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EDISON WHEN BETWEEN 14 AND 15 YEARS OLD

By FRANK LEWIS DYER
General Counsel for the Edison Laboratory and Allied Interests
and
THOMAS COMMERFORD MARTIN
Ex-President of the American Institute of Electrical Engineers, Secretary of the National Electric Light Association

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EDISON AFTER FIVE DAYS AND NIGHTS CONTINUOUS LABOR ON HIS PHONOGRAPH, 1888

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HOW A MAGNETO MAKES ELECTRICITY

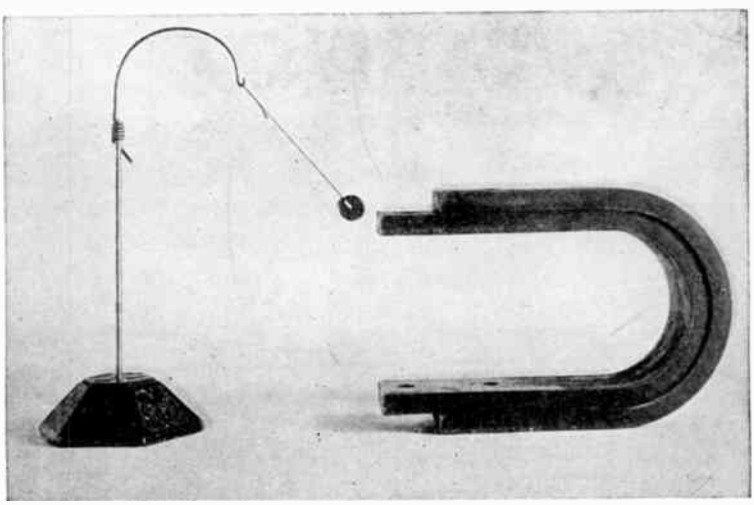
The Principles Involved and Method of Operation Explained and Illustrated. How Sparks are Produced Mechanically for Ignition Purposes

P. S. TICE

It is the writer's purpose to draw attention in the following to the elementals governing each electrical and magnetic action involved, and to show how these occur and are related to and supplement each other in the production of ignition sparks in the modern magneto. The magneto, as we are coming to know it in motor boat practice, is one of the most highly specialized developments of electrical and mechanical engineering effort with which we have to deal; and, while the principles underlying its operation are not late discoveries, the manner of their combination is comparatively new and in some cases highly original. Therefore, in order that a clear understanding of these combinations and their results may be had, each principle employed will first be explained individually and as if it were acting alone, and later the relationship of each to the others and all to the magneto as the motor boatman knows it.

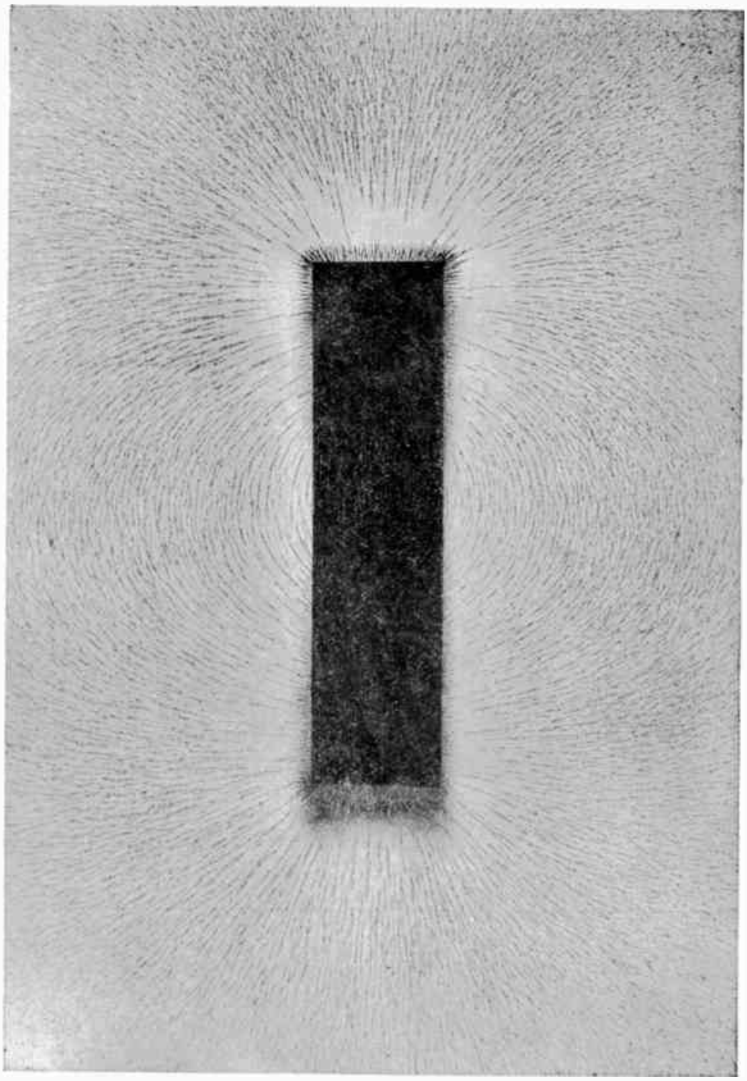
MAGNETISM AND MAGNETS

Magnetism is defined as that property possessed by bodies of certain substances whereby, under given circumstances, they exert an attracting or repelling force upon certain other bodies, without



Copyright by "Motor Boating" **Fig. 1. A demonstration of magnetism**

A small disc of steel, suspended by a fine thread, maintained in the position shown by the attractive force of one pole of the U magnet.



Copyright by "Motor Boating" **Fig. 2. Lines of force in the field of a bar magnet**

The looping of the lines of force to form closed circuits through surrounding space and the body of the magnet itself is to be particularly noted. In "posing" for this and the other field pictures the bar magnet rested upon a dull, white card placed upon the floor, and the camera was arranged to point directly down upon them. A piece of thin glass resting upon the magnet supported the iron filings which were sprinkled on and which give the map of the lines of force.

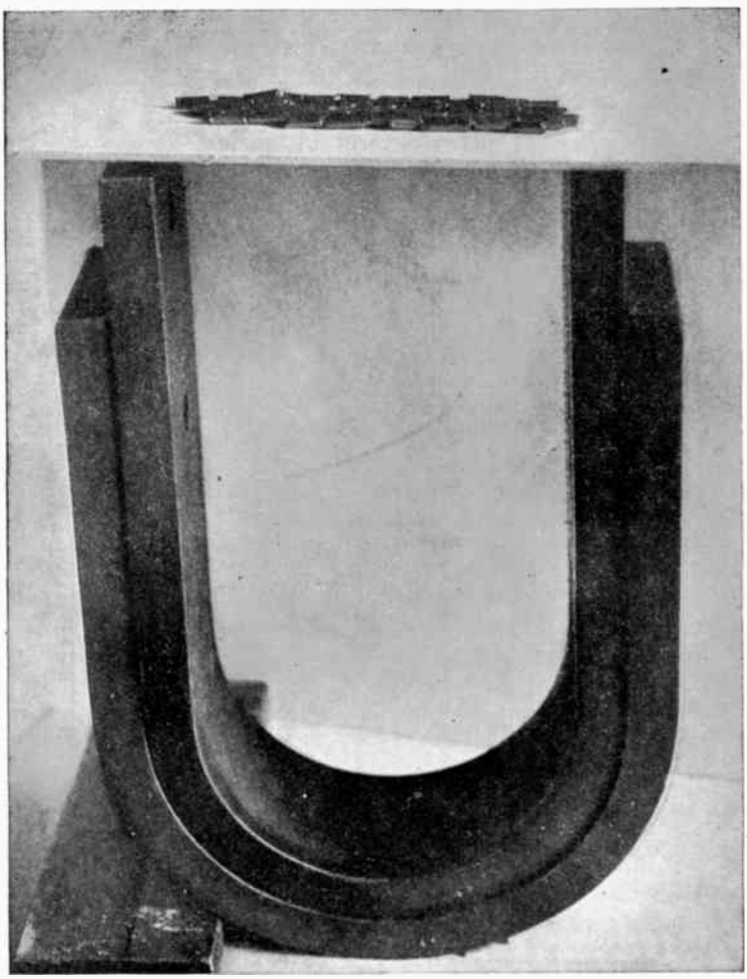
physical contact having been made between them, as in Fig. 1. A magnet is a body which possesses magnetism.

Though all substances show some magnetic quality, there are three which form a group distinguished from all others in this respect, and while only a feeble manifestation of magnetism may be caused in other metals and non-metals, iron, nickel and cobalt take magnetism very readily and in relatively enormous quantities.

Aside from the fact that a magnet possesses magnetism, one of its chief characteristics is polarity, or the possession of magnetic poles. That is, when any magnet, of whatever form, is freely suspended by a fine cord or fibre it can normally assume but one position with reference to the earth. The latter is itself a large magnet, the magnetic axis (an imaginary straight line joining the magnetic poles) of which very approximately coincides with its axis of rotation. The magnetic poles, positive and negative, of any magnet are at the ends of the magnetic axis, hence the magnetic poles, or poles, for short, are, in the earth, located in the North and South Polar regions, respectively.

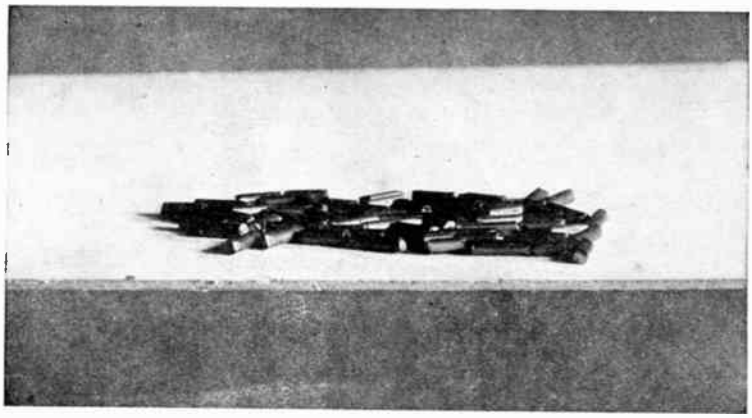
It is also a property of magnets that poles of like sign, two positives or two negatives, repel, while those of unlike signs, one positive and one negative, attract each other. Therefore, when a magnet is freely suspended, it normally takes up a position in which its positive pole is presented to the negative pole of the earth, and *vice versa*. In the case of the suspended magnet, that pole which points North is called the North or positive pole, and the other, the South or negative pole. It is this magnetic principle, as is well known, which is used in the making of compasses.

Since magnets exert a force upon each other and upon other substances which normally have no magnetism, without physical contact, as per the above definition of magnetism, it is obvious that magnetic influence extends across space in the neighborhood of a magnet. The space or region surrounding a magnet, and in which magnetic influences exist



Copyright by "Motor Boating" **Fig. 3. A demonstration of the theory of magnetism (a)**

The arrangement of the molecular magnets when in a magnetically saturated state. The small pieces shown are permanent magnets, and each may be taken, for purposes of illustration, to represent a magnetic molecule; and the entire collection of small pieces as the body which is being magnetized. The large U magnet here furnishes the magnetizing field.



Copyright by "Motor Boating" **Fig. 4. A demonstration of the theory of magnetism (b)**

The same pieces as in Fig. 3 after the removal of the magnetizing force; showing the tendency toward demagnetization in a body upon the removal of the magnetizing influence. The pieces repel each other and arrange themselves with magnetic axes in promiscuous directions.

is called a magnetic field. Upon investigation, this field is found to be traversed by so-called lines of force, each line being distinguished throughout its length from all other lines, the number of lines depending upon the magnetic strength of the magnet. The paths of the lines of force are curved, each extending from the positive (+) or N pole, through space to the negative (—) or *S* pole. This can be demonstrated in either of two ways: by bringing a small, freely pivoted magnetic needle into proximity with one of the poles of a relatively large magnet, and moving it away from that pole in the direction momentarily indicated by the direction of its length; or by the iron filings experiment, which gives a map of the lines of force existing in the plane in which the experiment is made, as in Fig. 2. In the figure a great number of particles take the place of the pivoted magnetic needle and assume positions in which their magnetic axes coincide as nearly as may be with the paths of the lines of force.

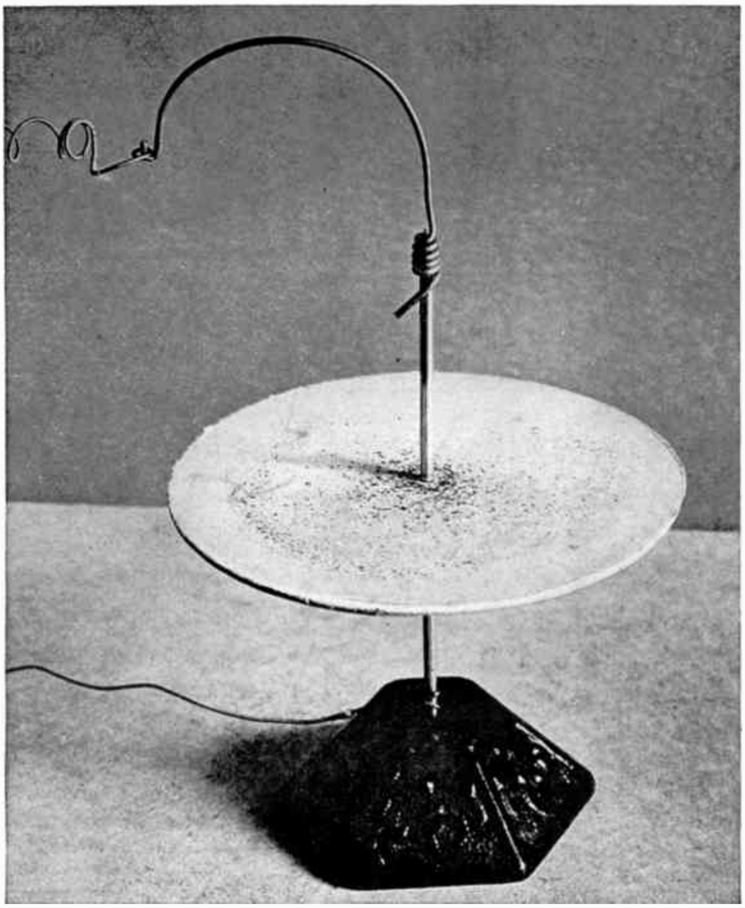
Fig. 2 also serves to illustrate another property of magnets, *i.e.*, the ability to cause bodies, hitherto not magnetized, to assume a condition and act in a manner identical with that of the energizing magnet itself. That is, upon bringing a piece of non-magnetized magnetic material within the field of a magnet, that substance at once assumes all the characteristics of the magnet itself, and retains them so long as it remains within the field.

This is called magnetic induction, from the fact that the characteristics of magnets, magnetism and polarity, are induced by the proximity of a magnet with its field in a body which does not normally possess them. Fig. 3 shows, upon a larger scale, what is shown in a general way in Fig. 2. As shown in Fig. 3, induced magnetism in one body is capable of inducing magnetism in another body, and that one in still another, and so on.

Any substance in which magnetism can be induced, and which is therefore attracted by a magnet, is termed a magnetic substance; and all substances which are not quite strongly magnetic, compared with those that are most strongly magnetic, are termed non-magnetic. Whenever magnetic material is needed, iron or its alloys, such as wrought iron and steel, is exclusively employed because of its great magnetic qualities.

THEORY OF MAGNETISM

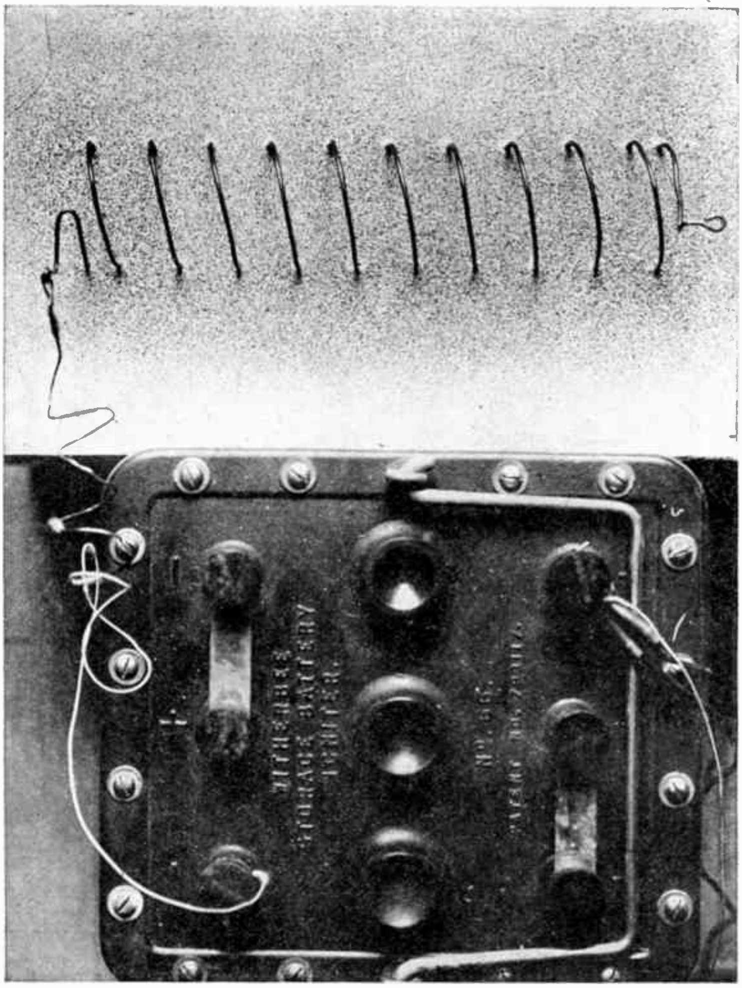
Just here the theory of magnetism should be taken up briefly, since without knowing its fundamentals it will be difficult to understand the reasons for the existence of permanent and temporary magnets or for the fact that any given magnetic body can be but just so strongly magnetized, *i.e.*, to a given limit, upon the attainment of which state the body is said to be magnetically saturated.



Copyright by "Motor Boating" **Fig. 5. Circular lines of force about an electric current**

Fine iron filings sprinkled upon a card through which a current is carried by the vertical conductor shown, arrange themselves in concentric circles coinciding with the circular, closed lines of force.

The accepted hypothesis states that each infinitesimally small portion, the molecule, for instance, of all substances is in itself a tiny magnet of a greater or lesser strength, depending upon the substance, as above. It further states that due to the random directions of the magnetic axes of these tiny magnets, as found in the body, no resultant polarity is normally displayed by the aggregation of all the particles; and that the process of magnetization of the body consists in a turning of these magnet-particles, under the influence of a magnetic field, so that like poles of the magnet-particles point in the same direction. The chief point inferred by this is that no change takes place in the pole strength values of the particles, but that magnetization consists simply of an orderly and uniform rearrangement of the polar directions, so that the body has a definite, resultant magnetism, depending for its intensity or strength upon the relative number of magnet particles which the magnetizing force or field has succeeded in turning. From this it appears that when the magnetizing force is sufficiently strong and is applied for a long enough time to turn all the magnet-paticles in a common direction, the magnetism of the body will have reached a maximum value, beyond which it cannot go with further increase in the strength of the magnetizing field. In practice, such a state of maximum magnetization is readily attainable.

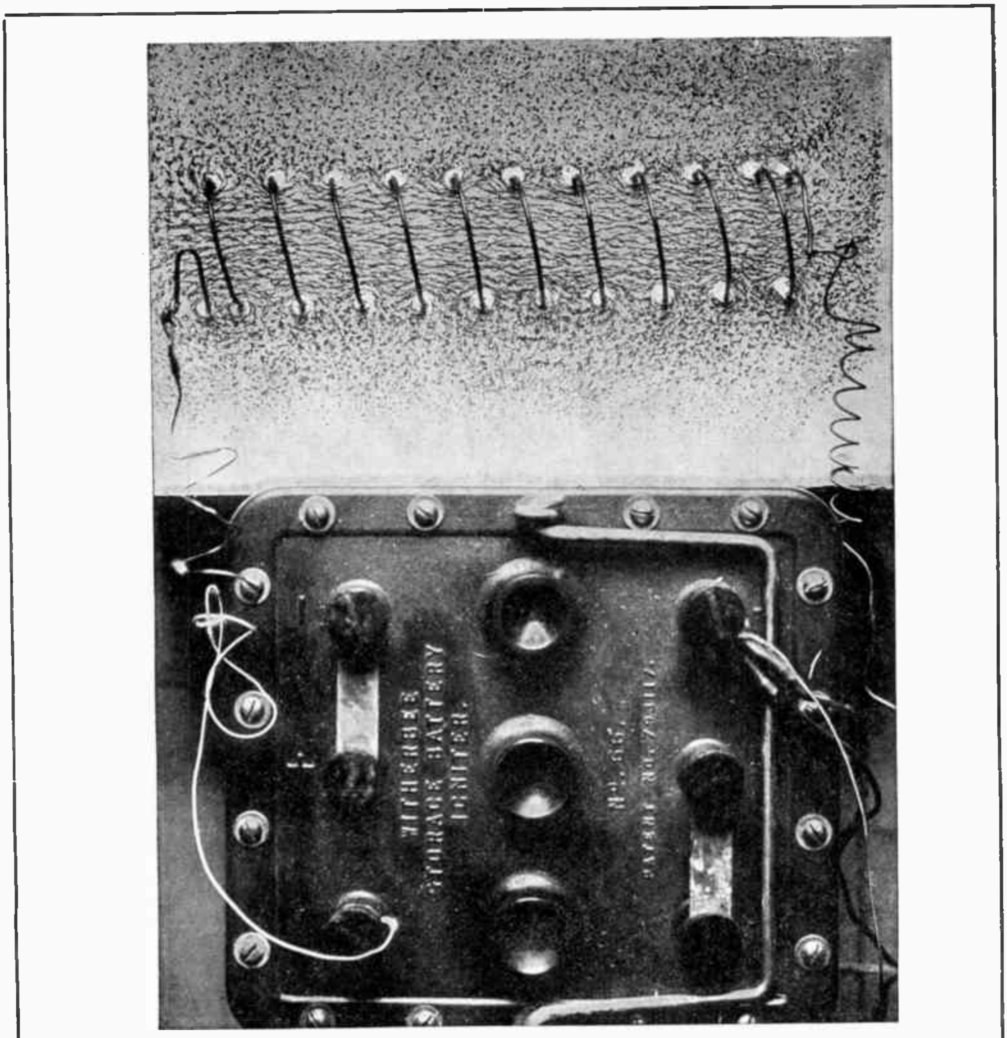


Copyright by "Motor Boating" **Fig. 6. The connecting link between magnetism and electricity**

Fig. 6 shows a copper wire, which in itself is non-magnetic, woven through a white card to form a helix, only the upper portion of which is, of course, visible. The card is sprinkled with iron filings. As the right-hand end of the wire is not connected with the battery (partly shown at the bottom of the photograph), no current is passing through it and the iron filings are not affected.

This theory is equally clear in regard to permanent and temporary magnetizations. It is a recognized fact, as applied to all substances in the universe, that the softer, more ductile or more mobile the substance, the greater freedom is allowed the molecules of that substance, and the more readily may their relative positions be changed. This truth is most readily grasped by comparing two extreme cases, say that of steel with that of a gas, as air. In the steel, the substance particles, called molecules in the following, are very close together, in contact with other molecules on all sides, and therefore confined; whereas, with air, the spaces between the molecules are enormously greater, and the molecules are therefore much freer to assume new relationships, one with the other. Now compare iron in the soft state, annealed wrought iron, for instance, with hardened steel.

Suppose a magnetic field of a given strength were to act upon bars of equal size of the above iron and steel, respectively. The induced magnetism in the iron will be many times greater than that in the steel because of the lesser resistance offered in the iron to the turning of the molecule-magnets. However, when the field is removed, it will be



Copyright by "Motor Boating" **Fig. 7. The connecting link between magnetism and electricity.**

In Fig. 7 electric current is passing through the helix, its right-hand end being connected with the battery through a group of lamps (not shown) which are used to cut down the flow of current to a safe limit. It will be seen that the lines of force about the helical coil of wire through the card, when the current is flowing, cause the iron filings to arrange themselves in lines within the magnetic field produced by the combination of the circular lines of force about each turn of the wire.

found that the steel possesses the greater magnetism, and for the same reason that its magnetism was the lesser while under the influence of the magnetic field. Fig. 3 will assist in the explanation of this. A series of molecule-magnets is here shown in a magnetically saturated state. From the above-mentioned characteristics of magnets, namely: that like poles repel and unlike poles attract each other, it appears that within a magnetized body itself, considering that body as made up of magnet molecules, there exist strong demagnetizing forces, since a molecule with its magnetic axis parallel to that of another, adjacent molecule, tends by induction to reverse the polarity of that molecule, or to turn it about bodily so that the unlike poles come in juxtaposition. If the turning is fully accomplished, the body or bar, as a whole, loses its magnetism and returns to the state in which it was before the application of the magnetic field, as in Fig. 4. Steel being harder than iron, does not permit of such a ready reshifting of the molecule-magnets, and, therefore, retains a part of the magnetism induced in it. The retained magnetism is called residual magnetism.

It is a fact that, aside from the influence of the chemical constituents in the steel upon the initial polar strength of the molecule-magnets, the retained or residual magnetism is almost directly proportional to the molecule coercion or "hardness" of the steel magnetized. The above statement gives the reasons for the almost instantaneous loss of magnetism in soft iron when the magnetizing field is withdrawn and applies equally to the cause of the gradual loss of magnetism with age in hardened steel magnets, such as are used in magnetos, which because of their relatively ready retention of magnetism are termed permanent magnets.

ELECTRO-MAGNETISM

In investigations of electric currents, it has been found that the flow of electricity through a conductor, as a wire, creates a magnetic field exactly similar in all respects to that caused by a magnet. That is, a magnetic field due to an electric current has power to attract and repel magnets and all magnetic substances, cause magnetic induction, etc., just as is done by a magnet, as discussed in the above. However, the magnetic field due to an electric current is differently disposed with reference to the conductor than is the field created by a magnet, referred to itself. This is shown in Fig. 5.

If now a helical coil of wire, called a solenoid, be formed as in Fig. 6, and a current be passed through it, Fig. 7, the density of the magnetic field due to the current is greatly increased, and a bundle of parallel lines of force is created. These lines of force are disposed with reference to the solenoid in exactly the same directions as are the lines of force in a field due to a magnet; and the solenoid behaves exactly as would a bar magnet, displaying magnetism, polarity, etc., so long as the current is flowing. A sectional iron filing map of the field of a solenoid, as in Fig. 6, is shown in Fig. 7. It is particularly to be noted in Fig. 7 that the circular lines of force, as in Fig. 5, are present about each portion of the wire for a short radial distance. Fig. 7 shows the paths of return of the lines of force through the body of the magnet to complete the magnetic circuit, as mentioned.

ELECTRO-MAGNETIC INDUCTION

Experimenters of past generations discovered that, while a current of electricity flowing through a conductor will create a magnetic field about the conductor, Fig. 7, the converse is also true, in that an electric current can be induced in a conductor located within a magnetic field. That is, an electric pressure will be induced, providing that the electric or metallic circuit of the conductor is closed and that it is moved within the magnetic field in such a manner that the number of lines of force about it is caused to vary.

In verbal illustration of this, a simple experiment will be described: If a length of copper wire, say 30 or more feet, be stretched, not too tightly, from wall to wall, east to west, of a large room, and its circuit be closed through a delicate galvanometer or electric current indicating instrument, it will be found that, upon causing the wire to vibrate in a vertical direction, the galvanometer will indicate the passage of an electric current with each vibration. The explanation is that in vibrating vertically, that is, toward and away from the magnetic axis of the earth, the wire momentarily passes from a region of a given magnetic intensity to one of greater intensity, and *vice versa*, within the magnetic field of the earth, which is in all respects similar to the field of the bar magnet in Fig. 2. When the wire vibrates horizontally, it does not pass through regions of varying magnetic intensity, and, therefore, no electric pressure or current is induced in its circuit. Of course, the difference in intensity in the earth's field within the amplitude of the wire's vibrations is very slight, but it is sufficient to cause the induction of a current which is measurable with a delicate indicating instrument.

This latter experiment, while extremely simple in itself, shows exactly upon what electro-magnetic induction is dependent; if the wire is vibrated more sharply, the galvanometer indicates the passage of a greater current; if its length is increased, without its speed of vibration being altered, a similar

(*Concluded on page* 230.)

THE MODELMAKER

E & M

A MODEL STEAM TURBO-BLOWER

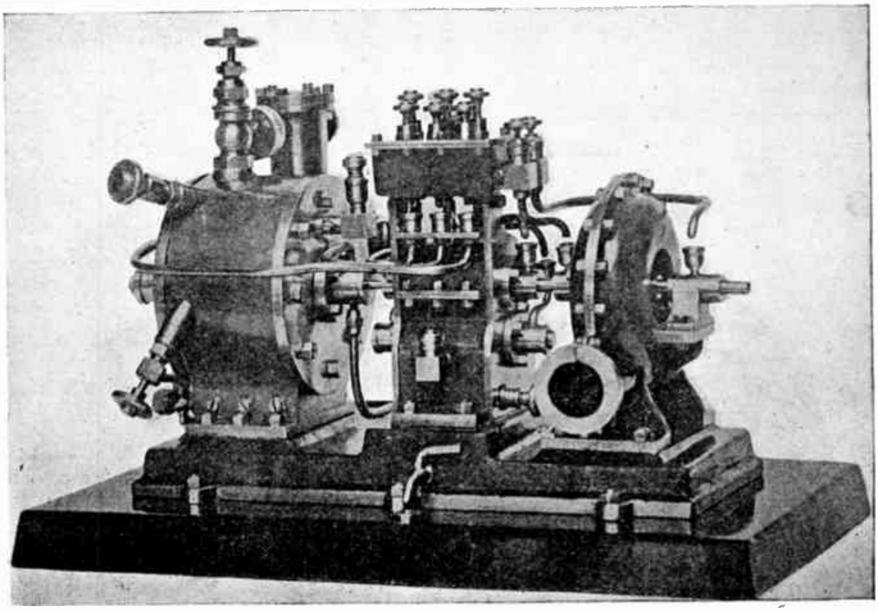
A. R. GRIGGS

The following is a description (with photograph) of a model De Laval steam turbo-blower of my own design and construction. Machines of this type are used for gas pressure-raising and for generator blowing of a water-gas plant. In designing this model, however, I found that, in view of its small size, it would be necessary to depart from the standard design of these machines in order to ensure its satisfactory and continuous working. Another factor that influenced the design was that, not having facilities for obtaining small castings, I had to so arrange the design that the various parts could be built up. The only casting used was the foundation plate—an iron casting which I had cast off my own pattern, and which I have described later on.

TURBINE

The turbine, as before stated, is a De Laval type, having a rotor of 2¼ in. diameter. This was constructed of hard brass, and the vanes and wheel being of one piece there are no joints at the roots of the blades to give any subsequent trouble. To prevent the steam escaping radially through centrifugal force, a light steel shrouding is secured round the outside of the blades. The rotor was mounted on a ⅛ in. diameter silver-steel shaft, and accurately balanced. This shaft is of sufficient flexibility to enable the rotor to run without any vibration whatever as soon as the critical speed is passed.

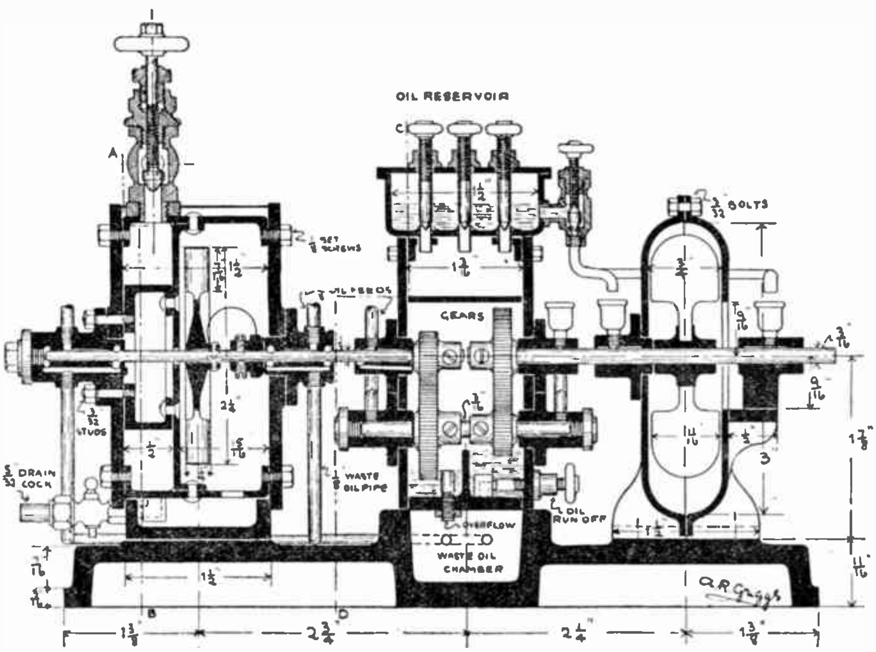
The turbine casing is made of a piece of 2¾ in. diameter brass tube flanged internally at each end, to which the covers are secured by eight ⅛ in. set-screws. The casing is divided into two parts by a diaphragm plate; the rotor runs in one division, and the other is formed into an annular steam chest, the diaphragm plate being provided with



Model Steam Turbo-Blower

two steam nozzles set at an angle of 20 degrees. These nozzles have a throat diameter of .04 in., and are fitted with the standard De Laval shut-off valves, which can be seen in the photograph projecting through the casing. The turbine case is secured to a rectangular base, which is provided with flanges for bolting the turbine to the foundation plate. The interior of the base serves as a reservoir to collect any water condensed out in the rotor chamber, and thus keeps it perfectly clear; and a 5/32 in. drain cock is fitted so that the reservoir may be emptied from time to time.

steam before it is run off. This point would not be so important if a larger separator had been fitted, but this would have spoilt the appearance of the model. The separator is built up of ¾ in. internal diameter seamless brass tube, with the top and bottom flange riveted and soldered. The top cover, to which the baffles are secured, is fastened to the separator flange by six 5/32 in. setscrews, so that by unscrewing these the baffles can be lifted out altogether for cleaning or renewing. The separator is fitted with a ⅛ in. drain cock for keeping it clear of water.

