speed of 375 revolutions a minute.

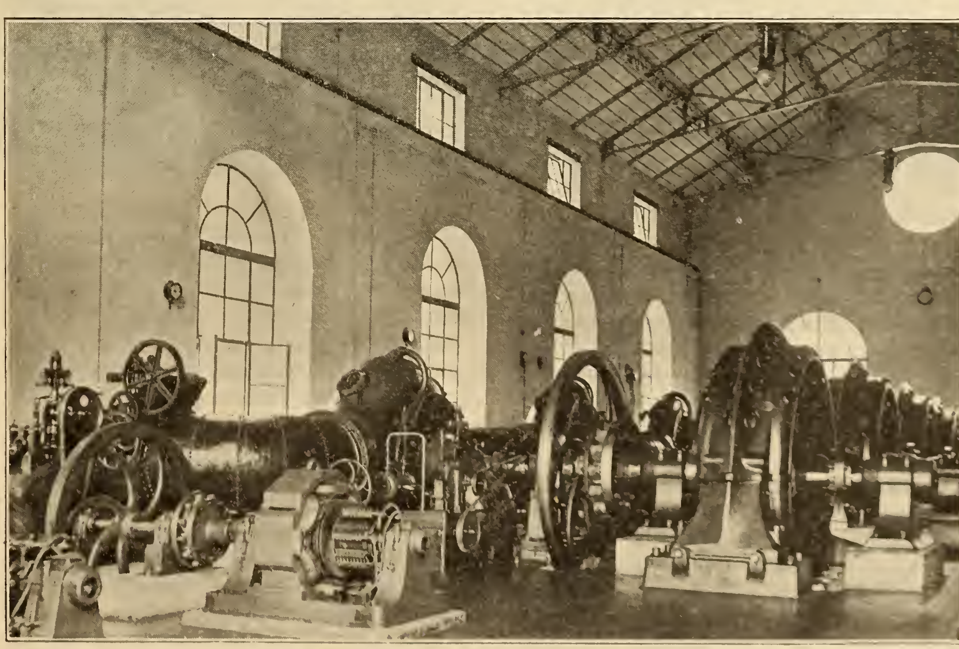
The small dynamo shown in the left foreground of the interior view is what is known as an exciter. An exciter is an ordinary dynamo of small size, which



HEAD GATES AND CONTROLLING WORKS, SCHILIENE PLANT.

generates direct current and forces it around through the field coils of the main dynamo, energizing them, so that the main dynamo can produce current.

Alternating current dynamos such as are used in this installation must have one of these small externally driven dynamos to energize their fields, as al-



DYNAMO ROOM IN SCHILIENE PLANT.

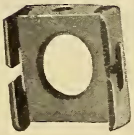
ternating current will not do the work. A direct current dynamo, on the other hand, usually excites its own field right from its armature circuit, as it produces the kind of current that is required

A PUSH-BAR SNAP SWITCH.

Once in a while an invention is made that is not evolutionary, but revolutionary. This applies not only to big things but also to as small a mechanism as a snap switch—small in size only, for a snap switch is a necessity wherever electric lighting current goes and millions are in use.

The simple mechanism shown by the accompanying illustrations, made by a prominent Milwaukee concern, resembles none heretofore made. Push one end of the push-bar and you open the circuit with a quick snap; push the other end and the circuit is closed—with an equally quick snap.

PUSH BAR.



MOVING CONTACT.

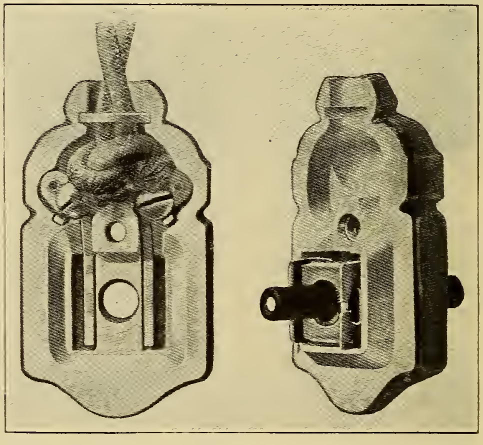
STEEL SPRING.

The principle embodied in this switch mechanism is that of a coiled spring contracting on a tapering surface—the action being similar to that of a rubber ring slipped over the knob of an umbrella, or a coiled wire sleeve supporter, which, when passed over the elbow will travel a short distance up or down the arm of itself.

The three small illustrations indicate the only mechanism necessary to make and break the circuit. First there is the push-bar, made of very hard and smooth non-conducting material, with an enlarged center portion. Then there is the little coiled spring which fits over the push-bar, having to stretch considerably to pass over the enlargement. Finally there is the little contact piece of copper inside which the spring is mounted, and which, when the switch is closed, bridges across the two terminals and closes the circuit.

The larger illustration shows a pendant type switch embodying the principle, which principle is the same in all the various forms in which the switch is made. When the wires are attached to the terminals in a cavity in the shell, the two halves are closed and held in place by screws.

Pushing the bar very slowly, by way of experiment, the internal mechanism does not respond until the widest portion of the push-bar slips through the coiled spring and then—*click!*—the contact piece snaps over to the other side faster than the eye can follow it, and the circuit is closed. Push the bar in the opposite direction and the contact piece is thrown the other way, opening the circuit.



INTERIOR OF PUSH-BAR SNAP SWITCH.

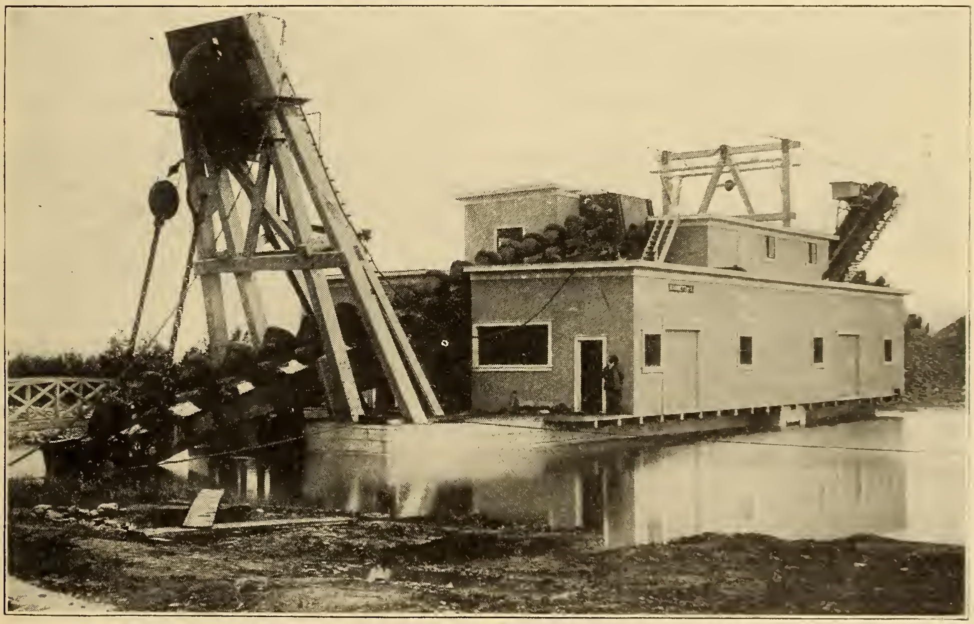
This principle is applied to the various types of switches in common use, such as the ordinary wall switch, for turning on the lights as you enter a room, the pendant switch for turning on lights that are high up or out of reach, and the lamp base switch to which an ordinary incandescent lamp is attached. The exterior parts of these switches are of porcelain instead of metal, which is another unusual feature, and there is consequently no possible way of getting a shock from them.

ELECTRIC DREDGES FOR GOLD PLACER MINING.

Where hydroelectric power is available, as in California, electrically operated gold dredges are utilized in placer gold mining to great advantage. The accompanying illustration shows an electric gold mining dredger at Oroville, Cal., which is said to be working the hardest ground in California and doing the work with remarkable results.

It is well known that crude as were the early devices for treating the rich placer grounds and extracting the latent fortunes deposited there by the forces of nature, yet men continued for years to pan and sluice, and rock and waste, until the modern dredger made its advent to the astonishment of the mining world.

It is maintained that the best sort of a gold dredging proposition to be found is one where the ground is nearly level, containing a soft bedrock and free from a great quantity of very large boulders. In every instance it must be borne in mind that adequate facilities are necessary for supplying the pond with a small quantity of water. When such a piece of property has been located, the values therein should be thoroughly tested, either by drilling or by test shafts. When this has been done and the value proven, the last unknown quantity in the dredging proposition has been solved, since the price of the land and the cost of the dredge can always be readily ascertained. The other details, such as power, the length of time that the dredge can be worked per year and cost of transportation are small items which can be calculated for a certainty before hand.



ELECTRIC GOLD DREDGER.

The gold dredge of to-day consists of a chain of digging buckets, carried on a steel girder termed a "ladder," which is hinged at the top end on a tumbler gantry and supported at the lower end by steel ropes and sheaves, which allow the ladder to be raised and lowered, and a set of side ropes feeding the ladder in a horizontal direction. The buckets dump the material into a rock lined chute or rock box, which in turn feeds the material into a revolving screen.

The perforated plates in this screen separate all the coarse material from the "fines." Inside the screen is a water pipe fitted with nozzles. The water delivered at a high pressure through these nozzles, thoroughly washes off all gold from the large boulders as they roll around in the screen. The coarse materials or tailings, are carried up and stacked at the stern of the dredge, while the "fines" containing the gold are treated on patent gold saving tables.

The driving machinery winches, pumps and electrical apparatus are all mounted on a barge or hull and we have an arrangement called a gold dredge.

It is stated that the speed of the bucket chain is about 55 to 65 feet per minute. depending on the hardness of the ground. The actual capacity depends on hardness, the size of gravel and the ability of the winchman to dig full buckets. The output on Oroville ground is 8,080 cubic yards (bank measure) in 140 hours, or 57 cubic yards per hour.

ILLUMINATION OF PICTURE GALLERIES

Theoretically, artificial lighting of picture galleries, being under control, ought to enable the artist to secure special effects that he otherwise could not hope to attain.

ILLUMINATION OF THE HEINEMAINN PICTURE GALLERY.

Paintings have been found to deteriorate rapidly when exposed to the fumes of combustion emitted by certain illuminants and, until the advent of electric lighting, many of the large galleries were not illuminated artificially. The electric incandescent lamp, the arc lamp, Moore tubes, etc., however, now offer abundant means of artificial lighting which will not injure the pictures and which in many instances will bring out the artist's conception better than daylight.

Some pictures require individual lights to obtain the proper effect while others require the softer glow of diffused light, in either case electric lamps of one type or another are used in all picture galleries. It is necessary, however, to study the question scientifically and also to study the object which the artist had in view.

When the object in view is to represent as nearly as possible the correct colors of the paintings, some form of diffused lighting is generally used. An example of this method, using enclosed arc lamps is shown by the accompanying cut, reproduced through the courtesy of the London Illuminating Engineer. This picture is an interior view of the Heinemann Picture Gallery in Munich, Germany.

WATER PURIFICATION BY OZONE.

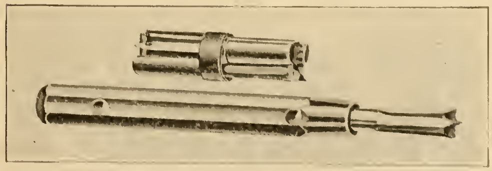
A plant for demonstrating the efficiency of ozone in the purification of public water supplies has been completed on the banks of the lower Schuylkill, in West Philadelphia. Records show that the raw water of the Schuylkill, at the point where it is taken from the river, is nothing but diluted sewage. It contains as high as 2,500,000 bacteria per cubic centimeter, which is twenty drops. After a rough straining, to remove the coarser particles of suspended matter, the water contains from 253,000 to 700,000 bacteria. After ozonization it contains from five to 55, the average being 25. The 25 bacteria which are left are of the harmless varieties, mainly the hay bacillus, which has no effect whatever on the human organism. The offensive odor of the water is also destroyed, and its discoloration removed.

The process is entirely mechanical and automatic. An electric switch is turned, two or three valves are opened, and the operation needs no further attendance. Electric current is taken from the city's wires to operate a motor generator, producing a current of 100 cycles, which is raised by transformers and condensers to a 10,000 voltage. By the operation of reactance coils and condensers, voltaic arcs and sparks are prevented, and the current passes as a pencil of blue light from each of several millions of metallic discharge points across a short air gap to nickel receivers. Atmospheric air is drawn across this gap by means of an air pump, and in so passing is partially converted into ozone. The ozonized air is then forced through a stand pipe, in which it meets a current of water flowing in the opposite direction. The contained bacteria are instantly destroyed

The reason of this is extremely simple. Chemical analysis of the bodies of bacteria show that they are made up of 84 per cent of water and about 16 per cent of solids. Of these solids more than half is made up of carbon. The strong affinty of oxygen for carbon is well known. Ozone, being a concentrated form of oxygen, has an even greater affinity for carbon, and the moment a bacillus comes in contact with a bubble of ozonized air the carbon of its body combines with oxygen, and the bacillus is consumed as completely as if it had touched a flame. Indeed, the process is analagous to that of combustion. Just as though burnt up, nothing remains of the bodies of the bacteria but carbonic acid gas, which partially rises to the surface of the water and passes off into the air, and is partially taken up by the water.

ELECTRICIAN'S DRILL HOLDER.

The electrician who is in the habit of carrying in his already overfilled kit a variety of sizes of drills—all in full 12-



ELECTRICIAN'S DRILL HOLDER.

inch lengths—will appreciate the Star drill holder and set of drills shown in the accompanying cut. The drill holder is light, but solid and substantial, enabling a firm hold to be taken and a solid blow struck. The drills are short and provided with ends shaped to fit the holder. They are made with 1-4, 5-16, 3-8, 7-16 and 1-2 inch bits. The entire set of special drills and the holder itself can be slipped into the pocket.

ELECTRIC DISCHARGES TO INCREASE GRAIN YIELD.

Sir Oliver Lodge, the noted English scientist, recently carried out some very interesting experiments in the utilization of high tension, high frequency electric discharges for increasing the yield of various grains. In a recent report on this subject Sir Oliver explains the method and the results obtained.

The method is to stretch over the field to be treated a number of wires on poles, something like low telegraph wires, but high enough for loaded wagons and all the usual farming operations to go on underneath the wires.

The wires are quite thin, and are supported by a few posts in long parallel spans about thirty feet apart. They are supported on the posts by elaborate high tension insulators, and they extend over all the acreage under experiment, another similar plot being, of course, left without any wires.

The system of conductors is then connected at one post with a generator supplying positive electricity at a potential of something like a hundred thousand volts, and with sufficient power to maintain a constant supply of electricity at this potential.

Leakage immediately begins, and the charge fizzes off from the wires with a sound which is sometimes audible, and with a glow which is visible in the dark.

Any one walking about below the wires can sometimes feel the effect on the hair of the head, as of a cobweb on the face. He is then feeling the stimulating action of the electrification.

The electrification is maintained for some hours each day, but is shut off at night. The power required to generate the electricity is very small, for although the potential is high the quantity is insignificant, and the energy is accordingly comparatively trivial.

FLASHING ELECTRIC SIGNS.

BY EGBERT REYNOLDS DULL.

To the layman this is no doubt a subject that he has passed by with the mere supposition that the fantastic and spectacular effects which he sees in electric signs are produced by a machine, and that is where his knowledge generally ends.

Wherever you see moving and changing electric lights in any form, the effect is produced by what is known as a flasher. The name describes the machine. A traveling salesman in attempting to sell flashers will bring out two principal points; first, that they cut the cost of burning any sign almost in half, and secondly, that they compel a person to look at the sign whether he wishes to or not. Both of these are true, and in order to carry out the customer's ideas of economy and attractiveness, the manufacturer of these devices is compelled to carry at least 20 different types in stock, to say nothing of an unlimited number of sizes of each particular type for the different purposes. Principal among the types of sign flashers are the "Single Pole," "Carbon," "Chaser," "Series," "Flag," "High Speed," "Script Breaker," "Lightning," and "Combination." It is the effect from these machines with which the public is most familiar.

FIG. 1. SIGN REQUIRING THE COMBINATION OF FIVE FLASHERS.

The Single Pole type of machine is better known to the public as the machine that spells out one letter at a time on a sign. It is nothing more or less than a number of electric switches of a peculiar construction that are raised and lowered by means of a series of cams on a shaft, which cams in turn are operated by a small motor.

The Carbon type machine is of an entirely different construction, containing large heavy switches, known as the double pole type. This is the kind of machine that will light a sign first on one side and then the other, and handle signs by whole lines at a time. The service being constant, an ordinary knife switch, with which the reader is familiar, would not answer the purpose. The knife switch which you see on a wall is generally operated by hand three or four times per day. The flasher must be able to carry any kind of a load 10 to 20 times per minute. This would burn the hand switch up in a night, but the flasher is so constructed that all the destructive elements existing in the breaking process are taken care of by carbon contacts, which can be adjusted as they wear and replaced when they are consumed. This machine will handle any load up to and including 400 four candle-power lamps on one switch.

For extra large loads ranging from 500 to 5,000 lamps, there is used what is known as the Series type. This machine breaks the current at a large number of points simultaneously. If you were to attempt to break such heavy current as is required for this number of lamps, at one point, the arc would jump across the opening in the switch and soon destroy carbon as well as anything else. But to provide against this the current is broken at from four to six points simultaneously. This could be likened to six switches leading to the same light, one man operating each switch, and at a pre-arranged signal all six of the men pulling their switches at the same time. If the switch operated by any one of the men had a tendency to hold an arc, there would be the switches operated by the five other men breaking at the same time to assist him.

The Chaser type is known best to the public as the "snake" machine. It is the one which produces the effect of snakes, rats, or whatever you are a mind to call them, running around the edge of a sign. This requires an individual wire to be run to every lamp in the border. The machine always has a certain number of lamps on at one time, according to the length of the object desired to run around. If the customer wants an object 10 lamps long, when the machine picks up the eleventh it drops off the first. When it picks up the twelfth it drops off the second, and so on in a continuous motion, very rapidly, which gives the appearance of an object crawling around the border. If only one or two lamps are on at a time, it will look like a flea hopping around. Four lamps will look like a rat, six or seven will look like a squirrel. Over ten lamps looks like a snake.

