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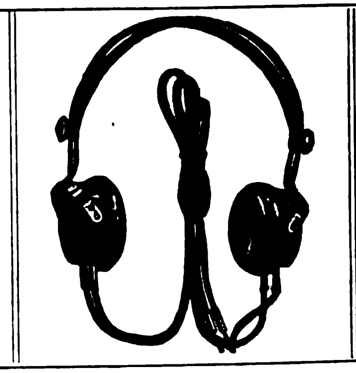

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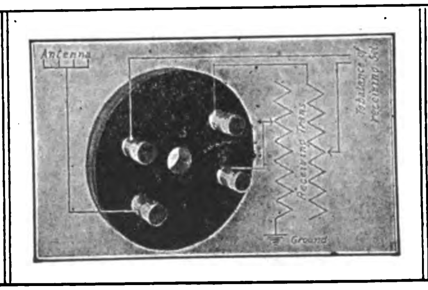

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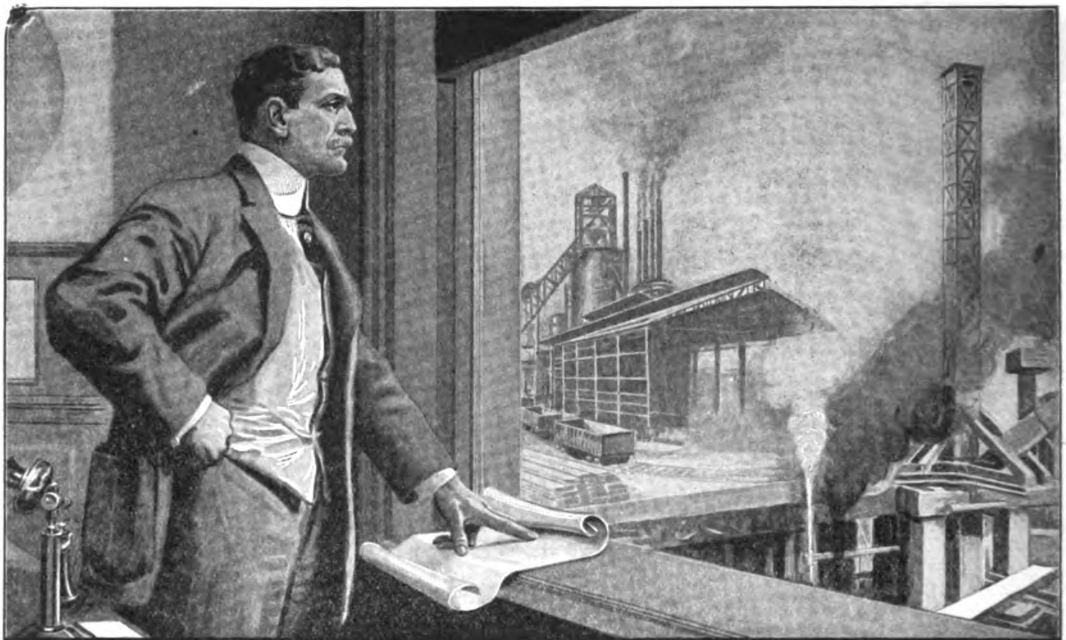

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ELECTRICIAN & MECHANIC

VOLUME XXVI | MAY, 1913 | NUMBER 5

A PRACTICAL SECTION-LINER

Prize Article

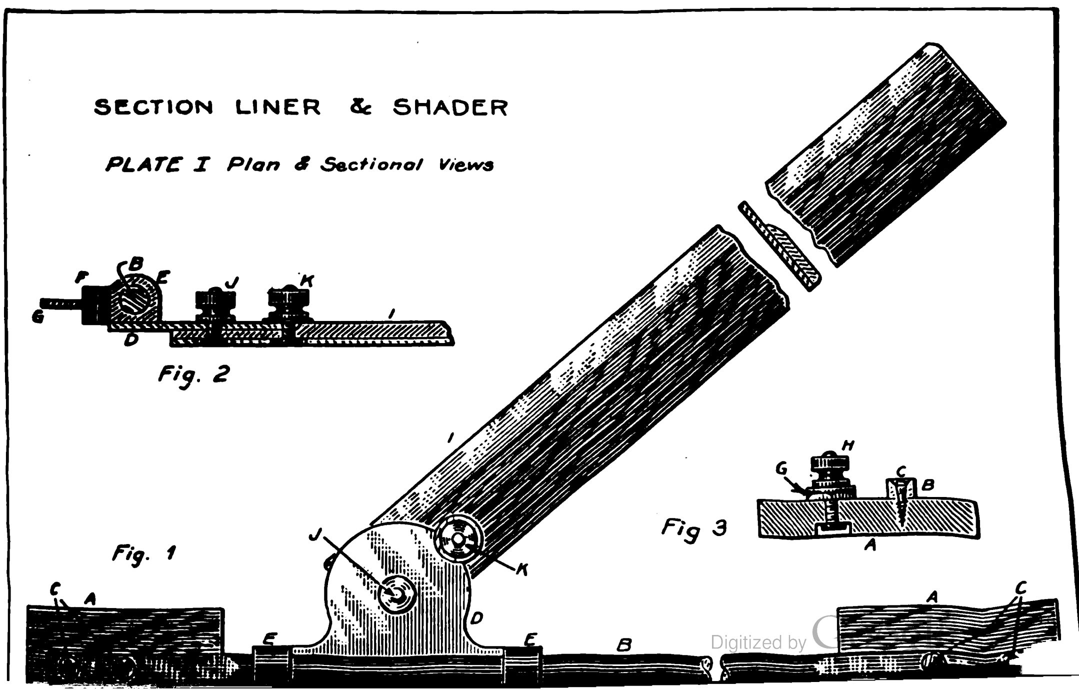
P. MERTZ

The designs of most section-liners are such that they cannot be constructed and made to work satisfactorily, unless the machining of the parts is done by one quite expert with tools. There are also some that are very simple and easily made, but their use generally gives unsatisfactory results, mostly due to the great liability of slipping while in use.

A type of section-liner eliminating most of the above faults was designed and constructed by the writer, and is shown in the accompanying illustrations.

In Plate I is shown the assembled instrument: Fig. 1, plan view; Fig. 2, cross-sectional view through the runner; and Fig. 3, cross-sectional view through one of the bases. Plate II shows working drawings of each of the parts separately, while Plate III shows samples of the work that can be done with the section-liner.

The bases *A* can be made of almost



any sort of wood, hardwood preferably. The rod *B* carrying the runner can be made of brass, iron or steel. As can be seen, it is flattened at both ends, so that it can be more easily fastened to the bases *A* with screws *C*.

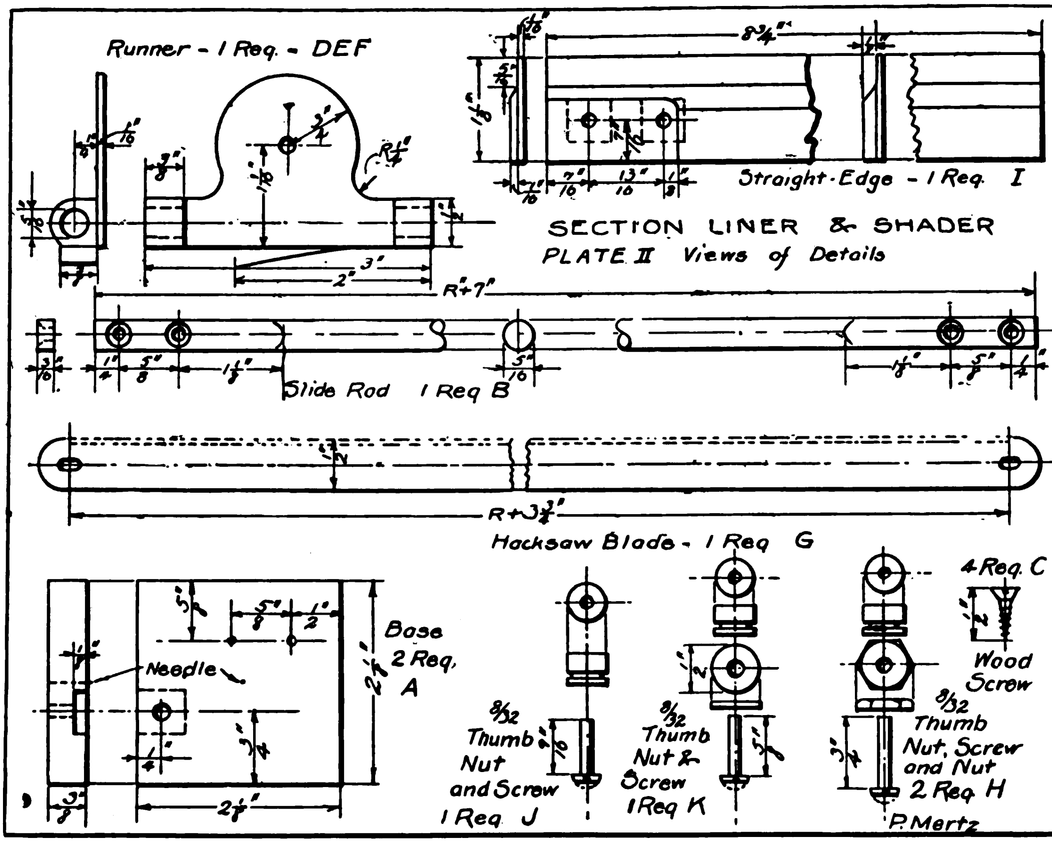
In Plate II, in the dimensions referring to the length of the rod, the letter *R* stands for the range of the section-liner. This is, in other words, the distance any part of the runner has moved when it has gone from the extreme left to the extreme right as far as it can go. On the writer's instrument, being primarily constructed for shading (the use of the device for this purpose will be explained further), the range is only 5 in. However, a more practical range would be 8 in., or more, especially if great areas are to be covered with cross-hatching. To return to the rod, it should be as straight as it possibly can be gotten, or trouble may later be encountered in using the section-liner. The runner *DE* is cut from a piece of heavy (1/16, in.) sheet brass, iron or steel. It will be found easier to cut it with a hack-saw and smooth down the edges with a file than to use shears. The runner is supported on the rod *B* by means of the blocks *E*. These are preferably made of brass filed and drilled to shape. In the writer's instrument the rod *B* and the blocks *E* were taken from the discarded part of a typewriter; thus *E* slides smoothly over the rod, without any jarring. These blocks are neatly soldered to *D*; soldering being used because it is a much simpler way than to fasten them together with screws, for which holes must be drilled and tapped.

However, the escapement is the part of this section-liner giving it its great simplicity and practicability. It consists of a piece of alarm-clock spring *F* soldered to the right-hand block *E*, as shown in Figs. 1 and 2. This piece of clock spring bears upon the toothed side of a hack-saw *G*, the teeth of the hack-saw being turned to the right. This hack-saw *G* is fastened to the bases *A* by means of the bolts and thumb-nuts *H*. The latter can be taken from the binding-posts of old batteries. The heads of the screws are, of course, sunk in, so as not to injure the surface of the paper upon which they rest. The writer has found the use of a hack-saw very satisfactory, as in general the teeth are accurately spaced on them. For general work one with 20 teeth to the inch is used, although if one with 30 can be had its use is recommended. Another hack-saw with 16 teeth to the inch should, if possible, be added to the equipment. This is used for drawing scales, as will be explained further on.

The usual holes in the hack-saw are lengthened with a file, as can be seen in Plate II, *G*. This feature permits of moving the part up and down, although it is not absolutely necessary, and very good work may be done without it.

The straight-edge is another very important part of a section-liner. Most section-liners have a wooden one, while some have it all celluloid (or some such transparent material). As can be seen from the illustrations, the form employed by the writer consists of a celluloid straight-edge *I*, over which is glued a piece of wood reinforcing. The celluloid permits of seeing the work immediately below the line being drawn; an advantage always appreciated in mechanical drawing, but especially when cross-hatching is being done. At first a solid celluloid straight-edge was used, but this did not prove satisfactory, owing to the fact that it bent sidewise, and it was difficult work to rule straight lines. However, by gluing a piece of wood over the celluloid, leaving a margin of about 5/16 in., a very good straight-edge is had. Perhaps a better one might be had by purchasing a maple celluloid-lined one, but these are quite expensive.

The method of clamping the straight-edge to the runner *D* is unique in that no difficult semi-circular slot has to be cut in the latter, although the joint is just as rigid. As shown in Figs. 1 and 2, Plate I, the clamping is done by means of two battery thumb-nuts *J* and *K* with screws. The screw for the former *J* passes through a hole in *I* and another in *D*. It is made from a round-head machine screw of the right size. The head of the screw has been filed down then so that it does not mar the paper underneath. A hole is cut in the celluloid, as can be seen, so that what remains of the head is sunk below the surface of the straight-edge. A battery thumb-nut is screwed over this screw. The other clamping screw *K* is practically the same as *J*, except that it clamps *D* under a washer. It will be



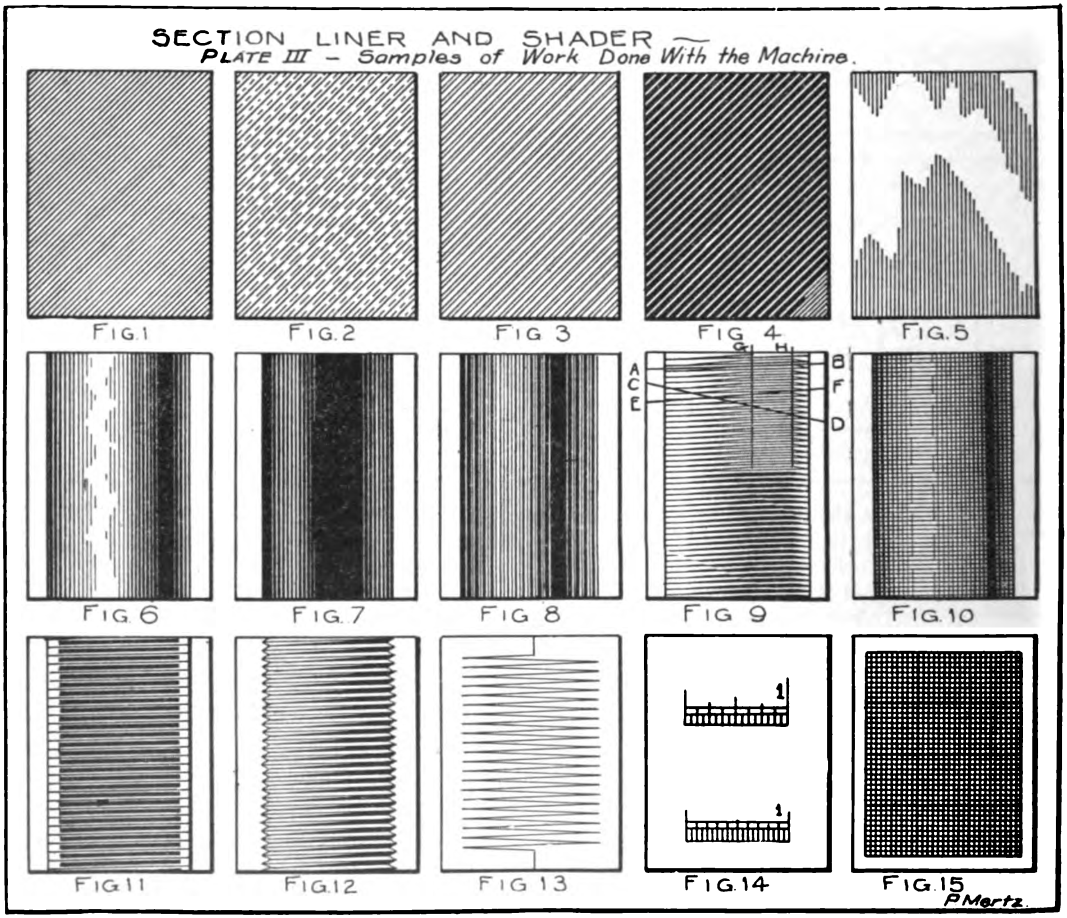
seen from the drawing that the wood *I* under *D* has been filed to admit the latter. Thus the washer under *K* lies flat. If desired, the straight-edge *I* need not be filed, but then a small piece of wood or metal must be placed under part of the washer, to make it lie flat; otherwise it will not satisfactorily clamp *I* to *D*.

A rather fine needle should then be driven through each of the bases *A*, projecting about 1/16 in. from the under surfaces of these. The projecting top part of the needle is then broken off flush with the top of the base.

The section-liner is now complete after the wood parts are finished with stain and wax. A little oil put on the rod *B* about once a month will help a good deal towards the smooth working of the instrument.

The next thing after having constructed a section-liner is to be able to use it properly. For ordinary cross-hatching, the 20 teeth to the inch hack-saw is used, and the straight-edge inclined at an angle of about 45 degrees to the bar *B*. With this Figs. 1 and 2, Plate III, can be drawn without explanation, save that Fig. 2 looks better when the lines are somewhat closer together than in Fig. 1. Sectioning such as is shown in Fig. 3 can be done by loosening the bolts *H H*, slipping the hack-saw *G* a little to the right (this is possible only if the holes in the latter were filed oval, as mentioned before) and drawing only alternate lines. Then *G* is slipped to the left, and the remaining lines filled in. Cross-sections of insulating material, as shown in Fig. 4, can be done by first cross-hatching, as in the lower right-hand corner (having the lines somewhat closer together than in Fig. 1), and then filling in the alternate white spaces.

Metal surfaces, such as shown in Fig. 5, are shaded in the same way as Fig. 1, except that the shade-lines are parallel to one of the edges, and do not cover the whole surface. The shading of curved metal surfaces is shown in Fig. 6. This is self-explanatory, except that it might be mentioned that the lines are all the same distance apart and vary only in thickness. This gives a much better effect than when the shade-lines are nearly equal in thickness, and the curved effect found by changing the distance between them. The use of a section-liner also renders the process much easier, and can well be adopted by the draftsman who has much trouble in giving curved effects to rods. Curved hard rubber or glossy black surfaces are shaded as shown in Fig. 7. It differs from Fig. 6 in that the lines comprising the shading are of such thickness that a good part of the surface is entirely black. Also the reflected light on the right is a little more to the left than in Fig. 6. It is understood that no lines are necessary to be drawn



that the lines are slightly heavier and fine lines are inserted between the regular shade lines. When the milling is too fine to be conveniently drawn it is usually simply shaded, as in Fig. 6.

Side views of coils in which the wire is heavy enough to be conveniently drawn can be shaded in the manner shown in Fig. 9. After the wire has been represented, unshaded, in slightly finer lines than otherwise, two pencil lines *G* and *H* are drawn. Then, having the straight-edge in the general direction *AB* (parallel to the wire), lines extending from *G* to *H* are inserted between the wire-lines. The straight-edge is then swung to the direction *EF* (the whole section-liner should be swung so as not to alter the angle between the straight-edge and the shown. The spaces which have not already been filled by the ink (see upper part of illustration) are filled in with the pen as can be seen in the lower part.

When the wire is too fine for doing the above, the shading is simply put on as shown in Fig. 10, that is, the same shading as in Fig. 6 (except that the lines are somewhat finer).

Screws can be very quickly done, as shown in Fig. 11, which needs no explanation beyond that, to save time, the light lines are drawn first; the heavy ones are inserted after the first are dry. When the screws have a heavy enough thread, they can be represented as shown in Fig. 12.

With a section-liner, symbols representing helices or coils used in wireless telegraph diagrams can be quickly and neatly executed (Fig. 13).

Earlier in this article the use of a section-liner for drawing scales was mentioned; scales so drawn are illustrated in Fig. 14. The upper one is the common scale of inches, and in drawing it the 16-teeth-to-the-inch hack-saw blade must be used on the instrument. The decimal scale is shown in the lower part of the figure, and the 20-teeth-to-the-inch hack-saw blade is used for this. In drawing these scales it is necessary that the straight-edge of the section-liner be at right angles to the slide-rod, or they will not be found to be accurate.

A good kind of cross-section paper can be easily produced with this section-liner, a sample of which is shown in Fig. 15. This is especially useful when a regular piece of cross-section paper is not at hand. There are many other uses to which this instrument may be put which will easily suggest themselves, and are too numerous to mention here.

MECHANICAL BILL COUNTER FOR U.S. TREASURY

Money counting is an art. Anyone can count a small sum of money slowly. To count a large sum of money quickly requires not only muscular skill of a high order, but strict attention. It is wearisome, nerve-racking. The monotony of it makes the human counter liable to error.

So a mechanical automatic money counter is a machine greatly needed, not only in the Treasury of the United States and its sub-treasuries, but in banks, counting-houses and other establishments where large sums of money must be totaled constantly.

Not until John P. Buckley invented his money-counting machine, however, did the Treasury officials believe that mechanism could take the place of the human brain. But the single machine of its kind in the world now counting laundered money in the basement of the Treasury at Washington is the first of a larger order, and it is expected, if the twelve machines now being made for the Treasury prove the possibilities indicated by the present machine, to equip the Treasury with large numbers of them, as well as the sub-treasuries.

Mr. Buckley's machine cannot count without a bill in the machine. The attendant sits before a low table on which is a small and compact mechanism. In front of her are several small, rapidly revolving rolls of a metal, on top of which are rapidly revolving wheels of brass. These wheels and rolls are in contact, and through them runs a small (half ampere) electric current. When a bill is fed in between the brass wheels and the rolls, the circuit is broken. The current has been actuating an electric magnet. The instant the magnet ceases to act, springs raise two flap doors to the compartment toward which the rolls and wheels are feeding the money. The bill slips out of the rolls and rests on these little flap doors. The act of raising these doors by the springs has actuated a mechanical counter. The instant the bill is ejected by the rolls, the electrical contact is re-made, the magnets pull down the doors, and the bill drops flat into the rack below.

When ninety-nine bills have fallen into the rack below, the little doors fly up as before for the hundredth bill, and count it, as before, as it passes through the rolls. But the little doors do not drop down again, a mechanical trip holding them in place. This is the signal for the operator to put a piece of blotting-paper or other separator on top of the hundredth bill. She then presses a button and the doors drop, carrying the hundredth bill and its separator into the magazine below.

A UNIQUE ALTERNATING-CURRENT NETWORK PROTECTOR

FRANK C. PERKINS

The accompanying illustrations, Figs. 1 and 2, show the design and construction of a metropolitan alternating-current network protector of the three-wire 12½ k.w. type. The photograph, Fig. 1, shows complete device ready for installation, while Fig. 2 shows coil and fuse block removed from case, and drawings Figs. 3 and 4, the electrical connections of this novel equipment.

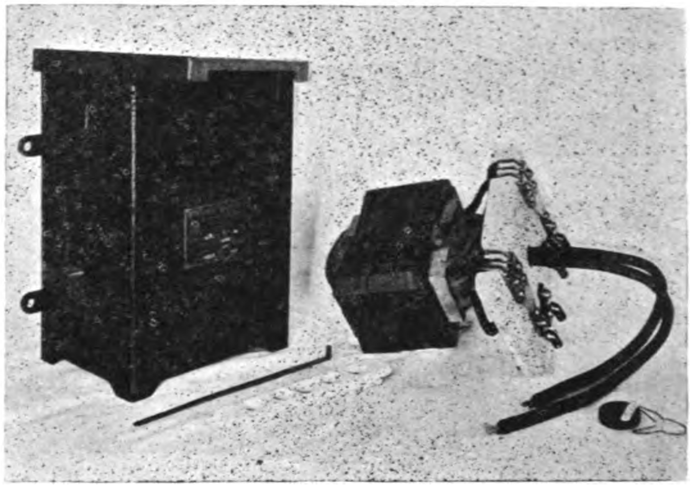


Fig. 2

Continuity of service in the distribution of alternating current for light and power is of great importance. It is the custom to generate at relatively high voltage, distributing by primary feeders and mains to points adjacent to where the power is required. At these points transformers are installed stepping down from the primary to secondary or low voltage suitable for the distributing network.

At first it was the custom to utilize small unit transformers, usually a transformer for a single or a small number of customers, and this practice is still followed in certain communities where customers are widely separated. In more or less congested territories it is found desirable to group the customers, extending the low voltage or secondary distributing mains over a considerable area, installing transformers of large units at convenient points and interconnecting them on both the primary and secondary sides.

This system has the advantage of improving the voltage regulation and takes advantage of the diversity factor in the customers' demand, so that the aggregate of the several large transformers thus connected can be less than the sum of the maximum demand of all the customers, whose several maxima never occur at the same time.

Where this network of system of connection is desirable, continuity of service is absolutely necessary, but in this method of multiple connection, in case of one transformer's burning out or otherwise causing a short-circuit on the system, the primary fuse of the defective transformer

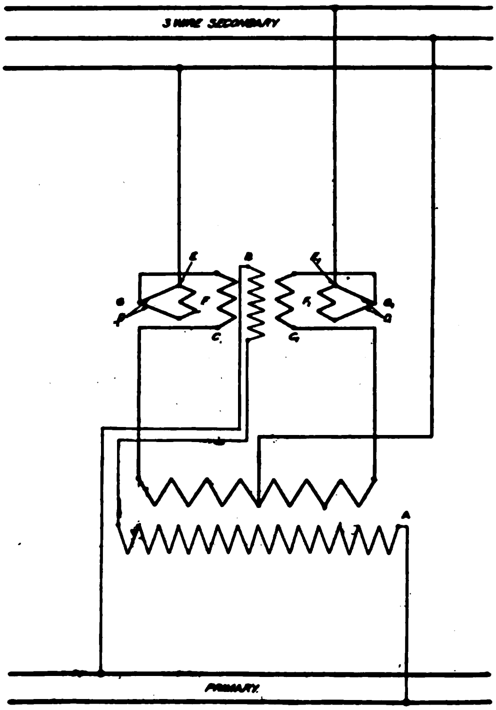


Fig. 3

the transformer nearest the short-circuit will take up most of the load, which will cause the fuse on this transformer to blow, in turn shifting its load to the next transformer.

In the same manner the fuses of the entire number are ruptured and the service supplied from this particular network of transformers interrupted, it being necessary before the service can be re-established to visit all the transforming points and replace the fuses, and this is a matter of delay and difficulty.

The alternating current network protector illustrated was designed instantaneously to disconnect a defective transformer, protecting the secondary network by preventing an overload on the remaining transformers and a consequent interruption of the service. It is entirely electrical—positive in action—free from moving parts—requires no attention or adjustment.

It is in reality a series or current transformer, having three windings: a primary, which is connected in series with the primary of the step-down or service transformer; a secondary winding, which is connected in series with the secondary of the transformer; and a third winding, which is of few turns and heavy wire so that the ratio of current that will flow in this coil when short-circuited and active is high as compared with current in the other coils.

The primary and secondary windings of the protective device are wound with the same ratio of turns as the primary and secondary of the step-down transformer with which it is to be used, and is connected in line with the step-down transformer, so that during normal operation the currents in the primary and secondary windings of the device oppose each other in direction, and as the ratio of the device and step-down transformer are equal the excitation in the two windings of the device are always equal, and being in opposition no current in the short-circuited coil.

In the electrical connections of the device for a three-wire network shown in Fig. 3, the commercial transformer is shown at *A*, one terminal of the primary being connected in series with a coil *B* of the current transformer.

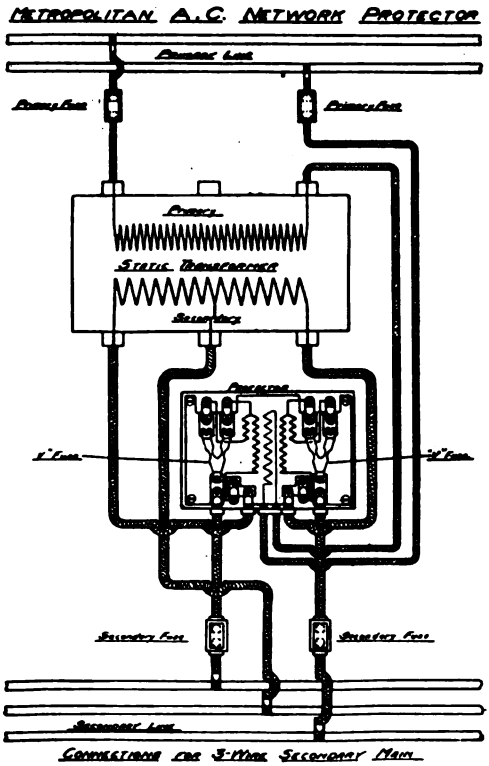


Fig. 4

The terminal of the secondary of the commercial transformer are connected each through its own coil C and C_1, on the current transformer. These latter coils connected to the middle point of the looped fuses D and D_1. One side of the fuses is connected from E and E_1, to the outer conductors of the three-wire network. The fuses D and D_1 act as a short-circuit connection on coils F and F_1.

The function of this combination is that under normal conditions the currents in the primary B and the secondary coil C and C_1 having the same ampere turns and connected in opposition will neutralize each other so that there will be no magnetic flux circulating in the core of the current transformers to energize the coils E and E_1.

This balance of conditions is maintained at all loads and is only upset by a reverse current flowing from the secondary network into the transformer as is occasioned by a short circuit in the latter. This condition immediately reverses the relative polarity of the coils C and C_1, thus energizing the core and causing a heavy short-circuit current to flow through the coils E and E_1, by way of their short-circuiting fuses D and D_1.

