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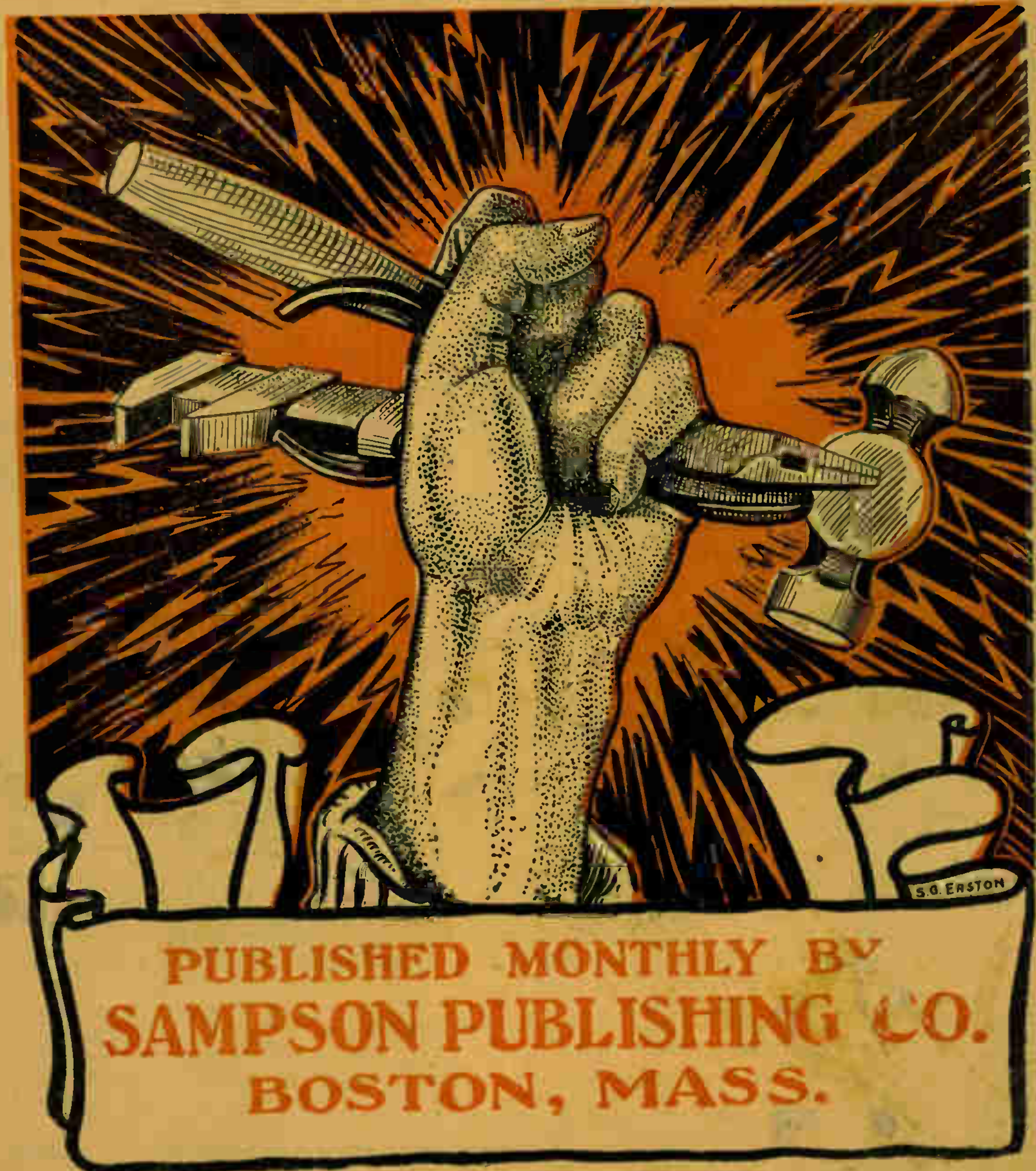

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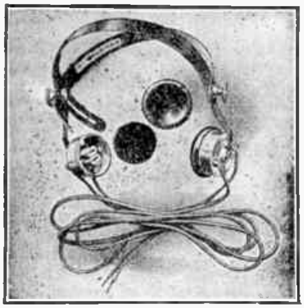

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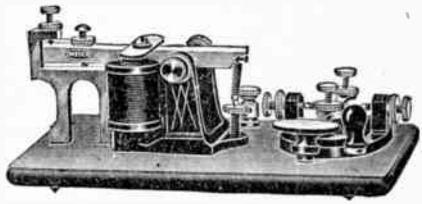

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ENGINEERING LABORATORY PRACTICE—Part II

Steam Engine Testing

P. LE ROY FLANSBURG

One of the primary objects in making a steam engine test is to determine the power developed by the engine. While there are various ways of measuring the power, this article will describe but one, namely, that in which a steam engine indicator is used. The reason for selecting this particular method of testing is

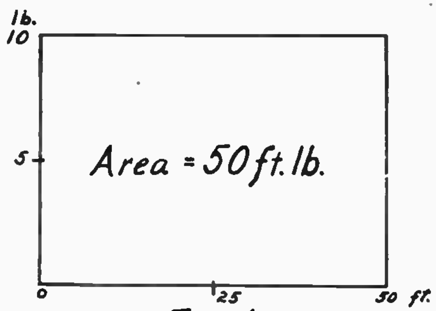


Fig. 1.

that the indicator diagram obtained shows not only the power developed, but also many other things that it is important for the engineer to know, among which may be mentioned the arrangement of the valves for admission, cut-off, release and compression of the steam in the cylinder. There are, however, several objections to the use of the indicator for engine testing, as the indicator, even when in good order, is liable to an error of from 2 to 3 percent and can seldom be run at more than 350 or 400 revolutions per minute.

Since work is the product of Force by Distance, it is possible to represent work by an area. For instance, the lifting of a weight of 10 lbs. through a distance of 50 ft. might be represented by such a diagram as is shown in Fig. 1.

In this diagram the weight lifted is represented by the ordinate AB, and the distance through which the weight moves by the abscissa AC. The area $ABDC$ representing the number of foot-pounds of work done.

In a similar manner the work done by the steam in an engine cylinder can be represented by an area in which one set of co-ordinates is proportional to the piston travel, while the other set of co-ordinates bears a constant ratio to the pressure of the steam within the cylinder during a single cycle of the engine. This steam pressure, which is acting upon the piston, of course varying at different points of the stroke.

The easiest way of determining this work area is by the use of an instrument known as the steam engine indicator. This instrument consists substantially of a carefully adjusted piston of known area (usually ½ in.) moving without sensible friction in a cylinder. The bottom of the piston is subjected to the pressure of the steam in the engine cylinder, while to resist the upward movement of the indicator piston, a spring of known

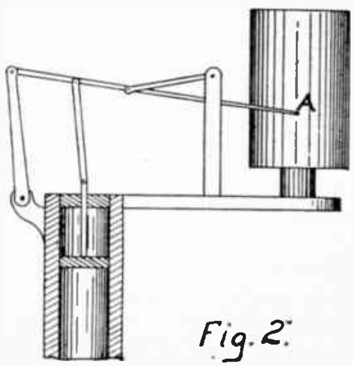


Fig. 2.

resilience is employed. This spring is very carefully calibrated, so that if a pressure of 10 lbs. lifts the indicator piston ½ in., a pressure of 20 lbs. will raise it 1 in. Fastened to the top of the piston is a rod which is allowed to project upward through the cylinder and to which is attached a lever arm. Any movement of the indicator piston either upward or downward is transferred by means of a parallel motion to a brass point. This point is marked "*A*" in Fig. 2.

The length of the lever arm is so proportioned that the motion of the piston will be magnified a certain amount. The brass point traces a line upon a special sheet of chemically treated paper.

The paper upon which the record is made is wound upon a drum, which is so connected to the cross-head of the engine that for every displacement of the cross-head the drum revolves a certain amount. As the piston moves up or down inside of the indicator, the drum will be rotated and the brass point will trace a line on the indicator card. Since the rotation of the drum is proportional to the motion of the piston of the engine, every point on the line drawn will correspond to the pressure inside the engine cylinder at that displacement of its piston.

When testing an engine, the indicator is attached to the engine cylinder by tapping a hole in the cylinder at the clearance space. The engine is then started and the drum of the indicator is connected by a cord to the cross-head of the engine.

As steam is admitted to the cylinder, the pressure rises rapidly and the brass point of the indicator draws a line similar to *AB* in Fig. 3. If the steam is admitted quickly enough, the line *AB* will be practically vertical.

During the time that the valve is open, the curve traced will be one resembling *BC*. At the moment of cut-off, the point *C* is obtained, and from this point to point *D*, the steam is expanding in the cylinder. This curve *CD* will approximate an equilateral hyperbola, and is the expansion curve for all true gases. The point of release (namely, the point where the exhaust valve opens) is shown by point *D* on the diagram. From this point, there is a loss of pressure until we reach the lower limit of cylinder pressure. The line *EF* represents the pressure against which the piston must act during

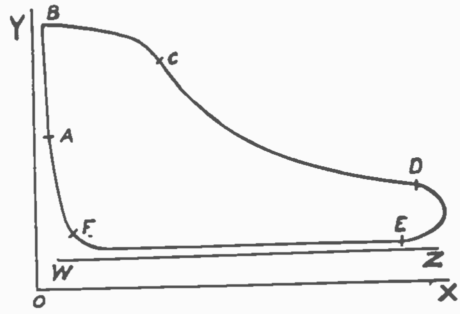


Fig. 3.

the return stroke. The point at which the exhaust valve closes is hard to locate definitely, but is to be found somewhere near to point *F*. After the exhaust valve has closed, the steam remaining in the cylinder is compressed, and the pressure rises until it reaches the pressure represented by point *A*.

One cycle has now been completed, and as the admission valve again opens the piston begins to move forward. It is evident that the work done is represented by the area enclosed by the curve *ABCDEFA*. If the indicator diagram is planimetered (or the area found in some other way), and this area is divided by the length of the diagram a pressure is obtained which is known as the mean effective pressure. The pressure so obtained is equivalent to a pressure which, if allowed to act through the whole length of the stroke, would produce the same amount of work as does the varying pressure which really does act upon the piston. *WZ* represents on the diagram the pressure of the atmosphere, and is 14.7 lbs. above the zero line of pressure.

In computing the horse-power of an engine from an indicator diagram the formula, $\text{H.P.} = \frac{PLAN}{33{,}000}$, is made use of.

In this formula, *P* equals the mean effective pressure, *L* equals the length of the engine stroke, *A* equals the area of the engine piston, and *N* equals the number of revolutions per minute. *P* is measured in pounds per square inch, *L* in feet, and *A* in square inches. Thus it is at once seen that *PLAN* gives us the work done in foot-pounds, and since a horse-power is the quantity of work equivalent to the raising of 33,000 lbs.

through a distance of 1 ft. in one minute's time, it is possible to obtain the result in horse-power if *PLAN* is divided by 33,000.

In Figs. 4, 5, 6, 7 are shown indicator cards obtained from actual tests. Figs. 4 and 5 are from tests made upon a high-speed single-acting engine, while Figs. 6 and 7 are from tests made upon a Harris-Corliss engine. These cards and the computations given for them are simply given to show how the horse-power of an engine may be obtained and no claim is made that the engines are run at their highest efficiencies. We see from the cards in Fig. 4 and Fig. 5 that the engine valves were not set exactly right, while the hump in the curve of Fig. 4 near release, and the reverse loop in the upper part of the curve of Fig. 5, tell us that probably a small amount of steam leaked past the piston.

Fig. 4.

$L = 3.49$ in.
$A = 0.75$ sq. in.
$P = \frac{A}{L} = 0.308$ lbs.
Scale of the spring = 60 lbs.
Therefore M.E.P. = 18.48 lbs.
Area of piston = $(4\frac{1}{4})^2(\pi)$ sq. in.
$N = 374$
$L = 8$ in.

$$\text{H.P.} = \frac{PLAN}{33,000} = 18.48 \times \frac{8}{12} \times (4\tfrac{1}{4})^2(\pi) \times \frac{374}{33,000} = 7.92$$

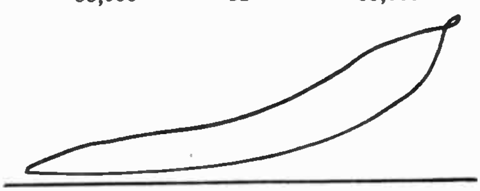


Fig. 5.

$L = 3.49$ in.
$A = 1.13$ sq. in.
$P = \frac{A}{L} = 0.324$ lbs.
Scale of the spring = 60 lbs.
Therefore M.E.P. = 19.44 lbs.
Area of piston = $(4\frac{1}{4})^2(\pi)$ sq. in.
$N = 374$
$L = 8$ in.

$$\text{H.P.} = \frac{PLAN}{33,000} = 19.44 \times \frac{8}{12} \times (4\tfrac{1}{4})^2(\pi) \times \frac{374}{33,000} = 8.33$$

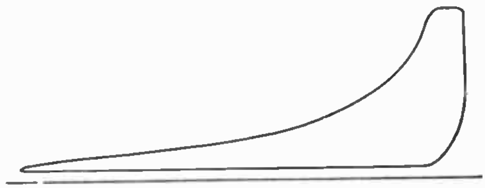


Fig. 6.

$L = 4.60$ in.
$A = 2.04$ sq. in.
$P = \frac{A}{L} = 0.443$ lb.
Scale of the spring = 40 lbs.
Therefore M.E.P. = 17.72 lbs.

$$\left(\frac{LA}{33,000}\right) = 0.00300$$

$N = 66$

$$\text{H.P.} = \frac{PLAN}{33,000} = 17.72 \times 66 \times 0.00300 = 3.51$$

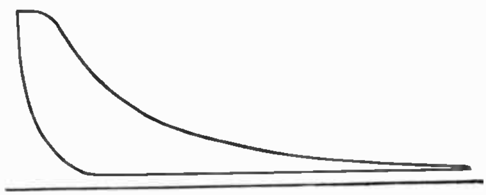


Fig. 7.

$L = 4.63$ in.
$A = 2.03$ sq. in.
$P = \frac{A}{L} = 0.438$ lb.
Scale of the spring = 40 lbs.
Therefore M.E.P. = 17.52 lbs.

$$\left(\frac{LA}{33,000}\right) = 0.003103$$

$N = 66$

$$\text{H.P.} = \frac{PLAN}{33,000} = 17.52 \times 66 \times 0.003103 = 3.59$$

GLUE AND HOW TO USE IT

W. J. H.

Glue is an adhesive used chiefly for woodwork, and, being soluble in water, loses its hold if the work is kept in damp situations or is frequently wet. Glue may be purchased either in solid or liquid form. The latter is useful when only required occasionally for small work; but solid glue, which has to be melted for use, is both cheaper and better, and is most commonly used by woodworkers. Glue varies in quality; but the way in which it is used is the main factor in making it hold well. A man who knows how to use it can do better work with poor glue than a less experienced one can do with the best glue.

The joint must fit closely everywhere; the glue must be of suitable consistency, hot, applied quickly, and the joint closed and kept tightly pressed together until the glue is dry. The joint must not only be fitted perfectly before gluing, but it must be as close as possible after, the glue being in the fibers of the wood, and not in an appreciable film between the surfaces. To ensure this, the parts are always rubbed together whenever possible with heavy pressure, to force superfluous glue out at the edges. When this cannot be done conveniently, simple pressure has to suffice. In some cases even this cannot conveniently be applied except by hand, while the gluing is being done.

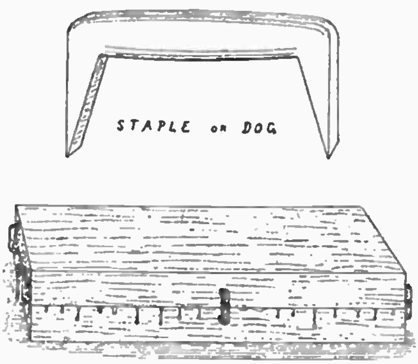


Fig. 1.

In very small joints this does not matter so much; but when there is any doubt about glue holding a joint, it is never relied on alone. Screws or nails are used in addition, and glue is regarded only as an assistance to these, and not the primary means of union. In such cases, less pains are taken to make a good glue joint. The insertion of screws or nails will spoil it as a perfect glue joint if they are put in before the glue is dry, and, generally, if screws or nails are to be used, it is very objectionable to wait a day or more for glue to dry before inserting them, in order to gain a very slight advantage in the character of the joint.

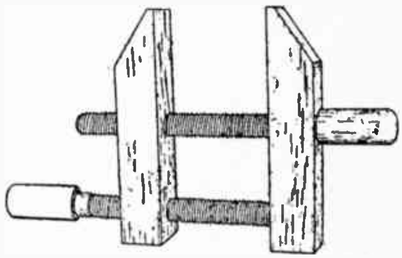


Fig. 2.

When glue alone is used, the work must be laid aside for drying, the time allowed depending on the size and character of the work and the subsequent operations on it. A small bit glued on anywhere will dry quickly; a large joint requires more time.

Glue is dissolved for use in a glue-pot, consisting of an outer pot for water only, and an inner pot for the glue. Water is added to the latter to reduce it to suitable consistency. Heated in this way, the temperature does not rise above that of boiling water, and the glue does not burn and stick to the pot as it would in a single vessel. For occasional use at home a special glue-pot is not necessary, as glue can be melted very well in an old tin placed in a saucepan of water. Before heating, glue should be allowed to soak in water for a few hours. This softens it, and it can then be melted in a few minutes, or as soon as its temperature can be raised to the usual maximum height. If not previously soaked, it takes a long time for it to melt, and lumps of imperfectly dissolved glue remain in it for hours; besides which, prolonged heating weakens glue. It is best to make small quantities at a time, and use it up without many reheatings. The process of heating is also hastened if the glue is broken into small pieces before putting it in the water. Glue must be kept as clean as possible, and especially free from grease of any kind. In workshops where glue is constantly being used, two pots or more are kept, so that while one is in use glue can be soaking in cold water in the other ready for heating when wanted. In other cases a pot is cleansed at night, and glue put in to soak ready for use next day.

Glue-brushes also required experienced treatment. While the glue is being dissolved, a stick should be used to stir it with. The brush is not to be put into it until about to be used. A new brush should be soaked for a little time in hot water before being put into the glue. Brushes should not be left in glue that is allowed to get cold. They should be taken out as soon as the glue is done with, and soaked in hot water, so that the bristles will not get stuck together. For gluing large surfaces, a large brush is necessary to spread the glue as quickly as possible. For applying glue to very small and intricate places, suitable sticks of wood pared thin at the end are better than brushes. Sometimes the bristles of a new brush are too long and flexible, and bend too easily. The brush can be stiffened by binding string around the bristles just below the handle. When the brush has worn shorter, this string is removed.

For large surfaces glue is diluted rather thin; for very small work it should be comparatively thick. It is better, if possible, to warm large surfaces before applying the glue, so that it shall not become chilled too much before the joint can be closed; in which case it fails to hold well. Sometimes hot water is applied immediately before the glue to serve the double purpose of warming

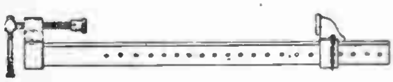


Fig. 3.

the wood and diluting the glue for a large surface. When glue is kept constantly hot, it is necessary to add water occasionally to keep it thin enough for use. In diluting it for immediate use, hot water should be added. If cold is used, a little time should be allowed for the glue to become heated up again. Thickening is slower process, requiring the addition

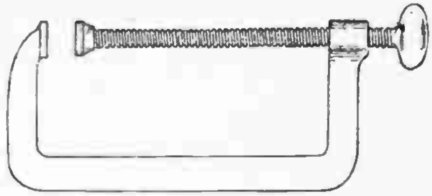


Fig. 4.

of more glue broken very small, or time allowed for the water to evaporate.

After being glued, joints are kept under pressure in various ways, depending on the character of the work. The staple, or dog, and the way it is used is shown in Fig. 1. As many of these as may be necessary are simply driven in with a hammer nearly as far as they will go, and, owing to the way their spikes are shaped, they draw the joint together. It will be seen in Fig. 1 that all the taper of the spikes is on the inside, the outer edges being parallel. When the glue is dry, the staples are pried out with a screw-driver. They make holes in the wood, but these are seldom objectionable. They are oftener used in end grain than in side grain.

The hand-screw, Fig 2, is in very common use for squeezing small joints together. Hand-screws are generally used in pairs; but the number required depends entirely on the size of the work. After being adjusted, the final tightening is accomplished by a turn of the screw farthest from the gripping portion of the jaws. This causes them to close at that part, and spread slightly more open at the opposite end where the screw is thrusting. It will be seen that the screw nearest the beveled or gripping end passes entirely through both jaws, but is threaded only in the farthest one. The other screw passes through one jaw, and merely pushes against the other, its end fitting in a hole to keep it in position. A great deal of squeezing power can be exercised with a hand-screw; but care must be taken to see that the jaws are gripping the work parallel. Hand-screws are made of wood and in different sizes. Their capacity from tips of jaws to the nearest screw is rather limited, but is sufficient for most work, and when a broad surface has to be clamped, hand-screws are used at intervals all round the edges. If this still leaves a considerable middle portion unaffected by them, bars of wood are placed across the exterior of the work, and gripped with it to extend the area of pressure.

Next in importance to the hand-screw comes the long bar-cramp, Fig. 3. This is used chiefly for large frames, and for boards edge to edge. It is used a great deal for other purposes besides squeezing glue-joint, as, in fact, the hand-screw and staple are also. Fig. 4 is a metal "G" cramp, which is very useful and is obtainable in a wide range of sizes. Its action is simpler than that of the hand-screw; but it is not so commonly used for woodwork, one reason being that blocks of wood are often necessary to prevent its small metal jaws from damaging the surface of the work. Another reason is that in making great variations between the distances of the jaws the workman has a way of revolving the hand-screw which opens or closes them rapidly, but with the "G" cramp it can only be done slowly. In large sizes also the hand-screw is cheaper and lighter than a metal clamp.

Besides the regular appliances for clamping, there are numerous methods which are more or less improvised to suit the work. Sometimes weights are put on top of the glued parts, often with large pieces of wood under the weight to distribute the pressure. Sometimes work can be wedged or bound with string. Sometimes small wire nails are driven in at an angle around the edges with their heads projecting sufficiently for withdrawal after the glue is hard.

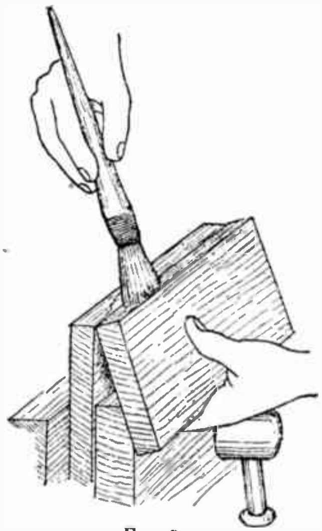


Fig. 5.

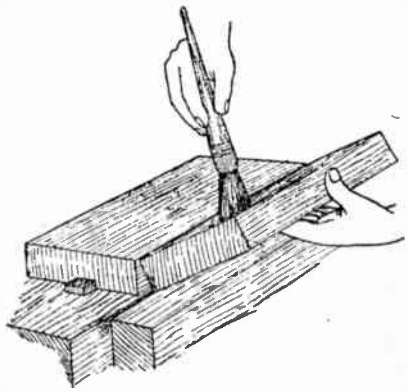


Fig. 6.

The wet glue swells the surface a little, and there is always a tendency for the joint to curl at the edges. If the wood is very thick, this is impossible, and if it is extremely thin, it may be too weak to overcome the hold of the glue. When moderately thin, the outer surface is often washed with hot water to counteract the effect of the hot glue on the other side. In other cases where a small bit has to be glued on, it may be put on extra thick to prevent curling at the edges, and trimmed down after the glue is set. If pressure on the exterior can be employed, no other means of keeping a close joint is necessary.