The Flag type machine, as its name indicates, is used principally for operating waving flags, pennants, etc. This machine runs at a very high speed and generally contains from 15 to 20 switches. Each switch breaks about 120 times per minute. This effect is virtually the reverse of a snake machine, because the former is a border of dark lights with rays of light traveling around it, while the latter is a flag of light with folds of darkness running down through it. These folds are of varying widths, and generally run from three to six showing in the flag at all times. The folds near-

FIG. 2. LARGE SPECTACULAR SIGN OPERATED BY COMBINATION FLASHER.

est the staff are short and quick, gradually increasing in width as they decrease in speed to the outer end. By watching a waving flag at any time you will notice that this is the natural condition.

The High Speed machine probably produces the most spectacular effects of any. It is used for revolving wheels, hubs, and circles, falling water, fountains, smoke, steam and cloud effects. It is built somewhat on the order of a single pole machine with the exception that it must go very rapidly, some making as high as 250 breaks a minute, on every switch in the machine. The proportions of darkness to light are arranged by the length of time the switches are on as compared with the time off, and the object to be exhibited determines the speed. A slowly rising cloud of smoke from the end of a cigar will not run over 100 breaks per minute, while a stream of seltzer squirting out of a siphon will run at the rate of 250 a minute.

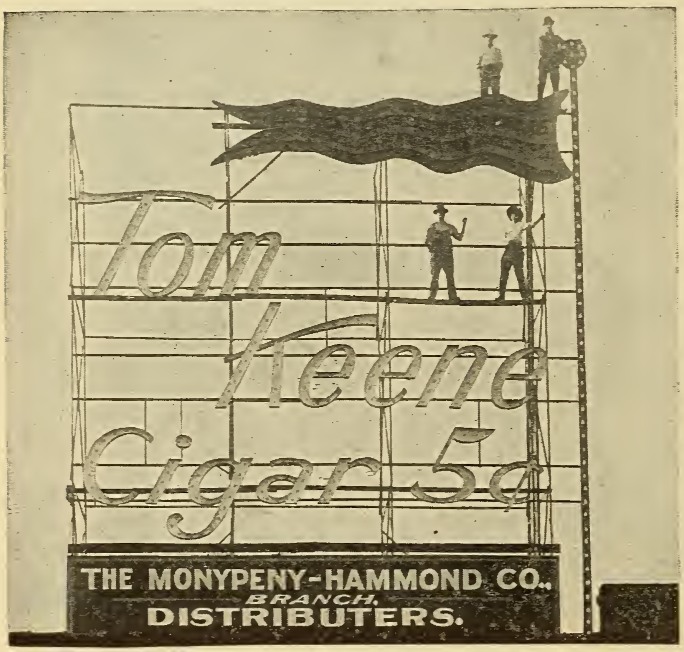


FIG. 3. WAVING FLAG EFFECT FROM TWO-PART COMBINATION FLASHER.

The Script Breaker is the machine which gives the appearance of a script sign being written out, one socket at a time. This gives the appearance of an invisible hand writing the name in fire. In this case every lamp is connected to the machine by its own individual wire. The machine picks up one lamp at a time until they are all lighted. While they are picking up it gives the appearance of being written out. After they are all on, they hold for a few seconds, then all go out together and the sign repeats.

The Lightning type of machine is the one that is required to produce the rapid motion across a sign. This is utilized for throwing bombs in the air, streaks of lightning going across the face of a sign, shooting a billiard ball across a table, and in fact anything requiring as rapid motion as the eye will follow. It is very similar to a Chaser, running at a very high speed.

The Combination machines are those embodying two or more of the previously described machines. A Combination carbon and chaser would give the effect of rats running around the border of a sign, while the wording was being flashed as a whole in the middle, and again there may be half a dozen different sizes and combinations of machines to produce spectacular displays. Such a display is shown in the accompanying illustration (Fig. 1). This sign requires five different machines, all mounted on the same base and driven by one motor. All are connected together by means of chain gears, and running at different speeds in such manner that each will do its share of work at the proper time to produce the effect desired.

This Combination machine contains the following: The star at the top twinkles 150 times a minute with a Single Pole machine. The rays of the star radiating downward are not clearly visible be-

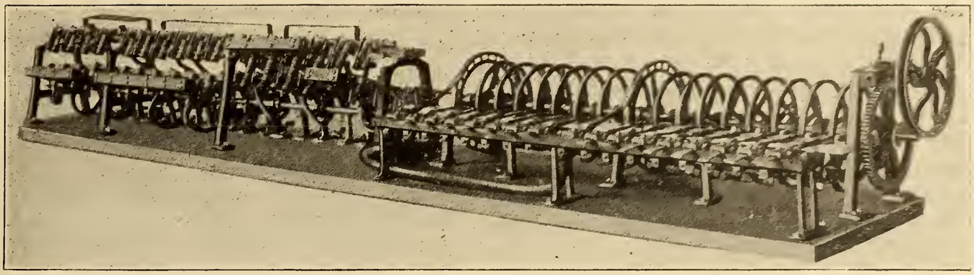


FIG. 4. COMBINATION SIGN FLASHING MACHINE.

cause they were red, and red does not photograph well. These rays shoot downward constantly somewhat on the order of the tail of a comet, which effect is produced by a high speed machine. Four times per minute a stroke of lightning starts at one point and travels with great speed all around the word "Casino." This is done with the lightning type. The "Gay White Way" is flashed on and off with a carbon machine, while the word "Casino" is flashed on and off with a series machine because it is a heavier load than a carbon machine would carry.

Fig. 2 shows another large spectacular sign operated by means of a combination machine. The fire on the end of the cigar, which consists of a number of amber and red lamps, lights up two or three times as though someone were drawing on the cigar. After puffing two or three times, a cloud of smoke rises from the end of the cigar and curls upwards for a few seconds. Then the wording is brought on, one line after another.

Fig. 3 is also operated with a Combination machine consisting simply of two kinds, flag type and a carbon. The pennant across the top of the sign, which is 25 feet long, waves continuously as though being blown by the wind, while the wording is flashed on one line at a time.

Fig. 4 shows one of the machines as they are arranged. This is a combination of three different types. It is six feet long, one foot wide and one foot high and weighs about 200 lbs. All the various contactor devices for turning on and off the groups of lamps are mounted on a single shaft driven by an electric motor.

The various switches, levers, wheels and parts these machines are all finished ready for use, and, in an emergency, an order which is received in the morning's mail can be on the cars at night. Such a machine to be built outright without the parts in stock would probably take six men a full week of eight hours a day.

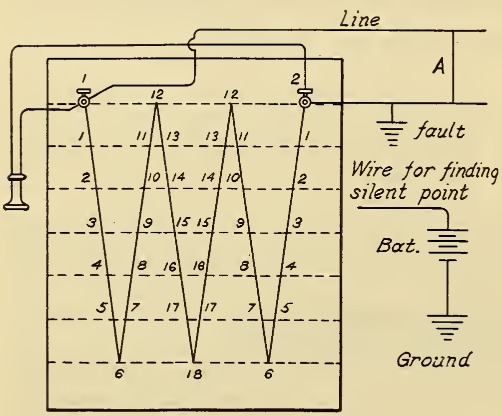
SIMPLE METHOD OF TESTING CABLES.

To the Editor Popular Electricity:

Being a devoted reader of your popular magazine, and especially interested in electrical measurements of cable, I would like to explain a very simple test which is not generally known, but which I find with a series of experiments is more accurate than a bridge or galvanometer for locating grounds in cable. It cannot be affected by foreign battery, heat or cold, as with a bridge, therefore I think it more convenient and handy than a galvanometer, especially so since many of the smaller exchanges are not equipped with instruments for measuring cable. When trouble occurs the cable must then be gone over with a car, and if no hole is found in the armor, as is often the case when the cable is hit by lightning, it must be opened and tested until the trouble is located. If the cable is a long one, eight or ten places will sometimes be cut in the cable before thre trouble is located. The diagram and formula will explain how the test is made.

First get a piece of fiber or board about seven or eight inches long, and about six inches wide. Then take a piece of German silver wire 36 inches long, and stretch it over the board as shown in the diagram. Now mark the board off in scale divisions of one inch. Everything is now ready for the test.

Find the actual length in feet of the cable to be measured. Then suppose one side of the pair to be measured is grounded. Go to the cable box and tie the pair together, or in other words, short-circuit it, as represented at (A). Then go to the other end and put one side of the pair on the binding post marked (1) in the diagram and the other on post (2). Then take a head receiver and put one terminal on (1)



SIMPLE METHOD OF TESTING CABLES.

and the other on (2) with the line to be measured. Ground one side of four or five dry cells, and with the wire from the other terminal go over the wire on the bridge until a point is found on the bridge where no click is produced in the receiver on touching the wire to this point. Note what scale division the silent point is on, then use the following formula:

(1) Multiply the length of the cable by 2.

(2) Multiply this product by the silent point, and

(3) Divide this product by 36.

For example, suppose the cable to be 500 feet long, and the silent point to be 8.

500×2=1,000.
8×1,000=8,000.
8,000÷36=222.

The distance from you to the fault is therefore 222 feet; or 500 — 222 is 278. the distance in feet from the cable box.

If both sides of the pair to be measured are grounded, take another clear pair, and use each pair as one side of one pair.

The size of the wire makes no difference in the formula, but both sides of the pair must be of the same size wire.

D. M. W.

READING THE WATTMETER.

BY C. O. DUNTEN.

Users of electrical power are prone to look with more or less suspicion upon their wattmeter. This is due in part to the somewhat mysterious character of the power measured and in part to the inability of the consumer to intelligibly translate the meter reading into the monthly bill from the power company. Much more amicable relations would exist between the power company and the consumer if this condition of affairs could be obviated.

Integrating wattmeters record the sum of all the power consumed since the dial pointers were last in the zero position. In some wattmeters this power is read directly from the dials, while in other wattmeters the dial reading must be mulitplied by some constant which is usually given on the wattmeter face below the dials. To get the amount of power consumed during any one month it is necessary to subtract the meter reading at the end of the month from the reading at the first of the same month and use the multiplier, if one is given.

The reading of the wattmeter can

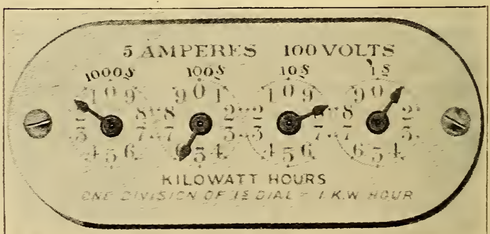


FIG. 1. WATTMETER DIAL.

best be understood by taking a concrete example. Fig. 1 shows four dials with their pointers. To read these it is best to record the reading of each pointer, beginning with the dial to the right and writing the result from right to left to obtain the reading of all four dials. As a general rule it may be stated that when a pointer stands between any two numbers on a dial, the lower number is always read.

In Fig. 1 the pointer of the right-hand dial stands at 1. The pointer of the second dial from the right has passed the 8 but has not reached the 9, therefore the reading is taken as 8, and the total of the two dials is 81. On the next dial the pointer is midway between 5 and 6. It cannot be read 6 until the pointer of the preceding dial has completed the revolution, consequently it is read 5, and the total of the three dials is 581. In the same way the left-hand dial pointer stands between 1 and 2 and cannot be read 2 until the pointer of the preceding dial has covered the remaining distance between 5 and 0. The reading is accordingly taken as 1, and the total of the four dials is therefore 1581. This

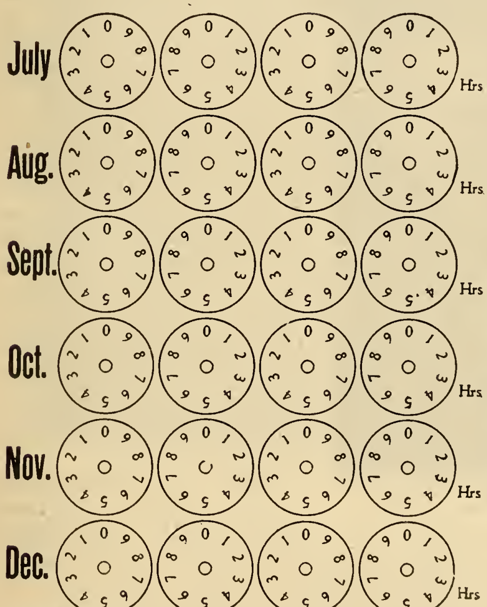


FIG. 2. CHART FOR RECORDING METER READINGS.

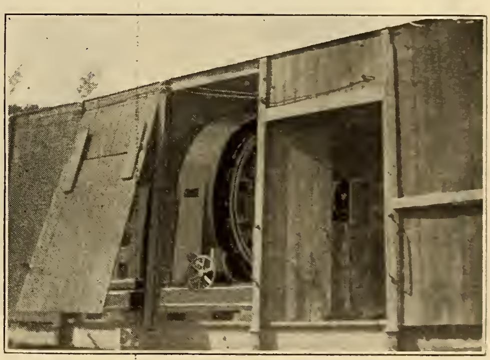
means that the meter has registered 1581 kilowatt hours since last it was set at zero. The difference between the readings at the first and last of the month multiplied by the meter constant and by the cost of electrical power per kilowatt hour should check with the bill received from the power company for that particular month.

A convenient and easy scheme for keeping a record of each month's meter reading is by preparing a card similar to that shown in Fig. 2. By marking the position of each pointer on this card when the meter is read, a permanent record of the meter readings is kept and the bills from the power company for any month can be checked whenever desired. Cards similar to Fig. 2 are sometimes furnished by the power company for this purpose.

A PORTABLE SUB-STATION.

A sub-station used in connection with an electric light and power system is a station near a center of distribution which takes high voltage alternating current from the main power station and transforms it to direct or alternating current, as the case requires, of a voltage suitable for commercial use. The machines for doing this are of two types, known as rotary converters or motor-generators.

Sometimes the regular sub-station in some particular locality does not have sufficient capacity to furnish all the low-



PORTABLE SUB-STATION.

voltage current required, in case there is some special drain on the current supply. To meet such conditions and to help the regular sub-stations out when they are supplying the street car system during some unusual rush traffic the Pacific Electric Company has built a number of portable sub-stations one of which is shown in the picture.

The motor-generator mounted in an electric box car and can be sent to any of the permanent sub-stations of the company's interurban lines on short notice and then connected.

High voltage alternating current is sent out to these sub-stations, then stepped down by a transformer for the induction motor, which in turn drives the direct current generator which furnishes the current for the car line.

LOUD SPEAKING TELEPHONE FOR ELEVATORS.

The telephone and electric elevator are brought into combination in a very interesting manner in the immense new Singer and Bourne Building in New York. The operating conditions in this building are unusual as the tower reaches to the remarkable height of 612 feet above the curb and elevators traverse nearly the whole distance. There is reason to believe, however, that if the system of telephones were applied to the elevators of smaller office buildings and department stores it would result in increased efficiency of service.

The telephone equipment installed in these elevators enables the starter at the bottom to give oral orders to the car operators at any and all times. The operators are likewise kept in communication with the starter and the engineer, and the engineer can talk with the starter and operators. Communication may also be had by these parties with the watchman on the fortieth floor, likewise with the machine shop, engine room and boiler room.

As described in the Electrical World, the telephone system includes a small private exchange in the basement, supplied with current by a 24-volt storage battery, which is charged from the lighting mains. All telephone connections other than those made by the starter when he desires to speak with the car operators under his control are made by the telephone operator at the private exchange switchboard.

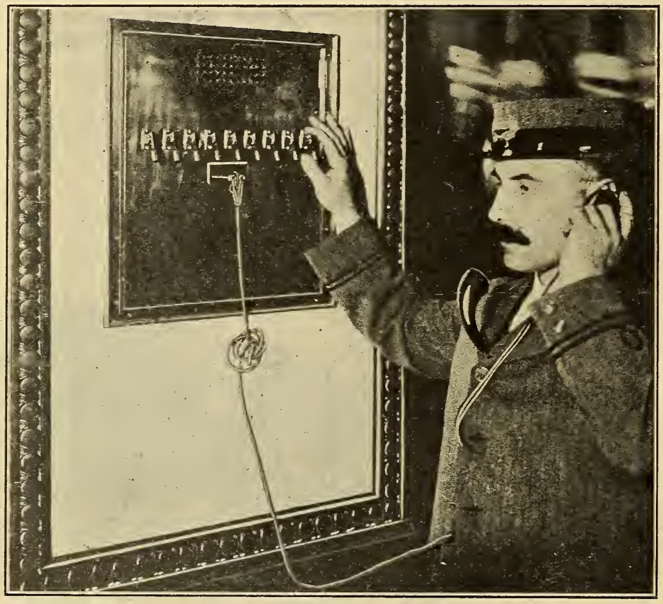


FIG. 1. ELEVATOR STARTERS SWITCHING PANEL.

Each starter, while performing his duties, is within convenient reach of a small metal panel, mounted either upon the wall or upon one of the marble columns in the main hallway. Although the panel is flush with the surface of the wall or column, a call bell and a series of switches, the handles of which project through the panel for the use of the operator, are mounted behind it as illustrated in Fig. 1. The bell is for signaling the starter and the switches enable him to connect with any one of the car operators under his charge.

The flexible connection of the starter's telephone set enables the starter while connected in circuit to face in any direction and furnish information to those inquiring about the cars or the location of the tenants, watch the electric signal lamps which indicate the position of the cars and give attention to the arrival and departure of each car under his supervision.