The heavy short circuit current through the fuse immediately ruptures, and then isolates, the main terminal at G and G_1. A supply of current sufficient to blow the V fuse is obtained with a reverse current in the secondary of about one-quarter full load current on the transformer, the defective transformer will thus be instantaneously cut out and disconnected from the line, allowing the remaining transformers connected to the network to continue their function taking up the load of the defective transformer without any interruption in the service whatever.

TRUING EMERY WHEELS

LYMAN ROBBINS

The emery grinder is an absolute necessity in every woodworking shop. But every emery-wheel should be kept in first-class condition, otherwise it will be a necessary evil. With the improved truing devices which have been invented, there is no excuse for a wheel's being out of condition for a single instant.

The hand truing tool is well known to most shop men, but the automatic truing device may be a novelty to other woodworkers. This new piece of machinery is entirely permanent upon the emery-wheel and requires only a turn of the wrist to bring it into operation. It is power-driven and travels forward a certain distance and cuts away every particle of emery from the wheel within that distance.

Once an automatic truing device has been tried in the shop, you will have no further use for the hand tools, except in shaping up special emery-wheels and grinding intricate cutters.

Some shops do not have even a diamond point for truing emery-wheels. And I have seen a bundle of washers quently, never waiting until the surface is out of round. By thus truing, the wheel will always be ready to do its best work and the greatest possible quantity thereof.

Do not overlook the matter of light. Good work cannot be done with an emery-wheel which is placed in a dark corner and so located that the workman obtsructs what little light does get to the machine.

Put the emery grinder in front of a window if possible. If it must be in a dark place, see that a good lamp, electric if possible, is located where it will give light enough for the workman to see what he is doing.

While installing the emery grinder, do not forget to procure a machine with room for a half dozen wheels upon the spindle. Put on several grades of emery and into two of the wheel spaces place an oilstone and a leather buffing wheel. These two wheels will be found as great time savers as the emery wheels themselves.

As a result of the recent tests, government experts declare that the Arlington

RADIOTELEGRAPHY*

COMMENDATORE G. MARCONI, LL.D.,D.SC.

The practical application of electric waves to the purposes of wireless telegraphic transmission over long distances has continued to extend to a remarkable degree during the last few years, and many of the difficulties, which at the outset appeared almost insurmountable, have been gradually overcome, chiefly through the improved knowledge which we have obtained in regard to the subject generally and to the principles involved.

The experiments which I have been fortunate enough to be able to carry out, on a much larger scale than can be done in ordinary laboratories, have made possible the investigation of phenomena often novel and certainly unexpected.

Although we have—or believe we have—all the data necessary for the satisfactory production and reception of electric waves, we are yet far from possessing any very exact knowledge concerning the conditions governing the transmission of these waves through space, especially over what may be termed long distances. Although it is now perfectly easy to design, construct, and operate stations capable of satisfactory commercial working over distances up to 2,500 miles, no really clear explanation has yet been given of many absolutely authenticated facts concerning these waves. Some of these hitherto apparent anomalies I shall mention briefly in passing.

Why is it that when using short waves the distances covered at night are usually enormously greater than those traversed in the day-time, while, when using much longer waves the range of transmission by day and night is about equal and sometimes even greater by day?

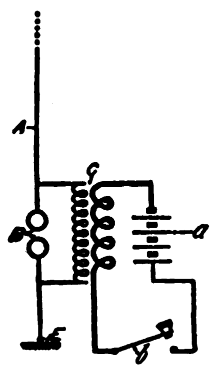


Fig. 1

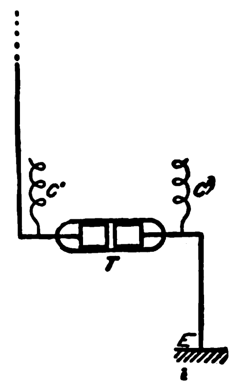


Fig. 2

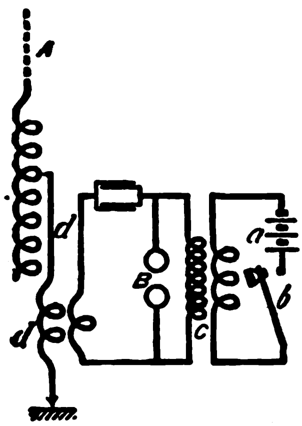


Fig. 3

What explanation has been given of the fact that the night distances obtainable in a north-southerly direction are so much greater than those which can be effected in an east-westerly one?

Why is it that mountains and land generally should greatly obstruct the propagation of short waves when sunlight is present and not during the hours of darkness?

The general principles on which practical radiotelegraphy is based are now so well known that I need only refer to them in the briefest possible manner.

Wireless telegraphy, which was made possible by the fields of research thrown open by the work of Faraday, Maxwell and Hertz, is operated by electric waves, which are created by alternating currents of very high frequency, induced in suitably placed elevated wires or capacity areas. These waves are received or picked up at a distant station on other elevated conductors tuned to the period of the waves, and the latter are revealed to our senses by means of appropriate detectors.

My original system as used in 1896 consisted of the arrangement shown

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diagrammatically in Fig. 1, where an elevated or vertical wire was employed. This wire sometimes terminated in a capacity or was connected to earth through a spark gap.

By using an induction coil or other source of sufficiently high tension electricity sparks were made to jump across the gap; this gave rise to oscillations of high frequency in the elevated conductor and earth, with the result that energy in the form of electric waves was radiated through space.

At the receiving station, Fig. 2, these waves induced oscillatory currents in a conductor containing a detector, in the form of a coherer, which was usually placed between the elevated conductor and earth.

Although this arrangement was extraordinarily efficient in regard to the radiation of electrical energy, it had numerous drawbacks.

The electrical capacity of the system was very small, with the result that the small amount of energy in the aerial was thrown into space in an exceedingly short period of time. In other words, the energy, instead of giving rise to a train of waves, was all dissipated after only a few oscillations, and, consequently, anything approaching good tuning between the transmitter and receiver was found to be unobtainable in practice.

Many mechanical analogies could be quoted which show that in order to obtain syntony the operating energy must be supplied in the form of a sufficient number of small oscillations or impulses properly timed. Acoustics furnish us with numerous examples of this fact, such as the resonance produced by the well-known tuning fork experiment.

Other illustrations of this principle may be given; *e.g.*, if we have to set a heavy pendulum in motion by means of small thrusts or impulses, the latter must be timed to the period of the pendulum, as otherwise its oscillations would not acquire any appreciable amplitude.

In 1900 I first adopted the arrangement which is now in general use, and which consists, as shown in Fig. 3, of the inductive association of the elevated radiating wire with a condenser circuit which may be used to store up a considerable amount of electrical energy and impart it at a slow rate to the radiating wire.

As is now well known, the oscillations in a condenser circuit can be made to persist for what is electrically a long period of time, and it can be arranged, moreover, that by means of suitable aerials or antennae these oscillations are radiated into space in the form of a series of waves, which through their cumulative effect are eminently suitable for enabling good tuning and syntony to be obtained between the transmitter and receiver.

The circuits, consisting of the condenser circuit and the elevated aerial or radiating circuit, were more or less closely coupled to each other. By adjusting the inductance in the elevated conductor, and by the employment of the right value of capacity or inductance required

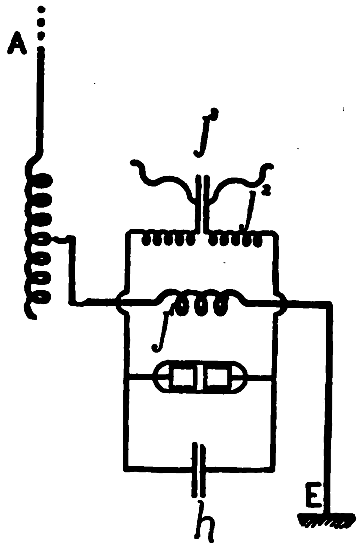


Fig. 4

in the condenser circuit, the two circuits were brought into electrical resonance, a condition which I first pointed out as being essential in order to obtain efficient radiation and good tuning.

The receiver, as shown in Fig. 4, also consists of an elevated conductor or aerial connected to earth or capacity through an oscillating transformer. The latter also contains the condenser and detector, the circuits being made to have approximately the same electrical time period as that of the transmitter circuits.

At the long distance station situated at Clifden, in Ireland, the arrangement which has given the best results is based substantially upon my syntonic system

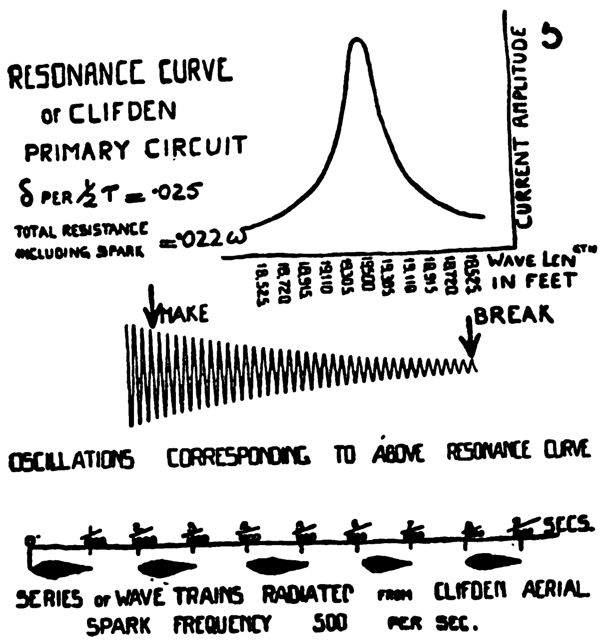


Fig. 5

of 1900, to which have been added numerous improvements.

An important innovation from a practical point of view was the adoption at Clifden and Glace Bay of air condensers, composed of insulated metallic plates suspended in air at ordinary pressure. In this manner we greatly reduce the loss of energy which would take place in consequence of dielectric hysteresis were a glass or solid dielectric employed. A very considerable economy in working also results from the absence of dielectric breakages, for, should the potential be so raised as to even produce a discharge from plate to plate across the condenser, this does not permanently affect the value of the dielectric, as air is self-healing and one of the few commodities which can be replaced at a minimum of cost.

Various arrangements have been tried and tested for obtaining continuous or very prolonged trains of waves, but it has been my experience that, when utilizing the best receivers at present available, it is neither economical nor efficient to attempt to make the waves too continuous. Much better results are obtained when groups of waves, Fig. 5, are emitted at regular intervals in such manner that their cumulative effect produces a clear musical note in the receiver, which is tuned not only to the periodicity of the electric waves transmitted, but also to their group frequency.

In this manner the receiver may be doubly tuned, with the result that a far greater selectivity can be obtained than by the employment of wave tuning alone.

In fact, it is quite easy to pick up simultaneously different messages transmitted on the same wave-length, but syntonized to different group frequencies.

As far as wave tuning goes, very good results—almost as good as are obtainable by means of continuous oscillation — can be achieved with groups of waves, the decrement of which is in each group 0.03 or 0.04, which means that about 30 or 40 useful oscillations are radiated before their amplitude has become too small to perceptibly affect the receiver.

The condenser circuit at Clifden has a decrement of from 0.015 to 0.03 for fairly long waves.

This persistency of the oscillations has been obtained by the employment of the system shown in Fig. 6, which I first described in a patent taken out in September, 1907. This method eliminates

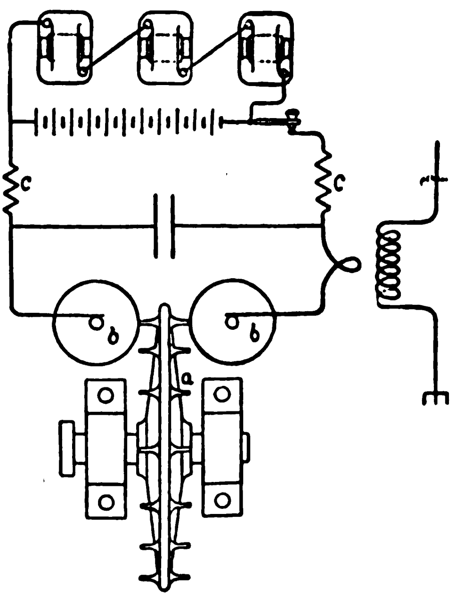


Fig. 6—Disc Discharger. Continuous Current

almost completely the spark gap and its consequent resistance, which, as is well known, is the principal cause of the damping or decay of the waves in the usual transmitting circuit.

The apparatus shown in Fig. 6 consists of a metal disc *a*, having copper studs firmly fixed at regular intervals in its periphery and placed transversely to its plane. This disc is caused to rotate very rapidly between two other discs *b*, by means of a rapidly revolving electric motor or steam turbine. These side discs are also made slowly to turn round in a plane at right angles to that of the middle disc. The connections are as illustrated in the figure. The studs are of such length as to just touch the side discs in passing, and thereby bridge the gap between the latter.

With the frequency employed at Clifden, namely, 45,000, when a potential of 15,000 volts is used on the condenser, the spark gap is practically closed during the time in which one complete oscillation

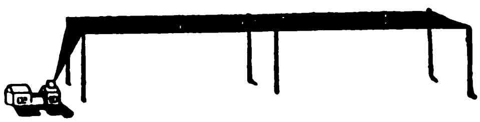


Fig. 7

only is taking place, when the peripherical speed of the disc is about 600 ft. a second. The result is that the primary circuit can continue oscillating without material loss by resistance in the spark gap. Of course the number of oscillations which can take place is governed by the breadth or thickness of the side discs, the primary circuit being abruptly opened as soon as the studs attached to the middle disc leave the side discs.

This sudden opening of the primary circuit tends to immediately quench any oscillations which may still persist in the condenser circuit; and this fact carries with it a further and not inconsiderable advantage, for if the coupling of the condenser circuit to the aerial is of a suitable value the energy of the primary will have practically all passed to the aerial circuit during the period of time in which the primary condenser circuit is closed by the stud filling the gap between the side discs; but after this the opening of the gap at the discs prevents the energy returning to the condenser circuit from the aerial, as would happen were the ordinary spark gap employed. In this manner the usual reaction which would take place between the aerial and the condenser circuit can be obviated, with the result that with this type of discharger and with a suitable degree of coupling the energy is radiated from the aerial in the form of a pure wave, the loss from the spark gap resistance being reduced to a minimum.

I am able to show a resonance curve taken at Clifden which was obtained from the oscillations in the primary alone, Fig. 5.

An interesting feature of the Clifden plant, especially from a practical and engineering point of view, is the regular employment of high-tension direct current for charging the condenser. Continuous current at a potential which is capable of being raised to 20,000 volts is obtained by means of special direct-current generators; these machines charge a storage battery consisting of 6,000 cells, all connected in series, and it may be pointed out that this battery is the largest of its kind in existence. The capacity of each cell is 40 ampere-hours. When employing the cells alone the working voltage is from 11,000 to 12,000 volts, and when both the direct-current generators and the battery are used together the potential may be raised to 15,000 volts through utilizing the gassing voltage of the storage cells.

For a considerable portion of the day the storage battery alone is employed, with a result that for 16 hours out of the 24 no running machinery need be used for operating the station, with the single exception of the small motor revolving the disc.

The potential to which the condenser is charged reaches 18,000 volts when that of the battery or generators is 12,000. This potential is obtained in consequence of the rise of potential at the condenser plates, brought about by the rush of current through the choking or inductance coils at each charge. These coils are placed between the battery or generator and the condenser *c*, Fig. 6.

No practical difficulty has been encountered either at Clifden or Glace Bay in regard to the insulation and maintenance of these high-tension storage batteries. Satisfactory insulation has been obtained by dividing the battery into small sets of cells placed on separate stands. These stands are suspended on insulators attached to girders fixed in the ceiling of the battery room. A system of switches, which can all be operated electrically and simultaneously, divides the battery into sections, the potential of each section being low enough to enable the cells to be handled without inconvenience or risk.

The arrangement of aerial adopted at Clifden and Glace Bay is shown in Fig. 7. This system, which is based on the result of tests which I first described before the Royal Society in June, 1906,* not only makes it possible efficiently to radiate and receive waves of any desired length, but it also tends to confine the main portion of the radiation to any desired direction. The limitation of transmission to one direction is not very sharply defined, but nevertheless the results obtained are exceedingly useful for practical working.

In a similar manner, by means of these horizontal wires, it is possible to define the bearing or direction of a sending station, and also limit the receptivity of the receiver to waves arriving from a given direction.

The commercial working of radiotelegraphy and the widespread application of the system on shore and afloat in nearly all parts of the world has greatly facilitated the marshaling of facts and the observation of effects. Many of these, as I have already stated, still await a satisfactory explanation.

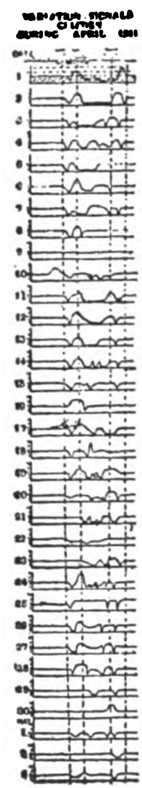


Fig. 9

daylight on the propagation of electric waves over great distances.

The generally accepted hypothesis of the cause of this absorption of electric waves in sunlight is founded on the belief that the absorption is due to the ionization of the gaseous molecules of the air

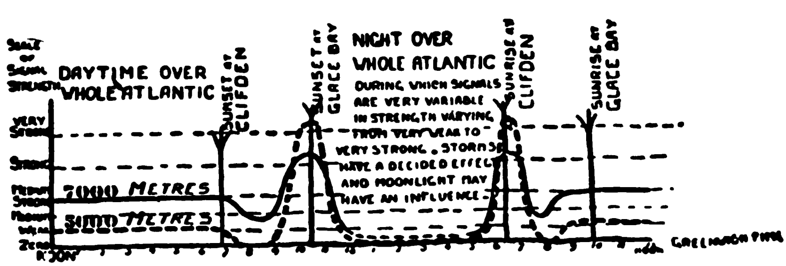


Fig. 8

A curious result which I first noticed over nine years ago in long-distance tests carried out on the steamship *Philadelphia*, and which still remains an important

affected by the ultra-violet light, and as the ultra-violet rays which emanate from the sun are largely absorbed in the upper atmosphere of the earth, it is probable more ions or electrons than that which is in darkness, and therefore, as Sir J. J. Thomson has shown,* this illuminated or ionized air will absorb some of the energy of the electric waves.

The wave-length of the oscillations employed has much to do with this interesting phenomenon, long waves being subject to the effect of daylight to a very much lesser degree than are short waves.

Although certain physicists thought some years ago that the daylight effect should be more marked on long waves than on short, the reverse has been my experience; indeed, in some transatlantic experiments, in which waves about 8,000 meters long were used, the energy received by day at the distant receiving station was usually greater than that obtained at night.

Recent observation, however, reveals the interesting fact that the effects vary greatly with the direction in which transmission is taking place, the results obtained when transmitting in a northerly and southerly direction being often altogether different from those observed in the easterly and westerly one.

Research in regard to the changes in the strength of the received radiations which are employed for telegraphy across the Atlantic has been recently greatly facilitated by the use of sensitive galvanometers, by means of which the strength of the received signals can be measured with a fair degree of accuracy.

In regard to moderate power stations such as are employed on ships, and which, in compliance with the international convention, use wave-lengths of 300 and 600 meters, the distance over which communication can be effected during daytime is generally about the same, whatever the bearing of the ships to each other or to the land stations—while at night interesting and apparently curious results are obtained. Ships over 1,000 miles away, off the south of Spain or round the coast of Italy, can almost always communicate during the hours of darkness with the post-office stations situated on the coasts of England and Ireland, while the same ships, when at a similar distance on the Atlantic to the westward hardly ever communicate with these shore stations unless by means of specially powerful instruments.

It is also to be noticed that in order to reach ships in the Mediterranean the electric waves have to pass over a large portion of Europe, and, in many cases, over the Alps. Such long stretches of land, especially when including very high mountains, constitute, as is well known, an insurmountable barrier to the propagation of short waves during the daytime. Although no such obstacles lie between the English and Irish stations and ships in the North Atlantic en route for North America, a night transmission of 1,000 miles is there of exceptionally rare occurrence. The same effects generally are noticeable when ships are communicating with stations situated on the Atlantic coast of America.

Although high power stations are now used for communicating across the Atlantic Ocean, and messages can be sent by day as well as by night, there still exist periods of fairly regular daily occurrence during which the strength of the received signals is at a minimum. Thus in the morning and the evening, when, in consequence of the difference in longitude, daylight or darkness extends only part of the way across the ocean, the received signals are at their weakest. It would almost appear as if electric waves, in passing from dark space to illuminated space and *vice versa*, were reflected and refracted in such a manner as to be diverted from the normal path.

Later results, however, seem to indicate that it is unlikely that this difficulty would be experienced in telegraphing over equal distances north and south on about the same meridian, as, in this case, the passage from daylight to darkness would occur more rapidly over the whole distance between the two stations.

I have here some diagrams which have been carefully prepared by Mr. H. J. Round. These show the average daily variation of the signals received at Clifden from Glace Bay.

The curves traced on the diagram, Fig. 8, show the usual variation in the strength of these transatlantic signals on

The strength of the received waves remains as a rule steady during daytime.

Shortly after sunset at Clifden they become gradually weaker, and about two hours later they are at their weakest. They then begin to strengthen again, and reach a very high maximum at about the time of sunset at Glace Bay.

They then gradually return to about normal strength, but through the night they are very variable. Shortly before sunrise at Clifden the signals commence to strengthen steadily, and reach another high maximum shortly after sunrise at Clifden. The received energy then steadily decreases again until it reaches a very marked minimum, a short time before sunrise at Glace Bay. After that the signals gradually come back to normal day strength.

It can be noticed that, although the shorter wave gives on the average weaker signals, its maximum and minimum variations of strength very sensibly exceed that of the longer waves.

Fig. 9 shows the variations at Clifden during periods of 24 hours, commencing at 12 noon throughout the month of April, 1911, the vertical dotted lines representing sunset and sunrise at Glace Bay and Clifden.

Fig. 10 shows the curve for the first day of each month for one year, from May, 1910, to April, 1911.

I carried out a series of tests over longer distances than had ever been previously attempted, in September and October of last year, between the stations of Clifden and Glace Bay, and a receiving station placed on the Italian Steamship, *Principessa Mafalda*, in the course of a voyage from Italy to Argentina (Fig. 10*a*).

During these tests the receiving wire was supported by means of a kite, as was done in my early transaltantic tests of 1901, the height of the kite varying from about 1,000 to 3,000 ft. Signals and messages were obtained without difficulty, by day as well as by night, up to a distance of 4,000 statute miles from Clifden.

Beyond that distance reception could only be carried out during night-time. At Buenos Ayres, over 6,000 miles from Clifden, the night signals from both Clifden and Glace Bay were generally good, but their strength suffered some variations.

It is rather remarkable that the radiations from Clifden should have been detected at Buenos Ayres so clearly at night-time and not at all during the day, while in Canada the signals coming from Clifden (2,400 miles distant) are no stronger during the night than they are by day.

Further tests have been carried out recently for the Italian Government between a station situated at Massaua in East Africa and Coltano in Italy. Considerable interest attached to these experiments, in view of the fact that the

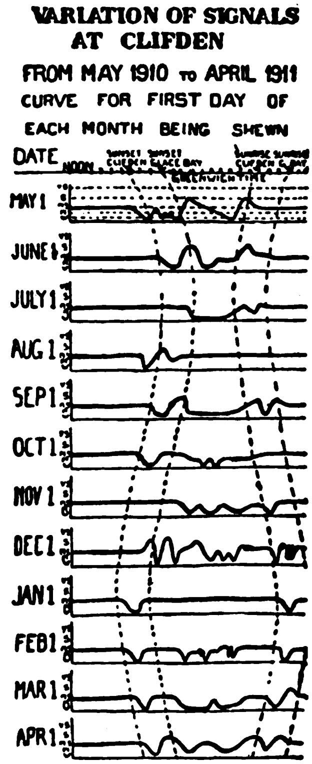


Fig. 10

line connecting the two stations passes over exceedingly dry country and across vast stretches of desert, including parts of Abyssinia, the Soudan, and the Libyan Desert. The distance between the two stations is about 2,600 miles.

The wave-length of the sending station in Africa was too small to allow of transmission being effected during daytime, but the results obtained during the hours of darkness were exceedingly good, the received signals being quite steady and readable.

The improvements introduced at Clifden and Glace Bay have had the result of greatly minimizing the interference to which wireless transmission over long distances was particularly exposed in the early days.

The signals arriving at Clifden from Canada are as a rule easily read through any ordinary electrical atmospheric disturbance. This strengthening of the received signals has moreover made possible the use of recording instruments, which will not only give a fixed record of the received messages, but are also capable of being operated at a much higher rate of speed than could ever be obtained by means of an operator reading by sound or sight. The record of the signals is obtained by means of photography in the following manner: A sensitive Einthoven string galvanometer is connected to the magnetic detector or valve receiver, and the deflections of its filament caused by the incoming signals are projected and photographically fixed on a sensitive strip, which is moved along at a suitable speed. On some of these records, which I am able to show, it is interesting to note the characteristic marks and signs produced among the signals by natural electric waves or other electrical disturbances of the atmosphere, which, on account of their doubtful origin, have been called "X's."

Although the mathematical theory of electric wave propagation through space was worked out by Clerk Maxwell more than 50 years ago, and notwithstanding all the experimental evidence obtained in laboratories concerning the nature of these waves, yet so far we understand but incompletely the true fundamental principles concerning the manner of propagation of the waves on which wireless telegraph transmission is based. For example, in the early days of wireless telegraphy it was generally believed that the curvature of the earth would constitute an insurmountable obstacle to the transmission of electric waves between widely-separated points. For earth connection, especially in regard to the transmission of oscillations over long distances.

Physicists seemed to consider for a long time that wireless telegraphy was solely dependent on the effects of free Hertzian radiation through space, and it was years before the probable effect of the conductivity of the earth was considered and discussed.

Lord Rayleigh, in referring to transatlantic radiotelegraphy, stated in a paper read before the Royal Society in May, 1903, that the results which I had obtained in signalling across the Atlantic suggested "a more decided bending or diffraction of the waves round the protuberant earth than had been expected," and further said that it imparted a great interest to the theoretical problem.* Prof. Fleming, in his book on electric wave telegraphy, gives diagrams showing what may be taken to be a diagrammatic representation of the detachment of semi-loops of electric strain from a simple vertical wire, Fig. 11.

As will be seen, these waves do not propagate in the same manner as does free radiation from a classical Hertzian oscillator, but instead glide along the surface of the earth.

Prof. Zenneck† has carefully examined the effect of earthed receiving and transmitting aerials, and has endeavored to show mathematically that when the lines of electrical force, constituting a wave front, pass along a surface of low specific inductive capacity—such as the earth—they become inclined forward, their lower ends being retarded by the resistance of the conductor, to which they are attached. It therefore would seem that wireless telegraphy as at present practiced is, to some extent at least, dependent on the conductivity of the earth, and that the difference in operation across long distances of sea compared to over land is sufficiently explained by the fact that sea water is a much better conductor than is land.

The importance or utility of the earth connection has been sometimes questioned, but in my opinion no practical manner connected to earth. By connection to earth I do not necessarily mean an ordinary metallic connection as used for wire telegraphs. The earth wire may have a condenser in series with it, or it may be connected to what is really equivalent, a capacity area placed close to the surface of the ground. It is now perfectly well known that a condenser, if large enough, does not prevent the passage of high-frequency oscillations, and therefore in this case, when a so-called balancing capacity is used, the antenna is for all practical purposes connected to earth.

I am also of opinion that there is absolutely no foundation in the statement which has recently been repeated to the effect that an earth connection is detrimental to good tuning, provided of course that the earth is good.

Certainly, in consequence of its resistance, what electricians call a bad earth

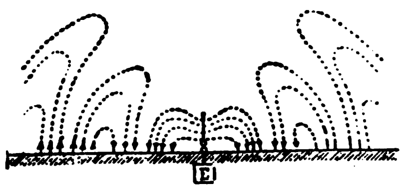


Fig. 11

will damp out the oscillations, and in that way make tuning difficult; but no such effect is noticed when employing an efficient earth connection.

In conclusion, I believe that I am not any too bold when I say that wireless telegraphy is tending to revolutionize our means of communication from place to place on the earth's surface. For example, commercial messages containing a total of 812,200 words were sent and received between Clifden and Glace Bay from May 1, 1910, to the end of April, 1911; wireless telegraphy has already furnished means of communication between ships and the shore where communication was before practically impossible. The fact that a system of imperial wireless telegraphy is to be discussed by the imperial conference, now holding its meetings in London, shows the supremely important position which radiotelegraphy over long distances has assumed in the short space of one decade. Its importance from a commercial, naval, and military point of view has increased very greatly during the last few years as a consequence of the innumerable stations which have been erected, or are now in course of construction, on various coasts, in inland regions, and on board ships in all parts of the world. Notwithstanding this multiplicity of stations and their almost constant operation, I can say from practical experience that mutual interference between properly equipped and efficiently tuned instruments has so far been almost entirely absent. Some interference does without doubt take place between ships, in consequence of the fact that the two wave-lengths adopted in accordance with the rules laid down by the international convention are not sufficient for the proper handling of the very large amount of messages transmitted from the ever increasing number of ships fitted with wireless telegraphy. A considerable advantage would be obtained by the utilization of a third and longer wave to be employed exclusively for communication over long distances.