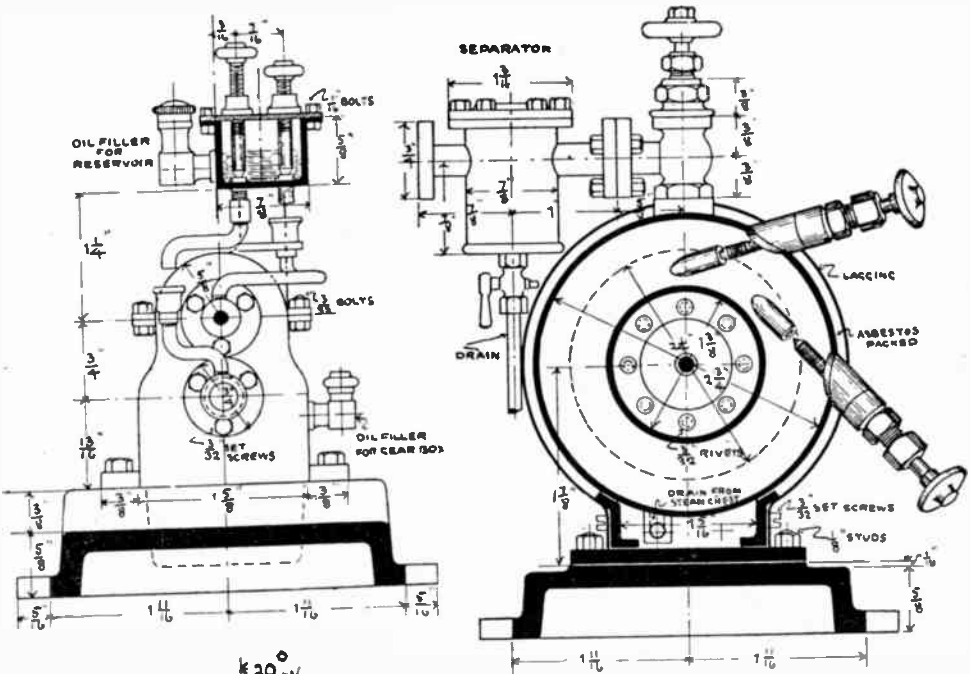


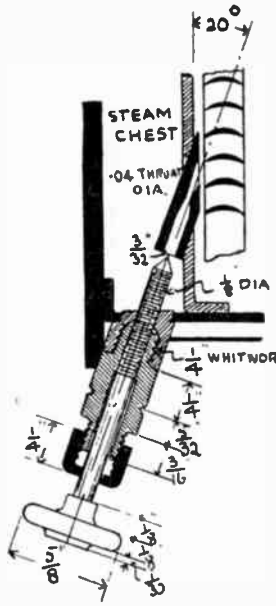
SECTION OF MODEL STEAM TURBO-BLOWER

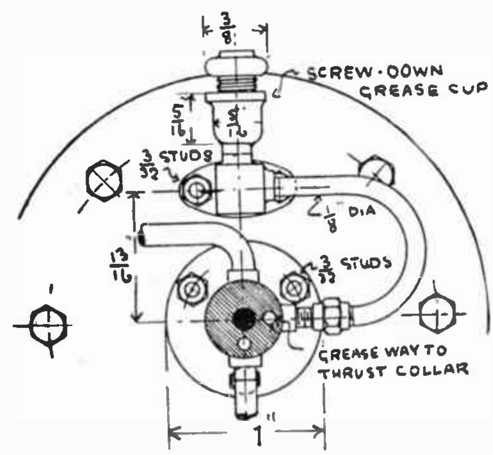
The annular steam chest is also fitted with a drain cock. The turbine case is lagged with asbestos and planished steel.

The main steam supply is ¼ in. in diameter, and before the main stop valve (seen on top of the turbine) is placed a steam separator to arrest any water that may be carried along with the steam; it being essential that the steam should be as free from water as possible when it enters the nozzles. The separator is provided with wire gauze baffles, specially designed to prevent the water already collected from being taken up or forced over by the

The turbine is provided with a ½ in. internal diameter exhaust pipe, the elbow of which can be seen in the photograph of the back. It is intended at some future time to connect this to an ejector condenser. The turbine runs at 20,000 revolutions per minute, and in consequence of this high speed of rotation the bearings of the rotor shaft have been designed for ample and continuous lubrication. The oil from the oil reservoir is introduced into the middle of the bearing on the upper part, and flows either way by means of oil channels; and after lubricating the shaft it is collected at the ends by a recess







END VIEWS AND DETAILS OF MODEL STEAM TURBO-BLOWER.

formed in the bearing and on the shaft. The oil then flows back again to the centre of the bearing through an oil way drilled under the shaft-hole, and thence by a copper pipe to the waste oil chamber under the gear-box, from whence it can be drawn off at intervals.

In order to take the thrust of the steam on the rotor, a thrust collar is provided on the rotor shaft running against the faced end of the bearing inside the exhaust chamber. This is lubricated by grease from the screw-down grease cup seen over the main bearing in the photograph.

REDUCTION GEAR

A compound arrangement of reduction is employed—that is, there is an intermediate shaft. The total reduction is 5 to 1. The ordinary spur-wheel gearing is used, but the wheels have extra wide teeth to reduce wear, and are made of hard gun-metal. The whole gear is encased in an oil-tight box, and the intermediate shaft running in oil lubricates all the gearing. An oil-filling plug is provided (seen in the front of the gear-box), and also a run-off valve and overflow. The upper part of the case is removable, so that the gearing may be got at. The sides of the gear-box are extended to carry the oil reservoir for supplying all the bearings. As the high-speed bearings require ample lubrication, the oil cups (the three seen in front of the gear-box) are kept as high as possible, so as to provide a good head for the oil. All the other bearings have the oil cups screwed in them, and are supplied by means of piping run from the reservoir. The supply of oil to all bearings is regulated by screw-down needle valves—seen on top of the oil reservoir. All the oil supply pipes are of 1/8 in. diameter solid drawn copper tube. A feature of the whole oiling arrangement is that the amount of oil going to the bearings can be seen and regulated accordingly, and a stoppage of any of the oil supplies can be observed at once.

BLOWER

The blower is made after the Sturtevant type, and is entirely built up. The casing is hammered out of sheet brass 1/16 in. thick, and is made in halves and bolted together by sixteen 1/32 in. bolts. The feet of the blower were cut out of sheet brass 5/32 in. thick, being suitably bent and shaped, and hard soldered to the casing. The fan is 2 1/2 in. diameter, and has six blades, slightly curved, mounted on a hub which is secured to a 5/16 in. diameter silver-steel shaft. Only one inlet is provided, and this is placed on the outer side of the blower. The fan runs at a speed of 4,000 revolutions per minute.

The foundation plate is an iron casting 7 3/4 in. long by 3 3/8 in. wide, and is secured to a polished mahogany base by six bolts. Facings are provided for the turbine, blower and gear-box, and below the latter is a waste oil chamber cast in the foundation plate.

The working of the model is most satisfactory, and with the method of continuous lubrication that I have employed it is possible to run the turbine at the high speed of 20,000 revolutions per minute, and to maintain this for hours without the slightest heating of the bearings, etc.; while there is practically no mess from waste oil running over the machine.—*Model Engineer.*

How a Magneto Makes Electricity

(Continued from page 226.)

result is noted; and if both its length and speed of vibration are increased, the value of the electric pressure induced is found to be doubly increased. These facts point to but one conclusion, namely that the induced current depends for its value upon the number of lines of force cut by the conductor in a given length of time. It is to be noted that the induction of current in the conductor circuit takes place just the same and is of the same value whether the conductor cuts the lines of force or the lines of force are made to cut the conductor, all that is necessary being the proper relative displacement of one with reference to the other.

The truth of the last statement is readily conceivable. In the case of two closed conductor circuits in juxtaposition, as in the common induction coil, a current flowing through one of them creates a magnetic field about itself, as in Fig. 7, and also about the conductor of the second circuit. If now the circuit carrying the current is broken, the magnetic field due to the current flow is removed and its vanishing lines of force cut the conductor of the second circuit and thereby induce an electric pressure within it. The vanishing lines of force also cut the conductor through which the current producing them was flowing before the break in the circuit, and also induce an electric pressure within it. The action in the first instance is termed mutual induction, and in the second instance is termed self-induction. Mutual and self-induction, as employed and found in practice will be taken up a little later.

The poet led his friend, the politician, to the top of New York's tallest tower, to admire the view. The man of politics seemed stunned for a moment by the beauty of the far-flung panorama. Then he spoke in a low, reverent voice: "Gee! what a lot of assembly districts you can see from here."—*Everybody's.*

THE HOME CRAFTSMAN

RALPH F. WINDOES

America is fast becoming a nation of home-lovers. Thousands of small homes have sprung up on the outskirts of our large cities. Homes built by their owners and planned by their owners. Each has a style about it that is individual, and each should have furnishings in it that are also individual. Few of us can afford to have our furniture made to order, but we all can make it ourselves during our spare moments. And we all know that hand-made furniture possesses an intrinsic value which machine-made articles never have. The craftsman leaves the imprint of his personality upon his handiwork. There is also the joy of creation, the pride in results, for when a man steps back and views the finished product of his own hands, a feeling of self-satisfaction comes over him which makes him feel capable of doing the work of two men. It is, in part, for this wonderful fellow that this department has been planned.

And then there is the business man we hope it will help, for he owes it to himself to have some occupation other than the business he happens to be engaged in, to keep up the circulation of his thoughts, or to maintain his proper balance in life. If he will devote but an hour each day to his home workshop, he will find that it will repay him in more ways than one.

Following the business man comes the invalid; some poor unfortunate, who, perhaps, has partially lost the use of his limbs, but whose hands are always aching for something to do. For him we will give some forms of handiwork that will not require the use of his limbs.

And then there is the boy who has reached the age where the use of the saw and hammer is his greatest desire. If he lives in the city where manual training is offered in the public schools, this desire is in part satisfied, but if not, he will have to resort to a course such as we will here offer.

We might go on for two or three pages with a list of those we desire to help, but you all know yourselves, and if you think this work would help you in the slightest degree, financially or otherwise, you owe it to yourself to take it up.

For the manual training teacher every design in the course will prove helpful, as they have all been tried out in a manual training school, or a home workshop.

The work covered will consist in furniture making, sheet metal work in copper and brass, wood and chip carving, pottery making, stencilling, block printing, leather work and other forms of handiwork practiced nowadays. It is not intended that these articles shall take the place of a course in design or craftsmanship such as is obtained in an art school, but we mean simply to give directions and drawings for things of beauty and usefulness which any one can make.

We have taken it for granted that the craftsman knows the use of the most common woodworking tools, but if he does not, he can easily acquaint himself with them by seeking the advice of a good book on tools, or the services of a carpenter or a cabinet maker.

The best location for a home workshop is upon the first or second floor in a secluded, well-lighted room. If such a location is impossible, a dry cellar makes a suitable substitute. But here the tools are more likely to rust, so it would be well to rub a little oil on the shiny parts occasionally.

There is much talk nowadays about the high cost of tools, but if a complete set is purchased all at one time, this cost will be much diminished. The following list will be those needed to carry on the work properly, and it is strongly advisable that the best grade be purchased, as good work cannot be done with poor tools.

WOODWORKING TOOLS

One 2 ft. brass bound rule.
One 8 in. marking gauge.
One spoke shave.
Three firmer chisels, 1/4, 1/2, 1 in.
Three firmer gouges, 1/4, 1/2, 1 in.
One 8 in. try square.
One 6 in. T bevel.
One 10 in. back saw.
One 22 in. hand saw, 10 points.
One 24 in. rip saw, 8 points.
One compass saw.
One bracket saw, 4 in. deep.
One doz. blades for bracket saw.
One iron smooth plane, 1 3/4 in. cutter.
One iron jack plane, 2 3/8 in. cutter.
One 10 in. draw shave.
One cabinet scraper.
One 12 oz. hammer.
One 10 in. ratchet brace.
Four auger bits, 1/4, 1/2, 3/4, 1 in.
Six gimlet bits, assorted.
One Forstner bit, 5/16 in.
One expansion bit, 7/8 to 3 in.
One screw driver bit.
One bit gauge.
One rose countersink.
One 10 in. screw driver.
One mallet.
Six hand screws, 12 in. open jaws.
Six hand screws, 8 in. open jaws.
One mounted oil stone, medium.
One oil can.
One half round cabinet file.
Two flat files, fine and medium.
Two three-cornered files.
One round file.
One file card.
One square-nose cutting pliers, 6 1/2 in.
One bench brush.
One pair dividers.
Two nail sets, small and medium.
One steel square.
One putty knife.

To these might be added a number of special tools from time to time, such as a universal plane, a router plane, an automatic boring tool, a chute board, etc., but they are more in the class of luxuries rather than necessities.

A miter box, furniture clamps and a bench hook will be needed. They may be purchased or made at home. Directions for making them will be given later in the series. There can be no satisfactory work done with dull tools: a grind stone will be necessary. One of the small stones which can be clamped onto the bench is recommended for home shop use.

METALWORKING TOOLS

In addition to the above, the following tools will be needed for the metal work.

One round nose pliers, 6 1/2 in.
One pair snips, 2 1/2 in. cut.
One 8 oz. ball pien hammer.
One hand vise.
One rick punch.
One chasing hammer.
One round end mallet.
One jeweller's saw frame, 4 in. deep.
One doz. extra blades for above.
One set chasing tools (6).
One hand drill.
One doz. assorted drills.
One rivet set.
One riveting hammer.

Other tools, consisting of numerous hammers, stakes, anvil heads, etc., may be added from time to time.

Lists of tools for the other crafts will be given out from time to time as the work advances. Materials needed for each problem will be listed with the problem, also methods of finishing.

A strong bench to work upon is of great importance, and a design for one is next shown. If the craftsman considers himself capable, he may put it together himself; but if he is beginning, it is advisable that he have it made by a carpenter or a cabinet maker.

A WORK BENCH

This bench is best constructed of maple with soft wood drawer linings. In the drawing two drawers are shown, but more may be added below them if the builder so desires. The 2 in. part of the top should be glued up from narrow strips set edgewise. The vise is of the rapid-acting, parallel-jaw type used extensively in cabinet works.

The lumber should be ordered as follows, cut to exact size and sanded:

1 piece 2 in. x 11 in. x 40 in. maple.
1 piece 1 in. x 2 in. x 40 in. maple.
1 piece 1 in. x 6 1/2 in. x 40 in. maple.
1 piece 2 in. x 3 in. x 23 in. maple.
2 pieces 2 in. x 3 in. x 18 in. maple.
2 pieces 2 in. x 2 in. x 17 in. maple.
4 pieces 2 in. x 2 in. x 25 in. maple.
2 pieces 7/8 in. x 5 in. x 23 in. maple.
4 pieces 7/8 in. x 2 in. x 23 in. maple.
4 pieces 7/8 in. x 2 in. x 12 1/8 in. maple.

A Work Bench

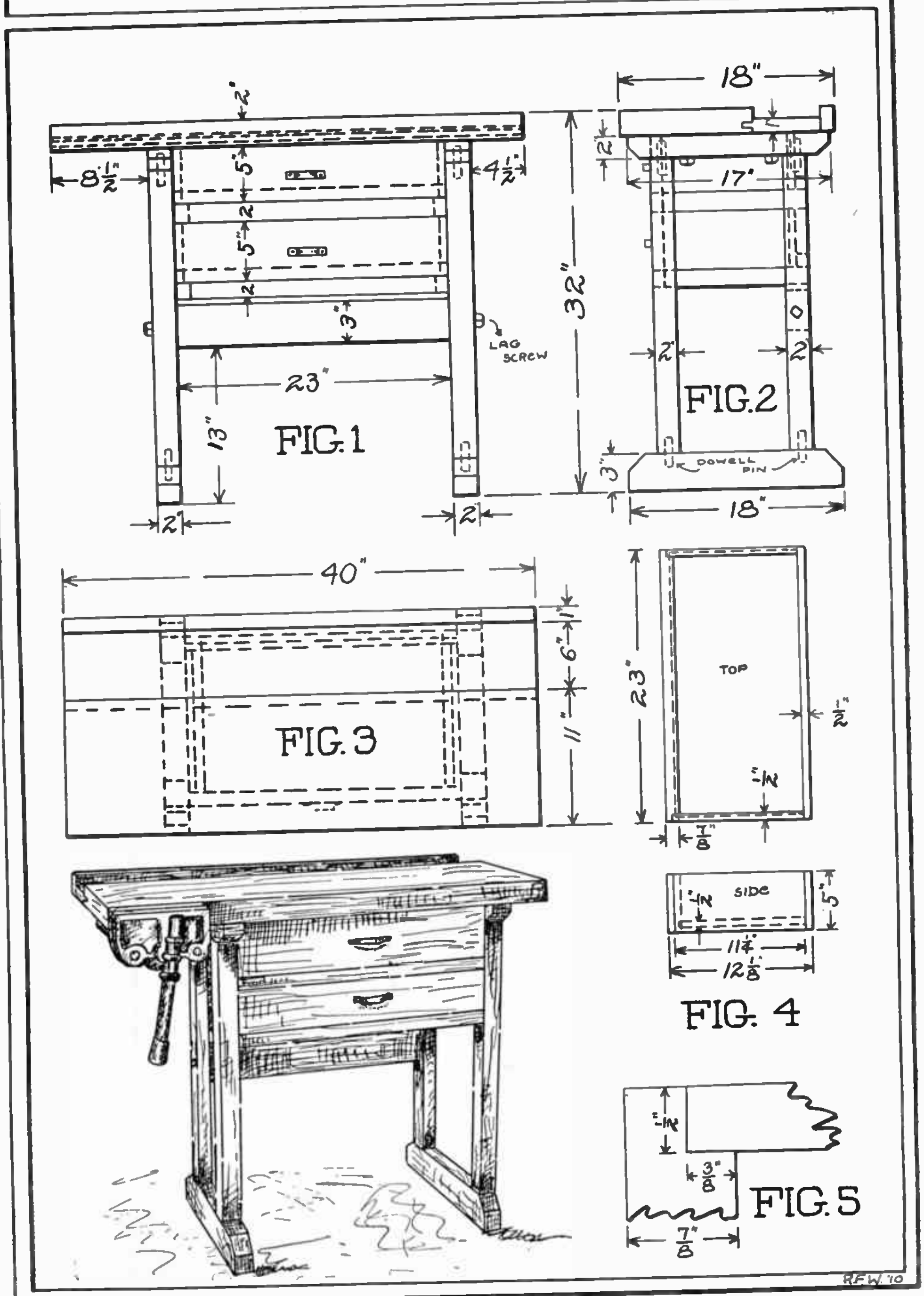


FIG. 1
LAG SCREW
23"
13"
32"
FIG. 2
18"
17"
DOWELL PIN
FIG. 3
40"
TOP
23"
SIDE
$11\frac{1}{4}$"
$12\frac{1}{8}$"
FIG. 4
FIG. 5
R.F.W. '10

2 pieces ½ in. x 5 in. x 23 in. pine.
4 pieces ½ in. x 5 in. x 11¼ in. pine.
4 pieces ½ in. x 5½ in. x 22½ in. pine.

In addition to the lumber will be needed:

2 ft. ¾ in. dowell rod.
2⅜ in. x 5 in. lag screws, with washers.
2⅜ in. x 4 in. lag screws, with washers.
2⅜ in. x 3 in. lag screws, with washers.
2 drawer pulls.
1 rapid action vise, 9 in. opening.
1 bench stop.
½ pt. liquid glue.
1 box 2 in. 10s flat head bright screws.
5 lbs. 2 in. finishing nails.
3 lbs. 1 in. finishing nails.

There will be considerable glue, nails and screws left over, but they may be used on subsequent work. If the craftsman prefers hot glue to the liquid form, he may use it, but the liquid glue is nearly as strong and it does away with all the muss and trouble of preparing the hot glue.

In the drawing of the work bench, Fig. 1 is the side elevation, Fig. 2 the end elevation, Fig. 3 the plan or top view, Fig. 4 a detail of a drawer and Fig. 5 an enlarged detail of one corner of a drawer.

Begin the work by assembling the top. The 1 x 6½ in. piece is fastened to the 2 in. piece by means of the tongue and groove joint. It would be well to have the joint fitted at the mill, as it would save much labor and look much better than if made by a beginner. The back piece is screwed into place, the screw heads being countersunk. Next fasten the cleats to the top with the smaller size of lag screws, using two washers under each head. Now dowel the legs to these top cleats and the floor pieces, and put in the back brace. Be very sure that your dimensions are the same as those given on the drawing for all of these steps. While the glue on the pins is drying, the vise can be put into position. Then you are ready to assemble the drawers. The bottom, composed of the 5½ in. pieces is rabbeted into the front and sides a little way up from the lower edges. The joint used to hold the front on to the sides is made according to the detail of Fig. 5, and is nailed into place. The runs for the drawers are made of the ⅞ x 2 in. stuff, as are also the pieces that prevent the drawers from sliding back too far. When all is complete, fit the bench stop in place a little above and to the right of the vise. If the vise has metal jaws when you receive it, it would be well to line the inside of them with pieces of maple, so as not to mar any soft wood held in them.

The finish on the bench should consist in a good coat of raw oil, and when dry by two coats of shellac. The shellac can be purchased ready for use, or you can buy it in the dry form and cut it yourself. It comes in two colors, white and orange. White shellac is recommended for the work in this series. To cut the dry form, the best method is to use an earthenware or glass dish with a tight cover. Fill the dish about half full of the powder and pour on enough wood alcohol to cover it. Stir it up occasionally and add more alcohol until it reaches the consistency of thick molasses. Thin it out with denatured alcohol and it is ready for use. Sand the wood down between each coat, as it raises the grain somewhat.

ADDRESSES

For the benefit of those living in a small town or in the country we will give the addresses of firms carrying wood and metal working tools. It would be well to make out a list of the tools you intend to purchase and send it to one or more of them asking for prices. If you cannot afford all of the tools on the given list, cut it down to those you think you will need the most, but above all get good tools.

Woodworking Tools:
Chandler & Barber, Boston, Mass.
The Hammacher, Schlemmer Co., New York.
The Chas. A. Strelinger Co., Detroit, Mich.
Orr & Lockett Hardware Co., Chicago.

Metal Working Tools:
The above, and
The Frost Arts and Crafts Workshop, Dayton, Ohio.

(To be continued)

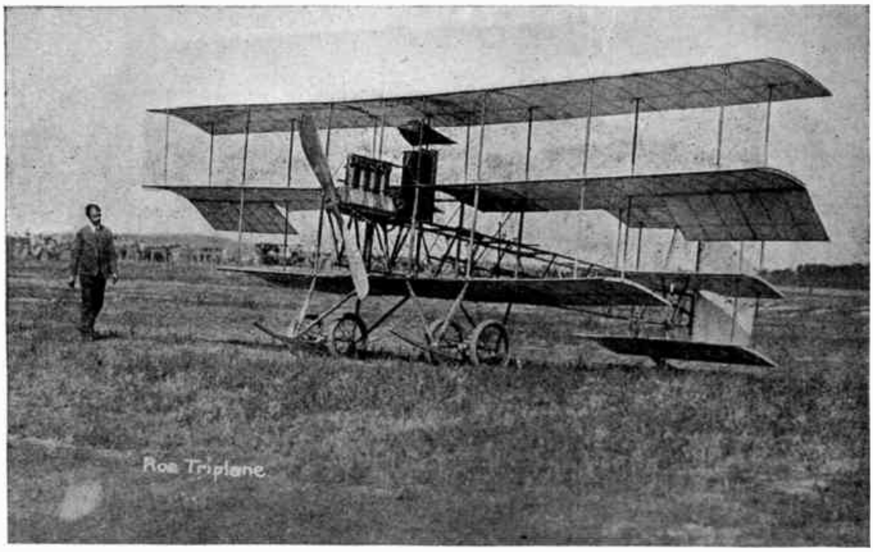
These be Fly Times, Sure

"Have you fly paper?" asked the lady.
And the clerk says, "Which will you choose—
The Daily Aeroplane Record, or *The Aviation News*?"

AUTOMATIC STABILITY IN AEROPLANES

While the aeroplane has developed in a great many ways with considerable rapidity, it is still entirely dependent on hand control for its stability, at all events when there is any wind, and a great deal of ingenuity is being expended in devices to make the stability automatic. The question therefore arises to what extent such automatic stability is practicable or desirable. The term "automatic stability" may be used in two senses. In the first place it may simply mean such a disposition of the planes that the machine has a tendency to fly in a horizontal position in still air, or, in the second, it may mean some device which will keep the machine horizontal in a wind and correct any deviations caused by puffs and eddies. The difference between these two principles can well be seen if we take the analogy of a boat. The first meaning of the term would simply be that it would have a general tendency to go straight, unless the rudder was altered; the latter, that the steering was taken entirely out of the steersman's hands, and that a straight course was kept by some means, such as a gyroscope, without the necessity of manual control.

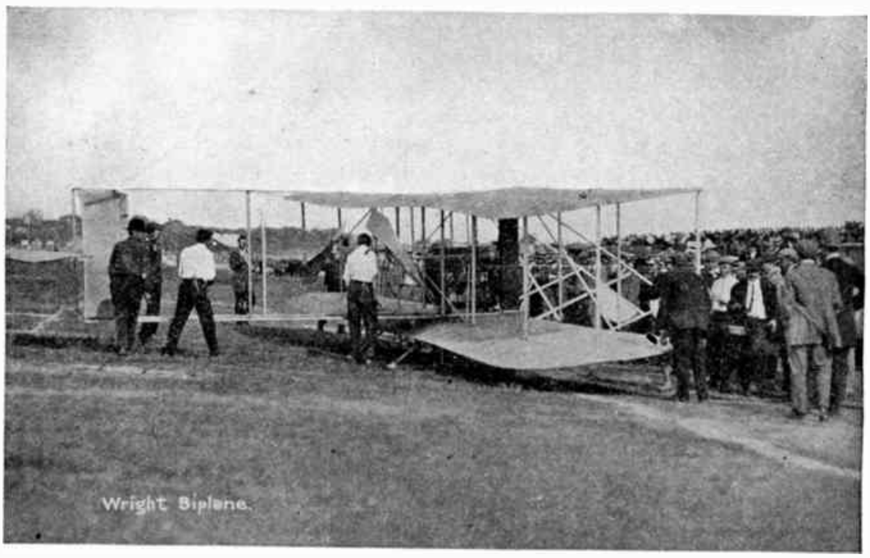
With regard to the first point there seems no doubt that the machine should have as great a tendency to fly in its correct position as is consistent with its being handled as required. In the early French machines the stability was entirely automatic, both laterally and longitudinally. If it was desired to go up, the engine had to be run faster; and if to descend, the engine was run slower or stopped. Lateral stability was provided for by vertical partitions between the planes. This system is unsatisfactory in many ways, one of the most obvious being that it prevents the full speed of the machine being used in horizontal flight. It also prevents the machine being tilted over for turning corners sharply. Further, it does not appear to provide satisfactorily for the correction of deflections due to the varying currents of air. Hence, purely automatic stability of this type has been completely abandoned in all recent flying machines.



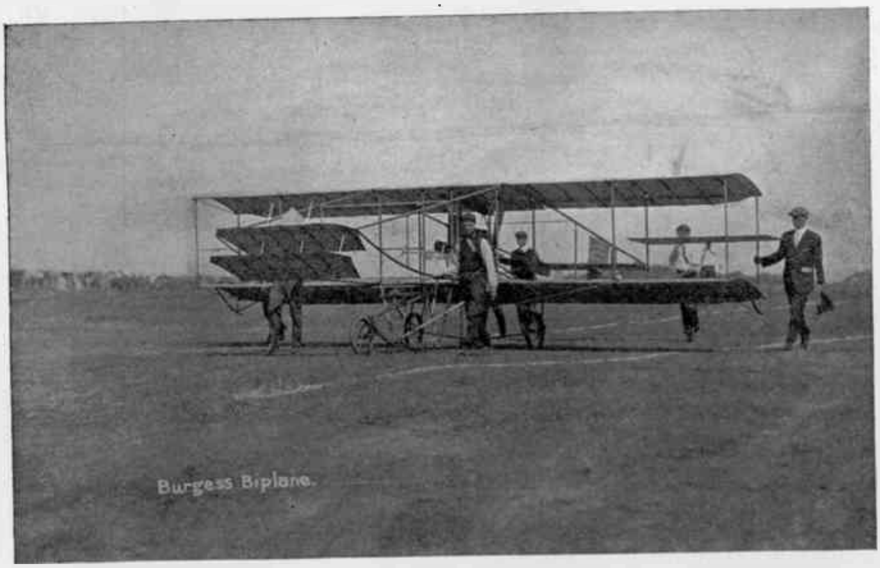
In the early American aeroplanes, on the other hand, we have the extreme of the hand control. As there was no tail at all, the longitudinal stability depended entirely on the hand-control, and there was no real tendency for the machine to fly horizontally if the control lever was released. The result of this difference from the French machines was very evident when the Wrights first came over to Europe, for they could manoeuvre in the air in a way that the French had never dreamed of. At the same time the extent to which the stability was dependent on the hand-control appeared to be overdone, as it made the machine more difficult to fly than was necessary.

The large majority of the recent flying machines, therefore, have some kind of a tail, with a fixed surface, supplemented by a hand-controlled elevator. If the fixed part is of suitable size, there will then be a speed at which the machine will fly horizontally, even if the lever-controlled elevator is released, and the latter need therefore only be used for altering the elevation independent of the speed, and for correcting the disturbance caused by puffs. The lateral stability of all recent machines is hand-controlled, as in the early American ones.

It is theoretically possible to replace the hand-control in this type of machine by an automatic one controlled by a gyroscope or some similar device. This system has been much advocated in some quarters, and a good deal of ingenuity has been expended on its development. It seems very doubtful, however, whether it would be satisfactory even if a perfect arrangement for it could be designed. The theoretical advantage would be that the fallibility of the human factor would be eliminated, and the machine would fly at its proper level under all circumstances. Those who advocate automatic control point out that the results are disastrous if the pilot loses his head or makes a mistake in a hand-controlled machine. If, however, the control was absolutely automatic, it is not clear how the machine could be properly handled. In starting, for instance, the machine must elevate rapidly, afterward assuming a more horizontal position for flight. Again, should the engine stop, the machine must be depressed at the head in order to make a "vol plane" or it will stop and all control will be lost. In this case the machine would be almost certain to fall. In puffy winds the purely automatic control would probably also be a source of danger, as it would prevent the machine being humored in accordance with the puffs. What is true of the longitudinal stability is also true of the lateral stability.

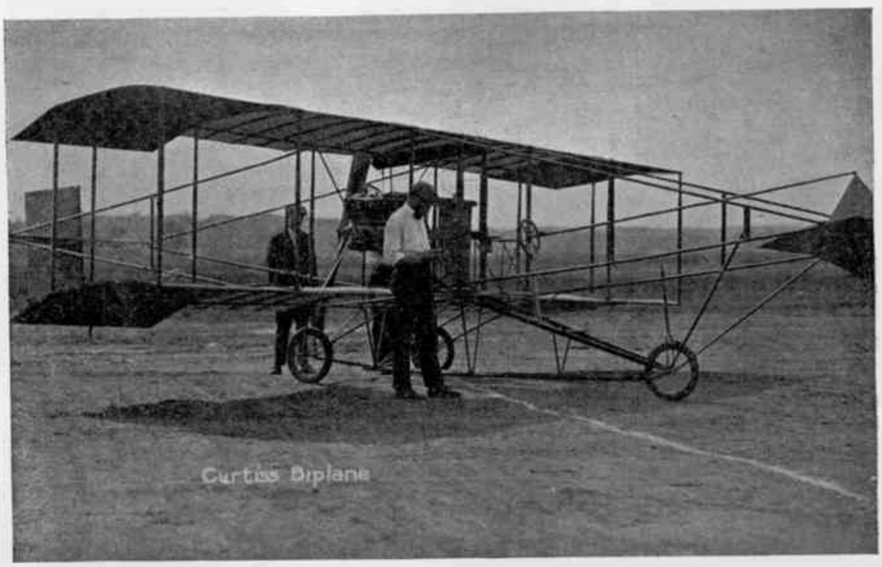

Wright Biplane.

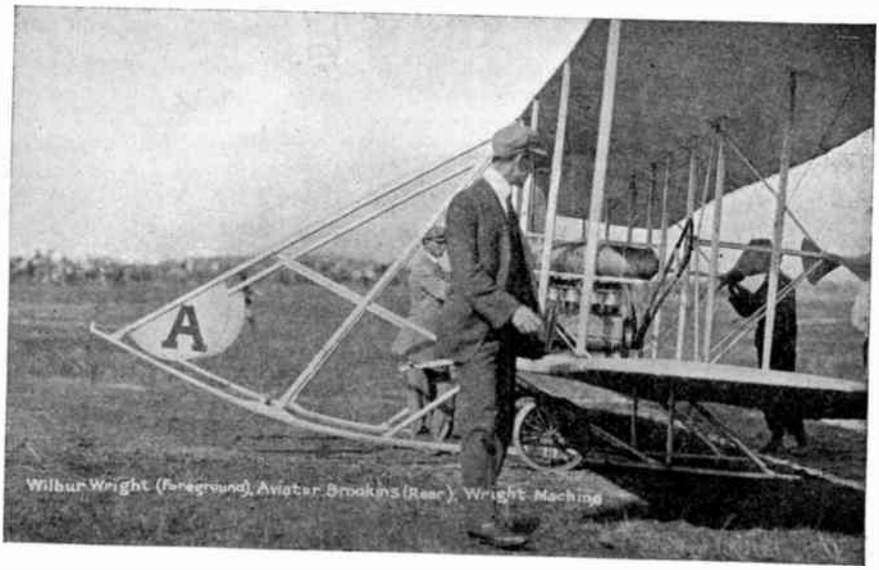
Of course, a system of automatic control might be devised which, again, was inter-connected with a hand control, so that it might be modified to suit circumstances; but in this case it appears probable that the disadvantages of both the hand and automatic control would be retained. There would be all the complication of an automatic control, while there would be as great a liability for the pilot to make a wrong movement as if the automatic part was not there.