Loud speaking receivers are used in the elevator cars so that the operators can hear the orders transmitted to them by the starter without placing the receivers to their ears or otherwise interfering with their work. These receivers were specially designed for use in the elevator cars, and although each contains the same elements which make up the ordinary bipolar receiver, these elements have been modified to secure an unusually loud and clear enunciation. The dia-

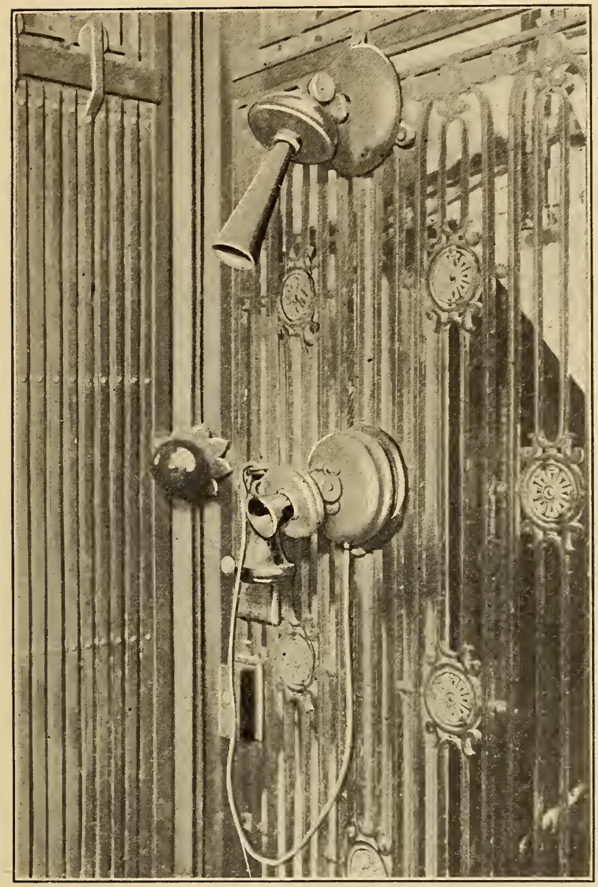


FIG. 2. TELEPHONE IN ELEVATOR CAR.

phragm has a comparatively large diameter and is held so as to be free from strain. The horn, as shown in Fig. 2, is rigidly attached to the receiver proper, but the whole is clamped to a base so that when mounted in the car it can be adjusted vertically.

In addition to the loud talking receivers, there is in each elevator car, as shown in Fig. 2, a metal case wall telephone set for the operator's use in securing a connection through the private exchange switchboard in cases of emergency.

RECORD IN TELEGRAPHING.

The Democratic convention at Denver saw other records broken besides that for a political demonstration. One record that was smashed was for long distance telegraphing. The man who broke this record was George W. Conkling, the New York Sun's chief operator.

Working over a wire that stretched more than half way across the continent, about 2,500 miles, Mr. Conkling attained the high speed of 3,136.20 words an hour, or 52.27 words to the minute, a record which has never before been equaled anywhere. Furthermore, Mr. Conkling in just twenty-eight working hours sent over this wire to The Sun by the Morse system and using the Phillips code a total of 73,000 words, an average of 2,60.14 an hour, or 43.45 words a minute. Much of this matter was sent from a seat in front of the speaker's stand in the convention hall while pandemonium was being raised.

INTERESTING TELEGRAPHIC STATISTICS.

The German government has recently published some interesting statistics as to the use, and the cost of the use, of the telegraph in the various countries of Europe and in the United States.

As might be expected, this country has by far the greatest mileage of lines, 1,155,480 miles, an amount nearly equal to that of the United Kingdom, France and Germany combined. But in the number of messages the United Kingdom takes the lead, with 94,000,000, against 65,500,000 in the United States, 58,000,000 in France, and 52,500,000 in Germany.

In the average cost of messages the United States is at a very great disadvantage, having to pay 42 cents, against 16 in the United Kingdom, 15 in Germany and only 12 in France.

The total receipts for telegraphing in this country are correspondingly large, being $27,985,000, as against $15,247,000 in the United Kingdom, $8,299,000 in Germany and $7,334,000 in France.

SOME APPLICATIONS OF ELECTRICITY TO DENTISTRY.

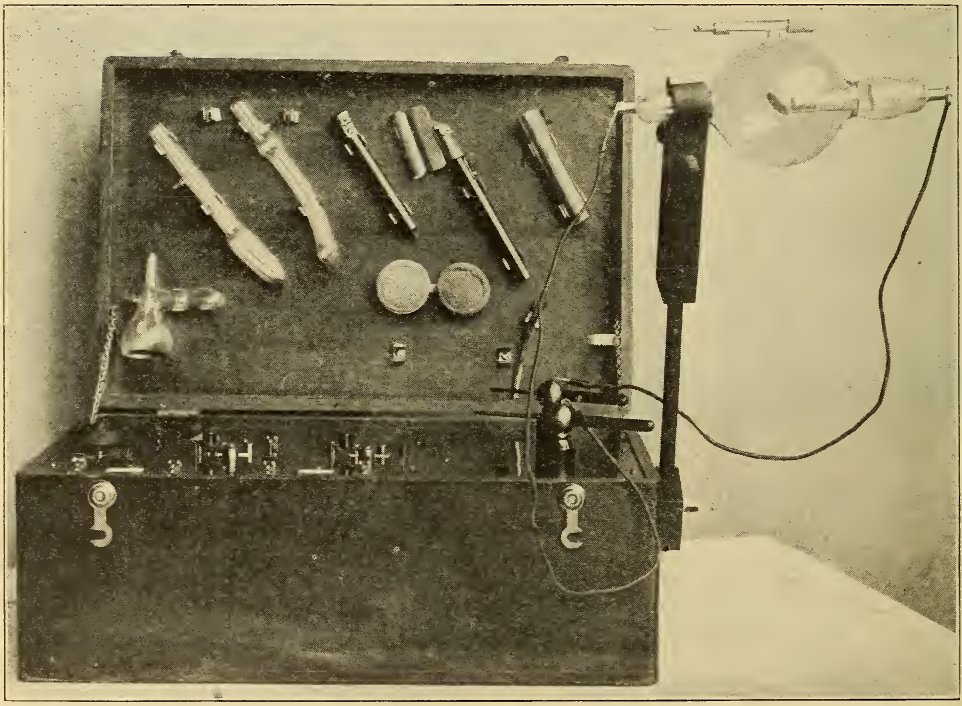
To the student of electricity the modern dentist's office contains many interesting things besides the proverbial torture devices. Not only is electric current applied in various way to diagnosis and the actual operations, but it is also available as a cheap and efficient source of power in the laboratory and workshop where artificial teeth and crowns are made.

In the diagnosis of a case and before actual operations are begun, the X-ray offers a sure and simple method which has only been recognized in the last few years. The principal drawback to its use before this has been the inconvenience and trouble of taking and developing X-ray pictures and the technical knowledge necessary to operate the coil. Apparatus of this kind has been greatly simplified, however, and is now manufactured in a form available to any dentist, the Dental Special X-ray Coil shown herewith being an example of a compact and efficient outfit.

In making an X-ray picture of a tooth to determine its condition, it is only necessary to place the dental film in the patient's mouth back of the tooth, excite the X-ray tube and then remove the film and develop it. A type of dental flouroscope also goes with this set, which is about the size of a dental mirror, and which permits the operator to observe the interior of the tooth directly without the necessity of making a radiograph or X-ray picture. This latter device is sufficient in most cases.

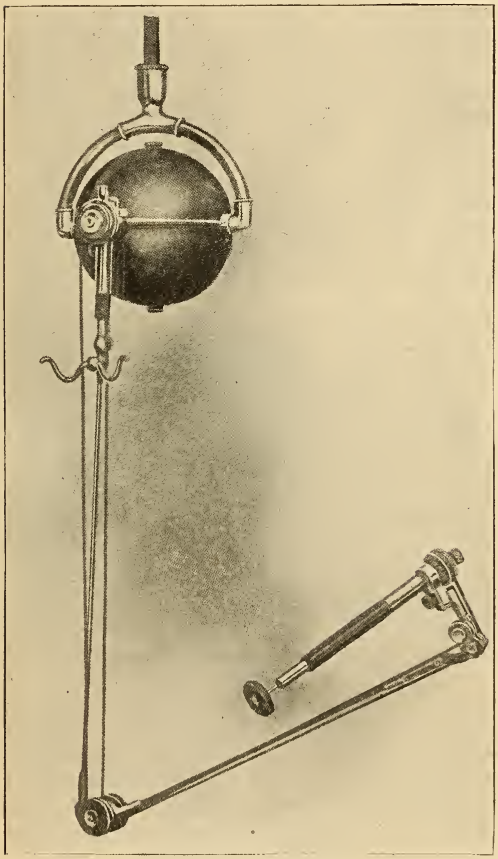
The small glass tubes which are seen held to the cover of the box are vacuum tubes which can be connected to the terminals of the X-ray coil, and they are for applying the X-rays to the treatment of Pyorrhea and other diseases of the teeth and gums.

Value of the X-ray can hardly be



DENTAL SPECIAL X-RAY COIL.

overestimated. It permits a thorough study of unerupted, impacted and supernumary teeth, it furnished a means for investigating the length and strength of the roots to determine the anchorage for bridge work or in placing crowns.

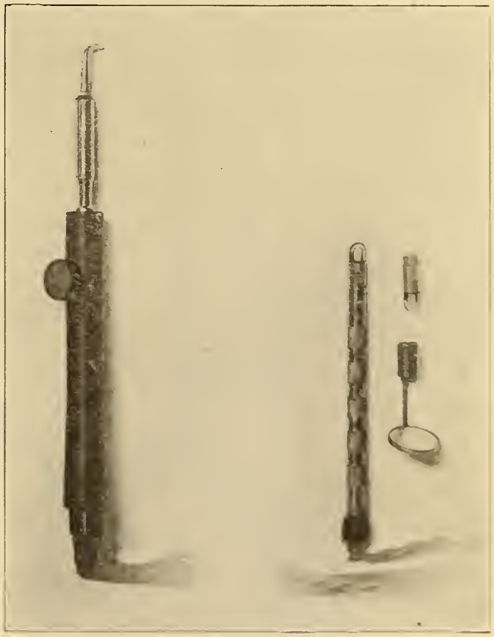


DENTIST'S SUSPENDED MOTOR.

Coming now to the real dental instruments for drilling, grinding, pounding and otherwise producing uncomfortable sensations, the electric motor is made to run them all. The motor is suspended from the ceiling and is provided with a many jointed arm which permits the working end which carries the drill or polisher or tiny "pile driver" to be held in any position desired. In the case of the Ritter engine shown in one of the illustrations, it is very little trouble to take out one instrument and insert another in the arm-piece. A belt runs from the motor along the arm to the instrument end and passes over the joints or elbows without becoming twisted or tangled.

Motor operated engines are a great advantage, since dental operations require great care and accuracy, and these cannot be attained to the highest degree when the operator is pumping away with his foot on the old-fashioned treadle.

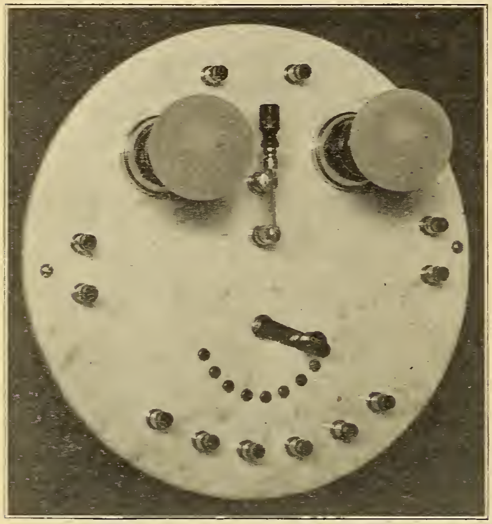
One of the illustrations shows two very interesting devices—the electric hot air syringe and the illuminated mouth mirror. The hot air syringe consists of a cylindrical handle through which runs a rubber tube from the compressed air tank and terminates in a bent-over nozzle. Electric conductors are also carried into the casing and terminate in a heating coil which heats the air as fast as it comes from the nozzle. An even heat is thus obtained and the dentist is



HOT AIR SYRINGE AND ILLUMINATED MOUTH MIRROR.

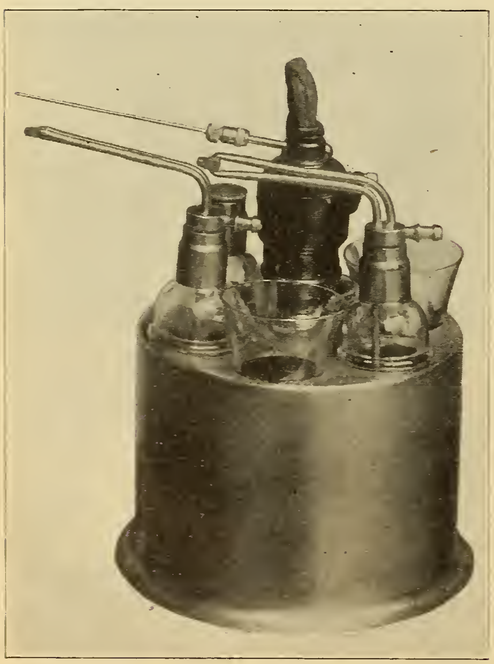
not put to the unnecessary trouble of heating the nozzle over an alcohol lamp.

The illuminated mouth mirror consists of a very small electric incandescent lamp mounted on the end of a hollow handle, the conductors to the lamp being carried through the handle. The mirror is mounted on a collar which fits over the lamp base. When in operation the light may be thrown on exactly the spot desired.



DENTIST'S SWITCHBOARD.

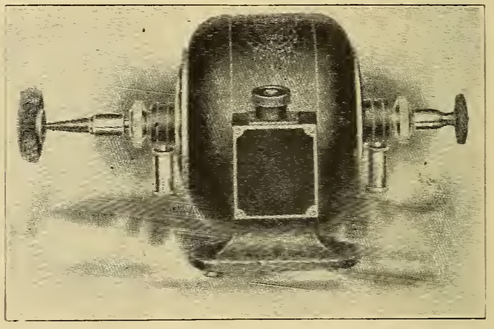
In some dentists' offices elaborate switchboards are in use for controlling the current for the various electrical devices. A comparatively simple and at the same time a very neat one is shown in one of the half-tone illustrations. It is put up in a round form, using for a base a highly polished white Italian marble. All parts and binding posts are handsomely nickel plated. The board is constructed to operate on either direct or alternating current, and has two sets of binding posts for supplying current at the full voltage to engine, lathe, bracket lamp, fan, furnace, gold annealer, etc.



DENTAL HEATING SET.

It also contains three extra sets of binding posts for low voltage, to operate the hot air syringe, illuminated mouth mirror and root drier.

The De Vilbiss dental set for heating atomizers and keeping various solutions at the proper temperature is an ingenious arrangement. It consists of a closed vessel of polished brass with a removable bottom. Holes are provided in the top into which are set the bottles of the atomizers and also tumblers for rising and antiseptic solutions. In the center is an opening for an incandescent lamp, which is mounted with the bulb inside the vessel. This is an economical form of heater, as never more than a four-candle power bulb should be used and a two-candle power bulb will keep the solutions at blood heat.



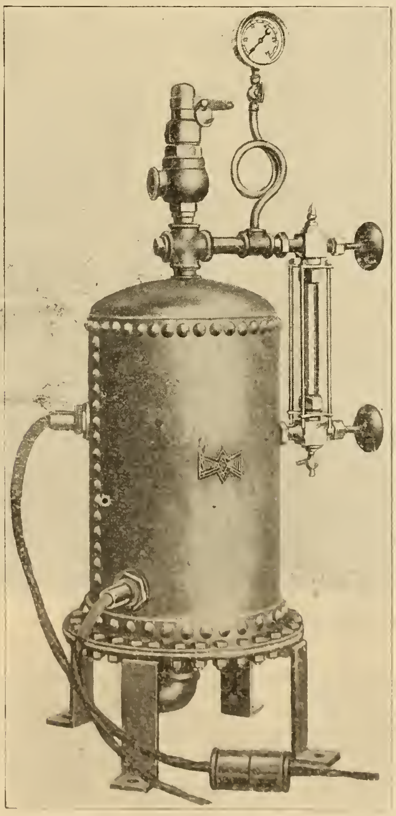
ELECTRIC LATHE AND POLISHER.

In the mechanical processes of the laboratory and workshop electricity now plays an important part and is used for heating small furnaces, gold annealers and for driving the dentist's lathe. The Columbian electric laboratory lathe here illustrated is one example of many types used by crown and bridge workers. It is provided with chucks for the various tools which are mounted on the end of the motor shaft, including also carborundum wheels, polishers, etc. Four speeds are obtainable, ranging from 1,000 to 3,000 revolutions a minute, and the motor developes one-sixth of a horse power.

AN ELECTRIC STEAM BOILER.

Where a small quantity of steam is required it is often advantageous to employ an electrically heated steam boiler, avoiding the expense of a fireman and the heat and annoyance of gas or oil burners.

The Simplex electric boiler illustrated herewith is equipped with steam and water gauges, safety valve, feed, blow-off and steam connections, as usual in standard boiler practice. The electric heat is generated inside the boiler, so



ELECTRIC STEAM BOILER.

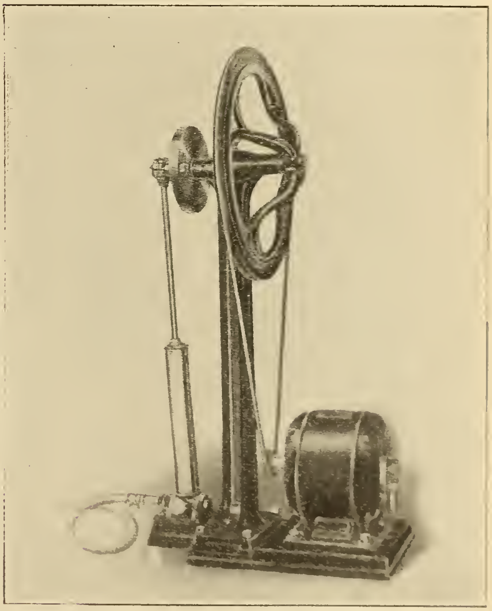
that none is wasted, and is subject to control by means of regulating switches.

The consumption of current is at the rate of about 10 kilowatts per standard boiler horsepower, or about 340 watts per pound of water evaporated per hour.

Numerous applications of electric steam boilers are found where steam is used for heating parts of machines in which it is condensed and returned as hot water to the boiler. When such a closed system can be used, the device is economical and frequently far more desirable and satisfactory than piping considerable distances for small requirements.

SMALL MOTOR DRIVEN AIR COMPRESSOR

In doctors' and dentists' offices, laboratories, barber shops and in artists' studios for operating air brushes, compressed air is often required, but in small



MOTOR DRIVEN COMPRESSOR.

quantities not warranting the installation of an elaborate or expensive compressing plant. A small motor of one-twentieth to one-sixth horsepower will do this work at a very small cost for current. The outfit shown herewith will furnish air sufficient to fill a five or 10 gallon tank to a pressure of 50 pounds to the square inch in 20 minutes. The little motor drives the fly wheel and crank, which in turn operate a small plunger pump similar to a tire pump. The Emerson motors supplied with this outfit are furnished for alternating or direct current as the case may require.