In regard to the high-power transatlantic stations, the facility with which interference has been prevented has to some extent exceeded my expectations. At the receiving station situated at a distance of only 8 miles from the powerful sender at Clifden, during a recent demonstration arranged for the Admiralty, messages could be received from Glace Bay without any interference from Clifden when this latter station was transmitting at full power on a wave-length differing only 25 per cent. from the wave radiated from Glace Bay, the ratio between the maximum recorded range of Clifden and 8 miles being in the proportion of 750 to 1.

Arrangements are being made to permanently send and receive simultaneously at these stations, which, when completed, will constitute in effect the duplexing of radiotelegraphic communication between Ireland and Canada.

The result which I have last referred to also goes to show that it would be practicable to operate at one time, on slightly different wave-lengths, a great number of long-distance stations situated in England and Ireland without danger of mutual interference.

The extended use of wireless telegraphy is principally dependent on the ease with which a number of stations can be efficiently worked in the vicinity of each other.

Considering that the wave-lengths at present in use range from 200 to 23,000 ft., and moreover that wave group tuning and directive systems are now available, it is not difficult to foresee that this comparatively new method of communication is destined to fill a position of the greatest importance in facilitating communication throughout the world.

Apart from long-distance work, the practical value of wireless telegraphy may perhaps be divided into two parts: (1) when used for transmission over sea and (2) when used over land.

Many countries, including Italy, Canada and Spain, have already supplemented their ordinary telegraph systems by wireless telegraphy installations, but some time must pass before this method of communication will be very largely used for inland purposes in Europe generally, owing to the efficient network of land lines already existing which render further means of communication unnecessary; and therefore it is probable that, at any rate for the present, the main use of radiotelegraphy will be confined to extra-European countries, in some of which climatic conditions and other causes absolutely prohibit the efficient maintenance of land-line telegraphy. A proof of this has been afforded by the success which has attended the working of the stations recently erected in Brazil on the upper Amazon.

By the majority of people the most marvelous side of wireless telegraphy is perhaps considered to be its use at sea. Up to the time of its introduction, ships at any appreciable distance from land had no means of getting in touch with the shore throughout the whole duration of their voyage. But those who now make long sea journeys are no longer cut off from the rest of the world; business men can continue to correspond at reasonable rates with their offices in America or Europe; ordinary social messages can be exchanged between passengers and their friends on shore; a daily newspaper is published on board most of the principal liners, giving the chief news of the day. Wireless telegraphy has on more than one occasion is the arrest, which took place recently through its agency, of a notorious criminal when about to land in Canada.

The chief benefit, however, of radiotelegraphy lies in the facility which it affords to ships in distress of communicating their plight to neighboring vessels or coast stations; that it is now considered indispensable for this reason is shown by the fact that several governments have passed a law making a wireless-telegraph installation a compulsory part of the equipment of all passenger boats entering their ports.

Deaf and Dumb Converse

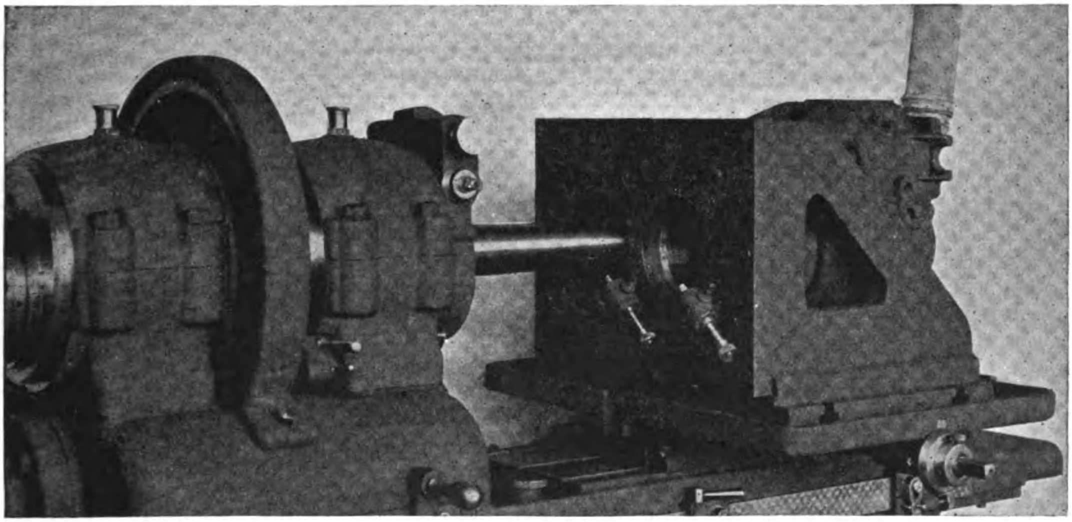
DR. LEONARD KEENE HIRSHBERG

A curious electrical device—called a "deaf mute's telephone"—has recently been designed to enable those who can neither speak nor hear to communicate rapidly, not only with each other, but also with persons more fortunate than themselves, but who are not conversant with the "finger sign" language. The 'phone comprises essentially an electrical keyboard, somewhat like that of a typewriter, and is also fitted with a "universal system" arrangement of letters. This keyboard is connected by wire with an electric signal board, which comprises the "talking machine." It consists of thirty-six incandescent light globes, each with a large letter of the alphabet or one of the nine numerals painted on the end of the bulb. The person who wishes to "converse" presses the keys, spelling out the words as on a typewriter, the person at the other end reads the letters as they flash on the lamps. The keys descend on points of contact in the same manner as do the printing typewriter telegraph machines. This does away with any false or lost motion, and insures perfect contacts. The keyboard, however, can be operated as quickly by an expert as an ordinary typewriter, and the letters and numerals can be read as quickly as they can be flashed out. Thus persons familiar with an ordinary universal keyboard could readily operate this device, and with a little practice could become expert at it. The device is also useful for silent signalling and conversation between two people of normal faculties who desire to keep their conversation

MANUFACTURE OF AUTOMOBILE ENGINE CYLINDERS

GEO. F. WORTS

The cylinders are cast in sand molds singly, although some makes embody the "en bloc" type of motor in which all cylinders are cast together forming one block. From the foundry, the rough castings are removed to a cleaning room where all vestiges of sand are carefully removed and the rough places, called "fins," resulting from imperfections in the mold, are ground off by an abrasive wheel of coarse grit attached to a small electric "hand motor." The cylinder is then bored out, reamed and otherwise machined until the hole has approached to within seven thousandths to eleven thousandths of an inch of size, leaving on an average of nine thousandths of an inch to be removed by grinding. Heald Cylinder Grinding Machines are largely used which employ the high speed abrasive wheels and put the finishing touch to the "heart" of the motor car, as it can truthfully be called.



A battery of five of these machines is in constant operation at the factory visited by the writer and produce on an average of 250 cylinders a day.

A steady shower of sparks where abrasive meets iron, bearing striking semblance to the fiery tail of a comet, bombards the sides of the cylinder as the expert mechanic manipulates the complicated machine to reduce the bore to the desired 4½ in. diameter. So accurately must this work be done that the deviation of a mere two thousandths of an inch—the thickness of a hair—is all the workman is allowed. In other words, the diameter must not vary from the limits of 4½ in. to 4½ plus two thousandths of an inch.

Each machine is equipped with a water-cooling arrangement to continually spray the exterior of the cylinder, as the heat developed by the rapidly spinning wheel must be constantly dissipated or else the expansion of the metal will throw out the most expert calculations and result in an imperfect cylinder.

The abrasive wheel, which is of somewhat smaller diameter than the hole to be ground, is secured to the end of a high speed axle turning within a long, tapering spindle which revolves "off-center"—so that the entire circumference of the bore is touched in one revolution of the spindle. At the same time the cylinder moves back and forth on a "carriage," thus providing for the entire length of the bore to be ground uniformly.

At first, in "roughing out," the carriage moves quite rapidly. But as the desired diameter is neared, the speed is greatly diminished and the final traversal occupies over a minute and a half. The finished cylinder is then removed from the machine, touched up where necessary with a fine file and dispatched to the assembling department.

TALES OF LOFTY TUMBLES

The "irony of life" was strikingly illustrated in the newspapers the other day when one read, in the same column, of a rustic who slipped from a 6-barred gate and broke his neck, and of an Italian aeronaut who fell 1,000 ft. with his collapsed balloon with no worse result than a sprained ankle.

It is not long since a French lady, Mme. Morel, and her daughter, while climbing in the Alps, near Zermatt, fell a distance of 1,200 ft. (not much less than a quarter of a mile), and, although the mother was killed on the spot, her daughter escaped with a few bruises. Mr. Whymper, the famous mountaineer, had a similarly miraculous deliverance from what seemed to be certain death when scaling the Matterhorn a few years ago. Losing his footing, he fell from rock to rock to the bottom of a precipitous gully, 100 yd. in depth, only to recover his feet with no worse damage than a badly cut head.

While climbing a waterworks tower 240 ft. high in Chicago not long ago a steeple-jack called Sutherland dislodged a loose stone and was precipitated to the ground from a height of 175 ft., fortunately striking the telegraph wires 40 ft. above the street and thus breaking his fall. The spectators gasped with horror as they saw the man drop swiftly to destruction; a rush was made to pick up his shattered remains, only to discover that he was practically unharmed. Not a bone was broken, and a week later he was walking about as if nothing had happened.

More remarkable, and, indeed, almost incredible, was the experience of Charles Woolcot when he was making a parachute descent in Venezuela. At a height of 3,000 ft. Woolcot flung himself off his balloon into space, when, to the horror of the thousands of onlookers, the parachute failed to open. The man dropped like a stone with terrible speed, until, when about 200 ft. from the earth, the parachute flew open, and at once collapsed. He was dashed to the ground, his right thigh and hip were broken, both ankles and knees were badly crushed, and his spinal column was dislocated. And...

But it is in the history of ballooning that one encounters the most remarkable cases of sensational drops from the clouds. When Mr. Wise, a famous aeronaut of seventy year ago, was once making an ascent, his balloon exploded at an altitude of 13,000 ft., and began to drop swiftly to the earth, more than a couple of miles below. "The descent at first was rapid," Mr. Wise writes, "and accompanied by a fearful moaning noise, caused by the air rushing through the network and the gas escaping from above. In another moment I felt a slight shock, and looking up to see what caused it, I discovered that the balloon was canting over, being nicely doubled in, the lower half into the upper."

The balloon had, in fact, formed itself into a parachute; and, oscillating wildly, continued its descent until it struck the earth violently, throwing the aeronaut 10 yd. out of his car. "The car had turned bottom upwards, and there I stood," says Mr. Wise, "congratulating myself, the perspiration rolling down my forehead in profusion."—*London Tid Bits.*

How to Test a Silver Solution

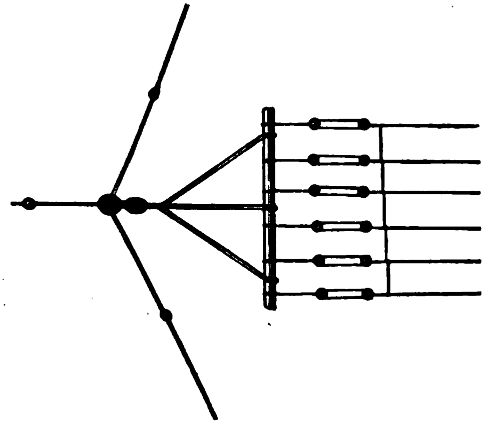
The writer has found the following method of determining the metal in a silver-plating solution to be a very simple, yet accurate, one, says Charles A. Stiehle, in *The Metal Industry:*

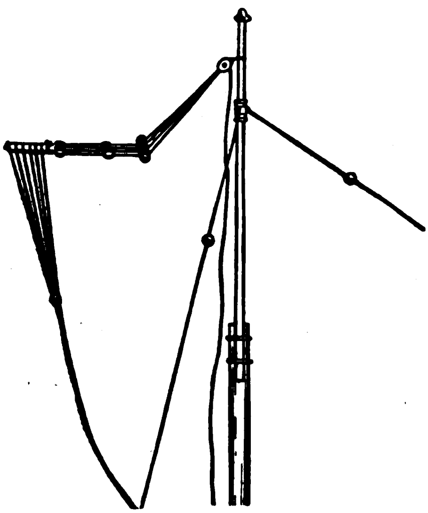
Take 1 oz. of the solution and evaporate in a porcelain dish over a water or sand bath to dryness; then put into a small size clay crucible, about 3 in. high, adding at the same time a few pennyweights of pearl or soda ash. Now put the crucible into the melting furnace, heating slowly at first, so that the contents do not boil over, then give a good heat so that the silver will melt. After taking from the fire and allowing to cool break the crucible, when the silver will be found as a button in the bottom. Now clean the silver from all flux, then weigh, and for each grain of silver in the button, multiply by 142, the number of ounces in the gallon. This will give you the amount in grains that the gallon contains.

WIRELESS TIME-RECEIVING STATION SUCCESSFULLY ESTABLISHED BY KANSAS JEWELER

To E. L. McDowell, of Arkansas City, Kans., belongs the distinction of being the first jeweler in this section, if not in the United States, to have successfully established at his place of business a wireless time-receiving station. Those of the trade who attended the conventions of the state associations last summer will recall the interesting address delivered by H. E. Duncan, of the Waltham Watch Company, on the then new and interesting subject of wireless time service. Mr. McDowell, who believes in the educational value of attendance at conventions, was present at the annual meeting of the national association in Kansas City when Mr. Duncan explained the possibilities of this new service. With a mind alert to new ideas in his line, Mr. McDowell listened attentively, and at once considered the feasibility of establishing such a station at his store. He forthwith consulted with one of the wire chiefs at the local Atchison, Topeka and Santa Fe relay office in his city, and together they planned the erection of the station.

The aerial poles are 42 ft. high, each composed of three sections of galvanized iron pipe. The bottom section is a length of 2-in. pipe, the middle 1½ in. and the top section 1¼-in. pipe, mounted on insulators. The small pipe is slid inside the larger one 15 in. and drilled, and two bolts are put through them. A five-way





piece is used for the guy wires and top and bottom pipe. An ordinary glass insulator is put on the top of the poles.

Each pole is guyed with three heavily-insulated wires, anchored to nearby buildings. A 2-in. pulley was secured near the top of each pole for elevating and lowering the spreaders of the aerial and 80 ft. of ⅜ in. sash cord was run through each of these pulleys.

The aerial consists of six No. 12 aluminum wires, 70 ft. long, fastened 18 in. apart to bamboo spreaders 9 ft. long. Each wire is insulated from the spreaders by two insulators at each end. The wires are then all connected by a wire across the ends. Mr. McDowell is not certain that it is necessary to have the lead-in wire attached to each of the six serial wires. Two, he thinks, attached to each outside wire might answer, though he states that he got no results till he connected all six wires by cross wires at both ends as shown on aerial. The lead-in wire is made by dropping a wire from each aerial wire to a point 5 ft. below the spreaders, where they are bunched and connected to a No. 10 weather-proof copper wire, which leads to a 100-ampere lightning switch, which is grounded just outside the store. From the switch the wire is carried through a porcelain tube into the store, to the instruments. These are a Blitzen receiving set, as shown at Kansas City.

The lead-in wire is 85 ft. long, and for ground No. 10 water-proof copper wire 40 ft. long is clamped to a water-pipe under the floor. All connections, including aluminum wires in the aerial, are soldered. The total height of aerial is 70 ft. from the earth and 40 ft. above the roof of the building. The station complete has cost just $125, covering labor and everything.

Mr. McDowell first received the time on November 24, 1912, and has received it in a very satisfactory manner since that date. Quite a little difficulty was experienced at first, owing to interference, as Mr. McDowell informs us that he has telegraph, telephone, electric light and street car wires all running very near the point at which he was compelled to erect his aerial; but after soldering the aerial wires and putting wires across the end, he obtained the desired results. He also had trouble with the ferron detector, which came with the set, and substituted a silicon detector, using a brass point on the sensitive silicon mineral, and met with good success almost at once.

The signals now come in clear and distinct every morning at 11 o'clock and are signed NAH (Brooklyn Navy Yard). He has also heard GO (Chicago), GV (Galveston), Holland, Mich., and many of the steamers on the Gulf of Mexico, and can find at any hour of the day many different stations working, as the Blitzen receiving set gives great selectivity, especially in tuning out all unwanted stations when the time starts. He also caught New Orleans, and thinks he caught Arlington, but is not sure of the latter. It is quite remarkable considering the distance that the Brooklyn Navy Yard signals are clearest of all.

During a recent heavy storm, the sleet and ice so weighed the wires of the aerial that four of the six were broken. It was Mr. McDowell's intention to replace these aluminum wires with No. 14 phosphor-bronze in order to secure greater strength. In the interval, before the arrival of the latter, however, he patched

when new, and can be obtained at any carpet store. They should be shellacked and the ends filled with wax. He obtained from the electric company round porcelain insulators of the desired size, one wire passing around and the other through the insulator. The glass insulators placed on the tops of the poles he obtained from the telegraph company.

The satisfactory results obtained by Mr. McDowell have naturally increased his enthusiasm, and he expressed his willingness to give any assistance he can to his brother jewelers who wish to install a similar time service. It should be kept in mind that the novelty, mysterious character, and absolute accuracy of this service create unusual curiosity in the public, and thus the service becomes a powerful advertisement as well as an institution which the entire locality must appreciate. Mr. McDowell says: "The advertising I have had out of the wireless is worth all it has cost to install. With the Seth Thomas tower clock, a Hawana regulator, and a wireless to receive the time by each day, we are authority for time in this locality.

Arlington, the new government observatory, is located near Washington, D.C., and from this very powerful observatory it is expected that time can be distributed to vast distances. It is calculated that wireless waves travel at a speed which would enable them to make nine circuits of the globe in one second and, therefore, the elapsed time between the sending and the receiving is such an infinitesimal amount that it is not worth reckoning. The waves when sent from Washington are 4½ miles in length. Some time ago The South Bend Watch Company installed a wireless station to get the correct time direct from Arlington, South Bend being 543 miles from the distributing station.—*The Keystone*.

To Remove Verdigris

Mix in an earthenware jar one part

MAKING A SMALL WHEEL PATTERN

H. MUNCASTER

Some time ago the writer was in want of a small flywheel, and not caring for any of the designs on the market, decided to make a pattern for a suitable wheel. From former experience he judged that the making of an actual pattern in wood would be a very trying task, and not at all times satisfactory, such a pattern being fragile, and also liable to warp with damp or heat. The method adopted was so successful, and is so full of possibilities, that it is offered to readers, says *The Model Engineer*, in the hope that it may prove equally serviceable.

The wheel required was to be 4 in. in diameter by 1 in. wide on face, with five flat tapering arms, as shown in Fig. 1.

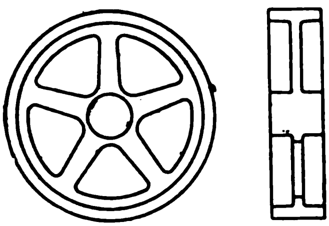


FIG. 1.

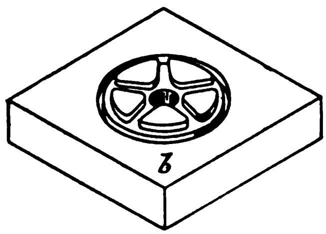


FIG. 3.

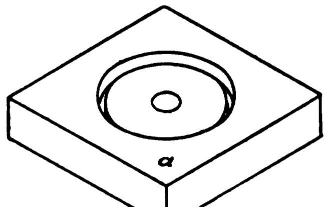


FIG. 4.

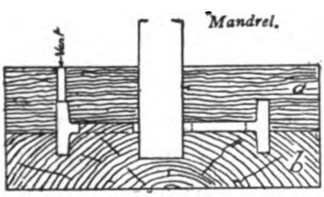


FIG. 5.

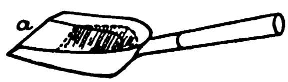


FIG. 6.

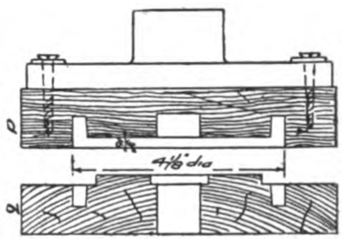


FIG. 2.

Two pieces 6 in. long were sawed off a piece of 6 in. wide by 1¼ in. flooring board, and roughly planed, back and front. These were mounted (in turn) on the faceplate of the lathe by means of wood screws through the slots in the faceplate, a washer being put on each screw to give a suitable bearing for the head.

No other tool than a ¼ in. wide joiner's chisel was available, but this proved quite suitable, and the wood was faced by the aid of this and a 4 in. hand turner's rest. After facing, an annular groove representing half of the rim, plus the half thickness of arm, was cut into the face (see *A*, Fig. 2). The middle was then cut away a depth equal to the thickness of the arm, and, finally, a ¾ in. hole was cut in the center to form the boss of the wheel. The second portion was mounted in a similar manner and turned to suit the faces (see *B*, Fig. 2), being complementary to the first part, as shown on sketch, the hole in the center being cut right through the wood. The isometrical views of these are shown in Figs. 3 and 4. The arms were then drawn in pencil on the piece *b*, and cut out to the required depth, the outer portion having been cut back previously in the lathe 3/16 in., to allow of this being done conveniently, the turned portions forming a capital means of gauging the depth for cutting the arms. The whole of the work only occupied about three-quarters of an hour.

The two parts were then put together as shown in Fig. 5, arranged so that the grain of the wood should cross in the different pieces. A ¾ in. diameter mandrel was put through the hole to keep the two parts of the mold central, and a stout wood screw put in at each corner to hold them together, a hole being first bored through to the rim to allow the air to escape when pouring the metal. The mold was thus completed and ready for the metal.

The kitchen fire was then stirred up to make it burn brightly. Having no melting-pot for our metal, the stove shovel was requisitioned, and as it was moderately deep, was quite suitable for the work, it being only necessary to keep the edge at *a*, Fig. 6, a little above the level. About 1½ lbs. of good solder, containing a large percentage of tin, was used, and about a thimbleful of antimony. The shovel was placed on the fire and the solder melted, then the antimony added, the whole being carefully stirred before pouring. The mold should be set so that the vent hole is slightly higher than any part of the casting; a penny piece was about the right packing when the mold was set on a level surface. The metal was poured from the corner of the shovel into the center hole (the mandrel, of course, having been withdrawn after the parts were screwed together), keeping a steady stream until the metal showed at the vent hole. The metal seemed to shrink to some extent in casting, and a little more metal was added. A piece of ¼ in. rod was warmed, and worked into the hole until the whole had set. After about half an hour the casting was taken from the mold, chucked in the lathe, and turned up, making a beautiful job, perfectly true and clean, and quite hard enough for use as a pattern.

There may be some risk of the metal's escaping from the mold if the faces do not quite touch. This can, however, easily be remedied by daubing clay round the outside, or by placing the mold in a box and packing damp sand or garden soil around it.

Many uses for this method may be suggested, as the making of patterns for boiler ends, cylinder covers, blanks for gear wheels, etc., and the pattern can be melted up when used, if not likely to be again required.

It should be kept in mind that a pattern must be at least ⅛ in. per foot longer than the required casting, and should allow a reasonable amount for any machining that may be necessary to the casting.—*Model Engineer and Electrician.*

STORAGE BATTERY HELPS

S. FRED PILGRIM

The following article is intended for any one who has anything to do with storage cells, and will be especially welcome by commercial operators on shipboard.

When the voltage of the cells falls below 1.75 volts, it is time to recharge them. They should not be exhausted to a lower voltage than this, because by so doing the battery deteriorates very rapidly. Never allow cells to stand discharged.

If, when charging, the temperature of the cells becomes over 100 degrees F., stop the charging until the cells cool again. This heating may be due to too much sediment in the cells; if this is the case, the cells should be taken apart, the old electrolyte removed, the plates and holder washed out, and the cell refilled again. New electrolyte may be made by mixing one part of pure sulphuric

When charged, the voltage of each cell should be about 2½ volts. After the voltage is first brought up to the standard, it will be found that it drops considerably, so after the first charge allow the cells to stand about an hour; reduce the charging current to about half what it was, and again allow the cells to come to about 2½ volts per cell. Generally, the manufacturers of the batteries give the rate at which the cells should be charged; but if not, it will usually be about five amperes. Eight hours should be taken in charging if the cell has been fully discharged.

It is not advisable to recharge a battery until its charge (not voltage) is at least one half expended, and the length of charge given it, if only partly exhausted, should be in proportion to the fraction of the charge which it is estimated to have

A PRACTICAL TESLA COIL

J. PIKE

Many possessors of spark coils may be interested in a Tesla coil which I have made recently. The coil is for the purpose of producing high-frequency effluxes and various experiments for the amusement of one's friends—after the manner dear to the heart of the amateur electrician. For reasons stated further on, no photograph has been made of the completed coil, but details of the construction are here given.

The coil consists of a primary of a few turns of thick wire, or, in this case, of copper *strip*, 3/32 in. section and ⅜ in. wide, and a secondary of a few hundred turns of fine wire placed inside the primary, the whole immersed in boiled oil, therefore enclosed within a box, which must, of course, be quite oil-tight.

In the first figure will be seen the method of building up the primary, and here I may say that an endeavor has been made to utilize material which is

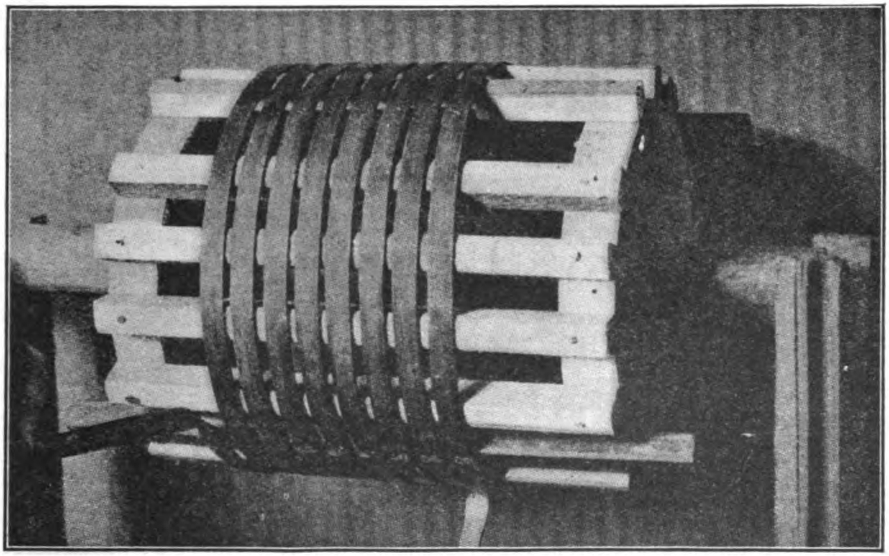


Fig. 1. Showing Method of Building Up the Primary

for use with enclosed arc lamps; it measures 7 x 4⅜ in., and the diameter of the primary was arrived at by taking, approximately, 3 to 2 as the ratio to determine the amount of insulation between the one coil and the other. The glass chimney being nearly 4½ in. in diameter, I thought 6½ in. would be a suitable diameter for the primary, therefore had turned two wood discs 1 in. thick and 5½ in. in diameter, and these, being properly centered, were then drilled through to a size equivalent to a stout broom shank. The two discs being placed parallel and about 6 in. apart, strips of wood, ½ in. section and about 6 in. in length, were nailed to the edges, as seen in the figure; these ½ in. strips, plus the diameter of the discs, bring the turns of copper to an even 6½ in. At two opposite sides are two ebonite or *vulcanized fiber* rods, 9 x ½ in. section, the wood rods being spaced between we must measure carefully the starting-point from which to lay down the strip. The eight turns take up about 4 in.; therefore, if we place a foot-rule over one of the *fiber* supports and make a mark at 2½ in., and at each ½ in. until we arrive at 2½ in. from the further end, the spaces will be about right. Then upon the opposite *fiber* support we make similar marks, but start at 2¾ in. This is, of course, essential, because the primary is wound as a spiral, with ⅛ in. space between each two turns, and this result is achieved by fastening the commencing end (leaving 8 in. or so free) at the side of the 2½ in. mark, then at the 2¾ in. mark on the opposite fiber rod, when, arriving at the full turn, we find the strip falls naturally at the 3 in. mark. The copper must be secured to the fiber supports with brass screws, and, for the most part, two will be required in each case. With a little assistance the copper is easily pressed and bent into place, and screws may be put in as the work proceeds.

The eight turns having been put down, we finish by leaving a spare 8 in. or so for connections, and proceed—if this has not been done before—to put in the *two* screws requisite to properly secure the turns. These screw heads should be neatly flush with the copper or filed smooth, and the part then covered with, say, Chatterton's cement, this merely to cover over any sharp edges or points left in the filing, which otherwise might facilitate sparking between the primary and secondary. This done, the wood and fiber supports may be unscrewed or the nails withdrawn, so that the frame may be detached, leaving the spiral properly shaped, as in the figure. If necessary, and to strengthen the structure, shorter (4 in.) pieces of ebonite or fiber may be put on at additional points—one may be seen in the photograph.