In gluing two pieces of average size together, one of them is secured in the vise, as in Fig. 5, or is laid on the bench, as in Fig. 6, with its front end against the bench-stop, and has a staple driven into the bench behind it, or is secured behind in any other convenient way to prevent it from slipping about on the bench while the other piece is being adjusted on top. Then the other piece is held by its side in a tilted position, as shown, and glue applied to both surfaces as quickly as possible, and the piece held by the hand is turned over onto the fixed piece. Then it is slid backwards and forwards a few times on the other, and with some amount of side movement, to rub as much glue as possible out at the edges. As the glue is forced out the sliding becomes more difficult, and exact adjustment of the parts must be made without allowing the slightest separation of the surfaces. If they are allowed to separate while the adjustment is being made the glue joint will be a very poor one. They should be separated completely and re-glued. As soon as they are adjusted, staples are driven in or clamps applied. Very often staples are driven first and clamps put on as well. Then the work is laid aside for several hours to dry. In order to accomplish the clamping as quickly as possible after the gluing, the clamps required are set to size and laid ready for use before the glue is put on. Work of the size shown in Figs. 5 and 6 would be glued by a single workman, but assistance is always obtained for gluing large joints. In such cases a man stands at each end, pressing down on the upper piece of wood and doing his share in sliding it backwards and forwards, and making the final adjustment as exact as possible. There is no objection to using a mallet or hammer if the parts hold too tight to be adjusted a small amount at the finish; but it is avoided as a rule, because there is more risk of breaking the joint by a blow than there is by pushing and pulling. Joints glued in this way (assuming that the surfaces fit each other) are the most perfect glue joints possible, with the exception of veneering joints, to be spoken of further on, and the methods adopted in veneering are impossible in gluing thick wood.

Glue is used in many cases where a strong joint is impossible unless screwed or nailed as well as glued. Under ordinary circumstances glue cannot be trusted to hold end-grain or crossed-grain surfaces. The grain of both parts must run parallel. End-grain does not unite well at all to another surface. The glue sinks into the pores and the joint is easily broken. By applying two coats of glue the absorption is minimized, but there is no strength in such a union. In crossed grain the shrinkage of each piece is at right angles to the other, and this breaks the glue joint. Screws or nails are nearly always used in such cases. Plywood is an exception, and veneering is often done with crossed grain, but the wood in both cases is perfectly seasoned, and is never intended to stand even a damp atmosphere, leave alone exposure to the weather. Moreover, the gluing is exceptionally well done. Joints with parallel grain can shrink or swell in unison without breaking the hold of the glue. Mortise and tenon joints are nearly always glued, although the surfaces in contact are entirely crossed and end-grained, but it is only in very light cabinetwork that the glue is trusted alone. There is, moreover, the fact to be remembered that such joints, and dovetails also, fit with some degree of tightness independently of the glue. Another point about them is that the surfaces are too small to shrink much. In dovetails, especially, glue is quite satisfactory, because the dovetailed framework is invariably made secure by the attachment of the bottom piece or back. In putting these joints together, and in doweled joints also, there can, of course, be no rubbing of the parts to work out the superfluous glue. They are pressed together and clamped, if the character of the work permits clamping. In gluing dovetails, the form of these insures a tight connection in one direction, and in the other way they are simply driven with a mallet or hammer on a block of wood until the parts are as close together as they will go. In all glued work glue is applied to both the surfaces to be united. An exception is in gluing such things as cloth or paper to wood, when the glue should be applied to one only.

In cabinetwork and joinery, glue blocks, as shown in Fig. 7, are very frequently stuck in interior angles to assist in holding

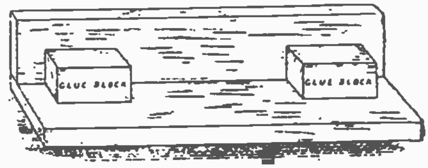


FIG. 7.

parts together and keeping them at right angles with each other. They are used only in positions where they will not be visible when the work is finished and in place. The blocks are planed in long pieces measuring, perhaps, 1½ in. in cross section, and are cut off in blocks 2 or 3 in. long. They are simply glued into the angles, being rubbed backwards and forwards slightly, to make a good joint, but are not clamped or secured in any way except by the hold of the glue.

They are, of course, used only for indoor work. They are common in the plinths and cornices of wardrobes and similar carcass furniture, and in staircases.

In veneering, or gluing, very thin wood on the surface of thicker, there are two methods peculiar to that class of work, neither of which are applicable to the gluing of thick pieces together. In one the wood is treated almost as if it were paper, and is squeezed to the thicker material with an appliance called a veneering hammer, superfluous glue being forced out by the pressure and sliding action of the thin smooth edge of the hammer. This makes a close union, and the veneer is so thin that it remains as it is pressed, and does not require prolonged pressure. The other method is to clamp hot plates of wood or zinc, known as cauls, on the veneer, and leave them there till the glue is dry. This method is adopted for thick veneer. The heat of the cauls penetrates the veneer in a few moments, and causes the chilled glue to run freely again, and, combined with the pressure, this makes a perfect glue joint. For small work by this method hand-screws are used to apply the pressure. On a large scale entire boards are veneered and put in presses specially for the purpose. Veneering also differs from ordinary work in the method of preparing the joints. For uniting two pieces of thick wood it is necessary to fit the surfaces to each other, generally by planing them perfectly true. Veneer, being thin, will accommodate itself to an untrue surface, and though the veneered surfaces are approximately flat or curved, as the case may be, they do not have to be carefully fitted. An absolutely smoothly-planed surface is unsuitable for this work, and roughness is generally imparted with a toothing-plane to make a better glue joint.

TESTING WIRELESS TELEPHONE RECEIVERS

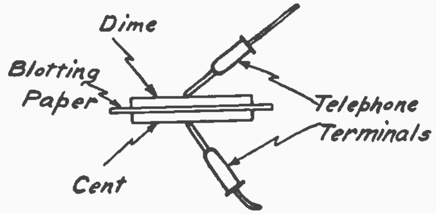
NORMAN M. DRYSDALE

It often happens that a fault in the receiver of a wireless set may be traced directly to a disconnection, either in the telephones themselves, or in the leads connecting them.

The most common method of ascertaining whether this is the case, is to connect them to a dry cell; a very loud click heard in the phones denoting a complete circuit. Now this method is very detrimental to their sensitiveness, as the comparatively large current passed through the magnet windings tends to upset the delicate degree of magnetism already existing between the ferrotype plate and the magnet poles. This degree is such that it requires but a very small additional magnetism to actuate the diaphragm. If, therefore, this balanced condition is upset, it will require a much larger addition of magnetism, thus the sensitiveness of the instruments will be reduced.

The following test provides just sufficient current to effect the diaphragm, and besides indicating a complete circuit or otherwise, also gives one some idea of their sensitiveness.

Procure a dime and cent piece, and between them sandwich a piece of blotting-paper, moistened with water. It will be found that on applying one terminal of the telephone leads to the dime, and the other to the cent, quite a loud click will be heard in the receivers, pro-



duced by the contact of the two dissimilar metals, brought about by the damp blotting-paper, generating a minute current. It should be noted that the coins should not be allowed to touch each other or the little cell will be short-circuited and fail to produce any current.

"So you heard the bullet whiz past you?" asked the lawyer of the darkey.

"Yes, sah, heard it twict."

"How's that?"

"Heard it whiz when it passed me, and heard it again when I passed it."—*American Boy.*

THE LATEST TYPES OF MERCURY CONVERTER*

DR. W. HECHLER

The theory of the converter is well known, so that the present article is confined principally to its technical aspects, though a few preliminary words may be advisable with regard to some of the physical points of the problem. Between the electrodes of a vacuum tube, the negative of which consists of mercury, a direct current at 1,000 volts is necessary to start the arc. The resistance to the passage of the current lies entirely at the mercury cathode, but as soon as the arc is formed it falls to a low value so long as current passes to the cathode. This change in the resistance is caused by the ionization of the mercury vapor. The permanent voltage-fall between the electrodes is made up of losses at the cathode, anode and in the mercury column, and amounts generally to something between 13 and 25 volts. If, now, the current falls below a certain definite value for the hundred-thousandth of a second the arc is extinguished; consequently, with ordinary single-phase current, a continuous arc is impossible, because the current periodically passes through the zero value. An auxiliary direct current of some kind is therefore necessary, and this is obtained by means of choking coils, which cause a slight overlapping of the currents in the circuits into which the whole is divided. This is, of course, unnecessary with polyphase current, but with single-phase current, there are two ways in which the choking coil may thus be arranged. In the one case the coil is arranged in parallel with the anodes of the vacuum tube, and therefore in parallel with the secondary terminals of the transformer, while its middle point is connected through the direct-current circuit to the cathode. In the other arrangement the choking coil is placed between the middle point of the transformer winding and the cathode, and is therefore in series with the direct-current circuit. The author gives, further, some oscillographic records of the currents and voltages in the different parts of the circuit, which are not, however, reproduced here. It suffices to say that the amount of overlap is a very important factor, determining, as it does, the nature of the direct-current wave which is produced. With polyphase current the overlap is already provided by the nature of the current itself, and the greater the number of the phases the less will the resulting direct current tend to pulsate.

The vacuum tubes, used as converters, differ in the number of the electrodes, which depends on the number of phases; there are also differences in size, both of the tubes and of the electrodes, the anodes depending on the maximum value of the direct current to be delivered; finally, the distance between the electrodes depends on the voltage of the direct current. As already stated, the distance between the electrodes, particularly that between cathode and anode, determines the working voltage. Up to 200 volts the internal drop is about 15, and in the shapes in which the tubes are usually constructed, it is independent of the current which these are intended to carry. The efficiency of the converter depends on the fall of voltage in the tube, and on the losses in transformer and choking coil, and it increases as the direct-current pressure rises.

The complete apparatus includes the tube with its transformer and choking coil, which can be mounted on the switchboard together with the switches and instruments. The shape which it eventually takes depends partly on the purpose to which it is to be applied, and one of the most important is that of charging accumulators. For this purpose the Allgemeine Elektricitats Gesellschaft builds units for 5, 10, 20 and 30 amperes for single-phase current, and for 30 amperes for polyphase current. The starting is effected by hand, a knob being mounted on the front of the switchboard. If this knob is turned, the tube is rotated sufficiently to bring the mercury of the cathode into contact with that forming an auxiliary anode; and on turning the knob back into its

*Abstract of an article in the "Elektrotechnische Zeitschrift."

original position, the mercury connection is broken, though it has in the meantime completed a circuit from the cathode through the auxiliary anode and its series resistance to one of the main anodes. The breakage of this circuit causes a spark, which is sufficient to start the main arc. The converter obviously cannot work without load, neither can it at once be put in series with the battery; consequently it is allowed to work on a special resistance, which is put in parallel with the battery and then gradually cut out of the circuit. The whole operation of starting up requires at the outside 10 seconds, though in the smaller sizes, after starting the arc, the circuit through the battery can, if necessary, be closed at once. The regulation of the voltage is effected by varying the ratio of transformation; in the 5-ampere size, it is, however, effected by varying a resistance in series with the battery. Other methods of regulation are also adopted to meet special cases. Thus, with a converter having a range from 55 to 235 volts, the changes are effected in three stages, each of which has 21 finer stages of adjustment, by which it is possible to charge 22, 44, 66 or 88 cells in series. The only external difference in this case consists in the mounting of two simple switches in addition to the usual apparatus.

Another use to which these converters are put is for lecture lanterns and for small searchlights, and they are then constructed in 30-ampere sizes, giving 50 or 60 volts direct current. The tipping of the tube is effected automatically by a relay, which is then cut out of circuit along with the resistance of the auxiliary anode. There are also all kinds of other types. The battery type is made without any device for regulating the pressure and with automatic starting relays. Converters for medical purposes are usually of this kind, as, for instance, in Hahb's magnets for ophthalmic use, and in Finsen's light treatment. They are also used for operating electromagnetic brakes on locomotives in colliery work; the starting being effected automatically, the maximum output being 10 amperes at 220 volts. This piece of apparatus shows conclusively that it is not sensitive to shocks of a mechanical nature, the converter being mounted on the locomotive. They are also used for driving direct-current motors, which are sometimes to be preferred to those of the alternate-current type; and similarly, they are not unknown in electrochemical laboratories.

At present in Germany the largest size gives 40 amperes on polyphase circuits, and 30 amperes with single-phase, though in America it has lately been found possible to give a permanent output of 50 amperes under the latter conditions. The heating at the fused joints, carrying the leading-in wires, is the point on which the maximum limit depends. In America experiments have been made in the use of metal instead of glass for the main body of the converter; but these require the use of certain subsidiary apparatus, which can only present advantages in the very large sizes, suitable for use with large batteries and searchlights. But the simplest solution would probably be to use several converters in parallel, which would necessitate the use of something of the nature of series resistances to ensure stable working. For purposes of this nature, special types have also been devised by which some of the minor losses incidental to such a combination can be avoided.

The first aerial service is shortly to be initiated in Great Britain under the direct control of the Postmaster-General. King George is personally interested in the scheme, and has given permission for the use of Windsor Park as the terminus of the service, which is to have London for its starting-point. In many large London business houses special "aerial" letter-boxes are to be placed for the reception of the "aerial" missives. When collected by postmen these will be placed in Government sealed letter-bags and, if the negotiations which are now proceeding are satisfactorily completed, will be rushed across to the Hendon aerodome. There the safely-sealed bags will be securely strapped to the waiting aeroplane, which will then be piloted across to Windsor.—*English Mechanic.*

AUTO DEPARTMENT

POINTS TO BE CONSIDERED IN PURCHASING AN AUTOMOBILE

"CHASSIS"

Unfortunately, perhaps, the first point to be considered by most of us in purchasing a car is the cost. Of course it is a foregone conclusion that we want the best we can get for our money, and it is to aid the uninitiated in the selection that this article is written.

Granting that we have not to consider the cost, the most expensive car is not necessarily the best, yet it is a pretty general proposition that quality and price, with some notable exceptions, are approximately proportional. There are concerns who have built up a name for themselves in the early days, and who still build excellent cars, but who get a price for their product higher than a newer concern could get for a car of equal quality. In other words, people of means are willing to pay for a name. This applies to makes commanding a high price, since there is greater competition in the lower-priced field. Hence the writer believes that, generally speaking, one gets more for his money if he buys a medium or comparatively low-priced car than when he buys a high-priced car; but he does not advocate a cheap car in any case. Doubtless there are many who would take issue on this point and present plausible arguments in their defence. Be this as it may, the arguments the other way seem more plausible.

There are many good values to be had in used cars, but purchases of this character must be made with extreme caution, and should not be undertaken without expert advice. It is better to pay an engineer, or even a good mechanic, a reasonable fee to pick out a good car, than to be "penny wise and pound foolish" in trying to save such a fee only to find that the car you select is faulty, both in design and workmanship, and the same advice applies equally whether you are buying a new car or an old one.

After deciding what price you will pay for your car, consider well what duties it must perform, and, if possible, have it put through similar duties during the demonstration which should invariably precede a purchase. Remember that a low-powered car is very practical for city use, or where there are good roads and slight grades, but that such a car will not be very suitable for extended tours over rough and hilly roads. If you wish to take all hills excepting very heavy grades on high gear, only a car with a high-powered motor will answer your purpose and you will have to pay well for the luxury. Many advocate cars of this character in the belief that a large motor run, as it will be ninety percent of the time, at low speed, will stand up better than a small motor run more constantly at a comparatively high speed. This is undoubtedly true to some extent, but it is also true that a motor of this type run at low speed is very inefficient in point of fuel consumption. However, a much larger factor than motor depreciation is tire expense, and this will vary in almost direct proportion to the weight of the car, and will increase very rapidly with increase of average running speed. Cars with large motors must have all their parts in proportion in order to withstand the strains imposed when the motor is run at its maximum power. Hence we see that weight increases with power, and tire expense, with weight; and we reach the inevitable conclusion, that other things being equal, the lighter car has a marked advantage.

Safety is, of course, a prime factor, and reliability is next in importance, hence weight must not be decreased so as to interfere with these. Light weight without sacrifice to strength, however, is particularly important in axles and those parts between them and the road. These parts are dead weights on the tires and are not cushioned from them by springs. Hence they pound the tires, and in consequence decrease their life. One designer whom the writer could mention considers this point so important that he has offered a dollar per pound per car for a design which will decrease the weight of these parts on his product without sacrifice to strength and durability or unduly increased cost of manufacture.

When considering the question of safety, it is well to look closely at the running gear and the steering gear. See that these parts are strong and so put together that they cannot be loosened by the severe vibration to which they are constantly subjected. Remember that a broken steering gear may easily result in a serious accident.

It is perhaps natural that men who have used horse-drawn vehicles all their lives should compare their first automobile with these vehicles. They will find a car much more heavily built than a carriage, for the reason that the former carries its own means of propulsion and can travel, in normal use, three times as fast as a horse. These conditions require heavier parts, and the result is a heavier vehicle. The heavier the vehicles, the larger the motive power necessary to propel it at any given speed, hence, with other things being equal, the lighter vehicle again has an advantage in this particular.

Simplicity in design and accessibility of parts are points well worth consideration. A car having a motor which is cluttered with a mass of piping, operating levers, rods, etc., is certainly harder to care for than a simple appearing motor. In fact, the latter type is considered much better design, and the former is likely to have inferior design in more essential parts as well as in the parts which appear on the surface.

Accessibility is a point which receives far greater consideration today than it did in the early days when cars frequently had the motor under the body and in such a position that the latter had to be lifted whenever the motor required much attention. It is still well to consider this point, however, particularly with respect to such parts as are likely to require inspection, adjustment, frequent cleaning or lubrication not automatically cared for, such as magneto, oil and water pumps, grease cups, oil level gauge, carburetors, etc. It is well, also, to see that all parts subject to wear are covered to prevent penetration of grit.

Lubrication of all surfaces where one part slides or rolls upon another is a matter of prime importance. For pistons and bearings within the crank case, splash lubrication is usually sufficient, although other methods, not so much employed, are considered more scientific by some capable judges. In order to maintain a constant level in the troughs under the connecting rods in the "splash" system and oil pressure on the bearing in the forced system, a pump is necessary. Same should be conveniently located to enable removal for cleaning when necessary. Gear pumps are very generally used for this purpose, but piston pumps operated from eccentrics on the cam shaft are considered rather better practice. But the motor is only one of the many parts which should be lubricated. The transmission, differential, wheel bearings and steering gear worm should all be enclosed and so packed as to hold grease, or, better yet, oil, although the latter is hard to retain except by expensive construction, and therefore is seldom provided for on cars of moderate price.

The selective type of change speed gear has come to be generally accepted as standard, and is to be preferred above any other gear speed reduction. The friction drive is not to be overlooked, however, and has some inherent advantages, including simplicity and ease of operation. This type of drive requires comparatively frequent renewal of the friction surface of the wheel, however, and hence should be so designed as to enable replacements without difficulty.

Planetary transmissions have but two points in their favor: small first cost and ease of operation. They are seldom constructed for more than two speeds forward, and because of this are not often applied to large cars. In fact, they are used almost exclusively on runabouts and very light cars and are as a rule to be avoided by purchasers who are looking for durability and efficiency in transmission.

A majority of cars today are shaft-driven. This form of drive has the advantage of quiet running and greater efficiency than a chain drive, but the latter permits a strong rear axle, and is probably more dependable for very rough or hilly work and hard usage.

No car should be without brakes of ample proportions. In fact, two independent brakes are very desirable and are usually provided on the larger cars. Both the foot brake and the emergency brake should be capable of locking the rear wheels.

The frame of the car is usually of steel, but some makers still use wood reinforced with steel. Undoubtedly the latter construction is better suited for absorbing shocks and is more resilient. On the other hand, a steel frame is likely to be stronger.

For easy riding, full elliptic springs are most desirable. They require the double universal joint construction for the drive shaft, however,—a requirement which has both advantages and disadvantages—and are not so much used as three-quarter elliptic and semi-elliptic springs.

All of these points and many more should be considered by a prospective purchaser and can really be given their proper weight only by an engineer of long experience in the line. The purpose of these suggestions will, however, be realized if they serve to point out the way in a few particulars to the man who is about to invest in an automobile.

PROFIT AND LOSS

Big Returns in Electric Circuit

F. WEBSTER

It has been said that anyone, not excluding a deaf mute, will prick up his ears and take notice when offered a "sure thing proposition" for doubling his money. As the electrical engineer can offer better than double, it might be of interest to some of the present-day investors to study one of the old problems relating to capacity and inductance of circuits, this particular one giving over 5 to 1.

Thus, suppose that a certain circuit is arranged as shown in Fig. 1. This circuit is laid out so that it leaves the line at *A*, and has an incandescent lamp at *B*. Immediately below the lamp *B*, the circuit is divided at *C*, one branch having an incandescent lamp *D*, and an inductive coil *E*, and joins the other line wire at *F*. The other branch leads from *C* and has an incandescent lamp *G*, and a condenser *H*, and reaches the line wire at *I*. The main line voltage is 550, alternating with a frequency of 133. The resistance of the incandescent lamps is 100 ohms each, the inductance of the coil *E* is 0.597 henry, and the capacity of the condenser is 2.49 microfarads. The arrangement is such that when 0.4 ampere passes through lamp *B*, there is approximately 1 ampere passing through the lamps *D* and *G* in the branches; that is, the sum of the amperes in the branches, or 2 amperes, is 5 times the current through the lamp *B*.

Several terms have been used in describing Fig. 1 that may be new to some operating engineers. While a thorough understanding of these terms as to their values and their relations to each other would require a special training in electrical engineering, yet the application of the principles involved is easily understood. A brief explanation of the meaning of each term is given in simple language below, and the reader, if he does not have an electrical training, should take it for granted that the applications are correct. The article is written for the purpose of showing the unexpected conclusions which are sometimes arrived at when using alternating currents, and not for the purpose of giving a dictionary of electrical words.

The pressure of an electrical current is called its electromotive force or voltage, and it is represented by the letters e.m.f., and the unit as measured by switchboard instruments is called the volt. The voltage corresponds with the steam pressure of a boiler, while the electric current corresponds with the quality of steam flowing from it. The pressure does not depend upon the size of the boiler, likewise the voltage does not depend upon the size of the generator. The unit of electric current is called the ampere. Any wire or device for transmitting an electrical current has a resistance which tends to cause a loss of pressure; that is, the voltage grows less as the length of line increases. The unit of resistance is called the ohm. A piece of copper wire 1,000 ft. long, and having a diameter of 0.1 in., has a resistance of about 1 ohm. In the formulas for working electrical problems, the resistance of the circuit is represented by the capital letter *R*.

Besides the resistance of the wire, it may be so arranged that when an alternating current is passed through it, the current will be choked back; that is, the current wave will lag behind the voltage wave and what would be its normal flow. This lag of current takes place when the wire is wound in a coil, and the effect is greatly increased by placing an iron core in the coil. The choking effect of a coil is called its inductance and the unit for measuring it is called the henry. The ordinary transformer has considerable inductance and causes the current to lag in the line. The henry is represented in formulas by the capital letter *L*.

For an alternating current the strength is continually varying and also its direction of flow alternates. Its strength starts at zero and rises to its greatest value, declines to zero and builds up to its greatest value in the opposite direction and then diminishes to zero. This series of wave-like operations is called a cycle, which is repeated continually. The method of designating the cycles of the current from an alternating current generator is to give their number per second or frequency and the term is represented by the small letter *n*.

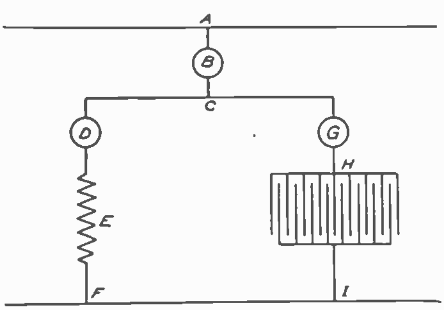


FIG. 1. CIRCUIT CONTAINING INDUCTANCE AND CAPACITY

A condenser is a device made up of flat sheets of tinfoil, every sheet in the stack being connected to opposite terminals. The sheets are separated from each other by insulating material, as shown at *H*, Fig. 1. A condenser can be charged with a quality of electricity and then made to discharge itself. The farad is the name of the unit of capacity of a condenser, but as this unit is very large as compared with the capacity of the ordinary condenser, it is customary to state the capacity in millionths of a farad, called a microfarad, the prefix "micro" meaning a millionth part. The farad is represented by *J*. The condenser causes the current wave to go ahead of the voltage wave; that is, it gives lead to the current. This lead effect is just opposite to the lag effect caused by induction and can be made to neutralize induction. A rotary convertor or a synchronous motor acts like a condenser in giving lead to the current in the line.