THE PRODUCTION AND USE OF RADIUM.

BY DR. ALFRED GRADENWITZ.

The discovery of certain radiations which, though being invisible to the eye, manifest themselves by the most striking effects, has brought about a veritable revolution in the field of science. The typical representative of the substances giving out those radiations, is radium, or rather its chemical compounds, as the element itself has not yet been isolated.

Owing to the scientific interest attaching to this wonderful substance in the last few years, and the practical uses it is liable to be put to, especially in medicine, it will not be amiss briefly to record the complicated processes required in its manufacture.

Apart from being among the most remarkable substances known to man, radium salts are the most precious of all chemical compounds, one kilogram (about 2.2 pounds) of radium bromide being estimated at about $80,000,000.

Owing to this extreme costliness, it will be understood that the amounts of radium salts generally handled in laboratories are rather minute, and as the effects of radium are of extraordinary intensity, those small quantities are quite sufficient to show any phenomena so far discovered.

In order, however, to give an idea of the enormous amounts of material required to produce even such minute quantities as a few milligrammes of radium salts, it may be said that whole wagonloads of diverse ores have to be submitted to a lengthy treatment in order to extract these extremely small quantities.

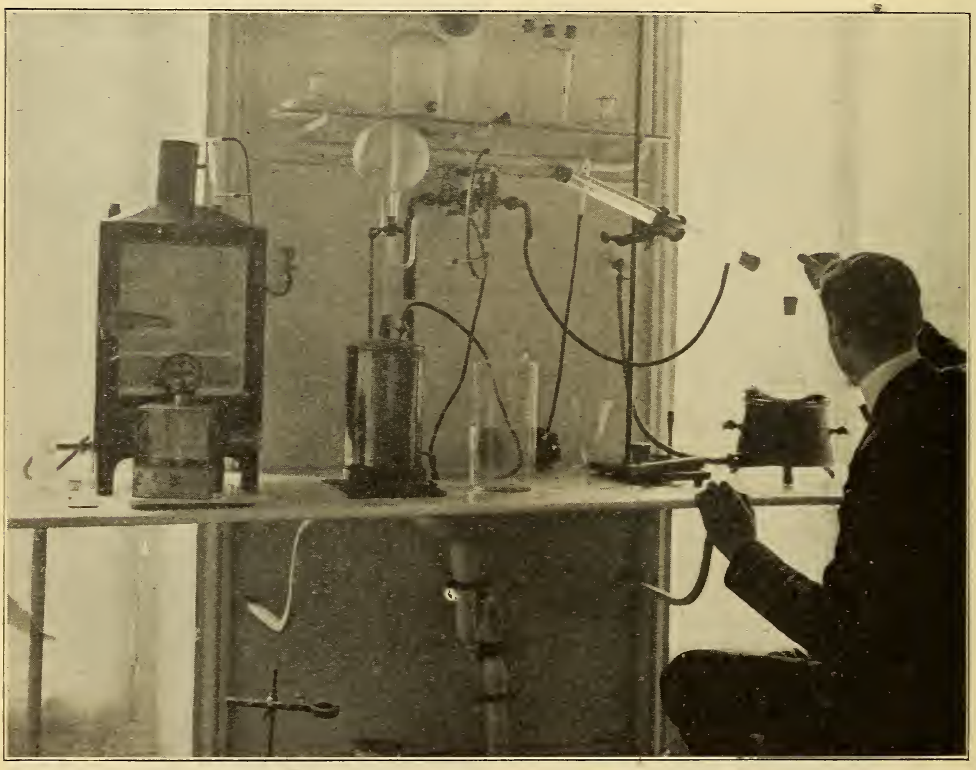


FIG. 1. INVESTIGATING THE RADIO-ACTIVITY OF MINERAL WATER.

By discontinuing the various operations at a given stage, the activity of the radium salt can be varied at will, according to the special purpose it is intended for, and a whole scale of different intensities can be readily produced. After what is called the "gross treatment" of the ores, the activity of the product will be from 50 to 60 (taking the activity of uranium as unity), while the final operations will raise it to from 1,000 to 2,000,000.

At a special radium factory recently installed at Nogentsur-Marne, France, the most varied ores are treated, and on their arrival are all taken to the crushers, where their further treatment varies according to the kind of material. The method described in the following applies more particularly to pitchblend, or rather to pitchblend residues, which are the most important of radium holding materials.

The "gross treatment" is carried out in wooden tanks, and cast iron tanks provided with stirring devices. Each ton of residue will require five tons of chemicals and 50 tons of rinsing water. The residues contain sulphates of practically all metals, and as radium sulphate is the least soluble of all, this property is utilized to separate it from the remaining sulphates by washing it alternately with alkali salts and water. These successive washings will remove each time the metal having the most soluble salts.

At the end of this difficult treatment one to two kilogrammes of radium bromide remain from each ton of original residue, but this small amount shows an activity two million times higher than metallic uranium.

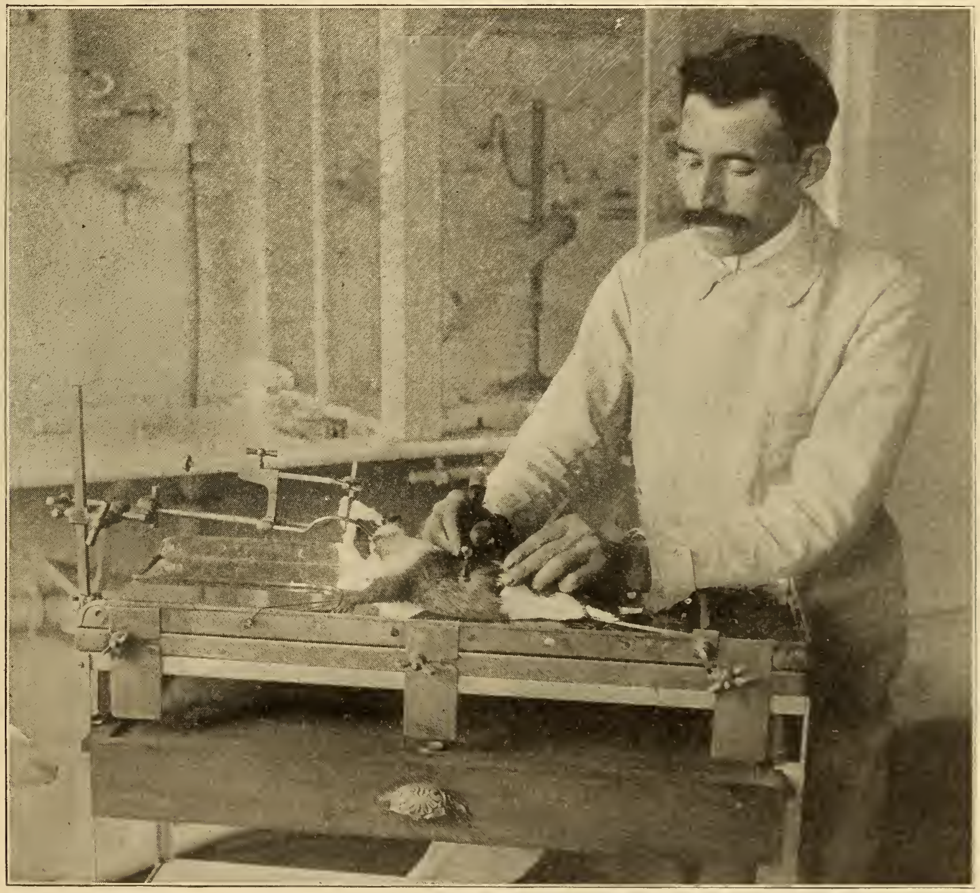


FIG. 2. TESTING THE BIOLOGICAL EFFECTS OF RADIUM.

The most important part of the factory is the laboratory, where chemical analyses and spectroscopic tests are carried out, in addition to measuring the activity of each product, as well as of the emanations they are liable to produce.

In order to allow the wonderful qualities of radium to be more thoroughly investigated, a special Radium Institute has now been founded at Paris. This institute is provided with the most improved apparatus for research work, each department being controlled by specialists—physicists, chemists, biologists, and medical men.

A subject particularly investigated at this institute is the radio-activity of mineral water (Fig. 1). It has been known for some time that the water of certain sources, while containing quite immaterial amounts of minerals, is more effective than that of others, holding large

FIG. 3. TREATING RHEUMATISM WITH RADIUM.

amounts of such substances; also artificial waters are never found to be as beneficial as the corresponding natural waters. If the radio-active qualities, as presumed, be really shown to be the cause of those effects, it would be quite feasible to produce by artificial means a water of any desired qualities.

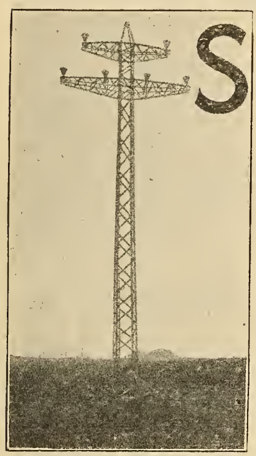
In another department the nature of radium and radium-emanations is investigated from a purely scientific point of view, by means of a number of instruments designed by the discoverers of radium, as well as by Sir William Ramsay, and other scientists. A classical experiment, which should be mentioned in this connection, is the conversion of radium emanation into the element helium. This experiment consists of placing a solution of radium bromide in the interior of a flask, producing a vacuum above the liquid, and allowing its emanation to escape through a tube into a glass bulb, cooled by liquid air. On contact with the emanation the water will be decomposed after a few days, and the presence of a third element will be noted in the gaseous mixture. This third element, which is the product of conversion of the emanation, is condensed in the glass bulb, and is found to be an ordinary gas, to which the law of Mariotte is applicable. This gas imparts to the glass a violet hue, and possesses a spectrum of its own, according to which it has been identified with helium.

In addition to measuring the radioactivity of minerals, the biological effects of radium salts on rabbits, guinea pigs, and even on man, are investigated (Fig. 2). For these physiological and therapeutical experiments there are used special instruments, comprising a box, that contains a radio-active substance, and a mantle surrounding this and protecting the operator against the effects of radiation. By continuing these experiments it is hoped to accurately ascertain the therapeutical effects of radium rays, which, while being analogous to some degree to those of X-rays, are much more intense than the latter and therefore may be conducive to even more remarkable results.

Another type of apparatus which is used very frequently at the Radium Institute, is made up mainly of a small metal casing, consisting of two parallel plates, between which 15 centigrammes of radium-holding barium salts are compressed in the form of a plane layer six to seven-tenths of a millimeter in thickness. The metal plate, intended to be applied to the guinea pig or the human organ submitted to radium treatment, is a thin aluminium foil. The other plate, which is somewhat thicker, carries a joint which can be mounted on the end of a metal rod, provided with a wooden handle, and accordingly can take any desired position.

After some months of operation, the results so far obtained are rather encouraging. The workers connected with the laboratory have already succeeded in utilizing the relieving effects of radium for the treatment of inflammations of the joints and of rheumatism (Fig. 3) and in healing some lighter affections of the skin. It is even hoped to be successful in the treatment of tumors and cancer and tuberculosis, but the experiments made in this direction are yet far from being concluded.

ELECTRIC POWER FROM THE CHICAGO DRAINAGE CANAL.



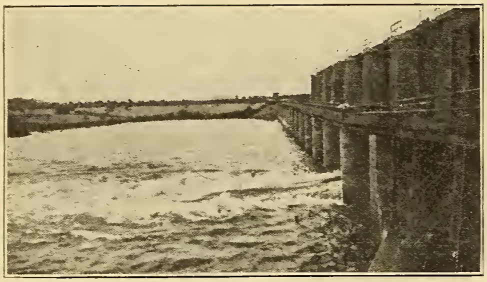
SIXTEEN years ago active work was begun on the Chicago Drainage Canal with the object of diverting the sewage from Lake Michigan into the Desplaines river, thereby purifying the water supply of Chicago. Eight years later the work was completed, and now stands as one of the most remarkable engineering feats ever accomplished. The canal extends from Robey street and the Chicago river to Lockport, Ill., where it discharges into the Desplaines. Extending for a distance of 29 miles across the country, the canal is largely cut through solid rock, and to the observer the great piles of rock and debris along its banks appear to be a low range of rocky hills extending away into the distance as far as the eye can reach.

The width of the canal is 250 feet and the depth 22 feet. Together with the improvements to the Chicago river its cost was over $50,000,000.

The Chicago river no longer flows into Lake Michigan but instead the waters of the lake flow "up" the Chicago river, through the canal, down the Desplaines and the Illinois and finally lose themselves in the bosom of the Mississippi. On their way they have swept out from the Chicago river the accumulated deposits of generations and made it almost clean, so clean, in fact, that recently a two mile swimming race was held where once there was little more than a bed of slime.

VIEW ON THE DRAINAGE CANAL.

When this work was first undertaken,



THE CONTROLLING WORKS.

little attention was paid to the power development made possible at the 12-foot fall near Lockport. When the Sanitary Canal was in good working order, however, and was performing satisfactorily the function for which it was designed engineering talent was brought to bear on a project to utilize this wasted power and there is now in operation at Lockport a modern electric power plant capable of generating over 20,000 horsepower, with provisions for doubling this output later. Large quantities of this power are now delivered to Chicago for municipal purposes over a 44,000 volt, aluminum transmission line. This line is carried on masts of steel, 60 feet high.

Everything about the plant is built on solid rock. The power house, controlling works and ship lock are placed side by side and form a dam across the channel. The retaining walls at the sides are constructed to hold the water level near the top of the building, giving a fall of about 34 feet to the turbines.

A movable crest dam and controlling works joins the power house to the east and regulates the flow of water. Next to this is the lock capable of passing boats 22 feet wide and 100 feet long.

Five electric generators or dynamos are at present installed in the plant, each having a capacity of over 5,000 horse-

EXTERIOR OF CANAL POWER HOUSE.

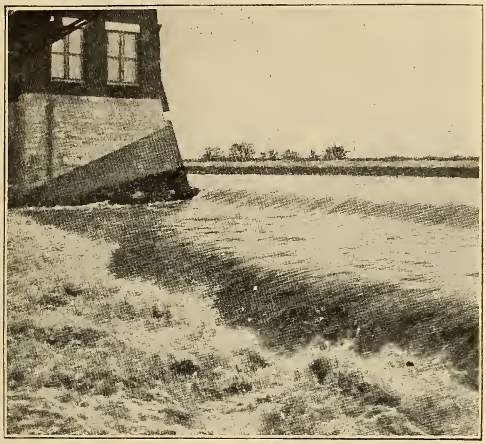
power. These are direct connected to great turbine water wheels of 6,000 horsepower each. In spite of their size these generators revolve at the rate of 163 revolutions a minute. They generate alternating current at 6,600 volts

They weigh, complete, 4,000 pounds each and are set in concrete foundations.

The views presented herewith show the exterior and interior of the power plant, and some interesting features of the work in the vicinity of the plant.

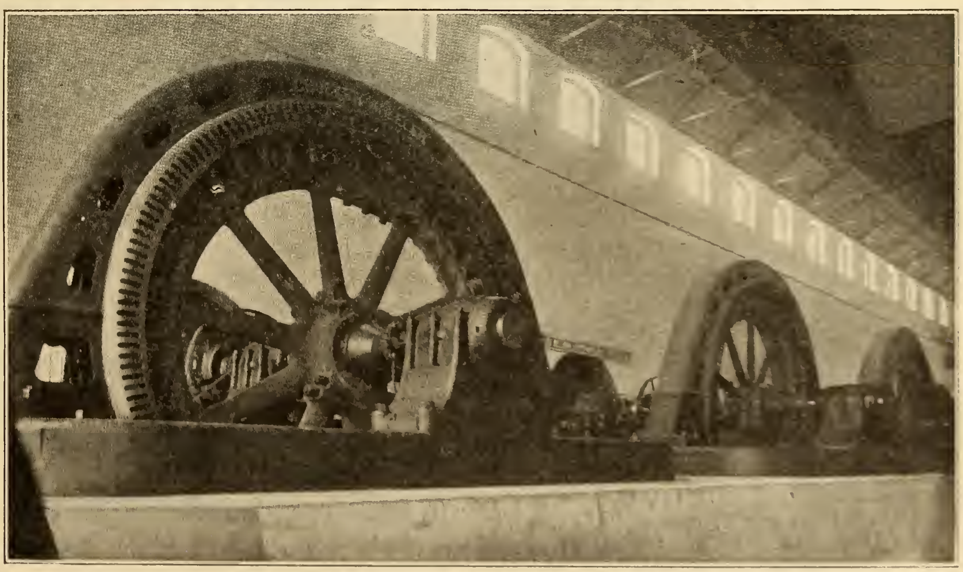
which is raised by transformers to 44,000 volts for transmission to Chicago.

The investment involved in the construction of this plant is $4,000,000. It is owned and operated by the Sanitary District of Chicago, a public body or-



BEAR TRAP DAM.

ganized under state law and governed by nine trustees elected by the people. It is the purpose of the Sanitary District not only to furnish electric power to Chicago but also to cities along the route of the transmission line and to industrial undertakings which will eventually spring up along the banks of the canal.



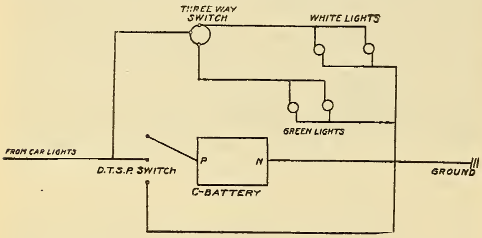
INTERIOR OF CANAL POWER PLANT.

ELECTRIC SIGNAL LIGHT FOR STREET CARS.

Safety of operation on electric railways, as on steam roads, makes necessary the employment of proper classification and tail lights on the cars. The lighting of these signals on the electric car may, however, be done more advantageously than on the steam car, due to the fact that there is always at hand a source of electric current, namely the trolley, which permits of the use of an electric system of lighting which is much more satisfactory than oil lamps, owing to the small maintenance expense and greater convenience.