To wind the secondary, the glass

with seccotine, the ebonite rod inserted and fixed in like manner.

We require now to mount the cylinder —for winding—in another stand, which should be just high enough for comfortable working and to admit of a spool of thread and a bobbin of wire (No. 38 S.W.G. cotton-covered) being placed beneath. Fig. 2 is a photograph of the secondary on completion of the winding. One layer only is put on, and each turn is spaced from its neighbor by a turn of the thread. The figure shows an extemporized driving wheel at the side, but this is not much use in practice, it being better and much easier to pay out the wire and cotton with one hand and to revolve the drum with the other hand, which also will be required to properly align the turns. The turns should be fairly

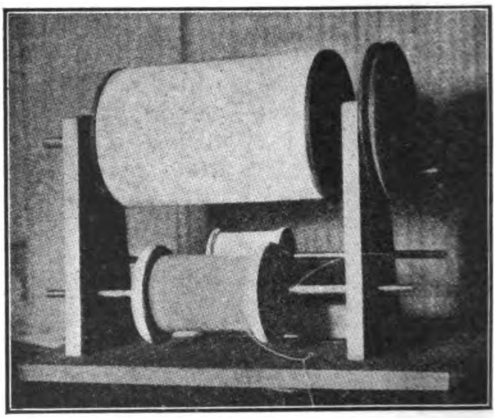


Fig. 2. Showing Method of Winding the Secondary

tight, and, of course, even and close. At the commencing and finishing ends of the drum at least a foot of spare wire should be left, secured temporarily by insertion into a small cut into the wood flange; then a little hot wax secures it permanently.

Some writers advocate the removal of the cotton turns after winding on the

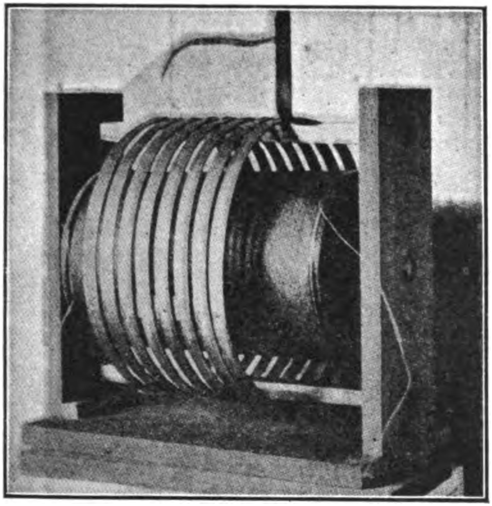


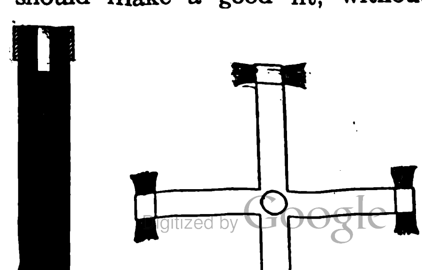
Fig. 3. Showing the Primary and Secondary Coils mounted in Hardwood Stand

In Fig. 3 we have the two coils (primary and secondary) mounted permanently in a hardwood stand, ready to be placed in the box. Very little description is necessary here. The wood is teak, and the stand—put together without any nails or screws—is just big enough to fit the retaining vessel. When making the stand, one of the sides, after careful measuring, etc., is fixed and the coils put in place; then the other side support is put in, being secured with seccotine or glue. The fiber supports of the primary and the ebonite rod passing through the secondary being of equal length require no further alteration, but may be secured tightly by means of small wedges of wood, if necessary. No difficulty should be experienced in getting the secondary in a central position.

The box to hold this should be very neatly made of teak and the corners dovetailed; it must, of course, be water- or oil-tight, and for this size (10 x 8 x 9 in. inside) be 1 in. thick. The box, being guaranteed tight, is improved by a thorough basting inside with hot paraffin wax; in this way we may line the box out with a layer of wax 1/8 in. thick or so, and be quite safe against leakage.

The ends of the primary are brought to one side and secured there with bind- be at least 1 in. in diameter, and at the top I find it convenient to fit a piece of brass tubing capped at one end to form a cup, into which—on completion of the coil—various accessories can be placed, *e.g.*, brass balls, terminals, straight brass rods, etc. Fig. 4 shows what is intended. A piece of No. 14 copper wire is soldered to the bottom of the cup after drilling a hole to take one end, and, before fitting on the lid or cover, the fine wires from the secondary are soldered each to one of the wires depending from the pillars.

Two Leyden jars are provided, and they measure 9½ x 4 in., coated inside and out to a height of about ¾ in. with tin-foil, care being taken to get an even coating, *i.e.*, to have the foil in optical contact with the glass. If possible, the inside coating—with the exception of the bottom—should be in only two pieces, these overlapping; but if necessary, three may be used. I presume all our readers know how to make a Leyden jar, so that no words need be spent over the matter beyond stating that the desiderata are the even coating inside and out, the foil being put on with glue—thin, hot, well made, clean, and applied with a fine brush, so that it is no more than a smear of glue. Being placed in a warm, dry atmosphere—more dry than warm—the jars will be ready for use in a week. The brasswork in use with them is for each—a stout brass rod, ¼ in. in diameter, terminating in a large brass ball (1½ in.); this ball is carefully drilled horizontally to take a smaller rod (fitted with short ebonite handles), which in turn terminates in a smaller brass rod (1 in.). As these balls form the spark gap, they should be arranged so that the height is the same in each case, and the rods should make a good fit, without



being tight. In place of the usual caps or lids I use ebonite discs—1/16 in. thick, cut with dividers to make a good fit inside the jars (top end). These discs, being drilled through their centers, are pushed on to the upright rods so that the latter are kept in a vertical position. The discs should be within an inch or two of the top in each jar. The simplest way to secure them in position is to cut out of brass tubing collars to make a good fit on the rods—two for each. These little collars are sawed through on one side and given a slight grip between pliers to ensure a tight fit. One is pushed over the rod to the height requisite, the disc is put in place, and the second then

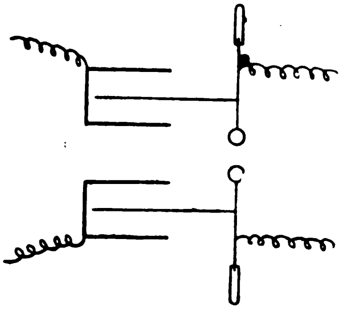


Fig. 6.

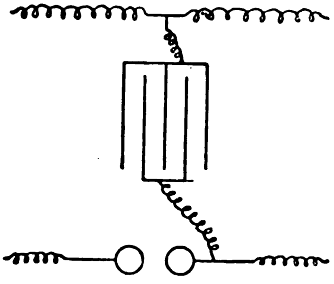


Fig. 7

secures it in position. The rods, balls, collars, etc., should all be highly polished and free from sharp edges, and so on. At the bottom of each rod is fitted with solder a piece of thin sheet brass, cut cross-wise and bent to fit the bottom of the jar. The arms of the cross are about ½ in. longer than necessary to fit, to make room for a small tuft of fine wire (a piece of the best silk-covered flexible lamp wire will supply this, see Fig. 5).

tightly. We get in this way four excellent contacts in the bottom of each jar.

The secondary terminals of a spark coil—6 in. at least—are connected to the inner coatings of the Leyden jars, and an adjustable spark gap is arranged between them, see Fig. 6. The coil being started, one of the jars becomes charged with positive and the other with negative electricity, and when the e.m.f. is sufficiently high a spark leaps across the gap.

The outside coatings of the jars are connected to the primary (of the Tesla coil), and the e.m.f. of the oscillating currents is raised by induction, by providing the secondary coil of fine wire, which in this case is placed inside the primary. Very fine brush discharges are produced at the terminals of this secondary.

The discharge between the balls of the spark gap appears to the eye as one single spark, but it consists actually of a succession of extremely rapid electrical oscillations or waves. As long as the inner coating of the jar is charged with positive electricity the outer coating must be charged with a similar quantity of negative electricity. As soon as the spark leaps over the charge disappears, but on account of the change the outer coating becomes positively charged, and this again induces a negative charge on the inner coating. It has been calculated that the sparks follow one another in an opposite direction with an interval of about one-millionth part of a second, and on account of their rapidly oscillating character comes the term "high frequency" currents. Every change of potential taking place on the inside coatings induces a similar change of the same intensity, but in an opposite direction, on the outer coatings, and these latter are connected to the Tesla in the manner indicated.

Another way is to provide a separate and adjustable spark gap, and to use either one jar only or the two in parallel (see Fig. 7). In this case the outer coatings of the jars—which may stand upon a strip of tin-foil—are connected to one of the secondary terminals of the spark coil and to one of the primary terminals of the Tesla. The inner coatings are connected to the other secondary

The physiological effects from the secondary terminals of the Tesla coil will be found entirely different from those of the spark coil. The latter must always be treated with the greatest respect, and no one is likely to forget a shock from a large coil. Referring to Fig. 7, we may say roughly that all that part of the apparatus to the right hand must not on any account be touched while the "spark coil" is at work; *always* switch off the current before attempting any adjustment of the apparatus. With regard to the Tesla coil, however, one need not be so particular with the apparatus arranged as Fig. 6, as it should be in the usual orthodox way for medical use. We may take sparks from the Tesla secondary with impunity; that is to say, there is no shock whatever. Arranged as in Fig 7, we do experience slight shocks if the finger is approached hesitatingly to either of the Tesla secondary pillars; but if we take a brass rod in the hand and approach it to the pillar, we may take big sparks therefrom and feel nothing.

The current should, however, be *always switched off* before making any fresh adjustment of the jars or spark-gap.

One important modification remains to be mentioned, and this is a simple method of tuning the apparatus. The primary coil, Fig. 3, is made with eight turns of copper strip, and, other things being equal, this may be, for the size, correct; but it is well to have an arrangement whereby we may cut out two or three of the turns, and this may be done by proceeding as follows:

Premising that the finished coil in its case is not particularly ornamental, and is therefore not pictured, and nothing would be shown thereby to be of any value, the reader will imagine a cube of about 11 in. each way. The two terminals of the primary will be on one side and those from the secondary on the other, taken up through ebonite pillars, as described. Now before placing the lid or cover in position, the position of the primary turns should be carefully measured, so that if we drill two, three, or more holes in the lid, a copper or brass rod thrust through one or other of them will make contact with a turn of the copper strip. Now imagine one of the wires from the outside coatings to be fitted with a short piece of brass rod, and instead of inserting into the binder provided for it, push it through one of the holes in the lid, so that seven, six, or five only of the turns are used. The rod should make a decent fit in the lid, as it is required simply to make contact by touch. It is not possible in this apparatus to move the primary, otherwise the turns in use should be fairly central to the secondary winding, but this difficulty may be overcome by making holes for each turn and using a similar rod for the other wire. In this way we could cut out the two end turns, at any rate, and thus use six turns, all placed centrally over the secondary. Another point is to drill these holes diagonally, so that the pins or rods may be as far away as possible from the secondary pillars. Testing the apparatus figured, I found no essential difference using six turns or eight, as sparks were emitted in profusion between the secondary pillars, 8 in. apart.

The results will largely depend upon the efficiency of the induction coil used; a coil which gives a long, thin spark, even if continuous, is not so good as one which gives "fat" sparks. The Leyden jars also will modify the results. Carefully made and equal to professional work, the output will be very gratifying. —*The Model Engineer and Electrician.*

Artificial Ebony from Oak

The blocks of wood are immersed for 48 hours in a warm saturated solution of alum and sprinkled several times with a decoction of logwood; smaller pieces may also be steeped for a certain length of time in the decoction, which is prepared in the following manner: One part of logwood of best quality is boiled with 10 parts of water; it is then filtered through linen and the liquid evaporated at low temperature until its volume is reduced by one-half, and to every quart of this bath are added 10 to 15 drops of a saturated solution of soluble indigo entirely neutral in reaction. After having watered the blocks several times with this solution, the wood is rubbed with a saturated and filtered solution of verdigris in warm concentrated acetic acid, and this operation repeated until a black color of the desired intensity is obtained. The oak wood dyed after this fashion is said to present an aspect similar to that of real ebony. The method is obviously unwieldy for large surfaces, even if satisfactory in other ways.

OIL AND GAS ENGINE DEVELOPMENT

JOHN CREEN

The well-known disadvantages of the caloric, or "hot-air," engines have been largely overcome by the late improvements in gas and oil engines. These latter have also a much greater efficiency than steam engines, especially if efficiency is calculated on the basis of the heating effect of the fuel required to operate a steam engine, with that necessary to operate a gas motor of the same horse-power. In a simple gas engine a mixture of inflammable gas and air fills a portion of the cylinder in which the piston moves, and when this is ignited (by electric spark or otherwise), it explodes and propels the piston with corresponding force to the opposite end of the cylinder; then by the action of the fly-wheel or balance-wheel the piston returns, partially taking in another charge of gas and air, which, by exploding, moves the piston in the opposite direction. In other gas engines the movements of the piston are so arranged that the explosive mixture of gas and air is compressed before it is ignited.

Gasoline, benzine and oil motors are operated on the same principle as the gas engine, the explosive gas mixture being formed by passing air through gasoline, which thereby becomes charged with the requisite amount of inflammable gasoline or benzine vapors, which behave in the motor in the very same manner as the mixture of gas and air. Such liquid fuel motors require about one pint of gasoline per horse-power per hour, while an engine operated with natural gas requires from 12 to 20 cu. ft. of gas to produce the same effect, and of illuminating gas about 10 to 30 per cent. more.

The development of large gas engine units has been going steadily forward during the last fifteen or twenty years, and probably the first large engine of this class was that exhibited by the John Cockerel Company at the Paris Exposition in 1900. This engine was rated at 600 h.p. At the present time, 1,500 h.p. in each cylinder of the four-stroke-cycle type, and 2,000 h.p. in each cylinder of the two-stroke-cycle engine, have been

is prepared to install gas engine plants of large power capacity at a cost not exceeding, and in some instances less than, that of a corresponding steam turbine installation.

Various methods of utilizing the waste heat of the gas engine exhaust have been attempted from time to time, and the demand for such devices has been large. In this connection it may be stated that the expansion of a gas while propelling a piston may be allowed to proceed, while the energy imparted to the piston is replaced by heat supplied to the expanding gas from without; the expanding gas is kept at the same temperature, and therefore it is said that the expansion proceeds isothermally. This operation may also be reversed and work converted into heat by applying the power gained by raising the piston, to push the piston back, and withdrawing the heat liberated by the work of compression as fast as it appears, so that the gas is always at the same temperature. The heat energy of a gas is independent of its volume, and the energy of a mixture of gases is equal to the sum of the energy of its constituents.

Several schemes for utilizing the waste heat from the gas engine are at present commercially in use, but according to recent opinions the most efficient method of using the exhaust is through a combination of gas and steam engines. Present practice indicates that about 3 lbs. of steam are generated per brake horse-power hour, by means of boilers heated by the exhaust. According to Mr. A. L. Chorlton, the use of exhaust boilers with efficient steam engines, and specially-designed gas engines of the two-cycle type, will effect marked thermal economies and reduce the initial cost per horse-power of the installation. One of the technical journals states that Mr. Chorlton shows by numerical examples the possibilities of such an engine, first examining the case of the addition of a steam end to a normal economical gas engine. He assumes a standard engine of this heat to be recoverable. From this at 80 per cent. efficiency of conversion, at 100 lb. pressure, there would be recovered about 2½ lb. of steam per brake horse-power hour. This amount of steam in an ordinary simple steam engine would not give more than 10 to 12 per cent. of the main engine power, a return that scarcely justifies the first cost of the steam cylinder; consequently no development has taken place in this direction. When, however, one deals with a special combined compound engine, each part of which is made in the way most suitable for the purpose required, a very different result is obtained. In order to reduce the cost of the gas engine part, the compression would be lowered, and, with the ignition retarded, a much lower maximum pressure and temperature would result; the total British thermal heat units used would go up to about 12,000, but more would be rejected to the exhaust, and with a special arrangement of boiler, economizer pipes, superheaters in exhaust, etc., 50 per cent. of the waste should be recoverable. There should be obtained from this 4 lbs. of steam per brake horse-power hour. The steam cylinder used would be similar in type to that of the two-cycle engine—that is, with no exhaust valves. The unidirectional flow-engine of this type has been largely adopted in Germany with very economical results. The jacketing of the ends can be accomplished by exhaust gas. For small engines of this type it is safe to assume a steam consumption of 12 lbs. per brake horse-power hour; a consumption of 10 lbs. has been obtained in actual practice.

Although the steam turbine has to a certain extent superseded the reciprocating steam engine for the generation of electricity in central-station work, and will probably hold the field for some time to come, it is interesting to note that the Diesel engine, owing to its great success in small-station work, is now looked upon seriously as a possible rival to the steam turbine.

In a paper recently read before the Municipal Electrical Association at Brighton, England, the relative cost of a 10,000 k.w. installation for steam turbines, gas producers and engines, and Diesel engines was discussed at length, the author proposing the use of seven sets each of 1,450 k.w. capacity. His figures on operating expenses, etc., are decidedly in favor of the Diesel engine. Attention was also called to the very economical use of these engines as a substitute for substation converting machinery, and such stations are already in operation, and others in course of construction in London.

The Diesel engine is somewhat of a cross between a hot-air and oil engine, and is based on the principle that the air portion of the explosive gas mixture is compressed and incidentally heated by the motor before the oil or other liquid fuel is introduced, thereby causing the required ignition under conditions which are claimed to insure a higher efficiency of the fuel than any other motor.

It is also noteworthy, in connection with the Diesel engine and its development, to refer to its rapid increase in size and power. Engines of a few hundred horse-power have become common in Europe. In many electric stations in Switzerland, Diesel engine units of 2,000 h.p. are at present in use; and it has been recently stated that the development of the large size Diesel engine has been so successful that it will not be long before 1,000 h.p. developed in one cylinder will be nothing extraordinary.

One company of world-wide reputation is at present considering more than 2,000 h.p. in a single cylinder of the Diesel engine. It is stated that engines of this type, with four cylinders, developing 1,000 h.p. each, can be made as light as the corresponding triple-expansion steam engine. Further, the weight of such engines compares favorably with that of the corresponding turbines and boilers; and it is on record that a 1,000 h.p. installation of this type weighed only 187 lb. per horse-power, as against 180 lb. for a steam turbine and boiler installation.

Perhaps one of the most interesting features of the Diesel engine development is its application to marine propulsion for almost all types of vessels and submarine craft; and it is now being used by many of the principal navies of the world for the latter, while designs are now under way for comparatively large engines for torpedo boats, destroyers, etc. Russia is credited with at least four freight vessels of 1,000 h.p. and two 14-knot gunboats of the same horse-power rating. In December, 1911, two vessels, nearly 400 ft. long and of 7,000 tons capacity, each fitted with Diesel engines of 2,500 h.p., and with two auxiliary Diesel engines of 500 h.p., were tried out in European waters.

An interesting comparison will shortly be placed before the public by the British Admiralty, which is preparing to try out, side by side in a twin screw cruiser, a steam engine and a Diesel engine of 6,000 h.p. each. A destroyer recently ordered by the British Admiralty will have on each shaft a steam turbine and a Diesel engine. The plan is to operate the turbines when high speeds are required, but under cruising conditions, when the speeds are low, owing to the poor economy of the steam turbines, the Diesel engines will be used. The combined economy from this arrangement will be exceedingly interesting.

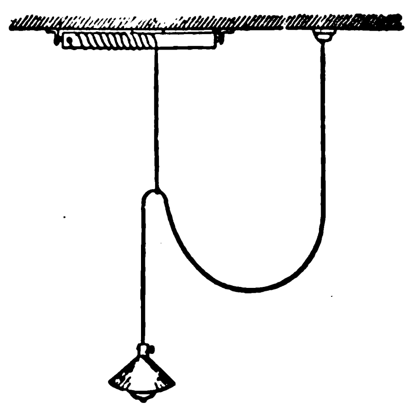
In the foregoing connection, a brief reference ought to be made to the maiden voyage of Motor Ocean Liner *Selandia*. This is the first cargo and passenger vessel which has made so long a round voyage (21,500 miles) entirely independent of the use of steam power. In spite of the fact that the vessel embodies many new principles, and was strange to its engineers, only one slight adjustment of the exhaust valves, involving a fifteen-minutes' stop for the engines, was found necessary during the entire trip. In all matters of fuel consumption, ease of manouvering, and general behavior, the engines far exceeded expectations. Very few alterations in design are suggested by the experience of the engineers on the maiden trip, and these relate chiefly to the heat radiated from the exhaust, which affected the temperature of the engine room. The trouble has been corrected on the *Selandia* by the installation of supplementary fans and ventilators, and will be avoided in future boats, by the natural cooling of the exhaust chambers above deck. The fuel consumption fell considerably below that estimated by the builders; on the home voyage the *Selandia* averaged ten nautical miles per hour on a consumption of 8.5

able rates at Singapore than in any European port. The opening up of all gears and bearings at Copenhagen on the completion of the voyage, and the inspection by Lloyd's representatives at that port, showed that everything was in perfect order, and that no parts had suffered undue strain. The temperature of the water cooling the cylinders at no time exceeded 40.6 degrees Centigrade, although 53 degrees had been previously established as a working maximum.

Although steam engines probably will not be rapidly displaced in the larger ocean-going craft, yet the crude oil engine seems to be especially adapted to a great number of services in marine propulsion. The quantity of fuel needed approximates a third of that required for the steam engine, hence the radius of action for a given weight of fuel is greatly increased; further, the boilers can be eliminated, and the space utilized for carrying cargo.

A Workshop Lighting Hint

A correspondent of the *American Machinist* says: "I find that there is no handier way of hanging an incandescent lamp, either for use on a machine or vise, than the one shown in the accompanying sketch. Simply take the stick of an old spring window blind, cut it to a suitable



Method of Hanging an Incandescent Lamp in Workshop

length, and attach it to the ceiling or any place directly above the spot where the

GEAR WHEELS AND GEARING SIMPLY EXPLAINED—Part III

ALFRED W. MARSHALL M.I.MECH.E., A.M.I.E.E.

When the shafts between which the rotation is to be transmitted are not parallel to one another, conical toothed wheels, called bevel wheels, may be used. They have peculiarities, and are difficult to construct so that they will work properly together, maintaining the relative velocities of the shafts. If the shafts are at right angles and the wheels are of equal size, they are then often called miter wheels. When planning a pair or train of bevel wheels the first step is to imagine them as cones with smooth surfaces rolling against each other and transmitting the motion by frictional contact, Fig. 27. The relative velocity of cone *W* to cone *P* will depend upon the diameter *AA* of cone *W* to the diameter *BB* of cone *P*. If these diameters are equal, cone *P* will make one revolution for each revolution of cone *W*. If any other diameters which are in contact, such as *CC*, *DD*, are selected, they will be in the same proportion to one another as the large diameter *AA* is to *BB*. We can imagine a series of such pairs of diameters between the bases and points of the cones, and each pair will bear the same proportion to one another. The entire surfaces, therefore, of the two cones, roll together with the proportional velocity of the large circles *AA*, *BB*, and the entire

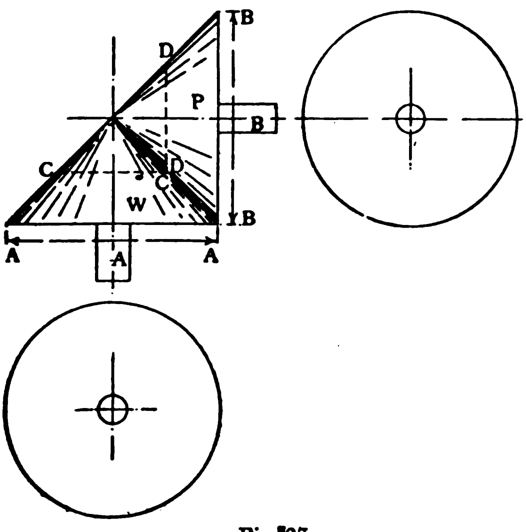


Fig. 27

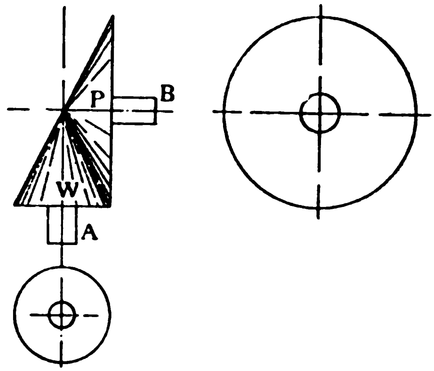


Fig. 28

surface of each cone forms a pitch surface of that cone. We could thus correctly select any pair of diameters upon which to form the pitch circles of the cones. In practice the circles formed upon the largest diameters *AA* and *BB* are selected as the pitch circles. To drive one shaft by the other at any relative number of revolutions you should thus make the sizes of the circles forming the bases of the cones in proportion to the desired relation between the revolutions of the shafts. Thus, if shaft *B* is to make one complete revolution while shaft *A* makes one revolution, you should design the base *AA* of cone *W* so that it has a diameter equal to the base *BB* of cone *P*; if shaft *B* is to make one revolution while shaft *A* makes two revolutions, the base of cone *P* should be designed with a diameter twice as large as the diameter of the base of cone *W*, Fig. 28; and so on. The bases of the cones are equivalent to the pitch circles of flat gear wheels, and the shafts which they connect will rotate with relative velocities proportional to the diameters of the bases of the cones. In these explanations it is assumed that the axes of the shafts intersect. This is the condition usually met with in practice.

Such a pair of cones, made of wood, metal, or other material, will transmit the motion of one shaft to the other by contact friction between the surfaces. If they are large in proportion to the amount of power to be transmitted and conditions of working are favorable, the friction may be sufficient and no slipping occur. To prevent slip, teeth may be provided, as in the case of flat gear-wheels. This introduces a difficulty, as the teeth and spaces must be conical and follow the shape of the pitch surfaces of the cones. For example, if we construct teeth of similar shape and character to those used for flat wheels, they must be made to taper from the base to the point of the cone, as indicated by the shaded surfaces, Fig. 29. If they are made of uniform height and thickness, or of less angle of taper than would terminate in the point of intersection of the pitch cones, they could not work together, but would foul and break off if sufficient power was applied to drive the shafts. Every part of the surface of each tooth—the faces and flanks as well

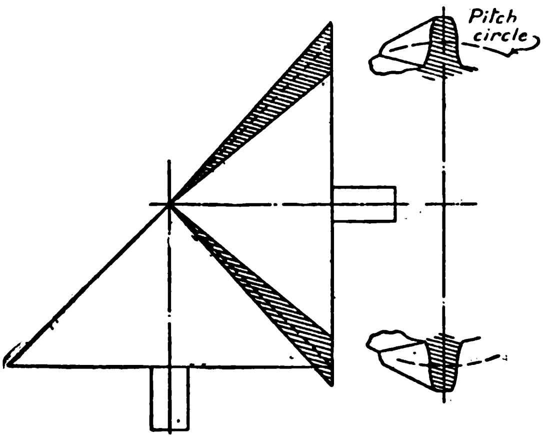


Fig. 29

as the tops—must be conical, the taper coming to a point at the intersection point of the pitch cones. The teeth, if properly made, will, therefore, become very thin at the parts which are near to the points of the pitch cones, finally vanishing away. Only a portion of the length is of practical use, and bevel wheels are never made to the complete theoretical extent of the pitch cones, the breadth is usually made equal to one-third the distance *D*, Fig. 30. Each wheel thus becomes a truncated cone, but is actually part of a complete cone, as indicated by the dotted lines, Fig. 30.

This principle of rolling cones permits considerable latitude in selecting the size of the wheels, and in this respect the problem differs from that of connecting two parallel shafts by flat spur wheels.