In considering the question of automatic stability, when maintained by any mechanical contrivance, it must always be remembered that there is the possibility of its going wrong, and in many cases the probability of this is at least as great as the probability of the human being failing. How far this would be the case in automatic control it is impossible to tell, but the apparatus would probably be complicated and delicate, while it is necessary that the weight should be cut as fine as possible, and it must work under all conditions of weather without having any attention whatever en route. It is possible that a control absolutely reliable under these circumstances might be made, but it is quite certain that there are many elements of failure present, and failure would be disastrous.

In fact there is a great deal of truth in the old saying that "the best automatic machine is a well trained man." This may not, of course, be universally true, and there are undoubtedly cases where really automatic devices work well; for example, the ordinary safety





Wilbur Wright (Foreground), Aviator Brookins (Rear), Wright Machine

valve. There are, however, a very large number of cases where it is found best to rely on the man in control, and it is not found that in practice this entails any serious risk. The fact that a serious accident would occur if a man did not do the right thing is no reason in itself why he should not do the right thing. Signal men, engine drivers, motor car drivers and a very large number of other men are all in positions where a false move would cause a bad accident, but there is no reason why they should make false moves, and they very seldom do. Similarly, at sea, the whole safety of a ship and all on board is entirely dependent on the action of those in charge. In the case of a small boat, such as a fishing boat, sailing in a heavy sea, a mistake on the part of the helmsman may cause the death of all on board; yet no one feels nervous, for they know that there is no reason why he should make a mistake.

It seems therefore probable that in the future the navigation of the air will follow the practice of the navigation of the sea, and that the guidance will not be automatic but hand-controlled. Not only will this in all probability give greater stability under all ordinary conditions than is likely to be attained by any automatic device, but it will give far more power of meeting unusual conditions. The aeroplane, like the boat, is subject to waves and puffs, and in order to get the best results there must be a power of meeting the disturbances caused by them. Anyone who has seen a skilled man steering a small boat in a heavy sea will realize that there is no possibility of making any automatic device which would take his place, and that any attempt to make the steering automatic by such means as a gyroscope would mean the certain swamping of the boat in a sea through which she could be steered quite safely by hand. A corresponding result will probably also be obtained with the aeroplane.

—*London Engineering*.

Jimmy saw a mosquito on the wall one day that had evidently had a full meal off some one, as it was quite red with blood; and he called out: "Oh, Mother, look! Here's a mosquito, and he's ripe!—*Everybody's*.

It was at a colored camp-meeting in a southern town, and a colored evangelist was exhorting his hearers to flee from the wrath to come. "I warn yo'," he thundered, "that, in the language of the Scriptures, there will be 'weeping and wailing and gnashing of teeth.'"

At this point an old colored woman in the back of the tent stood up: "Brother, I have no teeth."

"Sister," returned the evangelist, severely, "teeth will be provided."

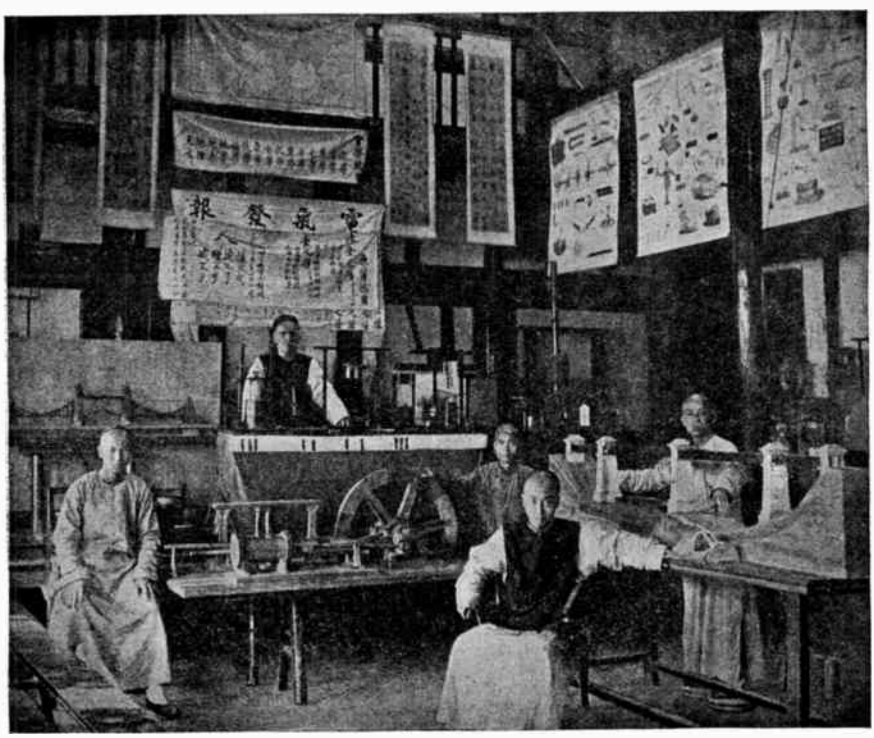
—*Everybody's*.

ELECTRICAL INSTRUCTION IN CHINA

At the meeting of the London Society of Model Engineers, on February 1st, Dr. William Wilson, of the China Inland Mission, gave a most interesting lecture on his experience in teaching native students in China the construction and working of electrical and other scientific apparatus. In his opening remarks, Dr. Wilson referred to the remarkable progress which China is now making in the adoption of western methods and ideas. The few hundreds of miles of railway, which sufficed till quite recently, have now grown to several thousands of miles; the telegraph system, which formerly existed only in the Treaty Ports, is now being extended all over the country; while the postal transmission of letters, which used to be carried on by native coolies at infrequent intervals, is now done in a wonderfully prompt and systematic manner. Even postal orders are in regular use, and the three thousand post offices now in existence are being added to at the rate of about one per day.

This modernizing progress has extended even to the conduct of examinations. Formerly, the examination hall at the capital of the Province in which Dr. Wilson was located, consisted of some 20,000 separate cells, this number of students being examined at one time, and each student being confined in his own cell for three days, the period for which the examination lasted. Now this has been all done away with, and the students are examined by the methods which prevail in the western world.

Dr. Wilson said that for a long time he found it was very difficult to get into sympathetic touch with the educated native classes. They were all students of Confucius, and having mastered the writings of that historic sage, they considered that there was nothing more which the "foreigner" could teach them. This self-sufficient feeling made them very difficult of approach, until at last Dr. Wilson hit upon the happy idea of trying to interest them in the wonders of electrical and



Dr. Wilson in his Science Lecture Hall

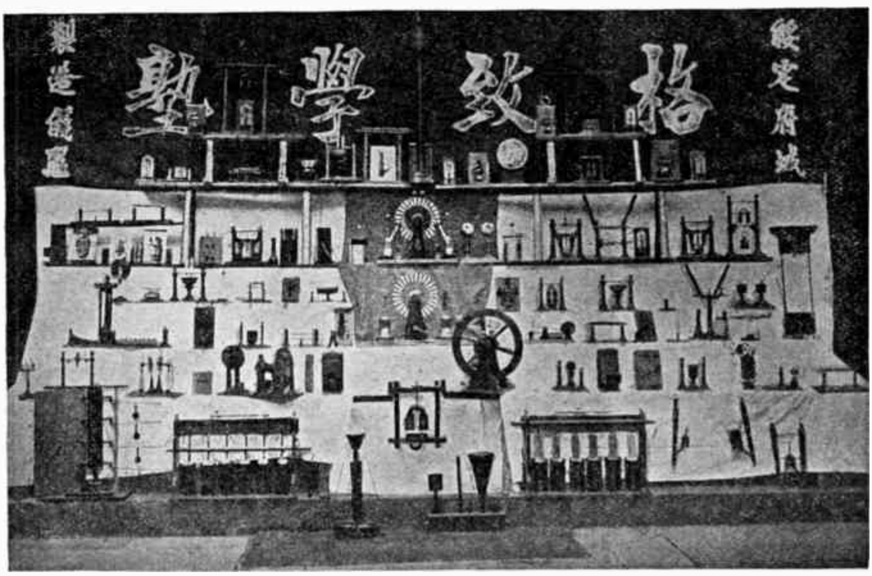
physical science. Having some spare space in the hospital attached to the mission, he arranged a show of scientific apparatus, which he invited students of the surrounding district to come and inspect. They came, and saw, and wondered, and so keenly was their interest aroused in the strange things demonstrated before them, that they begged Dr. Wilson to give a regular course of lectures. He replied that if they would guarantee the regular attendance of a selected set of students, he would see what he could do. The promise was at once forthcoming, and a preliminary course was arranged and commenced. So that the lectures might be given under proper conditions, a special lecture hall was built, measuring 50 x 30 ft., with a gallery all round, and the services of a joiner, a blacksmith and a tinsmith were engaged. These craftsmen were employed in making parts for the various pieces of apparatus which the students were to complete. A difficulty soon arose from the fact that no insulated wire could be obtained, although bright copper wire was to be had from Chong Ching, a mere trifle of eight days' journey away. Dr .Wilson accordingly devised a wire-covering apparatus, and made the students cover their own wire. After a time the students were relieved from this part of their work, and a discharged hospital patient was taught the process. He, having acquired the necessary skill, was regularly engaged on piece-work, under which arrangement the cost of covering worked out at about 1d. per 100 ft. Altogether, some 10 miles of wire have been covered. The compass needles, and the needles for the telegraph instruments were also obtained from Chong Ching, being made from the springs from broken clocks. So great was the demand for these springs that the inhabitants of Chong Ching mildly remonstrated, and pointed out that their clocks were not getting broken fast enough to keep pace with Dr. Wilson's requirements.

The first batch of students were twenty-six in number, and many of them were men who had taken their college degrees. One hour per day was occupied by a lecture, and the rest of the time was devoted to the making of apparatus. The work was arranged so that the students were all engaged on the same piece of apparatus on the same day, each student making his own complete instrument, which, when finished and tested, would be signed by the student with his name, and then placed in the stores. The course lasted one month, during which time each student was expected to make twenty different pieces of apparatus. Thus over 500 individual instruments would be completed during the month by the class. At the end of the course each student would receive from the stores the various pieces of apparatus he had made, and having carefully packed them up, would engage a coolie to carry them home for him, the journey in most instances meaning several days' march.

The number of students increased so much as the interesting nature of the studies became more generally known, that the stock of parts for the apparatus had to be prepared 100 sets at a time, no less than six joiners being engaged on piece-work on their preparation.. These parts were made during the intervals between the courses and put into stock, so that when the students arrived, everything was ready for giving out to them. The number of pieces of apparatus being subsequently increased to twenty-three, and 100 sets for each instrument being put in hand at once, there were no less than 2,300 sets of parts in stock in the stores at the commencement of each course.

Dr. Wilson showed a number of photographs of apparatus made by the students, and these included Wimshurst machines, induction coils, telegraph instruments, wireless telegraphy apparatus, batteries, telephones, microphones, galvanometers, electro-magnets, electric motors, etc. Amongst the various pieces of lecture apparatus was a wooden model of a horizontal steam engine, with the cylinder made to take apart to show the working of the piston and valve. This was made under Dr. Wilson's instruction by a native joiner, who had not the remotest idea of what it was he was making.. Another instructive model was that of the tubular bridge over the Menai Straits, shown side by side with a model to the sale scale of a Chinese bridge of 80 ft. span, which, locally, was considered a fine piece of work. The native bridge is, of course, quite dwarfed by the immense tubular bridge. The latter is used also to explain the use of hydraulic power in lifting the enormous iron spans into place, and another model shows the use of air-locks in the construction of foundations. In the lecture-room are a number of wall diagrams explaining various details of construction of scientific apparatus, and also a cardboard model of the Tower Bridge.

A particularly interesting photograph was that of a group of apparatus made by one of Dr. Wilson's best students. This young man arrived at the mission station at a time when there was no course in progress, and was told he would have to wait three months for the next course. He did not mind this at all, but quietly settled down and commenced to study from books. When the first course arrived and had been duly completed, he decided to wait for another course, in spite of being told that the same ground would be covered again. He said he thought he would understand it better if he did it all again. The second course completed, he decided to stay for yet another, and again went through the regular routine. In the intervals he made some extra pieces of apparatus, such as a Bramah press, force and suction pumps, and other physical apparatus. On returning to his native city he was appointed by the Chief Mandarin to give a lecture in an old temple, and this dignitary was so pleased with the student's work that he presented him with a top hat and dress boots—the highest compliment he could pay.



Some Apparatus Made by Dr. Wilson's Students

A short time before Dr. Wilson returned to England on furlough, an exhibition was held at the capital of the Province, which is a city of some 400,000 inhabitants. The Mandarin in Dr. Wilson's locality was informed by his superior in office that the exhibits from his district had in previous years not been at all satisfactory, and he was told that on this occasion something special would be looked for. The Mandarin, knowing of Dr. Wilson's work, consulted him, and suggested that he should show some of his own and his students' apparatus. Dr. Wilson consented, and six coolies were dispatched to the capital, a ten days' journey, with two complete sets of apparatus—one specially got up for exhibition purposes, and the other representing the ordinary work of the students. The exhibition was held in an enormous temple, and in a suitable building the electrical exhibits were arranged, one half of them being shown at work. By special ar-

Native Students at Work

rangement with the educational authorities, numerous parties of students from the various schools and colleges visited this section of the exhibition, and were immensely interested, not only in the instruments themselves, but in the lectures and demonstrations which Dr. Wilson and his students gave.

The enthusiasm which has thus far been aroused in the better-class native for this science study has decided Dr. Wilson to settle in the capital on his return to China, and to continue his work amid the more populous surroundings. He hopes by this means to be able to exert a beneficial influence, which it would be impossible to do in any other way.

The scene of these really remarkable educational doings is 1,500 miles from the coast, near the borders of Thibet. To arrive there Dr. Wilson has to go from Shanghai 600 miles up the Yangtse River to Hankow, thence by smaller steamer up to I. Chang, and a further two weeks' sail by junk up to Wan-Hsien. The river is then quitted and a five-day overland journey made to Sui-Ting-Fu. When one considers that if electrical apparatus were ordered from England, it would have to be transhipped several times, to be handled in the roughest of ways by ignorant natives, and that, finally, after its journey of several months, it would probably arrive mostly broken in pieces, one realizes the wisdom of Dr. Wilson in making his apparatus on the spot. But in realizing this, one cannot help but admire the remarkable resourcefulness and ability which has enabled him to do it in the face of what to most people would be insuperable difficulties. Needless to add, Dr. Wilson's lecture was listened to with the deepest interest, and his modest but fascinating account of his experiences evoked the greatest admiration and enthusiasm amongst the members of the Society of Model Engineers.—*Model Engineer*.

The South Sea Finger-Bowl

Civilized man did not invent the finger-bowl either in form or in use. It was used in the South Sea Islands some hundreds of years before Europeans and Americans found out that they were necessary to their own refinement. A bowl of water is handed round to every diner in a South Sea house.

This South Sea finger-bowl is half a cocoanut-shell, beautiful, useful, practically unbreakable, yet not of sufficient worth to prevent its being thrown away tomorrow and replaced by a fresh one from the nearest palm.

LATHE WORK: OVERHEAD FOR MILLING ATTACHMENTS—Part III

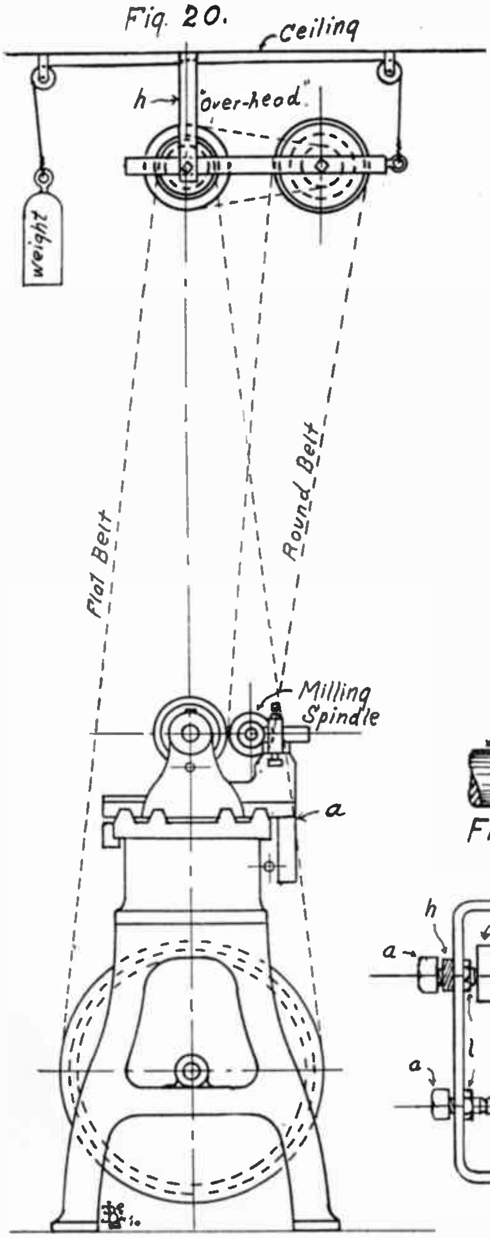
"SIGMA"

As stated in my last article, I will take up the matter of suitable apparatus for driving the milling spindle. Owing to the longitudinal movement of the milling attachment, provision must be made to permit the driving pulley to move lengthwise along its shaft, and this is usually done by splining the shaft and fitting a feather key its entire length. A key seat is cut in the hub of the pulley, thus permitting it to slide freely along its shaft, but at the same time revolving with it. However, one of the best overheads yet devised—and it has the merit of being very easily and cheaply constructed—is shown "belted-up" in Fig. 20 and in detail in Fig. 21.

This type differs from the one just described in that the pulley is replaced by a long wooden drum and over which the belt is free to travel longitudinally. As the tool is moved in a traverse or vertical direction the tension of the belt would be continually interfered with, so some arrangement to automatically keep the tension uniform must be provided.

By referring to Fig. 21 it will be seen that the wooded drum is not driven directly by the lathe foot wheel or other source of power, but an intermediate shaft and pulleys is provided. This intermediate shaft is hung from the ceiling or other support, and the drum is arranged so as to swing around it as a

Fig. 20.



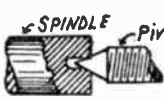


Fig. 21a.

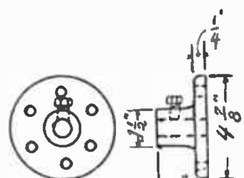


Fig. 22.

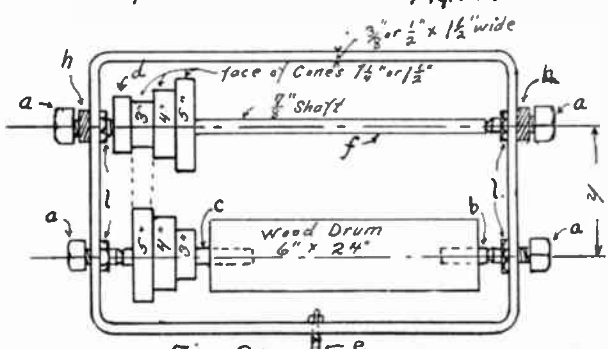


Fig. 21

centre. Thus, while the distance between these two shafts is the same in any position of the drum, a very satisfactory and efficient method of securing a uniform tension of the driving belt is easily obtained by swinging the drum upward.

The drum and intermediate shaft *f* is carried in an iron frame as shown in Fig. 22, and which can be made by any blacksmith. Pivot bearings are used instead of the usual type, as they are easier to make and run with very little friction. The pivot screws *a,a,a,a*, are ordinary "cone" end set screws, and the included angle of the point is usually 82 degrees, though some makes are of 60-degree angle. When the frame is received from the blacksmith it should be as near square as possible, and when laid on a flat surface all four corners should bear on it equally, and if found to be all right the holes for the pivot screws can be laid out, drilled and tapped. Lock-nuts *l* are used to prevent the pivots from turning after they are properly adjusted.

The hanger *h* supports the whole arrangement, and it is merely a piece of 3/8 x 1 1/2 in. iron bent U-shaped, and the two ends drilled so as to let the pivot screws pass through nicely, and thus when the hanger is attached to the ceiling, with the frame in place, the frame and the drum can freely swing about the shaft *f*. The cone pulleys can be "built-up" of single iron pulleys, or they can be turned out of hard wood, in which case a simple pattern should be made from which two castings are obtained similar to Fig. 22. These flanges are drilled out and the boss tapped for a set screw so they can be secured to the shafts, and the flanges are drilled with six small holes so they can be attached to the largest cone pulley with wood screws, the other two pulleys being glued and screwed to each other and to the large pulley. An alternate method is to use square shafts and all pulleys made with a square hole and a drive fit on the shafts, glue being applied to the holes before driving them on.

The shaft need not go clear through the drum, but short shafts can be driven into holes bored in each end of the drum about 6 in. deep; and, while not shown in the drawing, collars might well be applied at each end of the drum so as to prevent any possibility of the shafts working into it and letting it drop out of the frame.

A detail of the shaft ends is shown in Fig. 21a, and it will be seen that the shaft is centre-drilled and reamed much the same as is done on work that is to be turned in the lathe, a small drill being run in first far enough to give plenty of clearance for the end of the pivots. The distance *y* need not be over 14 in. and should hardly be less than 12 in. An eye-bolt *e* is attached as shown, and the cord or light chain to which the tension weight is fastened is secured to it. A couple of ordinary screw pulleys are attached to the ceiling as shown in Fig. 20, and the chain is passed over these. After the overhead has been completed and fastened in place to the ceiling, move the lathe in such a position that the belt from the foot wheel to the overhead will just clear the lathe at *a*, Fig. 20.

If the frame has been made of too light iron, or for any other reason there is a tendency to spread apart end-wise when in use, 3/8 in. holes can be drilled midway between the pivot screws and a 3/8 in. rod passed through with a nut on either end, by which means the frame can be pulled together and prevent any future trouble from this cause.

The Erratic Popular Taste

"Young man," said the woman at the ticket office, "why don't you answer me when I ask you whether this is a moral and proper show?"

"Because," answered the theatre treasurer frankly, "I'm not a good enough judge of human nature to know which way to answer without losing a customer."—*Washington Star.*

"You are charged with carrying a razor," said the magistrate; "what have you to say?"

"But hit's a safety razor," pleaded Rastus.

"What difference does that make?" the court asked.

"Well, Yo' Hono', a safety razor am carried only fo' de moral effect."

—*Everybody's.*

OXY-ACETYLENE WELDINGS AND THE GENERATION OF OXYGEN GAS

F. A. SAYLOR

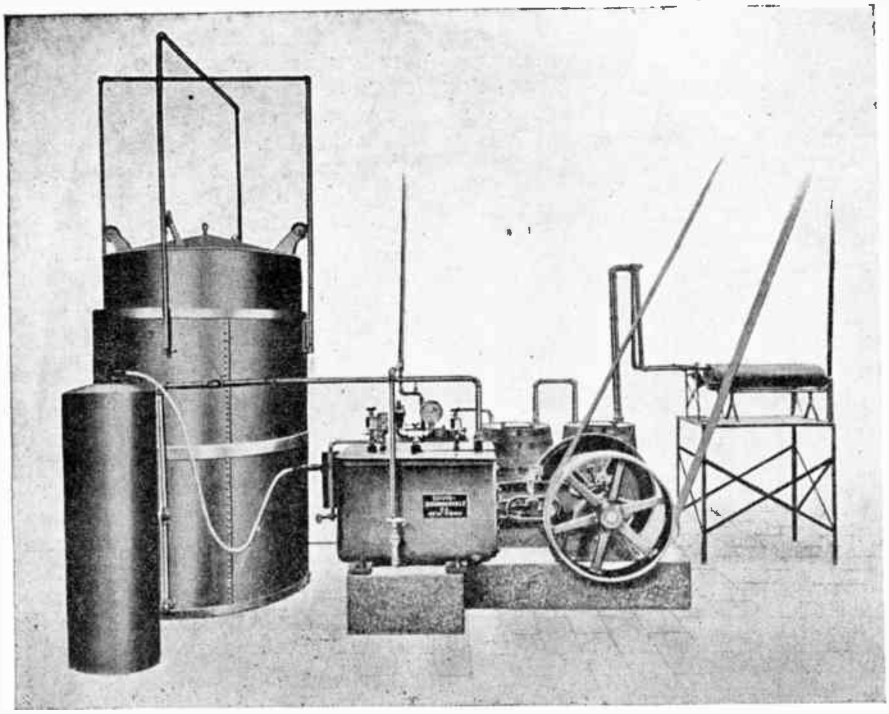


Fig. 1 Externally heated oxygen plant with compressor

In the oxy-acetylene process of welding, two gases are used: oxygen and acetylene. The acetylene is made by immersion of carbide of calcium in water and the generating apparatus is very simple.

Its use is so wide-spread that almost everyone is acquainted with the process of manufacture, but as oxygen is not generally used for domestic or industrial purposes, the method of manufacture is not so well understood.

The blow torch uses a mixture of the two gases in the proportion of 1 part acetylene to 1¼ parts oxygen, and as the cost of oxygen is over double that of acetylene, the question of a cheap source of supply is vital to the user of the autogenous welding plant.

Hundreds of repair shops have sprung up all over the country since the advent of this process, and more are being equipped every day. The garage and automobile repairsmen are especially interested as well as machine shops and general blacksmiths, and the process is particularly adapted for their use.

Among the proprietory chemicals are oxyvite, oxygenite, lavossite, epurite (oxone), etc., all of which are or have been more or less used by owners of welding apparatus. Most of these are ordinary chemicals or chemical mixtures, which have been given titles by their exploiters so that clients will purchase from them alone.

Some of these processes claim a very low cost of production, but as a rule when this is true the apparatus is high-priced. A combination sometimes used for production of oxygen is copper sulphate, iron sulphate and bleach powder. A steel tank containing an agitator, to stir the mixture, is used as a generating chamber. This tank has a hand hole in the top through which to introduce the bleach powder. The bleach powder (chlorinated line) is put in first, then the hand hole is closed. Water is then admitted and afterwards a solution of iron and copper sulphate is allowed to flow in at the bottom. As soon as the iron and copper sulphate reach the solution of bleach powder and water, oxygen is liberated. The agitator should be kept moving constantly during the process of generation.

As soon as generation starts the gas is carried off to a cleaning tank, where it is passed through clean water, and then a caustic solution to remove the chlorine; it is then gathered in a gasometer and compressed into a tank.

A plant of this character can easily be made, but it is rather cumbersome.

The chemicals most largely used for the purpose of oxygen generation by welders are potassium chlorate and manganese dioxide. These can be purchased almost anywhere, and the cost is low. A number of different plants are on the market, ranging in price from a couple of hundred dollars upward to a thousand, but in all of them the principle is the same though the method of application may be different. They all work on the basis of the decomposition of potassium chlorate under heat into free oxygen and potassium chloride. Manganese dioxide is added to the potassium chlorate in the proportion of 1 part of the black oxide of manganese to 8 parts of potassium chlorate. The manganese is added to prevent too rapid generation, also to make the mass more permeable to the heat. Heat is applied either internally or externally.

In the internally heated type of plant the mixture of potassium chlorate and manganese dioxide are placed in a heavy retort of steel or wrought iron, and a cartridge of carbon placed in the centre. A small quantity of ignition powder is placed on top the cartridge and fired. The cap is then closed, and the oxygen generated by the heat sustains combustion of the cartridge. The excess of oxygen not used for combustion passes out of the retort through one or more cleaning devices into a storage tank, where it compresses to an amount determined by the size of the tank and amount of the charge.

Fig. 1 shows an externally heated plant using pump to compress the gas.

With this plant the mixture of potassium chlorate and manganese dioxide is placed in a pan and the pan inserted in a light sheet steel retort. The retort is then sealed, and heat applied externally by means of a gas jet. The gas passes from the retort into three wash barrels, the first and last of which contain pure water, and the second a solution of caustic soda. After passing alternately through the barrels it flows into a gasometer from which it is drawn by a pump and compressed into tanks at about 300 lbs. per sq. in. pressure. The pump must be especially designed for oxygen, and is usually two-stage, first cylinder compressing to 150 lbs., and the second taking from the first to 300 lbs. The cylinders are submerged in water, the linings are composition metal and lubrication is by means of a soapy solution.

Oil must never be used as a lubricant in the presence of oxygen, as, being carbonacious, it forms a highly explosive mixture.

Fig. 2 shows an externally heated plant not requiring compressor.

This is probably the simplest and safest type of plant manufactured, as no compressor is required, yet tanks can be filled to the same pressure as with a pump, and both portable tanks and stationary receiver can be filled at the same time.

This plant consists of but three parts, viz.: furnace and retort, scrubber and receiver.

The furnace is a sheet steel or iron case lined with asbestos board with perforated bottom and hinged door. If coal, coke or wood are to be used as fuel, the perforated bottom can be omitted, and light grate bars of cast-iron used.

Through this furnace, close to the top, is passed a heavy retort, 5 or 6 in. in diameter, of wrought iron or steel. One end of this retort is closed by a heavy threaded cap or a flanged connection can be used with blind end. The other end is closed by a ½ in. plate welded or brazed in. This end is pierced for ½ in. extra heavy pipe line, in which are placed in the order named a safety valve, gauge, union and asbestos packed iron cock.

The scrubber consists of a 5 in. extra heavy tube, the lower end of which is seated in a cast base, and the upper provided with flange and bolted cover. Half way in the scrubber a nipple is inserted and to this is attached a pipe extending to the bottom of the tube. A

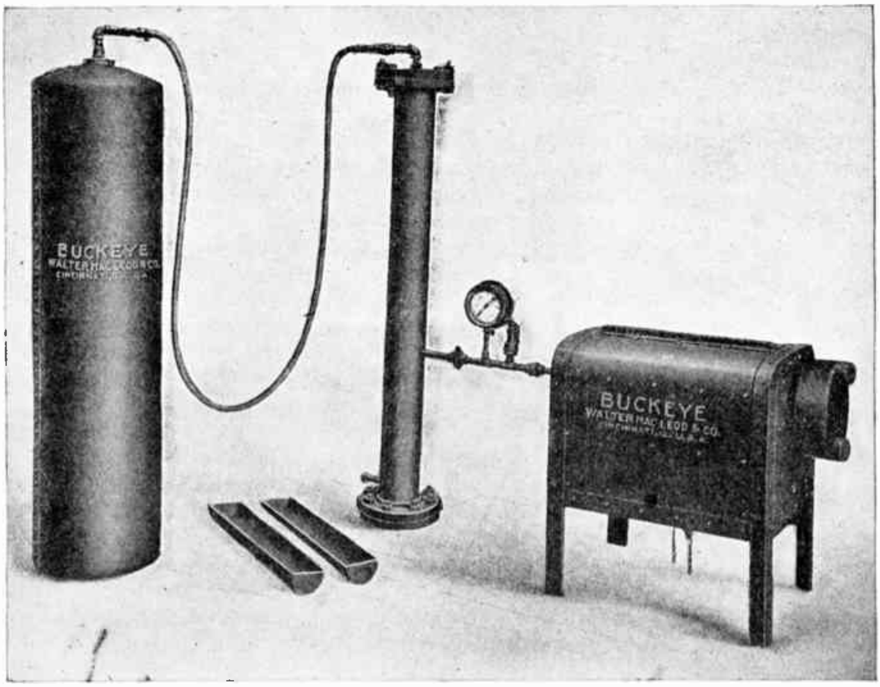


Fig. 2. Externally heated oxygen plant not using compression

filter is inserted in the top, and alternate layers of some filtering substance and a chemical for cleaning the oxygen are placed in the case. From this scrubber a pipe is connected to the receiver.

If the plant is of the so-called portable type, acetylene is purchased in cylinders, but in larger plants the generator is almost invariably used.

It is impossible to compress acetylene in cylinders by itself, as it is highly explosive when compressed to 30 lbs. or above.

It was discovered several years ago that acetone—a wood distillate—had the peculiar property of absorbing twenty-five times its volume of acetylene for each atmospheric pressure to which it was raised. This is taken advantage of by the manufacturers in order to safely compress the gas into portable form.

Cylinders of steel are filled with asbestos discs until completely filled. Acetone is then introduced until the discs are filled to saturation. Acetylene is then compressed into the cylinders until a pressure of 150 lbs. is registered.

A cylinder 10 x 30 in. will hold 125 cu. ft. of gas compressed to 150 lbs., and a cylinder 12 x 36 in. will hold 225 cu. ft., weight of the filled tanks being about 90 lbs. and 160 lbs. respectively. These tanks are provided with suitable valve and key, and in the bottom of the cylinder is inserted a fusible plug. A reducing valve supplied with the plant is attached to the outlet on the tank so that the tank pressure of 150 lbs. can be cut down to the necessary blow-pipe pressure, which ranges from 1 or 2 lbs. with the small size tips, to 10 or 12 lbs. with the large size nozzles.

The larger-sized plants use acetylene generators of the pressure type, and the gas is piped to the work bench, where it is reduced in the same manner as with the tanks.

The oxygen supply for the portable plants is contained in tanks somewhat larger than the acetylene cylinders, but as oxygen is not an inflammable gas, and is inert unless mixed with some foreign substance or gas, it is not necessary to have an absorbing medium in which to compress it. It is compressed directly into steel cylinders at pressures ranging from 250 to 1,800 lbs. per sq. in., dependent upon the method of manufacture.

It is usual to compress 100 cu. ft. in

a cylinder, and at the lower pressure, the cylinders measure about 16 x 54 in., and weigh about 180 lbs., while the high pressure cylinders weigh about 132 lbs. and measure considerably less.

The oxygen is reduced in pressure in the same manner as the acetylene, and both gases are conducted to the blow-torch by rubber hose, and unite in the mixing chamber of the nozzle. This means that the two gases are kept separate until very close to the point of ignition, and the mixing chamber is reduced to the smallest possible dimensions. This is a wise provision, as the mixture is highly explosive.

All blow-torches are provided with devices to prevent the flame from traveling back to the source of acetylene supply and thus causing an explosion.