Heretofore the obstacle which has stood in the way of the use of electricity for this purpose has been the uncertainty of continuous current supply, for if the trolley current should fail or the trolley wheel should leave the wire, the lights would fail at just the time they were most necessary. In the Lintern car signal system, however, this difficulty has been overcome.

By means of an ingenious but simple method of wiring and auxiliary batteries of dry cells, current is supplied for one or more rear-end signal lights, one or more classification lights, or both, and does away with the only objection to using current from the trolley circuit for car signal lights. The signal lights are normally supplied by trolley current which has passed through the lighting circuit of the car to the positive side of the auxiliary batteries, and is then caused



ELECTRIC SIGNAL LIGHTING SCHEME.

to divide, part of the current flowing through the auxiliary batteries to ground, as shown in the diagram.

The current which passes through the auxiliary battery tends to keep the cells charged and up to voltage. If, owing to low voltage on the line, there is a deficiency of current from the lighting circuit to properly light the signals, the battery supplies sufficient current to keep the signal lights at normal illumination.

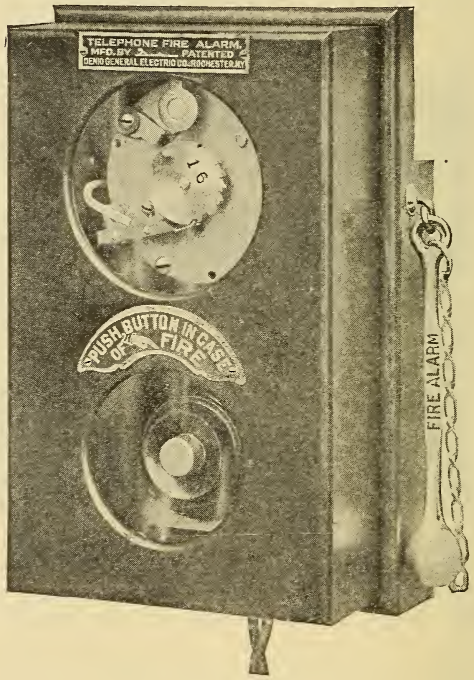
FIRE ALARMS OVER TELEPHONE WIRES.

A problem that many able telephone engineers have been trying to solve is how to make telephone circuits more remunerative. The problem has evidently been solved by the Denio Telephone fire alarm system, which furnishes a by-product, so to speak, of the telephone line.

The practicability of the Denio system has been arousing much interest among telephone engineers and telephone companies throughout the country, especially in many small towns where the expense of establishing systems similar to those in use in large cities is too large.

For the street a double iron box is located where desired, and wires connected to any telephone circuit, permitting the alarm to be transmitted direct to fire headquarters.

For the house, store or factory two styles of boxes are used—one a manual box and the other both manual and automatic. In the manual box all one has to do in case of fire is to break a glass and push a button. Each box has a different number, and the exact location of the fire is transmitted to the fire department in a few seconds. The automatic box can also be operated by pushing a button. In case no one discovers the fire, the alarm is sent in automatically by means of a fusing wire or thermostat,



FIRE ALARM BOX.

which is operated when the heat reaches 160 degrees Fahrenheit.

After the alarm has been transmitted to the fire department, the telephone operator rings the telephone bell, thus notifying the person sending the alarm that it has been received. In the case of an automatic alarm a person would be awakened by the ringing of the telephone bell.

No less authority in electrical science than Thomas Edison is reported to have said: "If electricity is a substance or fluid of any kind, I have not been able to find, see, weigh or in any manner sense it." Electricians, and students of physics generally, are more and more inclined to the belief that there is no such thing as electricity. The phenomenon known as electricity may be likened to an echo. Sound is a rate of motion. It is claimed by some of the advanced thinkers that there is a rate of motion that will always cause the effect known as electricity."

ELECTRICAL MEN OF THE TIMES.

ELIHU THOMSON.

So young is the electric industry that we have instances of men who were not only pioneers in its development but are still among the leaders. One of these men is Elihu Thomson of West Lynn, Mass., inventor with six hundred United States patents to his credit and practical electrical engineer and business man.

Elihu Thomson is of Scotch-English parentage and was born in England in 1853. He came to the United States in 1858 and was educated in the public schools of Philadelphia, graduating from the Central High School in 1870. Later, in 1876, he was given the chair of professor of chemistry in that institution. His inclinations were toward electricity, however, and as he had an aptitude for mechanical construction he spent much of his time in making his own apparatus for carrying out his numerous electrical experiments.

Professor Thomson's first great achievement was the development of the Thomson-Houston system of electric lighting, based on his patents, some of which were taken out conjointly with Professor E. J. Houston. He left his professorship in 1880 to take up the development of this work. The business was begun in Philadelphia, but was removed in about a year to New Britain, Conn. Professor Thomson had associated with him such men as C. A. Coffin, now president of the General Electric Co., and F. W. Rice, Jr., now third vice president of the same company. The Thomson-Houston Co. was merged, in 1892, with the Edison General Co., forming the present General Electric Co., in the Lynn works of which Professor Thomson is now actively engaged.

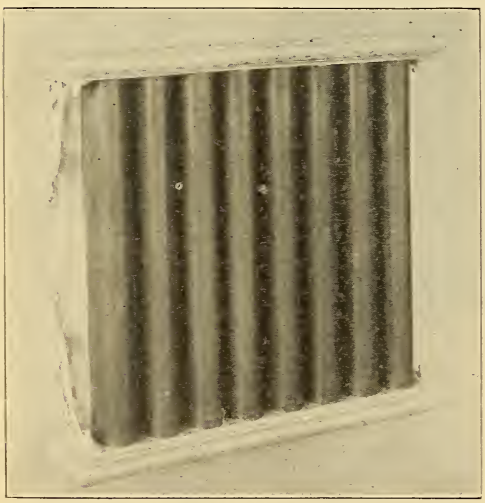
Among Professor Thomson's inventions are the method of electric welding now extensively used, and the Thomson electric meter, which was given a prize in the Paris meter competition in 1890 and of which there are now nearly 2 000,000 in use. His pioneer researches and inventions in the alternating current field and his high frequency work are also well known.

He was decorated in 1889 for electrical inventions by the French government as Officier et Chevalier de la Legion d'Honneur, given the honorary degree of A. M., Yale, and Ph.D., Tufts, has received many medals and awards, among which is the Rumford medal, and was awarded grand prix at the Paris expositions of 1889 and 1900. He is past president of the American Institute of Electrical Engineers, fellow of the American Academy of Arts and Sciences, member of the Institution of Civil Engineers, London: the American Chemical Society, the American Physical Society, and of many other societies here and abroad, and was official U. S. delegate to Chamber of Delegates, Electrical Congress, in 1893, at Chicago. He has been for many years a fellow of the American Association for the Advancement of Science, serving as vice president at the Columbus meeting, Section B, Physics, and has been vice president of the American Physical Society. He was president of the International Electrical Congress at the exposition in St. Louis in 1904.

ELECTRICITY IN THE HOUSEHOLD

THE LATEST ELECTRIC HOUSEHOLD CONVENIENCES.

Outside of its application in the culinary department of the household, electricity provides for a great many conveniences which are characteristic of the well ordered home. After all, the real enjoyment of a good housekeeper comes in proportion to her ability to provide those little things which lend to the comfort of her family, and electricity is now her most efficient aid.



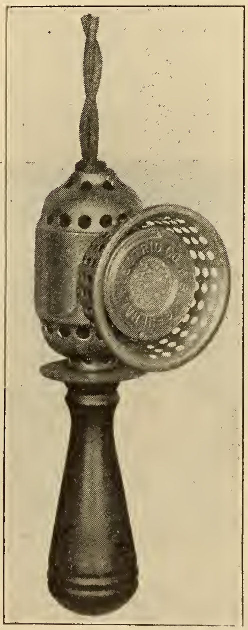
WALL SUSPENSION TUBULAR AIR HEATER.

LUMINOUS RADIATOR.

With the coming of early Fall and the first cool days and nights the problem arises what to do about starting up the furnace or the steam heating system. "As sure as they are put in operation," we say, "the weather will change, and so what is the use, for awhile longer at least?" So more than likely the whole family will submit to several shivering spells during the Fall. The particular province of the electric radiator is to tide over just such occasions as these, and it is surprising how late in the season these radiators will furnish all the heat that is necessary.

Two types of electric radiators are shown in the illustrations herewith. One type is known as the wall suspension tubular air heater and comprises several heating units in the form of long resistance coils which are inclosed in sheet iron casings. These heating coils are mounted between an upper and a lower shelf piece with brackets for fastening to the wall. The complete heater is compact and of neat appearance, an ornament to any room in the house.

The second type of heater is known as the luminous radiator. It is provided with large cylindrical heating bulbs or glowers made on the principle of the incandescent electric lamp. They are specially designed, however, to transform the electrical energy into heat. The luminous radiator produces heat immediately upon the turning of the switch. The frame or body of the heater is of ornamental iron, fitted with a polished cop-

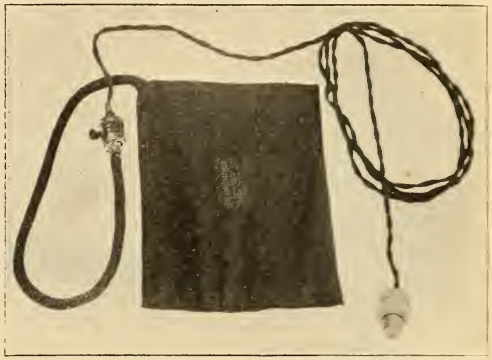


ELECTRIC CIGAR LIGHTER.

per reflector for projecting the light and heat out into the room. The radiator emits a soft, pleasant light through its ground glass bulbs, fully as cheerful to sit by of an evening as a grate, and there is never any danger of coals snapping out and burning the carpet.

"Where is a match?" says the man of the house as he bites off the end of his cigar preparatory to starting for the train in the morning. Sometimes he says it in a lamb-like manner and sometimes—but that isn't the point; the cigar must be lighted before he gets out in the wind, otherwise his tender fingers may be burned. Instead of hunting for this match 365 times in a year, why not hang an electric cigar lighter in the hall and save him 365 minutes of his precious time? It is an unobtrusive little object as it hangs from its electric cord, and really becomes almost a necessity after it has been in use for a time and its value appreciated.

A hot water bag has always been regarded as a household necessity. It was



ELECTRIC HEATING PAD.

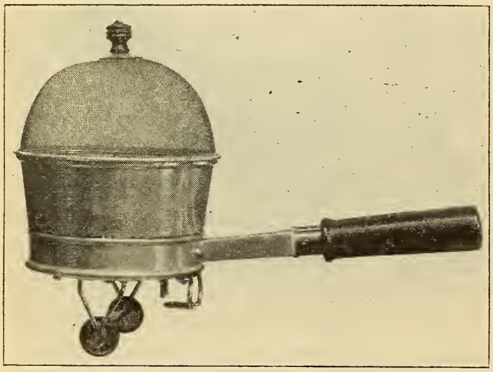
a great improvement on the heavy brick or stone, heated in the oven and wrapped in a cloth, because it required less preparation and was easier to handle. The electric heating pad is an improvement over the hot water bottle with still greater convenience and with the additional feature of perfect temperature control.

SHAVING MUG

The cord may be attached to the nearest lamp socket, the pad placed in position, and its temperature regulated at will. After the switch has been set to give the required heat, whether low, medium or high, no further attention is necessary.

The hot water bag is applied at a high initial temperature and quickly cools off, but the electric pad maintains any one of three degrees of heat indefinitely; or where it is desired to use the pad very hot, it may be first applied cold and the temperature gradually increased without unpleasantness or shock. With a damp cloth, the pad may be used in place of a poultice.

The pad is made of fine resistance wire woven into flexible asbestos carefully insulated and covered with felt, and the best feature about it is that it never leaks.



CORN POPPER.

Every housewife takes particular pride in the appointments of the bath room. To make the equipment complete the electric shaving cup is required. This little device consists of an ornamental aluminum base spun on an enamel cup. The use of this cup is a real luxury which the men appreciate, as it insures hot water for shaving at all times and at just the right temperature to make a fine lather.

Every one will appreciate the convenience of a small water heater to be used at night in case of sickness, and also to heat the baby's milk. The electric heater for this purpose is ready to perform its function at a moment's notice. The milk or water bottle is set in the heated water inside the heater. The ordinary nursery bottle is used and its contents are warmed almost instantly after a few teaspoonfuls of water are poured into the heater.

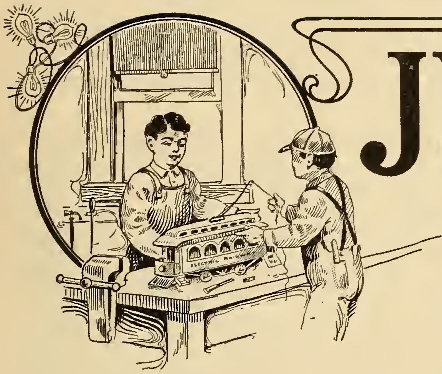
In steam and furnace heated buildings no way is provided for the enjoyment of that old fashioned pastime of popping corn, and there is nothing that children enjoy more than this in the long winter evenings. The electric corn popper meets the requirements. The bottom of the pan is heated electrically by a conducting cord attached to the lamp socket, though the cord and its attachment are not shown in the cut. A cover of wire netting is provided, also little rubber wheels underneath, so that the popper may be rolled rapidly back and forth over the table to keep its contents in motion. There are no face scorching and arm cramping which are attendant upon the manipulation of the old fashioned popper shaken over live coals.

MAKING TOAST ON THE BREAKFAST TABLE.

What woman will not appreciate this little device which enables her to prepare delicious toast while seated with her family at the breakfast table? The toaster is neat in appearance and takes

MAKING TOAST ON THE BREAKFAST TABLE.

up but very little room on the table. An ordinary cord and plug connects it to the electrolier. Then snap the switch and in a few minutes the toaster is ready to perform its duty. With this toaster, a coffee percolator and a chafing dish many an appetizing breakfast may be prepared without once leaving the table.



JUNIOR SECTION

A TOY MONORAIL CAR.

Much has been written concerning the Brennan monorail car, which travels on two wheels like a bicycle, and is kept upright through the action of a gyroscope—a form of top. The Brennan car is too complicated to imitate on a small scale, but, strange to say, a car that will imitate the actions of the Brennan invention is more easily made than a standard form of four-wheel car.

The track should be laid out first. Get a four-inch by one-half-inch pine board, as long as convenienet—at least four feet. Loops at the ends are necessary for the car to turn, and Fig. 1 shows how they may be made of one-half-inch pine board.

For the single rail a material known as brass angle, one-fourth inch in size, is utilized. This is tacked down to the wood base or roadbed, with the horizontal flange turned inward, and the upright or rail portion just one-fourth inch from the edge of the board. Where the rail follows the curves of the loops, notches may be cut in the flange to facilitate bending. Fig. 1 shows the run of the track.

Now get some strips of soft sheet iron, fairly thick, three-sixteenths of an inch wide. With a small pair of pliers bend each strip into a series of steps or notches, exactly one inch long and one-eighth inch deep. Then tack these iron strips on the under side of the wooden roadbed, exactly underneath the rail, and following it all around the track. Figs.

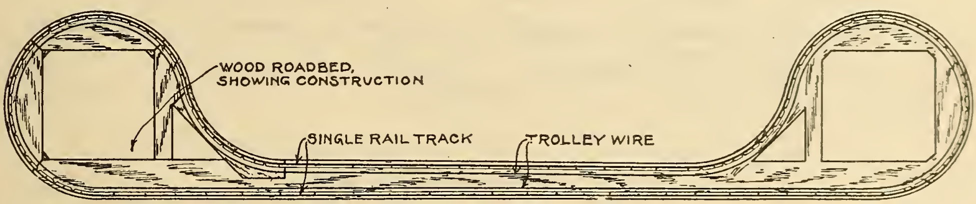


FIG. 1. TRACK FOR TOY MONORAIL CAR.

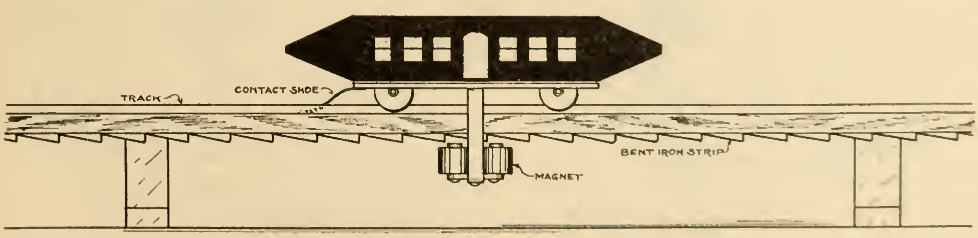


FIG. 2. SIDE VIEW OF TRACK AND CAR.

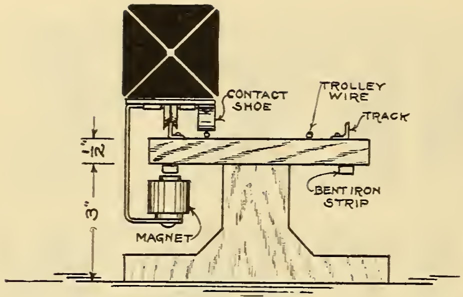


FIG. 3. SECTION OF TRACK AND END VIEW OF CAR.

2 and 3 show how the iron is bent and placed. The ends of the strips are abutted so as to make the iron continuous.

This is an elevated road, and Figs. 2 and 3 give a good idea of the wooden feet which must be provided for the structure to stand on.

The trolley wire is made of No. 18 bare copper wire, and is run along the board a half inch from the inner edge of the rail flange. It is fastened to the roadbed by forcing the doubled wire into holes drilled four inches apart, as shown in Fig. 4. The course of the wire is shown in Fig. 1. Measure off and mark every half inch of the wire after it is in place. Each alternate half inch of the wire is now coated with enamel or insulating varnish, and the half-inch spaces between left bare and clean (Fig. 4). When this insulation dries the track is complete.