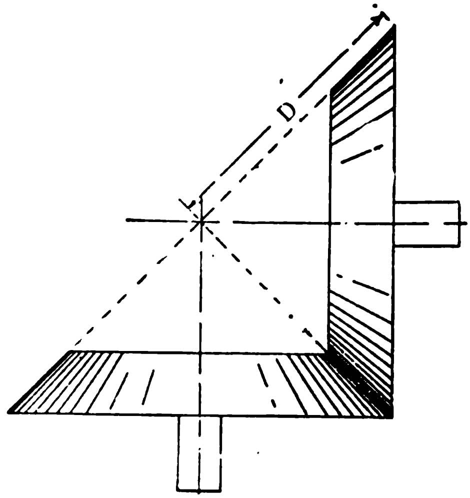


Fig. 30

In the latter case the size of the wheels is limited by the distance between the shafts, but when the shafts are at an angle the wheels may be of any size within the limits of the space of the machine or the surroundings of the shafts. For example, in Fig. 31 the shafts *A* and *B* are to be connected by the wheels so that they rotate with equal velocities. Wheels of size *CC* may be used, or of size *DD*, or any intermediate size, without affecting the relative speed of the shafts. Both pairs of wheels could be used simultaneously, because all bevel wheels on either shaft having pitch surfaces meeting on the line of the two cones, indicated by the dotted lines,

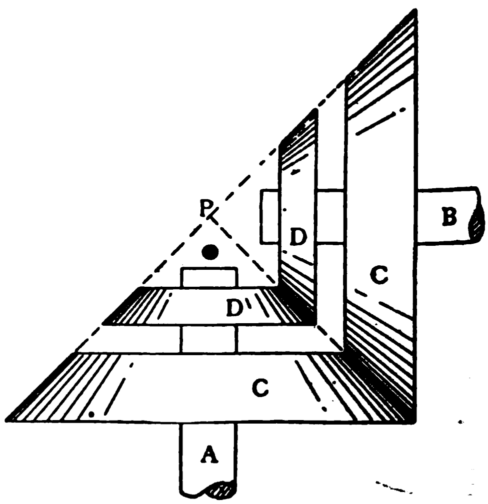


Fig. 31

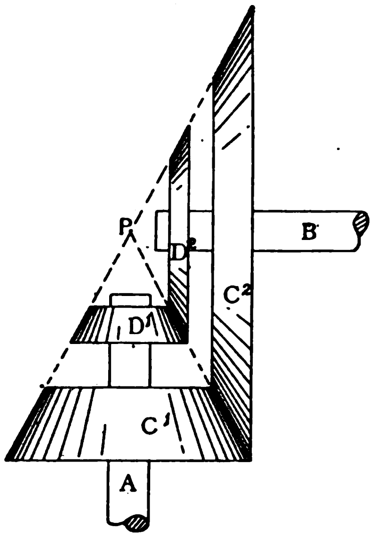


Fig. 32

are really a portion of one large conical wheel, the teeth and pitch surfaces of which extend from the point to the base of the largest wheel. The principle is not affected if the shafts rotate at different relative velocities. For example, in Fig. 32 shaft *A* makes two revolutions to one revolution of *B*. The wheels may be of size *CC* or *DD*, or any other size, provided their pitch surfaces form part of the cones indicated by the dotted lines. The relative numbers of teeth must remain the same or be in the same ratio. If *C*1 has 30 teeth and C2 60 teeth, *D*1 must have 30 teeth, and *D*2 60 teeth, or numbers of teeth having a ratio of 1 to 2; thus *D*1 could have 15 and *D*2 30 teeth,

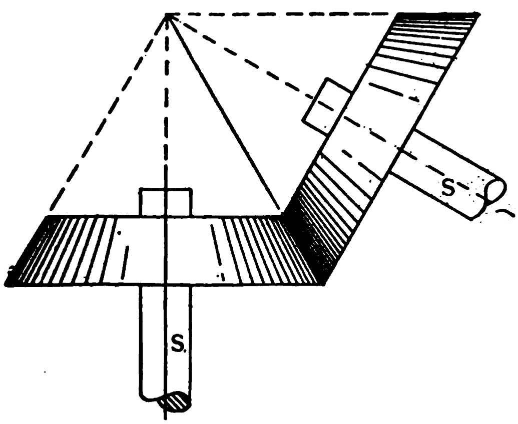


Fig. 33

and so on. The sizes of the wheels to connect a pair of shafts whoses axes are at an angle can therefore be determined by matters of convenience and strength required to transmit the power. Obviously a large pair of wheels can have teeth of greater size than a smaller pair. If the shafts are not at a right angle to one another the principle of rolling cones is still applicable, if the axes of the shafts intersect. Fig. 33 is a diagram showing two shafts intersecting at an angle of less than 90 deg., and Fig. 34 shows the shafts intersecting at an angle greater than 90 deg. in each instance the cones have equal diameters, so that the two shafts will rotate at equal speeds. The shafts may be made to rotate at different speeds by designing the cones so that their diameters are of corresponding proportions to the speeds, as in the case of shafts at a right angle. Fig. 35 shows the principle of rolling cones applied to an internal gear connecting two shafts *SS*, which are at an

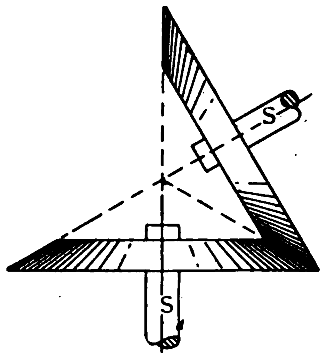


Fig. 34

angle. In this arrangement the wheel *P* must be smaller than the other, as it is a pinion working inside an annular wheel.

The term crown wheel and pinion is sometimes given to the gear shown in Fig. 36. Correctly speaking crown wheel is another name for bevel wheel, and the gear shown in Fig. 36 should be formed on the principle of rolling cones. If the wheel *W* is made with straight teeth and a cylindrical pinion *P* is used to gear with it, the arrangement will not work correctly. The wheel may be represented by a flat disc *W*, Fig. 37. In fact, its pitch surface would be a part of such a disc. The pinion would be represented by a cylinder *P*, rotating in contact with the disc; such a cylinder would form the pitch surface of the pinion. Obviously all parts of the circumference of *P* must move with the same velocity. But all parts of the surface of the disc will not move with the same velocity. That part represented by the dotted circle *C* will have a much greater surface speed than the part represented by the dotted circle *D*. As both parts are in contact with the circumference of *P*, the circle *D* will be trying to drive *P* at a slower speed than it is being driven by *P*. Every part of the surface between *C* and *D* will, therefore, be trying to rotate *P* at a different rate of speed. As *P* can only rotate at one speed at any instant, a slipping and grinding action must take place between the surfaces. If the surface of the disc is cut away so that only a circular ridge is left in contact with *P*, such as would be represented by the

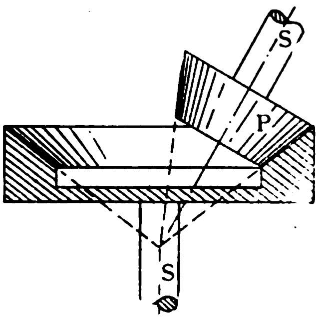


Fig. 35

circle *C*, this action would be reduced to a minimum. The gear shown in Fig. 36 can be, therefore, made to work if the teeth on *W* have very small breadth, as indicated by the sketch, so that they make very narrow contact with *P*. Such a wheel can then only transmit or receive a very small amount of power or its teeth will soon wear away. When the diameter of the wheel is great compared to that of the pinion, the error in the shape of the teeth as regards taper is small, as indicated by the dotted sketch Fig. 36, but it still exists.

The teeth of bevel wheels are formed on the same principle as the teeth of flat wheels, but the shapes of the faces and flanks are not developed upon the actual pitch circles. A section through

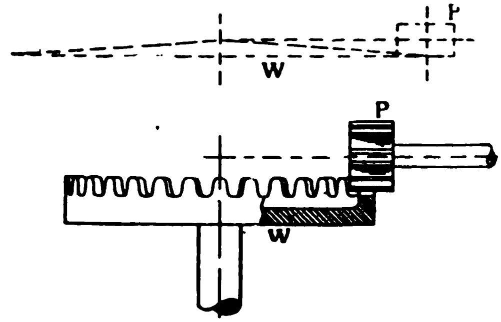


Fig. 36

a tooth which would show its actual shape would not be in a plane parallel to the base of the pitch cone as indicated by the teeth shown by Fig. 29, but would be in a plane perpendicular to the conical pitch surface. The teeth are placed so that they are perpendicular to this pitch surface; therefore, it would not be correct to develop their shape by curves generated on the circumferences of the pitch circles. They are developed upon circles *CC* of larger diameter, as indicated by Fig. 38, the centers and radii being found by drawing lines *B* at a right angle to the pitch surfaces, and meeting the centers of the shafts at *DD*. The circles upon which the curves of the teeth are formed are then found by radii equal to the distance from *D* to the edge of the pitch circle. The numbers of the teeth are calculated with reference to the pitch circles *PP*, and not with reference to the circles *CC*. The pitch is merely applied to the circles *CC* and the teeth shaped by rolling curves, as in the case of flat wheels, as if *CC* were the true pitch circles, but it is kept the same as found by dividing the circumference of the true pitch circles *PP* by the required numbers of teeth. Only

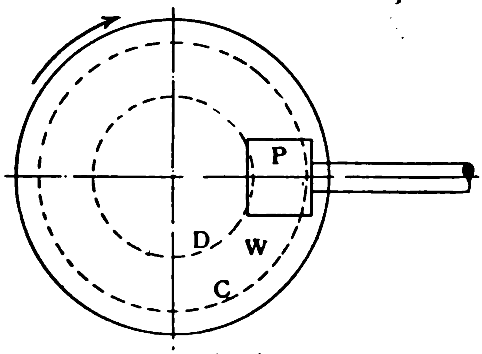


Fig. 37

a part of the circumferences *CC* is therefore required, in fact, sufficient only for the motion of the curve generating circles. This question of shaping the teeth need not concern you if you are merely preparing a blank to send to a wheel cutter; it only concerns anyone who is actually shaping the teeth. The necessary thing is to make the blank of sufficient size and suitable shape to be cut. Sufficient margin must be allowed above the conical pitch surface to form the part of the teeth which projects beyond the pitch circle. The amount necessary for this is found by adding a part *T* projecting above the pitch surface, and the dimensions *S* is the depth to which the spaces will be cut below the pitch surface. The small ends of the teeth are terminated parallel to the lines *B*. The inner face of the wheel is, therefore, recessed as indicated at *R*. The lines of the sketch indicate the manner in which the teeth taper towards the point *O*, where the axes of the two shafts intersect. This is also indicated at *V*, where the small ends of the teeth are shown developed upon a circle *W*, concentric with *C*, and having a radius *YZ*, found by drawing a line from *Z* to *Y* perpendicular to the conical pitch surface of the wheel. A complete blank

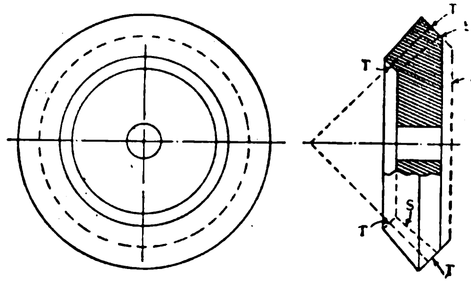


Fig. 39

ready for cutting the teeth would have an appearance as indicated by the sketch Fig. 39, which is partly in section. The dotted lines *SS* indicate the depth to which the teeth will be cut.

It is usual to make the thickness of the wheel somewhat greater as indicated by the dotted line *A*, to avoid a weak edge at the bottom of the spaces between the teeth. If a pattern is being made and the teeth cut out by hand, the curves for the faces and flanks must be applied to the surfaces *TT*, either by a template or by setting out with compasses, having been found by construction or development on the circles *C* and *W*, Fig. 38. A consideration of the tapered form of the teeth will show the difficulty of shaping them by cutters in a machine. In fact, when cut by milling cutters, they usually only approximate to the correct form, and some methods of cutting leave a certain amount of shaping to be done afterwards by filing. The general idea being to produce the teeth as correctly as possible by the cutter at the large end.

The general rules for shapes of teeth of flat wheels also apply to the teeth of bevel wheels; they may be on the cycloidal or involute systems. One wheel may be of the lantern pattern, as Fig. 20, and have pins for teeth; such a pair of wheels have their teeth shaped precisely upon the same principles as the teeth of a flat wheel, and lantern pinion. When the teeth are produced by a circular milling cutter they should be of involute form, as the cycloidal shape is extremely difficult if not practically impossible to obtain by this method.

(To be continued)

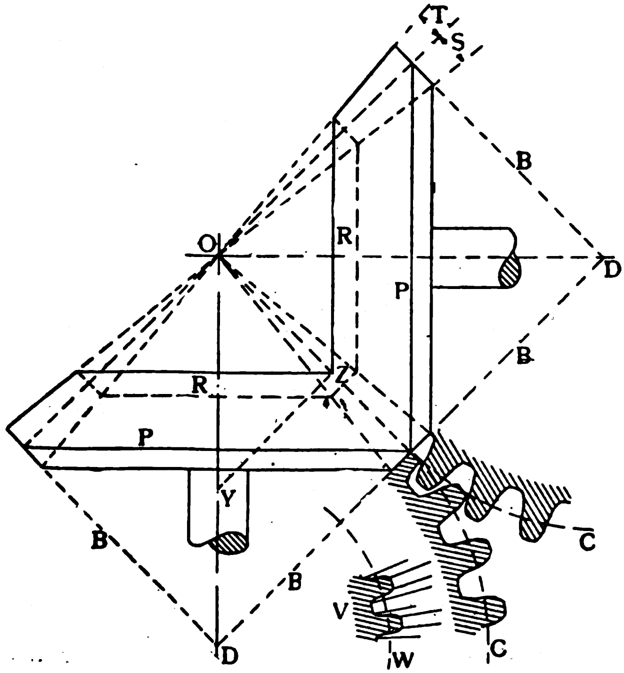


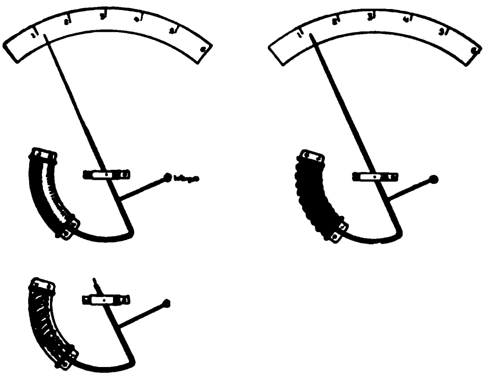
Fig. 38

CONSTRUCTION OF A VOLTMETER AND AMPERE-METER

LLOYD H. ORDWAY

The principle of both of these instruments is a solenoid and a soft iron core—movable, and connected to the pointer so that any variation in current or voltage is indicated on the scale. It is the type of instrument once standard with the Edison companies.

The construction of both instruments is identical, with the exception of the solenoids. The first thing necessary is to draw a circle with a $2\frac{1}{2}$ in. radius, then, using the same center, another circle of $2\frac{11}{16}$ in. radius. Now, draw a line from the center to the large circle. Next, get a piece of copper or brass tubing, about $\frac{5}{16}$ in. inside diameter by $\frac{1}{32}$ in. wall, and about $3\frac{1}{4}$ in. long. Fill it



with melted lead or rosin, and, when hard, bend it so that it will lay along the arc of the larger circle. The center of the tube when laid on the drawing should about line up with the inner circle. Melt the lead or rosin out of the tube, fit heads of wood or hard rubber 1 in. in diameter, cover the tube with several layers of paper and wind full of No. 22 magnet wire, bringing the two ends out for terminals.

Now, with a couple of narrow strips of thin copper, strap the coil to the wooden base and bring the two wires for binding-

inner circle, mark the center on the wire to coincide with the center of the circle. Drill a hole here and solder in a $\frac{3}{4}$ in. piece of a needle that has been ground to sharp points on both ends so as to serve for a pivot. Now flatten with a file about $\frac{1}{2}$ in. of the end of the straight portion and solder a piece of thin sheet copper cut to the shape of a pointer.

Next, make a U-shaped yoke to form a bearing for the pointer; and bear in mind this bearing must have the same relative position with regard to the coil as the center does to the circle, since the iron wire must float within the solenoid without touching the sides.

When the pointer sets at zero, the end of iron core should enter the solenoid about $\frac{3}{16}$ in. If it does not, place a weight made of a drop of solder on the end of an arm and solder it to the core in the position shown. A little experimenting will bring this right.

If this instrument is too sensitive, place a resistance of German silver or iron wire in series with it.

The ammeter is of exactly the same construction, except that the solenoid is made of a single layer of large, bare copper wire about $\frac{1}{4}$ in. in diameter, but the size will depend upon the current to be measured—No. 6 may be ample. It is wound around a $\frac{5}{16}$ in. rod very tightly, using a pipe wrench to wind it. Then with a screw-driver force the convolutions apart on one side until the center of the coil coincides with the arc of the circle. Now, be sure all of the turns are separated so as not to make contact, and then strap it down as was the coil on the voltmeter, but taking care to insulate the straps from the coil by strips of cardboard. This instrument is not very sensitive, and so the movable member must be very carefully made. If it is not sensitive enough to suit, cut down the air gap between the coil and core by

SMALL DYNAMO AND MOTOR TESTING

BARTON MOTT

This article is intended to give in a short space a general plan of operations for testing small dynamos and motors. With most small models it is not practicable to test them in the same way as one would a large machine. The principal objects in view in the testing of a small machine, say up to ¼ h.p., are to observe the behavior, with regard to sparking, overheating, etc., while running at full load, and to find the energy required to enable it to give the best results. For this purpose the machine is tried under various conditions in a place where adjustment and alterations can easily be made.

First, during construction, every coil should be tested by means of a battery and galvanometer just as soon as it is wound, in order to make sure that the winding has not broken anywhere, as sometimes happens with old wire, and to see that the coil is properly insulated from the core. A battery of about six cells will prove very useful for these tests. Fig. 1 shows the connections for testing a section of the armature winding. If the wire has not broken, the gal-

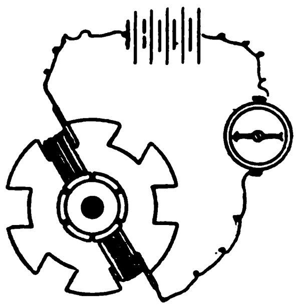


Fig. 1. Testing Armature Winding

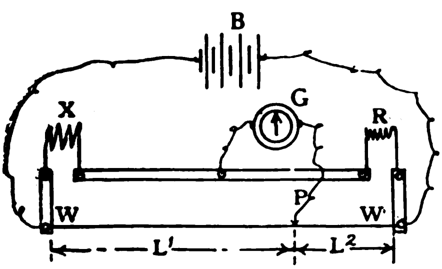


Fig. 2. Measuring Resistance by Slide Wire Bridge

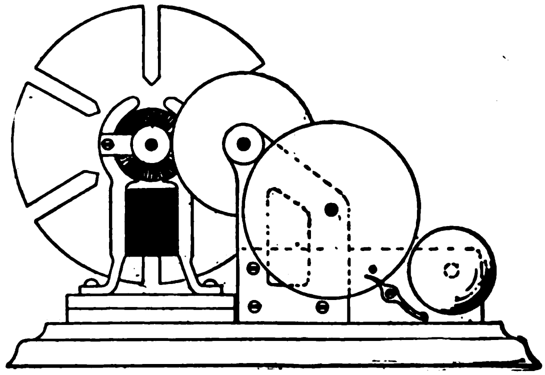


Fig. 3. Auxiliary Speed Counter

vanometer needle will jump to one side every time the circuit through the winding is closed. The test for leakage is made by joining the wire from the galvanometer to one end of the winding; then, if there is no movement of the needle, when the wire from the battery is touched to the core or frame of the machine, there is no leakage. The insulation of that winding is correct. Slight movements of the needle during this leakage test may be the result of dampness, caused by the spirit in the varnish.

In the case of small dynamos, where the field winding is not on a detachable bobbin, but is wound directly on to the core, it is advisable, whenever sending a current through it, as in the conductivity test, to make the connections so that the magnetism caused by the current will be of the correct polarity. The commutator should also be tested with the battery and galvanometer to prove that the segments do not make contact with each other. When the armature is finished, and each section has been tested, the total resistance should be measured. If the brushes are clean and making good contact with the commutator, their resistance will be practically nothing, so the armature resistance may be measured from brush to brush by means of a Wheatstone Bridge, or by using a galvanometer. The resistance of the field should also be measured. Fig. 2 shows how to find the resistance by means of a slide wire bridge. *R* is a known resistance, *X* the unknown.

The end of wire P is moved along the slide wire WW until there is no deflection of the needle, when the resistance

$$X = \frac{L^1}{L^2} R$$

The first step in testing a finished machine is to see that it is firmly screwed down, that the bearings are oiled, the belt even and not too tight, the brushes making good contact, and that all electrical connections are well made. The field magnets should be tested with a magnetic needle to see that they have the correct polarity, or at least that they are not both the same. If it is found that the poles are of like polarity, the field magnet should be remagnetized correctly by means of a powerful battery.

A test card should be made out on which the type of machine, date of test,

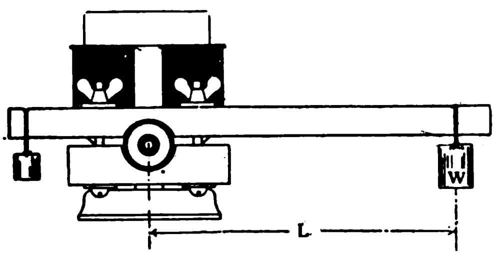


Fig. 4. A Simple Wooden Brake

speed, volts, amperes, etc., and all conditions and results obtained should be recorded.

In testing a dynamo some arrangement must be made for absorbing the current generated, such as an adjustable wire or liquid resistance. Wire is to be preferred, as, owing to electrolysis, small liquid resistances are inconstant and are difficult to adjust. A voltmeter should be connected across the brushes and an ampere-meter in series with the resistance. A starting switch should be provided, and the machine run up to speed before closing the circuit. The resistance is then regulated until the meters show that it is working at full load. It

altered. The brushes should have a forward lead with a dynamo, backward with a motor. Sparking at the commutator may be due to many causes, such as wrong connections or short circuits in the armature, rough commutator, brushes in the wrong place, or too great a load. The armatures of many small machines will cause a certain amount of sparking because of the difficulty in getting each section wound with an equal amount of wire. Overheating of the windings is usually caused by overloading the machine.

With small shunt machines it is not usually possible to regulate the current in the field winding. It is, however, an interesting experiment to excite the field winding with an independent current by means of the battery, and see the effect of running the armature with various field strengths and at various speeds. If the air-gap of a dynamo is large, this experiment will show if any improvement could be made by altering the field winding.

TESTING FOR HORSE-POWER AND EFFICIENCY

The amount of power that a machine develops, can, in the case of a dynamo, be read in watts from the volt- and ampere-meters (watts = volts x amperes); in the case of a motor determined by means of a prony brake. The efficiency of a machine is the ratio of the power produced to the power consumed.

To take the case of a dynamo first. The efficiency equals the electrical output divided by the mechanical input, both powers expressed in watts. For example, 1 h.p. = 746 watts. So in a case where a dynamo takes 1-6 h.p., to make it generate 60 watts the efficiency would be

$$\frac{60}{1\text{-}6 \times 746} = .48, \text{ that is, 48 per cent.}$$

To read the electrical output of a dynamo is easy enough, but, unless it is electrical and mechanical. The chief electrical losses are due to the resistance in the armature and in the field-windings. These resistances should be measured, as has already been described, while the machine is hot—just after running. Having found these resistances, the watts lost in each way may be determined thus: Let the total loss in the armature and field winding be expressed in watts = W.

In a series machine $W = C^2 (R_a + R_f)$.

In a shunt machine $W = C^2_a R_a + C^2_f R_f$. In these formulas R_a = the resistance of the armature.

R_f = the resistance of the field.

C = the total current.

C_f = the current in the field = $\frac{\text{voltage}}{R_f}$

C_a = the current in the armature $= C—C_f$.

It has been found by experiment that all other losses in most small machines can be fairly well accounted for by reckoning them as equal to 25 per cent. of the total output. So we now get the input by adding the watts lost in the field and armature plus 25 per cent. of the output plus the total output. Another way of finding the input would be to make careful note of the exact conditions, pressure, speed, etc., under which the driving engine is running when working the dynamo, and then to replace the dynamo with a prony brake and adjust it until the engine is running under those same conditions again. A more direct method would be by means of a transmission dynamometer. There is another direct way which is particularly suitable for small dynamos, namely, the balance method, as described at the end of this article.

In the case of the motor the input is electrical and the output mechanical. This time it is the input that can be read from the volt- and ampere-meters. The output or horse-power is measured by means of a prony brake, and a speed recorder or some arrangement of gearing to enable the revolutions per minute to be counted by sight. With a dynamo the speed can be calculated from that of the driving engine, allowing 5 per cent. for belt slip. Sometimes, with very small machines, it is difficult to find the speed by these methods. In such cases an auxiliary motor may be used, the speed of which is shown by a counter or by gearing. This motor has a disc with slots cut radially in it mounted on its shaft. Another disc, the same size, with the same number of slots, is mounted on the shaft of the machine being tested. The two machines are placed in line, and the speed of the auxiliary one regulated until both discs appear to be standing still. The speeds of both machines are then alike. Fig. 3 is an illustration of a toy motor rigged up as an auxiliary speed counter. Almost any cheap little motor supplied with current from the battery

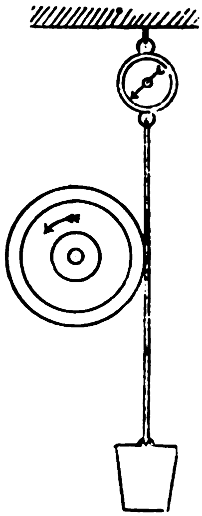


Fig. 5

will do for this. An adjustable wire resistance must be provided in order to regulate the speed. The slotted disc—which may be made of cardboard—can be put on to the same end of the shaft as is the gearing. The sizes of the gear wheels in number of teeth are—fifteen on the armature shaft, seventy-five and fifteen on the intermediate, and ninety on the countershaft. Any wheels having about the same ratio would do. The last wheel has a small pin inserted in one side, which rings the bell for every thirty revolutions of the armature shaft. Two simple prony brakes are illustrated here. The one shown in Fig. 4 consists of two wooden blocks, which are clamped on to the motor pulley by means of two bolts. The small weight on the left is to counterbalance the longer arm, and should be adjusted until the brake is perfectly balanced on the pulley. This is most important. When the perfect balance is obtained, the two bolts must be tightened until the brake begins to clamp the pulley. When the pulley revolves and the nuts are tightened, a weight, W, must be added. This weight is increased in order to keep the brake balanced horizontally. The pulley should be well lubricated with grease or soap. The horse-power = .0001904 times the revolutions per minute, times the distance L in feet, times the weight W in pounds. Fig. 5 shows another type, using a spring balance. The weight may consist of shot or sand. W is the direct reading of the spring balance. With this type the horse-power =

$$\frac{2\pi r(\text{r.p.m.})}{33{,}000} \times W.$$

The torque of a motor is its turning effort. It is equal to the belt pull in pounds multiplied by the pulley radius in feet.

$$\text{Torque in ft.-lbs.} = \frac{H.P.}{(\text{r.p.m.})\ .00019}$$

It may be measured directly by means of the prony brake, by first loading the arm with a weight and clamping the brake on to the pulley fairly tightly, then gradually increasing the current supply to the motor until the pulley just begins to turn.

The efficiency of a motor is found by dividing the power developed, expressed in watts, by the number of watts that it is consuming.

An interesting method for measuring the power absorbed by a small machine is that in which the magnetic field is used as the brake. The machine to be tested is put between centers—in the lathe, for example, a center in each end of the armature shaft. The frame of the machine now has to be balanced with weights, as in the prony brake. The best way to do this is to fasten a bar of wood on to the top of the frame, on . . . .

in his particular case are worth while making, such as, in the case of a shunt motor, the overload capacity or the speed variation—that is, the difference in speed between no load and full load. A series-wound motor should never be allowed to run at full speed when unloaded.

The additional interest that a model provides to its owner when he thoroughly understands it well repays the trouble taken in carrying out these simple tests.—*The Model Engineer and Electrician.*

Final Test of New Wireless Station

The final test of the new wireless station of the Navy Department at Arlington, which is still in the hands of the contractors, was made last month when an effort was made to exchange messages between the station and the scout cruiser *Salem* at a distance of 3,000 miles. Orders had been issued by the Navy Department for the *Salem* to fill up her crew so as to be in readiness for the test on January 15. She then put across the Atlantic, and in making the tests described a circle, the radius of which was 3,000 miles, the distance called for in the Government contract. The *Salem*, with as powerful wireless apparatus as any in the Navy, proved able to respond to any message flashed from the giant towers across the Potomac. The tests at the new Arlington station have been very satisfactory. While few of these have been at full capacity, the station at the Mare Island Navy Yard, Vallejo, Cal., had been reached, and frequent communication has been had with Colon, a distance of 2,000 miles. The station will be shut down in a week to allow the installation of a new spark-gap.

Huge Electric Clock

To advertise the Boston Edison Company, a large electric sign has been set up in that city, measuring over all 54 ft. in width by 60½ ft. in height. The sign contains a clock, with the dial 34 ft. in . . .

DESIGN FOR A PORTABLE DRAWING FRAME

W. B.

Suffering from the baneful effects of working at a table, I had often thought that I should find a frame advantageous and also convenient. I do not wish it to be understood that mine is *the* original idea, but I have a thought that for convenience, rigidity, and portability it will compare with any I have hitherto seen.

How many draughtsmen would be glad to be able to work in their own sitting-room, and, when work is done, take off the drawing-board, fold down the top frame, swing round the wide feet to the span of the feet at the base of the frame standards, lay their square on the brackets and instrument on the square, push all back into a convenient corner, drop a light baize cover over all, sit down, and have an hour with a fellow-amateur? This is what I did several years since, and I do not regret the dollar and a half spent for material and the time occupied in the making.

Before I describe the drawings, I should like to say there is ample space and provision for a foot rail, if desired; but I prefer it as it is. This frame is perfectly free from the least vibration, even under strain.