The oxygen being at a very much higher pressure than the acetylene (from two to three times higher) in event of the nozzle being stopped up by a bit of hot metal, dirt or otherwise, would back up into the acetylene pipe and when ignited a heavy explosion would take place, probably doing considerable damage to the operator. Flash backs frequently occur in almost every style of torch, but the mixing chamber being small no damage is done.

The flash back protector is either a back pressure valve, wire screen, scored cylinder or a chamber packed with porous earth, mineral wool, or a number of very small tubes. All of these are effective, some better than others.

Torches vary greatly in design, but all follow along the same lines in their principle of operation. The variation is in the mechanical details and each manufacturer exploits his own ideas as to what is desirable or non-desirable in a torch, but all strive for the all-important feature of a mixture of gases that will give a neutral flame.

OXYGEN

Oxygen is widely distributed, and enters into every form of animal and vegetable life and is combined with many of the elements. It can be extracted from many substances, but for commercial use these are at present confined to but very few.

The manufacturers who depend upon the sale in large quantities use the electrolytic, barium oxide or liquid air processes, but all of these require a large primary investment, and are intended only for manufacture on a very large scale.

The electrolytic process depends upon the decomposition of water into its two elements of hydrogen and oxygen by means of an electric current. It is used only where electricity can be made cheaply, as the cost is high.

The barium oxide process is declared by authorities to be more a laboratory process than a commercial proposition, and the only installation in the United States for the manufacture of oxygen for public sale, has not been in operation long enough to warrant any deduction to the contrary.

The one successful method of generation of oxygen in very large quantities at a very low rate, is the liquid air process. In this process air is liquified and the oxygen separated from the nitrogen by fractional distillation. It is claimed that the cost is very low, but as the first cost of a plant is high, and the quantity made is great, it is suitable only for companies organized for the sale of oxygen.

The user of the oxy-acetylene welding process who is desirous of making his own gas has a great many methods at his command, and the apparatus is moderate in price. Some of these methods demand the use of a proprietory chemical, in which case he is dependent entirely upon the company from whom he purchases his generating apparatus for his supply of raw material, and some use chemicals purchasable on the open market.

The receiver consists of a welded, riveted or brazed tank of not less than 5 cu. ft. capacity, tested to at least double the pressure at which the gas is to be compressed. A valve is inserted between the scrubber and receiver, and another on the far side of the "Tee" leading into the tank. The pipe line can be extended beyond this valve, to take as many tanks as may be desired, and these tanks can be connected permanently in the line, or a hose connection made, allowing the tanks to be removed and used where desired. Where a plant of this character is used for shop work, the receivers are usually connected permanently and a pipe line run from them to the work bench, where as many attachments as may be needed can be made.

The operation of generating gas is very simple. A mixture of potassium chlorate (8 parts) and manganese dioxide (1 part), weighing from 12 to 20 lbs., according to the size of the retort, is placed in a pan and the pan inserted in the furnace. The cap is screwed on, or if it is of the flanged type, the plate is bolted in place and heat is applied.

The heating arrangement may be of any type whether solid, liquid, or gaseous. The solid would, of course, be coal, wood or coke, the liquid a coal oil, gasoline or fuel oil burner, and the gas either natural, artificial or acetylene. In a very short time (from 15 to 30 minutes, dependent upon the nature of the fuel) it will be noticed that the pipe leading from the retort is getting warm, and shortly the gauge shows that generation has commenced. The rise in pressure is regular and rapid, requiring about 12 to 15 minutes to exhaust the charge. When the needle of the gauge will rise no higher the charge is exhausted, and the valve between the retort and scrubber must be closed.

The retort can then be opened, a fresh charge inserted and the operation repeated. After the first charge has been made, generation is more rapid, as the retort is warm and less time is required.

Four feet of gas is generated per pound of mixture; if the receiving tank is of 6 cu. ft. capacity, this will give a pressure in the receiving tank of 10 lbs., so that with a 20 lb. charge in the retort, 200 lbs. pressure is secured in the receiver. The gas passing into the scrubber is cooled very rapidly, and may be used at the torch as soon as generation starts.

There is very little opportunity for accident with a plant of this type. Even if the valve between the scrubber and retort is left closed when a charge is inserted, the safety valve will prevent damage to the apparatus.

It requires very little floor space, about 20 x 60 in., and can be expanded to generate any amount of gas required.

A PANTOGRAPH

C. W. WEBBER

A pantograph is an instrument used by draftsmen for enlarging drawings, maps, etc., and should be known by every student. Before turning to the construction of the instrument it would be well to give a brief description of it. The pantograph belongs to that class of mechanisms known as four-bar linkages, and may be represented by the diagram, Fig. 1, in which AF and FC are two straight members pivoted at F, and having the two members BD and BE pivoted to them at D and E, the members being pivoted at B. Now if point A is fixed and we move B, it will be seen that point C will move also. It can be easily proved that if A, B and C lie in the same straight line and the figure $BDFE$ is a parallelogram, the distance which B moves is to the distance AB as the distance C moves is to the distance AC. Representing the new position of the parts by the dotted lines we have

$$BB' : AB = CC' : AC$$

It will thus be readily seen that by placing a pencil at C and a tracing point at B, that by following the outline of a drawing with B it will be reproduced on a larger scale by the pencil C, for it can also be shown that C and B will move in the same direction and in a similar manner. It only remains to adjust the ratio of the distances AB and AC to get any degree of enlargement.

The construction of a good instrument is quite a simple matter, needing the following material:

(1) 4 pieces of straight grained wood 22 in. long, ½ in. wide and 5/16 in. thick.

(2) 1 piece of wood 3½ in. long, 1 in. wide and ½ in. thick.

(3) 3 No. 8-32 filister head brass machine screws ¾ in. long.

(4) 1 piece brass tubing with thick walls, tube to be a running fit for the heads of the machine screws (3). This will be about 17/64 in. inside diameter and 3 in. long.

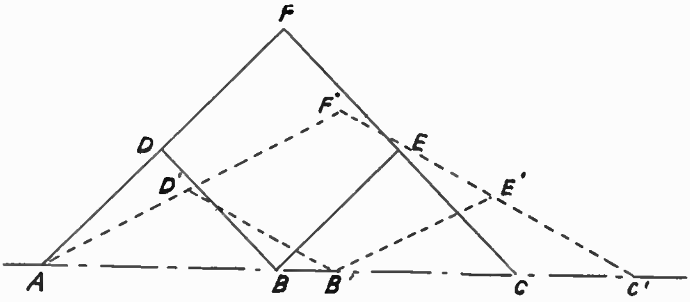


Fig.1.

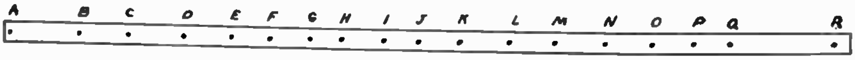


Fig.2.

(5) 2 No. 4-36 thumb screws ¼ in. long.

(6) 3 No. 8-32 brass thumb nuts, such as are found on dry batteries.

(7) 1 piece brass rod, 1 in. long, ¼ in. diameter.

(8) 1 piece No. 24 spring brass wire 2 ft. long.

(9) 1 steel ball bearing ¼ in. diameter.

(10) 2 small screw eyes having ½ in. shanks, and 2 having ¾ in. shanks.

While this seems a rather long bill of material, it can all be bought for twenty-five or thirty cents. The sticks would probably be made of wood at hand, while old dry cells are very common so that these two items would cost nothing.

A centre line is drawn along each stick (1) and distances laid off (Fig. 2) as follows, *A* being ¾ in. from the end:

A B	$2\frac{7}{32}$ in.	I J	$\frac{19}{32}$ in.
B C	$1\frac{25}{32}$ in.	J K	$\frac{61}{64}$ in.
C D	$2\frac{21}{32}$ in.	K L	$\frac{23}{32}$ in.
D E	$1\frac{29}{32}$ in.	L M	$\frac{9}{16}$ in.
E F	$1\frac{13}{32}$ in.	M N	$\frac{7}{16}$ in.
F G	$1\frac{1}{8}$ in.	N O	$\frac{11}{16}$ in.
G H	$\frac{57}{64}$ in.	O P	$\frac{15}{32}$ in.
H I	$\frac{23}{32}$ in.	P Q	$\frac{11}{32}$ in.
		Q R	$2\frac{17}{32}$ in.

It would be better to lay off the distances on one piece only, and then clamp all four firmly together and drill holes at each point large enough to allow one of the screw eyes to be screwed in without splitting the wood. Letter the holes as shown in the drawing (Fig. 2).

Next, from the piece of wood (2) cut a block, as shown in Fig. 3, boring holes at *A* and *B* for screw eyes as above.

Next in order is the pencil holder. From the brass tubing (4) cut a piece ¾ in. long and solder the head of one of the machine screws into one end. This can be done very nicely by cleaning the head of the screw and the inside of the tube, and then tinning the head. By tinning is meant to give it a thin coating of solder. Apply flux to the inside of the tube and force the head of the screw in, then heat for about one-half a minute in a gas stove flame. This gives a nice joint which is very strong.

The finished holder is shown in Fig. 4. A hole is drilled in the tube at *A*, with a No. 45 drill and tapped 4-36. This is to hold the thumb screw (5). A pencil such as is used on dance orders is placed in the tube and the thumb screw tightened. This completes the pencil holder.

The tracer is made in the same manner, except that in place of the pencil a dull point is used. This can be made from the short piece of brass rod (7), by

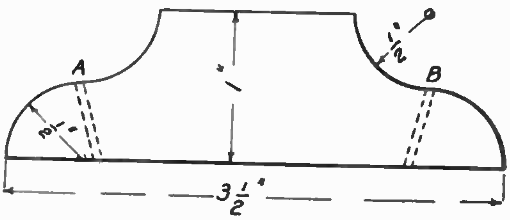


Fig.3.

putting it in a chuck and finishing to a point with a file while rotating it rapidly, being sure to round the point slightly.

The back support is made from a piece of the tubing (4) 1 in. long, having a piece of brass (Fig. 5) soldered on the bottom. The support is shown in cross-section in Fig. 6. After the bottom piece is soldered on, a spring is made by winding the brass wire around a 3/16 in. rod. The steel ball (9) is dropped in, the spring put over that and the screw soldered into place.

The parts are now assembled, as shown in Fig. 7, the holes at the ends of the sticks being enlarged enough to receive the machine screw.

The instrument is used as follows:

The point *A* (Fig. 1) is fastened on the left side of the drawing board, being sure that the point *F* rests on the board. Next, the drawing paper is fastened on the right side of the board with the drawing to be copied just to the left of it. With the instrument set at the desired ratio, set the tracer on the extreme left of the drawing and see if the pencil is on the drawing paper; next try the right side and also the top and bottom. If the pencil runs off of the paper the position of the drawing should be changed so as to keep it on, if then it falls off at the other side, the paper is not large enough, and a larger piece should be used. When everything is ready, holding the pencil with the right hand, trace the drawing, letting the tracer point follow the lines. It will be found that the copy will consist of wavy lines, which can be straightened up afterwards,

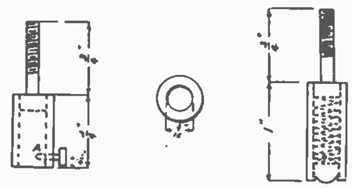


Fig. 4 Fig. 5. Fig. 6.

as it is impossible to follow the lines of the drawing exactly. If an extra large copy is desired an enlargement can be made and a second made from this.

In adjusting the ratio care should be taken to see that the screw eyes go through holes of the same letter on all four sticks. The enlargements which can be obtained by using the different letters are given in the following table:

B	1 to 1⅛	*J*	1 to 3
C	1 to 1¼	*K*	1 to 3½
D	1 to 1½	*L*	1 to 4
E	1 to 1¾	*M*	1 to 4½
F	1 to 2	*N*	1 to 5
G	1 to 2¼	*O*	1 to 6
H	1 to 2½	*P*	1 to 7
I	1 to 2¾	*Q*	1 to 8

By interchanging the pencil and tracer points, the instrument can be used as a reducing instrument.

It may be of interest to some readers to know how the distances *AB*, *BC*, *CD*, etc., were obtained. Referring to Fig. 1 they were found in the following manner. A large piece of drawing paper was tacked on the drawing board and a base line *AC* 24 in. long was laid off; then, with *A* as a centre and a radius of 20 in., an arc was drawn; with

(*Concluded on page* 268)

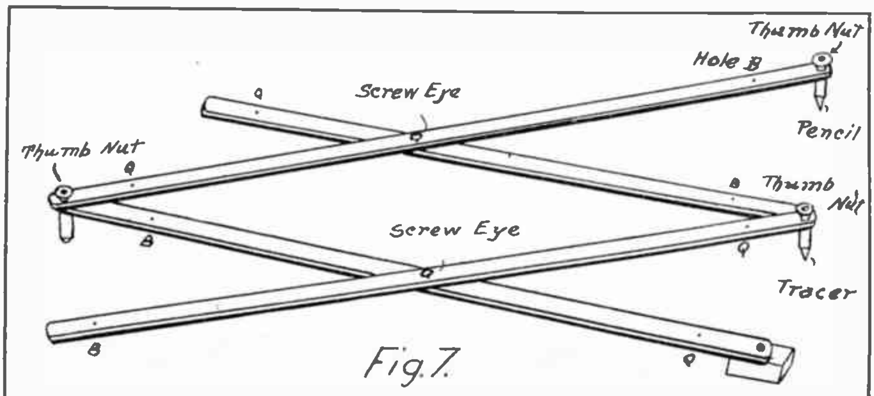


Fig. 7.

QUICK DESPATCH PNEUMATIC TUBE SYSTEMS

H. F. GRIFFEN

In these days of rapid transit and quick communication, one often hears spoken the prophecy that some day it will be possible for one to reach distant cities instantaneously by traveling in miniature air-tight cars through pneumatic tubes.

Just what development will take place along this line it is difficult to forecast but in this article it is the intention to recount what has been accomplished up to date in developing pneumatic despatch systems for short distances, and if these short haul systems are the forerunners of long distance heavy traffic systems, it is well that we get an understanding of what has been so far accomplished.

During the early period of the development of this service the work of perfecting the then poorly constructed and operated systems was carried on very slowly, and comparatively little was done at that time to bring before the public a high class, inexpensive and economical despatch system that could immediately prove its worth and value to the commercial world. But the industry has, under the direction of able men during the past few years, gained much headway; and now the apparatus and devices used in this service have been brought to a high state of perfection, and, their efficiency and value becoming more widely known, they are being used by department stores, banks and trust companies, telephone and telegraph corporations, the United States Post Office, in fact, by nearly every large concern whose business demands such a carrier service.

Where there was formerly but one inefficient system in operation, there are now dozens of first-class, up-to-date systems working satisfactorily, and these are proving their value and usefulness as time goes on.

The methods of constructing and operating these tube systems vary according to the size and nature of the matter to be carried, the surrounding conditions, and requirements of the service. Let us consider first one of the latest types: the "pressure-vacuum" system, using a tube of 2 or 3 in. inside diameter.

A large system with 50 to 70 stations, such as would be used by a large department store, would be laid out and arranged as follows: After the location of the stations and the central office and the position of the motor-blower units have been decided on, the tube runs are laid out carefully in units of six or eight stations each, in such a way as to use a minimum amount of tubing—which is a very important, and one of the principal items when brass tubes are used, and also because the shorter the lines, the lower the pressure used need be, and the less time required to send a carrier to its destination.

For sending off carriers at the central office, a device commonly termed a "swivel" is used. This swivel is merely a circular plate in which the six tubes enter, opening at the top, over which fits a sliding tube that conveys the air. When it is desired to discharge a carrier to a certain station the operator has merely to insert the carrier in the tube entering the swivel from that station, and slide over the opening the "air" tube. This act automatically starts the motor-blower which instantly furnishes all the air necessary to propel the carrier to its destination.

Each station has a single tube coming from the central office and using air under pressure, while all stations on a unit are connected to central by one "vacuum" tube, a "sending inlet" being located at each station to receive the carriers to be delivered to central, which on being placed in the tube are immediately sucked in to central, carriers covering a distance of 300 ft. or more in a very few seconds. By this method seven tubes only are required where formerly twelve or more were used. The pressure now used in short lines is rarely more than ½ or ¾ lb. per sq. in. above or below atmospheric, both the pressure and vacuum sides of the blower being utilized; the "vacuum" or receiving tubes being operated by the vacuum.

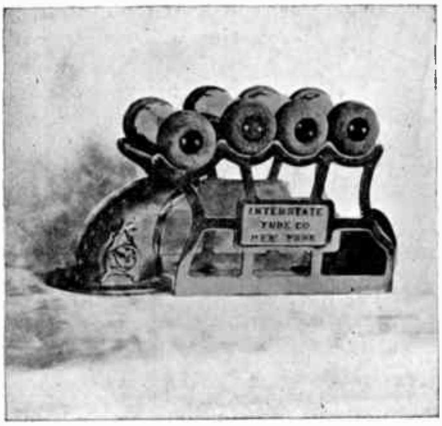


Fig. 1
Small Counter Station

The arrangement at the central office is very neat and compact, and the receiving terminals and sending swivels of the various units are so arranged as to be most convenient for the attendants. A small "counter station" and a central office "receiving terminal" are shown in Figs. 1 and 2 respectively. Looking at Fig. 2 you will easily form an idea of the construction of the terminal. The tube on the right is the vacuum line coming from all the out stations, and picks up and despatches to central any carriers inserted in the inlets. The carriers reaching this terminal at a high speed, knock open the leather doors, and discharge into the receiving tube and shoe on the left-hand side. The middle tube continues on to the vacuum side of the blower, conducting the moving column of air in the tube. The leather doors remain closed by reason of the partial vacuum in the tube, and by the force of a light steel spring on the hinge of the door.

At the bottom of the middle tube will be noticed a small box slightly larger in diameter than the tube. In this box is a grating which serves to catch coins or small articles that may by chance fall from carriers in transit.

The small counter station shown in Fig. 1, as will be seen by referring to same, is very compact and requires little space. It can be conveniently located in an easily accessible though out of the way place and be entirely out of the way of salesmen and customers.

Compressed air is usually supplied by a direct acting compressor or by motor-blowers. Generally the latter are used, and in such cases the equipment is located as near the central office as possible, proving a more economical method of installing.

Each unit is operated by a rotary blower connected by belt to a ½ h.p. motor, which is controlled automatically, as will be explained further on, and each unit is an individual system, so that in case of breakdown only the unit in trouble will be affected.

Fig. 3 shows roughly the electrical connections of a system of this kind. One of the most important features of this service is the fact that no current is used except when a carrier is in the line. When a carrier is inserted at the central office or at any of the out-stations, a small button making an electrical contact on the inlet or swivel, as the case may be, is closed by action of the door against the button. This closes the local battery circuit for an instant.

By again referring to Fig. 3, you will see that this circuit has two taps to magnets on the "timing device," which will be explained below. This local circuit, by virtue of the small magnet, closes the contacts connected with the 110-volt mains, completing the motor circuit and starting the motor-blower which generates compressed air for the out-going lines and produces vacuum for the receiving line.

In Fig. 3, the timing device is shown in the lower left-hand side of the sketch. The upper part of this device is a hollow receptacle shaped like two saucers placed together, with a leather disc or diaphragm between them. Attached to this leather disc is a small brass plate and a rod extending below towards the high voltage contacts. Just below the diaphragm plates is a magnet, while above is another which operates a small valve. To one side of the diaphragm is connected a small pipe coming from the vacuum side of the blower, and over the end of this pipe is placed a small cap in which is placed an adjustable orifice that permits air to be sucked out of the diaphragm shell at any desired rate.

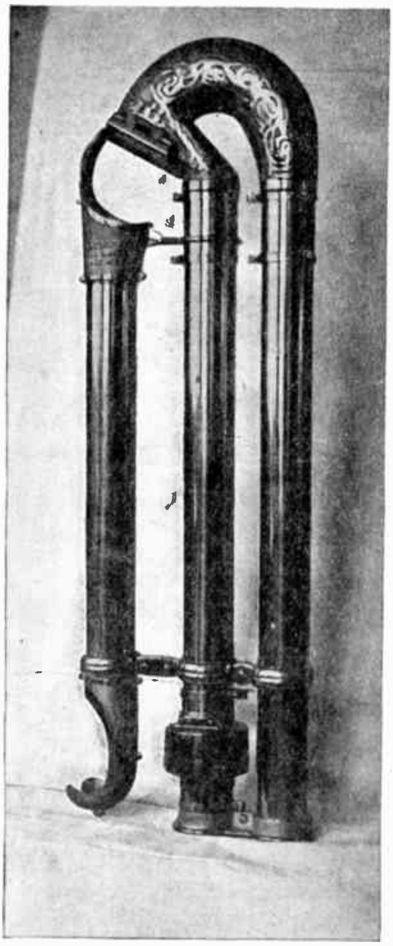


Fig. 2
Terminal Station

We shall now see just what happens when a carrier is placed in the tube at the swivel or one of the sending inlets: The opening of the inlet door, as we have before mentioned, closes the battery circuit which actuates the two electro-magnets at the diaphragm. The upper magnet opens for an instant the small valve which allows the air chamber above the diaphragm to fill with air as the leather disc with its plate and rod drops down. This action here explained, allows the rod to drop down as far as it is possible for it to go, thereby resetting the timing device. The lower magnet draws down the spring contacts and closes the motor circuit, and the contacts are then held down by a small catch spring. The motor starts as soon as the contacts are closed, and the valve closes the instant the inlet door is closed, thus opening the local circuit. Immediately now, the partial vacuum in the small pipe created by the action of the blower exerts its power and begins to pull up the leather diaphragm and its connected rod as fast as the size of the orifice in the cap allows the air to be exhausted from the air chamber. When this rod reaches its limit, it releases the catch holding the power contacts down, which then fly back, breaking the motor circuit and bringing the blower to rest.

The entire adjustment is secured by varying the size of the opening in the cap of the small pipe entering the upper side of the diaphragm. In this manner the motor can be caused to operate during any desired number of seconds, according to the requirements of the tube lines of the unit it supplies.

From the foregoing it is evident, therefore, that the entire system is operated and controlled automatically, and the methods and principles used are very simple. Indeed, there is small chance for these systems to get out of order. All of the electrical contacts are kept clean by a wiping action, and owing to the rapidity with which the power circuit is broken at the carbon buttons, there is no opportunity for continued heavy sparking. The motors and blowers are usually of heavy construction, the motor generally being bolted to an iron plate on top of and forming a part of the blower, and a belt tightener is generally used to insure good pulley contact. The timing device with its valves, diaphragm, etc., is very simply constructed.

As a whole, it may be said that the different modern types of automatic control are as reliable and positive in their action as is possible with the present knowledge of the art.

There are still in operation some of the first systems installed, though most of the original plants have been replaced by modern apparatus because of the great saving in cost of operation and maintenance over the old systems. Before the present stage of perfection was reached, two, and sometimes three tubes were required where now but one is used, and the motor-blowers were kept in operation constantly, a very wasteful and costly method which did little to promote the development of pneumatic tube work. It was not until recently, comparatively speaking, that rapid advances have been made and the service extended to serve many purposes.

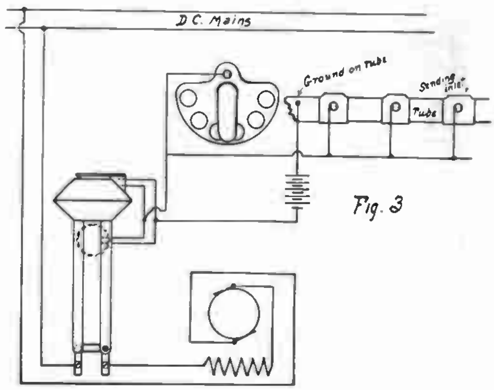
Fig. 4 shows a station installed a number of years ago, though the methods of operating the system of which it is a part have been modernized to some extent.

In former years the United States government employed wagons almost exclusively for transporting mail matter, expecially over heavy routes, but these old methods have been supplanted by underground pneumatic tube systems, using pipes of various sizes according to the demands of the service.

These latest methods have proven so economical and inexpensive considering the service rendered, that systems have been installed in most of the large cities of this country, connecting generally, city main and branch offices.

In these twentieth century days where commercial and social life demand quick rush service all the time, the tube lines are of great use to the government in its work of collecting and distributing mail matter. The public demands a fast mail service, and pneumatic tubes have supplied these demands.

The telegraph companies, especially, are adding constantly to their tube equipment. This is a business in which tubes can be used to excellent advantage, in-as-much as it has been found that despatching messages via tube is faster, more economical, and more satisfactory over short distances, than by messenger. Lines from a few feet to a few miles in length are now used extensively, and, in fact, the business has grown so rapidly and the tubes are so successful that they are used to their full capacity night and day, and new lines are being constructed all the time. Indeed, there is no business outside of the telegraph, unless possibly we except large department stores, where tube despatch systems show such great economy, although it must not be inferred that they are not economical of operation elsewhere, for



it is the great volume of business handled that lowers the unit cost.

Selecting for our subject such a tube line as we have just been discussing, it will prove interesting to go into the matter a little further, forming a mental picture in our minds of a long underground tube line in a city such as New York or Chicago.

Imagine a 2 in. or 3 in. brass tube a couple of miles long running from the fifteenth story of a skyscraper straight down to a point below the street level, thence through the building wall, buried in the soil below the surface of the street to a depth of about 3 ft.; following down street and avenue, making bends and corners and turning here and there to avoid obstructions, for generally all streets in the commercial centre of a large city are filled with gas and water pipes, sewers, electrical conduits and subways, manholes, etc., and one may readily imagine what a hard time of it the pneumatic tubes have coming in later. But picture the tube as finally reaching a down-town building, the terminus of the tube line, after perhaps looping in and "picking up" a couple of offices on the way, and ascending to the top of a building 200 or 300 ft. high. Now a line of this kind would ordinarily have, say, thirty 90-degree short radius bends, and one hundred off-sets, or 45-degree bends, used in getting around or under sewers, manholes, etc.

During a busy day there might be in the line at one time seventy carriers weighing, when loaded, approximately ½ lb. each; assuming that four of the carriers are at a given instant ascending

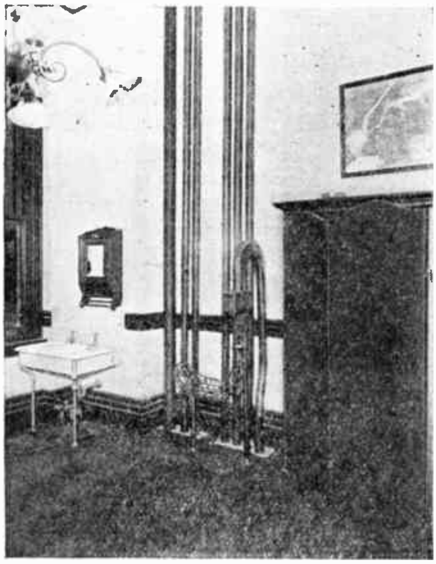


Fig. 4
A Pneumatic Tube Station

the vertical section in one building, sixteen just rising up in the tube bends passing over obstructions in the street, and the balance fairly evenly distributed throughout the whole street section. Now, using a pressure of only 13 or 15 lbs. per sq. in. the speed of the carriers through the tube is nearly ½ mile per minute, which is wonderful indeed, when one considers that there is a weight of 35 lbs. in the whole line that must be pushed along against friction, and, as we mentioned before, lift bodily four of the carriers in the vertical section, and push "uphill" the sixteen that are just about to ascend the incline of bends in the street. It is certainly remarkable the way such a system can handle the business, and the way it does take care of the heavy traffic is a good substantiation of the claims made today for service of this type. From figures showing the cost for installation and operation, the cost for up-keep, depreciation, and interest on investment, it is evident that the usefulness and life of pneumatic tube lines compares favorably with almost any mechanical contrivance yet invented.

Of course it is possible to overload anything and tube systems are no exception to this rule, for we cannot get from anything more transformed energy than we put into it primarily. When a line becomes blocked by reason of too many carriers being inserted in the line at one time or from obstructions of any kind, it is necessary in order to clear the tube to increase the pressure momentarily, or, failing in this, to reverse the pressure and blow back some of the carriers, or whatever the obstruction may be. When the usual pressure is put on again, the lightened load is always easily handled.

As in indication that this science is yet in its infancy it may be stated that those engaged in the work of designing and planning pneumatic tube installations find that the generally accepted theories of pneumatics do not always hold good in the operation of long distance tube systems; there are a great many considerations which may be gleaned only from practice and experience which have an intimate bearing on the success or the failure of undertakings along this line.

One difficulty that has long puzzled those in charge of long distance tube lines is the condensation of moisture on the inside surface of the brass tubes under the street, under certain weather conditions. This has proven a very annoying and expensive source of trouble in some cases, it being necessary to use water-tight carriers, and various devices to take care of the water coming from the tube at each end. This condensation is believed to be due to the fact that the underground brass tubes were enclosed in iron pipe instead of wooden duct or other heat insulating material.

The requirements of corporations and large mercantile institutions are many and varied, and some peculiar situations are met with at times in tube construction. In some cases a rectangular or elliptical tube is used for the carrying of books, or articles of various size and shape. Such systems are operated in the usual manner, quietly and economically, the same general plan being followed as in the standard types using round tubes.

Carriers are made of leather, fibre, brass, aluminum or steel, in any shape or size required. For a small circular tube a leather carrier is used with a felt head and flexible leather skirts which closely fit the inside of the tube and prevent the air from getting by unnecessarily. The leather body itself is cylindrical in shape and in length about three or four times the diameter of the tube, and is slightly less in diameter than the tube so as to prevent binding when passing through short radius cast bends which must be frequently used in interior installations. Brass shell carriers which open with a sliding lateral motion, and are equipped with heavy felt pieces at each end which rub against the inside surface of the tube and take up the wear, are used almost exclusively by department stores for their service, as they can be very readily opened or closed. Closed carriers are used entirely where money is to be carried on account of the liability of loss in transit.

Leather body carriers are used in the larger sizes also, though it becomes necessary to reinforce with a steel or aluminum shell when the size reaches 4 or 5 in. in diameter.

From these small carriers the sizes and kinds run up to the great heavy carriers which handle mail matter in the Post Office tubes. Some of these are a foot or two in length and 6 or 8 in. in diameter, and must be very strongly built, in order to stand up under the severe strain they receive in going through the rough iron pipe and sharp elbows of those lines.

Throughout the period taken to bring about these developments in pneumatic tube work, many types of timing devices have been designed, the different systems and the various methods of operation demanding each their own particular device for automatically controlling the motor-blowers or air supply.

In some systems the insertion of a carrier in the line operates a solenoid switch by means of a local circuit. As soon as the motor starts, a rack and pawl mechanism operates to open the power circuit when the motor has made a certain number of revolutions, by lifting the rack which opens the solenoid switch.

In other types where a constant supply of air is maintained, there need be no electrical connections to start a motor blower, but simply a device to open a port allowing air to enter the tube at the proper time. This is accomplished in the following manner:

A small motor of about 1/10 h.p. is mounted on a base large enough to accommodate the entire mechanism, and so connected by means of worm wheels and gears to reduce the speed in a ratio of 200 to 1. Thus where the motor makes 1,200 revolutions per minute we got 6 revolutions per minute on the low-speed wheel. This low-speed wheel transmits its movement to a rod which is lifted in consequence six times per minute, and the movement continues until the rod has traveled far enough to push over a tiny valve, letting air from the constant pressure tank into the upper side of a diaphragm. This diaphragm is connected to a valve which closes when air is permitted to enter the diaphragm under pressure, the action closing the large valve and thereby shutting off the air supply, and at the same time opening a light contact which stops the small motor.

When a carrier is inserted in the line at any point, a releasing mechanism allows the rod to drop down, thus closing the motor circuit and starting the motor which immediately begins to pull up the rod again. The air is also shut off at this instant from the diaphragm and the consequent opening of the large valve allows air to enter the tube.

More than thirty years ago patents were secured protecting inventions providing for the construction of pneumatic cars and tubes large enough to carry a number of passengers, but up to the present time no satisfactory tube system has been constructed, chiefly because the methods of operation of such large passenger traffic systems are too expensive compared with present transportation systems.

Wonderful progress has been made during the past few years and many changes and inventions have been worked out, making pneumatic tube systems as operated today of great importance commercially, but we are now looking confidently ahead to the time when we shall be able to travel hundreds of miles in air-tight cars almost instantaneously. Let us see who shall be the first to make possible and practical such a transportation system.

WIRELESS TELEGRAPHY

In this department will be published original, practical articles pertaining to Wireless Telegraphy and Wireless Telephony

THE CONSTRUCTION OF A WAVEMETER AND A HOT WIRE METER FOR USE WITH WIRELESS TRANSMITTING INSTALLATIONS

W. C. GETZ

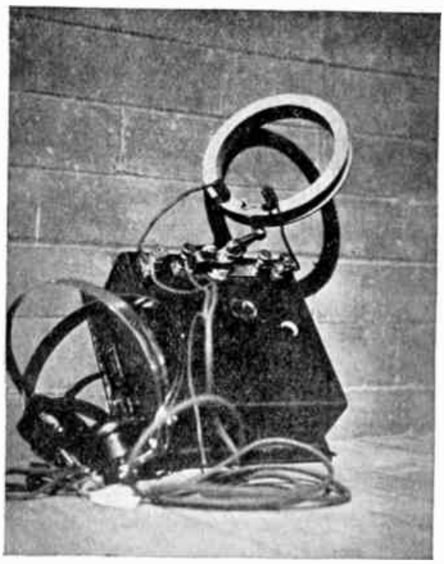


Fig. 1
Wave Meter

In this article I shall give data by which a reliable wavemeter and a sensitive hot wire meter can be constructed, such as are required in wireless telegraph installations. Many experimenters have transmitting outfits which are not developing anything like their full efficiency, merely because the operator had no suitable means of tuning his set. For that reason this article will describe a type of wavemeter more directly suited to the needs of the average experimenter than to the requirements of the high power set described in the previous issues of this magazine, and while it can be readily used with the latter set, it is more particularly adapted to such stations having wave-lengths from 150 to 500 meters.

The mention of the word wavemeter usually gives the experimenter a vision of a costly instrument, unattainable to the amateur, whose readings are secured only after the most painstaking scientific calibration. On the contrary, a wavemeter is a comparatively simple piece of mechanism, easily constructed and calibrated by any intelligent experimenter to a fair degree of accuracy.