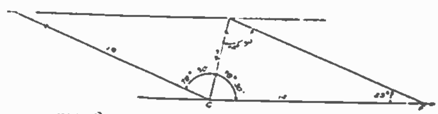


FIG. 2. PHASE RELATIONS OF CURRENTS

The method of computing the current that would flow through the circuit in Fig. 1 is by means of two formulas or rules. These formulas have been worked out in text-books on electricity, and all that is to be done in the present case is to insert the values given in the problem and complete the arithmetical work. When the resistance of a lamp and the amount of current flowing through it are known, the amount of loss of pressure in volts is found by multiplying the resistance by the current. Thus, the loss through the lamp *B* will be $0.4 \times 100 = 40$ volts, and the pressure left to force the current through either of the branches will be $550 - 40 = 510$ volts. The formula for finding the amount of current that flows through the left branch *C F*, where the current lags or is choked back by the inductance of the coil *E*, is as follows:

Square the inductance in henrys; square the frequency and multiply these squares together and the result by 39.48; to the result add the square of the resistance in ohms and take the square root of the sum; divide the e.m.f. by this root and the quotient will be the current in amperes.*

By putting the values of the terms in the problem in place of the names in the rule, it appears as follows:

$$\text{Current} = \frac{510}{\sqrt{(100^2 + 39.48 \times 133^2 \times 0.597^2)}} = \frac{510}{508}$$

equals 1 ampere, approximately, which is found by performing the arithmetical operations as indicated.

To find the current flowing in the right hand branch, where the current gets ahead of the pressure caused by the condenser, use the following rule:

Multiply the square of the capacity in microfarads by the square of the frequency and divide 25,350,000,000 by the result; to the quotient add the square of the resistance in ohms and take the square root of this sum; divide the e.m.f. by this root and the quotient will be the current in amperes.†

And when the data of the problem is inserted in place of the letters, the formula has this form:

$$\text{Current} = \frac{510}{\sqrt{\left(100^2 + \frac{25,350,000,000}{133^2 \times 2.49^2}\right)}} = \frac{510}{491}$$

Lag and the lead of electric currents can be expressed in terms of an angle, just as the eccentric on the shaft of an engine is set a certain angle either ahead or behind the crank position. Thus, in Fig. 2, suppose the line *AC* represents the direction of the current at a particular instant in the main line and through lamp *B*; then the current in the branch line *CF* of Fig. 1 will be behind *CA*, and that in *CI* will be ahead of *CA*. These angles between the directions of the currents are easily computed by the use of trigonometry. Those readers not familar with this branch of mathematics will have to consider the results only, without reference to the method of getting them. It might be stated here, however, that trigonometry is a very easy as well as a useful subject to learn.

The cause of the current in the two branches being much larger than that in the line is due to the lag caused by the inductance in the coil *E*, and to the lead caused by the capacity of the condenser *H*. The current in the branch with inductance *E* lags behind that through the branch with the lamp *B* by an angle whose tangent equals 6.28 x frequency x inductance ÷ resistance = 6.28 x 133 x 0.597 ÷ 100 = 4.989, corresponding to an angle of 78 degrees, 30 minutes. The values of angles corresponding to different tangents are given in handbooks. The current through the condenser *H* leads that through the lamp *B* by an angle whose tangent equals 1,000,000 ÷ (6.28 x frequency x capacity x resistance) = 1,000,000 ÷ (6.28 x 133 x 2.49 x 100) = 4.8077, corresponding to an angle of 78 degrees, 30 minutes. The differece in phase between the currents in the two branches is equal to the sum of, the two angles computed above, or 78 degrees, 30 minutes plus 78 degrees, 30 minutes equals 157 degrees, and this angle is laid off as shown in Fig. 2. The current flowing through the lamp *B* and the line equals the geometrical sum of those in the two branches; that is, its value will be represented by the length of the diagonal *CA* of the parallelogram constructed on the lines *CF* and *CI* in Fig. 2. The lines *CF* and *CI* should be of equal length and to any convenient scale to represent 1 ampere. The length of *CA* will measure 0.4 of *CI*, or *CF*.

Therefore, when the get-rich-quick scheme is worked backwards, as it always is sooner or later, generally sooner, the investor who has put in a lot, always gets in return what the combination happens to deliver, which is very little.—*Practical Engineer.*

The rural delivery system costs $35,-000,000 a year; the rural carrier's daily load is absurdly small—a pitiful 25 lbs.; it could be 500 lbs. without adding materially to the cost of the service.

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*In Short form:

$$\text{Current} = \frac{\text{e. m. f.}}{\sqrt{(R^2 + 39.48\ n^2\ L^2)}}$$

Where letters represent quantities as stated in the text.

†The short form is:

$$\text{Current} = \frac{\text{e. m. f.}}{\sqrt{\left(R^2 + \frac{25,350,000,000}{n_2\ J^2}\right)}}$$

WIRELESS TELEGRAPHY

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

REGULATIONS GOVERNING WIRELESS EQUIPMENT ON OCEAN PASSENGER STEAMERS

The following is a copy of a circular issued by the United States Department of Commerce and Labor June 15, 1911, to the collector of customs and others concerned in an Act approved June 24, 1910:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the first day of July, nineteen hundred and eleven, it shall be unlawful for any ocean-going steamer of the United States, or of any foreign country, carrying passengers and carrying fifty or more persons, including passengers and crew, to leave or attempt to leave any port of the United States unless such steamer shall be equipped with an efficient apparatus for radio-communication, in good working order, in charge of a person skilled in the use of such apparatus, which apparatus shall be capable of transmitting and receiving messages over a distance of at least one hundred miles, night or day: *Provided*, That the provisions of this Act shall not apply to steamers plying only between ports less than two hundred miles apart.

Sec. 2. That for the purpose of this Act apparatus for radio-communication shall not be deemed to be efficient unless the company installing it shall contract in writing to exchange, and shall, in fact, exchange, as far as may be physically practicable, to be determined by the master of the vessel, messages with shore or ship stations using other systems of radio-communication.

Sec. 3. That the master or other person being in charge of any such vessel which leaves or attempts to leave any port of the United States in violation of any of the provisions of this Act shall, upon conviction, be fined in a sum not more than five thousand dollars, and any such fine shall be a lien upon such vessel, and such vessel may be libeled therefor in any district court of the United States within the jurisdiction of which such vessel shall arrive or depart, and the leaving or attempting to leave each and every port of the United States shall constitute a separate offense.

Sec. 4. That the Secretary of Commerce and Labor shall make such regulations as may be necessary to secure the proper execution of this Act by collectors of customs and other officers of the Government.

REGULATIONS

I.—*Administration*

1. The Department will appoint three wireless ship inspectors, whose districts shall be:

North Atlantic, from New York to the Canadian boundary;

Middle Atlantic and Gulf, from Philadelphia to Galveston, including Porto Rico;

Pacific, from Puget Sound to San Diego, including Alaska and Hawaii.

2. These inspectors are authorized to communicate directly in their respective districts with collectors of customs, and to co-operate with them in the enforcement of the law.

3. Collectors of customs and wireless ship inspectors, as far as practicable, shall visit ocean passenger steamers subject to the Act, before they leave port, and ascertain if they are equipped with the apparatus in charge of the operator prescribed by the first section of the Act.

4. Where an ocean passenger steamer subject to the Act is without the apparatus and the opertor prescribed, or either of them, and is about to attempt to leave port, the customs officer or wireless ship inspector visiting the vessel shall—

(*a*) Notify the master of the fine to which he will be liable, and of the particulars in respect of which the law has not been complied with;

(*b*) Notify at once the collector of customs, if necessary, by telephone;

(*c*) Prepare in writing a report of his action, stating particulars as in (*a*), to be transmitted to the collector of customs. The collector will transmit a copy to the United States attorney for the district in which the port is situated.

5. The Act does not authorize the refusal of clearance in case of violation of its provisions, but specifically provides for the imposition of a fine in a sum not more than five thousand dollars upon conviction by the court. The collector of customs, accordingly, when advised that an ocean passenger steamer subject to the Act is attempting to leave port in violation of its requirements, shall at once notify the United States attorney. Subsequently he shall report the case briefly to the Secretary of Commerce and Labor.

6. The Act does not apply to a vessel at the time of entering a port of the United States. Customs officers and wireless ship inspectors may, however, accept as evidence of the effi-

ciency of the apparatus and the skill of the operator wireless messages shown to have been transmitted and received by him over a distance of at least one hundred miles, by night or day, during the voyage to the United States.

7. In cases of violations of the Act the efficiency of the apparatus and the skill of the operator will be determined by the court (see Section 3 of the Act). Collectors of customs and wireless ship inspectors, accordingly, are enjoined that the reports required by paragraph 4 (*c*) of these regulations must be precise statements of the facts as the basis for proceedings by the United States attorney.

II.—*Operators*

1. Paragraphs 3 and 4 of Article VI of the Service Regulations, annexed to the Berlin International Radio-telegraphic Convention, provide:

3. The service of the ship station must be carried on by a telegraphist holding a certificate issued by the Government to whose authority the ship is subject. This certificate testifies to the technical proficiency of the telegraphist as regards:

(*a*) The adjustment of apparatus;

(*b*) Transmission and sound-reading at a speed which must not fall short of twenty words a minute;

(*c*) Knowledge of the regulations applicable to the exchange of radio-telegraphic traffic.

4. In addition, the certificate testifies that the Government has bound the telegraphist to the obligation of preserving the secrecy of correspondence.

The Berlin Convention has been ratified by the following nations, dominions, and provinces: Great Britain, Canada, Australia, British South Africa, India and New Zealand, Germany and all German protectorates, France, Norway, Japan, the Netherlands and Dutch Indies, Russia, Sweden, Austria-Hungary, Spain, Denmark, Belgium, Brazil, Turkey, Portugal, Roumania, Mexico, Bulgaria, Persia and Tunis.

Wireless operators holding valid certificates issued by the Governments named above will be recognized by this Department as persons "skilled in the use of such apparatus" within the meaning of the Act unless in the case of a specific individual there may be special reason to doubt the operator's skill and reliability. Such certificates should be ready at hand for the inspection of customs or other officers before the steamer departs from the United States.

2. (*a*) The Commissioner of Navigation will issue operators' certificates of skill (see Appendix A) in radio-communication and operators holding them will be recognized as persons "skilled in the use of such apparatus" within the meaning of the Act, unless in the case of a specific individual there may be special reason to doubt the operator's skill and reliability. Such certificates should be ready at hand for the inspection of customs or other officers before the ship departs from the United States.

(*b*) To secure a certificate an operator will pass an examination in the adjustment of apparatus, correction of faults, change from one wave-length to another, transmission and sound-reading at a speed of not less than fifteen words a minute American Morse, or twelve words Continental, as the operator may elect. Operators are advised to learn as soon as practicable the Continental system, recognized by the Berlin Convention and employed by the United States Navy.

(*c*) The examinations will be held at the United States navy yards at Boston, Mass., Brooklyn, N.Y., Philadelphia, Pa., Washington, D.C., Norfork, Va., Charleston, S.C., New Orleans, La., Mare Island (San Francisco), Cal., Puget Sound, Wash.; at the naval stations at Key West, Fla., San Juan, P.R., and Honolulu, Hawaii, and also at the Bureau of Standards, Washington, D.C. Applicants for certificates should communicate in writing with the commandants of the navy yards or stations named, or with the Director of the Bureau of Standards, to ascertain the day and hour when they can be examined. The certificates will be delivered at the places named.

(*d*) After an applicant has secured a certificate he should go before a notary public to take the usual oath for the preservation of secrecy of messages received in the line of duty.

(*e*) These examinations for the present will be open to—

(1) Operators actually employed as such by a wireless or steamship company, including shore operators;

(2) Operators seeking employment as such by a wireless or steamship company, including shore operators; and such applicants shall present letters from the company with which they seek employment;

(3) Applications for examination of operators of either class may be made by the wireless or steamship company in behalf of a number of operators by name.

3. Additional provision will be made later for the examination of operators by wireless ship inspectors at the New York and San Francisco customhouses and at other customhouses hereafter to be designated.

4. A wireless ship operator not possessing a certificate of skill as provided herein may present for the consideration of the visiting customs officer or wireless inspector other competent evidence of skill, or the wireless inspector may examine him, if practicable. If such examination be satisfactory, the wireless inspector will issue a certificate.

III.—*Apparatus*

1. When the efficiency of the wireless apparatus is certified by a foreign government, such certificate will be recognized by this Department, but the customs officer or wireless ship inspector may, if he deem it necessary or desirable, satisfy himself that the apparatus is in good working order.

2. Whenever practicable, the customs officer or wireless ship inspector shall satisfy himself on his visit before the departure of a passenger steamer subject to the Act that the apparatus is efficient and in good working order within the meaning of the Act, and, if satisfied, he shall issue a certificate in the form in Appendix B. Duplicates of such certificates shall be retained in the files of the collector of customs.

3. When inspection of the apparatus by a customs officer or wireless inspector is not practicable, the master of the steamer may furnish to the visiting customs officer a certificate in the form in Appendix C. Such certificate shall be retained in the files of the collector of customs.

4. The current necessary to transmit and receive messages shall at all times while the steamer is under way be available for the wireless operator's use.

5. A storage battery or some other auxiliary which will produce sufficient power to operate the transmitting apparatus for four hours, ordinary sending, should be suitably installed and ready for use in case of accident disabling the electric plant of the vessel. After January 1, 1912, vessels will be required to carry such battery or auxiliary.

6. One extra pair of head telephones and three sets of extra cords and one extra detector should always be kept on hand.

IV.—*Additions or Amendments*

Additional or amendatory regulations will be issued from time to time as they may appear necessary.

BENJ. S. CABLE,
Acting Secretary.

APPENDIX A

NAVIGATION SERVICE FORM 751

Operator's Certificate of Skill in Radio-Communication

This is to certify that, under the provisions of the Act of June 24, 1910, —— —— has been examined in radio-communication and has passed in:

(*a*) The adjustment of apparatus, correction of faults, and change from one wave-length to another;

(*b*) Transmission and sound-reading at a speed of not less than fifteen words a minute, American Morse, twelve words, Continental, five letters counting as one word.

The candidate's practical knowledge of adjustment was tested on a —— set of apparatus.* His knowledge of other systems and of international radio-telegraphic regulations and American naval wireless regulations is shown below:

—— —— ——.

(Signature of examining officer) —— ——

Place —— ——, Date —— ——, 191–.

By direction of the Secretary of Commerce and Labor:

—— ——,

Commissioner of Navigation, Washington, D.C.

I, —— ——, do solemnly swear that I will faithfully preserve the secrecy of all messages coming to my knowledge through my employment under this certificate; that this obligation is taken freely, without mental reservation or purpose of evasion; and that I will well and faithfully discharge the duties of the office: So help me God.

(Signature of holder) —— ——.

Date of birth, —— ——, ——.

Place of birth, ——, ——.

Sworn to and subscribed before me this — day of ——, A.D. 191–.

(*Seal*) —— ——, *Notary Public.*

(On back of Form 751)

Service Record

This is to certify that the holder of this certificate has served satisfactorily as wireless operator under my command during the period named.

Name of Steamer	*Period*	*Master*
....	From......, 19.., to......, 19	....
....	From......, 19.., to......, 19	....
....	From......, 19.., to......, 19	....
....	From......, 19.., to......, 19	....
....	From......, 19.., to......, 19	....
....	From......, 19.., to......, 19	....
....	From......, 19.., to......, 19	....
....	From......, 19.., to......, 19	....
....	From......, 19.., to......, 19	....

APPENDIX B

NAVIGATION SERVICE FORM 752

Certificate of Wireless Inspection

Port of —— ——
—— ——, 191–.

This is to certify that I have today examined the apparatus for radio-communication on the S.S. ——, of which —— —— is master, about to leave this port for ——, and I have found the same efficient and in good working order, as prescribed by the Act of June 24, 1910.

(Signed) —— ——,
Wireless Ship Inspector.
(Or) —— ——,
Customs Inspector.

APPENDIX C

NAVIGATION SERVICE FORM 753

Master's Certificate of Wireless Apparatus

Port of —— ——,
—— ——, 191–.

This is to certify that I have today examined the apparatus for radio-communication on the S.S. ——, of which I am master, about to leave this port for ——, and I have found the same efficient and in good working order, as prescribed by the Act of June 24, 1910.

(Signed) —— ——, *Master.*

* It is not intended to limit the employment of the holder to a particular system, but merely to indicate the particular system in which he was tested for adjustment of apparatus.

This certificate is valid for two years, subject to suspension or revocation by the Secretary of Commerce and Labor for cause. It should be kept where it can be shown to officers of the customs or other officers of the Government just before the ship leaves port.

DESIGNING AND DRAWING OF A SCREW PROPELLER

Considered from the Standpoint of Descriptive Geometry; also from the Shop or Pattern-Maker's Method

GEORGE JEPSON

Editor's Note:—The directions given in this article apply to the design of both ship and aeroplane propellers; the latter, however, being equipped with but two blades instead of four, in accordance with modern practice.

The drawings here may be considered part of a third year course given in a technical school or an evening school. Therefore the person who attempts to make these drawings should have a good knowledge of the principles of Projection.

We will first consider the drawing from the descriptive method. The principle employed in making the drawing for a ship's screw or propeller, each blade of which is practically a warped or helicoidal surface, is precisely the same as that in making the drawing for any other warped surface, such as a V or square-threaded screw.

Such surfaces, viewed from any standpoint, are always seen in oblique projection. The propeller may have two, three or four blades. In an ordinary screw, whose center lines are equidistant apart, all of the helical surface is used, while in the propeller only part of such a surface is used. To make a drawing of a propeller (Fig. 1) having the following dimensions:

Pitch, 4 ft. 6 in., or 54 in.;

Diameter 3 ft., or 36 in.;

Diameter of shaft is 4 in.; diameter of hub, 9 in.; the length of the hub is 10.3 in.; the taper of the shank is .75 in. to a foot; the thread of the nut that holds the propeller upon the shaft has 2.5 threads per inch, regardless of its other dimensions, and should be left-handed when the screw propeller is right-handed. The nut should be securely fixed to keep it from backing off.

The width of the key equals 0.22 times the diameter of the shaft, plus 0.25 in. The thickness of the key equals 0.55 times the width. The thickness of the blade is shown in section on Fig. 1, and is made 0.5 in. for every foot of diameter of the propeller, measured at the center of the shaft, as shown, and the point is made one-sixth that of the root. In addition to the thickness of the blade shown on blade *D* (Fig. 1) it also shows in section the different widths and thicknesses of the blade upon each of the different concentric circles.

Then, to draw the warped surfaces of the blades, first draw two perpendicular diameters, and make a circle which represents the disc view of the imaginary cylinder, which circumscribes the greatest diameter of the propeller. Then divide the radius of the circle, beginning at the circumference, into four or more equal divisions, and through those points (2, 3, 4 and 5) draw concentric circles. The fourth circle may coincide with the hub.

Now divide the circumference of the disc view into any convenient number of equal divisions, just as the end view of the design of a common bolt would be divided.

Suppose the propeller to have four blades, and the number of divisions of the diameters to be 36 (9 for each arc of 90' degrees). From these points of divisions on the outer circle draw radial lines, thus dividing the inner concentric circles into the same number of similar and proportional parts.

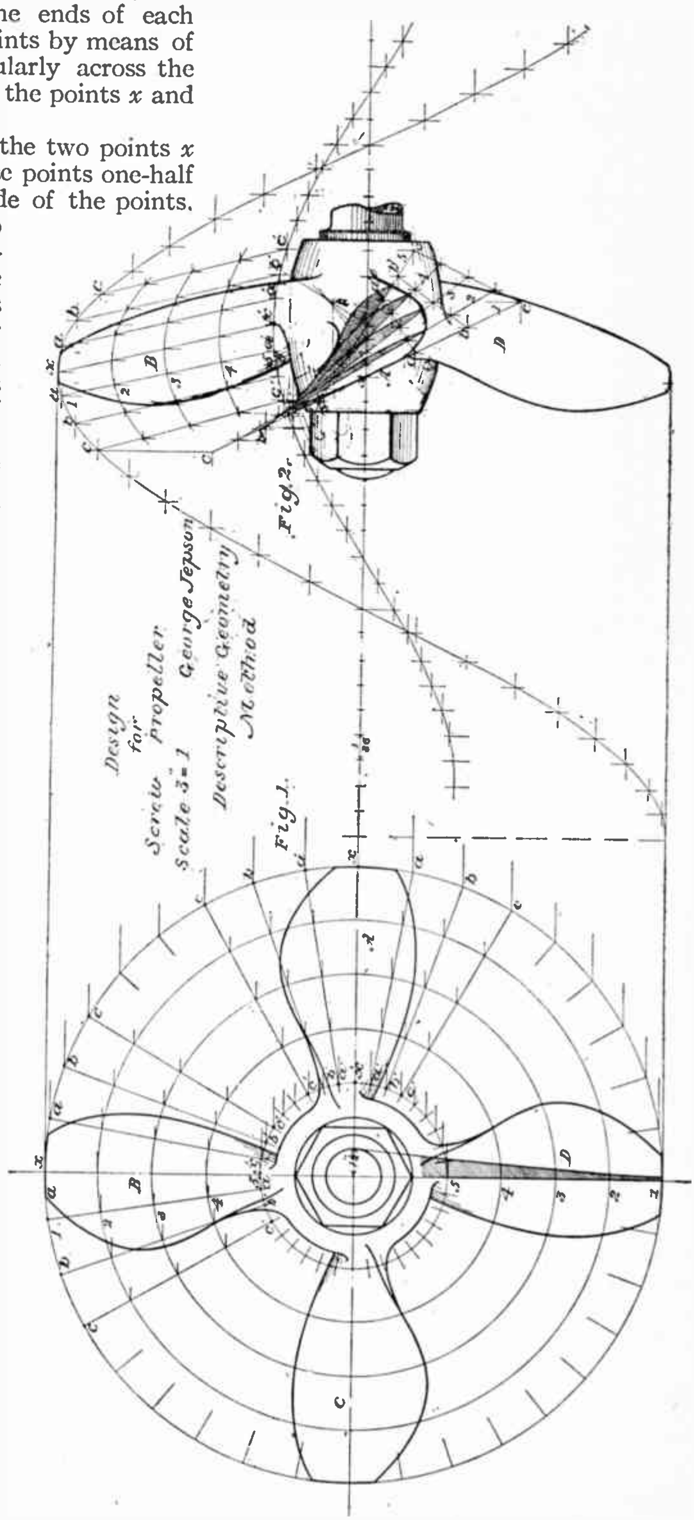
Now draw the hub and the outline of the four blades about the four center lines, according to your best general idea of their shape (about which experts differ very much). They should be of such a dimension that they will be contained within about 16 of the radial divisions—four divisions, more or less, for each blade.

The lines governing their shape will intersect the concentric circles, which are really end views of helices, and the radial lines in various points.

To draw the edge view of the propeller (Fig. 2), wherein the propeller shaft is seen parallel to the projecting plane, first project the imaginary cylinder containing the propeller, together with its axis, and draw the projecting lines of every point found in the disc view.

Begin with the points x and x', the middle points upon the ends of each blade, locating these points by means of a line drawn perpendicularly across the line just protected from the points x and x' in the disc view.

Now, having located the two points x and x', lay off from those points one-half of the pitch on each side of the points, and divide the pitch into 36 equal divisions already used in the disc view, and draw by means of these divisions, all or only that part to be used of the four helical curves which form the ends of the blades.



As we are to make the blades rake away from the ship, the position of x' at the middle of each blade is on Fig. 2 placed 2 of the 36 divisions to the right of x. (It may be placed a greater or less number of divisions.)

Now draw the helical curves Nos. 1 and 5 containing the points x and x', respectively, and making x and x' the middle of its own pitch. It should be clearly understood that the helical curves forming the bottoms of the threads of any bolt, V or square, travel just as far along the bolt as the helical curves forming the point of such threads. Therefore, beginning at x' (Fig. 2) the division already laid off may be used.

Now connect by straight lines the points x and x', also the points a, b and c, as shown upon the drawing in the larger curve No. 1, with the similar points, a', b' and c' in the smaller curve numbered 5. These points have already been located by projection from the disc view. These lines represent the radial lines of the disc view, as seen in the edge view in oblique projection.

Draw the other helical curves, 2, 3 and 4; then locate in similar lines in the edge view all other points of the disc view, thus completing the edge view minus the thickness of the blade.

The thickness is best shown upon the blade extending toward the draughtsman, which is at right angles to the projecting plane, and which is marked "blade *A*" in the drawing (Fig. 2).