Fig. 1 gives the front elevation of frame as set for a man about 5 ft. 8 in. in height. The drawing-board simply lies upon the framed top, and can be shifted to any position to suit the light

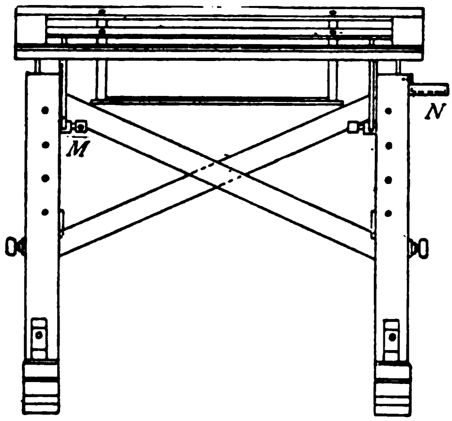


Fig. 1

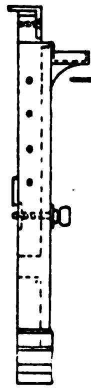


Fig. 3

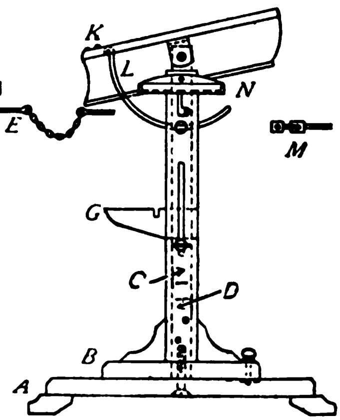


Fig 2

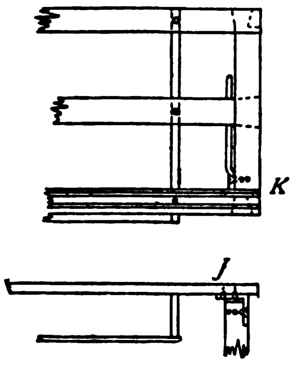


Fig. 4.

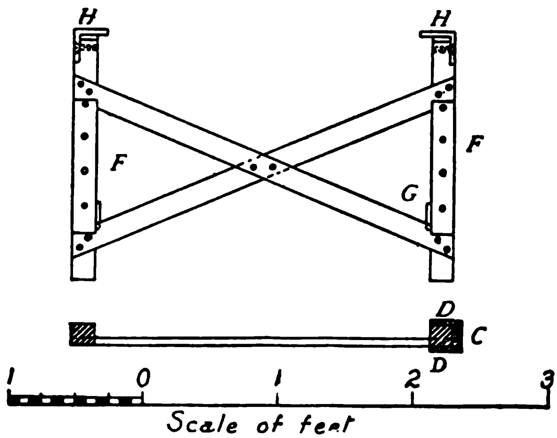


Fig. 5.

Design for a Portable Drawing Frame

and convenience of the draughtsman. This is a great convenience, especially where one's sight is failing.

Fig. 2 shows an end elevation; Fig. 3 a line view of one of the standards; Fig. 4 a plan and front view of the framed top and open shelf underneath (now shown 4 in. clear, but mine is only 3 in. clear). Fig. 5 is the braced sliding frame and the plan of same, and on the right hand the sliding case is shown in section; the bracing is as seen from the back.

CONSTRUCTION

To those who will afford it, the whole of the wood used should be kauri for the frame and yellow pine for the top and shelf. But where economy has to be studied, even white deal will do. But the whole should be carefully and truly wrought. *A*, Fig. 2, are bases with claws glued and screwed on and prepared for the swivelling screw, which should be 4 in. and stout. These bases will be swung round when the frame is not in use. *B*, Fig. 2, are the feet of the standards, into which are tenoned the lower pieces of 2 x 2 in., as shown by dotted lines. *C* is the stoutest portion of the sliding case, and, as shown, is glued and screwed to the 2 x 2 in. *DD* are the back and front portions of the slide case, and these are screwed to *C* and also to the 2 x 2 in. The slot shown in *C* is for the thumb-screw, as shown, which, with its brass nut, is let into the 2 x 2 in. front slides for clamping. Shown on *D*, Fig. 2, are four holes, into which the pin *E* passes, and through one or more holes in the 2 x 2 in. *FF* (to choice). These pins take up the dead weight and relieve the thumb-screws. Fix—where shown at *B*—carefully squared angle-blocks, also glued and screwed. There is shown at *B* thumb-screws, passing through and screwed into a flush-nut in *A*.

Fix at *G* on the slides, Fig. 5, 3/8 in. brackets, as shown, with a gap in same so that the back edge of the blade of the square may rest in same when not in use.

The carefully braced frame, Fig. 5, should have if possible, hard wood 2 x 2 in. slides at *FF*, braced as shown. *HH* are two pieces of coach hooping, carefully forged with a sharp internal angle, each into slides at *HH*, and made with lower end curved, and fixed with a well-fitted pivot-screw to slide *FF*, but not too tight.

Form the shelf, Figs. 1, 2, and 4, by screwing through the top frame, as shown, into the checks and nailing the bottom to the checks. All the edges of the bottom to be rounded; the back and front ends of checks to be cut to form, as shown. The reason for the edge next the draughtsman projecting is to give him a quicker touch of his various instruments. It is as well to fix on the bottom a beveled strip to prevent slipping. Fix—where shown at K, Fig.2 — two fillets 3/8 x 1/4 in., the upper one to form stop for drawing-board, and the lower one forms a channel for instruments. The edge of top frame next the draughtsman should be eased away, as shown, for comfort of touch.

At *K*, Figs. 1 and 2, are stays made of 1/4 in. soft steel, neatly bent at upper end so as to receive a screw, and fixed, not too tightly, to the inside edge of top frame. (This part of top frame to be 3½ in. wide). The remaining portion of the stays are to be neatly bent to a radius of about 6 in. from the center of the pivot-screw. Screw guide-eyes *M*, also shown on Fig. 1, and set screws are fitted in the heads of *M* to pinch the stays *L*. The zinc tray *N*, Figs. 1 and 2, is very easily made, and is convenient for instruments and for color platters.—*The Model Engineer and Electrician.*

Sulphated Accumulator Plates

H. C. ROBSON

The following may be of some use to your readers. Having an accumulator to clean that was badly sulphated, I set to work to clean it in the following way: Get about ½ lb. of ammonium acetate, dissolve in 1 qt. of water and put in earthenware jar and immerse the lead plates and allow them to stay for half an hour, keeping them hot during this while. The plates will now be free from the sulphate, wash and dry, and they can now be replaced in the accumulator case. In this method the plates need not be detached, thus saving a great deal

INFORMATION FOR SHIPS DESIRING TO FORWARD RADIOGRAMS THROUGH U.S. NAVAL RADIO STATIONS

1. The charges to be collected on board ship consist of:

(*a*) The ship charge.

(*b*) The coast station charge.

(*c*) The charges for land line or cable transmission.

(*a*) Is fixed by the company operating the radio set on board ship. (*b*) Is fixed by the Secretary of the Navy for naval radio stations. (*c*) Is fixed by the Secretary of War for Alaskan telegraph lines and cables and by the telegraph and cable companies in the United States.

2. Each ship should have on board tariff sheets showing the charges for each station open to general public business and the telegraph and cable rates from each station to any point in Alaska, the United States, or Canada, and as far as possible to any part of the world. However, should the ship not be provided with these rates, they may obtain them by means of a service message to a coast station. Call the station and send the interrogation signal twice, followed by: "——rate to——." Naval stations will be prepared to furnish rates by cable to foreign countries; also the radio rate through any foreign coast station open to general public business, and the ship rate of any ship whose name is to be found in the international list of radio stations.

3. The charge for a radiogram must in every case be paid in full by the sender. A receipt for charges prepaid should be demanded and retained by the sender for possible future inquiries. A sender may designate the coast station to which he desires his radiogram to be sent. The operator will then wait until that station is the nearest; if no station is designated the message must be sent to the nearest coast station. In case there are alternative routes for the transmission of a message beyond the coast station, the sender should designate the route. In the United States, he should state whether the radiogram is to be forwarded by the Western Union or Postal Telegraph Companies. In routing the message the letters "W" and "P" should be used to designate these companies respectively.

PRIORITY OF MESSAGES

4. Ordinarily the business between the ship and coast station should be carried on in the following order:

(*a*) Messages relating to the navigation of the ship.

(*b*) Service messages relating to the conduct of the radio service, or to previous radiograms transmitted by the stations concerned.

(*c*) Commercial messages.

5. Messages of the same rank will be transmitted in the order in which they were handed in. The coast station will direct whether the ship and station are to send messages in alternate order or in series of several messages. The time occupied by a series of messages may not exceed 12 minutes.

NUMBERING OF MESSAGES

6. Messages for certain coast stations should be numbered in sequence, beginning with one, each station to have a separate series of numbers. A new series should commence with midnight each day.

CODE

7. The International Morse Code only will be used by naval stations.

SHIP TO CALL COAST STATION

8. As a general rule, the ship calls the coast station when its distance is less than 75 per cent. of the normal range of the coast station, as given in the international list. Before beginning to call, the ship operator should adjust the receiver for the calling wave-length of the coast station and his detector for maximum sensitiveness, after which he should listen in to see if the station he wishes to call is not engaged. If he finds that the station is working with another ship or station, the operator must wait for the first break before calling. Too much care cannot be taken in carrying out these regulations, as by calling a station already busy an operator is liable to interfere and cause delay, not only for his own message, but for any others that may be in progress. On the request of the coast station, a ship will immediately cease calling, and the station will then indicate,

approximately, the time it will be necessary to wait.

COAST STATION THE CONTROLLING STATION

9. Operators should remember that the coast station controls all communications in its neighborhood, in which it is guided solely by the desire to handle as much work as possible. When a coast station receives calls from several ships, it shall decide the order in which the ships shall be received in order that each ship may be allowed to exchange the greatest possible number of messages before going out of range. Preference is therefore given to the ship whose position, course, and speed indicate that she will be the first to pass out of range.

FAILURE TO REPLY

10. No reply having been received to a call repeated three times at intervals of two minutes, a call should not be renewed until after an interval of 20 minutes, and then only if no communications are going on which will be interfered with.

PROCEDURE WHEN SIGNALS BECOME DOUBTFUL

11. When signals become doubtful, a message will be repeated at the request of the receiving station three times only. Should the signals be unreadable in spite of being thrice repeated, the message will be canceled. If an acknowledgment of receipt is not received, the ship again calls the station. If no reply is made after three calls, they shall not be continued. Should the station think that the message may be delivered, it acknowledges receipt, inserts the service instruction, "reception doubtful," at the end of the preamble, and sends on the message.

SUPERFLUOUS SIGNALS

12. Every effort should be made to cut down the number of superfluous

Calls

5. A call shall be preceded by the ATTENTION signal

— • — • —

The call of the station shall be made three times and separated from that of the calling station, also repeated three times, by

— • • • (DE)

6. The signal

— • — • — — • — (CQ)

shall be known as the INQUIRY signal, to be used for calling any ship or station which may be within range, when its name is not known. It shall be preceded by the ATTENTION signal,

— • — • —

followed by

— • • • (DE)

and the call of the inquiring ship or station repeated three times.

7. A station called shall reply by giving the ATTENTION signal,

— • — • —

followed by the call of the calling station repeated three times, the signal

— • • • (DE)

her own call repeated three times, and the GO AHEAD signal

— • — (K)

The use of GA or G shall be discontinued.

8. If a station called does not answer the call repeated three times at intervals of two minutes, the call shall not be resumed until after an interval of 15 minutes, the station making the call having first made sure that no communications are being interfered with.

9. When a station is called by several ships it shall decide the order in which it will work with them. In general, a station controls all radio communications within its range as far as commercial work is concerned.

Examples

(1) Ship KSA calls NAN thus:

— • — • —

(2) KSA sees a ship on the horizon, or, having nothing in sight, wishes to inquire if there is any ship or station within range:

—•—•— (ATTENTION signal)
—•—• ——•— (INQUIRY signal)
—•• • (DE)
KSA KSA KSA

NJS answers:

—•—•—
KSA KSA KSA
—•• •
NJS NJS NJS
—•—

Position Reports

10. A position report shall be preceded by the letters TR and shall be made as follows:

(*a*) The approximate distance, in nautical miles, of the vessel from the coast station;

(*b*) The position of the ship given in a concise form and adapted to the circumstances of the individual case;

(*c*) The next port at which the ship will touch;

(*d*) The number of messages, if they are of normal length, or the number of words if the messages are of exceptional length.

The speed of the ship in nautical miles shall be given specially at the express request of the coast station.

Commercial ships may be expected to use the form required by the Berlin Convention. (See examples, (2) page 4.)

12. Special care shall be taken not to interrupt the business of the station, which may be receiving signals at the time that cannot be received on board ship on account of the lower aerial; the ship shall, therefore, cease calling promptly on demand.

13. The signals

•—••• (WAIT),

and QRM, QRW, QRX and QRY (see par. 73) shall be used to cover cases of interference.

Examples

(1) After station acknowledges ship's call, ending with

—•—

the ship sends: TR, 50 (nautical miles).
Off Cape Fear
Havana
4 (number of messages)

(2) A commercial vessel, especially if foreign, may be expected to send:
50 (distance)
93 (bearing from station)
184 (course)
9 (speed)
40 (number of words)

The numbers may be separated by the BREAK sign or the signals QRB, etc. (par. 73), may be used.

Transmission of Radiograms

16. The station, after acknowledging the position report, shall reply, giving either the number of words or the number of messages to be sent to the ship and the order of transmission, if the station is ready to send or receive at once; if not, the station shall inform the ship of the approximate length of the wait.

17. In case the ship is not ready to receive for the moment, she shall inform the calling station of the approximate length of the wait.

18. The object aimed at must always be the handling of the greatest amount of business before ships get out of range.

19. Before beginning an exchange of messages the station shall inform the ship whether the messages shall be sent in alternate order or by series of so many messages, in case there are several to be sent each way. The abbreviations given later (par. 73) may be used to indicate the order, or the word "series," if there are less than five messages.

20. The transmission of every message shall be preceded by the ATTENTION signal.

21. When a message to be sent contains more than 40 words, the sending ship or station shall interrupt the transmission after each series of about 20 words with an interrogation

••——••

and shall not continue until the receiving station repeats the last word received and

—•—

The Preamble

22. The preamble consists of all the items sent before the address. It follows the ATTENTION signal

—•—•—

and is separated from the address by the BREAK or DOUBLE DASH

—•••—

Numbering of Messages

24. Each message, regardless of class, sent by a ship or station, will be numbered in sequence, the first message of each day sent to a certain ship, station, or land line office, to be numbered 1. Each ship or station will have a separate series of numbers for each station or land line office to which it transmits, a new series to begin each day at midnight.

25. The receiving number is that given by the ship, station, or office received from, and will not be transmitted, but a new number will be assigned, in case the message is retransmitted, and will be the next number in sequence for the station sent to. The number will be transmitted as the second item of the preamble of the message (following the abbreviation "Ofm," "Svc," or "Msg"), without the abbreviation "No" or "Nr." In receiving a series of messages the sequence of the receiving numbers will be noted, and in case a break in the sequence should occur, inquiry for the missing message shall be made immediately.

Examples

(1) The first ten messages received at a station on a certain day are from the S.S. *Amazon*. They should be numbered 1–10 by the *Amazon*. The next two messages are from the *Reid*, numbered 1 and 2 by the *Reid*.

(2) The next messages from the *Reid* are sent to the *Louisiana* direct. They should also be numbered 1 and 2 by the *Reid*.

(3) All of the messages received by the station from the *Amazon* and the *Reid* are turned over to a land line or cable office for further transmission with the numbers 1–14, being the first messages sent that day through that office.

Station Call

26. The station call shall follow the number. The sending operator's sign shall not be transmitted, but shall be recorded on the message blank. No operator shall change his personal sign without the authority of the electrician in charge of the station, or the radio or signal officer on board ship. No two operators at a station or on board a ship shall use the same sign.

The Check

27. The check shall consist only of the number of words, including the address and signature, with the exceptions noted in the following paragraph and under the heading "Counting of words" (par. 68). The number or numbers only shall be sent without the indication "Ck."

Dating

29. After the check, the ship, station, or office of origin shall be sent, except by the originating station itself, followed by the original date should the message not be forwarded or delivered on the original date. The *name* of the original ship, station, or office shall always be sent in order to avoid errors on account of similarity of call letters. A message forwarded over a land line by a coast station shall show its own name as office of origin, followed by that of the ship.

30. On board ship and at stations which receive messages from the public direct, the time when a message is filed—*i.e.*, handed in for transmission—shall be noted on the sending blank. This time shall be known as the "time of filing."

35. For a message to be forwarded by land wire or cable, the particular line or cable shall also be indicated after indicating the ships and station handling it by radio. For land lines in the United States, use "W" for Western Union Telegraph Co., "P" for Postal Telegraph Co.

The Address

36. The address must consist of at least two words. Telegraph companies will register radio addresses at all offices without charge. The cable addresses prescribed by Navy Regulations shall be used for radiograms.

Body of Message

37. The message and signature, if any, must be sent exactly as received. The address, message and signature must be sent with special care, the sending operator regulating his speed to suit the ability of the receiving operator, avoiding a jerky style of sending. Slow steady sending at the rate of about 20 words per minute will give best results. Messages containing code words or cipher should be sent more slowly than those entirely in plain language. Government

messages containing code words and cipher shall be immediately repeated back by the receiving station, with the following exceptions:

(1) In repeating a message of more than 10 words, containing few code words or cipher groups, the code words or cipher groups only shall be repeated.

(2) Weather reports and other reports made up of code words with which operators may become familiar from frequent use need not be repeated. Should the receiving operator have any doubt about one or more words, he should repeat and get

•••▬• (UNDERSTOOD)

from the sending operator.

Signature

38. The indication "Sig" before a signature shall not be transmitted. No signature is required for any except official messages. In case a message is not signed, no mention of the fact shall be made, as the check will be a sufficient indication.

End of Message

The message is ended by the END OF MESSAGE signal, the cross (+) of the International Morse code,

•▬•▬•

followed by the station call.

Example

Order of transmission of a radiogram after receiving the signal "K" (go ahead). ("Prairie" sending to Key West.)

1. ▬•▬•▬ *Attention* signal.[1]
2. OFM (or) SVC (or) MSG — Government message, or service message, or commercial or private message.
3. 5 — Number.
4. NQM — Station call.
5. 5 — Check—number of words.
6. USS. *Wyoming*—Originating station.
7. 12 — Original date, if other than date of transmission.
8. Via NAR W Route.
9. ▬•••▬ *Double dash* or *break* (end of preamble).
10. Larrimer New York — Registered radio address.
11. ▬•••▬ *Double dash or break.*

by the word before that sent incorrectly or before a word omitted.

Example

"Arrive ten tonight, stay in waters indefinite

••••••••

in these waters indefinite."

Repeating

40. In addition to its uses as an interrogation, the signal

••▬▬••

shall be known as the REPEAT signal, and shall be used to obtain a repetition of messages or words as follows:

1. To have a single message entirely repeated, send, (*a*), call of station sending message, (*b*), the REPEAT signal three times, (*c*), station call.

2. To have one of a series of messages repeated, send, (*a*), call of station sending message, (*b*), number of message, (*c*), the REPEAT signal three times, (*d*), station call.

3. In case the first part of the message is received satisfactorily, indicate the last word received and get a repetition of the last part of the message by sending (*a*), call of station sending message (*b*), number of message, if necessary, (*c*), last word received, (*d*), REPEAT signal, (*e*), station call. This will be taken to mean "Repeat after——."

4. In case the last part of the message was received satisfactorily, indicate the first word of the part received and get a repetition of the message as far as that word by sending, (*a*), call of station sending message: (*b*), number of message, if necessary; (*c*), the REPEAT signal; (*d*), first word of part received; (*e*), station call. This will be taken to mean, "Repeat as far as——."

5. To get a repetition of one or more lost or doubtful words, send, (*a*), call of station sending message; (*b*), number of message, if necessary; (*c*), word received just before lost or doubtful word or

(2) NAM
6
•• — — ••
•• — — ••
•• — — ••
NAL
(Repeat your No. 6.)

(3) NPC
1
Report
•• — — ••
NPD
(Repeat after word "Report.")

(4) NPO
•• — — ••
Nicholson.
NPT
(Repeat as far as "Nicholson.")

(5) NLC
4
Several
•• — — ••
Instruct.
NAO

"Received" Signal

41. To acknowledge a single message or series, send:

(1) The RECEIVED signal, R.
(2) Number of message, or numbers of first and last messages of a series.
(3) Ship or station call.
(4) Operator's sign.
(5) The GO AHEAD signal if ready to receive another message; the ATTENTION signal, preamble, etc., if a message is to be sent; or the FINISHED signal,

••• — • —

followed by ship or station call if all business is cleared, which shall be answered by the other ship or station in the same manner.

Examples

(1) • — • (RECEIVED).
4
NPC
XP

(2) • — •
1
5
NJC
GL

(3) • — •
11
15
NAX
V
••• — • —
NAX

NAR answers:
••• — —
NAR

Language

42. A radiogram may be sent in plain language, code language, or cipher:

(1) Radiograms in plain language are those composed of words, figures, and letters which offer an intelligible meaning in any of the European languages. The words and letters must be written in Roman characters. In case of unfamiliarity with the language being sent, the sending operator's statement that a message is in "plain language" shall be accepted.

(2) Code language is composed of real words not forming intelligible phrases or of artificial words consisting of pronounceable groups or letters, such as words in which the letters are alternately consonants and vowels. No code word, whether real or artificial, may exceed ten letters in length. The real words may be drawn from any of the following languages: English, French, German, Italian, Spanish, Portuguese, and Latin. The artificial words must be formed of syllables which must be pronounceable according to the current usages of one of those languages. Combinations formed by running together two or more real words, whole or contracted, or a real word and some other expression are prohibited.

(3) Cipher is composed of:

(*a*) Arabic figures or groups, or series of Arabic figures having a secret meaning, or letters or groups, or a series of letters having a secret meaning.

(*b*) Combinations of letters not fulfilling the conditions applicable to plain language or code.

Letter and figure cipher cannot be combined in one group.

Counting of Words

44. The word system of counting shall be observed, and all words in the address, text, and signature must be counted and charged for.

Abbreviations

73. The following abbreviated signals will go into effect with the London Convention, July 1, 1913, and will be used by ships of all nations which may ratify that convention. They shall be used between stations and, wherever practicable, with commercial ships that are familiar with them, after receipt of these instructions:

— • — • — — • — (CQ)

Signal of *inquiry* made by station desiring to communicate.

— · — · (TR)
Signal preceding position report; or "Send position report."

— — · · — — (!)
Signal indicating that a station is about to send at high power.

Abbreviation	Question	Answer or Notice
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?	This is ——.
QRB	What is your distance?	My distance is ——.
QRC	What is your true bearing?	My true bearing is —— degrees.
QRD	Where are you bound for?	I am bound for ——.
QRF	Where are you bound from?	I am bound from ——.
QRG	What line do you belong to?	I belong to the —— Line.
QRH	What is your wave-length in meters?	My wave-length is —— meters.
QRI	How many words have you to send?	I have —— words to send.
QRK	How do you receive me?	I am receiving well.
QRL	Are you receiving badly? Shall I send 20 · · · — · for adjustment?	I am receiving badly. Please send 20 · · · — · for adjustment.
QRM	Are you being interfered with?	I am being interfered with.
QRN	Have you much static?	There is much static.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRQ	Shall I send faster?	Send faster.
QRS	Shall I send slower?	Send slower.
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready. All right now.
QRW	Are you busy?	I am busy (or: I am busy with ——). Please do not interfere.
QRX	Shall I stand by?	Stand by. I will call you when required.
QRY	When will be my turn?	Your turn will be No. ——.
QRZ	Are my signals weak?	Your signals are weak.
QSA	Are my signals strong?	Your signals are strong.
QSB	Is my tone bad?	Your tone is bad.
	Is my spark bad?	Your spark is bad.
QSC	Is my spacing bad?	Your spacing is bad.
QSD	What is your time?	My time is ——.
QSF	Is transmission to be in alternate order or in series?	Transmission will be in alternate order.
QSG		Transmission will be in series of 5 messages.
QSH		Transmission will be in series of 10 messages.
QSJ	What rate shall I collect for ——?	Collect —— for ——.
QSK	Is the last radiogram canceled?	The last radiogram is canceled.
QSL	Did you get my receipt?	Please acknowledge.
QSM	What is your true course?	My true course is —— degrees.
QSN	Are you in communication with land?	I am not in communication with land.
QSO	Are you in communication with any ship or station (or, with ——)?	I am in communication with —— (through ——).
QSP	Shall I inform —— that you are calling him?	Inform —— that I am calling him.
QSQ	Is —— calling me?	You are being called by ——.
QSR	Will you forward the radiogram?	I will forward the radiogram.
QST	Have you received the general call?	General call to all stations.
QSU	Please call me when you have finished (or) at —— o'clock.	Will call when I have finished.
QSV	Is public correspondence[1] being handled?	Public correspondence[1] is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?	Increase your spark frequency.
QSY	Shall I send on a wave-length of —— meters?	Let us change to the wave-length of —— meters.
QSX	Shall I decrease my spark frequency?	Decrease your spark frequency.

[1]Public correspondence is any radio work handled on the commercial tunes 300 or 600.

Additional abbreviation proposed for international use, and authorized for naval stations:

Abbreviation	Question	Answer or Notice
QSZ	....	Send each word twice. I have difficulty in receiving you.

When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation.

Examples

Station A. QRA? = What is the name of your ship or station?
Station B. QRA *Celtic* MLC = This is the *Celtic*. Her call is MLC
Station A. QRG? = To what line do you belong?
Station B. QRG *White Star* = I belong to the *White Star* line.

QRZ = Your signals are weak.
Station A then increases the power of its transmitter and sends:
Station A. QRK? = How are you receiving?
Station B. QRK = I am receiving well.
QRB 80 = My distance is 80 nautical miles.
QRC 62 = My true bearing is 62 degrees, etc.

CONDENSER TUBES

A number of interesting papers have been presented before the British Institute of Metals, among which should be particularly mentioned, "The Corrosion of Brass Condenser Tubes," by Mr. Paul T. Bruhl. This paper is the result of a thorough study of this troublesome problem and brings out certain very interesting conclusions arrived at by the author. "In this connecton, attention should be called," says Carl F. Woods, of the staff of Arthur D. Little, Inc., chemists and engineers of Boston, "to the proceedings and the report of the corrosion committee of the Institute which was opened a year ago with a view to carrying out an exhaustive and authentic research on the corrosion of brass and bronze. The committee have decided to erect in Liverpool a plant in which the conditions of marine condenser service should be as closely imitated as possible. The plant is to consist essentially of four cast iron tubes, each fitted with tube plates to carry 12 condenser tubes, these iron tubes representing four small independent condensers. The condensers will be connected direct to the exhaust of a small engine which in turn will drive a circulating and vacuum pump for circulating sea water through the condensers. Each condenser will be fitted with the same kind of tubes, and the committee has decided for the first set that one condenser shall be equipped with the so-called 'Admiralty' mixture with a tube plate of naval brass, the equipment being carried out with the same extreme care insisted upon by the 'Admiralty' practice. The second condenser will represent the best class of commercial practice, the tubes being 70-30 mixture and the plates of yellow metal. The exact equipment of the other two condensers had not been decided upon at the time of the committee's progress report, but they will be compositions representative of commercial practice. The results obtained from careful experiments carried out in this way should be of the utmost value as it should be possible to practically duplicate service conditions and at the same time to control the various conflicting conditions in such a way as to arrive at definite well-founded conclusions."

Electric Vulcanizer for Automobile Tires

J. C. MUNN

An electrically-heated vulcanizer for either the inner tube or the casing of automobile or motorcycle tires has been recently placed on the market. The vulcanizer consists of an electrically heated vulcanizing clamp for holding the tire in position and a small rheostat for regulating the amount of current. Tire repairs can be made in the minimum of time and with very little expense. The work can be done by anyone and there is no danger of injuring the tire.

HOME-MADE ELECTRIC CHANDELIER

A. C. GOUGH, M.E.

The massive brass fixtures, finished in various effects, harmonize splendidly with the other furnishings of the popular arts crafts room. The more delicate and intricate designs of fixtures lending themselves better to the room furnished with Colonial, Louis XIV and Rococo designs of furniture. Perhaps, the modern, plain massive brass fixture is the most acceptable of all for the arts crafts room; but designs in wood offer

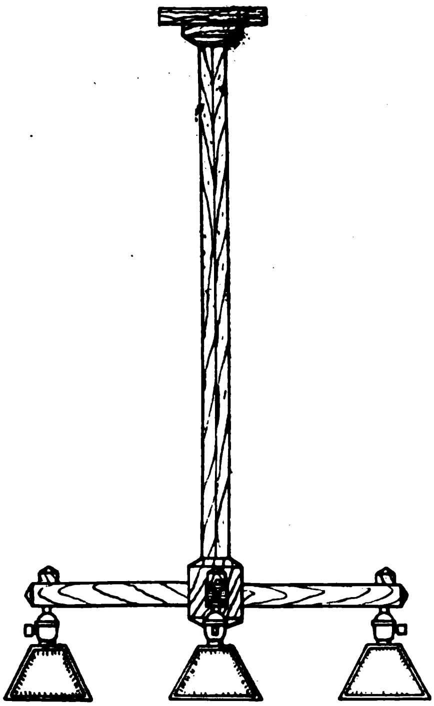


FIG. 1

possibilities, in appearance as well as in the low cost of making, for those who wish to make their own fixtures.