In Fig. 1 is given the photograph of a wavemeter recently constructed by the writer, which is sufficiently accurate for all practical purposes. This, it will be noticed, consists of a box containing an adjustable condenser; a detector of the improved silicon type; a wood form containing a number of turns of copper wire; and a pair of high resistance telephone receivers, connected to the detector.

The adjustable condenser being the most difficult part of the set to construct, we will therefore consider it first. In Fig. 2, we have given a photograph showing the appearance of the adjustable condenser with the cover removed. It will be seen that this consists of a number of semi-circular plates of brass, mounted in a fixed position on the base-board, and between which rotate smaller semi-circular plates, the top one of which is provided with a graduated scale so that the degree of rotation may be instantly determined. Referring to Fig. 3, we have a drawing showing the side elevation, plan, and cross-section views of this condenser.

The condenser case, as shown in this drawing, consists of a base-board 7¾ in. square on its outside edge, which is moulded to a distance of ⅜ in., thus making the top of the board 7 in. square.

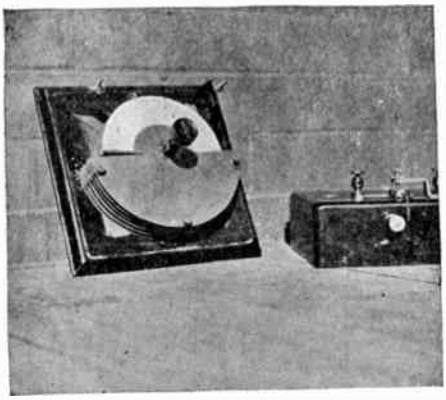


Fig. 2
Adjustable Condenser

The board is ½ in. thick. Over this is the cover and sides, which are finished in one piece, 7 in. square and 2¼ in. high, outside dimensions. This is made of ⅜ in. stuff, neatly joined, and given a highly-polished finish.

The fixed and rotary plates are shown in Fig. 4, which also shows the handle and insulating bushing. The fixed plates consist of discs of 1/20 in. brass having a 3 in. radius. The top and bottom plates have an "ear," or projection, on the straight edge, as shown, while the intermediate plates are cut as indicated by the dotted semi-circle. In this ear in the first and last plates, a 7/16 in. hole, centred with respect to the circumference of the plate, is placed, in which the insulating bushing fits. This is to provide an upper and lower bearing for the shaft of the movable member.

The movable plates are made of the same thickness of brass, and are cut 5 in. in diameter. A projection similar to the one previously described is provided on each of these plates, having a hole of ⅛ in. in diameter in same.

The handle consists of a knurled knob of hard rubber 1 in. in diameter and ½ in. thick, which is fastened to a brass shank, 9/16 in. in diameter at point next to knob, then 5/16 in. for a space of 3/16 in. in its length, and finally terminating in a No. 8-32 machine screw stud, ⅝ in. long.

The bushing is of hard rubber, 5/16 in. inside diameter, 7/16 in. outside diameter, and ¼ in. high. A flange 9/16 in. in diameter and 1/16 in. deep extends around the upper edge, to prevent the bushing from slipping through the condenser plate.

Again referring to plan and sectional views in Fig. 3, we see that the top plate of the condenser consists of the fixed plate with the "ear" projection. Then comes a movable plate; then a fixed plate without the ear; and so on until the bottom plate is reached, which is a duplicate of the top plate. Washers ¼ in. thick are used to space the plates apart. It will be seen that three No. 8-32 machine screws extend through the base-board, in position to coincide with the holes in the fixed plates.

In assembling, each plate is placed on in the order stated, and then a washer or nut (the common type of battery

Adjustable Condenser for Wavemeter.

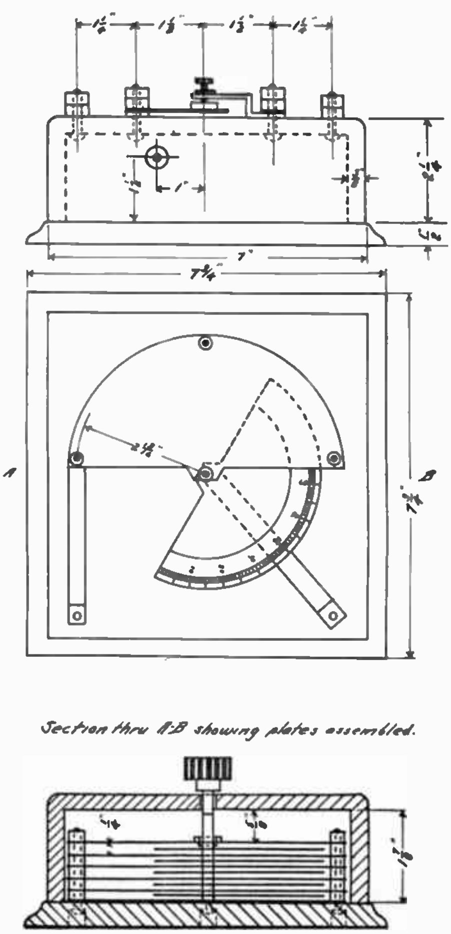


Fig. No. 3.

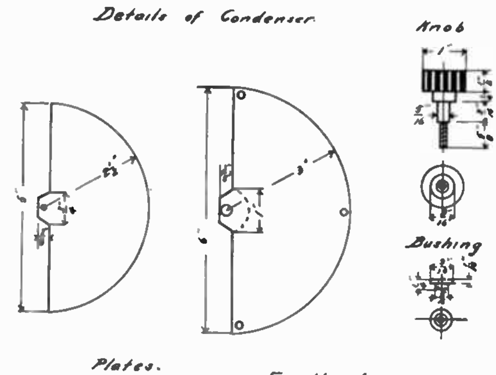


Fig. No. 4

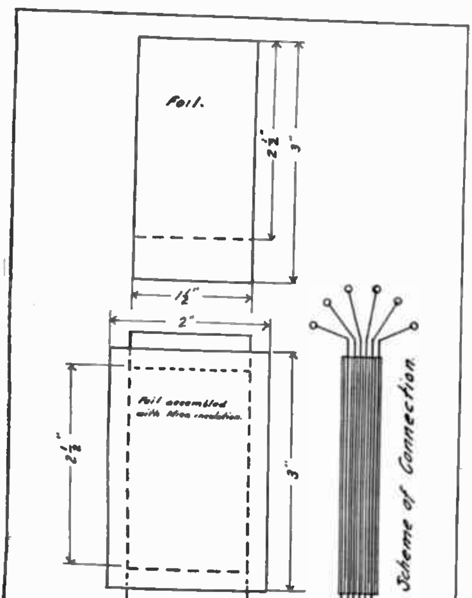
thumb nut with No. 8-32 thread is excellent for this purpose) is screwed down, on each of the three screws. In this manner the plates are all spaced evenly apart and held perfectly tight.

The movable plates are assembled in just the same way, and after being placed in the required position, are soldered to the shaft or axis, so that they will not work loose when rotated. They are then sandwiched between the fixed plates and should equally clear the fixed plates in all points when rotated.

The top movable plate is divided into one hundred equal parts as shown. A paper scale having these graduations may be made and glued to the plate, or the scale can be drawn directly on the plate itself with some sharp tool, before assembling.

Connection is made to the fixed and movable plates by two brass straps, which are shown in the plan view of Fig. 3. The one to the fixed plate screws under the bottom of the plate with the screw on the left side of the drawing. The one strapped to movable plate is carried to the centre of the set, and rests between the bottom movable plate and the top of the hard rubber bushing in the last fixed plate. These straps are of 1/20 in. spring brass ½ in. wide. The one to the movable element should be bent so that it keeps a constant contact against the brass plate.

In Fig. 5 we are given a view of the top of the condenser case, corresponding to the side view given in the top drawing of Fig. 3. It will be noticed that another rubber knob, not shown in Figs. 1 or 2, is situated in back of the adjustment knob. This controls the multiple contact switch of the fixed condenser units. As the capacity of the rotary condenser is very small at the maximum, it has been found necessary to introduce a series of fixed condenser units in multiple with the rotary condenser, so that



Fixed Condenser Units.
Fig. No 6

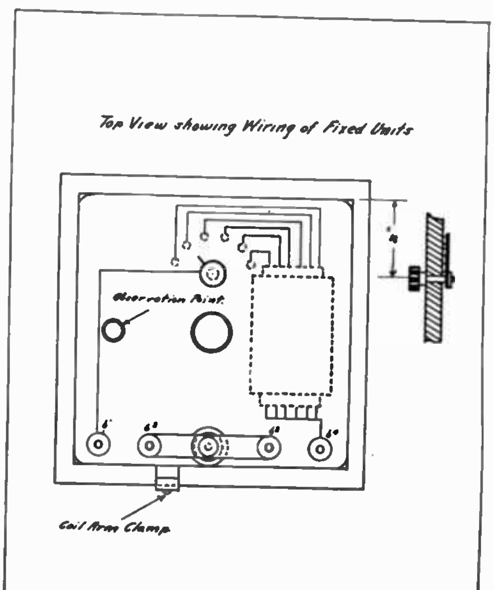


Fig. No. 5

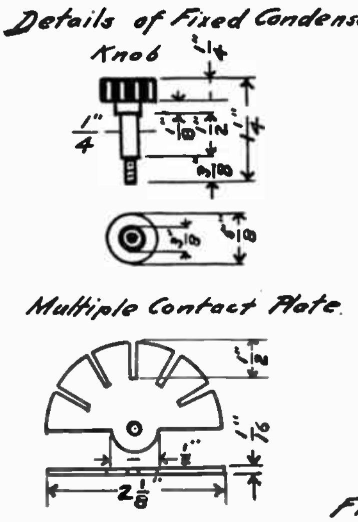


Fig. No. 7 W.C.G.

the capacity can be increased to points unattainable with the rotary condenser alone. Of course, if a larger rotary condenser were constructed in the first place this would be unnecessary, but as the construction of the larger type of condenser introduces many difficulties greater than the construction of the fixed units, besides making a more cumbersome instrument, the use of the supplementary fixed condenser is herewith adopted.

In Fig. 6 is given the dimensions of this fixed condenser. The condenser consists of 6 units, each unit comprising two sheets of tinfoil 2½ x 1½ in. separated by mica. For convenience of making connections, etc., the foil is actually cut 3 x 1½ in., but the actual overlapping or active area of each unit is only 2½ x 1½ in., as shown by the dotted line.

The mica is of an average thickness of .0045 in. (4½ mils), and is cut 3 x 2 in. In the lower view, showing the assembly of the mica and tinfoil, the overlapping distance of the foil is plainly shown by the dotted lines. The average thickness of the foil is about .0015 in. (1½ mils), but as this does not alter the capacity of the condenser, it may be ignored. However, the experimenter should see that *all other dimensions strictly accord with those given herein if the results given in the accompanying table are to be used*, as otherwise it will affect the results, thereby rendering the calibration of the meter inaccurate.

The side view in this figure (thickness exaggerated), shows that every alternate sheet of foil is laid in the same direction, so that every adjacent sheet will have the terminals projecting in the opposite direction, and hence will be of opposite polarity. At the bottom, the condenser plates are bunched, but at the top they are fanned out so that they can be connected to the respective studs of the multiple switch as shown in Fig. 5.

It will be seen that the studs of the multiple switch, the multiple contact plate, and the fixed condenser units, are on the *underside* of the cover. There is sufficient room for them here, and the appearance of the finished instrument is much neater by having them concealed in this manner. The side view in Fig. 5 shows the position of the multiple contact plate, when making contact with the studs.

Details of the multiple switch are given in Fig. 7. The handle, similar to that of the variable condenser, consists of a knurled knob, ⅝ in. in diameter, and ¼ in. thick. This is also fastened to a brass shank which terminates in a No. 8-32 machine screw stud.

The multiple contact plate consists of a semi-circular disc of 1/16 in. sheet brass, having five radial slots sawed in it at equal intervals so as to divide the switch plate into six equal parts. This is so that constant pressure can be maintained on each individual stud, regardless of the position of the stud due to any unevenness of the surface of the cover.

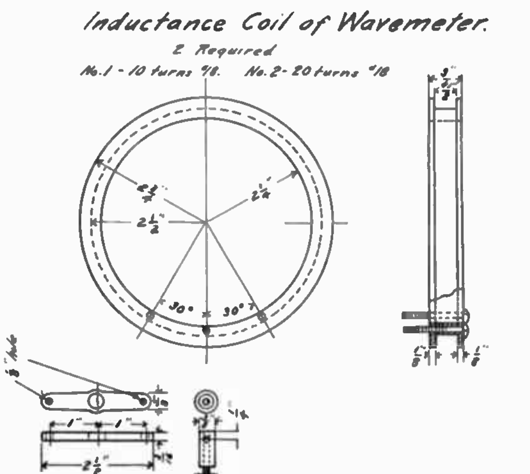
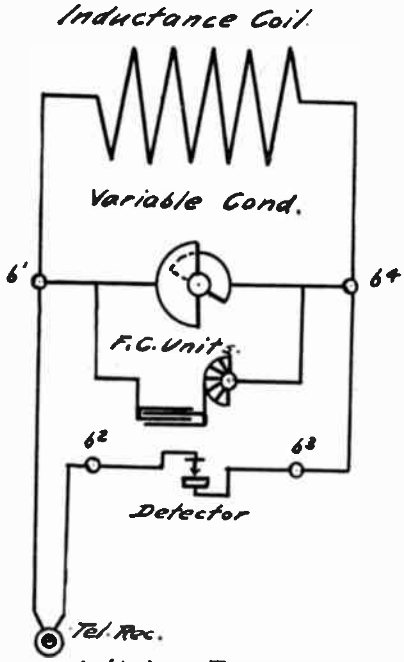


Fig No 8 W.C.G.



Wiring Diagram.
Fig. No. 9

In Fig. 5 it is seen that the fixed condenser units are connected one side to the variable condenser terminal and the other side to the switch studs. The other variable condenser terminal connects to the multiple contact plate. Thus, when the multiple contact switch is around out of contact with any of the studs, the capacity is that of the variable condenser. However, as we find that more capacity is needed we turn the switch so that first one unit is in, then so that two are in, and so on until sufficient fixed condenser units, together with the variable condenser, gives us the range of capacity we require.

At a point directly over the intersection of the fixed and movable plates of the variable condenser, and where the scale is easily visible, a hole is bored in the cover of the case which allows the operator to observe the position of the variable condenser. The upper fixed plate of the variable condenser serves as a guide line.

This view (Fig. 5) also shows the plan of the Improved Silicon Detector, a side view of which is given in Fig. 3. This can also be clearly seen in the photographs in Figs. 1 and 2. The silicon detector was selected, as it does not readily get out of adjustment and is fairly sensitive. Carborundum, pericon, or ferron can also be used with good results.

The telephone receivers are of the 1,800 ohm type of high efficiency receiver formerly manufactured and sold by the writer. Any reliable make of receiver having a resistance over 1,000 ohms can be used.

In Fig. 8 is shown the wooden form which holds the inductance of the wavemeter. This form is 4½ in. inside diameter, with a winding space of 5 in. inside diameter and ½ in. wide. The outside diameter is 5½ in., and the total width ¾ in. Two of these forms are required.

The first form contains coil No. 1, which consists of 10 turns of No. 18 B. & S. gauge, double cotton-covered annunciator wire. This wire should be evenly and carefully wound on the forms. Three holes, each ⅛ in. in diameter, are bored laterally through the form as shown, 30 degrees apart on the perimeter.

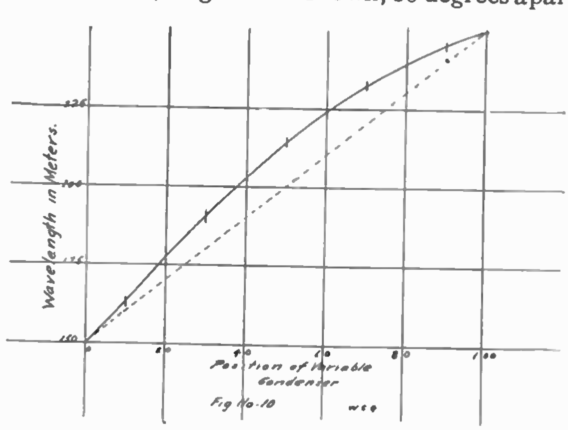


Table I—WAVEMETER

Minimum and Maximum Range in Meters of Variable Condenser, in Multiple with Units of the Fixed Condenser, as shown

Inductance Coil	No F.C. Units		Fixed Condenser 1 Unit		2 Units		3 Units		4 Units		5 Units		6 Units	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min	Max.	Min.	Max.
No. 1 (10 turns)	120	150	240	270	300	316	375	400	420	450	488	515	530	546
No. 2 (20 turns)	150	250	350	430	415	470	615	660	848	880	950	990	1080	1110

In the centre hole is placed a No. 8-32 machine screw which is to clamp the form to the supporting arm. In each of the outer holes studs are placed and the opposite ends of the windings soldered to the respective studs.

Coil No. 2 consists of 20 turns of No. 18 wire, finished in identically the same way as coil No. 1. In the lower corner of the figure are the details of the supporting arm and stud. The No. 8-32 machine screw previously mentioned is carried through the hole in the top of the stud. The lower end of the stud is fixed to the supporting arm with the thumb-screw, and the other end of the arm clamped to the case, with the lug shown on the side view in Fig. 3, and the top view in Fig. 5. This allows the coil to be rotated and held in any position desired by the operator.

We will now consider the wiring of the wavemeter. In Fig. 9 we have given the wiring diagram to be used. It is seen that the inductance coil, variable condenser, and fixed condenser units are in multiple, while the detector is in series with the telephone receiver, and both bridged across the condenser.

Now to the operation of the wavemeter. Referring to the attached Table I, we find given the various ranges of the wavemeter for certain combinations of the inductance coils and fixed condenser units, with the variable condenser. For instance, with the No. 1 coil in, we have a range of from 300 to 316 meters, with two units of fixed condenser, when varying the rotary condenser from 0 to 100; and with the No. 2 coil and 6 units of fixed condenser in, we get a range of from 1,080 to 1,110 meters, on altering the adjustable condenser from 0 to 100. This is, of course, assuming that the experimenter has conformed *exactly* to the dimensions given in this article.

Now the adjustable condenser by itself, with coil No. 1, gives us a range of from 120 to 150 meters, and with coil No. 2, from 150 to 250 meters. Hence, the amateur would assume that since the adjustable condenser is graduated into 100 equal divisions, if say a required wave-length were found when the variable condenser were at 50, the wave-length would be $^{50}/_{100}$ of the difference between 150 and 250, the extreme ranges, added to 150, the lower range, which would give us 200 meters.

But this is not exactly so, since the wave-length varies in a ratio of the square root of 2 to the capacity, which will make a slight variation. In Fig. 10 is a chart showing in full lines the curve for the wavemeter, using coil No. 2 and no fixed condenser. Were the variation of the wave-length directly proportional to the variation of the capacity of the condenser, the dotted line would represent the wave-length at the various positions of the condenser as indicated by the horizontal numerals. The true wave-length, represented by the curve in full line, was obtained by calibrating this scale of the wavemeter for each ten divisions, and is the accurate wave-length for the present condition.

But on inspection, it is seen that the variation between the dotted and full lines at the greatest, namely 60 points, is only 15 meters, so that the experimenter can safely take the value as shown by the dotted line, unless absolute accuracy is desired. The latter would require the use of a standard wavemeter, and the necessity of making up a set of curves similar to that in Fig. 10, one for each fixed condenser unit added to the variable condenser.

(To be continued)

AN INVISIBLE AERIAL

G. MACLEAN

Many experimenters have desired to erect an outside aerial, but have been prevented from doing so by the objections raised by a strict landlord. However, this is no excuse for anyone not entering the wireless field, for there are many plans that may be adopted to get around this difficulty. Examples of these are the iron bedstead aerial, the window screen aerial, the gas pipe aerial, the tin roof aerial, etc. We have experimented with the above with some success, but got no real satisfaction out of any of them. Almost anything will do for an aerial if you live within ten or twenty miles of commercial stations. For instance, in a room on the first floor of my house, 14 ft. from the ground, I have a 4-wire aluminum aerial 18 ft. long, 18 in. wide, and but 6 ft. above my instruments. With this aerial I can converse within a range of two miles, using 1 in. coils, and can receive from commercial stations 20 miles away.

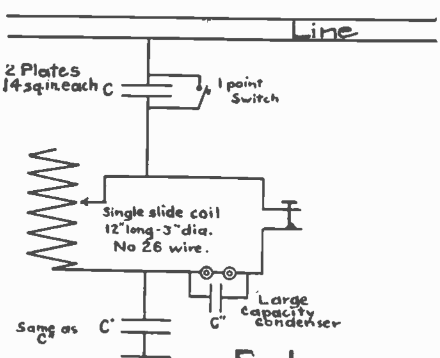


Fig 1.

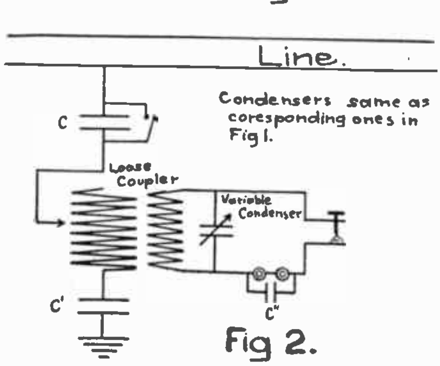


Fig 2.

These interior aerials will give satisfaction for short distances, but there is a much better arrangement which is within the reach of almost everybody—the use of the telephone wires for an aerial. These naturally have a very long oscillation period, but by the judicious use of condensers, or by the use of a loose coupler, this difficulty may be obviated and fairly sharp tuning obtained.

Only one wire of the line should be tapped and the hook-ups shown in Figs. 1 and 2 should be strictly adhered to to prevent interference with the telephone service.

The condenser *C* between the line and the tuning coil should be of very small capacity, two plates of not more than 14 sq. in. surface each, for the purpose of this condenser is to help atone for the long natural wave of the line, and its value lies in its small capacity. Around the condenser there should be a short-circuiting switch, so that stations with long waves as well as those with short waves may be heard. Whether the small condenser be in or out of the circuit there should be a large capacity condenser in the ground circuit, for otherwise the telephone wire would be grounded with disastrous results to the service.

By using the close coupling shown in Fig. 1, known as the "Fessenden single slide system," or the loose coupling of Fig. 2, absolutely no conversation that may be going on in the line can be heard, which is, of course, the only condition under which the telephone wires could be used.

To illustrate the long natural wave of the wire, during our experiments with these systems we found that without the small capacity condenser in the lead-in wire there was only one station that we could tune the circuit to. Later on we heard his signature, CGB, which is Glace Bay, Canada, who has a wavelength of 4,000 meters. As Glace Bay is about 900 miles from my station, about half of which is over land, it shows how far superior a telephone wire is to an iron bedstead or a window screen.

A SIMPLE METHOD OF OBTAINING THE CAPACITY OF ANTENNAS

ERNEST C. CROCKER

The effectiveness of an antenna depends, to a large extent, on its capacity, and, in order to tell which of two antennas has the greater capacity, or to find out if the addition of more wires is advisable, it is necessary to be able to calculate an antenna's capacity.

The capacity of an antenna increases with the number of wires, but not nearly in the same ratio. The capacity of an antenna depends almost directly on its length and very little on the size of the wire or its covering.

The following table gives values for a vertical antenna of one wire, and the figures express millionths of a microfarad.

Height	Size of wire No. 12	No. 18
20 ft.	52	50
40 ft.	90	85
60 ft.	125	119
80 ft.	160	150
100 ft.	200	188
120 ft.	232	220
140 ft.	270	254
160 ft.	306	290
180 ft.	343	320
200 ft.	380	350
400 ft.	700	660
1,000 ft.	1630	1550

When we have more than one wire, the second table will give us the figure by which to multiply the foregoing value. It is supposed that the wires are evenly spaced.

Number of wires	Ratio of length of antenna to spread of cross-arm 40 to 1	20 to 1	10 to 1
1	1.00	1.00	1.00
2	1.45	1.53	1.85
3	1.55	1.74	2.06
4	1.63	1.83	2.16
5	1.70	1.90	2.24
6	1.76	1.96	2.31
7	1.82	2.02	2.37
8	1.87	2.06	2.42
9	1.92	2.09	2.46
10	1.96	2.12	2.50

Example. The capacity of a No. 18 wire antenna 120 ft. vertical is the following in microfarads, cross-arm 6 ft. wide (ratio=20 to 1)

1 wire = .000232 = standard value.
2 wires = .000365 = 53% greater.
4 wires = .000425 = 83% greater.
10 wires = .000492 = 112% greater.

Since horizontal antennas are much used at present, we must find a way of determining their capacities. Fortunately, as is found by experiment, the capacity of a T or L type of antenna is equal to the capacity of the horizontal part plus the capacity of the vertical part. The capacity of the horizontal part may be quickly found by the third table.

For a wire with one high end and one low end, use the height of its centre. If the horizontal part of the antenna has more than one wire, multiply the value by the figure obtained in Table 2, just as in the case of the vertical part.

Example 1.—Find capacity of horizontal part of a 3 wire antenna, No. 18 wire, 150 ft. long, 15 ft. cross-arm, and 40 ft. above ground.

Solution.—By consulting the table, we find the capacity of one No. 18 wire at 40 ft. above ground to be 169 millionths mfd. per 100 ft. of length. Since this wire is 150 ft. long, it will be 1½ x 169 = 254 millionths mfd. for one wire. An antenna 150 ft. long with a 15 ft. cross-arm, has a ratio of length to cross-arm of 10 to 1, and by looking up Table 2, we find the figure for three wires at 10 to 1 ratio = 2.06. Now if we multiply 254 millionths mfd. by 2.06, we will have the required capacity, which is 254 x 2.06 = 523 millionths mfd., which is written 0.000523 mfd.

Millionths of microfarad for each 100 ft. of length (1 wire)

Height above ground	Size of wire No. 12	Size of wire No. 18	Height above ground	Size of wire No. 12	Size of wire No. 18
10 ft.	212	195	80 ft.	164	153
20 ft.	195	182	100 ft.	161	150
30 ft.	186	174	120 ft.	158	147
40 ft.	180	169	140 ft.	156	144
50 ft.	175	165	160 ft.	154	142
60 ft.	171	161	180 ft.	152	140
70 ft.	167	157	200 ft.	150	138

Example 2. Find capacity of 4 wire antenna, No. 12 wire, vertical height 60 ft., length 120 ft., 6 ft. cross-arms.

Solution.—Vertical part = 125 x 2.16 = 270 millionths mfd. (6 ft. cross-arm, 60 ft. vertical = 10 to 1 ratio).

Horizontal part = $\frac{120}{100}$ x 171 x 1.83 = 376 millionths mfd. (20 to 1 ratio).

270 + 376 = 646 millionths mfd. = total capacity, which is written 0.000646 mfd.

DISEASES OF ELECTRICAL MACHINERY

A. S. ATKINSON

The man who knows how in this world is the man who commands the high salary, and it does not matter much whether it is in business, science, or one of the professions that he distinguishes himself. Plenty can follow in the beaten paths and do work that is already cut out for them. The field of electricity is no exception. We have thousands of electricians who know the principles of electricity, and have a fair understanding of machines and their operation, but how many of these can rightly diagnose a case of "sickness" and apply the remedy?

To some the idea of applying the term of sickness to machinery may seem far-fetched, and when we speak of diseases of electrical machinery they may smile. But there are no more forceful terms to use. There are diseases of machinery which have causes, symptoms and remedies. The electrical doctor is, therefore, the man who must know, and his services are in demand. He goes about with a smile on his face, and recognizing the symptoms he unerringly lays his finger on the cause, and then the remedy is easily applied.

When an electrical machine stops suddenly, or groans, or just acts contrary, how many electricians can locate the cause and apply the remedy? Or better yet, how many can detect the symptoms of trouble before the disease has caused a breakdown, and then apply the remedy? Not many, as a rule, and that is why there is a steady demand for electrical doctors.

Like diseases of the body certain symptoms are sometimes baffling, for they may indicate any one of several causes. Take the heating of bearings for instance. This may occur in almost any machine. The symptoms may be manifested in a number of ways, such as the shaft not turning freely, squeaking or grating noise, an unusual tension on belt in a belt-connected machine, or pulley, armature or commutator hotter than bearing. With any or several of these symptoms manifest, the electrical doctor immediately tries to find the cause, and then applies the remedy.

Naturally his first consideration is the oil supply. If there is plenty of oil, and the passages are not clogged and self-oiling rings or other devices are revolving and acting properly, he looks elsewhere for the cause. Next, he slightly loosens the screws which hold the bearings in place, to see if this is the trouble, or it may be a thrust or pressure of pulley, collar or shoulder on shaft against one or both of the bearings. By a process of elimination he gets at the cause. If there is grit or foreign matter in the bearings it must be removed. Sometimes it is simply too great a load or strain on the belt that causes the trouble. In this case the pulley bearing is generally found to be hotter than the other. If this is allowed to continue for long it will be worn elliptical and the shaft may be shaken in the bearing in the direction of the belt when the latter is off. Reduce the load or belt tension, and if it is due to a strain all will run smoothly again.

Another cause of heating of bearings may be that the armature is nearer the pole pieces on one side so that greater magnetic attraction is produced on the near side. A little examination will show whether the armature seems to be drawn a little on one side. The shaft may fit too tight, or it may be sprung or bent. It is very difficult to straighten a bent shaft, but sometimes what seems like a bent or sprung shaft is simply the result of bearings being out of line. This can be remedied easily by loosening the screws and adjusting to a nice balance. A new shaft is sometimes rough or an old one has been cut or grooved by grit in it, producing heating of bearings. The shaft then must be filed carefully or turned in a lathe until smooth. Removing shaft and cleaning will in most cases remedy the causes of this class.

The electrical doctor thus must know his symptoms well, and then hunt the causes. Many experts have their ear and eye trained so well that they can tell almost instantly from the symptoms the cause of overheating of bearings. Training and experience make one's service invaluable in this respect. The man who knows how will thus prevent a breakdown and save valuable machinery. The man who does not know how will let things go, hoping that the machinery will right itself in time.

Noisy operation of all machinery means something wrong. The noise is the machine's protest against unbearable conditions. Especially in electrical machinery does noisy operation indicate something radically wrong. But how can the expert locate the trouble?

Suppose there is strong vibration, changing with the speed, and sometimes almost disappearing at certain speeds but returning with others. That means to the expert that the armature, revolving field or pulley or some other part of the machine is out of balance. The remedy is to stop the machine and make a perfect balance of parts, and then secure them firmly in position. Balance the armature and pulley separately. Sometimes the vibration is due to the armature striking or rubbing against the pole pieces. To find this out revolve the armature slowly to see if any portion of it touches or is so close as to touch when the machine is running. If it tends to stick or touch at any point, adjust it properly. Chip off or bind down any part of the armature that projects and causes the trouble, or file on all sides until there is a uniform clearance between it and the pole pieces at all points.

A rattling noise as well as excessive vibration is often due to shaft collar or shoulder, hub or edge of pulley or even the belt striking or scraping against bearings. Shift the collar or pulley and file properly or straighten the belt until it cannot strike. Rattling may also be due to loose screws or other parts. All screws, nuts and binding posts should be examined and tightened. This is the most common trouble in noisy machinery, especially in electrical machines which run at high speed. A worn screw or nut will work loose easily at high speed, and a worn or poorly fitted bearing will do the same.

Humming, hissing or squeaking that has a high pitch can generally be located by placing the ear near the commutator. Lift off the brushes one at a time, and if it is due to a sticky commutator a little application of oil will remedy it. Adjust the brushes carefully and smooth the commutator by filing and sandpapering. Great care must be exercised in this, and everything must be cleaned afterward or the grit of the sandpaper will cause trouble. Carbon brushes are sometimes apt to squeak in starting up or at low speed, but decreases at high speed. This is sometimes remedied by moistening the brush with oil or by shortening or lengthening the brushes. Run the machine with little or no load until the commutator and brushes are worn smooth. Sometimes a generator or motor seems to make a noise that is in reality caused by the engine. A good way to trace noise or vibration is to hold one end of a pencil in the teeth and place the other firmly against various suspected parts of the machine. The teeth are very sensitive to the vibrations, and they will soon show where they are the greatest.

Sparking at the commutator is a common trouble, but if only of moderate duration and amount it does not indicate anything seriously wrong; but if very persistent and considerable in amount, the cause should be hunted out and the remedy applied. If very bad it may burn and roughen the commutator, and even produce sufficient heat to injure the armature or bearings. Almost any machine having a commutator is liable to spark a little, and it is only when it grows excessive that notice should be taken of it. In properly designed and constructed machines the sparking is very slight and occasional.

One reason for excessive sparking is that the armature is carrying too much current or overload, which may be due to a short circuit somewhere. Excessive voltage on a constant-potential circuit or excessive amperage on a constant-current circuit may be responsible for the trouble. Any abnormal friction caused by armature striking or rubbing against the pole pieces may set up excessive sparking. A shaft that is sprung, bent or out of place may set up the same trouble as an overload. The remedy is to reduce the load, eliminate any short-circuit, and decrease the magnetic strength of the field in the case of a dynamo and increase it in the case of a motor.

Brushes not set at a neutral point will cause sparking, and also when the brushes make poor contact with the commutator. A close examination may show that the brushes touch only at a corner owing to the presence of dirt on the surface. Too much oil sometimes will cause the same trouble, or if the commutator is very dry a layer of smudge on it may be detected. Clean carefully. Occasionally a "glass-hard" carbon brush is met with, and it is incapable of wearing to a good contact and will therefore touch only at one point. Some carbon brushes are of such abnormally high specific resistance that it is impossible to get a good electrical contact with them. The only remedy is to get new ones.

The electrical doctor certainly has about as many symptoms of trouble to study as the physician who doctors human beings. The only difference appears to be that the human patient can tell just where the pain is. The electrical machine tries to do the same, but because so few comparatively understand the language of the machinery, the cause of the diseases are not always easily detected. A lot of tinkering and fooling in a blind sort of way would be avoided if every electrician understood the language of machinery. Some know it so well that they can tell instantly when trouble is brewing, and they can also often locate the seat and cause of it with unerring accuracy. A good thing for the young electrician would be to study carefully this language, and when he has thoroughly mastered it his services will be worth a good deal.