In the edge view the concentric circles of the disc view are represented by helical curves, all of which are shown as being drawn upon the front surface of the blade.

The section of the blades shown upon "blade *D*" (Fig. 1), shows the different thicknesses at the different concentric circles.

Having already obtained the widths in projection upon *A* and *B* in both Fig. 1 and Fig. 2, we will now proceed to show as much of the thickness as is possible in both figures, more especially in Fig. 2.

Referring to the section drawn upon "blade *D*," a line is seen passing through the center of the shaft and intersecting the different concentric circles at the points 1, 2, 3, etc., and the thickness is shown extending from this line toward the stern of the ship, *viz.*, it extends away from the center line, as shown in the section, and is measured back at right angles to the lines drawn upon the face of "blade *A*" (Fig. 2), beginning at point *x′* and similarly from all other points upon the oblique center line *x′* and *x*. Then through the two points showing the apparent width, and the point measured back from the center of those points showing the thickness, we shall have three points through which we will draw an arc of a circle, which represents the thickness in section.

As stated, the thickness nearest the hub is .5 in. for each foot of the diameter of the screw, and the point thickness equals one-sixth that of the root.

Suppose that in Fig. 2 on "blade *A*" we have drawn all the sections in their respective positions, they will appear to overlap each other, as shown in the drawing.

If we now draw a line tangential to the backs of those sections, we shall have shown a line representing the thickness

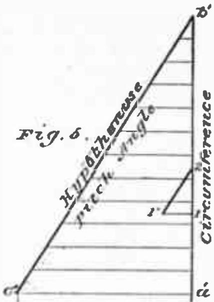


Fig. 5.

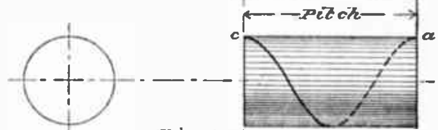


Fig. 4.

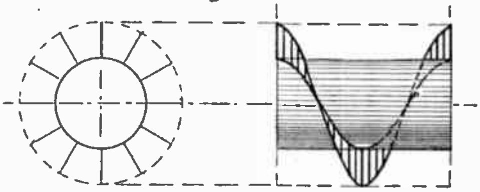


Fig. 3.

of the blade in that particular position. Any change of position, of course, would change such a line. Now it is for the draughtsman to transfer this thickness to the disc view.

It is almost impossible to represent by lines the merging of the blade into the hub without a model.

WORKSHOP OR PATTERN-MAKER'S METHOD

If a straight line, shown in the end view of Fig. 3, placed at right angles to the axis of a cylinder, be moved along, and at the same time around, the cylinder, as shown in the other view of the same figure, the line will generate a surface called a helicoidal or warped surface, part of which is used to form the blade of a propeller. The path traced upon the cylinder by the end of this line is known as the "helix or helical curve," and is again shown in Fig. 4. The top element of the cylinder in Fig. 4 is marked *a c*, and represents the pitch.

At some convenient distance from *ac* and parallel to it, draw the line *a′c′* (Fig. 5), which again represents the pitch of the screw. At *a′* erect a perpendicular *a′b′*, whose length equals the circumference of the cylinder of Fig. 4. Join *b′* and *c′*, and we have the hypothenuse of a right angle triangle. This represents the developed helical curve. Then angle formed by the lines *a′b′* and represents the "pitch angle" of the screw propeller.

If upon the line $a'b'$ in the right angle triangle we assume two points 1 and 2, any distance apart, say one-sixth of the line $a'b'$ (which is the circumference), and erect a perpendicular at point 1, whose length is also one-sixth of the pitch, and draw the smaller triangle 1'21, we shall find that its hypothenuse 1'2 is parallel to the hypothenuse $b'c'$, and all angles of the triangle are equal. Hence, in the drawing and designing of a screw propeller, instead of using all of the helical curve, as in the Descriptive Geometry method, we shall use only a certain portion of the pitch and a similar portion of the circumference.

We will now make a drawing of a propeller having the following dimensions:

Pitch, 4 ft. 6 in. equals 54 in.
Diameter, 3 ft. equals 36 in.
Radius, 1 ft. 6 in. equals 18 in.
Circumference, 9.42 ft.

Then, according to our text, we can obtain the pitch angle of a screw propeller by constructing a right angle triangle, whose long side will equal the circumference of the circle at the blade tip, and whose short side will equal the pitch of the propeller, the angle formed by the long side and the hypothenuse being the pitch angle.

For convenience in drawing we will make a similar but smaller right angle triangle, whose sides are obtained by dividing the sides of the larger triangle by 6.28 rather than by 6 as illustrated above.

The convenience of this choice is readily seen by noting that the *long* side becomes

$$\frac{\text{Circumference}}{6.28} = \text{radius},$$

which can be laid off at once. This, of course, requires the *short* side to be

$$\frac{\text{Pitch}}{6.28} = \text{in this case } \frac{54''}{6.28} = 8.59''.$$

This gives for the present design the right angle triangle having these dimensions: 18 in. radius of screw for long side of triangle, and 8.58 in. for short side of triangle.

First draw the outer circle (marked *xo*) of the disc view (Fig. 7) to any scale. The scale of drawing here is 3 in. to 1 ft.

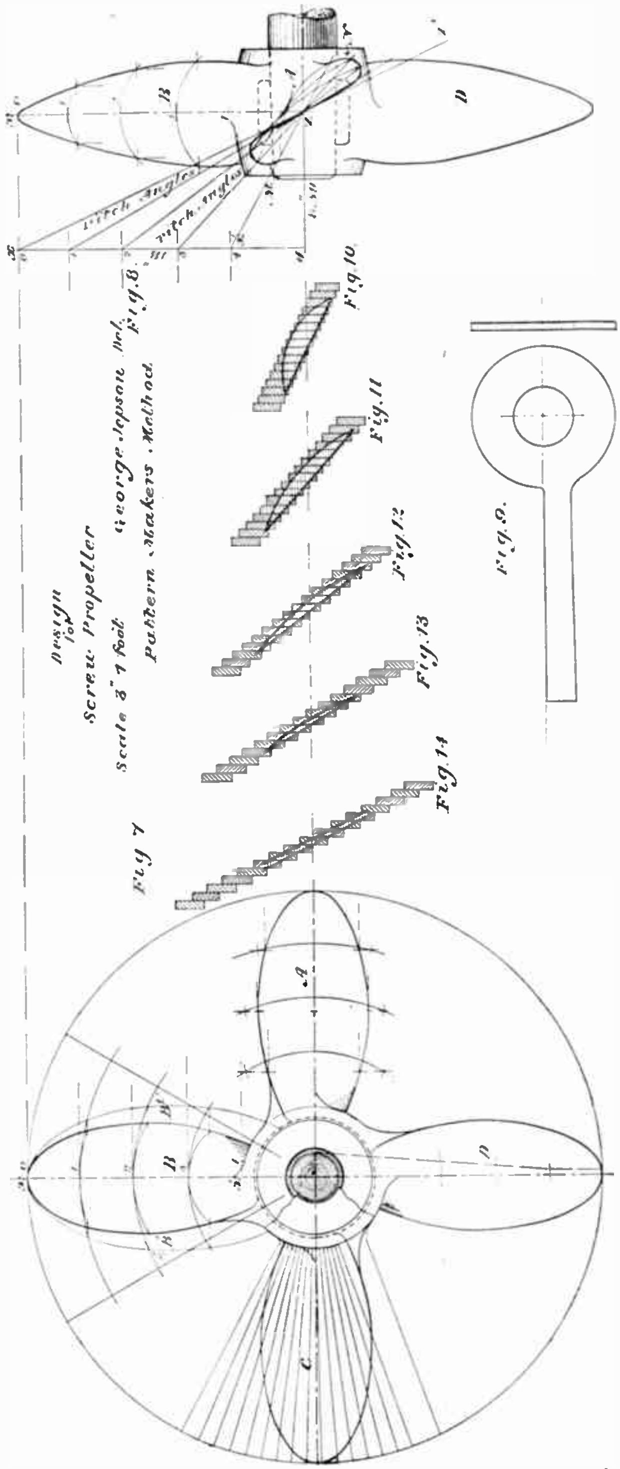
This is to be a four-bladed screw. Draw two diameters of the circle, as in Fig. 7, at right angles to each other. The four radii of this circle are the center lines of the four blades. The outline of the developed blade of the Standard Admiralty or Government screw is a true ellipse, the major axis of which equals the radius of the screw (in this case 18 in.) and the minor axis is made five-tenths that of the major (in this case 9 in.). A successful builder of steamships in this country makes the disc area of the screw, for single screws, 35 to 36 percent of the immersed midship section of the vessel, and that of double screws 42 to 46 percent.

Now draw the true ellipse, marked B', in Fig. 7, by trammel or otherwise, on the two dimensions given, 18 and 9 in. The blades in that position will occupy an arc of about 60 degrees. Therefore on either side of the radial line of blade B lay off an angle of 30 degrees, as shown by Fig. 7. Now draw a series of equidistant concentric circles (in this case 4), making one of those circles coincide with the hub. (For dimensions, see Appendix A). These circles are numbered 0, 1, 2, 3, 4. (0 is the circle of the greatest diameter), the fourth circle being part of the hub, as stated. This network of lines formed by the two radial lines and concentric circles partially contain the elliptical blade B in its parallel position.

To draw the edge view of this blade, assume any point Z on the horizontal center line, and at some convenient distance to the right, as shown on Fig. 8. As this screw is to be a right-hand one, measure from point Z to the left, as shown (8.59 in., as per formula), calling this line ZY, and from Y erect a perpendicular (YX) whose length equals the radius of the screw (18 in.). Draw a line from X through Z, say, to Z'; the line XZ is the hypothenuse of right angle triangle, XYZ. This hypothenuse represents the pitch angle of the screw for this part of the blade. Now project the points 1, 2, 3 and 4 in the radial line in Fig. 7, into the line XY in Fig. 8, which also represents the radius of the screw, and draw from those points through Z indefinitely. Those lines will represent the pitch angles of those particular parts of the blade; *i.e.*, as the diameters of the different concentric circles become smaller, the angles necessarily become larger, because the pitch remains the same.

Z and O represent the same point in blade A; Z being the tip of the screw blade, practically has no dimensions (see section on Fig. 7). Now from *Z* in Fig. 8, we will lay off (on their respective pitch angles) the different true widths, taking those widths from the true shape of the ellipse in Fig. 7 (from the blade marked *B*). Through these points we will draw a smooth curve when we shall have an outline (minus the thickness) of blade *A* in projection, and when this blade is extending towards the draughtsman and at right angles to a vertical plane. From blade *A*, Fig. 8, we may now project the apparent widths to the blade *A* in the other view in Fig. 7. These apparent widths may now be transferred to the other three blades, *B*, *C* and *D* in Fig. 7. The other view of *B*, Fig. 8, is found by the intersections of vertical lines, drawn from the points in blade *A*, with horizontal lines from the same points in blade *B*, Fig. 7.

This will complete the outlines of all the blades in both views. The thickness is best shown upon the blade *A*, Fig. 8, whereupon we may imagine and draw sections taken parallel to a vertical plane, hence at right angles to blade *A*, and at the distances from the center of the screw which coincide with the concentric circles, and shown overlapping each other on blade *A*, Fig. 8. One method of determining the different thicknesses at the different concentric circles is shown in Fig. 7, blade *D*, whereon a section is taken through the center of this blade, passing through the center of the shaft. The thickness is shown measured from this line back towards the stern of the ship. The greatest thickness is shown at the center of the shaft, Fig. 7, and is made .5 in. for every foot of diameter of the screw.



This, being 3 ft. in diameter, would make the thickness 1½ in. So from this point, 1½ in. back from the line, a line is drawn to the tip of the screw which, as previously stated, has no dimensions. Yet it is customary to give some small dimension and make it run parallel for a short distance from the tip, as is plainly shown in Fig. 7. Now, referring to the line nearest to the center of the screw *Z4*, Fig. 8, having already shown upon this line the true width, and point *Z* being the center, we will set off from *Z*, and at right angles to the line, the thickness shown by the cross section on the concentric circle, Fig. 7, blade *D*.

We shall then have three points through which we will draw an arc of a circle. That section will then represent the true section of this blade, taken at that particular place. The other sections will be similarly drawn upon their respective lines—*Z3*, *Z2*, *Z1*. A line drawn tangential to these sections on blade *A*, will represent a back line; that will be the nearest we can come to showing the thickness, as it merges into the hub of the screw. We are now ready to get out the stock from which to make the model.

Suppose that on Fig. 8 the horizontal distance between *M* and *N* is 7 in., and across the hub it measures 8 in., and that we use stock ½ in. thick, it will take 16 pieces ½ in. thick to make the screw, including the hub, which, of course, is part of the screw. The shape of the stock is shown in Fig. 9; the face of the stock is in a plane passing through the center of the shaft.

The cross sections of the assembled 16 pieces of stock for a blade are shown in Figs. 10, 11, 12, 13 and 14, wherein each section is represented isolated from, and parallel to, its own section in Fig. 8.

From the center point of Fig. 10, and upon the center line, we will measure eight ½ in. each side, and draw through those points vertical lines, as shown in Fig. 10. The depths of these pieces of stock will of course be limited by the thickness of the section, as shown. On blade *C*, Fig. 7, we have shown the lengths of these 16 pieces of stock; also the widths as they are placed, one over the other, to occupy an arc of about 60 degrees. The pieces are held in that position by glue and nailed temporarily until the glue sets.

Appendix A

A usual proportion for hubs equals the diameter of the screw divided by 3 to 4), making the dimensions for this hub 9 in. to 36 in. divided by 4 equals 9 in. diameter.

The length of the hub equals the diameter of the shaft, multiplied by 2.5, making the length of this hub 10.3 in.

The following formula for finding the diameter of the shaft may be used:

Diameter of the shaft equals the cube root of (70 multiplied by the horse-power, divided by the revolutions per minute.)

Assume the revolutions to be 100 per minute, and assume the horse-power to be 100. Then:

$$D=\sqrt[3]{\frac{70 \times 100}{100}} \qquad D=4.121 \text{ diam. of shaft.}$$

The formula for finding the horse-power, when diameter of shaft and revolutions are given, is the following:

The horse-power equals the cube of the diameter multiplied by the revolutions, the product divided by 70.

$$\text{H.P.}=\frac{D^3 \times \text{rev.}}{70}=\text{H.P.}=\frac{70 \times 100}{70}=\text{H.P.}=100$$

To find width of the key:

Width of key = 0.22 x the diameter of the shaft + 0.25.

Thickness of key = 0.55 x its width = 0.55 x 1.156 = 0.6358 = ⅝ in.

THE GROWTH OF ELECTRICITY ON RAILROADS

AUSTIN C. LESCARBOURA

A problem claiming the attention of the foremost engineers and authorities is before us. Shall steam locomotives be replaced by electrically-operated cars, and to what extent? The question is interesting, the opinions contradicting, and while the writer is not in a position of voicing an opinion, he will endeavor to review the subject from a popular standpoint.

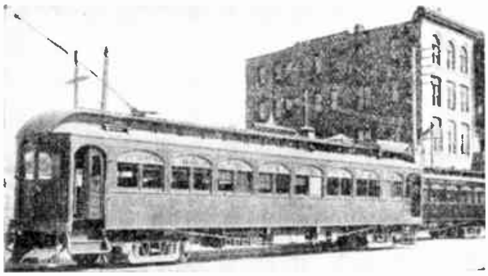


Fig. 1
Salt Lake and Ogden Railway Cars

The idea of electrically-operated railways is not a new one, and the first attempt at electrical cars dates back to 1835, when Stratingh and Becker of Gronigen, and Botto in Turin, constructed, respectively, their magneto-electric carriages. These experimenters are not the only inventors who were working on the problem, but their names stand forth as successful workers. The first practical electric railroad came much later, at the electrical demonstration of the Industrial Exposition of Berlin, in 1879. The tracks on which the car traveled were of a closed oval form, and about 900 ft. long.

The car consisted of a platform mounted on four wheels. Upon this platform, and covered with a wooden top, reposed a large Siemens motor, with its shaft revolving in parallel direction to that of the rails. By means of suitable gearing, the mechanical power was conveyed to the wheels. The current was supplied to the car through a third rail located in the center of the two regular rails, and the return circuit through the regular rails. It is interesting to compare this locomotive with the present electric street cars, for it required all the available space on the platform to accommodate the motor; whereas it is the practice at the present time to have the powerful motors placed below the car, and all the space above utilized for other purposes. Other exhibition railroads were built, but it was not until 1881 that the first permanent electric railroad was inaugurated at Lichterfelde by Siemens and Halske.

The installation of an industrial railroad at Breuil-en-Auge, at about the same time, created wide interest in the electrification of railways, and its possibilities. This system was designed by Clovis Dupuy, and proved a success in every respect.

The rails extended 2,040 meters over swampy ground, and owing to the difficulty of insulating the current under such conditions, it was decided to use accumulators in a tender hauled by the locomotive. The battery was composed of six cells of the Faure type, weighing 8 kg. each, and requiring seven to eight hours to charge. The locomotive proper contained a Siemens machine, occupying approximately half of the available space in the car. The motor not only performed the mission of propelling the car, but also served to rotate rollers which hauled long linen strips into the car.

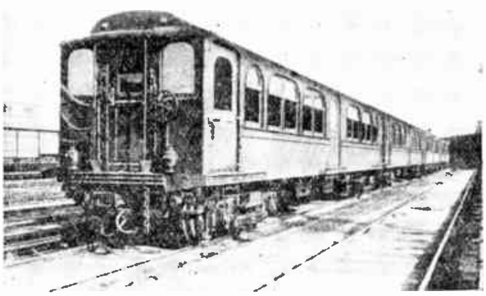


Fig. 2
The Hudson and Manhattan Railway Cars

Linen in long strips was spread on the ground to dry, and by means of rollers, it was possible to rapidly draw same into one of the trailers of the train. The locomotive could lift a weight of 935 kg., and the haulage power consisted in pulling the accumulator car, weighing 700 kg., and six other carriages, each weighing 800 kg., making the total weight of 6,400 kg., at the rate of a few miles per hour. As for the gathering of the linen, it did this work at the rate of 125 meters per 48 seconds, or the work formerly requiring seven men four or five hours, in one-half hour with but two men.

The Lichterfelde railroad was but 2½ km. in length. The motor was,

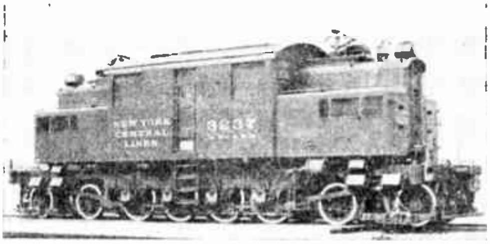


Fig. 3
The New York Central and Hudson River Locomotive

contrary to the previous types described, placed under the car, and between the two sets of wheels. It was a four-pole opposed affair, similar to two bipolar Edison motors placed facing each other with a common armature for both. Flexible belts conveyed the mechanical energy to both sets of wheels. The regulation of the speed was controlled from the platform, by means of inserting resistance as desired. This car represented many points embodied in regular street cars today, and the general appearance was identical but on a smaller scale. The car was capable of developing a speed of 40 km. per hour with 26 passengers. Copper strips were used between the ends of the rails, similar to the "bonding" process used today.

In 1884 the Molding-Bruhl line was lengthened, and overhead feed system employed. Instead of wire, hollow tubes were used, with a slot at the lower side. "Boats," or sliding parts fitting within these tubes and protruding through the slot, collected the current which traveled down the flexible wire to the car. The return current was sent through the rails. Two pipes were connected on each cross piece, the entire length of the track, for these "boats" could not pass each other, and the single track was used for cars traveling in opposite directions at the same time. It is noteworthy that this was the first railroad on which electric cars with more than one operating at a time were introduced as it was previously thought that such a performance would be impossible. These sliding contacts even today would possibly solve the difficulty of the trolley systems, when the small wheel leaves the wire. However, there are many devices which have been brought forward within the last few years, and which are simpler and just as effective, but strangely are not used in regular practice.

Coming nearer home, we find the first practical railroad of any size built in Richmond, Va., by Frank J. Sprague. The total rails covered 12 miles, with many curves and some 10 percent grades. The initial equipment consisted of 40 motor cars in 1888, and after conquering many difficulties, success was final, giving to America the embryo of its present day network of electric street railways.

The next ten years witnessed a continual battle being waged by various inventors with unique and queer ideas. Various interests were urging municipalities to place the ban on overhead trolley systems, claiming them "dangerous to human life, and a menace to property;" and so the battle kept raging, but the various interests were gradually being eliminated, with the most worthy remaining. Then the roads began to grow with remarkable rapidity, and the

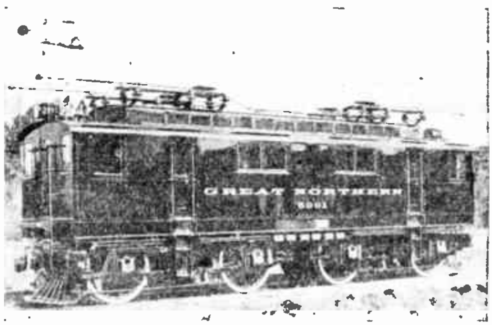


Fig. 4
The Great Northern Electric Locomotive

public was gladly induced to furnish the necessary money to carry on the work. Today, we find the electric car in every city of reasonable size, and, in fact, for inter-urban service, competing with the

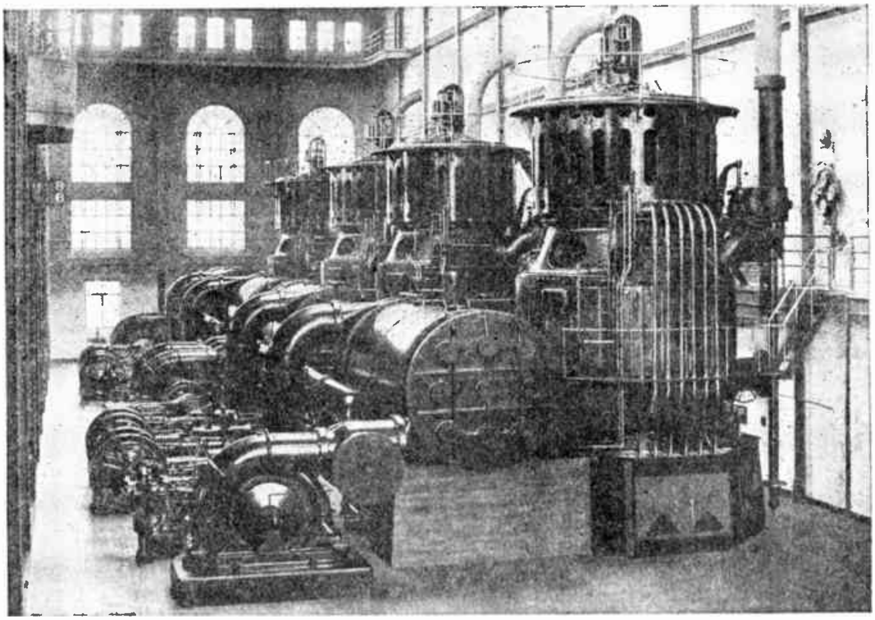


Fig. 5
The New York Central Power House

steam railroads, both for rates and for speed. Fig. 1 shows a model type of car, in this case being the cars used in the electrification of the Salt Lake and Ogden Railway. The total length of the road is 41 miles, and it has been electrically operated during the last few years only. Each car is equipped with four 100 h.p. Sprague G.E. motors, with the Sprague system of multiple unit control.

The first example of the electric current invading the steam railroad field was in 1895, when the General Electric Company undertook the electrifying of the Nantasket Branch of the New York, New Haven & Hartford R.R. Following this successful displacement of steam came the electrification of the Baltimore tunnel on the Baltimore & Ohio R.R. Since that time, there has been a gradual increase in the electrification of steam railroads, until today the question arises, "Shall steam locomotives be abolished?"

Various railroads have electrified their systems in whole or in part, and have different ideas as to the change. It is alleged that one road, after electrifying this 100 miles of double track, finds same a failure. Then again, some roads are very enthusiastic over their substitution, and prepare for more to follow. The New York Central & Hudson River R.R., probably the second railroad in the East, has electrified its system to High Bridge, N.Y., and contemplates extending this system within the immediate future to Croton, N.Y., a distance of 34 miles from the terminus. It is the understanding that the system will eventually be electrified to Buffalo, and current obtained for the best part, if not for all the system, from Niagara Falls water power.