Where the boards, casings, moldings, etc., of a room are finished in oak or dark wood, the wood chandelier may be finished to match. Or when a room is finished in white, the fixture may be coated with a white enamel. Another effect which lends itself to the largest variety of color schemes is, to first gild the fixture, then (after it is dry) wipe it with burnt umber. This may be easily done in a way that will produce an effect of age which is really artistic and lasting.

That the possibilities of designs in wood have not been sought is probably due to the fact that underwriters do not favor conduits constructed of wood. However, with a building constructed of wood, it might seem rather difficult to wire it without passing the wires through the wooden walls, etc. In this case, the underwriters require that the already heavily insulated wires have an independent casing of circular loom or porcelain supported within the hole through which the wire passes. While it is not nearly so important that the chandelier be wired with such precaution for safety, but that the wiring may not be questioned by the insurance companies, circular loom of good size and strength may be used to cover the wires throughout. If good size rubber-covered or weather-proof wire is used it is not at all necessary; but it may be most desirable to use independent pieces of circular loom upon each of the branch wires which extend to the sockets, with two larger pieces of circular loom within the vertical part, each containing the wire, or wires, forming one side of the circuit. However, with rubber-covered or weather-proofed wire, it is more than safe to use one piece of circular loom for the branches with a large piece of circular loom covering the wires through the vertical part.

The following tables give the values of currents allowed by underwriters in wires of various sizes:

	TABLE 1 *Rubber-covered Wires*	TABLE 2 *Weather-proofed Wires*
B.&S. Gauge	Amperes	Amperes
No. 18	3	5
No. 16	6	8
No. 14	12	16
No. 12	17	23
No. 10	24	32

A large incandescent lamp does not usually require more than 1 ampere; so No. 18 or No. 16 wire would have a current-carrying capacity much larger than necessary; except when electric heaters are to be used upon the circuit much larger wires should be used, say No. 12 or No. 10.

If the mechanic understands joining the wire electrically as well as mechani-

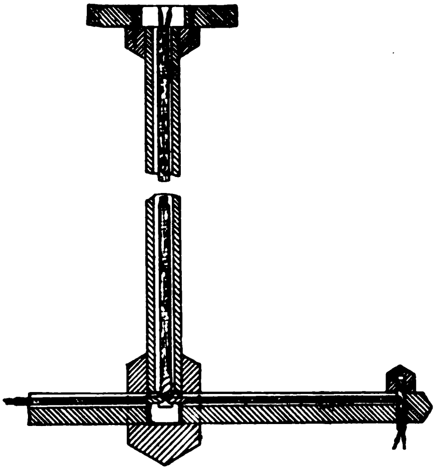


FIG. 2

cally, No. 18 wire may be used in the branches, one side of each branch all being joined to No. 14 wire which extends up through the vertical part. If the mechanic is not familiar with this method, it would, perhaps, be better to let the small wires extend up the entire length, making one side of the circuit so that the number of wires may be properly divided and secured at the terminal of the rosette.

A space at the top of the fixture, as indicated in Fig. 2, may be provided large enough that it will not be necessary to remove the base of the rosette, the wires being secured by the screws under which the feed wires are secured.

The central vertical part of the fixture may be constructed of two pieces glued together. These pieces should be grooved, or slotted, so that when they are secured together there will be a hollow space throughout not less than 1 in. square. The outside dimensions of this part should be 2 in. square or more. The branch arms may be 1¾ in. square or more, with blind slots to receive the wire, as indicated in Fig. 2.

The ⅛ in. pipe nipple, upon which the sockets are to be screwed, should have a drive fit, and a little glue may be used to set the nipple more firmly. As indicated in Fig. 2, the ⅛ in. pipe nipple should have a hole or slot, to receive the wire.

The designs for a chandelier of this kind are unlimited in number; but the design shown, Figs. 1 and 2, possess the advantage that it is as easily wired and assembled as the standard brass fixture.

It is believed the mechanic may find it desirable to make chandeliers of this kind for his own home; and, by looking up the matter of wiring electric fixtures, that he may add a profitable side line.

Making up a Small Gold Solution

Making up a small gold solution is usually a difficult job for the plater who has no equipment for it, says *The Brass World*. He finds it taxes his patience to "cut" the gold and make it into chloride or cyanide. It frequently happens, if the gold has not been properly dissolved in the aqua regia, that the chloride of gold contains too much acid and then the solution made with cyanide and the chloride is not satisfactory. Taking everything into consideration, the production of a gold-plating solution, although it is a simple matter theoretically, is not as attractive as it would appear.

The porous cup method of making a gold solution is the best method known, and it is to be recommended. The gold does not require "cutting" with acid, but is simply placed in the cyanide solution in the jar or stone crock, a piece of carbon placed in the porous cup and the current started. The gold dissolves in the solution, but does not pass through the porous cup.

The gold, therefore, requires no "cutting" or dissolving in acid and the process of making the solution is very simple. In addition, carat golds can be used, if desired, and any desired alloy may be employed by simply using it instead of the fine gold.

This method of making up a gold solution is so simple that the most inexperienced person can use it, and it is to be recommended, particularly when small solutions are to be used, as they generally are for the majority of gold-plating done.

The short ends of arc lamp carbons, says a contemporary, may be joined together and utilized again. They should be cut square, and the ends should be coated with a cement formed of a mixture to a pasty consistency of potassium silicate and carbon dust, and then pressed together by hand. Carbon rods made in this way of a number of pieces are said to burn well on continuous or alternating current, and to be no more brittle than ordinary carbons.

INTERESTING STORY OF PLATINUM

In view of the present-day use of platinum, our readers will be interested in the following story of this remarkable metal reprinted from *Cres-Arrow*, published by Whiteside & Blank, Newark, N.J.:

When we call platinum a new metal we have in mind the antiquity of gold and silver, and the fact that platinum was unknown to the world until 1735, when La Torre, a Spaniard and member of a French scientific expedition returning from Peru, announced its discovery. It was not until 1750, however, that William Watson, the English physicist, described it as a new metal.

Owing to its rarity and little known properties more than half a century elapsed before it was recognized as a native mineral.

In 1819 it was discovered in the gold washings of Verkhniy-Isetsk, in the Ural mountains.

The Russian government, quick to note its character, coined three-ruble pieces of platinum. Today the intrinsic value of the metal in these unique pieces is six times what it was when they dropped from the mint.

ORIGIN OF NAME

Through La Torre's discovery the Spaniards are responsible for the name platinum—platina, its older and equally correct form, being a diminutive of the Spanish word "plata," which means silver.

South Americans called it Platina del Pinto, and it luckily avoided the awkward title "frog gold," or "Mas Kodak," as the natives of Borneo called it in their picturesque language. Among English-speaking miners it bears the common name "white gold."

Because of its being found always in company with a number of other metals, iridium, osmium, ruthenium, rhodium, palladium, and gold, the Greek name "Polyxene," meaning "guest of many," was applied to it by the English Hausman, but this title was too scholarly to stick.

Something less than 5,000,000 ounces of platinum have come to light in the world's history, about 1 per cent. of the gold produced in the same time, and of this about 90 per cent. has come from the northern portion of the Goot of Perm, a district situated in the Ural mountains of Russia.

The land forming the comparatively small area of production is owned by a few of the nobility, who farm it out to peasants for mining purposes, but wisely control its output.

Of what is mined outside of Russia, South America produces about half, and Canada and Australia the bulk of the remainder. Our own United States is credited with less than 400 ounces per year, and this is quite a secondary product of the gold washings of Colorado and California.

OBTAINED BY PLACER MINING

Platinum is always found loose in shallow drift or alluvial deposits, in the form of sandy flakes or small nuggets, and is therefore always obtained by the methods of placer mining. This product of the placer miner, technically known as crude platinum, runs 75 to 85 per cent., and contains sand and metals, which on account of their weight, cannot be separated by this process. A ton of platinum sand yields from a few pennyweights to as much as an ounce and a half of the pure metal.

In the districts of greatest production, Nizhne-Tagilsk and Goroblagodatsk, in the Urals, the deposits contain many pebbles of serpentine, which is believed to have formed the original matrix, since disintegrated.

This platinum dust as received by the refiners is treated by various chemical processes to separate the platinum from the iron or black sand and from the gold, osmium, iridium and other metals present. It is then melted in an oxyhydrogen or electric furnace, which must be capable of generating over 3,600 degrees of heat, Fahrenheit.

After melting, it is poured into ingots of suitable weight. These are subjected while at white heat to great pressure to solidify their particles and are then rolled into plate or drawn into wire.

PLATINUM PROPERLY ALLOYED

Though pure platinum is one of the softest metals, when properly alloyed it becomes one of the hardest.

All the high qualities of platinum are annulled in combining it with inferior metals. Therefore, iridium, its royal native brother, whose hardness is excessive and whose rarity and value far exceed those of platinum itself, becomes its only appropriate alloy.

It is a rare stroke of fortune both to science and to the arts that the greater the percentage of iridium, the greater the durability and value of the metal. The addition of 10 per cent. iridium makes platinum harder than 14-carat gold, and 20 per cent. added to it makes it so hard that it will practically defy wear forever.

Probably no metal has experienced more fluctuation in value than platinum. In 1874 it was worth $6 or $7 per ounce. In 1898 it had increased to between $10 and $20. In 1907 its price averaged $35. Though it fell to less than $30 in 1908, probably through lack of commercial demand, it has risen steadily since then and has now reached the highest point in its history, being quoted at $46 per ounce. $50 per ounce is the present-day value of iridio-platinum suitable for jewelry making.

VALUE WILL INCREASE

The limited distribution of platinum and the steady increase in its demand during a long term of years give us every assurance that its value will never depreciate.

As art and science come more and more to recognize its marvelous virtues, the price of platinum is likely to soar beyond any height we now imagine.

The splendid character of platinum may best be expressed by those rare physical qualities which not only surpass the properties of all other commercial metals, but place it regally in a class by itself.

First, it has a greater specific gravity than any other known substance, excepting only iridium and osmium, with which it is always found and to which it has the strongest mineralogical alliance.

Secondly, its melting point is far higher than that of any metal known in the

Finally, when combined with its natural alloy, iridium, it possesses a hardness that approaches the absolute.

STANDARD FOR WEIGHTS AND MEASURES

The greatest evidence of its superlative worth is that the nations, seeking a medium that would maintain its character forever, chose platinum from which to make the standards of the weights and measures of the civilized world.

Platinum of standard hardness weighs 58.5 per cent. more than 14-carat gold. And while the gold costs but 64 cents per pennyweight, the platinum has a value of $2.50. As a concrete illustration of the difference in values of the two metals, a gold jewel weighing ten pennyweights would be worth $6.40. If duplicated in platinum it would require fifteen pennyweights twenty grains, and would have a value of $39.58.

For obvious reasons the cost of working platinum is far greater than that of working gold. However, the proportion of cost in relation to the value of the metal is so much less that the finished jewel will possess a far greater percentage of metal value than if made in gold.

The creator of art jewelry, therefore, whose science and skill have subjugated the stubbornly resisting metal, and whose pride is justified by his desire to perpetuate his craftsmanship, is given the privilege of using for his art this ideal medium.

The jeweler prizes every quality it possesses: its hardness, its permanence, its neutral and harmonious color, its capacity for taking a brilliant finish, its intrinsic value and its very rarity. It is costlier and more beautiful than gold and has the essential charm of fitting its purpose exquisitely.—*Keystone.*

Precautions to Observe when Heating Test-tubes

Never have outside of tube wet. Start

DRILLING THROUGH LATHE MANDRELS

OWEN LINLEY

It is always an advantage to have a hollow mandrel, and even in those cases where a hardened center prevents your taking the hole right through, it is a good compromise to make the hole as deep as possible. In fact, if you take the drill down the mandrel until you begin to feel the hardened center you will have a hole which will be deep enough for many purposes. If the mandrel is of such kind that it is possible to drill a hole right through it, and you decide to do so, it is best, if possible, to drill the hole and that of a hole that is not started true radiate like the adjacent spokes of a wheel.

I have drilled the mandrels of several lathes (after they have been made), and have come across a point that would rather give trouble to an amateur. In lathes where the center is carried in the nose, the extreme end of the hole is what is left by the turner when he drills it to make way for the boring-tool, and it often runs out. If it does so, the drill follows it, and it is difficult to prevent it.

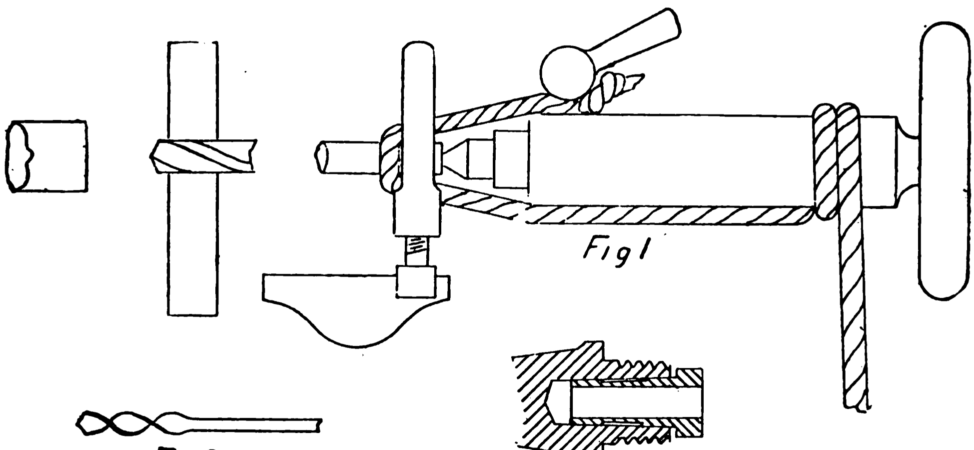


Fig 1

Fig 3

Fig 2

half-way from each end, as it much reduces the time and the trouble caused by the drill running out, as this is sometimes serious if you get the drill started badly. If the mandrel-head is of such type that you can reverse it on the bed, you can do it in its place; or if you have another lathe at your command, you can run the mandrel in that, holding one end in the chuck and the other in an extemporised stay made of hard wood, and bolted to the lathe-bed. Of course, when you drill the back half, and hold the nose of the mandrel in the chuck of the other, you must protect the thread by screwing a chuck or nut on it. In cases where you have to drill entirely from one end, it is most important that the drill should start perfectly true, for if it does not, the chances are that it will go from bad to worse, for the axis of the mandrel

You may do this to some extent by clamping the drill in the tool-holder, setting it opposite the center, which you then remove; but, even then, as the drill has to project some distance from the tool-holder, it has very little rigidity. You may remedy this, to some extent, by having the drill very sharp, running the lathe fast, and setting in very lightly until the drill has cut a true start for itself. If this cannot be managed, the best way is to make a bush to go in the center hole, to act as a guide for the drill. This is easily made, and this is, perhaps, the best way for an amateur to go about this, for although you may start a drill true, it will sometimes begin to run out after it has got about a quarter of an inch or so down the hole, and then it is almost impossible to get it right.

Take a piece of mild steel, a little

longer than the center hole, so as to have something to take hold of to withdraw it by. Hold it in the chuck, and drill it up and bore it to fit the drill you are going to use. Say, for example, it is a three-eighth drill. If you put the drill through the solid metal it will cut too large to make a good guide, so if you have a three-eighth bit, it is best to finish the hole with that. If you have not, I will explain how you can make a twist-drill bore a hole its exact size, and this knowledge is useful for other occasions, and for drilling brass. Put a five-sixteenth drill through the bush, and then follow it with the three-eighth. If you do this in the ordinary, it will hook itself into the hole, and jump off the poppet center, but the following simple contrivance will prevent it. Take a piece of cord (ordinary clothes-line will do), tie one end round the body of the poppet, or make a loop, and slip it over the binder nut (see Fig. 1), take the cord under the tail of the carrier, over the drill, under the body of the carrier, and back to the end of poppet-head, and take two turns round it. Now a slight tension on the free end of the cord will prevent the drill hooking it. You must see that the proper tension is on the cord before the drill touches the hole, otherwise it will hook in just the same.

The right way to start the affair is thus: Draw the poppet cylinder back as far as it will go, put the drill against the center, and clamp the head so that the point of the drill is half an inch off the mouth of the hole. Cut a piece of wood with a notch or vee in it for the drill to rest in, so that its point is about opposite the center of the hole. You can have several vees in this piece of wood to take drills of different diameters. Take the drill in the left hand, and having taken the cord round it, and the carrier, as I have described, put the counter-sink at the end on the center of the poppet. Take the cord in the right hand, and by its means pull the and by the time the point of the drill reaches the mouth of the hole, the cord will be in a strong state of tension, and will prevent the drill hooking in.

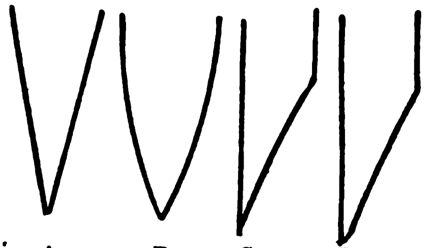
I have used this arrangement for many years, on all sorts of work, large and small, and it is really as efficient as a chuck on the poppet cylinder, and costs nothing. It is also useful for solid holes, especially with new drills, or in brass, as it stops the danger of the drill's bursting through and jumping off the center. Only a slight pull is needed on the end of the cord, on account of the friction of the turns round the barrel, and you let these slip gradually as you set the drill in. If the two lips of the drill are ground alike, it should now make a hole that it does not shake about in. Having got the bush bored, put it on an arbor and turn it to fit the cone in the end of the mandrel. This operation is made much easier if you turn a recess in the middle, as shown in Fig. 2. If you do not use much force in fitting this, and do not drive it in hard, there is no danger of injuring the cone. This bush will not only start the drill true, but will steady it for some way down the hole. Fig. 2 shows a section of the bush in its place. This bush had better be removed after the drill has entered the mandrel about an inch and a half, for it has no effect in steadying the drill after that distance, and gets in the way of removing the chips. Speaking of removing chips, I have always used a spiral scraper made of a piece of wire flattened and twisted, as Fig. 3. To use it, let the lathe run, push it up to the end of the hole, and then withdraw it, keeping it pressed against one side of the hole, and it will draw out chips faster than a hook.

I have also made a practice of twisting the long drill that you have to make to take the hole beyond the twist-drill. This is easily done when they are hot, and it is best to make the end much like the end of the twist-drill proper, as a flat drill cuts mild steel very slowly. I

SHARPENING EDGE TOOLS

W. D. GRAVES

The essential feature of a good cutting edge is that its two sides shall form a sharply defined acute angle, which can only be attained by having both sides straight as shown, much magnified, as *A* in the drawing, rather than curved, as shown at *B*. Where the novice usually fails in whetting an edge tool is in giving it a rocking motion, producing the rounded edge; and the principal element of skill in the operation lies in holding the blade and the stone at the same relative angle throughout. There are some apparent exceptions to this rule, as the common ax; but they are only apparent, not real. An ax used for chopping is better ground with the sides smoothly curved, but the sides of the extreme edge, if it is a good edge, must be straight. Of course, these straight sides may be very short, only as long as they are made by the final "setting," or whetting, of the edge, but they are there.



Various Forms of Cutting Edges

The proper "thickness" of the edge, *i.e.*, the degree of acuteness of the angle formed by the two sides, depends wholly upon the nature of the tool and the work it is intended to perform. A "thin" edge will, of course, cut more easily, but it will also break and become dulled more quickly; so the proper angle must be determined, by observation and experiment, for each tool and purpose. The conservative beginner will aim to err in the way of making the edge too thick; then as he finds it amply strong to do the work without breaking or nicking he will make it a little thinner, and so proceed till he learns the most effective and economical angle. An edge which would be sufficiently enduring on soft pine would become almost immediately blunted on lignum vitae; while, for use on any given wood, differently tempered tools require sharpening at different angles in order to give the best results.

As most wood-cutting tools are sharpened like a chisel, this form of edge may perhaps best be used in illustrating the method of sharpening all. If the tool is very dull the work of sharpening is expedited by first grinding it on a stone or wheel of a grit too coarse to make the final cutting edge; taking care to have it symmetrical and either straight or of the curve of the grinding wheel, as shown at *C*. This method of making the sides inwardly curved—or "hollow grinding"—which is carried to its extreme in razors, lessens the work of whetting, but tends to make the edge weak and incapable of withstanding hard usage.

On the grindstone or abrasive wheel the tool is brought to an edge somewhat more acute than is desired for the finished one; but, owing to the coarseness of the abrasive used, it is too rough for keen cutting. The final edge is "set" by rubbing with or on a flat finishing stone of finer grit, making a new and sharply defined bevel as shown, magnified, at *D*.

All cutting edges are somewhat serrated, some being finished on a stone so coarse that the serrations may be seen with the naked eye, as that of the common scythe. Such edges are made to cut by a sliding action, like a saw; and, for that matter, even a razor will cut much more readily if given a slight endwise motion.—*Scientific American*.

Drilling through Lathe Mandrels

(*Continued from page* 326)

then the hole is often a great convenience. I have drilled as far down the mandrel as possible, until I have felt the drill touch the hard steel plug that is forged into the end for the countersink.—*English Mechanic and World of Science*.

Capt. Hayden, commandant of the Key West, Florida, naval station, has received a letter from Cairo, Egypt, stating that the Lloyds wireless operators in that city had on numerous occasions copied messages sent from the Key West station. The distance is more than 7,000 statute miles, or more than 500 miles further than a former world's record.

EDITORIAL

We take pleasure in announcing that the first prize offered some months ago for the best practical constructive article, of a mechanical or electrical nature, has been awarded to Mr. P. Mertz, whose article, entitled "A Practical Section Liner," is published in this issue. Mr. Mertz' article excellently describes the construction of a useful tool, and his drawings, evidently made with the aid of the article described, show careful handiwork and a thorough knowledge of the subject. Several other articles were submitted in the competition, and it is probable that we shall use some of them in future numbers, in which case they will be paid for at our regular space rate.

We believe that competitions of this kind are of value to both those who take part in them and to other readers of the magazine, and we are especially desirous of developing the descriptive faculties of our subscribers. We will continue, therefore, this series of contests, and will award another prize of Ten Dollars for the best practical article on any mechanical or electrical subject submitted to us before July 1, 1913. The length of the article is immaterial, provided that the subject matter is carefully considered and sufficiently describes the points in question. We prefer illustrated articles, and neatness and finish of drawings will be considered in making the award.

We regret to be obliged to omit from this number the continuation of the excellent series of articles on Mechanical Drawing, by Mr. P. LeRoy Flansburg, whose illness has prevented the completion of his installment in time for

in Mr. Marconi's usual lucid manner. The other, of vital interest to all who are commercially interested in wireless telegraphy, is the latest publication of the United States Government on the subject of wireless telegraphy, and gives the rules for forwarding radiograms from ship to shore through naval stations. It also gives a very valuable list of abbreviations which are to be used after July, 1913, by ships of all nations in sending from one to another, and which are expected to be used immediately by all American ships, in order to save time and diminish the length of messages sent through the ether. Doubtless a knowledge of the information in this communication will be required for the passing of examinations for licenses hereafter, and we recommend its earnest and careful study by every operator.

The task of the Editor in deciding what his readers will find most helpful is not always the easiest of matters, and he is always grateful for information as to what will be most useful and valuable to his clientele. We have in prospect for future numbers many interesting articles but we would appreciate information from readers as to any subjects which would be especially helpful to them, and will make every effort to provide in an early number suitable material on any such subjects which may be suggested to us which seems likely to be of general interest.

New Wireless Records

The United States scout cruiser *Salem* left Gibraltar March 11 on her return trip

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.

1988. **Small Wireless Set.** M. C. K., Philadelphia, Pa., asks: Please publish in your magazine the directions of how to make a small wireless outfit, including the transmitting and receiving sets. Ans.—Nearly every number of the *Electrician and Mechanic* contains the directions for the construction of some instrument used in the transmitting or receiving sets of a wireless telegraph station. By referring to the back numbers you will obtain sufficient instructions to enable you to build a complete outfit. The directions of how to build a small set would interest but such a small number of our readers that it would not be worth while to take the space for such an article. We can furnish you with elementary books on this subject if you desire.

1989. **Dynamo Construction.** L. N., New York City, asks: I am using the armature and field pieces of a magneto to construct a dynamo. Instead of the permanent magnets of the magneto, I am using flat iron ¾ x ¼ in., to be wound and placed in position as in the accompanying drawing. What size wire and how many turns should I use for winding the armature and field magnet (the armature being the ordinary magneto kind, two sections for winding) to generate enough current to light a 6-volt Mazda lamp, 2 c.p. For a 8-volt Mazda lamp. How many revolutions a minute will the armature turn to generate this current? As this construction is for a special apparatus, no part can be changed but the windings. Ans.—In the ordinary magneto generator the spring of the permanent magnets is utilized to hold the cast-iron pole pieces against the armature bearings. With your proposed electromagnet you would have to incorporate the same idea, being careful not to use iron screws extending from pole to pole, else there will be improper paths for the magnetism. The section you propose for the electro magnet is too smal; the iron should be as wide as the vertical flat face of the poles, surely 1½ or 1¾ in., and it should be ½ in. thick. Let the

1990. ... market yet? Ans.—(1) Nothing further has been reported in regard to this simple form of turbine. From the fact that the manufacturers of the ordinary forms of turbines are making no changes in their designs would seem to indicate that there were positive defects in the practical working of the new form. (2) Gas turbines do not yet seem practical, the reason appearing to be the lack of materials that will withstand the high-working temperature.

1991. **Wireless Wave-Length.** E. S., Deer Lodge, Mont., says: I wish to know how the wave-length of a wireless station can be calculated, or I would be very much obliged to you if you will calculate it for me. My aerial is about 25 ft. above my instruments and they are 20 ft. above the ground. My loose coupler has 145 turns and 16 in. to a turn on the primary. The secondary has about 200 ft. of wire. My aerial is composed of 4 wires, 50 ft. long. Ans.—The wave-length of a wireless set is equal to 1885 $\sqrt{LC}$ meters, where L is the inductance in microhenries and C is the capacity in microfarads. Thus, in order to obtain a wave-length it is necessary to measure both of these quantities. As this is troublesome, the wave-length is determined for commercial purposes by a standard receiving set, or, as it is called, a wave-meter, which is calibrated to give the result directly. Your wave-length would vary with the amount of inductance or turns of wire you were using when tuning to a station. With your set it would probably vary from a minimum 150 meters to a maximum of 1,000 meters.

1992. **Wireless Calls.** C. W V., Yoakum, Tex., asks: (1) What is the call letters of the new station at Arlington, Va.? (2) What wave-length does it operate on? (3) Where are the following stations located: XCP, XCZ, KKA, and RS government station? (4) What wave-length does NAR operate on? Ans.—(1) NAA. (2) 3,800 meters. (3) KKA is the S.S. *Antilles* with New York as her home port know what size wire to use and how many turns to each coil. Starting coils will be wound in bottom half of slots 1 and 4, 5 and 8, 9 and 12, 13 and 16, then a running coil to fill slots 4 and 5, spreading into 3 and 6, 8 and 9 with 7 and 10, 12 and 13 with 11 and 14, 16 and 1 with 15 and 2. Is this correct, and will an impedance be needed in the starting coil circuit? My current is 110 volts, single phase, 60 cycles. Ans.—The diagram of winding for a small fan motor which you have sent for inspection seems entirely correct, and the result should be a finely working machine. We suppose you will have slots cut in the rotor so as to open the iron directly over the rods. In the design of a fan motor you must recognize that considerable heat is inevitable, and part of the work of the breeze is to keep the motor cool. If you run the motor without the fan, the heat is likely to be serious. Let the starting coils be wound with No. 20 wire, all you can get in the slots, and No. 23 for the running coils. Then instead of putting reactance in the starting circuit, put resistance only, say composed of a zigzag arrangement of bare German silver wire. The size can be No. 20, but the right length can be found from experiment only. This will reduce the lag in the temporary circuit, which, for the case at hand, should be more effective than interposing additional lag. Let us hear the result of your labors.

1994. **Babbitting.** H. E. D., North Haven, Conn., says: Have you a book on Babbitting? This is something I do not understand, in fact, never saw it done, but have done nearly everything else in the mechanical line, yes, and considerable in the electrical line. Well, I have an old Pope-Hartford transmission, in which the bronze boxes are worn very bad, and I am going to overhaul it as soon as I get through with the machine I am working on now. I am thinking of running Babbitt in these boxes. Would you advise it? Other mechanics advised trying it. As I have said before, I have had no experience at this job. I should like a book on the subject before I tackle it, and if you have not any, could you advise me where I could obtain one? Ans.—Babbitting is easily done by anyone who is willing to make reasonable preparations. If a bearing is so worn that the shaft is a poor fit, you cannot merely run some of the melted mixture into the crevice; considerable space must be prepared for it. Remove the bearing from its place, and in a lathe bore out the stock so that a thickness of Babbitt of about ⅛ in. will be provided. Chamber the place rather than bore it out straight through, thereby leaving thin lips at the ends for holding the shaft in its right place and for preventing the melted metal from running out. If an oil hole is already provided, this may be used for pouring in the Babbitt, but possibly the hole should be enlarged, say to ⅜ in. in diameter. Hold the shaft to which a fit is to be made in a gas flame so as to get it evenly covered with smoke. If this is impracticable, merely oil the shaft. Either precaution will prevent the shaft from surface of metal is smooth and final shaft is a proper fit. If you have a good equipment of tools, you may use an arbor that is a trifle small, and then ream out the hole to final size. Use a good quality of Babbitt—costing not less than 55 cents per pound. You will get a lot of helpful information as to the procedure by visiting the repair shops of a street railway company.