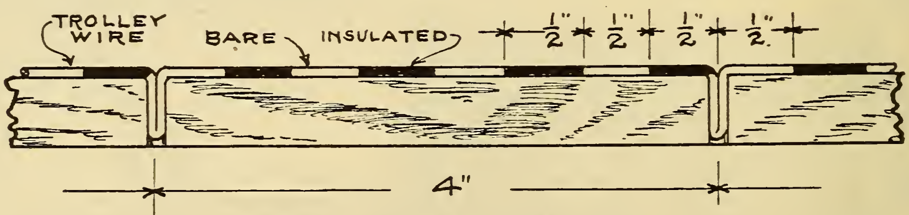


FIG. 4. SECTION OF ROAD BED.

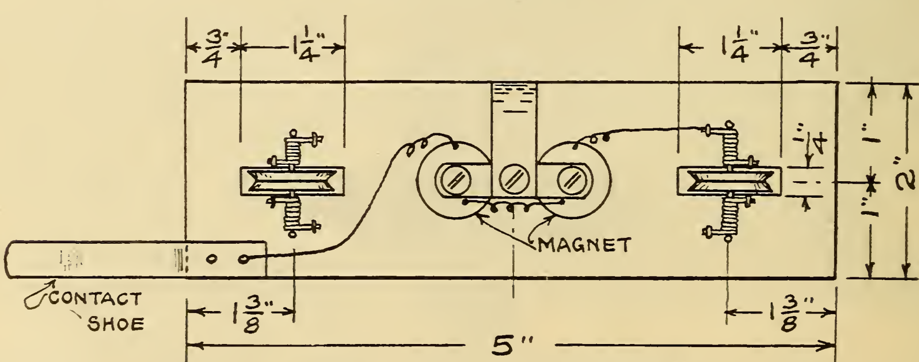


FIG. 5. UNDER SIDE OF CAR PLATFORM.

The monorail car is supposed to be a very high-speed affair, and to bear out this idea the body of our car is made pointed at each end, like an airship or submarine boat, to overcome air-resistance. It is readily glued up of thick paper or cardboard, and stained dark.

The truck or platform of the car is made of one-eighth-inch wood, about five inches long and two inches wide. On the line of the center, and near each end, are cut slots 1¼ by one-fourth inch for the two wheels, as in Fig. 5. The wheels are common grooved brass pulleys, about an inch in diameter and one-eighth inch thick. The shaft or axle for each wheel is a straight piece of steel or iron wire one-sixteenth inch thick and an inch long. The journals or bearings are each made of a few turns of brass or copper wire tacked to the under side of the platform. A tack opposite each end of the axles will prevent any end play or shake. The wheels may be soldered to their axles, but a drop of cement will do, as the wheels are not concerned in the work of driving the car. They should run very freely, but without any shake.

The trolley shoe, for collecting the electric current from the trolley wire, is a piece of very thin, springy brass, three-eighths inch wide and about 2½ inches long. It is fastened to one end of the platform in such a position that it is exactly over the trolley wire when the car is set upon its wheels on the rail. It is then bent down until its end touches the trolley wire.

Fig. 5 is a view of the under side of the car platform, and shows the wheels, journals, trolley shoe and magnet.

The latter is a simple electromagnet, and is used in our car in place of a motor. It is made from the two coils taken out of an electric bell. These are screwed to a piece of iron 1½ inches long, three-eighth inch wide and one-eighth inch thick. Three holes are drilled through this, of a size to clear the screws that fit in the cores of the coils—one hole in the center, and one one-half inch on each side of the center. When the coils are screwed in place, they should measure exactly an inch between centers.

To fasten this electromagnet to the car, a piece of one-half by one-sixteenth inch brass must be bent into a U shape. Each bent up end is three-fourths inch long, with a screw hole one-fourth inch from the end. The length of the brass between the bent ends is found by measuring the length of the completed electromagnet from the outside of the yoke or cross-bar to the other ends of the cores, and adding the distance from the under side of the car platform to the bottom of the iron steps. The electromagnet is then screwed to one end of the brass piece, on the inside, and the other end of the brass is screwed to the exact center of the platform. Figs. 2, 3 and 6 show the construction of these parts better than a description.

When all is in place, the car should stand level on its rail, with the magnet right under the iron steps, almost, but not quite, touching the latter; about one-thirty-second inch clearance is correct. If the magnet touches, put a few pieces of paper between the platform and the brass piece. If the clearance is too great, put a thin piece of metal between the brass and the magnet. If the car tips, balance it with a bit of lead; if it does not stand up firmly enough, put bits of lead around the magnet to weigh it down. A tap of the hammer will fix any iron step that is too high.

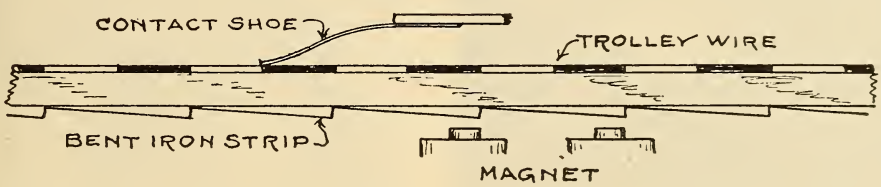


FIG. 6. RELATIVE POSITIONS OF MAGNET AND TRACK SHOE.

The trolley shoe must be adjusted so that when the magnet cores are even with the iron steps, the shoe is just passing from a bare to an insulated space on the wire. Fig. 6 shows the arrangement.

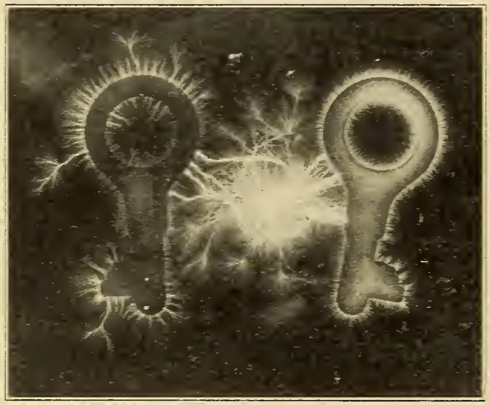
The electrical connections are as follows: From the trolley shoe to one coil of the magnet, to the other coil, then to one of the journals. Two or three cells of dry battery are connected, one terminal to the rail, the other to the trolley wire.

The car should run very easily. Give it a gentle start, and if everything is right it will attain considerable speed, leaning inward very prettily at the turns. The current passes along the wire, through the shoe to the magnet and back through the journal, wheel, and track, to the battery. The magnet is attracted to the iron step, and pulls the car along; but just then the shoe strikes the insulation on the wire, and the current ceases; but only for a half inch, when the magnet receives another impulse, and so on around the track.

Paul H. Woodruff.

HOW TO PHOTOGRAPH ELECTRIC DISCHARGES.

Boys who have access to an electrical laboratory will find that they can, with a little practice, secure some very interesting photographs of electrical discharges as shown in the accompanying illustration. Any well equipped high school laboratory contains the necessary apparatus. The essential apparatus consists of a spark coil capable of giving a good discharge, a telegraph key and six primary batteries.



PHOTOGRAPH OF ELECTRIC DISCHARGE.

First wire the batteries in series with the coil and insert the telegraph key in one main. Then get a piece of tin a little larger than the photograph you want, solder the tin plate to a piece of high tension cable and connect to one of the secondary terminals of the coil.

Secure another piece of cable like the first and solder a needle to one end of it, then connect to the other secondary terminal of the coil. Darken the room so that not a speck of light will enter, or wait until night. Have a ruby lamp such as photographers use, lay the tin plate on a table, lay a photographer's dry plate evenly on the tin plate, then sift powdered sulphur on the dry plate. Hold the needle on the dry plate, see that you are well insulated from the needle and press down on the telegraph key and make one spark occur on the plate.

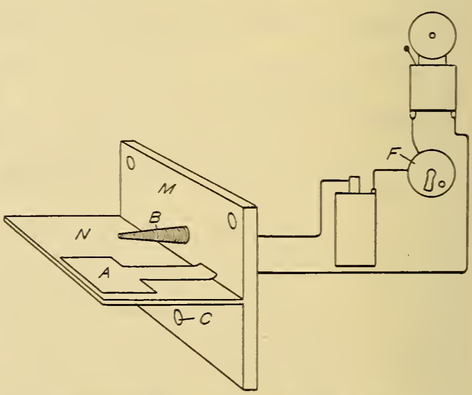
By laying different objects such as keys, money and the like on the dry plate a variety of designs may be made.

HARRY H. DOUGHERTY.

ELECTRIC BEDROOM ALARM.

Those who cannot tolerate the loud ticking of an alarm clock in the bed room will find relief in the electric alarm device described below. Any boy with a little ingenuity can connect the alarm, so that the clock will be outside the sleeping room and will operate an electric bell within the room to awaken the sleeper at any predetermined time.

The shelf (N) shown in the diagram may be mounted in the kitchen or any other place desired. To it is fastened the metal strip (A). Above the strip is a screw (B) passing through the base board (M). A wire is then connected to (A) and carried to one terminal of the bell which is located in the bed room. Another wire is run from (B) through a battery, through the switch (F) to the other terminal of the bell. The switch is also located in the bed room.



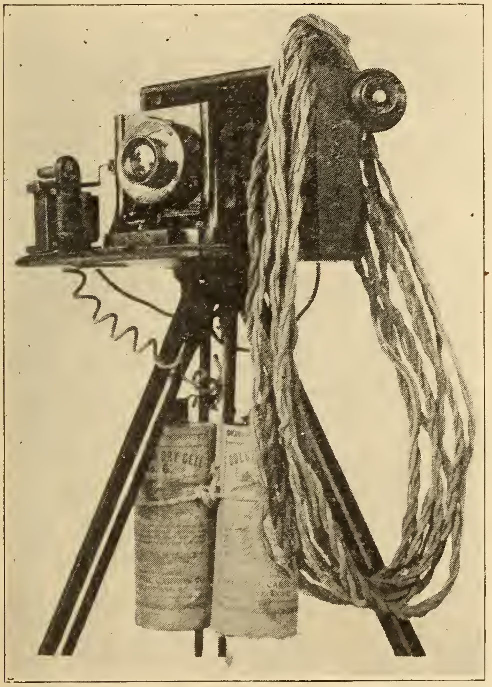
ELECTRIC BEDROOM ALARM.

Take any ordinary alarm clock, on which the alarm winding key turns when the alarm is sounded, and fasten a piece of heavy wire to the key so that it will revolve when alarm is on. Place the clock on the shelf with one of the legs resting on the tin strip (A). When the alarm is on, the wire will revolve till it strikes screw (B), thereby completing connection and ringing the bell till the switch is opened, which will require one to leave the bed, thereby preventing that "second nap."

To set the alarm simply remove the clock from the shelf, turn the alarm key back about one inch, and replace the clock on the shelf with one leg on the tin plate. Before retiring close the switch.

ELECTRICALLY OPERATED CAMERA.

Many readers of the Junior Section are no doubt amateur photographers and will be interested in the electrical camera operating device shown in the accompanying picture. Often it is desired to take a photograph of a group with the operator among the others. This is impossible by daylight exposure and by flashlight it means that whoever touches off the fuse to the powder must take a hurried dive into the group which is more or less disconcerting to himself and the others.



ELECTRICALLY OPERATED CAMERA.

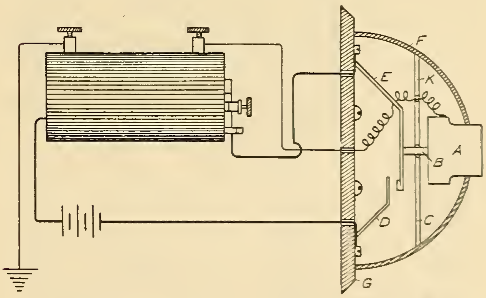
The arrangement shown in the cut is simply a small electromagnet mounted on a shelf attached to the camera and with its armature connected by a wire with the shutter. A few feet of lamp cord, two cells of dry battery and a push button complete the apparatus. The cord is connected with the terminals of the electromagnet with the batteries and push button circuit. When the circuit is closed the armature of the electromagnet is pulled down, opening the shutter. All that is necessary to photograph a group and the protographer himself is to focus the camera and run the cord to the group. When everything is in readiness the button is pushed and the plate exposed.

A VERY "SHOCKING" PUSH BUTTON.

Some inquisitive people are prone to enter doors that are particularly marked "keep out" or "no admittance." Indeed such a sign seems to make them all the more anxious to enter. The little device described below is productive of very amusing results and can be used anywhere that the victim stands on damp ground or any surface that is well connected, electrically, with the earth. It will probably result in more fun if a sign is placed near the button reading something like this:

* * * * * *
* DON'T TOUCH *
* PRIVATE SIGNAL *
* * * * * *

Referring to the diagram; (F) is the usual ebonite case, on the base (G). Inside of (F) is a circular piece of fiber (K) glued or shellaced in place. A hole is bored through to accommodate the fiber pin (B), which fits loosely. The regulation ebonite push button is replaced by a metal one, preferably with a shoulder as shown as (A). (E) and (D) are brass strips 1/4 inch wide, and bent as shown. (B) is of wood, fiber or rubber, shellaced to (A).



CONNECTIONS OF PUSH BUTTON.

Connections from the primary wires of a rather strong shocking coil are led to strips (E) and (D). One secondary terminal is well grounded; the other goes through a hole in (G) and one in (C) to the brass button (A) where it is permanently soldered.

It is obvious that when a curious visitor spies the completed article and expecting to ring a bell, pushes the brass piece (E) connection will be made with (D) causing the coil to start, and as the operator is standing on the ground, the secondary circuit will be completed and a pretty stiff shock will be administered. He will, very likely, quit "monkeying" with shop fixtures after a trial of this.

G. B. MEDEARIS.

SIMPLE ELECTRIC ALARM.

An automatic drop, as is well known, is a device for constantly ringing an electric bell or lighting a lamp after the current has been closed by pressure on a push button. One of very simple construction can easily be made in a few minutes from an old electric bell, a small strip of brass or copper and two binding posts off of a dry battery. An alarm constructed as described below was used successfully to protect a hen coop from marauders.

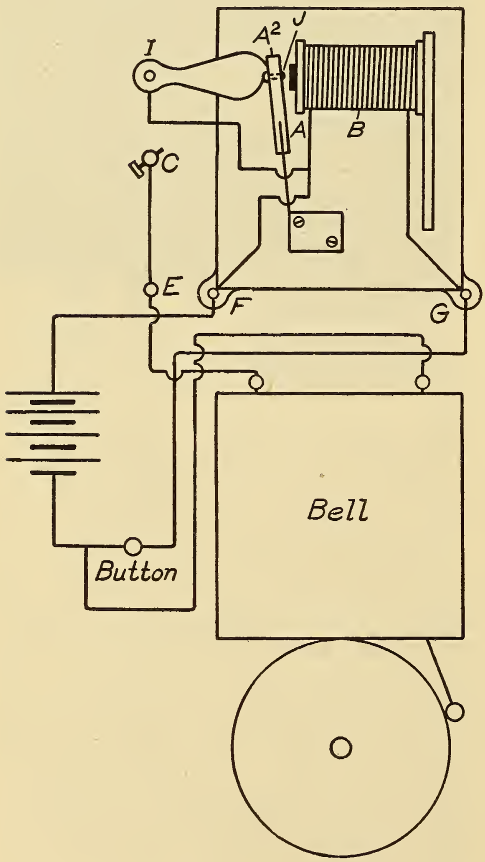


FIG. 1. CONNECTIONS OF ELECTRIC ALARM.

Secure an old electric bell and take off the lower magnet spool, being careful to leave the upper one intact. Next remove the clapper from the armature, it being mounted at the point (A^2) Fig. 1. Then remove the contact and the contact spring from the armature, leaving the armature as shown in diagram at (A).

FIG. 2.

Bore a small hole in the armature, or if the armature has a copper contact, drive it out and insert a small rivet in the hole, having the head toward the magnet (B). Next secure a piece of brass. That out of a clock is just right, as it will have a hole already in it and thus save time of boring. From this strip cut a section as shown by dotted lines in Fig. 2.

Now, place the binding part (1) just far enough away so that when the drop is in the position shown it will just rest on the rivet (J).

Place another post at (C), which will be within the radius of the drop (D), so that when it drops it will make a contact with (C). Run a wire from (C) to the post (E). Place bell, with drop, either above or below it. Make connections, as shown in Fig. 3, which are as follows:

1. Wire from battery to push button to post (G) on drop.
2. Wire from battery to post (F) on drop.
3. Wire from post (E) on drop to bell.
4. Wire from battery to bell.
5. Tap wire to (I) from wire leading from (F) to magnet (B).

When the button is pushed the armature (A) is drawn to the magnet (B) and releases drop (D) which drops to (C) making contact with (C) and (D) which will ring the bell until the drop is again in place. Arthur W. Peek.

QUESTIONS AND ANSWERS.

Readers of Popular Electricity are invited to make free use of this department. Knowledge on any subject is gained by asking questions, and nearly every one has some question he would like to ask concerning electricity. These questions and answers will be of interest and benefit to many besides the one directly concerned.

TROUBLE WITH A TELEPHONE POLE CHANGER.

Question.—At the place where I am employed we have a central energy telephone system, the ringing energy is supplied by 30 dry cells which operate through a pole changer. The other day the electrician told me he would have to discard the pole changer and get a motor-generator as it cost too much for batteries for they are renewed once a month. As we have direct current here at 110 volts, 24 hours a day, I told him that he might cut in a resistance and put the pole changer on the power current as he says the ringing current is about 50 volts. He said that would not work as it would burn out all of the relays in the exchange. I don't know anything about telephone engineering but I would like to know why it could not be done, and if so, how many ohms resistance would have to be cut in to reduce the potential to 50 volts.

Answer.—You must either have a very heavy ringing load, or your pole changer battery must be used for other purposes besides ringing, because your statement that the battery only lasts one month seems unreasonable. A pole changer battery consisting of dry cells, generally is supposed to last six or eight months.

It is rather insufficient to use only 30 dry cells in connection with a pole changer for ringing on average telephone lines unless they are of a comparatively short length. In general 60 to 80 dry cells should be used if no valid reason is preventive.

With reference to using 110 volt direct current, instead of dry cells, by inserting a limiting resistance in the primary circuit, so as to bring the voltage down to 50 volts, this will be found to be rather impractical, and furthermore, will only hold good for a certain resistance of the line circuit. If the resistance of your line is increased, or decreased, the voltage at the primary side of the pole changer will increase or decrease correspondingly.