A Pantograph

(Concluded from page 251)

C as a centre another arc was drawn, thus locating point F by the intersection of the two arcs. The distance AC was then divided into two parts, AB and BC. AB was bisected and a perpendicular drawn to it at the point of bisection. The inter section of this perpendicular with the member AF, gave the point D which corresponds to point F in the table. In the same way the distance AC was divided so as to locate all the other points: $1\frac{1}{8}$ AB being made equal to AC; $1\frac{1}{4}$ AB equal AC; $1\frac{1}{2}$ AB equal AC, etc., put to 8 AB equal AC.

If there are any ratios not given which the reader wishes to use they may, of course, be obtained in the above manner. The construction, however, requires a beam compass, which instrument will be described in another article.

It is now possible to turn on pure and invigorating air like electric light—by snapping a switch. The ozonizer can be attached to any electric light socket. Its function is the production from the atmosphere of ozone, a colorless gas which possesses extraordinary antiseptic and deodorizing qualities. By means of the new invention the invigorating air of the mountain top can be brought into the household.

THE MOTION PICTURE—Part VI

STANLEY CURTIS

The Stereopticon

Prior to the introduction of the cinematograph, the stereopticon or dissolving-view magic lantern reigned supreme in the lecture and general exhibition field. The novelty of "animated pictures" appeared to supplant the beautiful dissolving-view effects of the stereopticon, in the favor of the public for several years, but today we may find a pleasing combination of stereopticon views and moving pictures in many of the leading theatres.

The dissolving-view stereopticon may be described as two separate and distinct magic lanterns, usually arranged one above the other, having perfectly matched condensing and objective lenses and fitted with shutters so that the light may be slowly cut off from one instrument while it is growing brighter in the other. If a slide is placed in each lantern and the shutters are operated, the one view appears to literally melt into the other.

A third instrument is sometimes placed above the other two for the purpose of producing lightning, cloud effects, rain, snow, insects, angels, and many other effects on the pictures produced by the lower stereopticons. In the hands of a competent operator, the triple stereopticon may be made to produce effects beautiful beyond description. One especially striking series of views the writer calls to mind is the "Rock of Ages" set. The various scenes are projected from the lower stereopticons, while visions of passing clouds, angels, etc., are flashed from the upper instrument.

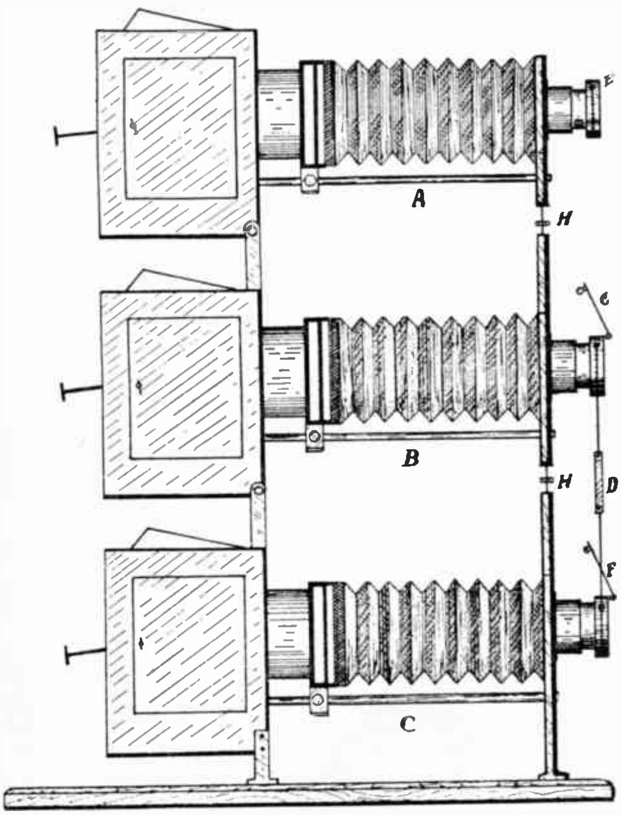


FIG. 19

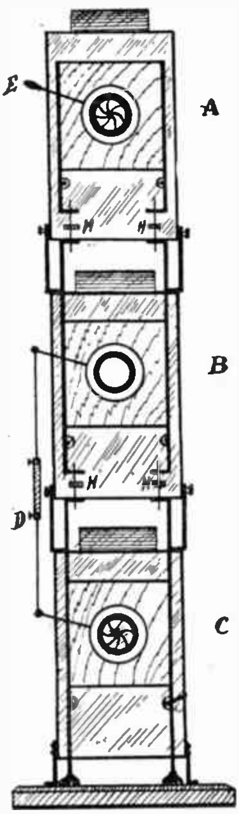


FIG. 20

Stanley Curtis -1910-

For various reasons these highly artistic effects are seldom seen in the average motion-picture theatre, the stereopticon in most cases being used merely for the projection of illustrated song slides. This condition of affairs may be attributed partly to the fact that the "up-to-date" theatre manager is far more interested in getting one crowd of people out of and another crowd into the theatre, than he is in presenting an interesting and entertaining show. Another reason for the lack of artistic stereopticon effects is this: the average operator of today scarcely knows how to manipulate a stereopticon in the proper manner. True, he can place the slides in their carriers and move the dissolver up or down; but how many times our eyes are offended by a big blue spot on the screen, while the "dissolving" is taking place.

Figs. 19 and 20 show the general arrangement of triple stereopticon. The iris diaphragm shutter is illustrated, as that is by far the best and most extensively used means of cutting off the light. The principle of operation is easily understood by reference to the drawings. The first slide to be shown is placed in instrument B, and the handle D is raised; this permits the rays of light to pass through the objective and the view is thrown on to the screen. The next slide may then be placed in lantern C, and the safety cap F raised, as the shutter beneath it is closed. By moving the handle slowly and evenly down, the view in C grows brighter and that in B fades out.

The action of the iris diaphragm is, no doubt, familiar to most readers, but for those who do not understand it, a glance at Fig. 21 will explain. In A, the iris is open to the fullest extent; at B it is half closed; while at C, no light can pass. The advantage of cutting off the light equally from all sides may be readily seen.

The third or upper lantern A, has an independent shutter operated by lever E, and from this instrument the various effect slides are projected upon the views shown by the lower lanterns.

Oxy-hydrogen gas or "lime-light" was used extensively a few years ago for dissolving stereopticons, and is still used in those rare instances where electricity cannot be obtained. The dissolving was done by an automatic valve which cut off the gas from one lantern and turned it on in the other. Unless well made, these valves frequently cause no end of trouble. The writer will not take up the subject of oxy-hydrogen light here in detail, as its use is prohibited by the authorities in many states in connection with or even in the same booth with a motion-picture machine using celluloid film.

A slide carrier, usually of the form shown in Fig. 22, is secured in each stereopticon. Most slides have a "thumb mark" in the lower left-hand corner to guide the operator, but he should never rely upon this mark implicitly, particularly in the case of a new set of slides, for the marks are sometimes misplaced; indeed they are often omitted entirely. The operator should therefore form a habit of glancing at each slide as he places it in the carrier. The slide must be *upside down* in the carrier, and the reading matter, if there is any in the slide, must start at the operator's side of the lantern. Fig. 22 shows this clearly, and illustrates a simple rule by which the operator may guide himself. Holding the slide up before him so that the reading matter runs from left to right, the operator inverts the slide as shown by the dotted lines in Fig. 22. To the uninitiated it may appear that some of this explanation is superfluous, but when the operator has to place and dissolve sixteen slides for a quick march song, for instance, in the space of three minutes, and all of this in comparative darkness, the lay reader can readily see that he must have a quick and effective rule to follow, otherwise in the hurry, several slides might appear either upside down or backwards on the screen.

Each day before the performance starts, the careful operator will light up the stereopticons and see if the projected squares of light on the screen are perfectly "registered." To do this the dissolving handle is placed in a neutral position, which permits an equal amount of light to pass from each lantern. If everything is properly set, only one sharp square of light is visible; but if such is not the case, a double square may be seen. The up and down adjustment is made at H, Figs. 19 and 20, and the

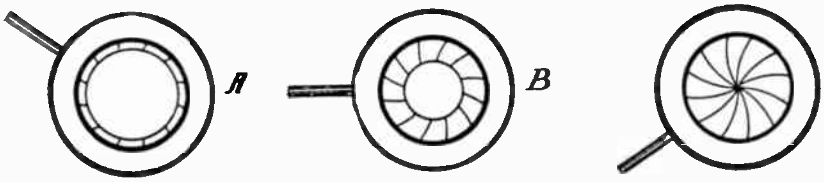


FIG. 21

Stanley Curtis - 1912 -

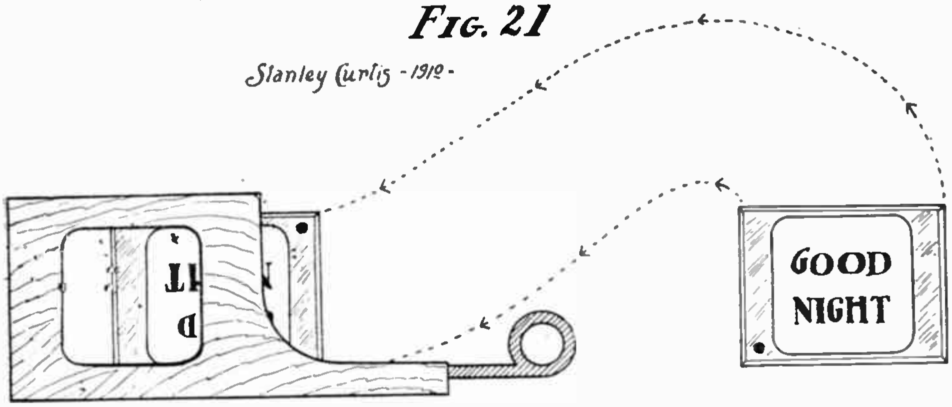


FIG. 22

lateral adjustment by moving the slide-carrier to one side or the other as necessary. This adjustment must be made with great care, as a movement of a sixteenth of an inch, even, is enormously magnified on the screen.

Probably the elimination of the blue spot, which appears frequently on the screen as the dissolving is done, has puzzled the operators more than anything else in connection with stereopticon work. There are two principal causes for the appearance of this very annoying "ghost"; one, the most troublesome perhaps, is when the condensing lenses are not of the proper focal length to go with the particular objective lens with which they are used. The focal length of the condenser should be such that its greater conjugate is equal to the equivalent focus of objective when arc is from 3½ to 4 in. from condenser.

The other cause for the blue ghost may be when the illuminant is not correctly centred and focused. Assuming that the condensers are suited to the objective lens, the adjustment of the arc is simple. This adjustment is also made in one lantern at a time with the others dark. The diaphragm is opened fully after the light has been started. If a shadow appears across the upper part of the field of light, the arc is too high; shadow across the lower field, arc is too low; shadow to right or left, arc is too far to right or left respectively. When the arc is centred there may be a ring or fringe of blue or orange colored light near the edge of the field. This may be removed by moving the arc nearer to or farther from the condensing lens, as the case may be. After these adjustments are completed, the diaphragm should be partly closed and the adjustment carried on, as every little imperfection shows as the light is shut off by the diaphragm.

THE BOOTH

In this chapter general specifications for the construction of booths or enclosures for motion-picture machines, as required by the Inspection Department of the Massachusetts District Police, will be given. A booth of this description is practically faultless, and, if properly constructed, will stand a most terrific film fire without showing any noticeable smoke or flame on the outside.

The booth should be at least 7 ft. high, the floor space to vary according to the number of machines in the booth, as follows: one picture machine, 6 x 8 ft.; one picture machine and one stereopticon, 9 x 8 ft.; two picture machines and one stereopticon, 12 x 8 ft. If there is any likelihood of a spotlight being installed, additional space should be provided.

The frame to be made of structural steel, as follows: four outside horizontal members at top and bottom; four upright corners and members supporting roof to be made of 1½ x 1½ x ¼ in angle irons. (*A*, Figs. 23, 24, 25 and 26).

Intermediate uprights to be spaced every 2 ft., and to be made of either 1½ x 1½ x ¼ in. angle iron; or of 2 x 2 x ¼ in. tee irons. (*B*, Figs. 24 and 25.)

Tee irons to which the roof is attached to be made of 1½ x 1½ x 3/16 in. tee irons. (*C*, Figs. 23 and 26.)

All joints to be made with a 3/16 in. steel plate, to which each angle iron or tee iron shall be riveted or bolted by the use of at least two ¼ in. bolts or rivets. (Fig. 27.)

All bolts or rivets in frame to have flat heads, said heads always to be placed on exterior side of booth; all angle or tee irons being so countersunk as to accomplish this result. (See Fig. 27.)

Frame to be built with a 6 x 2 ft. doorway (Fig. 27); frame of doorway to be built of 1 x 1 x 3/16 in. angle irons, which are to be joined together by the use of a 3/16 in. steel plate similar to that shown in Fig. 27.

Main Door.—Outside of door to be provided with a substantial spring sufficient to keep the door closed. The door to be provided with a stop to prevent it from swinging into booth or injuring the hinges.

Shelves.—To be made up of slate slabs or board not less than ⅞ in. thick, not exceeding 4 ft. in length or 12 in. in width. Said shelves, if of board, to be painted with at least three coats of asbestos paint, and supported by means of angle irons as shown in Fig. 4. The upper shelf to be used for rewinding and repairing of films; the lower shelf to be used for the storage of films. A separate metal case, made without solder, shall be provided for each film when the same is not in the magazine or in process of rewinding.

Ventilation.—Booths to be provided with an inlet on each of the four sides, said inlets to be 15 in. long and 3 in. high, the lower side of the same not to be more than 3 in. above the floor level. Said inlets to be covered on the inside with a wire net of not greater than ⅛ in. mesh, netting to be firmly secured to the asbestos board by means of iron strips and screws. (See Fig. 25.)

Near the centre of the top of the booth shall be a circular opening of not less than 10 in. in diameter, the upper side of said opening to be provided with an iron flange, which flange is to be securely fastened to the tee irons supporting the roof, as shown in Fig. 1. Securely fastened to this flange shall be a vent pipe of not less than 10 in. diameter, said pipe leading to the outside of the building, or to a special incombustible vent flue. In this vent shall be placed a box containing a 12 in. electric fan (see Fig. 24), said box to be provided with a door of sufficient size to permit of the examination or removal of this fan, this door to be made tight and provided with proper fastenings. Box and vent pipes to be made of galvanized iron or other incombustible material. Fan to be so connected that it can be controlled from within the booth.

Covering of Booth.—The sides and top of booth and door to be covered with asbestos boards of at least ¼ in. thickness, said boards to be so cut and arranged that vertical joints between boards shall always come over an angle or tee iron, so that both boards may be securely fastened to the same. (See Fig. 28.)

After booth is complete, all openings where combustible material is exposed must be plugged with asbestos cement or other equally satisfactory material. When joints of asbestos boards on outside of booth do not come over angles of tee irons, the cracks between the boards shall be covered with a strip of asbestos board at least ⅛ in. thick and 2 in. wide, said strips to be securely fastened to both boards in such manner as to cover the exposed joints. The above-mentioned strips and all asbestos board shall be secured in place by means of proper bolts and nuts; said bolts and nuts to be spaced not more than 6 in. apart.

Flooring.—Floor shall be made of two parts, an upper and a lower floor. Lower floor shall be made of board of

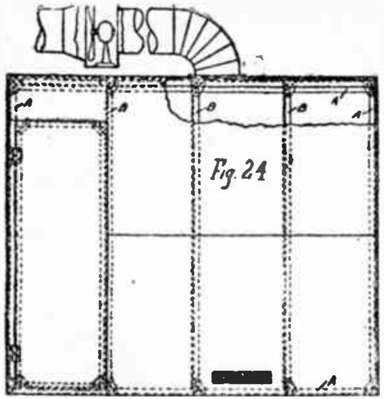


Fig. 24

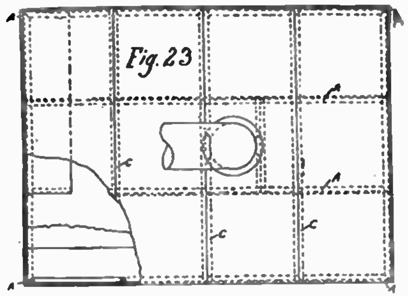


Fig. 23

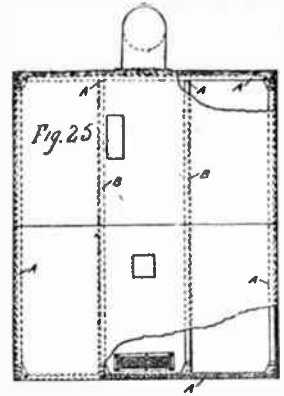


Fig. 25

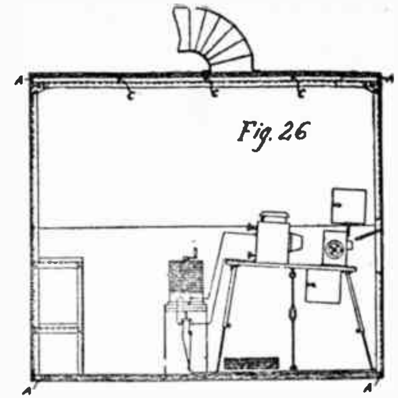


Fig. 26

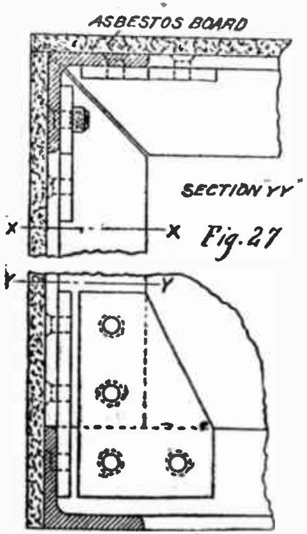


Fig. 27

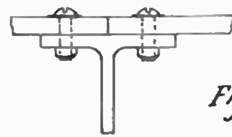


Fig. 28

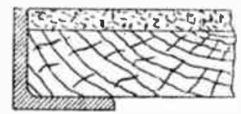


Fig. 29

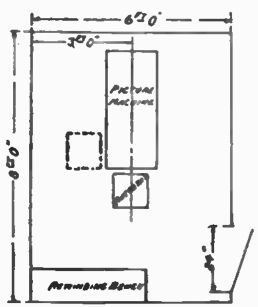


Fig 30

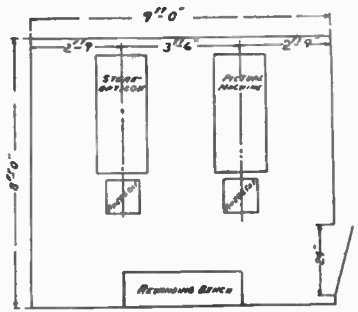


Fig 31

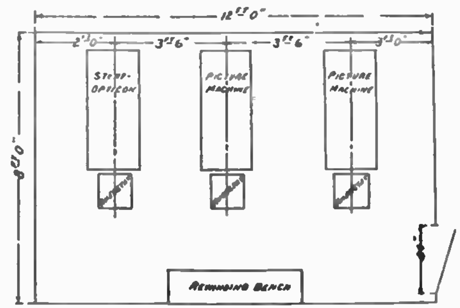


Fig. 32

⅞ in. thickness, supported on lower leg of horizontal angle irons. Resting on this floor shall be a floor made of asbestos board of ⅜ in. minimum thickness, or an equally good material. Concrete is widely used for the fireproof floor and makes an excellent substitute for asbestos. (See Fig. 29.)

Windows.—There shall not be more than two windows per machine in the booth, one for the operator and one for the machine. Window for the machine shall not be more than 6 in. high and 12 in. long, and shall be located and cut after machine is set up. Operator's window shall not be more than 4 in. wide and 12 in. high. All windows shall be provided with gravity doors, which, when closed, shall overlap the opening at least 1 in. on all sides; said doors to be held open normally by use of a fine combustible cord in series with a fusible link, so arranged that the doors may be easily released by hand.

Wiring.—If house lights are controlled from within the booth, an additional emergency control must be provided near the main exit, and kept at all times in good condition.

All electric wires to be brought into the booth and carried to all machines, lights, etc., in conduits, as shown in Fig. 4. One light will be allowed for each machine and one for the rewinding bench, but all such lights shall be provided with wire guards.

Rheostats. — All rheostats to be mounted on slate insulator properly supported, said supports to be made of iron and securely fastened to the floor. Rheostats to be securely fastened to slate insulator.

Machines.—Machines must be securely fastened to the floor, to prevent accidental overturning or moving of same. (See Fig. 26.)

Machine Location.—Machines to be located approximately as given in the plans, *viz.*: small booth, Fig. 30; medium booth, Fig. 31; largest booth, Fig. 32.

The picture machines must always be so located that the driving belt will be at least 2 ft. from the nearest parallel wall.

When the top magazine overhangs the front of the machine to such an extent that the passageway between rheostats and rewinding bench becomes too narrow, the rheostats may be set to one side of the machine, as indicated by dotted lines in Fig. 30; but rheostats shall always be mounted directly in the rear of the machine, when practicable. The location of the booth shall be subject to the approval of the State Inspector of Factories and Public Buildings.

Note.—These specifications are to be followed in the construction of every moving-picture machine booth, unless omitted or changed in part by the State Inspector. Booths must be approved by the Inspection Department of the State District Police. There is a decided advantage in placing the rheostats outside of the booth entirely, enclosing them in an incombustible box having a vent pipe leading from it to the main vent pipe from the booth. This box should be readily accessible to the operator and should be provided with a cover, easily removable.

(*To be continued*)

Vision as it is supposed to be

The traveling public, whether by land or sea, takes it for granted that the pilots and the captains and the locomotive engineers have good sight, or else they would not be there; and the same is thought to be true of policemen, firemen, and especially surgeons. As a matter of fact, however, all of these people come under the rule of the loss of accommodation for far and near as they grow older, and if examined by the usual tests there would be many of them who would be found to be lacking in visual acuity. Many a surgeon performs an operation without glasses when he does not see with the clearness which he did in earlier years. He can put on glasses and see as well as ever; sometimes he does and sometimes he does not. In the latter case he is spoken of as "clear eyed," while in the former his sight is "failing," whereas the truth is the other way, for the surgeon wearing the glasses not only sees well with them, but is preserving his good sight, while the surgeon who does not is compelled to depend unduly on his sense of touch. And yet the public, which does not know, would have the most faith in the man without the glasses.—*Optical Journal.*

ALPHABETICAL LIST OF CALL LETTERS OF WIRELESS STATIONS OF THE WORLD

(Including Shore Stations, Merchant Vessels, Revenue Cutters and Vessels of U.S. Navy)

A	Isle of Shoals, N.H.
AB	S.S. Alabama
AB	S.S. Sabine
AB	S.S. Chicago
ABD	S.S. Aberdeen
AC	S.S. Concho
AD	S.S. Denver
AD	S.S. Victoria
ADM	Amsterdam, Holland
AF	S.S. Colorado
AG	S.S. Rio Grande
AG	S.S. Yucatan
AH	S.S. Nueces
AH	S.S. Pennsylvania
AJ	S.S. Alamo
AJA	German pilot steamer Jade
AK	S.S. San Marcos
AK	S.S. Santa Clara
AL	S.S. Loftus Cuddy
ALG	Algiers, Algeria
ALM	Almeria, Spain
AM	S.S. America
AM	S.S. Comal
AM	S.S. Riverside
AM	Kamalo, Molokai, Hawaiian Islands
AN	S.S. Northwestern
AN	Anticari, Montenegro
AND	S.S. Minda
AO	S.S. Ohio
AP	S.S. Lampasas
AQ	S.S. City of Benton Harbor
AQ	S.S. Roanoke
AS	S.S. San Jacinto
AS	S.S. Admiral Sampson
ASD	Amsterdam navy-yard
ATB	U.S. Army transport Buford
ATD	U.S. Army transport Dix
ATH	U.S. Army transport Sumner
ATK	U.S. Army transport Kilpatrick
ATL	U.S. Army transport Logan
ATR	U.S. Army transport Sherman
ATS	U.S. Army transport Sheridan
ATU	U.S. Army transport Thomas
AU	S.S. Dolphin
AU	Chatham, Mass.
AV	S.S. Seward
AW	S.S. Olympia
AX	S.S. Kansas City
AX	Atlantic City, N.J.
AY	S.S. Geo. W. Elder
AZ	S.S. Brazos
A2	Avalon, Catalina Island, Cal.
A3	Tug Tyee
B	Baltimore, Md. (American Building)
B	Bocas del Toro, Panama
BA	S.S. Bermudian
BA	Buenos Aires, Argentine Republic
BA	Batavia, Dutch East Indies
BAO	Abo, Russia
BBF	S.S. Batavier IV
BBS	S.S. Batavier II
BBT	S.S. Batavier III
BBV	S.S. Batavier V
BC	S.S. Virginia
BD	S.S. W. S. Porter
BD	S.S. Trinidad
BD	New York, N.Y.
BF	Buffalo, N.Y. (News building)
BF	Philadelphia, Pa.
BG	Bridgeport, Conn.
BG	S.S. Iroquois
BGF	Helsingfors, Finland
BH	Boston, Mass. (Boston Herald)
BH	S.S. Chippewa
BH	Benton Harbor, Mich.
BH	Blaavands Huk, Denmark
BI	S.S. Indianapolis
BJ	S.S. John J. Barlum
BLH	Leckte, Russia
BLW	Libau, Russia
BM	S.S. Nyack
BN	S.S. Boston
BN	S.S. Rosecrans
BNCh	Nikolaistadt, Russia
BO	S.S. Nann Smith
BO	Brant Rock, Mass.
BP	S.S. Hermosa
BPS	Preste, Russia
BR	S.S. Bruce
BR	S.S. Thomas Barlum
BR	Britz, Germany
BRBR	Overtoom, Holland
BRW	Reval, Russia
BS	Philadelphia, Pa. (Bellevue-Stratford)
BS	Washington, D.C., Bureau of Standards
BS	U.S. Army cableship Burnside
BSP	Sevastapol, Russia
BT	S.S. Nyades
BTL	Butt of Lewis, Scotland
BU	S.S. Rupert City
BV	S.S. Cabrillo
BW	S.S. Alliance
BWT	Vladivostok, Siberia
BX	S.S. City of South Haven
BY	Shoeburyness, England
BYN	Babylonia, Brazil
BYR	Bombay, India
B2	Bessemer Barge No. 2
B3	Tug Goliath
C	Camaguey, Cuba
CA	S.S. City of Alpena
CA	S.S. Coamo
CA	S.S. Priscilla
CA	Cambridge, England
CAN	Saginaw, Mich.
CAR	S.S. Ashtabula
CAR	S.S. Regele Carol I.
CB	S.S. Carolina
CB	Buffalo, N.Y.
CB	Boca del Colorado, Costa Rica
CB	Cheribon, Dutch East Indies
CBJ	S.S. Sierra
CC	S.S. City of Cleveland
CD	S.S. City of Detroit
CD	Duluth, Minn.
CDN	Clifden, Ireland
CF	Detroit, Mich.
CG	Chicago, Ill.
CG	Cape May, N.J.
CG	S.S. City of St. Ignace
CG	Charlottenburg, Germany
CGS	S.S. Quadra
CH	Port Huron, Mich.
CH	San Francisco, Cal. (Chronicle)
CH	Chamartin, Spain
CHA	S.S. Harmonic
CHN	S.S. Huronic
CI	Erie, Pa.
CJ	Sault Ste. Marie, Mich.
CJ	S.S. San Juan
CJA	S.S. Juanita
CJL	Detroit, Mich. (Detroit Journal)
CLS	S.S. Charlois
CM	Calumet, Mich.
CM	Milwaukee, Wis.
CM	Buenos Aires, Argentine Republic
CMA	S.S. Hugh Kennedy
CMB	S.S. Jos. Sellewood
CMD	S.S. S. M. Clement
CMF	S.S. Pendenis White
CMG	S.S. Moses Taylor
CMH	S.S. James Gayley
CMI	S.S. W. H. Gratwick
CMJ	S.S. J. J. Albright
CMK	S.S. Walter Scranton
CMN	S.S. E. A. S. Clarke
CMP	S.S. Wm. E. Reis
CMQ	S.S. N. A. Hanna
CMR	S.S. H. S. Houlden
CMS	S.S. Lagonda
CMU	S.S. J. J. McWilliams
CMV	S.S. Major
CMW	S.S. Robt. L. Fryer
CN	Cleveland, Ohio
CO	Ashtabula, Ohio
CO	Cayo Criso, Cuba
CO	Coruna, Italy
CON	Marion, Mass.
COR	Corvo, Azores
CP	S.S. Ponce
CPA	Port Arthur, Ontario
CPC	S.S. Princess Charlotte
CPM	S.S. Princess May
CPR	S.S. Princess Royal
CPT	Tug Tees
CPV	S.S. Princess Victoria
CQ	Marquette, Mich.
CR	S.S. City of Erie
CS	S.S. Seneca
CS	S.S. Eastern States
CST	St. Thomas, Ontario
CT	S.S. Canada
CT	Toledo, Ohio
CTA	S.S. Tionesta
CU	S.S. City of Buffalo
CW	S.S. Commonwealth
CW	S.S. Western States
CW	Detroit, Mich.
CX	S.S. St. Croix
CX	Cleveland, Ohio
CY	Bay City, Mich.
DA	Seattle, Wash. (Hotel Perry)
DA	Santa Clara, Cuba
DA	S.S. Philadelphia
DAA	S.S. Admiral
DAB	S.S. Augustus B. Wolvin
DAB	S.S. Burgomaster
DAC	S.S. Dacia
DAF	S.S. Field Marshall
DAH	S.S. Adeline
DAI	S.S. Anni
DAK	S.S. Kronprinz
DAM	S.S. James H. Hoyt
DAN	S.S. Frank H. Peavey
DAN	S.S. Neubau
DAP	S.S. Prinz Regent
DAW	S.S. Adolf Woermann
DAZ	S.S. Prinzessin
DB	Tacoma Wash.
DB	S.S. Caracas
DBB	American schooner Dorothy B. Barrett
DBB	S.S. Birkenfels
DBN	Durban, Natal
DBR	S.S. Bremen
DBW	S.S. Bulow
DC	Washington, D.C. (Eighth and Water Streets)
DC	S.S. Iowa
DCA	S.S. Cap Arcona
DCB	S.S. Cap Blanco
DCE	S.S. Cap Verde
DCF	S.S. Cap Frio
DCF	S.S. Tietgen
DCH	S.S. Clare
DCI	S.S. Kronprinzessin Cecile
DCL	S.S. Clara Blumenfeld
DCO	S.S. Cap Ortegal
DCR	S.S. Cap Roca
DCV	S.S. Cap Vilabo
DDA	S.S. Kaiserin Augusta Victoria
DDB	S.S. Bleucher
DDC	S.S. Cincinnati
DDG	S.S. Bulgaria
DDF	S.S. Pisa
DDH	S.S. Hamburg
DDI	S.S. President Lincoln
DDJ	S.S. Batavia
DDL	S.S. Deutschland
DDM	S.S. Moltke
DDN	S.S. Pennsylvania
DDO	S.S. Prinz Oscar
DDP	S.S. Patricia