Before giving just brief data on the electric locomotives we will roughly cover the right of way. For supplying current, there are two methods generally used, with the various systems falling under one or the other of these two methods. The overhead system usually is employed with either a trolley wheel making the contact or a flexible diamond-shaped mechanical affair, which raises or lowers by means of compressed air at the will of the motorman. This arrangement is far more practical than trolley wheels for fast locomotives. The third rail system consists of having an additional rail laid on the outside of the two regular traffic rails. The current is collected by means of a contact "shoe." It is used in various forms, but the generally accepted and most improved type is where the rail hangs downwards, and the contact is made from underneath, allowing the three other sides to be completely encased in wooden covers. This makes accidental contact impossible, and only deliberate intention to incur personal injury can cause accident.

The electric locomotives are employed for hauling freight or passenger trains. For suburban traffic, unit motor cars are used; and each car has its own motor equipment, and is controlled from the master controller by a series of wires and magnetic switches. The Southern Pacific R.R. operates the Oakland and Alameda (Cal.) division with such cars. The trolley wire carries 1200 volts direct current, which is collected by a special collapsible arrangement. Each car is equipped with four 125 h.p. motors and the Sprague G.E. control. The Hudson & Manhattan Railroad, operating the cars through the Hudson River tunnels, uses similar cars, which are constructed entirely of steel, and have cement floors. Each car is equipped with two 160 h.p. motors and the Sprague multiple control. The New York Subway cars are similar in general design. An illustration of the tunnel cars is given in Fig. 2.

Electric locomotives vary considerably in design, but more or less the details are universal. In Fig. 3, we have a photograph of the type used on the New York Central & Hudson River R.R. The equipment of that road consists of 137 unit motor cars, and 47 100 to 115-ton gearless locomotives. Contrary to the general practice, no gears are used in these locomotives, but the armature is built directly on the shaft of the wheels, and, in fact, becomes part of same. The current is collected from a third rail by means of a contact shoe which catches the rail from underneath. In cross-overs or confused track switches, overhead trolley wires are used, and the collectors on top of the locomotive brought into play. The following data gives the complete electrical and mechanical details of interest:

Electrical

Voltage, 600 direct current.
Rated Amperes, 3,000.
Rated tractive effort, 20,000 lbs.
Maximum tractive effort, 35,000 lbs.
Total rated horse-power, 2,200.
Number of motors, 4.
Type of motor, G.E. bipolar.
Speed at rated amperes, 40 miles per hour.

Mechanical

Diameter of drivers, 44 in.
Number of driving wheels, 8.
Diameter of guiding wheels, 36½ in.
Total wheel base, 36 ft.
Rigid wheel base, 13 ft.
Width overall, 10 ft. 1 in.
Length, 43 ft. ½ in.
Height over cab, 13 ft. 9 in.

Weights

On drivers, 142,000 lbs.
Per driving axle, total 35,500.
Per driving axle, dead weight, 12,900.
Per guiding axle, total, 22,000.
Electrical equipment, 60,000.
Mechanical equipment, 170,000.
Total 230,000 lbs.

Another example of a successful type, is that of the Great Northern R.R. used on the electrified Cascade Tunnel division, which is noteworthy, inasmuch as it is our first three-phase railroad in America. The current is collected by trolley wheels from the overhead wires, at a potential of 6,600 volts. There is a continuous 1.7 percent grade on the system, and in some sections this even rises to 2.2 percent. Trains of 2,000 tons are hauled up the grades at a speed of 15 miles per hour. The entire installation and equipment was furnished by the General Electric Co., and Fig. 4 illustrates the locomotive used, of which there are but four at the present time in use on the Great Northern R.R., comprising the initial equipment. The data on this type is as follows:

Electrical (Continuous Rating)

Voltage, 6,600, three-phase A.C. 25 cycles.
Rated amperes, 91.
Rated tractive effort, 25,000 lbs.
Maximum tractive effort, 57,000 lbs.
Speed at rated amperes, 15.2 miles per hour.
Total horse-power, 1,000.
Number of motors, 4.
Type of motors, G.E.I. 506.

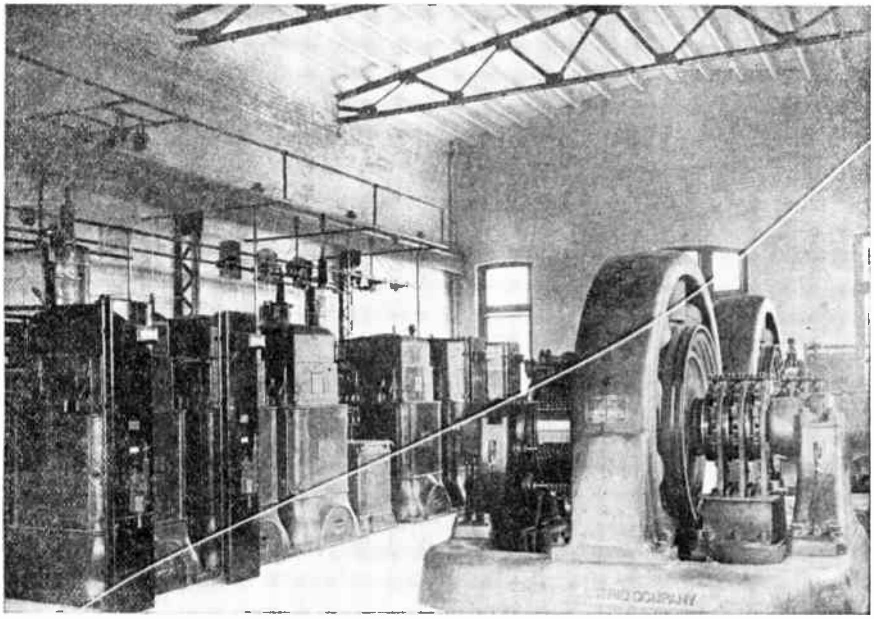


Fig. 6
Atlantic City Power Station

Mechanical

Diameter of driving wheels, 60 in.
Number of driving wheels, 8.
Diameter of guiding wheels, none.
Total wheel base, 31 ft. 9 in.
Rigid wheel base, 11 ft.
Width overall, 10 ft.
Length, 44 ft. 2 in.
Height over cab, 14 ft. 3 in.

Weights

On drivers, 230,000 lbs.
Per driving axle, total, 57,500 lbs.
Per driving axle, dead, 18,300 lbs.
Electrical equipment, 108,000 lbs.
Mechanical equipment, 122,000 lbs.
Total, 230,000 lbs.

Among the many electrified systems, the following are of note, and a passing word on each would be of interest. The Detroit River Tunnel, on the New York Central Lines, connects the Michigan Central tracks in the States with those in Canada. The tunnel is double-tracked with long grade approaches at each end. The current is supplied at 600 volts D.C. from the Detroit Edison Co. The total equipment consists of six 100-ton locomotives, similar to the type described in the preceding paragraphs of the New York Central R.R.

The Baltimore & Ohio R.R. has much improved its original electrification, and at the present time has four 80 ton, two 90 ton geared locomotives, and the original three 90 ton gearless locomotives.

The West Jersey & Seashore R.R. operates between Camden and Atlantic City, N.J., and is a branch of the Pennsylvania system. The road was converted from steam to electricity in 1906. The cars are of the multiple control unit type, each car having two 200 h.p. motors and the Sprague G.E. control. The entire mileage includes about 150 miles of track, and the power equipment of one power house of 6,000 kw. capacity, with eight sub-stations located along the lines. Sixty-eight cars are in operation at present, and maintain the schedule time of over 60 miles per hour.

The West Shore R.R. operates one of its divisions between Syracuse and Utica, which was electrified in 1907. The total mileage is 44 miles between terminals, and is equipped with third rail. The main power plant is located at Utica, and consists of Curtis steam turbine generators, transmitting 60,000 volts over the line to the four sub-stations. Each car is equipped with four 75 h.p. motors with the Sprague multiple control.

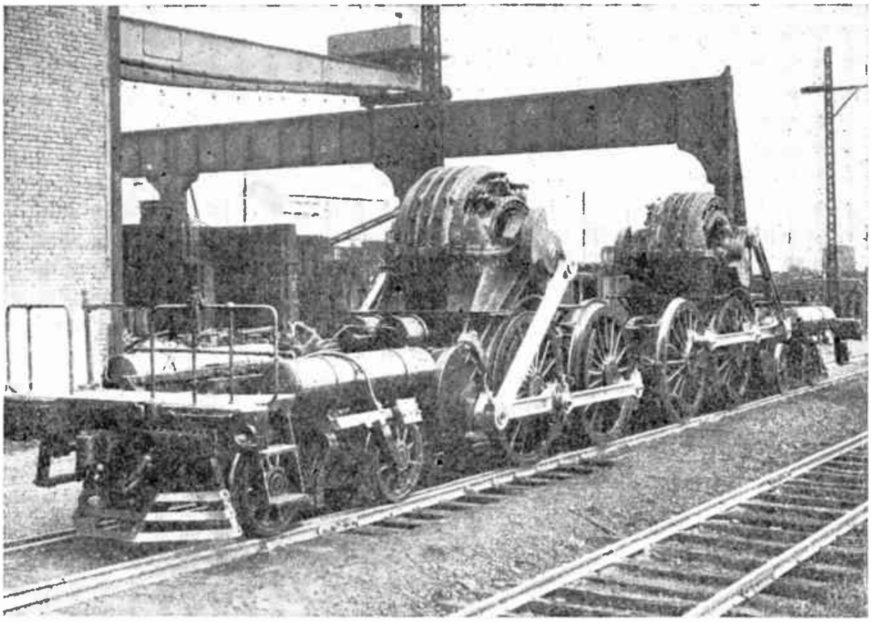


Fig. 7
The Motor Equipment of the Pennsylvania Locomotive

The Pennsylvania Railroad after exhaustive studies selected Westinghouse locomotives (600 volts direct current) for its New York terminal installation, which is one of the greatest engineering accomplishments of the age. These, the most powerful electric locomotives in existence, haul heavy passenger trains from Manhattan Transfer station near Newark, N.J., to the magnificent new Pennsylvania terminal in the heart of New York City. In addition to the locomotives, the entire equipment is of the Westinghouse type.

One typically progressive feature of the Pennsylvania locomotives is the use of Westinghouse field control for speed regulation. With the field control the locomotives can run at very high speeds, when necessary, and at the same time they can start the heavy through Pullman trains and operate them over certain sections at low speeds, with the minimum consumption of current from the distributing system. Each locomotive weighs complete, 157 tons and exerts a maximum draw pull of 79,200 lbs. The normal speed with a full train load is 60 miles per hour. Two electric motors exerting a joint power of 4,000 h.p. are located in the cabs of the two sections composing one locomotive. These motors are connected by driving rods to the wheels, as shown in Fig. 7. A complete view of the locomotive is given in Fig. 8.

In Fig. 9 we have an illustration of a N.Y., N.H. & H. electric locomotive drawing a train. The line is of the single phase alternating current type, and supplied by overhead feeders of a substantial construction. The railroad has 35 miles of double track main line electrified, leading out of New York to Stanford, Conn. The locomotive easily handles an 800 ton passenger train at 50 miles per hour, or a 1500 ton train at 40 miles per hour. The trolley voltage is 11,000 volts, and the highest insulation used throughout.

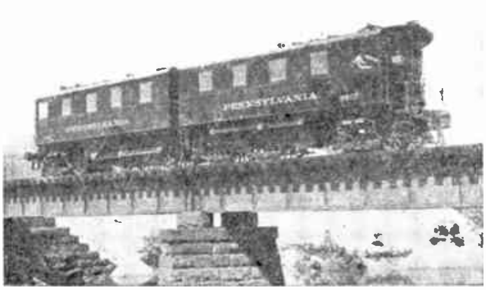


Fig. 8
The Pennsylvania Electric Locomotive

The power plants comprise one of the largest expense factors in the change from steam to electricity. Two methods are available for transmitting the current to be used, one of which is to supply the high potential current (alternating) directly through the trolley wire or third rail to the locomotive, and the other, which is more common, to transmit high voltage alternating current to sub-stations, where it is passed through transformers and rotary converters, then re-transmitted in the form of lower voltage and direct current to the third rail or trolley. The New York Central R.R. employs the latter method, having two power houses of 20,000 kw. at Port Morris, N.Y. Curtis steam-turbine-driven generators of 5,000 kw. per unit are used. The alternating current is transmitted to the numerous rotary converter stations where it is changed to direct current as well as stepped down to 600 volts. Fig. 5 shows one of the power stations at Port Morris. Fig. 6 illustrates a typical rotary station, in this particular case being that of the West Jersey & Seashore R.R. at Atlantic City, N.J. The transformers are noticed at the left-hand of the picture, while the rotary converter is noticed to the right of these.

The Great Northern R.R. has a power plant consisting of waterwheel-driven generators. The current of 33,000 volts is transmitted 33 miles to the mouth of the Cascade Tunnels, where a transformer station steps it down to 6,600 volts, the working voltage of the electric locomotives.

Whether electricity can prove superior to steam on the trunk railroads, is a problem upon which only the highest authorities can verse an opinion. A capable engineer has stated that while electricity will eventually replace steam for both local and long-distance passenger traffic, it will never replace the time-honored freight locomotive with its long string of cars. The writer has before him at the present moment an old engineering book which states in part: "At some future day, we may publish a special work on the history of the development of the electric railroads in America, and elsewhere, but at the present time (1891), there are so many electric railroad enterprises before the public, that it would be taking a flying shot to describe them further than to mention some of the chief in success and excellence." It illustrates that from the confused mass of ideas and inventions existing in 1891, the final perfected street railroad, employing electricity as motive power, was evolved. Why is it not logical, in consequence, to expect that the electric railroad will in as many years hence have been simplified and universally adopted?

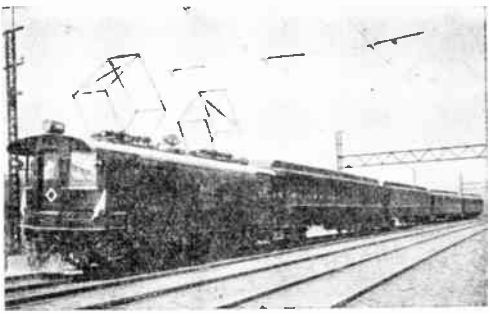


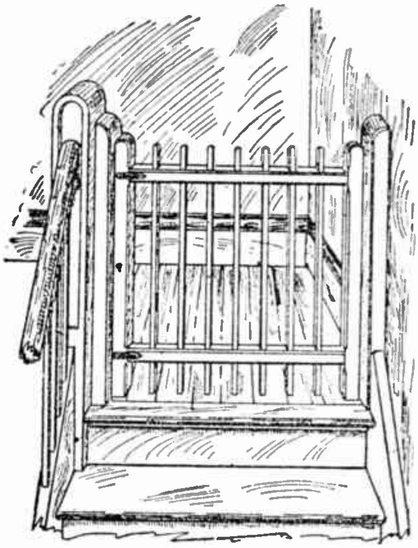
Fig. 9
N.Y., N.H. & H. Electric Locomotive

A SAFETY GATE FOR THE STAIRS

H. JARVIS

A small gate, either at the top or bottom of the stairs, is a necessity in all houses where young children are present. Its position largely depends upon circumstances. If the nursery is downstairs, the gate should be at the bottom, to prevent them climbing up and falling down again, but if, as is usually the case, it is upstairs, the gate should be at the top, to keep them from straying on to the stairs, which is as a rule the first place they will make for.

In Fig. 1 we show such a gate fixed at the top of the stairs, the hanging piece being screwed to the wall, and the shutting piece being fixed to the newel of the stairs. The plan of this arrangement is shown in Fig. 2, the various parts being marked as follows: *A* hanging piece, *B* shutting piece, *C* stiles of gate, *D* bars of gate, *E* rails of gate, *F* newel, *G* floor, *H* base-board. The height of the gate should be about the same as shown in comparison with the height of the newel,



Safety Gate for the Stairs

and the width will, of course, depend on the space to be filled. The hanging and shutting pieces should be fixed first—a suitable size is 3 in. wide by 2 in. thick. The former must be fitted over the baseboard, as in Fig. 1, and a screw or two into this will fix the bottom end. The top end, however, is what requires to be fixed most firmly, and to ensure this we must insert a wood plug in the wall, screwing into this, and covering over the screw-head with a plug of wood.

This method of fixing is shown sectionally in Fig. 3, where *I* shows the joints in the brickwork, and the plaster on the walls, *K* the wood plug, with the screw in it, fixing the hanging piece *A*, and *L* the plug covering the screw head.

To find the joints in the wall, if of brick, probe through the plaster with a brad-awl or wire nail, and then clear out all the mortar to the depth of some 2 in., and to the width of 1½ in. Make a wood plug as Fig. 4, and drive in very tightly. Cut off level with the wall, or slightly under. Now place the hanging piece in position, and mark the height of the plug. Bore in ½ in. from the face, so that the head of the screw will go in, continue through for the shank of the screw, and then insert the latter, screwing up as tightly as possible, but do not insert the plug *L* until later, in case the hanging piece has to be removed during the time the work is going on.

The fixing of the shutting piece is more simple, it having to be screwed to the wood newel only. It will no doubt be fully understood that all shaping and chamfering of the hanging and shutting pieces must be done before they are fixed. They must also be kept both to the same height, and also immediately opposite each other, as well as perfectly vertical. Should the wall or the newel be out in this respect, the new pieces must be so scribed as to put matters right; the opening for the gate will then be parallel.

The gate should be made some quarter of an inch narrower than the opening, so that no planing will be required to make it fit. The sizes of the various parts are as follows: stiles and rails 2 in.; square bars, 1 in. x ¾ in.

The making of the gate, after the wood is planed up truly, is very easy. The stiles are mortised to take the rails, as Fig. 5, being afterwards rounded at the top ends, and chamfered, as dotted lines.

The rails must be tenoned to fit into the stiles; also mortised for the bars, as Fig. 6, and then the corners chamfered off as dotted lines.

The bars simply require planing to size, the tops rounding, and the sharp corners slightly broken, just the extreme edge only taken off, not to show any bevel at all.

The bars should be a fairly tight fit in the rails, and should be inserted in the mortises before the rails are placed in the stiles, as if left till after, they have to be driven through the top rail a considerable distance, which is not likely to improve the finish.

The rails should be fixed to the stiles with pins. The bars should be tight enough to hold themselves, but to make certain they will not move, a small brad may be driven into each from the under side of the bottom rail.

The complete gate is shown in Fig. 7 ready for hinging. This should be done with a pair of brass or stout steel butts, as shown sectionally at *M*, Fig. 8. The hinging is a comparatively easy matter, and need not be detailed here. We would, however, remind our readers that the right method is to let one half of the hinge into each member, as shown, and not the whole thickness in one, and simply screwing to the other.

The best fastening is as shown at *N*,

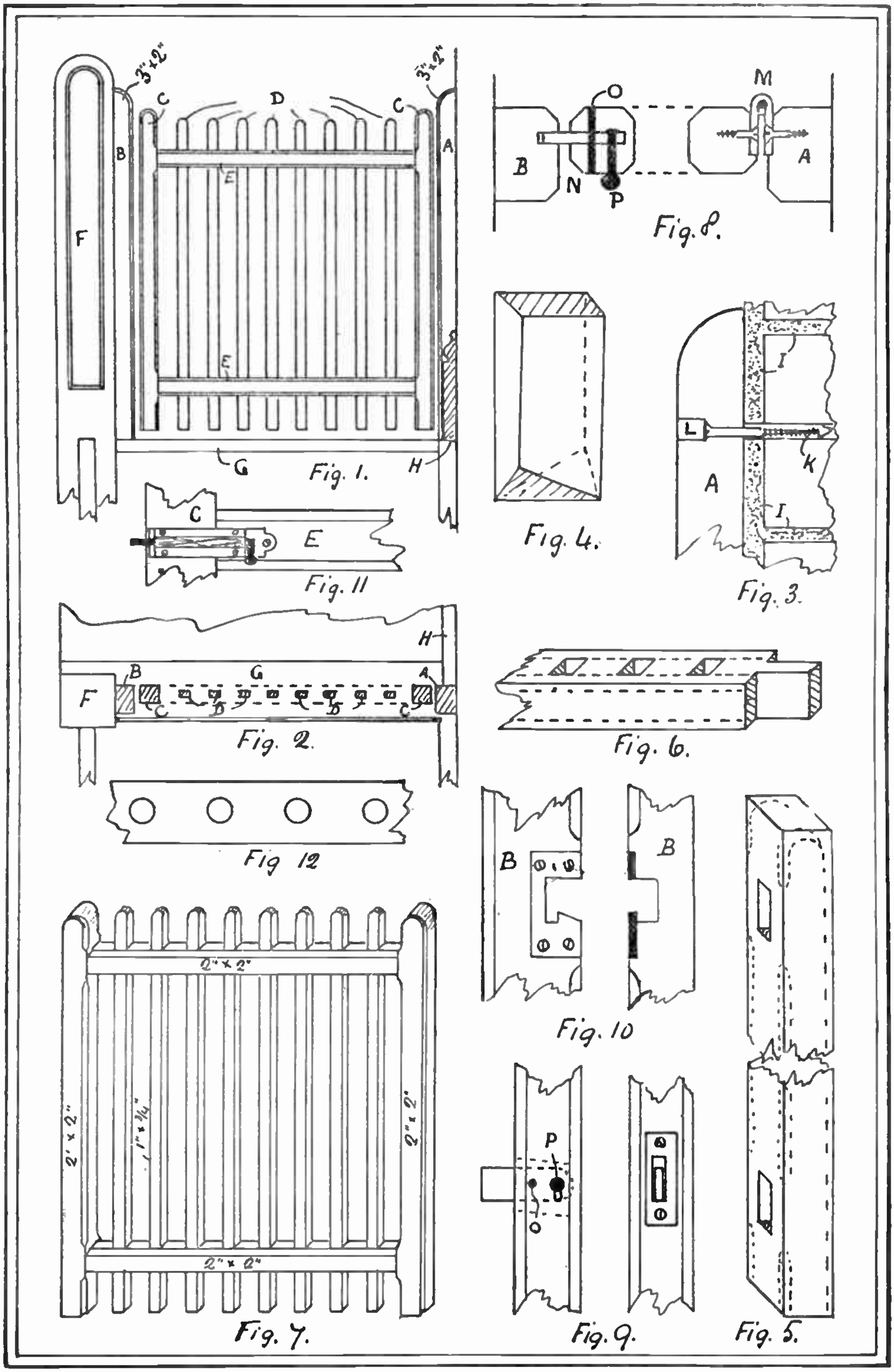

3"x2"
3"x2"
C D C
B A
F E
E
G H
Fig. 1.
M
O
B A
N P
Fig. 8.
Fig. 4.
L
I
K
A
I
Fig. 3.
C
E
Fig. 11
H
B G A
F
C D D C
Fig. 2.
Fig. 6.
Fig 12
B B
Fig. 10
2"x2"
2"x2"
1"x2¼"
2"x2"
2"x2"
Fig. 7.
P
O
Fig. 9.
Fig. 5.

Fig. 8, which consists of the latch, fitting into a mortise in the stile as shown, and pivoted on the pin, *O*. The knob *P* is connected to the latch, forming a means of working it, from the stair side only.

The latch projects far enough beyond the stile to slide up the striking plate, and drop in the notch of the same, the closing being automatic. The front and side views of the latch arrangement are shown in Fig. 9, and the same of the striking plate in Fig. 10.

Although the latch is a secret one there is a possible chance of baby fingers finding out the working of it, and it is best to supplement the fastening with a small brass bolt fixed on each of the rails of the gate, on the stair side, as shown in Fig. 11. These cannot be reached except by hanging over, so that they are absolutely safe as regards the young ones. An alternative method of making the gate, as far as the bars are concerned, consists of substituting round rods for the square bars. Thus instead of mortises, holes bored through the rails only would be required, as in Fig. 12.

The gate should be made from wood to match the hand-rail and ballusters, or if these latter are painted it may be made in deal or whitewood, and painted to match. If fixed as described, it is a tenant's fixture, and may be taken away in case of removal at any time.