1995. **Rotary Engine.** R. C., Garliestown, Scotland, says: I was wondering if any rotary engines have been constructed on the enclosed principle. I think an engine to the enclosed sketch might look economically, but I thought from the name of your book *Electrician and Mechanic* you would be able to know how it would look. Ans.—This form is about the very earliest of rotary engines, and has been used by many experimenters. Also, instead of serving as an engine, it has been largely employed as a blower, notably on the famous Thomson-Houston arc lighting dynamos, for blowing out the sparks at the commutator. The defects of the construction lie in the experience that the radially moving blades have a great deal of friction, and soon leak, and also that the thing is intolerably noisy.

1996. **Oscillation Transformer.** R. A. F., Malden, Mass., says: (1) The wireless inspector of this district has advised me to use an oscillation transformer instead of a helix. What are the specifications of one to use with a 3 in. coil? (2) What size condenser should I use? (3) Has a Leyden jar condenser any advantage over the plate type, and if so, why? Ans.—(1) Make the oscillation transformer of the pancake type. Use ¾ in. copper ribbon for the winding on hard rubber or shellacked wooden frames. The primary should contain three turns spaced ½ in. with the maximum 12 in. in diameter. The secondary should contain eight turns spaced ½ in. with the maximum 12 in. in diameter. (2) About .005 mf. Use larger if the coil will charge it. (3) Not for use in wireless work.

1997. **Spark Coil.** J. A. S., Kansas City, Mo., says: (1) Which would be preferable as to best spark or best service for wireless, the two spark balls or two halves of a spark ball flat sides facing from the points of sending rods? (2) Can you tell me the length of a spark that can be obtained from a Splitdorf auto coil, which is supposed to give 1,500 volts from a 6-volt 80-ampere-hour storage battery? (3) Can you connect two in series and get twice as big a spark? Ans.—(1) The two spark balls. (2) About 1-16 in. (3) Yes, but you are quite liable to puncture the insulation. Connect the secondaries in multiple and the primaries in series.

1998. **Tuning a Transmitting Set.** K. R., Toronto, Can., says: I have a ½ kw. Clapp-Eastham rotary spark quenched gap set, consisting of edgewise wound oscillation transformer, as described by Stanley Curtis in your November number, condenser of three units magnetic leakage transformer and rotary quenched gap. (1) How would one increase or decrease the have to be changed? (3) How would one tune this set for a wave-length of approximately, say, 500 meters with a hot wire and a wavemeter? The aerial is 190 ft. long and 75 ft. high above ground and instruments. (4) Could this be done without a wavemeter? Ans.—(1) Within moderate ranges you would vary the wave-length by varying the inductance of the oscillation transformer. (2) In order to obtain satisfactory results it is necessary that both the primary and secondary oscillation circuits be tuned to the same wave-length. Therefore, if you desire to alter your wave-length it will be necessary to change the inductance on both the primary and the secondary of the oscillation transformer. (3) To tune the set for a wave-length of about 500 meters, use the three sections of the condenser and vary the inductance of the primary of the oscillation transformer until a reading of about 500 meters is obtained on the wavemeter when a spark is passed in the primary oscillation circuit of the transmitter. While the reading is being made, the secondary circuit should be disconnected. When the desired value is obtained in the primary circuit, inductively couple to it the secondary circuit and vary the secondary inductance until a maximum reading is obtained on the hot-wire ammeter. (4) Not for any definite wave-length. If the primary oscillation circuit is tuned at random, the secondary circuit will be in tune when the maximum reading is obtained on the hot-wire ammeter placed in series with the antenna.

1999. **One-half Inch Spark Coil.** H. F. L., Columbus, Ga., says: (1) I wish you would kindly give me a plan for the constructing of a spark coil so as to produce a ½ in. spark. (2) Please state the kind of material and the quantity required for the construction. (3) Also tell the kind and the sufficient amount of current to operate this spark coil, whether battery or other current. I prefer both or battery. Ans.—(1) Philip Edelman in his book on "Experimental Wireless Stations" has some very interesting data on the subject of the construction of small spark coils. If you cannot obtain this book from your local library, we can furnish it for $2.00 postpaid. You can use any form of direct current from batteries or other source. Rectified alternating currrent would also come under this head.

2000. **Radio License.** L. R., New Durham, N.H., asks: (1) About how far should a 1 kw. transformer rotary spark gap, oil condenser, oscillation transformer and aerial 85 ft. high transmit at night over land, using 200 meters wave-length? I understand that the low wave-length cuts down the range. (2) I shall soon have two poles about 90 ft. high and can place them most any distance apart up to 150 ft. What type of aerial would you advise to give a long receiving wave-length and a sending wave-length below 200 meters? I understand that a condenser in series with the aerial will reduce the sending wave-length and also greatly reduce the range, and that when a duplex aerial is used the larger aerial absorbs most of the waves sent out, but I do not know which is best. One of my poles is almost directly above my apparatus which is on the second floor and the ground wire is 10 ft. long. (3) I am 15 miles from the state boundary and 30 miles from NAC, the nearest station. Could I get a special license to use a very long wave-length, and if so, how could I get such a wave-length? I want to talk with a fellow 30 miles away, and am afraid I cannot do so with the sort wave-length. Ans.—(1) If well tuned, you should be able to work from 25 to 50 miles, but local conditions cause such variations that we cannot give any definite data on the subject. (2) It would be better to use one pole with vertical antenna, which could be used both for transmitting and receiving. (3) It is very doubtful if the Radio Inspector would grant you a special license, unless you held a first-grade commercial license and could give a good reason for needing the longer wave.

2001. **Rays.** A. T., Brooklyn, N.Y., asks: (1) Where can I buy the best instruction books about X-rays Excells, medical coils, etc., so that I may obtain a thorough understanding of them? (2) What effect will ozone and X-rays have over human body? (3) Where is the largest electro medical instrument manufacturing company situated in New York City? Ans.—(1) We can furnish you with the following books at prices quoted: "Practical X-ray Work," by F. T. Adderman, $4.00; "Rarography and the X-rays," by S. R. Bottone, $1.10; "Something about X-rays for Everybody," by E. T. Bubier, 50 cents; "ABC of the X-rays," by W. H. Meadowcroft, 75 cents; "Röntgen Rays and Phenomena of the Anode and Cathode," by E. P. Thompson, $1.00; "Light Visible and Invisible," by S. P. Thompson, $2.00; "Medical Electricity and Röntgen Rays," by S. Tousey, $7.00; "Induction Coil in Practical Work, including the Röntgen X-rays," by L. Wright, $1.25; "X-rays Simply Explained," by L. Wright, 25 cents. (2) X-rays in themselves do not appear to have any affect on the body, although the burns resulting from the high-frequency apparatus used in their production are quite serious. Ozone, chemically known as O3, is a condensed form of oxygen, and breaks down readily in contact with moist substances. In doing so, it liberates nascent oxygen and furnishes a powerful oxidizing agent. Introduced into the lungs it therefore stimulates the circulation and other activities by reason of the increased amount of oxygen furnished the blood. Ozone also acts as a disinfectant and deodorizer. (3) We should advise your consulting the Business Directory of New York City, which is no doubt accessible to you.

2002. **Motor Winding.** W. McN., Albany, N.Y., says: Tell me the amount of wire and the size and how to wind for the armature and field of a Kester bi-polar, 1 h.p. motor, to be used on 30 volts direct current; also tell me where I can purchase Watson's book on storage batteries; also tell me the price of this publication. Ans.—The "Kester" is a design adapted for small sizes only, and you will find better proportions for a 1 h.p. size in various publications. Watson's design, described in "How to Make a 1 H.P. Dynamo," though involving a heavy machine, provides one that can be built with a minimum of tools and labor. We will be glad to suggest the proportions and windings of any other design, without further charge, if you can give us an idea as to the facilities at your disposal for building and running the dynamo. Perhaps you have underestimated the current input to develop the proposed power. 1 h.p. means a useful effect of 746 watts of electrical energy, but since there are unavoidable losses even in the best of machines, you will have to put in a greater amount than this, and for a machine of the size under consideration, 1,000 watts input would not be unusual. At 30 volts, this would mean 34 amperes. We wonder what source of current you have. To handle such an amount at the commutator would require a larger construction than is usual. You would be better off to adopt 110 volts, whereby 9 amperes would be sufficient, and require commutator and brushes of smaller dimensions, or permit use of carbon rather than copper brushes. The 30-volt machine would certainly require copper brushes, and these cause much more wear and attention than those of the other sort. Perhaps Watson's ½ h.p. machine would fill your needs. It is a fine looking and running dynamo, but is less easy to build. 15 to 20 lbs. of wire will be required for the two sizes. We can supply the book on Storage Batteries.

2003. **Wall Paper Paste.** C. E. C., Fairfield, Conn., asks: (1) What are the best paying positions outside of the Government and the salary? (2) How to make a good paste for wall paper. Ans.—(1) There seems to be no limit to the amount of salary a man can attain to in the United States, provided he has the necessary qualifications. Employers are always looking for those to whom they can pay higher salaries provided they can get more efficiency in the work. There is no field wherein high salaries cannot be attained by those who are able to deliver the goods. (2) Boiled flour paste is usually used for paper. Use a cheap grade of rye or wheat flour, mix thoroughly with cold water to about the consistency of dough, or a little thinner, being careful to remove all lumps; stir in a tablespoon of powdered alum to a quart of flour, then pour in boiling water, stirring rapidly until the flour is thoroughly cooked. Let this cool before using, and thin with cold water.

2004. **Protective Device.** H. S., Chicago, Ill., asks: (1) Will you kindly tell me how to construct a "protective device" suitable for a 1 k.w. flexible step-up transformer; that is, an instrument to prevent "kick-backs"? (2) What is my wave-length? I have an aerial 35 ft. high, 95 ft. long and six strands. Ans.—(1) A very satisfactory protective device consists of connecting two 1 m.f. telephone condensers in series across the line supplying the transformer. The common terminal of the condensers should be grounded with a wire at least as large as the line wire. A small spark gap set at about 1-32 in. should be connected

"head" was not involved. Ans.—There are errors in the answer to which reference is made, both typographical and in statement, and we are glad to rectify them. The formula reads, $H.P. \frac{Qh}{650}$, but explicitly states that this makes allowance for the loss in the wheel, whereas your note seems to indicate that this was the entire theoretical power, so in this point the answer is clear, but the error consists in not using H, meaning the "head," in place of "h," referring to the height of water above the weir. That is "h" was used with two meanings and led to confusion. To state the matter anew, a determination of the horse-power must be made on the basis of the number of foot-pounds in a given time, say per minute. If $h =$ the height (or depth) of water as measured at the weir, and $b =$ the breadth or width of the opening, both in inches, and the velocity of flow, by Torricelli's law, $V \sqrt{2gh}$, the number of cubic inches per second can be expressed as $Q\ bh \sqrt{2gh}$. The value of "g" is, as usual, 32.2, meaning the acceleration of gravity in feet per second. Since the weight of water is .036 lb. per cubic inch, 28 cu. in. will be required to make a pound. Then the weight of water passed per second will be $28bh \sqrt{2gh}$ lbs. If, after passing over the weir, the water falls a distance of H ft., the foot-pounds represented will be $28bh \sqrt{2gh}\ H$, and since 1 h.p. is equal to. 550 ft. lbs. per second, the theoretical horse-power will be $\frac{28bh \sqrt{2gh}\ H}{550}$. In the article in question, 25 was given instead of the correct number 28. If the dimensions of the weir are taken in feet and the flow in feet per minute, the quantity would be in cubic feet per minute, and since the weight of a cubic foot of water is 62.4 lbs., the number of feet pounds per minute would be $62.4\,Q$, and if the fall was H ft. in height, the horse-power would be $\frac{62.4\ QH}{33,000}$, which reduces to $\frac{QH}{530}$, but allowing for inevitable waste effort, a common value of the denominator is taken as 650, meaning that the efficiency of the wheel is 80 per cent. The particular sort of wheel to use depends upon the comparative values of Q and H. If the quantity of water is small but under a high head, the "impulse" type, well illustrated by the Pelton make is best, but if Q is large and H is small, the "reaction," or ordinary turbine is required. Under appropriate conditions each can show an efficiency of 80 per cent.

2006. **Electrocution.** L. W. W., Lawrence, Mass., asks several questions as to animal reliable than at present, horses were frequently electrocuted by getting tangled in a fallen wire. Poor joints in the track alone have never produced death. It seemed strange that while a man would often be involved in the same tangle he would escape with only meager burns or shocks. The reason was not and may not even now be entirely plain. However, it may be that while horseshoe nails are not supposed to enter any vitals, they may be more conductive into sensitive regions than we suppose. Again, a horse is likely to fall so as to bring his bare perspiring body into better contact with wires and track than a man whose clothing would be expected to make him almost immune. Under these divergent conditions, it may not be strange that a pressure of 500 volts may send enough current through a horse to kill him, while it is not uncommon for a man to get against the wires with comparative impunity. Boys, however, have been killed when in contact with such circuits. Under special circumstances men have been killed when the pressure was quite low, as was once illustrated in a Turkish bath establishment in London, when a man standing in a copper lined tub took hold of an accidentally grounded electric light fixture. This was a case of direct current supply at only 200 volts. It was not proved, however, that the electric current did such direct killing as in the case of criminals, for the fatality may have been more directly due to fright and heart failure. The lowest reported voltage with alternating current that produced death was recently in a mill in Providence, R.I., the pressure being about 350 volts. This would be equivalent in effect to about 600 or 700 volts with direct currents. In criminal electrocution, the pressure employed varies from about 1700 to 2000 volts, alternating, and under the special preparations for the circuit the current amounts to 7 or 8 amperes. Momentary contacts with sources at much higher voltage are not necessarily fatal, as was recently illustrated at Pittsfield, Mass., when one of the student-engineers accidentally took hold of the terminals of a 33,000 volt transformer, finger rings were melted, and the flesh burned away to the bone, but aside from these burns the man was not injured.

2007. **"American Electrician."** T. N. M., St. Louis, Mo., asks: Is there a magazine called the *American Electrician* (not *American Machinist*)? If so would like to know where published. Ans.—*American Electrician* was absorbed by the *Electrical World* (McGraw Pub. Co., N.Y.) in about 1906, and so is no longer published, but a monthly edition of the latter is supposed to cover the same ground. Subscription $1.00 per year.

2008. **Electric Elevators.** J. S., New York City, asks: Can you give me any information where I can get a book dealing on the subject of electric elevators. Ans.—"Elevators: Hydraulic and Electric," is a handbook containing full description and illustrations of the mechanism of all the modern types of electric and hydraulic elevators; also instructions regarding their care and operation; the danger incurred by careless handling is clearly set forth; a series of questions and answers follows. Designed for the use of engineers and operators. By Calvin F. Swingle. Price $1.00. The "Trust" elevator manufacturers, the Otis Elevator Co., Yonkers, N.Y., have various publications that can probably be secured for the asking.

2009. **Induction Motors.** J. B. W., Sault Ste. Marie, Mich., asks: Will you kindly let me know if you have any books or printed matter for sale which treats on winding of small induction motors (1½ h.p.)? I mean stator winding; if you have, please let me know the price of same. Ans.—The only adequate book of which we know is Hobart's "Electric Motors." Price $5.50. This, however, does not describe small machines. His book on "Armature Construction," price $7.50, you will find very profitable, but this, too, does not treat of small machines. Another book that deals rather more with the theory is by Bailey. Price $2.50.

2010. **Clock Magnet.** H. J. T., Loudonville, Ohio, asks: (1) We want to operate a magnet for a magnet release on a clock movement, which will be located a mile or a mile and a half from our office. With what size wire and how many turns will be required in the magnet? (2) How many cells and what kind would you advise? (3) We have a 14 gauge iron wire up, can talk over it with telephone, but cannot ring a door bell through it with open circuit (dry batteries). Can you advise how to figure out how many cells it takes to overcome the resistance and still work our magnet, which will require 3 or 4 volts (two cells will operate it on short circuit)? Ans.—(1) We would not advise you to change the magnet in the clock, but to use a 20 ohm relay at the end of the line. This would require less energy than the clock and would be more certain in its action. (2) Using the relay it will be necessary to have two dry cells in the clock circuit and about six in the line circuit. (3) To find out how many cells it is necessary to have, it is necessary to know how much current is necessary to operate the mechanism. Knowing the current, I; the electromotive force of the cells, E; the resistance of the line and mechanism, R; the resistance of each cell, B; the number required will be:

$$N = \frac{IR}{E - IB}$$

2011. **Storage Batteries.** W. C. H., Manomet, Mass., asks: Will you please settle an argument on storage batteries for me? (*A*) claims that the term "charging" storage batteries is wrong, as there is no such thing as charging or storing electricity in the cells, but that the electricity simply removes the foreign substance from the plates, allowing the acid to work on the plates, thus restoring them to their (the plates) normal condition to be acted upon by the chemical process. (*B*) claims that electricity is stored in the cells by charging them with an electrical current, but in order to hold the current these must have the chemical action. Now, if the electricity does not stay in the battery when it is charged, where does the electricity go? Ans.—If our opinion will serve in any respect as a peacemaker, we will be very glad to give it. It is certain that widely different views can be held on matters pertaining to electrical behavior, for as yet no one knows what electricity is, and therefore one person's opinion may be worth as much as another's. Whatever electricity is or is not, there is, however, no more reason to consider that it remains or resides as such in a storage cell than in a plating tank. Now, one of the fundamental ideas about electricity is that it is incompressible. This means that in a given piece of apparatus, just as much electricity must come out as went in. For instance, when an electric lamp is passing a certain current, an ammeter indicates the exact amount whether it be connected on one side of the lamp or the other. If there was any storage of actual electricity, an ammeter on the incoming side would read higher than on the outgoing. The nearest case to genuine storage is in the case of a Leyden jar, or other form of condenser. In the plating tank or storage cell chemical work is done, and that work abides after the current stops, so that whereas it is common and sufficient to use the expression "charging," it should be recognized as merely a convenience, and no more accurate than the equally incorrect yet acceptable expression "sunrise" or "sunset."

2012. **Storage Battery.** S. C. H., Cleveland, Ohio, asks: I am making a storage battery of lead plates, 7 x 7 in. by ¼ in., shaped grooves cut 1 in. apart dividing the plates into squares on both sides with 3-16 in. hole drilled through the plate where the grooves cross. Plates are ¼ in. apart, and I figure about 100 square inches exposed to the acid. With 5 of these plates in a cell (1) what would be the capacity and at what rate should it be charged? (2) What part of sulphuric acid should be used with water? (3) What voltage should be used to charge 10 cells? Ans.—It would seem that you had cut so few grooves as to make the increment of area hardly noticeable. With plain sheets the area of each side would be 49 square inches, and with both sides counted you will have 98. Add to this the narrow edges and you will have the 100 sq. in. without counting in the cuts you have made. You should have the grooves cut as closely together as 14 or 16 to the inch, with a resulting active area of 500 or more square inches. You will find descriptions and directions for cutting such in Watson's book on "Storage Batteries." If completely cut in this manner, you can charge at a rate of 4 to 5 amperes per plate, so that with five such positives and six suitable negatives you can use 20 to 25 amperes. You must allow 2.5 volts per cell for charging. Do not undertake to make a storage battery

secondary voltage on 110 v. d.c. (3) What would be the per cent. efficiency? Ans.—Your enquiry seems to indicate the ordinary "induction" coil type of transformer, windings being perhaps 10 in. long. We do not know of any successful use of such coils on 110 volts alternating current. The usual primary winding would consist of only two layers of No. 14 wire, and the current derived from batteries. Six storage cells will be found to give best results. If you employ 110 volts, the number of turns of wire in the primary will be so many as seriously to increase the self-induction, and therefore reduce the sharpness of the interruption. On open circuit, the secondary voltage would approach the number resulting from the ratio of the number of turns in the two windings. With the coil at work, the effects of magnetic leakage and ohmic resistances produce results altogether indeterminate. As the secondary output cannot be measured, there is no way to find out the "efficiency." With the closed core type of transformer, the results can be closely predicted.

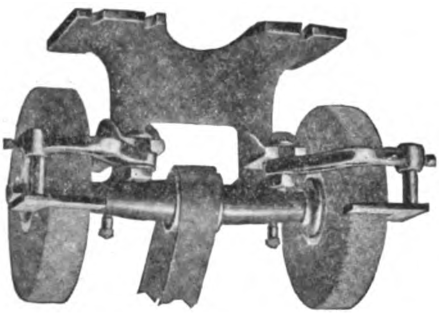
2014. **Rheostat.** Mr. F. J. B., Washington, D.C., asks: Various electrical companies use a sort of porcelain insulation on the backs of small rheostats and the resistance wires are imbedded in this; (1) What is the composition of this insulation? (2) How is it applied? (3) How or where can I find directions for the construction of a carbon resistor that is capable of developing heat sufficient to prepare brass for casting? Ans.—(1) Such rheostats are known as the "enamel" sort, the purpose of the enamel being not alone to serve as insulation, but as a conductor of heat. The wire constituting the resistance has a very small area exposed for radiation, and, in contact with the air only, its current capacity would be much less than when buried in the enamel. This result is quite unexpected, for at first thought one would believe the wire would be so prevented from cooling off as to reduce its capacity. The explanation is found in the fact that the enamel is very thin and is a fair conductor of heat, and conducts it to the ribbed iron backing that still further increases the area for radiation. (2) To make the enamel you can follow the regular procedure for making cooking or sanitary vessels. Of course there are various processes, some of them more easily applied than others, and also having varying degrees of permanence. First the iron must be covered with a "flux," and this can be made from a mixture of white lead, 10 parts; ball clay, 1 part; flint glass, 10 parts, and whiting 1 [illegible] When fused, this is to be run upon the [illegible] be laid in place.

TRADE NOTES

A NEW Power Grinder

A conservative estimate of the number of farms on which gasoline engines are used would place the figure between 40 and 60 per cent. There has been a great call for a cheap, durable and fast cutting grinder to be run by gasoline engine.

In putting out the new power grinder No. 308 and No. 309, the Luther Grinder Mfg. Co. have been able to make a strong, heavy machine, at a very low cost. The No. 308 is equipped with a medium Dimo-Grit tool sharpening wheel 7 x 1¼ inches in size. The No. 309 is practically the same as the No. 308, but has a fine grit wheel in addition to the medium one. These wheels are held on by flanges. In case of the 309 with the two wheels, the driving pulley is situated at the center of the machine.



With the 308 the driving pulley is at one side and the sharpening wheel at the other. The belt can come from above, from the side or from directly beneath. All bearings are extremely long, wide and heavy. The manufacturers are willing to guarantee all the parts of the machine for many years.

The sharpening wheel is of Dimo-Grit, the new fast cutting wheel for steel. Dimo-Grit is a further development of Carborundum, having all the best features of that well known substance and the additional advantage of leaving a smooth cutting edge on steel tools. Dimo-Grit is manufactured by the electric furnace process. In case this grinder is desired with Carborundum wheels instead of Dimo-Grit the number is then 308C and 309C.

BOOK REVIEW

Lefax. Loose leaf engineer's reference book founded by John Clinton Parker, published [illegible] Corporation, Pennsylvania [illegible]

It takes care not only of the data sheets published by the Standard Corporation, but of the engineer's own notes, and of data published in periodicals, for such may be filed on blank sheets of the same standard size as the data sheets, and indexed among them. Clippings can be so pasted or a synopsis of the article written on the blank sheet. Subscribers are invited to suggest subjects for data sheets, and such as furnish data sheets which are accepted will be paid for them.

On each sheet a filing index is printed which can be modified at the individual user's pleasure.

In the sample sheets sent out are tables of logarithms, circumferences and areas of circles, the 1912 standard of flange fittings, actual evaporation per boiler horse-power and factors of evaporation for saturated steam, properties of saturated steam from the new Marks & Davis tables, actual evaporation per boiler horse-power and factors of evaporation of superheated steam, 100 deg. superheat, sheet metal and wire standard gages, and an example of the advertising sheets sold to manufacturers of equipment for presenting data of interest to engineers. The one given among the samples is from the Parker Boiler company, and describes the design of a Parker downflow boiler.

Thick-Lens Optics. An Elementary Treatise for the Student and the Amateur. By Arthur Latham Baker, Ph.D., New York, D. Van Nostrand Co., 1912. Price $1.50 net.

The author of this book has compiled a very satisfactory manual of the mathematical optics of photographic, microscopic and telescopic lenses, and has given all of the formulas and diagrams necessary to enable a complete calculation of the properties of any combination of thick lenses, that is actual lenses, as distinguished from the theoretical thin lenses of the optician. The calculations are made for a single monochromatic ray, and therefore the book does not go into the question of achromatic or spherical aberrations, but it is sufficiently complete to enable the practical working properties of any of the combinations of lenses to be deduced, and to enable the student to find out what would be the effect of changing any of the components of his combination. Though the book contains a large number of mathematical formulas, and is therefore at first glance apparently confusing, the mathematics involved are of the very simplest kind, requiring a knowledge of only extremely simple algebra, one or two elementary problems in geometry, and the conception of the sine in trigonometry. Any reader of ordinary intelligence can master all the necessary mathematics in a few minutes. At the same time, the author has clothed his mathematical material in a form which is un-

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53	Aeronautics
27	Ainslee's
30	All Story Magazine
17	Amateur Photographer's Weekly
35	American Art News
17	American Boy
55	American Homes & Gardens
80	Amer. Machinist (w)
23	American Magazine
24	Amer. Photography
19	Amer. Motherhood
30	Argosy
35	Arts & Decoration
47	Automobile
20	Auto. Dealer & Repairer
17	Black Cat
27	Blue Book
17	Boys' Magazine
20	Building Age
30	Bulletin of Photog.
22	Camera
20	Camera Craft
17	Camera Craft (new)
170	Camera Work
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70	Harper's Weekly
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20	Housekeeper
8	Housewife
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95	International Studio
100	Iron Age (w)
40	Iron Age-Hardware
8	Ladies' World
90	Life
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9	McCall's Magazine
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9	Poultry Keeper
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23	Red Book
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40	St. Nicholas (new)
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23	Sunset
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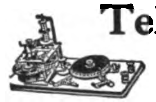

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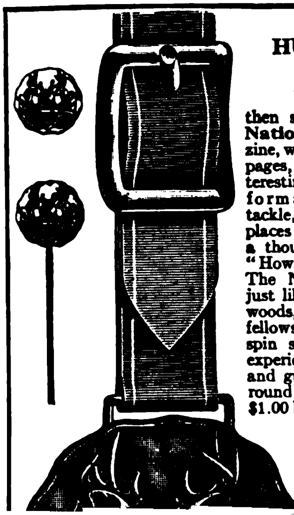

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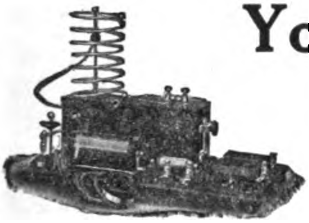

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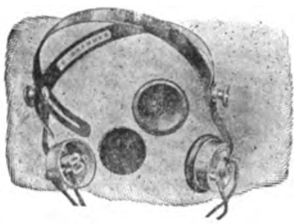

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MORGAN, ALFRED POWELL.
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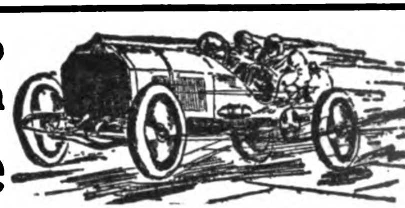

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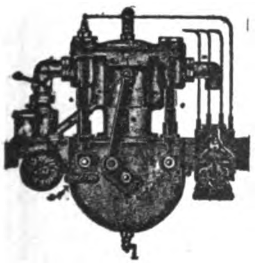

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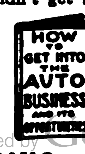

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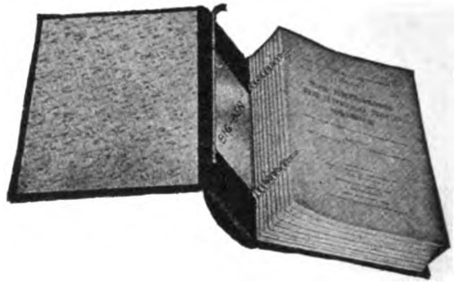

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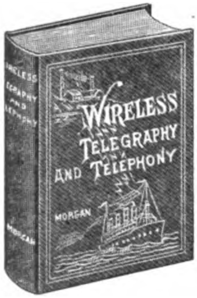

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