DDQ	S.S. Pallanza
DDR	S.S. Amerika
DDS	S.S. President Grant
DDT	S.S. Pretoria
DDV	S.S. Cleveland
DDW	S.S. Graf Waldersee
DDZ	S.S. Prinz Adalbert
DE	Pasadena, Cal.
DEH	S.S. Edmund
DER	S.S. Derfflinger
DEW	S.S. Elenore Woermann
DF	Santa Barbara, Cal. (Hotel Potter)
DF	Vancouver, British Columbia
DFB	S.S. Furst Bismarck
DFB	S.S. Fred. B. Wells
DFH	S.S. Fritz
DG	Sacramento, Cal.
DGK	S.S. D. G. Kerr
DGO	S.S. Grosserog von Oldenburg
DGN	S.S. Goeben
DGU	S.S. Gneisenau
DGW	S.S. Gertrude Woermann
DH	S.S. Kingfisher
DHB	S.S. Helene Blumenfeld
DHC	S.S. Camerones
DHE	S.S. Heluan
DHG	S.S. Habsburg
DHM	S S. Mendoza
DHN	S.S. Hohenstauffen
DHN	S.S. Frank T. Heffelinger
DHO	S.S. Hellig Olav
DHP	S.S. Presidente de Mintre
DHQ	S.S. Presidente Quintana
DHR	S.S. Holger
DI	S.S. Kingsway
DIR	S.S. Imperator
DJ	San Pedro, Cal.
DJC	S.S. James C. Wallace
DJR	S.S. James H. Reed
DK	Everett, Wash.
DKA	S.S. Kronprinzessin Cecile
DKB	S.S. Berlin
DKD	Ikeda Head, Wash.
DKD	S.S. Friedrich der Grosse
DKE	S.S. Princess Irene
DKF	S.S. Prinz Friedrich August
DKF	S.S. Konig Friedrich August
DKG	S.S. Konig Wilhelm II
DKG	S S. Grosser Kurfurst
DKI	S.S. Main
DKK	S.S. Neckar
DKL	S.S. Konigen Luise
DKM	S.S. Kaiser Wilhelm II
DKN	S.S. George Washington
DKO	S.S. Konig Albert
DKP	S.S. Kronprinz Wilhelm
DKR	S.S. Rhein
DKS	S.S. Barbarossa
DKW	S S. Kaiser Wilhelm der Grosse
DKZ	S.S. Prinzess Alice
DLO	S.S. Lutzow
DLW	S.S. Lucile Woermann
DM	Duluth, Minn.
DMR	S.S. Meteor
DMZ	S.S. Mainz
DN	San Luis Obispo. Cal.
DN	Drogden, Denmark
DNH	S.S. Nora
DOA	S S. Moskwa
DOR	S S. Oscar Second
DP	Dieppe, France
DPA	S.S. Prince Adalbert
DPE	S.S. Prinz Eitel Friedrich
DPL	S.S. Prinz Ludwig
DPS	S.S. Prince Sigismund
DPW	S.S. Prince Waldemar
DR	Eugene, Oregon
DR	Detroit, Mich.
DRC	S.S. Corcovado
DRL	S.S. Prinz Regent Luitpold
DRN	S.S. Roon
DS	South Haven, Mich.
DS	Port Townsend, Wash.
DSA	S.S. Scharnhorst
DSH	S.S. Senator Holthusen
DSM	S.S Sarnia
DSO	S.S. H. P. Bope
DSR	S.S. Senator Refardt
DST	S.S. Kleist
DSV	S.S. Siberia
DSZ	S.S. Seyditz
DTG	S.S.Titania
DTP	S.S. Admiral
DU	Wilmington, Del.
DU	Juneau, Alaska
DUF	S.S. Geo. W. Peavey
DUS	S.S. United States
DV	Chehalis, Wash.
DW	Newport, Oregon
DWA	S.S. Ward Ames
DX	Toledo, Ohio (Hotel Secor)
DYA	S.S. Ypiranga
DYK	S.S. Yorck
DZ	Lansing, Mich.
DZ	Portland, Ore.
DZN	S.S. Ziethan
D1	American schooner Pendleton Sisters
D2	Port Townsend, Wash.
EG	S.S. Earl Grey
EN	S.S. El Norte
ES	S.S. Easton
EY	Cerritos de Sinaloa, Mexico
FA	U.S. Army cable boat Field
FA	S.S. City of Columbus
FA	Malabang, P.I.
FAL	Fayal, Azores
FAU	Outer Jade lightship,Germany
FB	S.S. City of Atlanta
FB	Fairbanks, Alaska
FBR	Borkum Reef lightship, Germany
FC	Fort Andrews, Mass.
FC	S.S. City of Macon
FD	Fort Wood, N.Y.
FD	S.S. City of Memphis
FD	Nome, Alaska
FE	Ferrol, Spain
FE	Kotlik, Alaska
FEF	Elbe I lightship, Germany
FG	S.S. Naomi
FG	Fort Gibbon, Alaska
FH	Corregidor Island, P.I.
FIF	Eider lightship, Germany
FJ	S.S. City of Augusta
FJ	Fort Stevens, Ore.
FK	S.S. City of Savannah
FK	Circle City, Alaska
FL	Forth Leavenworth, Kan.
FLO	Flores, Azores
FLK	Flekkero, Norway
FM	Fort St. Michael, Alaska
FM	Fort Morgan, Ala.
FM	Zamboanga, P.I.
FN	Fort Hancock, N.J.
FNL	Flannon Isle, Scotland
FNT	Fastnet, Ireland
FO	Fort Monroe, Va.
FP	S.S. Nacoochee
FP	Petersburg, Alaska
FQ	Fort Egbert, Alaska
FR	U.S. Army cable ship Joseph Henry
FS	Fort Omaha, Neb.
FS	Jolo, P.I.
FT	Fort Totten, N.Y.
FV	Fort Levett, Me.
FVG	Villegignon, Brazil
FW	Fort H. G. Wright, N.Y.
FW	Wrangell, Alaska
FWF	Wesser lightship, Germany
FX	S.S. City of St. Louis
FX	Fort Worden, Wash.
FY	S.S. City of Montgomery
FY	U. S. Artillery harbor tug General R. B. Ayres
FZ	Yacht Lydonia
FZ	Fort Riley, Kan.
GA	S.S. City of Seattle
GB	S.S. Capt. A. F. Lucas
GB	Cape Breton, Glace Bay, Nova Scotia
GBA	Bolt Head, England
GC	S.S. Georgia
GCK	Brow Head, Ireland
GCS	Caistor, England
GD	Standard Oil barge 91
GD	Graady lightship, Denmark
GF	S.S. City of Everett
GF	S.S. Falcon
GH	S.S. Maverick
GH	Grand Haven, Mich.
GJ	Gjedser, Denmark
GK	S.S. Cottage City
GK	Standard Oil barge 94
GK	Karlskrona, Sweden
GLD	The Lizard, England
GLV	Liverpool, England
GM	Grand Marians, Minn.
GM	S.S. Asuncion
GM	S.S. Pilgrim
GMH	Malin Head, Ireland
GN	S.S. Atlas
GNF	North Foreland, England
GNI	Niton, England
GO	Chicago, Ill. (Congress hotel)
GP	Standard Oil barge 95
GQ	S.S. City of Pueblo
GRA	Copenhagen, Denmark
GRA	Guaraliba, Brazil
GRL	Rosslare, Ireland
GRM	Grand Rapids, Mich.
GS	S.S. Astral
GS	S.S. Senator
GU	S.S. Umatilla
GU	Guernsey, England
GU	Guadalajara, Spain
GV	Galveston, Texas
GV	S.S. Governor
GW	Grand Island, La.
GW	S.S. President
GX	S.S. Queen
G2	Los Angeles, Cal.
H	Holland, Mich.
H	Horten, Norway
HA	Cape Hatteras, N.C.
HB	New Orleans, La. (United Fruit Co.)
HB	U.S. Army Artillery harbor tug Harvey Brown
HBR	Heysham, England
HC	S.S. Arizona
HC	Carlobago, Austria Hungary
HD	S.S. Alameda
HD	Elizabeth City, N.C.
HDR	Helder, Holland
HF	Fiume, Austria Hungary
HK	S.S. Mariposa
HK	New Orleans, La.
HK	Cape d'Aguilar, Hongkong
HKS	Haaks lightship, Holland
HM	S.S. Jefferson
HN	S.S. Hanalia
HN	S.S. Chester W. Chapin
HN	S.S. Missouri
HNU	Hunstanton, England
HO	S.S. Corwin
HO	S.S. Chicago
HOK	Hoek van Holland
HP	Trinidad (High Post)
HQ	Mackinac Island, Mich.
HR	Horns Reef lightship, Denmark
HR	Cabo Haro, Mexico
HS	Tug Savage
HSM	S.S. Londonderry
HT	Nak Nek, Alaska
HU	Kahuku, Oahu, Hawaiian Islands
HV	Havana, Cuba (Vedado)
HV	S.S. Grant
HW	S.S. Mackinaw
HY	Cuban revenue cutter Hatuey
HX	Ludington, Mich.
HX	S.S. Humboldt
HY	Amesbury, Mass.
HY	S.S. Plymouth
HZ	Zengg, Austria Hungary
H2	S.S. Rose City
IBF	Brest, France (arsenal)
ICL	Ilha das Cobras, Brazil
IH	Inistrahull, Ireland
IN	S.S. Illinois
ITF	Toulon, France
ITR	S.S. Imparatul Traian
IVF	Port Vendres, France
JC	S.S. City of Racine
JCA	Kingston, Jamaica
JCS	Chosi, Japan
JD	S.S. North Land
JE	Jersey, England
JH	S.S. Horatio Hall
JM	S.S. Manhattan
JOI	Otchisi, Japan
JOS	Ose Saki, Japan
JS	S.S. North Star
JSM	Shiomizaki, Japan
JTS	Tsunoshima, Japan
JW	S.S. James Whalen
JX	Jacksonville, Fla.
KA	S.S. Antilles
KA	Puako, Hawaiian Islands
KAN	Angaur, Caroline Islands
KB	Spokane, Wash.
KBH	Bremerhaven, Lloyd Hall, Germany

KAR	Arkona, Germany
KBK	Bulk, Germany
KBM	Borkum, Germany
KBR	Brunsbuttelkoog, Germany
KC	S.S. Christopher Columbus
KCX	Cuxhaven, Germany
KD	S.S. Comus
KE	St. Helens, Ore.
KGH	S.S. King Harold
KHG	Helgoland, Germany
KJA	Yap, Caroline Islands
KM	S.S. Momus
KMR	Marienleuchte, Germany
KN	Erie, Pa.
KND	Norddeich, Germany
KPD	Pachena Pt., British Columbia
KR	S.S. Creole
KS	S.S. Santa Cruz
KST	Constanca, Roumania
KT	The Dalles, Ore.
KTS	Tsingtau, China
KTS	Signalberg, Germany
KU	Walla Walla, Wash.
KW	Key West, Fla.
KY	S.S. Kentucky
LH	Lahaina, Maui, Hawaiian Islands
LK(D)	Machrihanish Bay, Scotland
LNS	Cullercoats, England
LR	S.S. Lady Laurier
LRC	Castelneuvo, Austria Hungary
LRP	Pola, Austria Hungary
LRS	Sebenico, Austria Hungary
LSG	Loch Boisdale, Scotland
LU	Lussin, Austria Hungary
M	Havana, Cuba (Morro Castle)
M	Messina, Italy
MA	S.S. Alliance
MA	S.S. Maine
MAA	S.S. Carmania
MAB	S.S. Lombardia
MAC	S.S. Sicilia
MAD	S.S. Duca Degli Abruzzi
MAE	S.S. Duca di Genova
MAF	S.S. Mendoza
MAG	S.S. Cordova
MAH	S.S. Virginia
MAI	S.S. Caledonia
MAK	S.S. Indiana
MAL	S.S. Liguria
MAM	S.S. Lisiania
MAN	S.S. Niagara
MAO	S.S. Duca d'Aosta
MAS	S.S. Sardegna
MAT	Steam yacht Atalanta
MAT	American Tickle, Labrador
MAS	Asinara, Sardinia, Italy
MAU	S.S. Umbria
MAV	S.S. Florida
MAV	S.S. Alva
MAY	S.S. Antony
MB	Mobile, Ala.
MB	Cable steamer Mackay-Bennett
MBB	S.S. Asturias
MBC	S.S. Baltic
MBD	Bardera, Italy
MBE	Cape Bear, P.E.I.
MBG	S.S. Araguay
MBH	Battle Harbor, Labrador
MBI	Belle Isle, Newfoundland
MBL	Bernal, Argentine Republic
MBN	S.S. Arragon
MBO	S.S. Avon
MBQ	S.S. Ben-My-Chree
MBR	Broomfield, England
MBS	Palm Beach, Fla.
MBV	Becco di Vela, Caprera, Italy
MBW	S.S. Athenie
MBW	Brava, Italy
MC	S.S. Old Colony
MC	S.S. Sheboygan
MCA	S.S. Campania
MCB	Chateua Bay, Labrador
MCC	Cape Cod, Mass.
MCD	Steam yacht Cassandra
MCG	S.S. Cambria
MCG	Mocangue, Brazil
MCI	S.S. California
MCH	Point Rich, Nova Scotia
MCI	S.S. Chili
MCK	Clarke City, Seven Islands, Canada
MCL	Cable ship Colonia
MCM	Capo Mele, Liguria, Italy
MCN	S.S. Corsican
MCO	S.S. Chaco
MCP	Monte Capuccini, Ancona Italy
MCR	Cape Ray, Newfoundland
MCT	S.S. Bucaneer
MCY	Cape May, N.J.
MCZ	Cozzo Spadaro, Cape Passaro, Sicily
MD	S.S. Cristobal
MD	S.S. Shinnecock
MDC	S.S. Cedric
MDF	S.S. Dominion
MDL	S.S. Devonian
MDN	S.S. Sardinian
MDO	Domino Island, Labrador
ME	Steam yacht Electra
MEA	S.S. Etruria
MEB	S.S. Tamarac
MEC	S.S. Narragansett
MED	S.S. Cassandra
MEI	S.S. Iroquois
MEK	Merka, Italy
MEL	S.S. Bohemian
MEL	Melilla, Morocco
MEN	S.S. Navahoe
MEQ	S.S. Empress Queen
MER	S.S. Royal Edward
MES	S.S. Satrustegin
MET	S.S. Alfonse XII
MF	S.S. Finance
MFA	S.S. Lusitania
MFC	S.S. Arabic
MFC	S.S. Canada
MFD	S.S. Finland
MFD	S.S. W. H. Gratwick
MFH	Fraserburgh, Scotland
MFI	S.S. Furnessia
MFL	S.S. Winifredian
MFN	S.S. Pretorian
MFP	Fame Point, Quebec
MFS	Fort Spuria, Messina, Italy
MG	Tug Tatoosh
MGA	S.S. Mauretania
MGB	Steam yacht Lysistrata
MGC	S.S. Cymric
MGD	S.S. Saturnia
MGE	S.S. Germania
MGH	S.S. Harvard
MGI	Grosse Isle, Quebec
MGL	S.S. Canadian
MGN	S.S. Virginian
MGO	Giumbo, Italy
MGR	S.S. Royal George
MGY	S.S. Yale
MH	S.S. Panama
MHA	S.S. Noordam
MHB	S.S. New Amsterdam
MHC	S.S. Adriatic
MHH	New Haven, England
MHL	S.S. Cestrian
MHM	S.S. Potsdam
MHN	S.S. Cartheginian
MHP	Heath Point, Anticosti Island, Canada
MHR	S.S. Rotterdam
MHS	S.S. Statendam
MHX	Camperdown, Halifax, Nova Scotia
MHY	S.S. Rijndam
MI	S.S. Minnesota
MIA	S.S. Ivernia
MIC	S.S. Laurentic
MID	S.S. Inanda
MIK	S.S. Inkosi
MIL	S.S. Iolanda
MIM	S.S. Principesa Mafalda
MIN	S.S. Ionian
MIO	S.S. Principesa Iolanda
MIT	Itala, Italy
MJC	S.S. Suevic
MJH	S.S. Haverford
MJM	S.S. Merion
MK	S.S. Millinocket
MK	Milwaukee, Wis.
MKC	S.S. Olympic
MKD	S.S. Kroonland
MKF	S.S. Frisia
MKH	S.S. Holland
MKN	S.S. Corinthian
MKU	S.S. Makura
MKY	S.S. Killarney
ML	S.S. Montcalm
MLA	S.S. Guadeloupe
MLB	S.S. La Bretagne
MLC	S.S. Celtic
MLD	S.S. Leopold II
MLE	S.S. Lake Erie
MLF	S.S. Milwaukee
MLF	S.S. La Flandre
MLG	S.S. La Gascoyne
MLH	S.S. Lake Michigan
MLI	S.S. Montreal
MLJ	S.S. Montrose
MLK	S.S. Montezuma
MLL	S.S. La Lorraine
MLM	S.S. Lake Manitoba
MLN	S.S. Lake Champlain
MLO	S.S. Mount Royal
MLP	S.S. La Provence
MLQ	S.S. Mount Temple
MLR	S.S. La Navarre
MLS	S.S. La Savoie
MLT	S.S. La Touraine
MLU	S.S. La Champagne
MLU	Lugh, Italy
MLW	S.S. Montfort
MLX	S.S. Monmouth
MLY	S.S. Chicago
MLZ	S.S. Montcalm
MMA	S.S. Minnehaha
MMB	S.S. Madonna
MMC	S.S. Majestic
MMD	S.S. Malwa
MME	S.S. Mantua
MMF	S.S. Morea
MMG	S.S. Egypt
MMH	S.S. Moldavia
MMH	S.S. Marie Henriette
MMI	S.S. Charles Roux
MMJ	S.S. Mongolia
MMK	S.S. Minnetonka
MML	S.S. Macedonia
MMM	S.S. Mooltan
MMN	S.S. Minneapolis
MMO	Punta del Este, Uraguay
MMQ	S.S. Persia
MMR	S.S. Marmora
MMS	San Guilano di Trapani, Italy
MMT	S.S. Salsette
MMU	S.S. China
MMV	S.S. Perou
MMV	S.S. Mesaba
MMW	S.S. Minnewaska
MMY	S.S. India
MMZ	S.S. Arabia
MN	Tug Lorne
MN	S.S. Manitou
MNA	S.S. Pannonia
MNC	S.S. Romanic
MND	North Sydney, Canada
MNE	S.S. Menominee
MNG	S.S. Grotius
MNK	S.S. New York
MNM	S.S. Manitou
MNN	S.S. Numidian
MNO	S.S. Oranje
MNP	S.S. Prinses Juliana
MNQ	S.S. Marquette
MNR	S.S. Rembrandt
MNR	Indian Harbor, Labrador
MNT	S.S. Konig Wilhelm III
MNV	S.S. Vondel
MNW	S.S. Konig Wilhelm I
MOA	S.S. Ancona
MOB	S.S. Bologna
MOC	S.S. Oceanic
MOD	S.S. Otrato
MOE	S.S. Sienna
MOI	S.S. Columbia
MON	S.S. Mongolian
MOR	S.S. Ravenna
MOS	S.S. Toscana
MOT	S.S. Taormina
MOV	S.S. Verona
MPA	S.S. Carpathia
MPB	S.S. Empress of Britain
MPC	S.S. Canopic
MPC	S.S. Princess Clementine
MPD	Poldhu, England
MPD	S.S. Lapland
MPE	S.S. Princess Elizabeth
MPG	S.S. Empress of China
MPH	S.S. Philadelphia
MPH	S.S. Princess Henriette
MPI	S.S. Empress of India
MPJ	S.S. Empress of Japan
MPL	S.S. Princess Josephine
MPL	S.S. Empress of Ireland
MPM	Palmaria, Italy
MPN	Capo Sperone, Sardinia, Italy
MPR	Point Amour, Labrador

(*To be continued*)

CONSTRUCTION OF A SIX-INCH INDUCTION COIL—Part III

THOS C. STANLEIGH

The Apparatus described in this series of articles has actually been constructed, and is in use at the ELECTRICIAN AND MECHANIC *Laboratory.*

The question of a really useful discharging stand is seldom given much thought by the average amateur coil builder. The important part the stand plays will be fully appreciated when the experimenter desires to give one of those very entertaining exhibitions of high-potential and high-frequency electricity before a gathering of his friends. The stand herein described will be found exceedingly flexible and it permits of a wide range of adjustments. Its simplicity of construction, combined with these features still further commends it to the attention of the experimenter.

In Fig. 17 the elevation and plan of the discharger are given. Fig. 18 shows details of one of the pillars. The baseboard may be of dry oak or mahogany about 1 in. thick and finished up to 18 in. in length by 6 in. in width. It is preferable to soak the board in a long, shallow tray containing melted paraffin or else paint the wood liberally with the melted wax by means of a brush, afterwards setting it in a warm place so that the wax may partially permeate the wood. A wax finish may be applied and the board polished. With this method there is less brush leakage to the base than if the board were shellacked or varnished. The pillars are also made of wood and in this case the wax treatment is almost imperative. Hard rubber would, of course, be better, but its high cost for such a purpose almost prohibits its use.

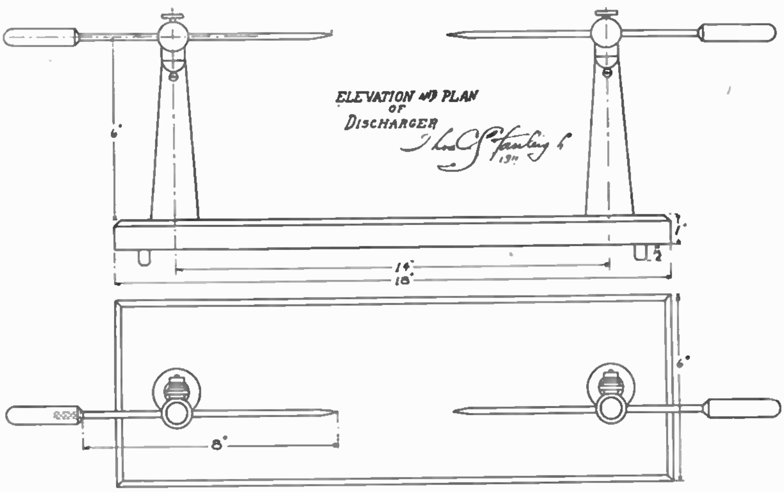


Fig. 17

The construction of the pillars is clearly shown in the drawing, and the dimensions given are only intended as suggestions. Scrap material may frequently be used in making such pieces of apparatus and the exact dimensions may be governed accordingly. The centre line of the discharging rods when mounted, should be at least 6 in. from

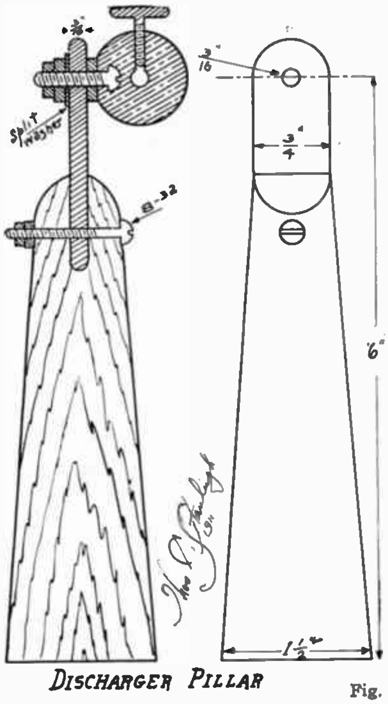
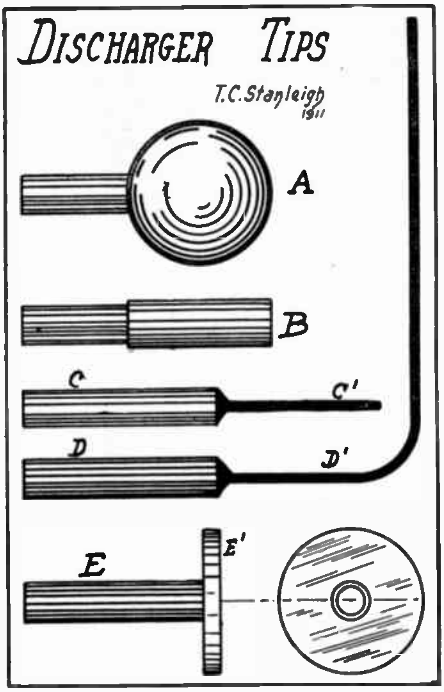


Fig. 18



the base, however, as various pieces of apparatus are to be placed under the points when the coil is in operation. The brass piece which supports the ball, is rigidly held in the wooden pillar by means of an 8-32 machine screw passed through the top of pillar and held in place by hexagon nuts. The connecting ribbon from secondary of coil is clamped under the second nut on this screw.

The ball may be taken from the end of a brass curtain rod, and after setting up a 10-24 screw in its opening the inside is filled with melted lead. A nut is then placed on the screw and carefully soldered to the brass shell of the ball. Holes are to be drilled for the 3/16 in. discharging rods to pass through and also for the milled head setscrew in the top. The ball is then mounted on the brass strip on top of pillar and secured in place by means of a split washer and hexagon nuts. This will enable the rod to be tilted to any angle or inclined downward to the base. The pillars are mounted on the base by means of wood screws passed up from underneath.

The rods may be of aluminum or brass with one end pointed and the other threaded to receive the short hard rubber handles, as shown in Fig. 17. These handles are solely for ornament, for any attempt to adjust the sparking distance while the coil is in operation will result in the operator receiving a severe and perhaps serious shock. Short pieces of 3/8 in. glass rod inserted in the under side of the baseboard at the four corners complete the discharging stand.

In the accompanying drawing various forms of discharging tips are shown, and the builder would do well to make all of them. Two of each kind will be required for certain experiments. At *A* the familiar ball type is shown. Two more curtain-rod balls may be brought into use here and short pieces of brass tubing are soldered into the openings. This tubing should be a good fit over the ends of the discharging rods. At *B* a zinc electrode is shown. This is a piece of 3/8 in. battery zinc to which the brass tubing has been soldered. At *C* a wire electrode is shown. Several of these should be made with various kinds of wire inserted, such as iron, copper, zinc, aluminum, etc. These are used to show the burning power of the spark. The condenser discharge across such electrodes makes a terrific crash, and where a more or less spectacular effect is desired, the wire gap is preferable to the form shown at *B*.

The terminal shown at *D* is very useful in connection with high frequency experiments, which together with a Tesla coil, will receive due attention in succeeding articles. The disc electrode *E* will considerably lengthen the spark if used in connection with a point on the other rod. All surfaces should be highly polished and they must be kept in that condition if best results are desired. The illustrations are full size but it is not essential that these dimensions be adhered to.

The subject of interrupters will now be taken up. Several types have been made in the Laboratory, but only those which have proved efficient will be discussed. The ordinary vibrator type is utterly unsatisfactory for a coil of this size. Not only will it stick and fail to operate when most wanted, but it cuts the spark length down by one-half or more. Several types were experimented with, but it was found impossible to get more than a 3½ in. spark, and a very thin one at that. On the other hand even the simplest of the mercury interruptors, that shown in Fig. 25, will readily give a 5 to 6 in. spark. The mercury interrupters will be described in the order of their efficiency and the electrolytic type will be discussed last of all, as it is in a class by itself.

Figs. 19 and 21 give side elevation and plan of an interrupter of the Mackenzie-Davidson type, and this is by far the best of all, barring the mercury-turbine, which is almost beyond the scope of the average amateur to construct. The principle of the Mackenzie-Davidson type is shown in Fig. 20. A two-bladed fan-shaped dipper is mounted on the end of a motor shaft and its blades make and break contact with the mercury in the bottom of the case. A small battery motor may be used, as the power required is but trifling. An adjustable resistance should be mounted on the same base so that the speed may be controlled. A series motor should be used. The resistance may be a coil of No. 24 German silver wire wound around a cardboard or wooden cylinder which has first been covered with a layer of thin sheet asbestos, as the wire may get pretty hot. A slider similar to the familiar tuning coil type is arranged to make contact with the wire and to cut out any number of turns until the proper speed of the motor is secured.

The most important feature of this interrupter is the shape of the fan. The great tendency of the blades is to spatter the mercury on leaving it and to produce a very imperfect break. So important is this matter that the author gives the scheme of laying out the fan in Fig. 22. These are the exact dimensions of the instrument which was found highly satisfactory in the Laboratory. A piece of 1/16 in. sheet brass is procured and cut to 4 in. square. After finding the centre, a circle is described on the plate as shown. Centre lines are then located and the lines across the top and bottom of the plate are scribed. These lines are 1⅝ in. from the centre line, as shown in Fig. 22. The layout is represented by the dotted lines. Measuring down from the top line 13/16 in. and to the left of the perpendicular 9/16 in., we locate the centre for the left-hand curve of the blade which has a radius of 15/16 in. Now to the right-hand curve. This centre is located at a point ⅝ in. from the perpendicular and right on the upper horizontal line. The radii are 1 9/16 and 2⅜ in. as shown. The lower half is marked in exactly the same manner. It is preferable to saw the fan out on a scroll saw, using the fine metal saws used by jewelers. If the fan is cut out by means of snips or a cold chisel the plate will be bent, and splashing of the mercury will be inevitable. The edges are to be sharpened with a file and afterwards smoothed up carefully while the motor is running with the fan mounted on its shaft.

Fig. 19 gives a part cross sectional view of the assembled instrument and the method of mounting the fan will be readily understood on referring to this illustration. A piece of brass tubing is provided to fit snugly on the motor shaft, and the fan is permanently sweat-soldered to one end of the tubing between two short collars. The other end of the tube is fitted with a short brass collar in which there is a countersunk set-screw. This collar should be a good fit on the tube, but it must be removable until the final assembling. A copper brush bears on the collar and forms an efficient connection with the blades of the fan.

The case for the fan is made of fiber. The principal dimensions are given in Fig. 20, and holes to pass 8-32 screws are located as shown. The side next to the motor is covered with a single piece of 1/8 in. fiber, while that on the other side is divided into two pieces on the line *K K*. The upper piece is secured in place with knurled nuts, while the lower half is permanently fastened by means of to the lower part of the aperture by means of short, countersunk screws. An 8-32 screw passing through the side, as shown in Fig. 20, makes connection with the mercury through the copper strip.

The device may be assembled and the motor mounted on the base in such a position that its shaft is in line with the centre opening in the fan case. The brass tube on which the fan has been mounted may be passed through

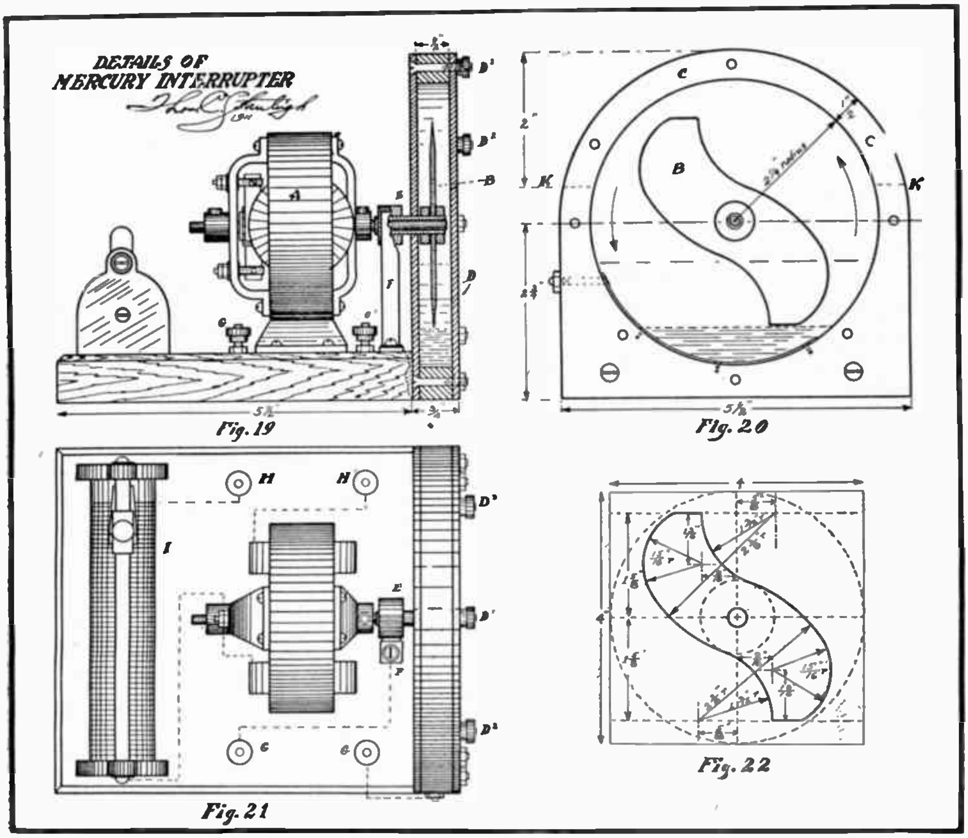


Fig. 19 Fig. 20 Fig. 21 Fig. 22

hexagon nuts. It is necessary to frequently renew the mercury and to clean the inside of case, as the mercury is rapidly pulverized by the action of the heavy spark at break. This trouble will not appear to any great extent if battery is used, but when the interrupter is used to break a circuit of 6 or 7 amperes at 110 volts D.C., the life of the mercury is considerably shortened. By careful work the case may easily be made watertight and this is necessary.

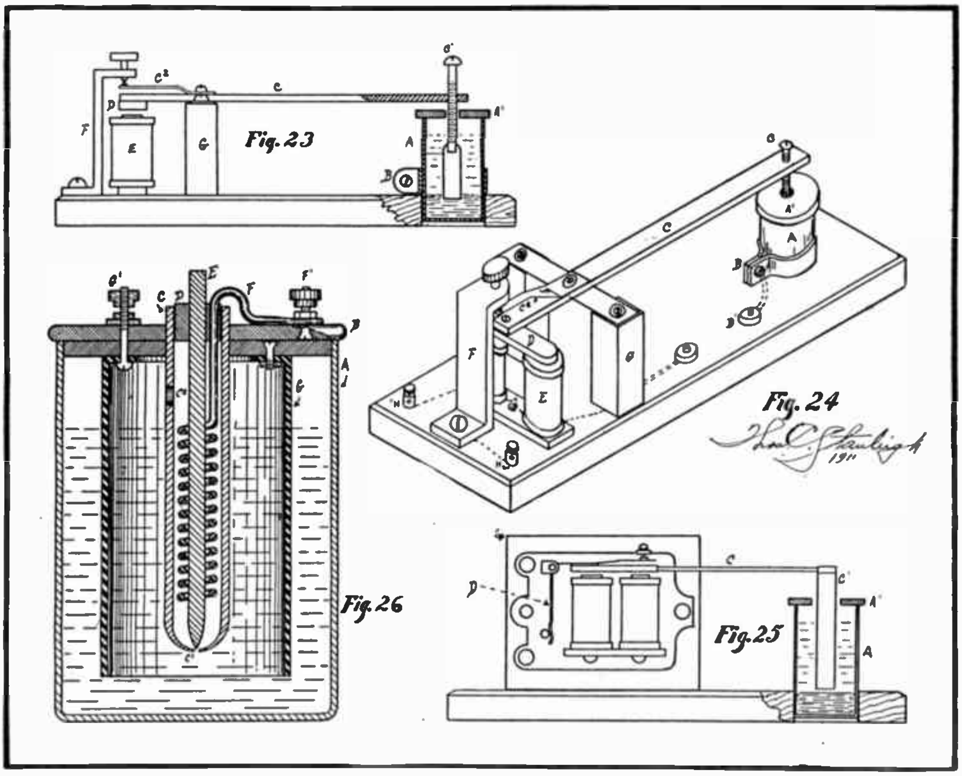
A narrow strip of copper is secured the opening and the collar fastened in position. By forcing the setscrew down hard the tube will be indented a trifle and thereby firmly secured to the shaft of motor. A test should now be made to see if the shaft will revolve freely and the fan is truly centred inside the case. The opening for the brass tube should only be large enough to pass the tube without binding; in other words it should be a running fit, for otherwise the case will leak. The brush, *F* should be built up of several strips of thin copper with a spring temper. It must make a good contact with the collar as the latter revolves, as it may be called upon to carry 10 or 12 amperes.

If everything works well the lower half of the outside cover may be fastened in place. If the builder is skillful enough to make this cover of glass he should certainly do so, as it is difficult to get just the correct amount of mercury in the case without being able to see it. Failing in this, however, the fiber cover may be used and the plan which follows will tell the operator when the mercury has reached a sufficient height. Before putting the cover in position, turn the shaft of motor until the fan is in the position shown in Fig. 20, and use some means to secure it there temporarily. Fasten on the lower half of cover and connect a battery and bell in series with the terminals *G*, *G* in Fig. 21. Mercury is then carefully poured in the case until the bell rings which tells that contact has been made between the fan and mercury.