Using a Life-Preserver

"The worst trouble about a life-preserver," said an old sailor, "is that few people know what to do with one when it's thrown to them. Many a man would drown in trying to get a life preserver over his head. The average person struggling about in the water would try to lift up the big life-ring and put it over his head. That only causes the man to sink deeper and take more water into his lungs.

"The proper way to approach a life-preserver in the water is to take hold of the side nearest you and press upon it with all your weight. That causes the other side to fly up in the air and down over your head, 'ringing' you as neatly as a man ringing a cane at a country fair. After that the drowning man can be rescued."

Life Insurance Solicitor Got a Hearing by Novel Method

A sale is made in the preparation.

Tom Lowry, the late traction magnate of Milwaukee, was one of the wealthiest men of the Northwest. He had been solicited by all the best life insurance salesmen in the country—or rather he had been approached by them; for as fast as they came within reach he threw them out of his office.

He became the talk of the entire life insurance fraternity, and obviously some of this got back to Tom, and he continued his attitude towards insurance just as a matter of pride.

Whenever a local general agent hired a new solicitor he first sent him over to Lowry as a courage test and to toughen up his hide a bit.

Now, anybody with any acquaintance with Tom Lowry at all knew his propensity for betting. He would bet on anything that contained any element of chance. He used to sit in the old Sherman House, Chicago, with companions and bet that out of the first twenty men next to pass five of them would have whiskers; then he would go to a ball game and bet that out of the next five men to bat three would fly out.

One day a young, rather cadaverous looking individual called at Lowry's office and asked that his card be presented to him—the card, by the way, merely contained the man's name.

Lowry sent back to know what the man wanted.

The cadaverous one replied that he wanted to make a bet.

He was admitted.

When the caller was fairly seated he said: "Mr. Lowry, I want to wager $1,800 to $100,000 that you will die within the next year."

"I'll take the bet," said Tom.

"All right," returned the man, "just sign this." Here the salesman presented an insurance application blank that had been previously made out.

Lowry signed it.

Time of sale, three minutes.

Time of preparation, as long as it took to think of it.—*Gibson's Magazine.*

The oiler's suggestion is as good as the manager's if it helps along the work.

THE EFFICIENCY TEST OF A LEAD STORAGE BATTERY

A. SPRUNG, E.E.

THEORETICAL DISCUSSION

In testing a battery for its efficiency it is necessary to determine the relation between the watt-hours output and the watt-hours input required to store up the battery in the same condition as it was previously (at the beginning of discharge.)

To make a very accurate determination, it is necessary before making the test to take the dimensions of the plate and vessels, weight of plates, electrolyte and containing vessel, the battery being fully charged. After making the test the same process should be gone over in order to determine the rate of disintegration and probable life of the battery.

When the battery has been fully charged the following will be noticed:

1. *The terminal e.m.f.* becomes approximately 2.5 volts, depending upon the rate of charge, *i.e.*, for a time more or less than eight hours there would exist a slightly smaller or greater value.

2. *The density of the electrolyte* measured by the hydrometer should gradually increase until it becomes constant at 1.8 specific gravity, unless the charge rate is so great that the water present becomes rapidly decomposed. It is advisable to use lead-weighted hydrometers. To keep a uniform density the electrolyte should be agitated when hydrometer readings are taken.

3. To distinguish the positive plate from the negative:

Positive	*Negative*
1. Formation of gases at the plates showing complete oxidation.	1. A complete reduction to spongy lead.
2. Dark brown or chocolate color, blackening indicates overcharge.	2. Dark slate color.

4. *Cadmium Test.*—Cadmium, when immersed in the electrolyte of a lead storage battery, gives reliable indications of the potential of the positive or negative plates with respect to itself. Insert the cadmium stick (connected to one terminal of a voltmeter) into the electrolyte, and connect the other terminal of the voltmeter first to the positive and then to the negative plates. If the running and charging conditions are correct, the voltmeter reading, as caused by the respective potential differences, will be nearly 2.5 volts for the positive plate and zero for the negative plate.

Thus, in making a test, the cell should be first charged to normal rate until the above stated "full charge" conditions are obtained. It is then necessary to *discharge* the cell at constant current rate until the terminal volts=1.8. During the *discharge* make note of the *temperature, specific gravity of electrolyte* and *cadmium voltage* about every 15 minutes. If the potential difference between the negative plate and cadmium stick=.25 volts before cell voltage=1.8, the discharging should be considered finished. If this should occur more than once, either local action or small capacity of negative plates are the cause. If the rate of discharge equals twice the normal rate, the terminal volts on discharge should equal 1.7. If the rate is four times the normal, the voltage should be 1.6. After discharging, the cell should be recharged with constant current, then note the terminal volts, cadmium volts, specific gravity and temperature every 15 minutes. If the readings indicate a complete discharge, the charging current should be reduced to one-half the normal. When the voltage, specific gravity, temperature, etc., become constant the charging should be discontinued.

A lead storage battery should never be completely discharged, as it is thereby likely to become "sulphated."

The chemical reactions which are believed to take place in a lead storage battery may be represented as follows:

	Positive	Electrolyte	Negative
Charged	PbO_2	$+ 2H_2SO_4$	$+ Pb$
Discharged	$PbSO_4$	$+ 2H_2O$	$+ PbSO_4$

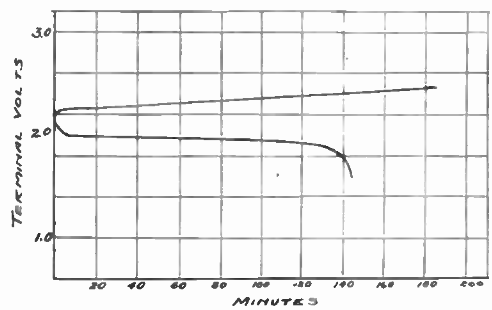
Charge Current →

Discharge Current ←

Chemical analysis shows that lead sulphate exists in the discharged plate. The density of the electrolyte decreases during the discharge of the cell, corresponding to the consumption of the sulphuric acid and the formation of water as shown in the above reactions. From a thermochemical standpoint the energy produced from the formation of lead sulphate from metallic lead and the peroxide corresponds to the voltage obtained.

EFFICIENCY TEST

In a storage battery the *efficiency* is the ratio of the amount of discharge to what is required to bring the battery back to its original condition. *Efficiency* can be expressed in ampere-hours, *i.e.*, ampere-hours efficiency equals ampere-hour output divided by the ampere-hour input. The efficiency can be expressed in watt-hour, *i.e.*, watt-hours on discharge divided by watt-hours on charge. This is the real efficiency, because it considers the energy and includes the voltage as well as the ampere-hours. The ampere-hour efficiency will show the action of the battery but is useless commercially. It is generally about 15 percent higher than the watt efficiency. It will possibly give an apparent efficiency of over 100 percent at times; this is due to the fact that



owing to a residual charge in the battery, it is possible to draw out more than is put in.

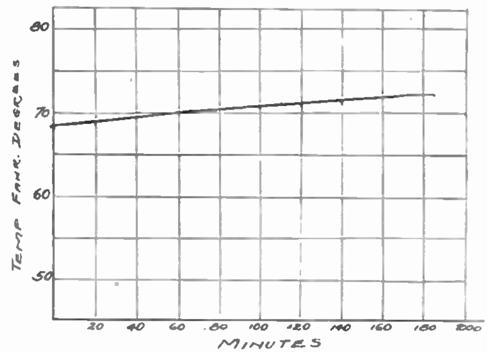
In general practice, it has been found that the efficiency of a storage battery plant when in good condition varies from 75 to 80 percent.

The results should be expressed in the form of curves drawn between time and terminal volts, cadmium volts, specific gravity, etc.

To obtain the watt-hours, multiply the average voltage by the ampere-hours.

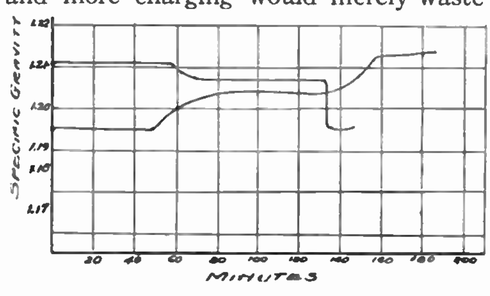
EXPERIMENTAL SOLUTION

It is required to find the commercial efficiency and characteristic curves of a lead storage battery by means of an experimental solution. To begin with, the connections for the test are made in the usual manner. The method of operation of test was as follows:



The battery is charged by throwing the switch on the charging side. In order to show the sudden jump in voltage, readings are taken in rapid succession at the start and later on as the curve becomes more straightened out readings were taken at longer intervals. The readings taken were, *first*, the time; *second*, with switch closed, the voltage of the battery, *i.e.*, charging voltage at closed circuit; *third*, with switch open, the voltage of the battery, *i.e.*, terminal voltage on open circuit. Next, the plus and minus cadmium readings were taken. Then the specific gravity and temperature readings were taken. In the meanwhile the current was held continually constant by means of a carbon pile rheostat. The same holds true for discharging the battery. In the test the charging was started at 2.2 volts (high due to a residual charge) and became fully charged at 2.47. These values are within the limits of 1.7 to 2.5 volts.

As seen from the curves the *rise in voltage* is gradual, excepting at the very beginning and at the end. When the cell is fully charged it is seen how the voltage becomes approximately constant from the curves. After a value of 2.47 volts was reached, the battery was considered fully charged, since the reading was constant throughout the last 25 minutes, and more charging would merely waste



RESULTS OF TEST

RESULTS TAKEN DURING CHARGING BATTERY

Charging

Time hr.min.	Volts Closed	Volts Open	Cadmium Volts Plus	Cadmium Volts Minus	Specific Gravity	Temp. Fo	R. Cell Ohms
0.00	2.2	2.15	2.32	.10	1195	68.2	.0023
0.01	2.225	2.175	2.325	.10	1195	68.2	.00165
0.02	2.225	2.175	2.35	.10	1195	68.2	.00165
0.03	2.25	2.18	2.35	.10	1195	68.2	.0023
0.04	2.25	2.18	2.35	.10	1195	68.2	.0023
0.05	2.25	2.18	2.35	.10	1195	68.2	.0023
0.06	2.25	2.18	2.35	.10	1195	68.2	.0023
0.07	2.25	2.18	2.35	.10	1195	68.2	.0023
0.08	2.25	2.18	2.35	.10	1195	68.2	.0023
0.09	2.25	2.18	2.35	.10	1195	68.5	.0023
0.19	2.25	2.18	2.37	.09	1195	68.5	.0023
0.29	2.25	2.18	2.37	.08	1195	69.5	.0023
0.39	2.25	2.18	2.38	.08	1195	69.5	.0023
0.49	2.29	2.20	2.39	.08	1200	69.5	.0023
0.59	2.30	2.21	2.40	.08	1200	70.	.003
1.14	2.35	2.25	2.42	.07	1205	70.5	.0033
1.29	2.35	2.25	2.43	.07	1205	70.5	.0033
1.34	2.38	2.28	2.45	.07	1205	70.5	.0033
1.41	2.38	2.28	2.48	.07	1205	70.5	.0037
1.46	2.39	2.28	2.48	.07	1205	71.	.0033
1.52	2.40	2.30	2.46	.07	1205	71.	.0033
1.59	2.40	2.30	2.49	.07	1207	71.5	.0033
2.04	2.41	2.31	2.50	.07	1207	71.5	.003
2.11	2.41	2.32	2.50	.07	1207	72.	.004
2.20	2.42	2.30	2.50	.07	1207	72.5	.0037
2.29	2.43	2.32	2.51	.08	1207	72.5	.0037
2.36	2.44	2.33	2.51	.08	1212	73.	.004
2.40	2.45	2.33	2.51	.07	1212	73.	.0043
2.44	2.46	2.33	2.52	.07	1212	73.5	.0043
2.52	2.47	2.34	2.52	.06	1213	73.5	.004
3.00	2.47	2.35	2.52	.06	1213	73.5	.004
3.05	2.47	2.35	2.52	.06	1213	73.5	

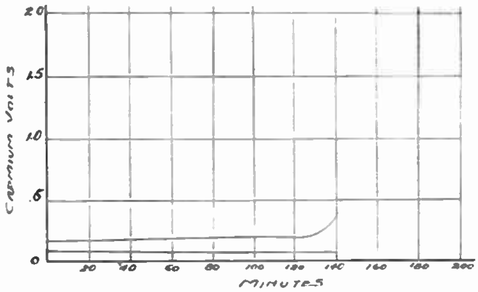
RESULTS TAKEN DURING DISCHARGE OF BATTERY

Discharging

Time hr.min.	Volts Closed	Volts Open	Cadmium Volts Plus	Cadmium Volts Minus	Temp. Fo	Specific Gravity	R. Cell Ohms
0.00	2.19	2.23	2.36	.16	73.5	1211	.0013
0.02	2.05	2.12	2.30	.16	73.5	1211	.0023
0.03	2.03	2.10	2.23	.16	73.5	1211	.00255
0.04	2.02	2.10	2.22	.16	73.5	1211	.003
0.05	2.00	2.09	2.21	.18	73.5	1211	.003
0.07	2.00	2.08	2.21	.18	73.5	1211	.00255
0.08	2.00	2.08	2.20	.18	73.5	1211	.00255
0.09	2.00	2.07	2.20	.18	73.5	1211	.0023
0.10	2.00	2.07	2.20	.18	73.5	1211	.0023
0.12	2.00	2.07	2.20	.18	73.5	1211	.0023
0.15	2.00	2.05	2.19	.18	73.5	1211	.00165
0.17	1.99	2.04	2.19	.18	73.5	1211	.00165
0.23	1.99	2.04	2.19	.18	73.5	1211	.00165
0.33	1.98	2.04	2.19	.18	73.5	1211	.002
0.46	1.97	2.02	2.18	.18	73.5	1211	.00165
0.57	1.96	2.01	2.18	.18	73.5	1211	.00165
1.02	1.95	2.01	2.18	.19	73.5	1208	.002
1.07	1.95	2.01	2.18	.19	73.5	1208	.002
1.18	1.95	2.01	2.17	.20	73.2	1207	.002
1.33	1.93	2.00	2.16	.20	73.2	1207	.0023
1.48	1.91	2.00	2.13	.22	73.2	1207	.003
2.03	1.88	1.98	2.12	.22	73.0	1207	.0033
2.09	1.84	1.95	2.12	.22	73.0	1207	.0036
2.13	1.82	1.95	2.11	.26	73.0	1207	.0043
2.16	1.81	1.95	2.11	.28	73.0	1196	.00465
2.20	1.79	1.94	2.10	.30	73.0	1196	.005
2.21	1.78	1.93	2.09	.32	73.0	1196	.005
2.23	1.72	1.92	2.09	.35	73.0	1195	.0066
2.24	1.61	1.91	2.09	.50	73.0	1195	.01

Average Voltage:
Discharge = 1.945
Charge = 2.32
Average Amperes = 30
Ampere-hour:
Charge = 92.5
Discharge = 72.5
Ampere-hour Efficiency
Efficiency = $\frac{72.5}{92.5}$ = 78.4 percent

Watt-hours:
Charge = 214.5
Discharge = 141.
Efficiency = $\frac{141}{214.5}$ = 65.7 percent



the energy in producing gases. It was noticed that the external voltage was higher in charging than in discharging, because of the internal resistances of the battery and the consequent voltage drop, which must be overcome in charging.

From the curves the exact amount of watt-hours can be determined at any time during the run.

It is seen how the *specific gravity* of the liquid rose from 1.195 to 1.215 from discharge to charged. This is due to the electrochemical actions taking place during the charging.

When the battery was fully charged bubbles of gas were given off.

The cadmium readings were taken to show their relation with the external voltage, *i.e.*, external voltage plus negative cadmium should equal at all time the plus cadmium. The positive cadmium readings ranged from 2.32 to 2.52, the latter being a value denoting full charge. The negative cadmium kept very low as would be expected, ranging from .1 to .06.

The resistance decreased on charging, due to the fact that the formation of a stronger solution is taking place. Since the resistance decreases with the strength of the solution, hence a decrease of *R*. The resistance of the solution would always naturally decrease when the density increases.

The temperature of electrolyte increases with charging, therefore *R* increases. The effect is small as compared to increase in specific gravity as affecting resistance.

In taking readings on open circuit we could bring out the values of the internal resistance, since the action is just like that in a motor,

or $e = P - IR$

where e=c.e.m.f. in this case charging voltage

$$\text{Commercial Eff.} = \frac{\text{Watt-hour discharge}}{\text{Watt-hour charge}} \times 100 = \frac{\text{Average Voltage Discharge} \times \text{Ampere-hours}}{\text{Average Voltage Charge} \times \text{Ampere-hours}}$$

P = Impressed e.m.f. in this case terminal voltage

I = current throughout

R = internal resistance

$$\text{or } R = \frac{\text{Voltage on open circuit less voltage on closed circuit}}{\text{current}}$$

The reverse reasoning holds for discharging. The operation of discharging is naturally the reverse of charging. The curves are relatively the same but they incline downwards. At the end of discharging the current fell so rapidly that the battery was considered discharged about one-half hour earlier than the predicted three hours.

Efficiency.—Since the test was started with a residual charge it was necessary to abandon the test with a residual charge in order to obtain a true efficiency.

A value of 65.5 percent commercial, or watt-hour, efficiency was obtained. This value is considered fair in storage battery plant, 75 to 80 percent being a good value. A value of 72.5 percent ampere-hour efficiency was obtained. This latter does not show the value of a storage battery. It was stated before that in a test of this kind it is possible to obtain more ampere-hours output than ampere-hours input.

SOME PATTERN-SHOP WRINKLES

J. A. S.

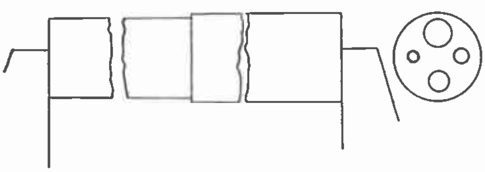
There is always something for the practical man to learn, and it does not follow that because a pattern-maker is efficient in his work, he knows everything that there is to know. Therefore, it may be of use to mention one or two little details in pattern-shop practice, which, although in themselves not very important, make for better and easier work. It is so easy to do things the hardest way. This is not an Irish bull, but a bit of philosophy.

For example, there is a right and wrong way of using a brad-awl. and the wrong way will often lead to trouble when thin, slender strips of wood have to be pierced. The method adopted by the junior craftsman is to pick up any old brad-awl and wriggle it through the wood with a wrist motion. Sometimes the edge is parallel to the grain of the wood; but it does not matter to the novice. But when the nail is put into the wood, the wood splits and there is a lot more work to do. The right way is to see that the awl has a sharp chisel edge on it, then to place that edge crosswise to the grain and to press it down through the wood without any twist. The fibers of the wood are then cut, not sprung apart, and then the introduction of the nail will not lead to a split. This seems almost too simple to write about, but it is the simple things that count.

Here is another wrinkle that saves worry: when driving a nail into a very narrow strip of wood, even when properly pierced, there is a chance of splitting the wood unless the nail, which of course has a point on it, is held with its point on a hard surface and given a tap with the hammer. This flattens the point a little, and it does not seem quite in accordance with theory that a blunted nail should cause less splitting than a sharp one. It is a matter of experience, however, that this is so. Possibly the explanation is that the flattening causes a small cutting edge to be formed at the end of the nail which shears its way through the wood instead of wedging it apart. Whatever the reason may be, the fact remains, and it is a fact worth knowing.

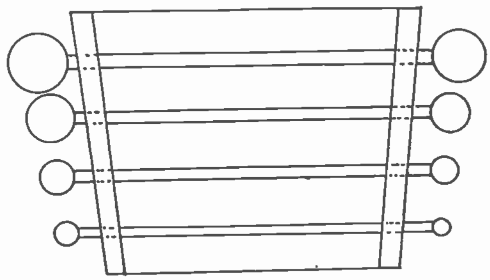
Every pattern-maker is acquainted with the fillets which have to be placed in the corners of a pattern in order to correct a sharp corner into a nicely-rounded curve. These fillets, if made of wood, have to be specially planed or shaped up, and are often more or less tedious and difficult to make. There are in the market leather fillets cut to the required rounded surfaces which only require to be cut off and nailed into position, and this method possesses the advantage of increased speed in working. Both methods are, however, rather costly, and an idea on this point which has been found very useful in practice may not come amiss. The central idea is in the use of beeswax, which is plastic, easy to put in place and mould, and when varnished over with the wood presents no joint or seam as is sometimes the case with wood or leather.

A very good way of preparing and applying beeswax is as follows: A piece of iron or brass tube, say 1½ in. in bore and 12 in. long is taken, and fitted with a wooden plunger a bit longer than the tube, as shown in the sketch. One end of the tube is closed with a piece of metal, as shown, in which are arranged a series of round holes ranging from 3/16 in. to ½ in. in diameter. The tube is first stood upright on the bench and the melted beeswax poured into it. When this has cooled off a little, so that it is plastic but not liquid, the plunger is put into the open end of the tube and the whole arrangement placed in the bench vise in such a way that the outer end of the plunger bears against the outside jaw, while the end of the tube with the holes in it rests against the inside jaw in such a way that



all the holes but one are closed up. The vice is then screwed up steadily, putting a pressure on the plunger, which forces the wax out of the exposed hole in a long circular band which is coiled up on the bench and then stored away ready for use. In this way bands of the different diameters are prepared.

When it is required to make a fillet, all that it is necessary to do is to take a length of a suitable diameter of beeswax band and lay it along the corner in the pattern which has to be filled up by the fillet. Then a steel ball mounted on a handle is heated in a flame (say the burner used for the glue-pot) and run along the band, softening it and at the same time pressing it firmly into the corner and giving it the required curve on the outer surface. In this way the fillet is finished in a quarter of the time, or less, that it would take to make the old-fashioned wooden fillet. The steel balls above



mentioned are easily prepared. Ordinary steel balls are taken and the temper drawn, and are then drilled and tapped for a piece of steel wire which is tapped and screwed into the ball. Each wire has a ball at each end, and the balls range in diameter from 3/16 in. up to ¾ in. They are kept handy on a small rack near to the bench, as shown in the second figure.

These time-saving wrinkles are only types of a great many more which have been devised to expedite the work of the pattern shop, but which cannot be mentioned in detail here. Enough has however been said to show that a little thought can at times save a great deal of work.

Aeroplane Chases Liner with Parcel for Voyager

One of the most novel purposes for which an aeroplane has ever been chartered was to carry a pair of eyeglasses to a passenger on the *Olympic*, just as she was leaving New York on her first eastward run. W. A. Burpee, the millionaire seedman of Philadelphia, broke his glasses as he was about to board the *Olympic*, and had a wireless message flashed to his optician to have a new pair delivered to his London office by the next boat.

The optician, however, saw a better way of delivery, and in five minutes had Thomas Sopwith, the English airman, then flying in New York, on the wire. The glasses were delivered to him by automobile, and he started in pursuit of the *Olympic*, reaching her as she was passing Fort Hamilton on the way out. He swooped down within a couple of hundred feet of the deck and dropped the padded package which contained the glasses.

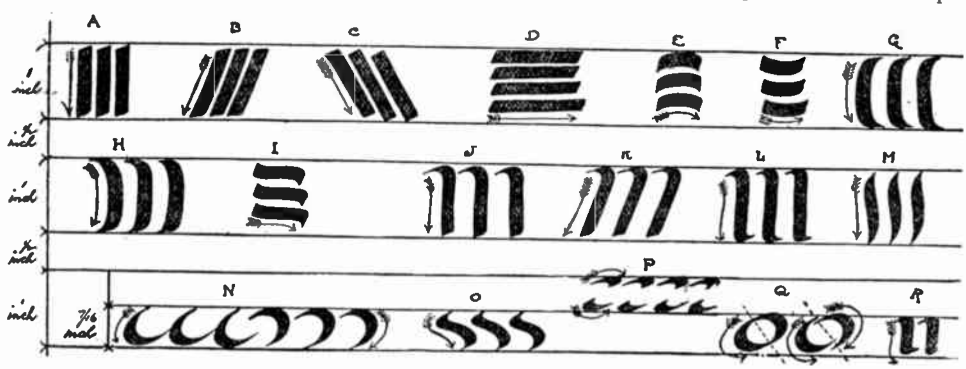
SHOW-CARD WRITING

The show-card has become so important a factor in window display that a mastery of the art of show-card writing is a most valuable accomplishment for the window trimmer. A writer in the *Apparel Gazette* gives the following elementary lesson on the art, which will be found valuable by the beginner.