Disregarding the effect which causes the secondary voltage of the pole changer to be lower than the primary voltage, we find that the voltage at the pole changer terminals is decreased to 50 volts, when the line resistance is 500 ohms, and a constant series resistance of 600 ohms is inserted in the 110 volt power leads, and a current of about 0.1 ampere will flow through the circuit. However, if the line resistance is decreased to 100 ohms, the voltage at the pole changer terminals is decreased to 15.7 volts with a current of 0.16 amperes flowing. If the voltage could have been kept constant at 50 volts, the current value would have been 0.5 amperes. Hence, there is an advantage in this method as it tends to keep the current at a somewhat constant value. However, one of the serious disadvantages comes into effect when the pole changer furnishes ringing current to several operators. In this event, two or more operators are liable to ring on different lines simultaneously, which may give rise to complications. As an example, suppose the pole changer furnishes current to the two previously mentioned lines at the same time, then we will find that under the same conditions as before, the 500 ohms line will take only 0.027 amperes, while the 100 ohms line will take 0.134 amperes, which is due to the fact that the terminal voltage now is decreased to 13.4 volts. Therefore, you may understand that having a high limiting resistance in the circuit, might possibly prevent a ringer, on a long line, to respond, if simultaneously other operators ring on the lines of considerably lower resistance.

This may be the most serious objection to your proposition. However, there is no danger of any relay coils burning up, due to ringing current passing through them, provided a proper limiting resistance is introduced in the primary power leads.

It would be rather difficult to suggest the most proper resistance to use, as this will depend upon the local conditions. It has to be of such a value so it does not prevent any ringer from responding under the most severe conditions, nor should a dangerous current flow upon ringing on the shortest line.

WIRELESS TELEPHONY.

Question.—(A) How can a simple detector for wireless telephony be constructed, excepting the De Forest Audion and Fessenden electrolytic. (B) Can a simple Audion be constructed.—C. L. S., St. Louis.

Answers.—(A) There is a large variation in the kinds of detectors you may find suitable for wireless telephony. With the exception of the "metal filling" coherer

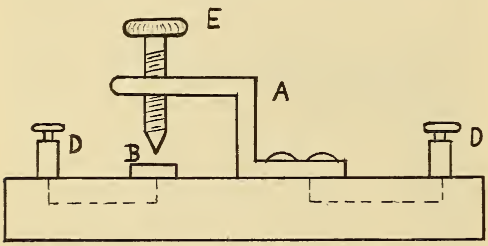


FIG. 1. SIMPLE WIRELESS DETECTOR.

or other type which it is necessary to tap to disarrange the mass when acted on by the wave, almost any type will answer that is used in connection with a telephone receiver. A carborundum or silicon detector will answer for wireless telephony. A very simple plan of the construction is shown in Fig. 1. (A) represents a metal standard with thumb screw (E), (B) a metal button and (DD) binding posts. Carborundum or silicon crystals are placed on the metal button (B) and the thumb screw (E) run down until the point touches the crystals. The connections are the same as made for the electrolytic detector and the same rules are observed in adjusting.

(B) The simplest form of Audion is the open flame type first used by E. Ruhmer in wireless experiments. This type was an alcohol lamp with two contacts of platinum held in the flame, the lower contact being large and the top a small wire. In Fig. 2 is shown the position in which the contacts are placed, the lower one resting in the cool spot of the flame and the top one at the point of the greatest heat. This is the first type of Audion to come in use. A second kind which is several times more sensitive than the above consists of a Bunsen burner using coal gas with the two contacts immersed in the flame, the lower one having a small trough filled with potassium hydroxide which vaporizes

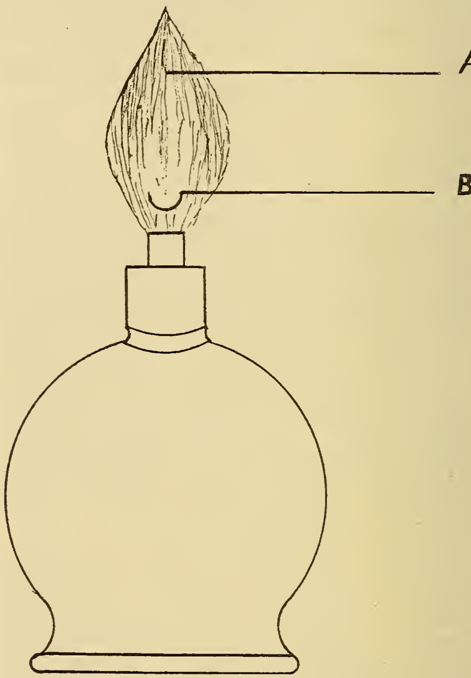


FIG. 2. OPEN FLAME AUDION.

and makes the flame more conductive. When the proper adjustments have been made very good results are secured. However, a detector of the first named type is recommended as it is very simple to construct and sensitive. DeForest has further extended the Audion by sealing the contacts in an incandescent lamp.

WHEATSTONE BRIDGE AND VARLEY LOOP TEST.

Question.—I would like better to understand the method employed for measuring unknown resistances by use of a Wheatstone bridge, and the Varley loop test. Will you kindly explain it by illustrations.—J. E. T., Strathroy, Ont., Can.

Answer.—In Fig. 1, (G) is a sensitive galvanometer, (B) is a battery, (R) and (R′) are known standard resistances, and (A) is a known adjustable resistance. The unknown resistance is inserted at (X). The keys (K) and (K′) serve to complete the circuit for momentary readings. To prevent inductive disturbances, the key (K′) is only operated while the key (K) is depressed.

It is evident that the galvanometer is not included in the actual circuit at all, but is bridged across a divided part of the circuit, like an island in a stream. Electric current follows the path of least resistance. If (R) and (A) offer less resistance than (R′) and (X), then the current will follow a zigzag course, pass-

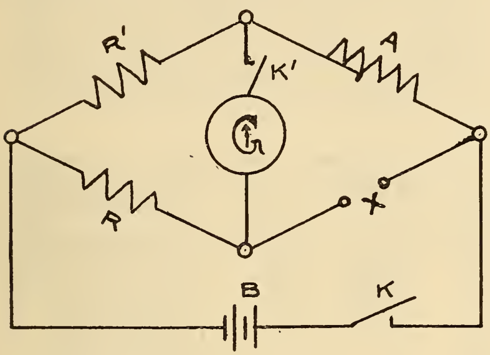


FIG. 1.

ing through the galvanometer. If (R) and (A) offer the higher resistance, the current will traverse the galvanometer in the opposite direction. Now suppose (R) and (R′) are of the same resistance; it is obvious that in order to produce no deflection (A) and (X) must also be of the same resistance. (A) being adjustable, it is varied until the galvanometer needle is at zero. The resistance (X) will then equal the resistance (A).

The Varley loop test is simply an adaptation of the Wheatstone bridge

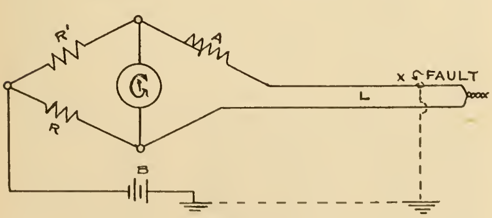


FIG. 2.

method to measuring line resistance. In Fig. 2 two line wires to be tested for the ground fault are substituted for (X) in Fig. 1. In this case the battery is grounded, which is exactly the same as connecting it to the point of fault in the wire. The far ends of the two line wires are twisted together.. The variable resistance (A) now has added to it the resistance of the bad wire, as far as the ground fault; while the unknown arm includes the resistance of the good wire plus the resistance of the bad wire beyond the fault. (R) and (R′) being the same, the resistance from both sides of the ground fault to the galvanometer must be the same to balance the needle. Then, of course, if we call the whole loop resistance L., and the resistance of the bad wire to the fault X,

$$X = \frac{L - A}{2}$$

Knowing the resistance per foot of the line wire, the location of the fault is readily determined.

WIRING, AND MOTOR AND TRANSFORMER OPERATION.

QUESTION.—(A) What is a static transformer and what are its uses, construction and operation Name two kinds of loss with no load and full load.

(B) How to figure the complete resistence of an office building by the voltmeter process, and to detect a ground in a conduit system by the same method.

(C) How does voltage vary according to speed, what is the effect on the field windings, and what are the effective armature conductors

(D) Give two methods for reversing direction of shunt motor.

(E) Give details as to how a three wire system is installed in a two flat building, showing if possible wiring and connections.—C. J. J., Chicago, Ill.

Answers.—(A) A static transformer is a device for obtaining a higher or lower voltage than that delivered by the source of supply, with the least possible loss of energy. It consists of two coils—a primary, which is connected to the supply, and a secondary, which is connected to the load. No electrical connection exists between these coils. The secondary voltage is to the primary voltage as the number of turns of wire in the secondary coil is to the number of turns in the primary. The secondary current (amperes) is to the primary inversely as the secondary voltage is to the primary. Step-up transformers are used to raise the voltage of a generator for economical transmission, and for experimental work. Step-down transformers are used to reduce a high line voltage for safe interior distribution, to adapt a voltage to a certain machine, for electric welding, etc. Two kinds of losses in a transformer are the loss in the iron, called the core loss, and the loss in the winding, called the copper loss.

(B) The resistance of any circuit may

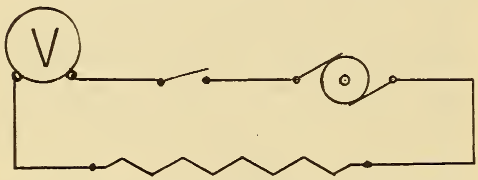


FIG. 1. VOLTMETER METHOD OF DETERMINING RESISTANCE.

be determined by the voltmeter method, whether it be the wiring of a building, the insulation of a cable, or merely a small coil. Fig. 1 shows a voltmeter of known resistance, a source of current of known voltage, and the unknown resistance connected in series. If V is the voltage of the applied current, R the voltmeter resistance, v the resultant read-

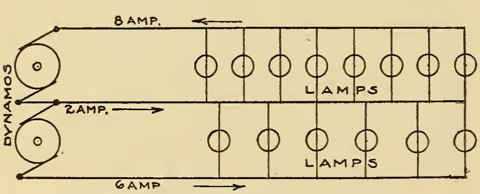


FIG. 3. THREE-WIRE CIRCUIT.

ing of the voltmeter and X the unknown resistance, we have

$$X = \frac{V-v}{v} \times R.$$

The second part of the question is solved in the same way. One terminal of the voltmeter is grounded, as shown in Fig. 2, and as the ground has practically no resistance, the formula as applied gives the resistance of the wire from the point (W) to the point where it is grounded. Knowing the specific resistance of the wire, the location of the ground fault is readily determined with approximate accuracy. However, the method, while not so accurate as the bridge method, is satisfactory for high resistances.

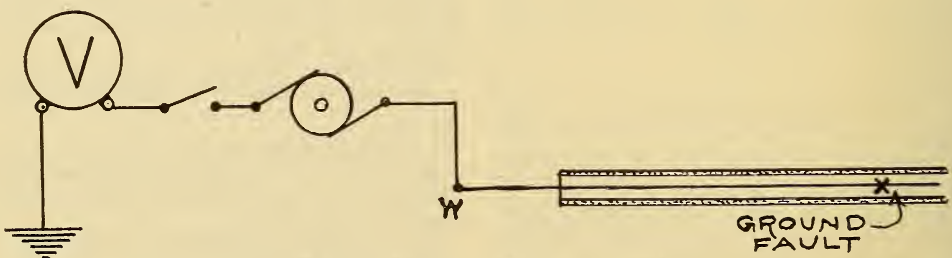


FIG. 2. VOLTMETER METHOD WITH GROUNDED CIRCUIT.

(C) This question does not indicate whether reference is made to a dynamo or motor, direct or alternating current, series, or whether the winding is shunt or compound. Without this information the question cannot be answered.

(D) A shunt motor may be reversed by reversing the connections of either the armature or the field to the line. Reversing the connections of both armature and field (that is, simply reversing the flow of the current through the whole machine) will not affect the direction of rotation.

(E) The three wire system of distribution is merely a method of saving copper in the line by allowing a higher voltage. Where 110 volt lamps are used, the difference of potential between the two outer wires would be 220 volts. If an equal number of lamps were connected on each side of the circuit, it would be balanced, and no current would flow in the center or neutral wire. The illustration, Fig. 3, shows eight lamps on one side and six on the other. In this case, if each lamp took one ampere, only two amperes will flow in the center wire. Obviously if the circuit can be nearly balanced the center wire may be smaller than the others—one-half the size, in practice. In a building such as you mention, the two apartments will probably balance each other, allowing one wire for each, and a common neutral wire.

NEW ELECTRICAL INVENTIONS

AUTOMATIC HEAT CONTROL SYSTEM.

Mr. P. A. Brown, 1860 LaFayette street, Denver, Colo., is the inventor of an ingenious device for controlling the temperature of electrically heated devices, such as flatirons, electric radiators, etc. Fig. 1 shows the application of this system to an electric flatiron which may be briefly described as follows:

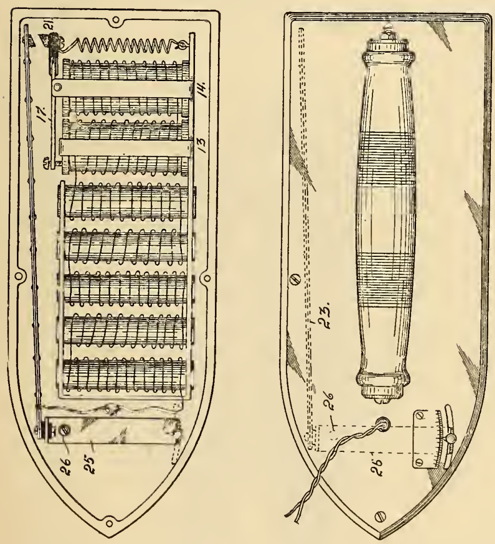


FIG. 1. AUTOMATIC HEAT CONTROL AS APPLIED TO FLAT IRON.

Within the body of the iron are a number of heating coils as shown, the two large coils (13) and (14) at the extreme right being electromagnet coils which not only perform the service of heating coils but also operate the armature (17) which carries the contact (21). The regulation of temperature is directly accomplished by the thermostat bar (23) which is fastened at one end to the indicating lever (25) pivoted at (26).

The thermostat bar is composed of two strips of metal riveted together and having different coefficients of expansion. With an increase of temperature the lower bar expands or lengthens more than the top bar so that the two, being held rigidly together, tend to curve upward and separate the contacts at (21) breaking the circuit and allowing the iron to cool off to a point where the bar again straightens out and closes the circuit.

The function of the indicating lever is to throw the bar to the right or left so that the distance between the contacts at (21) will be decreased or increased, making the time required for the bar to heat up and curve sufficiently to break the circuit less or greater as the case may be. The indicating lever is provided with a pointer which may be set to give any heat desired.

The movement of the thermostat bar closes the circuit just slightly, but enough to energize the electromagnet which is in series with the heating coils. The plunger of the electromagnet then forces the two contacts at (21) together firmly and makes a good contact. The circuit

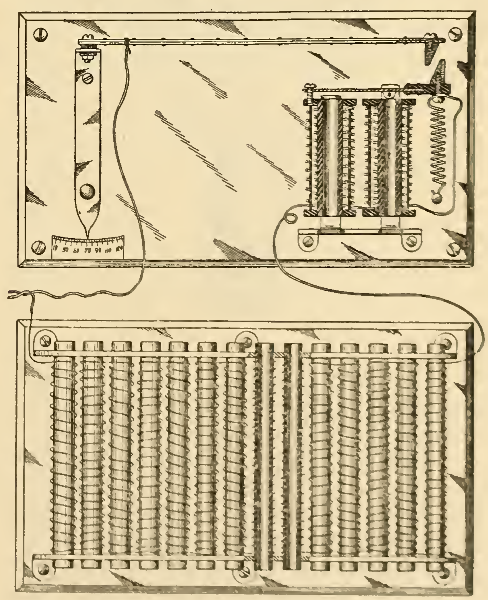


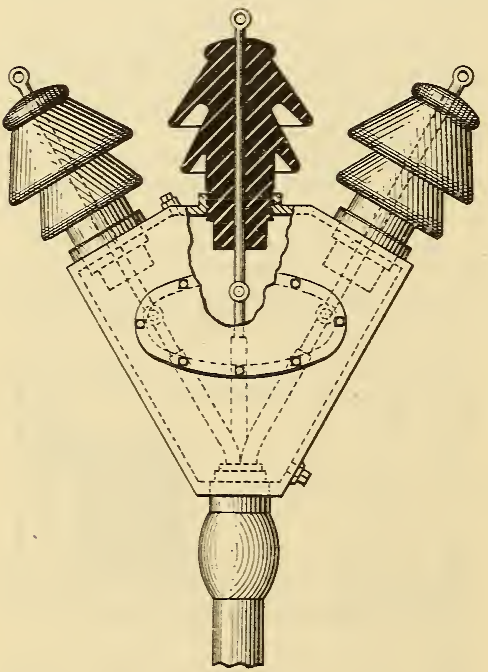
FIG. 2. AUTOMATIC HEAT CONTROL AS APPLIED TO RADIATOR.

is broken by the bar and electromagnets quickly, so that there is no injurious arcing at the contacts.

Fig. 2 illustrates the same principle applied to control the temperature of radiators, etc., the mechanism being similar except that the heating coils and the electromagnet thermostat are separate from each other.

TERMINAL FOR ELECTRIC CABLES.

In connecting overhead aerial lines with lead covered electric cables made up of insulated copper conductors, it is necessary to employ a terminal, i. e., a joint forming structure wherein the cable ends and from which the aerial line or lines lead, in order that moisture may

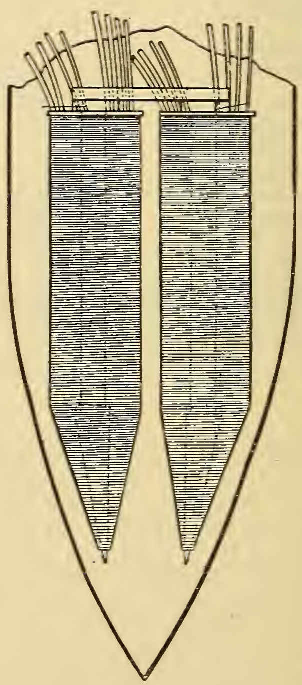


be excluded from the cable insulation. The accompanying cut shows a device for this purpose recently patented by Charles W. Davis of Edgeworth, Pa.