The end of the fan breaks contact with the mercury cleanly, as shown in Fig. 20, providing the mercury is at the proper height. The case is then half filled with water and the upper half of cover fastened in place. Alcohol is better than the water, but its use is attended with some danger as the arc formed at the break, in case the condenser should become disconnected, will fire the alcohol vapor, and, in such close quarters, cause an explosion. The connections for motor and resistance are shown by dotted lines in Fig. 21, as are also those for the interrupter proper.

While running at high speed, and with a potential of 20 volts or more, this interrupter produces a beautiful spark. It is of the flaming type and is soft in tone—distinctly different from the sharp crackling spark of other interrupters. For fluoroscope demonstrations of the X-ray, it is excellent and is only surpassed by the turbine or electrolytic types. With a condenser across the secondary, a fairly high-pitched spark can be obtained, and as the contact and break are positive, the spark is exceedingly uniform. It is necessary to use a somewhat higher voltage than with the ordinary type of interrupter if high speed is desired, but with the motor running at low speed and the three layers of the primary connected in multiple, a current of 10 amperes at only 6 volts will produce good 6 in. sparks with the coil described in these articles. The long, thin core and three layers of primary in series give best results with this break running at high speed. At low speed a shorter and thicker core with only two layers has given better results. Indeed, the slow interrupter in connection with a core 1⅛ in. by 12 in. and primary of two layers of No. 12 or No. 13 wire will give the full spark length with a smaller consumption of current. Where a fast spark is required a somewhat thinner core should be used, as the circuit is made and broken so quickly that the core does not have time to be fully magnetized.

A very efficient and easily constructed interrupter is illustrated in Figs. 23 and 24. In the latter figure the general construction is plainly shown. The arm *C* is of aluminum to secure lightness and therefore quicker action. This arm is supported near one end on a piece of stiff steel spring which is in turn fastened to the uprights of square brass rod, *G*. The magnets are removed from an electric bell, as is also the contact spring from its armature. A piece of soft iron *D* is secured to the end of the arm and the contact spring gripped under head of screw which holds arm to spring. The support for the other contact *F* consists of a piece of ⅛ in. brass bar. The cup for the mercury may be an old shaving-stick receptacle or other brass cup of similar size. One may be made of brass tubing by plugging up the end with a piece of hard wood which is afterward coated with shellac. Solder cannot be used to seal the cup, as the mercury will form an amalgam with the tin and a leak will result. The cup should be at least 2½ in. high and preferably a trifle higher, as the rupture of the circuit causes a series of miniature explosions in the cup unless the condenser is just right. Contact is made by means of a piece of copper strip as shown. The dipping contact is best made as shown in Fig. 23. A 6-32 long brass screw is inserted through a tapped hole in the end of arm, and is then fitted with a copper strip dipper cut squarely off at the bottom. As this adds to the weight of the end of arm, it tends to make the vibrations slower, and an arrangement which permits of a higher speed of interruption is to rivet a piece of aluminum wire to the end of arm, hammering and filing the other end to a wide knife edge. This, however, does not permit of any adjustment, and in that case some means of raising or lowering the mercury cup should be provided. A loosely fitting fiber cover is placed over the cup to keep the contents from spattering. In use the cup is filled with mercury until its surface just barely touches lower edge of the dipper. An eighth inch of water is poured over the mercury and finally the cup is filled with kerosene oil. This combination has been decided upon as the best for all around work. The connections are simple and are shown in Fig. 24. The complete parts for making this interrupter, including the necessary mercury, are for sale by advertisers in this magazine and its construction is within the reach of almost every experimenter.



Still another form is shown in Fig. 25, which explains itself. The arm of a bell is straightened out and the ball removed. A piece of copper strip is soldered to the end. The object of bringing out the arm and affixing a contact instead of merely bending the arm down at right angles is to secure a longer sweep, so that the motion may be more nearly perpendicular instead of sideways which causes a great deal of splashing. The connection to the arm is made at the spring *D* and not at the grounded binding post. In the latter case the contact between arm and pivot is very uncertain and considerable resistance will be offered. This interrupter is not so dependable as the last one described and its action is not so uniform.

The electrolytic type of interrupter is splendid where 110 volt direct current is available. The action on alternating current is not so satisfactory. Its only drawback is its inability to stand continuous use for long periods of time. The solution heats up and after a certain point is reached, the action is irregular.

A trial in the Laboratory of practically all of the easily constructed types has proved that the one shown in Fig. 26 is one of the best. The author has had this one running for from 40 to 70 minutes at a time without cessation, and that is something which he has been unable to do with any other type with which he has experimented.

Various low-priced interrupters may be purchased but they all have their drawbacks. One type in particular is equipped with a composition cover in which the porcelain tube is embedded. After twenty minutes' intermittent use the heat and acid fumes softened the inside of the cover sufficiently to loosen the porcelain valve and on still further use the tube dropped out entirely, causing a short circuit through the low resistance of the dilute acid in the jar. While this merely meant the blowing of a fuse, still it was unpleasant and it was necessary to wait until the cover had cooled sufficiently to become hard enough to hold the porcelain. It is difficult to understand how a manufacturer could "get past" with such a contrivance and it is still harder to understand why the same manufacturer does not make the simple change necessary in his instrument to turn it into one which would give excellent service.

The speed of the interruptions with this type of break is something terrific. It is said to reach into thousands per second. The frequency is proportional to the impressed voltage and to the number of turns on the primary. With few turns in the primary, a rather thin core and 110 volt direct current, the interrupter here described will give a tone of spark resembling the high-pitched Fessenden. It is open to question, however, if this exceedingly rapid rate of interruption is desirable for ordinary application to wireless. The spark is long and rather thin and is splendid for X-ray work. With the interrupter working well there is absolutely no flicker on the screen. By adding turns to the primary, the frequency of the spark is reduced, but it is considerably thickened. With three layers of primary in this coil and using 4 amperes of current, the spark is about 3 in. long but very thick. It is not well to work the coil very long on this plan, however, if it is wound with No. 36 wire in the secondary, as the current will be heavy enough to heat the wire and melt the wax. The electrolytic interrupter is most useful in connection with the coil to be described in the next article, and which is intended for use with a Tesla coil or an Oudin resonator to give high frequency sparks. This coil will also be adapted to the requirements of wireless telegraphy where alternating current is not available. On the other hand it may be used as an open core transformer on alternating current circuits with the modifications stated.

The construction of the electrolytic interrupter will be understood after reading an explanation of Fig. 26. The glass jar *A* should be at least 5 x 7 in., and preferably much larger, as the solution will not heat up so quickly if there is a larger quantity of it present. The jar is fitted with a cover of ¼ in. fiber which is thoroughly treated with paraffin. The tube *C* is what is known as an "ignition" tube and may be procured from a dealer in physical apparatus. The ordinary test tubes will not stand the heat and the action of the break. Having procured an ignition tube, take it to a glass blower and have him puncture the bottom with a small hole. It is useless to state what size of hole, for he will be unable to gauge it. The glass is so hard that it will break frequently, even in the hands of a competent glass-blower. Let him make the hole as small as possible and also drill an opening as at *C*2. This will permit the liquid which rises inside the tube to overflow. Provide a length of ¼ in. glass rod and have it pointed as shown, so that the point may rest in the hole at bottom of tube. Support the tube in a hole in the cover so that the lower end of tube is about 1 in. from the bottom of the containing jar. Coil up a length of lead wire around a pencil so that it will form a spiral inside the tube and bring the end out through the rubber stopper at top of tube. This stopper must have a hole in it just large enough to pass the glass rod with some friction. This will allow a partial adjustment of the opening to be made. It is upon the correct size of this

(Concluded on page 286)

PRACTICAL HINTS

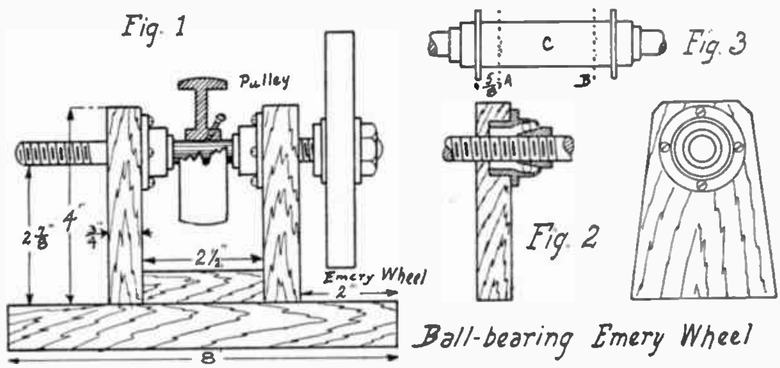
Ball-bearing Emery Grinder

ALFRED CHRISTIANSEN

This ball-bearing emery grinder will give good satisfaction, and is very easy to make from things found in every workshop.

Next get an old pulley (I used a sewing machine pulley) and fasten it to the shaft in the middle.

Now with the emery wheels and the nuts to hold them on, it is ready to put together. Screw the standards to the



Ball-bearing Emery Wheel

First get some good hard wood that will not split easily, and make four pieces of the following dimensions: baseboard, 8 x 3 x ¾ in., bevel the edges; make two standards 3 x 4 x 2 x ¾ in., like Fig. 2, make two; strengthener, 2 x 2½ x ¾ in.

Next, find an old front wheel from a bicycle and take off the hub, with the bearings and cones. Take out the axle and cut hub with a hack saw on lines marked *A* and *B* in Fig. 3. This will give you two bearing cups to be used in the standards just made.

Bore a hole in the standards 3⅛ in. from the bottom, large enough for the bearing cups to fit in. These holes should not reach quite through. This hole is *A* in Fig. 2. Bore another hole in the centre of this hole ½ in. in diameter right through *B* in Fig. 2.

Next screw the bearing cups to the standards, with small screws in the holes formerly used for the spokes on the bicycle wheel.

Now get a steel shaft the same diameter as the axle in the bicycle hub, 7 in. long. Thread 3⅛ in. on each end the same size threads as on the axle.

baseboard 2 in. from each end and very securely. Put the pulley and cones on the shaft and put it in place on the bearings, placing the balls in the cups first.

If care has been taken to make it strong and true, it will be very serviceable. Mine runs two 5 x ½ in. wheels. The bearings should be kept well oiled. It may be painted and screwed to a bench.

Be sure to thread the axle so that the stones will not fly off when running.

A guide may be made from a few pieces of scrap iron to hold the tools while grinding.

WORKSHOP KINKS

H. W. H. STILLWELL

For the Tool Box

Mechanics who have spent the greater part of their lives in the machine shop, and have "been through the mill" of experience, have numerous receipts, kinks, and little secrets which at different times during their career they have found good use for and always have them in some convenient place for handy reference in case of emergency. There are many cases of emergency in our modern machine shops these days. These are the days when a man must know what he is about, think quick, and know what to do when called upon.

The young mechanic has not had the years of experience that the older man has had and when he does come to some job that requires some expedient, he is up against it. It is for this class of beginners that the following is intended and may be found of great value at any moment.

A small serviceable note-book can be tucked away in one corner of the tool box and into this may be copied many valuable tables and other information.

To make Steel Soft so that it can be worked like Copper

Pulverize beef bones, mix them with equal parts of loam and calves hair, and stir the mixture into a thick paste with water. Apply a coat of this to the steel and place it in a crucible, cover this with another, fasten the two together with wire, and close the joint hermetically with clay. Then place the crucibles in the fire and heat them slowly. When taken from the fire let them cool by placing them in ashes. On opening the crucible the steel will be found so soft that it can be engraved like copper.

To Harden Steel in Sealing Wax

Watch and clock makers and engravers harden their steel in sealing wax. The article is heated to a white heat and thrust into sealing-wax, allowing it to remain for a second, then withdrawn and inserted in another part. This treatment is continued till the steel is cold and will no more enter the sealing-wax. The extreme hardness of the steel thus prepared enables it to engrave or bore steel hardened by other processes, the drill or engraving tool being first dipped in oil of turpentine.

Prevention of Rusting-in of Screws

The screws in machines exposed to heat and moist air soon rust in, even if oil is used, which makes the taking apart of the machine a very difficult task. By dipping the screws in a thin paste of graphite and oil, they can be removed without difficulty even after several years.

Compound for Welding Cast Steel

Mix 41$\frac{5}{10}$ parts of boracic acid, 35 parts of pure dried common salt, 15 to 26 parts of ferrocyanide of potassium, 7½ parts of resin, 4 of carbonate of sodium. When this compound is to be used a sufficient quantity is scattered upon the article to be welded, which has been heated to a light red heat; it is then heated to a strong yellow heat and the welding accomplished in the usual manner.

Six-Inch Coil

(*Continued from page* 284)

opening in proportion to the amount of current flowing and the impressed voltage that the success of the instrument depends.

The outer electrode is of sheet lead fastened to the cover and bent around the tube. The solution is sulphuric acid (CP) one part and distilled or rain water seven parts. Pour the acid into the water in a thin stream, stirring constantly with the glass rod. Do not under any circumstances pour water into acid or terrific boiling and perhaps an explosion may result.

The interrupter is connected in series with an adjustable resistance and the primary of the coil to the 110 volt lighting circuit. A 6-ampere fuse should be inserted in the circuit. The interrupter never draws over 6 amperes if working properly, and good results can be obtained by using 4 or 5 amperes. By cutting out resistance the frequency is raised and adjustments may be made to suit. The hot liquid rises to the top of the jar in use, and by using a large jar and long tube long periods of use may be had. The only difficulty which will be experienced is when the liquid rises and overflows through the opening in the tube. This establishes a connection between the two electrodes which partially shunts the path through the hole in the bottom of tube. This connection is only momentary, however, and it can hardly be considered a serious drawback.

(*To be continued*)

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department, free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but, if he so requests, anything which may identify him will be withheld. Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent at one time. No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage, and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will, in every case, be notified if such a charge must be made, and the work will not be done unless desired and paid for.

1563. **Dynamo.** R. J. M., Brooklyn, N.Y., sends a sketch of one having a toothed armature 2¼ in. in diameter and 2 in. long, there being 12 slots, each 5/16 in. wide at top and 1/16 in. wide at bottom, and ½ in. deep. Space for field coil is 4¼ in. in outside diameter and 2 9/16 in. inside, axial length being ¾ in. He asks what should be the winding to give an output of convenient or useful amount? Ans.—Your sketch is so incomplete that we cannot tell the shape of the iron of the field magnet, so cannot judge the probable output. Perhaps No. 20 wire on armature and No. 23 on shunt field would make a good trial. The November, 1908, number of the *Electrician and Mechanic* contained a good article on winding drum armatures, of which yours is one variety. A more detailed description of a machine with about your proposed dimensions is given in Watson's "How to Build a ¼ h.p. Dynamo," which we would be pleased to supply for 50 cents. In any case, you will find it advisable to change the shape of the armature slots, so as to have them with parallel sides, say ¼ in. wide and ⅜ in. deep. Oiled muslin, often known at the electrical stores as "empire cloth," is the best material for insulating such machines.

1564. **Motor.** H. B., Bay Ridge, N.Y., asks for directions for making a motor of 1 h.p. capacity to be run from two storage batteries of 6 volts and 60 ampere-hour capacity. Ans.—As the ordinary voltage of a single storage cell is two volts, it is clear that the cells to which you refer are of the ignition type, consisting really of three cells in one box. Further, the ampere-hour capacity probably means an allowable discharge rate of 2 or 3 amperes. Then with a maximum of 12 volts, the proper rate of working the cells will then be at a rate of 25 to 35 watts, which, allowing for a motor of about 50% efficiency, will give only a small part of a horse power. Automobile motors of the electric type are frequently of only 1 or 2 h.p., and the equipment of batteries necessary to run them weighs several hundred pounds. A common number of cells is 44, so as to allow economical charging from a standard 110 volt supply.

1565. **Windmill Power.** W. F., Buffalo, N.Y., wishes to know if it is practical to drive a dynamo by wind power, charge storage batteries, and thereby get cheap and ready electrical supply? Ans.—More than one inventor or experimenter has tried this, and occasionally an advertisement is seen for such equipments. Probably the first attempt was made by Chas. F. Brush, the "father" of arc lighting, and patentee of the pasted type of storage battery plates. He made quite an extensive equipment in the grounds at his residence in Cleveland. Another instance was found in later years, in Marblehead, Mass., and again in the South. We fail to find if any of them persevered through more than one season. Things sometimes work well when they are new, but after the novelty has worn off and deterioration set in, there is much more satisfaction in purchasing the electrical energy from the local company. It comes easiest and cheapest in that manner. In a windmill equipment, you will need conical pulleys, the position of the belt being controlled by a centrifugal governor, to make an attempt at uniform speed of dynamo. Then underload and overload switches for use between generator and battery, also end-cell or counter-cell control of the lighting circuit. We have a suspicion that the expense of a small amount of energy from such a source would exceed that of any one of several other ways. We will go into further details if you are interested.

1566. **Battery Motor.** H. M., Linesville, Pa., asks: (1) Can the winding on a small battery motor be changed so as to make it into a dynamo? (2) Will a small household medical coil give a spark, and if so how large a one? Ans.—(1) If it is of the better class of small motors having a laminated drum armature you might make it generate. The output would be very small. (2) No.

1567. **Radium; Oxide of Copper.** T. W. H., East Oakland, Cal., asks: (1) Could you please give me a simple description as to what "Radium" is; also if it is a liquid or a solid substance and of what use. (2) What is "Oxide of Copper" and how made? (3) How can an electro magnet be wound with a medium gauge wire to prevent sparking when the circuit opens on a pressure of about 6 volts. Ans.—(1) Radium is an element which occurs in extremely minute amounts in pitchblende and some other rare minerals. Unlike previously known elements, it continually decomposes at a fixed rate, producing other elements by its decomposition, and evolving enormous amounts of energy. It is used in medicine in the treatment of cancer, rodent ulcer, lupus, and other tissue and skin diseases, although the use is limited, owing to the extremely small quantity yet extracted, and its enormous cost. The commercial form is radium bromide, usually mixed with many times its weight of inert materials. (2) Oxide of copper is a black substance easily obtained by heating copper in the presence of oxygen; it is actually burnt copper. It may also be obtained by precipitating copper sulphate with caustic soda, washing the precipitated copper hydroxide and ignited to drive off water. (3) A condenser connected across the break in the circuit will absorb the spark.

1568. **Aerial Mast.** A. D. H., Lexington, Ky., writes: I am planning to build an aerial mast 100 ft. high, out of either 2 in. or 5 in. stove pipe. The 2 in. pipe comes in 10 ft. lengths and the 5 in. in 2 ft. lengths. I am going to use the guy wires for the aerial. They are to be made of No. 14 aluminum wire and anchored 50 ft. from the mast. Is No. 14 aluminum wire large enough to support the mast, which weighs 82 lbs.? How many guy wires would you suggest? Which should I use, the 2 in. or the 5 in. pipe? Ans.—We advise using the 2 in. pipe in 10 ft. lengths. Place three guy wires at every joint and three also at a point midway between each two joints. The pipe will have a tendency to buckle and you will need several people to assist you in raising it.

1569. **Aerial Lead-in.** E. H., Chicago, Ill., asks if the diagram he sends us is all right for an aerial lead-in? Ans.—We think this should give good results providing wire is carefully insulated.

1570. **Receiving and Sending Radii.** H. C. Pender, Neb., asks: (1) What is my sending radius with the following instruments: aerial is of 4 strands of No. 14 aluminum wire 1 ft. apart, 1 in. spark coil with 6 dry batteries. (2) My receiving radius: 1 slide tuner, detector is of the crystal type, 75 ohm receivers in series, one dry battery. (3) How much would a helix increase my sending radius? Ans.—(1) You might cover one mile. Why not experiment and test out your radius with other stations? (2) Receiving radius would be small with 75 ohm receivers. (3) A helix should increase your radius materially, as it would enable you to tune your set.

1571. **Induction Coil.** D. W. D., Montrose, Col., asks: (1) Please give the size of core for a 1 in. coil, the number of layers on primary, and what size of wire, using enameled wire, and the number of pounds on secondary, and the size, using enameled wire. (2) What is the best kind of an aerial using 4 wires and two poles, one 40 ft. high and the other 30 ft. high? (3) How far could I send with the above aerial and a 1 in. spark coil, strap key, fixed condenser, adjustable condenser, large helix, copper spark gap, 10 dry batteries; and will you please give the diagram for connecting it? The land is quite hilly around here but I mean I want to know what would be the distance I could depend upon? Ans.—(1) Core ¾ x 7 in.; primary 2 layers No. 16; secondary, 1½ lbs. No. 34. (2) Flat top aerial, bringing lead-in from lower end. (3) For diagram see Fig. 2, page 424 in May, 1910, issue. It is impossible to estimate your sending range accurately; possibly from 3 to 5 miles with 100 ft. aerial.

1572. **Induction Coil.** F. P. A., Montello, Mass., asks: (1) The sizes of two pieces of wire he sent us. (2) Specifications for ½ in spark coil. (3) If bare copper is better than rubber insulated wire for aerial. Ans.—(1) Larger wire No. 22 tinned copper; smaller, No. 36 d.s.c. (2) Core ½ in. x 6 in.; primary, two layers No. 20; secondary, ¼ lb. No. 36; condenser, 40 sheets tinfoil 4 x 5 in. (3) Bare copper wire is better but the other may be used.

1573. **Induction Coil; Storage Battery Plates.** G. I. K., Alma, Mo., asks: (1) Where he can find description of Spottiswoode's Giant Coil. (2) If he may again use the No. 34 enameled wire on the secondary of a coil which has broken down, by rewinding and soaking it in paraffin. (3) Where he can obtain grids for storage battery plates. Ans. —(1) Look through some of the old electrical books at your public library. (2) Yes. (3) You can obtain sheet and strip lead at a plumber's shop or at almost any hardware store. W. C. Houghton, 40 Pleasant St., Waltham, Mass., has cast grids for sale at a reasonable figure.

1574. **Direct Current for Wireless.** W. A. K., New York, asks: (1) Is it possible to use direct current of 220 volts as power for sending? (2) What instruments are necessary for the use of it? (3) How far would it send with ½ k.w. or 2 k.w. open core transformer? Ans.—(1) It is possible but not desirable. (2) An electrolytic interrupter or one of the mercury turbine type could be used. (3) Better to install a motor-generator and use 60 cycle a.c. to operate transformer, thus dispensing with troublesome and inefficient interrupters.

1575. **Electro-Magnet.** M. B. VanW., Pleasantville, N.J., asks: What should be the diameter and length of core, length of winding space, number of layers of wire, No. of wire B. & S. gauge and kind of covering of wire for an electromagnet to work on 110 volts A.C.? Magnet not to be over 5 in. long or over 3 in. in diameter, wire not smaller than No. 30. How many pounds of wire will be required for two magnets of this size? They will not be in circuit over one minute at a time. I want them to be as powerful as possible after following above dimensions. Ans.—To derive the data you require with absolute accuracy would necessitate the making of several test coils, and observing their performance. For data on this procedure, you are referred to the chapter on Electromagnets in Foster's "Electrical Engineer's Pocketbook." An approximate estimation for your requirements is as follows: diameter of core 1 in. (core to be built of iron wires annealed and cut to length); length of core, 5 in.; cross-section of winding space, 1 in. C 5 in.; wire size, B. & S. gauge No. 20; resistance, per magnet, 23 ohms; current in amperes, on 110 volts, 60 cycle, A.C., 5; amount of wire required per magnet, 7 lbs. We would recommend enameled wire, inasmuch as a greater number of ampere turns can be procured with same.

1576. **Wireless Troubles.** E. P. A., Philadelphia, Pa, says: My wireless receiving set consists of six detectors—three silicon, two pericon and one acid,—one variable condenser, a loose coupler, all of which are home made, and one fixed condenser of .001 capacity; phones, 1,000 ohms each. My antenna which is 60 ft. in height at one end and 30 ft. at the other is composed of four No. 14 aluminum wires about 12 in. apart. During the daytime I can hear Baltimore and New York fairly well, and at about 3 or 4 a.m. I can hear different ones working, but I can only get a vibration or scratching sound and it can't be read. Sometimes without any tuning coil it comes in readable for a moment and then fades out. Cannot get any results from variable condenser. I am a subscriber to your valued magazine and would be pleased if you will suggest some way to overcome this difficulty, so that I can read signals at all times. Also how far should I be able to read long distance signals? Ans.—Your variable condenser may cause part of the trouble. Test it to be just so near that the opposite plates do not touch. The trouble may also be caused by a swinging cross on a nearby electric power line; also test your aerial for leaks, or swinging cross against roof.

1577. **Lightning Arrester.** T. S. R., Brooklyn, N.Y., asks: In putting a lightning arrester on an aerial do not the oscillations jump same into ground, when sending? Ans.—The lightning arrester should be arranged to be disconnected with a switch when operating set, as otherwise transmitting current would jump across it.

1578. **Wiring Diagram.** L. G. B., Stockton, Cal., asks: I wish you would show me in your magazine a connection that has been used where I can use a loose couple with a slide on the primary and one on the secondary, a double slide tuning coil, a variable condenser, fixed condensers, head phones and detectors. I want it so I can with a D.P.D.T. switch in either the loose couple or the tuning coil. Ans.—The diagram given in Mr. Getz's article in the January, 1911, issue of this magazine. This may be readily converted, as the primary of the loose-coupled tuner is a double slide tuner.

1579. **Wiring Diagram.** L. W. W., Ashland, Wis., asks: I have a receiving set only and wish to know how to connect up my instruments with either a tuning coil or receiving transformer, as per diagram in Mr. Guilford's article on page 423 of the May, 1910, issue of *Electrician and Mechanic*, by means of a suitable double throw switch, but using a looped aerial in place of the straightaway in Mr. Guilford's diagram. I have heard that two tuning coils are needed for a looped aerial. Is this so, and if so, would it necessitate two receiving transformers also? How many slides are used on the tuner or tuners? (2) Please send me diagram, showing all connections, for the best looped aerial system, so as by means of a double throw switch I can use either the tuning coil (or coils) or the receiving transformer. Show also connections for the condensers, detector, potentiometer, battery and head phones. How many fixed and how many variable condensers are advisable and show where they should be placed. Show circuit through the aerial switch and also what kind of an aerial switch to use. (3) What should be approximately my receiving radius with the following apparatus: receiving transformer, variable and fixed condensers, different types of commercial detectors and a 2,000 ohm head set. Aerial is 125 ft. long, 100 ft. high at one end and 60 ft. at the other end; composed of six stranded phosphor bronze wires 2 ft. apart. What do I need to make my set more efficient? (4) How can I connect up my head phones so as to practice receiving the Continental Code, getting the same sound in the receivers as I would when receiving from a wireless station; as I do not know my code well enough to take messages accurately. Ans.—(1) If you place a variable condenser or a single slide tuner in the other end of your looped aerial, good results will be obtained. See the diagram given by Mr. Getz in the January, 1911, issue of this magazine, which shows an inductive tuner connected to a loop aerial. (2) The above-named diagram with one side of the loop run to another tuning coil will answer your purpose admirably. One fixed and one variable condenser required. For aerial switch, see design given in the September, October and November issues, article on aerial construction by Mr. Getz, in which an aerial switch is described. (3) With the above changes your set should be quite efficient. (4) Get a 4 ohm electric buzzer and a dry battery. Connect the buzzer to the battery, with a telegraph key in series to make and break the circuit. Place in a suitable position and run a wire from the inside end of the magnet windings of the buzzer to the ground. This will give you a buzz similar to that caused by a transmitting outfit.

1580. **Transformer.** G. D. Nicolet, P.Q., Can., asks: (1) Is this transformer intended to work on 110 volts, 30 cycle A.C. current, of good design for wireless: core, a hollow rectangle 12¼ x 8¾ in. with a cross section 2½ x 2½ in. Soft iron strips. Primary: 200 turns No. 10 B. & S. D.C.C. magnet wire, 100 turns on each leg (two layers of 50 turns). Secondary: about 15 lbs. No. 32 S.S.C. magnet wire wound in 16 sections, 8 on each leg. Supposing the insulation is good. (2) What should be the capacity of a good condenser to work in connection with this transformer and the loose-coupled system, two helixes? Antenna 115 ft. high, "T" system, 4 horizontal wires 100 ft. long. (3) What would be the output of sending? Ans.—(1) Yes, the transformer will work on 110 volt A.C. circuit. However, it is supposed you mean 130 cycles, as 30 cycles is rarely used in commercial work and is rather too low a frequency for wireless. (2) A condenser having about from .005 to .008 microfarads capacity would be proper for the transformer mentioned. (3) About 350 to 400 watts.

TRADE NOTES

We are in receipt of gasoline engine and lighting plant catalogs from the Detroit Engine Works, Detroit, Mich. This firm makes a specialty of small generating units for lighting country homes, hotels, office buildings and motion-picture theatres. Their equipment is up-to-date and high class in every particular, and their plants for supplying current for motion-picture arcs are especially complete. The generators with these plants are wound for 60 volts so that very little current is wasted in the rheostat. The engine is of the 2-cycle type, which possesses the distinct advantage of having practically no valves to get out of time or to leak. The operation of this type of engine is also very steady and the speed may be closely governed to compensate for sudden changes of load on the dynamo. Owners of motion-picture theatres which are in an isolated position will find it worth their while to investigate these power plants. The plants are also useful in theatres where only alternating current can be obtained, as they furnish a reliable source of direct current supply at low voltage for the arc lamp.

Messrs. Beetle and Maclean, 21 Bromfield St., Boston, Mass., have recently issued a price list of cardboard tubing which they furnish in diameters and lengths suitable for constructing tuning coils, loose couplers, Tesla coils, Oudin resonators, etc. They will be glad to send their price list to any reader upon request.

Cement manufacturers, architects, engineers and contractors will be interested in the announcement that *Cement Age*, of New York, and *Concrete Engineering*, of Cleveland, two of the leading monthly publications in the cement field, have been consolidated. It is the intention of the new publishers to slightly increase the size of *Cement Age*, which will have a type page of 6 x 9 in. A two column make-up will be a further innovation. It is the purpose to preserve the best features of both magazines, thus maintaining the prestige each has won. Allen Brett, editor of *Concrete Engineering*, for the past two years, will take the position as Associate Editor of the new publication, and Arthur E. Warner, formerly business manager of *Concrete Engineering*, will become western manager. There will be no change in the present staff of *Cement Age*, Mr. Lesley continuing as editor, Frederic F. Lincoln as president of the *Cement Age* Company, in charge of the New York Office, at 30 Church Street, and of the eastern advertising field, and Edward A. Trego, as associate editor.

BOOK REVIEWS

Heat. By J. Gordon Ogden, Ph.D. Chicago, Popular Mechanics Co., 1911. Price, 25 cents.

This popular treatise purports to set forth in simple language all the main facts about heat and its opposite cold in such simple language that all can understand it. In the effort to be popular, the author has sometimes allowed himself to make strange statements, as for instance the following: "If the normal temperature of the earth were at the freezing point of air, and we could obtain a block of ice such as is distributed by the ice man of today, such ice could be used as fuel, and would be put into the furnaces instead of coal." A professor of physics and chemistry and doctor of philosophy should certainly be able to grasp the difference between a fuel which produces heat by its oxidation, and a radiating source of energy, such as ice would be when surrounded by a medium at the temperature of liquid air. On the whole the book conveys many useful facts in a popular manner.

Storage Batteries: Their Theory, Construction and Use. By A. E. Watson, E.E., Ph.D. Lynn, Mass., Bubier Publishing Co., 1911. Price, $1.50.

The first edition of this book was justly regarded as one of the most valuable contributions to the practical literature on storage battery use and construction in recent years. In this, the second edition of his valuable book, Dr. Watson has thoroughly revised and modernized as well as greatly enlarged the contents of the first edition. The author has that rare ability to clearly express his thoughts in language entirely devoid of technical terms and there is no doubt that his latest offering to the field of electrical literature will be received with open arms by the practical man who wishes to know the "how" and "why" of the subject.

Full instructions are given for the construction and care of secondary batteries of various sizes and forms.

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A discussion of various commercial types of batteries, together with several illustrated examples of existing installations, still further enhances the value of this excellent little work.

How to Make a Wireless Set. By Arthur Moore. Chicago, Popular Mechanics Co., 1911. Price, 25 cents.

Even with the abundance of literature on this subject, there is still ample room for this recent addition to the Popular Mechanics Handbook series. The work is primarily intended for the youngest experimenter in the field and by following the instructions given, the average boy having ordinary mechanical ability will be enabled to construct a very practical little set. No attempt is made to theorize on the subject, and the space is entirely devoted to the more important constructional details. While the book will hardly create enthusiasm among the more advanced students of wireless, still it should meet with much favor among the experimenters who are just entering the field.

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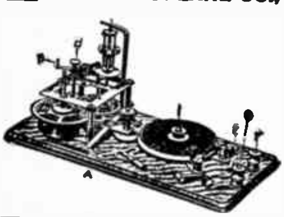

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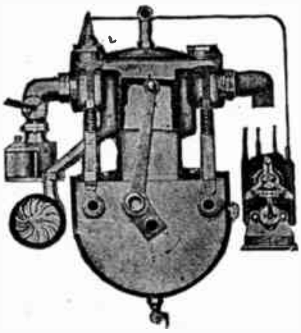

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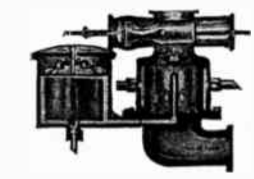

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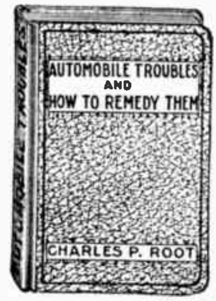

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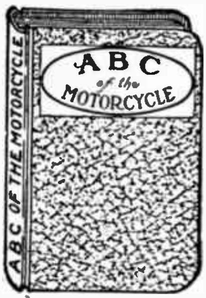

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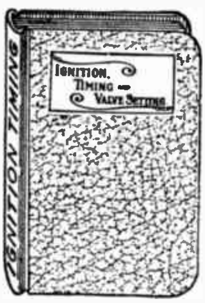

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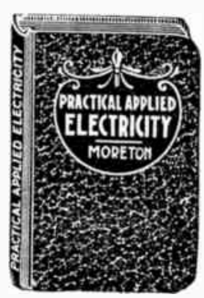

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