Before attempting to practise at all the beginner should supply himself with the right tools, which does not mean the buying of a very elaborate or expensive outfit, brushes, inks, paints, rulers, erasers, etc., but simply supplying himself with one good brush and a bottle of show-card ink.

For practice paper use common manilla wrapping paper with a smooth surface. Rule as indicated on the chart given herewith.

Before you make a stroke see that the brush is dipped several times into the ink, each time drawing the brush across the neck of the bottle the entire length of the hair, letting the ink run back into the bottle and reversing the brush or turning it over, so that as the ink flows from the brush it reduces the end of the brush to a flat, square or chisel point. This is important—next to having good utensils is the proper manipulation of the same. So very important is the part of brush manipulation to the beginner that very little progress can be made if he is careless about it.



It is not likely that your local paint supply store can furnish you with the brush necessary, but they are in communication with the manufacturers of them and can place a special order for a red sable pencil or quill with a square point, No. 11 or 12, 7/8 or 1 in. stock, or for a red sable rigger, No. 11 or 12. This brush will probably cost fifty cents. Your local stationer can, no doubt, supply the show-card ink in 2 oz. desk bottles, which sell for about ten cents. A foot ruler and a lead pencil complete the outfit.

These utensils, especially the brush and ink, are imperative and greatly facilitate the progress of the beginner.

The accompanying sketch illustrates the parts used in making both full-face and shaded letters of both upper and lower case alphabets. The assembling of these parts, spacing and slanting the same in harmonizing curves and straight strokes, produces alphabets that are very pleasing to the eye and that are easy to read.

Having the brush in good working order, begin the practice with Fig. A, the downward stroke. Holding the brush is the next important part. Take the brush as you would your pen, between the first finger and thumb, but not resting on the second finger, holding the brush so that you can roll it freely back and forward between them. The hand should rest upon the table, only the fourth and little fingers touching it. The brush should be held almost perpendicular, the handle in line with the second joint of the forefinger, not the third, as in writing.

Downward strokes in Figs. A and B are made with the finger movement, bringing the brush down, bending the fingers. Do not touch the pencil ruling, either top or bottom, but have the strokes just within. Fig. C is made with the arm movement, holding the fingers stiff and moving the hand backward, resting the fleshy part of the forearm upon the table. Fig. D is made with the arm movement, turning or rolling the brush, as directed above, between the forefinger and thumb, so that the flat part of the brush faces across the paper, not downward. Move the hand to the right, using the fourth and little fingers as a rest and guide.

The same idea is followed in making all the strokes contained in the chart, beginning and finishing the strokes, as indicated by the arrows. The beginner may have some trouble with the strokes that have pointed extremities, but if the brush is touched lightly at the start and lifted quickly at the finish of the stroke, this difficulty can be overcome.

LATHE SCREW-CUTTING

H. W. H. STILLWELL

Much valuable information has been written upon lathe work, some in a plain, practical and common sense manner, easily understood by the mechanic of average intelligence, and still more in technical language, which is almost impossible for the young mechanic to figure out for himself unaided.

Many of our best mechanical authorities seem to lose sight of the fact that perhaps the greater part of the readers of their articles are non-technical men and not familiar with much of the technology which their articles contain, nor with the higher mathematics they often employ.

It is the purpose of this article to place before the young mechanic some useful and valuable information in as simple and non-technical a manner as possible.

Almost all of the modern lathes are indexed; the index is figured or found from one common number, by which the teeth in each of the gears may be divided exactly, and the additional number of teeth in every next larger gear will be the same as the common number. For example: If the smallest gear of a lathe is of 24 teeth, the next 28 teeth, the next 32 teeth and so on, then the common number is 4. If the teeth increase by 5, then the common number is 5. If by 6, then 6, etc.

In lathes having no common number and with irregular gears, any number may be used to multiply by, which will then be the common number. This rule also holds good for lathes that have a common number in case it is desired to cut a thread that the index does not show.

DRIVING SCREW

The driving screw of a lathe is the next thing of importance that the operator must thoroughly acquaint himself with, to be able to correctly figure threads and gearing for that particular lathe.

In most lathes the true relation of the driving screw to the lathe spindle is maintained. In all such cases the driving screw is correctly represented and figured by the number of its threads per inch.

On a lathe where the true relation of the driving screw is changed by reason of a different sized gear on the feed spindle to that on the lathe spindle, the number of threads per inch on the driving screw does not correctly represent the same, and the correct driving screw must be found, which is done as follows:

Rule.—Take two gears of equal size, use one as driver, the other as driven, with any convenient size intermediate gear. Cut a thread, and the number per inch thus found will be the drive screw.

RULE 1

HOW TO FIND TWO GEARS

Rule.—Take the driving screw as a numerator and the required threads per inch as denominator; multiply each by the common number. The new numerator thus found will be the driver, and the new denominator will be the driven. In other words: the result of multiplying of the driving screw (the new numerator) must be placed on the lathe spindle and is the driver.

And the result of the multiplying of the required threads per inch (the new denominator) must be placed on the driving screw and is the driven.

Example

D.S. 4 Thds. 8 C.N. 10

$$\therefore \frac{4}{8} \times 10 = \frac{40}{80} \quad \begin{matrix}\text{Driver}\\ \text{Driven}\end{matrix}$$

NOTE.—This rule is the fundamental principle of all rules for threading or thread-cutting.

If a right-hand thread is to be cut, use one intermediate gear. If the thread is to be left-hand, use two intermediate gears.

NOTE.—When the driver or spindle gear is non-changeable or assumed, use this rule to find the driven.

Rule.—Multiply the number of teeth of the spindle gear or the driver by the desired number of threads, then divide that product by the number of threads per inch on the driving screw. The result will be the gear to put on the driving screw or the driven.

Example

D.S. 4 Thds. 8 Spindle gear or driver 32

∴ 8 x 32 = 256, then 256÷4=64, the driven

RULE 2

HOW TO FIND FOUR OR COMPOUND GEARS

Two gears will cut many plain and many fractional threads, except when very fine or very coarse. To cut very fine threads with two gears, that required on the lathe or feed spindle would be inconveniently small, and that required on the driving screw would be inconveniently large. It would be difficult, if not impossible, to find such small or large gears in the shop.

In all such cases it will be more convenient to use four gears which will be found as follows:

Rule.—First find two gears as shown in Rule 1; then find two numbers to multiply together into the driver without a remainder; and two numbers to multiply together in the driven without a remainder; then multiply each of the two numbers so found by the common number. The result will be the two drivers and the two driven to use.

Example

D.S. 4 Thds. 20 C.N. 6

$$\frac{4}{20} \times 6 = \frac{24}{120}$$

We now have 24 as the driver and 120 as the driven. Take 24 and find two numbers that will multiply together and make the same, as, 4 x 6=24; then take 120 and do likewise, as, 10 x 12=120. Then multiply 4 and 6, and 10 and 12 by the common number. The result will be the two drivers and the two driven to use, and the full example will read as follows:

D.S. 4 Thds. 20 C.N. 6

$$\frac{4}{20} \times 6 = \frac{24 \ . \ 4 \ . \ 6.}{120 \ . \ 10 \ . \ 12} \times 6 = \frac{24 \ . \ 36 \text{ drivers}}{60 \ . \ 72 \text{ driven}}$$

To prove the gears so found, use this rule.

Rule.—Multiply the first driver 24 by the desired number of threads 20; divide that product by the first driven 60; then multiply that quotient 8 by the second driver 36, and divide that product by the number of threads per inch on the driving screw 4. The result will be the second driver 72.

Example

24 first driver
20 desired threads

First driven 60)480(8 quotient

36 second driver
8 quotient

D.S. 4)288(72 second driven
28

RULE 3

HOW TO CUT FRACTIONAL THREADS PER INCH

Fractional threads per inch means: a certain number of whole threads and a fraction of another contained in one inch.

The easiest way to measure fractional threads is as follows: take any number of threads until they measure even inches, then count the number of threads in that number of inches.

When the pitch of a screw is given in the form of a fraction, as ⅜ pitch, then the bottom figure indicates the number of threads, and the top figure the number of inches. ⅜ pitch would be one thread in ⅜ of an inch, or 8 threads in 3 in., or $2\frac{2}{3}$ threads per inch.

Rule.—Find the number of whole threads in even inches, then find the number of threads on the driving screw in the same number of inches and multiply by any common number, same as Rule 1.

For instance, the desired thread is 4½ per inch, and the driving screw is 6 threads per inch. It will in that case be seen that 9 whole threads are found in two inches, and 12 threads in two inches of the driving screw.

The example will therefore read as follows:

Example

D.S. 6	Thds. 4½	C.N. 4
D.S. instead of 6	use 12	48 driver
		x 4 = —
Thds. instead of 4½	use 9	36 driven

D.S. 4	Thds. 3¼	C.N. 6
D.S. instead of 4	use 16	96 driver
		x 6 = —
Thds. instead of 3¼	use 13	78 driven

D.S. 4	Thds. 11½	C.N. 3
D.S. instead of 4	use 8	24 driver
		x 3 = —
Thds. instead of 11½	use 23	69 driven

D.S. 4	Thds. 2⅓	C.N. 5
D.S. instead of 4	use 12	60 driver
		x 5 = —
Thds. instead of 2⅓	use 7	35 driven

RULE 4

HOW TO CUT THREADS PER PITCH

Rule.—Multiply the top figure by the number of threads per inch on the driving screw, use that product as the numerator and the bottom figure as the denominator, then multiply each by the common number.

Example

D.S. 4	Pitch ⅜ in.	C.N. 6
$\frac{4 \times 3}{8} =$	$\frac{12}{8} \times 6 =$	$\frac{72 \text{ driver}}{48 \text{ driven}}$

When the pitch is measured by whole inches use this rule:

Rule.—Multiply the number of whole inches by the number of threads per inch of the driving screw, and use that product for the numerator, and for the denominator use 1 and proceed as per Rule 1.

Example

D.S. 2	Pitch, 3 in.	C.N. 16
3 x 2 =	$\frac{6}{1} \times 16 =$	$\frac{96 \text{ driver}}{16 \text{ driven}}$

When the pitch of a thread is given in one or several whole and part of another inch, as: 1 thread in 2¾ in. proceed as follows:

Rule.—Find the number of even threads in even inches, which will be 4 even threads in 11 in., then multiply the number of inches (11) containing the even threads, by the number of threads in one inch of the driving screw. Use that product as numerator and the even threads, which is 4, as the denominator.

2¾ pitch we find contains 4 even threads in 11 in. We find driving screw at 2 threads per inch contains 22 threads in 11 in. hence the example will read as follows:

Example

D.S. 2	Pitch, 2¾ in.	C.N. 5
Numerator	D.S. use 22	110 driver
	— x 5 =	—
Denominator, Pitch, 2¾ use 4		20 driven

RULE 5

PITCH OF DRIVING SCREW—HOW TO FIND GEARS FOR SAME

When the driving screw of a lathe is measured and designated by its pitch, as for instance ⅜ pitch, use the following rule to find the gearing for any desired thread.

As shown above, the top figure of the fraction always designates the inch or inches, and the bottom figure always designates the number of whole threads contained in the same; consequently a ⅜ pitch driving screw would have 8 threads in 3 in.

Rule.—To find the driver simply take the bottom figure of the fraction and multiply the same by the common number, as Rule 1. To find the driven take the top figure of the fraction and multiply the same by the desired number of threads to be cut, and then multiply that product by the common number.

Example

D.C. ⅜ pitch	Thds. 6	C.N. 4
$\frac{3 \times 6}{8} = \frac{18}{8}$	$\frac{8}{18}$ Reverse x 4 =	$\frac{32 \text{ driver}}{72 \text{ driven}}$

In order to avoid becoming confused in the use of this rule, another way to use the same is as follows: Place the figures of the pitch ahead of the example, following that reverse the same and proceed to figure as per rule. Your example would read like the following:

Example

D.S. ⅜ pitch	Thds. 6	C.N. 4
$\frac{3}{8}\ \frac{8}{3 \times 6} =$	$\frac{8}{18} \times 4 =$	$\frac{32 \text{ driver}}{72 \text{ driven}}$

THE HOME CRAFTSMAN

RALPH F. WINDOES

ETCHED PIPE RACK

In the pipe rack illustrated we have a very attractive piece of etched metal work. The material needed to construct the rack is as follows:

1 piece No. 20 gauge copper or brass, 5 x 12 in.
1 piece No. 20 gauge copper or brass, $2\frac{1}{8}$ x 12 in.
Rivets, asphaltum, acid (nitric), lacquer, fine steel wool.

Make a full-sized drawing on a piece of paper of the shape and design of the back. The photograph illustrated here is only a suggestion of a number that can be used, and it is strongly advised that the craftsman originate his own. When the drawing has been satisfactorily completed, clean the metal and transfer the design to it with carbon paper.

Cut the shape out with snips and the jeweller's saw, and cover the parts that are not to be etched with asphaltum. Place in a weak solution of the acid and leave until the etching is completed. Remove and wash in clear water and color as has been directed before in this series.

The narrow strip has six holes cut into it that have a diameter of $\frac{3}{4}$ in. The center for these holes is $\frac{3}{4}$ in. from one edge. Lay the holes out with a pair of dividers, drill a hole in each and saw out the circles. Bend a right angle $\frac{5}{8}$ in. from the back edge, and rivet this piece to the back.

A very finished appearance is given the edges if they are laid on a piece of iron and pounded with the ball pein of the hammer. Polish and finish the rack with a coat of lacquer.

HUMIDOR

The humidor has proven itself indispensable to the man who smokes. It is a companion piece to the pipe rack and should be designed with that end in view, though we will admit that the article illustrated does not show this point. The material list for this object includes:

1 piece No. 20 gauge copper or brass, 5 x 14 in.
1 piece No. 20 gauge copper or brass, 4 x 4 in.
1 piece No. 20 gauge copper or brass, $3\frac{7}{8}$ x $3\frac{7}{8}$ in.
2 pieces No. 20 gauge copper or brass, $\frac{1}{2}$ x $3\frac{1}{2}$ in.
Asphaltum, acid, fine steel wool, lacquer and small blotter.

Make a full-sized drawing of one side, $3\frac{1}{2}$ x 5 in., and transfer it successively to the large piece four times. This leaves a $\frac{1}{4}$ in. strip for fastening.

Etch it, as has been explained before, while it is flat. Finish it up and bend on the dotted lines shown. The bottom, which is $3\frac{1}{2}$ in. square, is cut and bent, making the four laps at right angles to the piece.

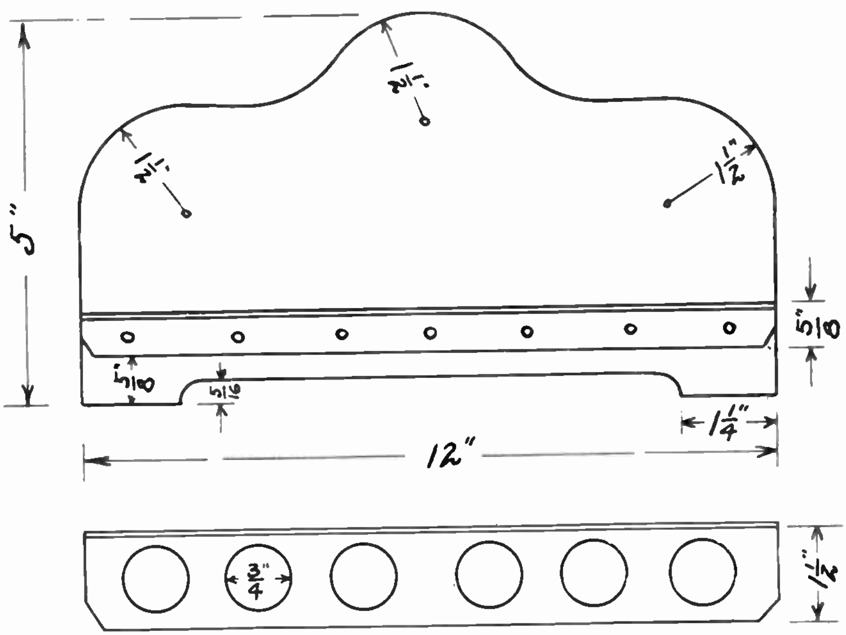
The cover is 4 in. square and is held in place by the two strips bent at right angles and soldered securely to it. It should be etched with an appropriate design, and after the soldering is completed, should be raised in the middle.

Beside the strips being soldered to the cover, the sides are soldered and the bottom held in the same way, as explained below.

When all processes have been completed, fit a piece of thick blotting paper in the cover and always keep it moist while the humidor is in use. Take it to a tinsmith and have him fit it with a square box of light zinc, in which the tobacco must be kept.

It is a good plan to glue a piece of felt or leather on the bottom of the humidor to prevent its scratching any article upon which it is placed.

ETCHED PIPE RACK -



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R.F.W. 1911.

SOLDERING

In addition to the tools and materials already at hand, the following will be necessary for the process of soldering:

Annealing tray.
Mouth blowpipe.
Bunsen burner or alcohol lamp.
Borax slate.
Camel's hair brush.
Powdered or lump borax.
No. 24 iron wire.
Silver solder.

The annealing tray may be purchased from craftsmen's supply houses, or a tray made of sheet iron, about 20 in. square and 4 in. deep filled with slag will answer the purpose very well. It must have riveted corners, as soldered corners would be liable to melt.

The bunsen burner that uses gas is a better source of heat for the work than an alcohol lamp, though the latter may be used if it is of large size.

A slate slab, such as is used to grind ink, makes a very good borax slate. The silver solder may be used any gauge, but about No. 20 works the best.

The surfaces that are to be soldered must be absolutely clean. This can be accomplished by scraping them with a sharp instrument, filing them or rubbing them with steel wool. After they are clean, be very careful about handling them, as solder will not flow over grease.

Next grind up a little borax on the slate with a little water, until it is of the consistency of thick cream. If the powdered borax is used, a stick will serve for the stirring. Cut a number of pieces of the silver solder into the borax, making them about 1/16 in. long.

Coat the cleaned surfaces with the borax where they are to be joined, and bind them together with the iron wire. Lift the pieces of solder from the borax with the brush and place them along the edges to be joined, putting them about 1 in. apart. Set the whole upon the annealing tray and apply the heat with the burner and blowpipe. Do not apply much heat at first, just enough to evaporate the water and let the borax crystalize. When this is accomplished apply more heat until the solder melts.

If these directions are faithfully carried out, the pieces clean and not too much heat applied at once, little trouble should be experienced with the soldering process.

Coal-Dust Danger

It being generally agreed that great colliery explosions, however they may originate, are spread by the progressive ignition of fine coal-dust, Prof. W. M. Thornton, of the Armstrong College, Newcastle-on-Tyne, has recently been experimenting with a view to getting rid of the dust danger in mines. His conclusions he indicated to a meeting of the members of the North of England Mining Institute at Newcastle.

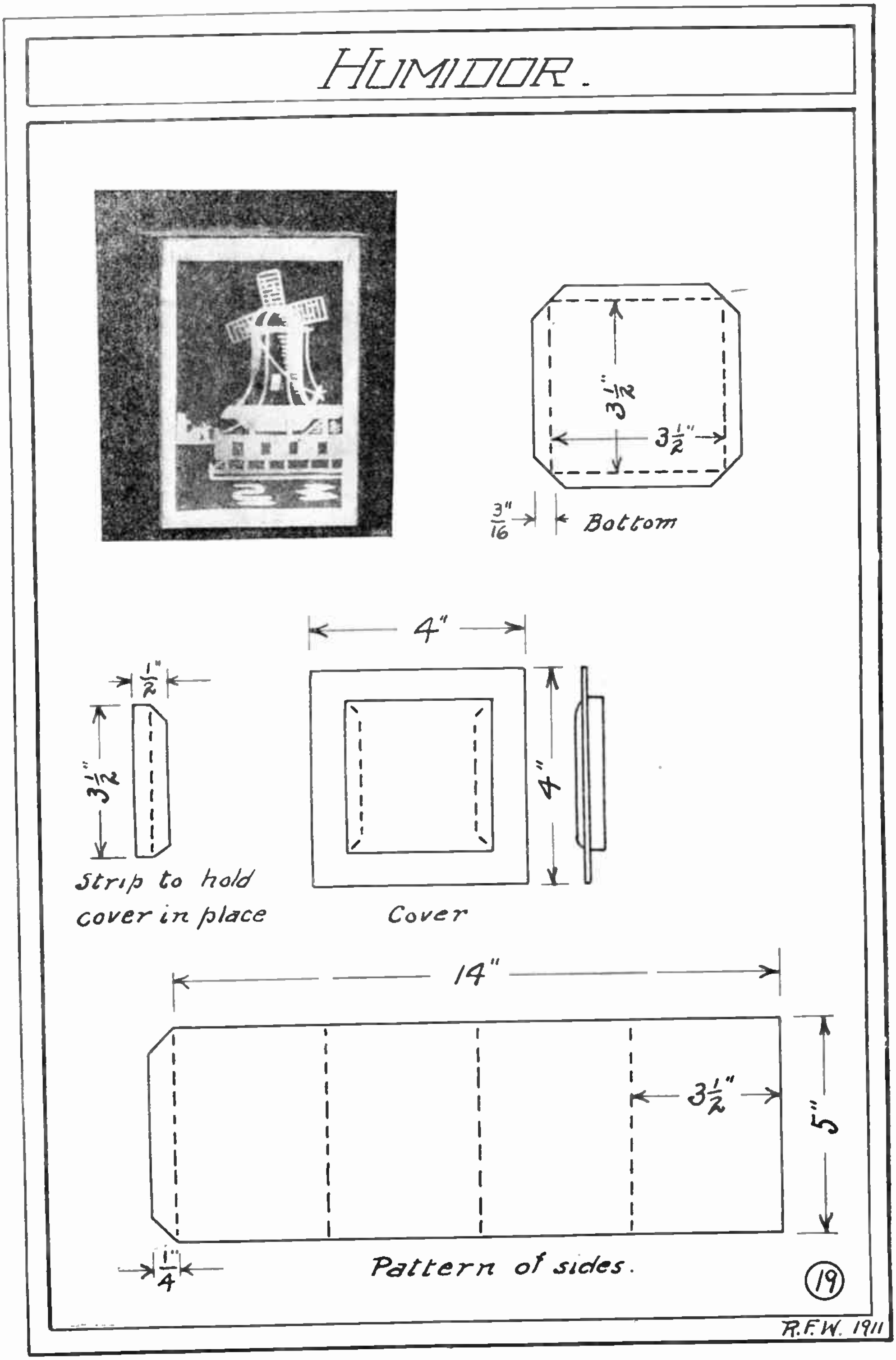
After carrying out very exhaustive experiments, he had hit upon a mixture of ten parts of water-glass with one part of resinous liquid soap and one of commercial carbolic acid. This mixture, he averred, could not be improved upon from the standpoint of cost and efficiency as a wetter or binder of fine dust. He had conducted experiments not only in the laboratory, but in the gallery of the E Pit, Udpeth Colliery Co., Durham.

He summed up his researches by giving, as a counsel of perfection, the advice that a dusty road in a mine should have the timbers and sides thoroughly, though quickly, swept by a brush, that being immediately followed by hand-spraying, especially on the tops of timbers, or fine spraying into the dusty air.

Dr. Thornton's conclusions were rather warmly contested by Dr. Bedson (Professor of Chemistry at the same college). Dr. Bedson declared that most of the substances with which Dr. Thornton had been dealing were dangerous, and he (Dr. Bedson) should classify them down a mine as he would classify matches. Soap dust was nearly as inflammable as coal dust, and, when the soap solution had dried, would result in a larger quantity of volatile matter being present than before.

Double Glazing for Sound-Proofing

An English builder has tried the plan of double glazing windows in sick rooms, studies, lecture rooms, etc., with a view to excluding noise from without, and with notable success. He found that the noise of heavy wagons and passing trolley cars was reduced to a bearable degree, and that conversation through a window having two thicknesses of glass with an air space between was almost impossible.


HUMIDOR.
3½"
3½"
3"/16
Bottom
4"
½"
3½"
4"
Strip to hold cover in place
Cover
14"
3½"
5"
¼"
Pattern of sides.
19
R.F.W. 1911

DRY CELL TESTING*

W. B. PRITZ

There are today at least 100 brands of dry cells upon the market, varying in quality from very efficient and reliable cells to those which must be considered very inefficient; and from these the consumer must select that brand which in his opinion will give best service. Before any conclusion can be reached regarding the adaptability of a cell to a particular service, the consumer must either accept the guarantee of the manufacturer or make for himself, as best he may, a service comparison of the cells in question.