At the lower end is seen the lead covered cable, the end of which enters a funnel shaped casing through a water tight joint. The three conductors of the cable branch out inside the casing, each leading to an insulated plug which also enters the casing through a water tight joint. The plugs have embedded in them conductors capable of being connected to the conductors within the casing which lead from the lead covered cable and to the aerial line conductors outside. The insulating plugs are made with petticoats similar to a high tension insulator to shed the rain and prevent leakage currents.

ELECTROMAGNETIC TORPEDO.

A new scheme for increasing the accuracy of submarine torpedoes has been invented by Howard Lacy of Kelvin, Camden Road, Carshalton, in the county of Surrey England. The interesting feature of the invention consists in placing powerful electromagnets in the nose of the torpedo, so that when the latter comes into the vicinity of the steel hull of a vessel it will be directed to its mark. The electromagnets also hold the torpedo against the hull until such time



as it is considered to be proper for the destruction of the vessel.

Current to energize the electromagnets may be obtained either from wires fed out from the torpedo boat, and which also could be used for setting off the explosive, or it could be derived from storage batteries located in the torpedo itself.

The electromagnets are specially wound with several sets of coils for obtaining different degrees of attractive force.

THE THEORIZER'S CORNER.

Many of us have a pet theory that we are aching to give to the world at large. There are others who feel it their duty to run down and "explode" such theories wherever possible. This corner in Popular Electricity is set aside for the theorizer and the "exploder," so that they may meet on common ground, and we await with interest the "fire works" to follow. The department will be devoted to theories concerning electricity and allied sciences.—Editor.

MORE ON THUNDER AND LIGHTNING.

I want to say to R. S. that his version of the cause of thunder and lightning in the July issue seems perfectly absurd. I would ask him a few questions. How far is it from the earth to the ether? If the ether is stationary how does the earth pass through it on its journey? How does he account for a flash of lightning going from one cloud to another, or from the earth to a cloud? Where does he get the idea of irregularities of the surfaces of the ether and the atmosphere? He gives us two distinct causes but does not associate lightning with thunder. When he says "the thunder is caused by the atmosphere rushing into the vacuum between it and the ether" and "lightning is caused by the friction of the irregular surfaces of the ether and atmosphere rubbing together" it does not seem that he can mean what he says.

F. W. S.

I believe the theory of R. S. (July issue) is wrong because ether is not a solid. As we leave the earth the air gets thinner so gradually that there is no certain meeting point between the atmosphere and ether.

Air has more or less ether between its particles, the amount depending upon the density of the air. If the contracting of the atmosphere caused a vacuum and the expanding caused thunder there would be a continuous roar of thunder following the snow capped mountains around the world, especially those in the torrid zone.

It would take an intense heat, far greater than we could stand, to heat the atmosphere to any great degree. The heating of the air close to the earth, instead of expanding the whole body, only causes the cooler air from above to rush in and take the place of the warmer. A local heat can only cause a local partial vacuum and a local wind.

E. H. J.

TRAVELING BY VORTICES.

According to the vortex theory, all matter is made up of constantly moving vortices smaller than atoms and acting on the principle of a smoke ring. This theory of an elementary vortex as the basis of all matter has been found useful in the explanation of certain chemical phenomena. The belief is also becoming more prevalent among scientists that electricity and matter are one and the same thing, that is, that matter is made up of positively and negatively charged ions which are subatomical and identical in all forms of matter.

Now I have a theory that all manifestations of energy that we see on every hand are but the combined and directed movement of a great number of these little vortices, which are made up in turn of the infinitesimal electrically charged ions whirling around each other in the same manner that the particles of smoke whirl to form a traveling smoke ring.

Some day scientists will find a way of utilizing this vortex movement of electricity, on a large scale, to furnish the energy for carrying people through the air, which will be simpler than the flying machine and more effective.

In a small way this is done now, although man must still depend on mother earth to sustain him. Take, for instance, the street car. As it travels along over the rails what is its motive power? Simply little whirls of electric energy around the wires in the armatures of its motors. If we could see these vortices we would see a car start out from the barns and scurry along the track being apparently carried along by these little whirls like leaves by a summer whirlwind. But this is all very crude as yet. We have to depend on wires to control the vortices. The problem of the next century will be to get control of these vortices so that they may be projected out through space without wires. Then all we will have to do will be to climb into our vortex actuated car, turn on the vortex—by an electric canon or otherwise—and away.

Wheels.

ELECTRICITY THE LIFE PRINCIPLE.

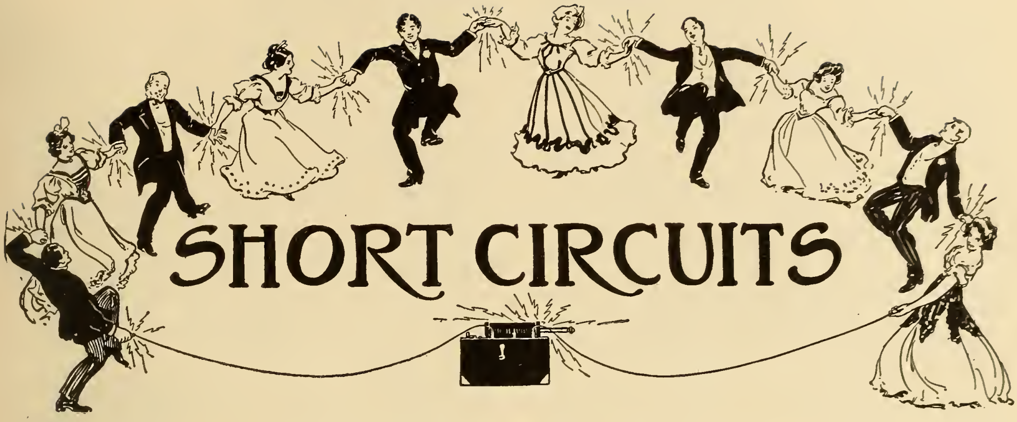
The theory advanced in your August issue by A. E. J. seems to be due to a very natural desire of the philosopher to generalize and to see in how far one all-embracing law may be detected as "governing" phenomena, organic, and inorganic. The attempt is certainly an interesting one and the conclusion arrived at quite natural on the part of an enthusiastic student of electricity, which no doubt A. E. J. is. Let me, however, point out that the theory of the two conflicting forces does not seem to be adequately illustrated. If hatred gives place to love, this seems to me to be an evolution of one state of mind into another. Similarly with the rest of the examples. Darkness does not seem to me to be a force conflicting with light, but simply to be a partial absence of a manifestation of force, namely, light. The same reasoning holds good in the case of strength and weakness and even as to good and evil, for these are, as the former, only relative terms, measured by relative standards. Although, as far as good and evil are concerned, ethics supply us with a scientific standard for appreciating them, yet as in all our knowledge, our morals cannot be absolute. I am far from advancing a theory of skepticism; my only object is to show that we are very far from being able to define God, his laws and his attributes.

As far as electricity as the "life principle" is concerned let me point out that, without wishing to engage in a controversy about the special properties and uses of electricity, in which, no doubt, A. E. J. would be considerably my superior, I should like to point out that from a philosophical point of view electricity is but one manifestation of molecular motion, i. e., of a force pervading the whole of phenomena accessible to observation. Indeed, it seems to me that electricity is compound molecular oscillation and does not, therefore, seem to be different from other molecular motion such as light and heat for instance, otherwise than in being compound instead of simple. If this is the case, which I do not doubt it is, then we have to go much farther in the definition of that force of which we have so many variegated manifestations. Naturally the principle suming up all the manifestations of force in the simplest manner will be the most satisfactory and I think that up to now we have not arrived at a more general law of force than this:

"Action and reaction are equal and opposite." Manifestly this does not give us the idea of God which we are so anxiously striving to arrive at, yet it helps us a great deal in summing up and comparing the great results of all scientific research. A. E. J. needs not in any way be discouraged by this, for he must remember that the marvels which surround us are so many and so complicated that it is quite natural that many attempts have to be made in order to arrive at the smallest conclusion. After all what is a lifetime in such matters? Let us not despair but wonder at the marvels which everywhere invite our attention. It is by long continued enquiry and indefatigable study that we learn to despise the pride of "scientists" and to pity the pride of ignorance. Does not A. E. J. agree with me?—H. H.

ELECTRIC TORPEDO FISH.

The torpedo fish is one of the most dangerous inhabitants of the sea. The torpedo is a disk-like creature, frequently attaining a length of five feet and weight of 200 pounds. They abound on the Atlantic coast and sometimes fishermen who make them captive in their nets are very sorry for it. Recklessly handled, the torpedoes quickly wreak vengeance on their captors. The shocks they give is tremendous, and strong men have often been knocked down and paralyzed for a considerable time.



SHORT CIRCUITS

"Please Miss, Mr. Jones has called, and I've shown him in to the drawing room. He said you were expecting him."

"Oh, Jane," cried Miss Smith, in a flutter of excitement, "go and fight the liar."

Jane's face was a picture, and it was not till she was half way down the stairs that she realized her mistress wanted the fire lit.

* * *

Angler—"Is it against the law to fish in this stream, can you tell me?"

Native—"No, but it's against common sense. There ain't no fish in it."

* * *

"I never pretend to know a thing when I do not," remarked Bennie, "When I don't know a thing I say at once: 'I don't know it.' "

"A very proper course," said Logg, "but how exceedingly monotonous your conversation must be, Bennie."

* * *

A. M. Downes, late secretary of New York's Fire Department, related at a dinner a fire-story.

"At the end of the first act of a drama," he said, "a man leaped hurriedly to his feet.

" 'I heard an alarm of fire," he said. "I must go and see where it is."

"His wife, whose hearing was less acute, made way for him in silence, and he disappeared.

" 'It wasn't fire," he said, on his return.

" 'Not water, either," said his wife, coldly."

* * *

"What in the world is that man doing, lying on his back under that mule?"

"Oh, don't worry about him, he is only an absent-minded chauffeur.

* * *

First Farmer—That new hired man of yours must have been a bookkeeper before he came to you.

Second Farmer—Why so?

First Farmer—I notice that every time he stops work for a few minutes he puts the pitchfork behind his ear.

* * *

Footsore and weary he sank to the ground and bit the dust.

"How shamefully sad!" cried the populace. "And to think he perished in the very sight of home!"

But there was no help for it.

The marble-hearted umpire refused to reverse his decision.

* * *

Mike—"Why do them false eyes be made of glass?"

Pat—"Shure, an' how else could they see through thim, ye thick head?"

* * *

Mistress—"I told you hours ago to turn on the gas in the parlor, Bridget."

Bridget—"Shure, and I did, mum. Don't yez smell it?"

Pat—"Yez may say what yez plaze, gintlemen, it's not onywhere ye'll be findin' braver men thon the Irish."

Banter—"Come off, Pat. It was only the other night I made five of them run."

Pat—"And was it long they were in catchin' ye?"

* * *

Jimson was paying an evening call, and Eva Fuffington, happy in the knowledge that 35 minutes patient toil had fixed her kiss curl in the most fetching manner, was bringing him around to the style of conversation which might lead to anything from a snatched kiss to wedding bells and confetti, when rat-a-tat came a knock at the front door.

"Bother," said Eva, peeping out of the window, "it's that horrid little Borbey."

"Say you're out," prompted Jimson.

"One of my New Years' resolutions was to tell no stories. Shall I say I am engaged?"

And Jimson guiless and lamb-like, was hooked.

* * *

Mr. Meanie—"I have nothing but praise for the new minister."

Mr. Goode—"So I noticed when the plate came around."

* * *

When Dr. Creighton was bishop of London he rode in a train one day with a small, meek curate. Dr. Creighton, an ardent lover of tobacco, soon took out his cigar case, and with a smile he said:

"You don't mind my smoking, I suppose?"

The meek, pale little curate bowed and answered humbly:

"Not if your lordship doesn't mind my being sick."—Good Health.

* * *

What was the fruit of your wooing?

A mixture of varieties. I had a peach who was the apple of my eye. I sought to make a pair with her, and made a date, but when the time came, she handed me a lemon.

* * *

"A lady boarded the train the other day with six children who were from eight to four years old. When it was time for the conductor to come around, she took the oldest one and put him on the seat and put the others on top of him according to their size. When the conductor asked her for her fare, she handed him one ticket. He looked at her and said: "Madam, how old are these children?" The lady replied: "Why, the oldest one is under five."

* * *

Mrs. A.—"Does Mrs. Lovelorn believe everything her husband tells her?"

Mrs. F.—"Does she? Well I should say so. He told her last week she looked prettier with a towel wrapped around her head than she did with a 'Merry Widow' hat and the dear little woman has been house-cleaning ever since."

ELECTRICAL DEFINITIONS.

Accumulator.—Storage battery.
Alternating Current.—That form of electric current the direction of flow of which reverses a given number of times per second.
Ammeter.—An instrument for measuring electric current.
Ampere.—Unit of current. It is the quantity of electricity which will flow through a resistance of one ohm under a potential of one volt.
Ampere Hour.—Quantity of electricity passed by a current of one ampere flowing for one hour.
Anode.—The positive terminal in a broken metallic circuit; the terminal connected to the carbon plate of a battery.
Armature.—That part of a dynamo or motor which carries the wires that are rotated in the magnetic field.
Branch Conductor.—A parallel or shunt conductor.
Brush.—The collector on a dynamo or motor which slides over the commutator or collector rings.
Bus Bars.—The heavy copper bars to which dynamo leads are connected and to which the out-going lines, measuring instruments, etc., are connected.
Buzzer.—An electric alarm similar to an electric bell, except that the vibrating member makes a buzzing sound instead of ringing a bell.
Candle Power.—Amount of light given off by a standard candle. The legal English and standard American candle is a sperm candle burning two grains a minute.
Capacity, Electric.—Relative ability of a conductor or system to retain an electric charge.
Charge.—The quantity of electricity present on the surface of a body or conductor.
Choking Coil.—Coil of high self-inductance.
Circuit.—Conducting path for electric current.
Circuit-breaker.—Apparatus for automatically opening a circuit.
Collector Rings.—The copper rings on an alternating current dynamo or motor which are connected to the armature wires and over which the brushes slide.
Commutator.—A device for changing the direction of electric currents.
Condenser.—Apparatus for storing up electrostatic charges.
Cut-out.—Appliance for removing any apparatus from a circuit.
Cycle.—Full period of alternation of an alternating current circuit.
Diamagnetic.—Having a magnetic permeability inferior to that of air.
Dielectric.—A non-conductor.
Dimmer.—Resistance device for regulating the intensity of illumination of electric incandescent lamps. Used largely in theaters.
Direct Current.—Current flowing continuously in one direction.
Dry Battery.—A form of open circuit battery in which the solutions are made practically solid by addition of glue jelly, gelatinous silica, etc.
Electrode.—Terminal of an open electric circuit.
Electromotive Force.—Potential difference causing current to flow.
Electrolysis.—Separation of a chemical compound into its elements by the action of the electric current.
Electromagnet.—A mass of iron which is magnetized by passage of current through a coil of wire wound around the mass but insulated therefrom.
Electroscope.—Instrument for detecting the presence of an electric charge.
Farad.—Unit of electric capacity.
Feeder.—A copper lead from a central station to some center of distribution.
Field of Force.—The space in the neighborhood of an attracting or repelling mass or system.
Fuse.—A short piece of conducting material of low melting point which is inserted in a circuit and which will melt and open the circuit when the current reaches a certain value.
Galvanometer.—Instrument for measuring current strength.
Generator.—A dynamo.
Inductance.—The property of an electric circuit by virtue of which lines of force are developed around it.
Insulator.—Any substance impervious to the passage of electricity.
Kilowatt.—1,000 watts. (See watt.)
Kilowatt-hour.—One thousand watt hours.
Leyden Jar.—Form of static condenser which will store up static electricity.
Lightning Arrester.—Device which will permit the high-voltage lightning current to pass to earth, but will not allow the low voltage current of the line to escape.
Motor-generator.—Combined motor and generator for changing alternating to direct current or vice versa.
Motor-dynamo.—Motor and dynamo on the same shaft, for changing alternating current to direct and vice versa or changing current of high voltage and low current strength to current of low voltage and high current strength and vice versa.
Multiple.—Term expressing the connection of several pieces of electric apparatus in parallel with each other.
Multiple Circuits.—See parallel circuits.
Neutral Wire.—Central wire in a three-wire distribution system.
Ohm.—The unit of resistance. It is arbitrarily taken as the resistance of a column of mercury one square millimeter in cross sectional area and 106 centimeters in length.
Parallel Circuits.—Two or more conductors starting at a common point and ending at another common point.
Polarization.—The depriving of a voltaic cell of its proper electromotive force.
Potential.—Voltage.
Resistance.—The quality of an electrical conductor by virtue of which it opposes the passage of an electric current. The unit of resistance is the ohm.
Rheostat.—Resistance device for regulating the strength of current.
Rotary Converter.—Machine for changing high-potential current to low potential or vice versa.
Secondary Battery.—A battery whose positive and negative electrodes are deposited by current from a separate source of electricity.
Self-inductance.—Tendency of current flowing in a single wire wound in the form of a spiral to react upon itself and produce a retarding effect similar to inertia in matter.
Series.—Arranged in succession, as opposed to parallel or multiple arrangement.
Series Motor.—Motor whose field windings are in series with the armature.
Shunt.—A by-path in a circuit which is in parallel with the main circuit.
Shunt Motor.—Motor whose field windings are in parallel or shunt with the armature.
Solenoid.—An electrical conductor wound in a spiral and forming a tube.
Spark-gap.—Space between the two ends of an electric resonator.
Storage Battery.—See secondary battery.
Thermostat.—Instrument which, when heated, closes an electric circuit.
Transformer.—A device for stepping-up or stepping-down alternating current from low to high or high to low voltage, respectively.
Volt.—Unit of electromotive force or potental. It is the electromotive force which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.
Voltage.—Potential difference or electromotive force.
Volt Meter.—Instrument for measuring voltage.
Watt.—Unit representing the rate of work of electrical energy. It is the rate of work of one ampere flowing under a potential of one volt. Seven hundred and forty-six watts represent one electrical horse power.
Watt-hour.—Electrical unit of work. Represents work done by one watt expended for one hour.

A DESERT POWER PLANT.

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