The present diversity in the methods of testing cells is very troublesome for both the manufacturer and consumer. The former is often called upon to guarantee the service of his product when subjected to certain tests which have little or no relation to any which he may have adopted, and although it is not impossible, it does become quite difficult for a manufacturer of dry cells to calculate from the results of his regular tests just what may be expected of his product when subjected to a particular test required in the specifications of his customer. The adoption of some standard tests which would hold between manufacturer and consumer alike would, therefore, be very advantageous to both. The establishment of such tests and the publicity which would thereby be given to the whole subject of testing would decrease the tendency of the small consumers (who, taken collectively, must use a considerable percentage of the output) to place reliance in the so-called tests which now form the basis for their judgment of a brand of cell, such as amperage or voltage readings.

It is easily shown that there is in no sense a relationship between service and short-circuit current. It is true that the amperage reading of a cell, coupled with a familiarity with the particular brand, does serve as a good indication of the age of the cell or the presence of any serious defect; however, the customer who judges solely from the short-circuit current is very apt to obtain inferior quality, and yet we are informed by dealers that at least 90 percent of the customers who buy cells off the shelves demand that they be so read and in most cases select that brand giving the higher current.

Let us consider, then, the requirements of a satisfactory test for dry cells and the conditions which have the greater influence upon the results obtained. In general (other than for purposes of research) there are but two reasons for desiring a test upon dry cells: (1) To ascertain what life may be obtained from a brand of cells in a certain service; (2) to ascertain which one of several brands will give the longest life in that particular service.

With the former object in view the knowledge is best obtained by actual use of the cells in connection with the appliance. In some cases this is the only feasible way in which the definite information sought can be obtained. The great majority of tests are carried on, however, with the second object in view—*viz.*, the comparison of two or more brands of cells for use in a particular service. Where the amount of testing is large, it is impossible, even were it expedient, to use the actual appliances for testing cells, and it becomes necessary to devise special testing methods and apparatus such that results obtained therefrom shall be comparable to the results obtained from the cells when placed in actual service. This is, we take it, the one necessary condition which dry cell tests must fulfil.

There have been tests devised which seek to go further and make the operating conditions not only comparable, but as similar as may be to the operating conditions of the service for which the test is intended. Upon this point there is some diversity of opinion. Some authorities claim that a test is of greater value and is more reliable the more nearly the conditions of test approach those of service, and, following out these claims, have devised certain tests which are rendered quite complicated, requiring much attention and apparatus for their continuance, by the introduction into the method of some of the irregularities to be expected in service. It is questionable, however,

*Abstract of a Paper read before the American Electrochemical Society.

if results of greater meaning are obtained from such strict adherence to service conditions. At best, such a test is but an approach to actual service, which must be continually varying from time to time and from locality to locality. Again, the apparatus necessary to carry on an irregular, intermittent test is very complicated and requires much careful attention. This feature limits its use to the large consumers and manufacturers.

Questions are often asked regarding the advisability of testing various brands of cells by connecting them in series and discharging them simultaneously. In general, we would advise against this method, though there are occasions when it is the only one that can be employed. Especially is this true when test conditions, such as length of contact and recuperation periods, strength of current and temperature of the battery, cannot be held constant for the separate testing of various brands. It is much preferable, for instance, to use the series method of test upon an automobile than to test the various brands upon different machines or upon the same machine at different times.

Temperature is a most important factor in dry cell testing, and a large part of the non-uniformity in the results of tests may, we think, be traced to temperature variations. For instance, the current increases as the temperature rises, and the differences in the current obtainable increase considerably as the temperature falls. The influence of temperature upon service is greater than it is supposed. Tests show great variations are obtainable between 60 and 95 degrees, between which values practically all testing is done. This makes the importance of temperature regulation very evident. The effect of temperature also varies with the nature of the service; high temperatures giving longer service where the drain is heavy, while low temperatures are favorable for light drain service lasting over a considerable period. Of prime importance in dry cell testing is a knowledge of the effect of temperature upon the rate of deterioration of cells when left on open circuit. To determine just what this effect might be, a number of cells were stored at seven different temperatures. The following table gives the initial currents and the drop in amperage after 10 weeks, expressed as a percentage of the initial values:

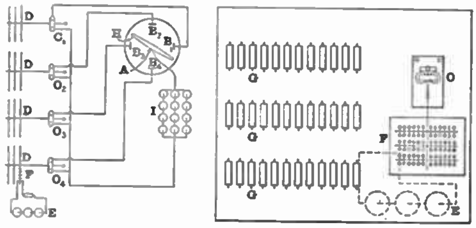
Temperature	Initial Amp.	Percent Drop in Amp. in 10 Weeks
41°F	18.1	4.4
77°F	22.0	10.0
95°F	21.0	19.0
113°F	22.8	25.0
131°F	23.0	52.0
149°F	20.5	71.0
167°F	21.0	98.0

The greatly increased rate of deterioration on open circuit at high temperatures no doubt accounts for the poor service obtainable at such temperatures over long periods of time. A knowledge of this effect of temperature would undoubtedly explain the cases, which are at times brought to our attention, of cells rapidly deteriorating upon a dealer's shelves, from "no cause whatever." The cells should be stored in a dry, cool place, and not in the corner behind the stove.

In interpreting the results obtained from a test of various grades of cells a caution must be given against drawing definite conclusions from the outcome of a single or a small number of tests. When the matter of choosing a brand is of much importance it is necessary to run a series of tests over a period of six months or a year. In this way a very good idea may be obtained of the average service results which may be expected.

In regard to the terms in which the results of dry cell tests should be reported, there is some difference of opinion, some authorities contending that the ratings should be expressed as the number of ampere-hours given by a cell under specified conditions to a certain working voltage value. Others claim that more practical meaning is attached to a statement of the length of time during which the cell is able to maintain its working voltage above the specified limiting value. It is the author's opinion that that method of rating should be used which gives to the consumer the exact information which he desires; hence, the rating of cells by the length of service of a given kind which they are capable of giving is favored.

It is perfectly evident that the consumer is interested in the length of service which he is able to obtain from a battery and not in the amount of energy given.



Complete Wiring Diagram. General Plan of Relay and Coil Table.

FIG. 1.—TELEPHONE TEST FOR DRY CELLS.

At first thought it might appear that the ampere-hour capacity of a dry cell bears such a relation to length of service, that either method of rating would give the same information. Such is not the case, however. Differences in discharge rate cause vast differences in the number of ampere-hours obtainable from the cell. From the nature of the discharge curve, it is quite difficult to calculate the length of service obtainable under the conditions limiting the ampere-hour rating, while to go further and deduce from the rated ampere-hour capacity under one set of conditions, the output to be expected under different conditions becomes a hopeless task. Equally hopeless is the final interpreting of the result in terms of length of service. Again, a dry cell does not always give length of service which is proportional to ampere-hour output. It is easily possible to produce two dry cells which will give equal lengths of service, the ampere-hour output of which will show marked differences. Hence a statement of the ampere-hour capacity of two brands of cells is very apt to be misleading, as it does not settle definitely which is the better cell to use upon a given service. For research purposes the energy or ampere-hour output of a cell is very useful, but as a practical rating for dry cells it is not satisfactory, especially from the standpoint of the consumer.

The author then proposes for consideration certain tests covering the two most important services, namely, telephone, and gas-engine ignition. The nature of these services was fully outlined in Papers delivered before the Society by Dr. J. W. Brown* and Mr. D. L. Ordway,† and therefore will be touched upon only in so far as is necessary to establish the relationship of the service to the tests which we propose.

*"Trans." Amer. Electrochem. Soc., XIII, 173 (1908).
†"Trans." Amer. Electrochem. Soc., XVII, 341 (1910).

It is recommended by one of the important telephone companies that the battery should at all times give a current of more than 0.14 amperes at the end of one minute after it has been disconnected from the transmitter and connected in circuit with an ammeter and a resistance of 20 ohms. This specification necessitates that the working voltage be constantly 2.8 volts or more. The author has been using for some time a test which requires a minimum of care and supervision and which is quite comparable to the more complicated tests. It subjects three cells in series to a discharge through 20 ohms resistance for a period of two minutes each hour, during 24 hours per day and 7 days per week, until the working voltage reaches the limiting value of 2.8 volts, the results being reported as the number of hours' service to this cut-off point. The energy drawn from the battery in this test is approximately equivalent to that consumed in the more complicated methods; the batteries give practically equivalent periods of service, and the number of cells, resistance in circuit and cut-off point are identical. The regularity of this test which we propose eliminates the mechanical appliances necessary to obtain decreased night and Sunday service. The left-hand portion of Fig. 1 shows diagrammatically the apparatus necessary and its arrangement. The hand of the clock *A* revolves once per hour, closing by means of the contact *H* the circuit of the battery *I* in turn through the contacts *B*, B_2, B_3 and B_4. This current magnetizes the cores of the telegraph relays *C*, C_2, C_3, C_4, causing the extended armature arms *D* to fall, bringing the inverted U-shaped fingers *F* into mercury cups, through which the test battery circuits *E* are closed. Each contact *B* is of such length that two minutes are required for the passage of the contact *H*. At the right of the figure is shown the arrangement of the relay and coil table. The test batteries are stored underneath the table and are read from the mercury cup *F*.

Fig. 2 shows a representative discharge curve obtained from a battery of three 2½ in. x 6 in. dry cells of a well-known brand. The curve passes through the

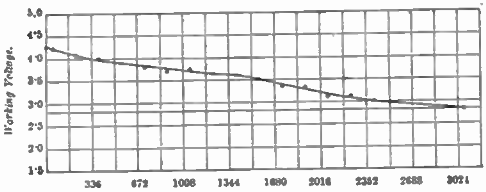


FIG. 2.—HOURS ON TEST.

values of the working voltage at the end of the discharge periods.

Ignition practice also presents great diversity in operating conditions, and formulating a satisfactory test to meet the demands requires much consideration of the various systems used. In developing a test suitable for this service, a 4-cylinder automobile engine, equipped with a standard make of spark coil was used. With different numbers of cells in series, resistance was cut into the circuit until the engine failed to operate satisfactorily. Limits of satisfactory ignition for these particular conditions were thus reached. Readings at this point were taken of the working voltage, average drain on the battery and the value of the impulse which the battery was capable of forcing through the primary winding of the spark coil.* The work was then duplicated, using in turn all the leading makes of coils. Thus it was possible to formulate what may be considered as average limiting conditions of actual ignition service. It was found that in the majority of cases five or six cells in series gave ample voltage. Efficient service was obtained in some cases with as low a drain on the battery as 0.2 or 0.3 amperes. It is very probable, however, that 0.5 ampere more nearly represents the average drain which could be maintained by the adjustment of coils without proper instruments.† A battery was found to give inefficient service when the impulse of current which it was able to send through the primary winding of the spark coil fell below 2 or 3 amperes, Fig. 3 showing a diagram of the arrangement.

From these findings the following test has been developed and adopted as standard for ignition service. A battery of six cells is connected in series with a 16-ohm coil, which permits an average drain on the battery throughout its life of approximately 0.5 ampere. Readings of the working voltage are taken at intervals throughout the test, the most important reading, however, being the impulse of current which the battery is able to force through a ½-ohm coil connected in series with the ammeter and in parallel with the 16-ohm resistance. When this value at the end of a period of contact falls below 4 amperes, the battery is considered unfit for service and discarded. This value is taken, rather than 3 amperes, in order to be conservative. All conditions adopted from investigation as representing the average ignition service have thus been duplicated. In settling upon the length of time during which the battery should be discharged, many users of automobiles were interviewed, and the consensus of opinion was that, after the novelty of an automobile wore off, the length of time during which a car would be in operation would average not far from two hours a day. The test batteries are therefore discharged for this length

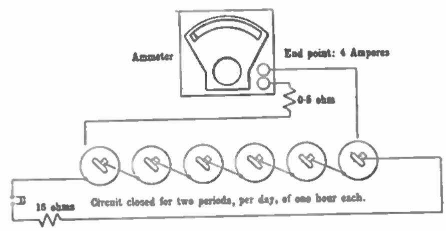


FIG. 3.—IGNITION TEST.

of time each day. The time is divided, however, into two periods, one hour in the morning and one in the afternoon. As a test for lighter service, the battery is sometimes subjected to two drain-periods of half an hour each. If the amount of testing be not too great, the circuits may be closed by hand, in which case no apparatus is needed other than instruments for reading, a number of 16-ohm resistance coils and a 5.0-ohm coil for use in taking the impulse readings.

This test has been used satisfactorily for several years. By slight variations, chiefly in the time of discharge, it may be made representative of any system of various types of ignition service.

*A full discussion of the impulse value and its importance in ignition service is contained in: D. L. Ordway, "Trans." Amer. Electrochem. Soc., XVII, 361 (1910).

†The value of the approximate drain, *viz.*, 0.5 amperes, does not apply to the various single-spark appliances now to be obtained, which are much more economical of current.

Since it is often the case that quite an interval of time may elapse between the manufacture and installation of a cell in service, a knowledge of what may be expected during this period becomes of no little importance, and hence an open circuit or "shelf life" test is quite essential. The ideal method for such a test would be the determination of the decrease of service capacity due to storage over definite periods. This practice, however, would entail much labor and expense where the amount of testing to be done is large.

The method generally employed to determine shelf life consists of reading the initial voltage and short-circuit current of a representative sample of cells, followed by current readings at intervals of one or two months, depending upon the nature of the cells in question. The ammeter for reading short-circuit current should be dead beat, and with its leads should have a resistance of 0.01 ohm. Two 30 in. lengths of No. 12 lamp cord make very convenient leads. The results are merely indicative of increase in internal resistance, and bear no definite relation to the service which the cells may give. However, this information, coupled with familiarity with a brand of cells, becomes a very good indication of its quality. It also serves to indicate any serious defects of manufacture. The cells are kept on the shelf until the short-circuit current has fallen below 10 amperes. This point is arbitrarily chosen, as it represents a point below which it would be difficult to market the cell. For practical purposes, the results are expressed as the number of months during which the short-circuit current remains above this cut-off point. Much more meaning, however, is attached to the rate at which the current falls, generally reported as the drop in amperage expressed as a percentage of the initial amperage. This is especially true when investigation of the quality of cells is the object. For practical purposes, however, the first rating given, *i.e.*, months to 10 amperes, is perhaps preferable.

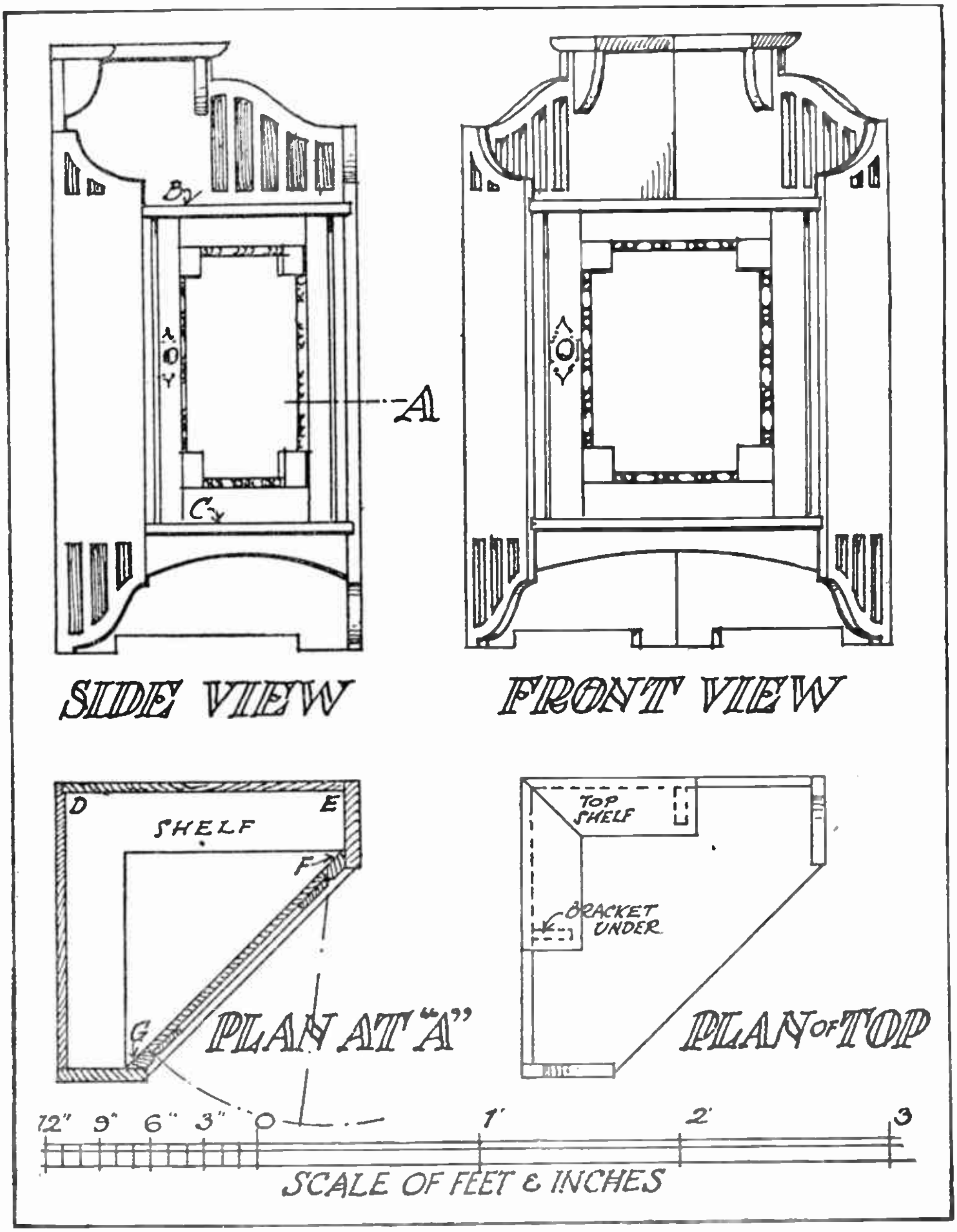
There are, of course, many miscellaneous services in which dry cells are used, tests for which must be formulated as occasion demands and to suit the particular needs of the case. For the more important uses, however, *viz.*, telephone and ignition services, we trust uniform methods of testing may soon be adopted which will be satisfactory to all.

A CORNER CUPBOARD

Such a fitting as the one illustrated herewith, can always be used to fill an odd corner, and will usually be found to occupy only space which would otherwise be entirely vacant. It can be made of any variety of selected straight-grained pine, and presents no especial difficulty in construction. Owing to its shape on plan, it will be easily understood upon reference to the drawing that while the side view shows the true shape of the sides and back, but foreshortens the door, which is at an angle of 45 degrees to the spectator, so also the front view gives the true shape of the door, but the other parts of the cupboard are foreshortened in width when seen from directly in front.

The top and bottom (see *B* and *C* on side view) should be first prepared out of ½ in. stuff and of the shape shown on the plans; the grain should run parallel with the front edges, and it will be best to form them of two widths glued together; their length along the back edges (as *D* to *E*) is 1 ft. 4 in. Next the two sides which are 2 ft. 6 in. x 5 in. and about ⅝ in. thick, are cut to the curved outline, shown on the side view, and the shaded portion fretted out entirely; then the two back pieces are prepared, and they will also have to be in two widths glued together to make the 1 ft. 4 in. required, and are 2 ft. 10½ in. high, with a square piece cut out of the bottom, and curved and fretted at the top to match the sides. These six parts can then be glued and neatly bradded together, thus forming the carcass of the cupboard.

A little shelf with a shaped edge, as shown 3½ in. wide, is then fixed at the top and partly supported by two wooden brackets of a simple curved outline; this shelf is in two pieces, 10 in. in their greatest length, and mitered as shown on the plan of top. A light curved arch piece with its ends splayed to suit is fixed under the front edge of the bottom to finish the lower part, and two ⅝ in. uprights similarly splayed are fixed at each side between the top and bottom (see *F*, *G* on



plan at *A*); the outer edge of these pieces might be slightly chamfered.

The only part now remaining to be described is the door, which will need careful fitting and hanging. It may be framed up with a panel in the orthodox way, if the craftsman cares to undertake the task, or a piece of three-ply of the full size of the door may have thin strips 2 in. wide glued along its edges to represent the styles of a door, and if this simple method is adopted it will be impossible to detect the difference without opening the cupboard. The door is decorated with 1½ in. square pieces about ¼ in. thick in the corners, and a small ornamental bead strip is filled in between as shown. A fillet should be fixed along *G*, projecting a little to stop the door, and neat hinges and a suitable spring catch or cupboard lock should be chosen.

The interior can easily be fitted with light shelves or pigeon holes to suit individual requirements.

DEFLOCCULATION *

EDWARD G. ACHESON, SC.D.

It is with much diffidence I speak on a subject that has not yet emerged from the embryonic state. My latest experimental researches had to do with it; I believe it will rapidly grow in importance in the scientific and industrial world; and finally, much work of a strictly scientific character remains to be done to reduce the fragmentary knowledge we now have of it to an exact science.

In my labors devoted to working out and developing industrial and commercial projects, I have upon several occasions found reactions, conditions and results that did not harmonize with the accepted theories and formulae of scientific men. Being an earnest believer in publicity, in order that any possible benefits that might accrue to the common welfare may the more quickly be enjoyed, I shall lay before you a detailed account of my experiments on the deflocculation of inorganic bodies. It will become very evident as my story unfolds, that throughout the series of experiments described and the working hypothesis employed, I was wholly disregarding the prevailing theories, and that I unconsciously entered the field of colloids.

Having worked out the problems involved in the manufacture of graphite from coal and other carbonaceous materials, I undertook, in the summer of 1901, the introduction of this artificially-made graphite into the crucible trade. My first efforts were devoted to the making of a satisfactory crucible of my graphite, using as a binding material, American clays. Many failures were met with, and I found it difficult to locate the cause of the failure, whether with the graphite or with the clay. I soon learned the manufacturers of crucibles in the United States invariably used as a binding agent for the graphite in the crucible body, clays imported from Europe. I secured samples of these imported clays, and found them much superior to the American ones in plasticity and tensile strength.

Chemical analysis failed to disclose the cause of the physical differences existing in the clays. The question involved interested me greatly, and I decided to endeavor to determine what produced the variations. I found it generally stated in the books that residual clays were non-plastic, and sedimentary clays were more or less plastic. Here was the starting point. Plasticity was developed by or during the act of transportation from the point of formation to the final resting-place of the clay. I did not believe there was anything in the simple act of the suspension in water that would produce the effect noted, and therefore looked for the cause of the foreign matter carried by the water. It seemed the most likely agents were the organic substances washed from the forests into the running waters. With this idea in view, I made a few experiments with those substances I thought likely to be found in the washings of vegetation. One of my early experiments was to treat kaolin with a solution of tannin, and I at once noticed less water was needed to produce a given degree of fluidity; also that the tensile strength and plasticity were increased.

Tests were made on the increased tensile strength of clay, as the result of treatment with organic matter, and it was found that briquettes made of Harris kaolin and dried at 120°C. would break with a load of 5.73 kg. per square centimeter, while the same clay, after treatment with two percent of catechu for a period of ten days, then formed into briquettes and dried at 120°C., would not break until the load was increased to 19.75 kg. per square centimeter,—an increase of more than 244 percent.

I now began to wonder whether or not the effect I had discovered was known, as it might have much value to an industry of such colossal dimensions and antiquity as clay-working. Moreover, it would be amazing if it should not be known, in view of the tremendous amount of experimental work that had been done on that art. I searched for some record of the addition of organic matter to clay during its working, and only one instance could I find, that of the Egyptians in brick-making, as recorded in the fifth chapter of Exodus. The accepted theory of using straw fiber as a mechanical bind-

*The text of an address delivered by Dr. E. G. Acheson of Niagara Falls, inventor of Carborundum, Acheson-Graphite, etc., before London Society of Chemical Industry, November 7, 1911.

ing agent had never appealed to me. Straw, however, contains no tannin, and the effect I had found had always been produced with tannin, or a substance containing tannin. I procured some straw, boiled it with water, decanted the resultant reddish brown liquid, and mixed it with clay. The result was like that produced with tannin, and equal to the best I had obtained. It now seemed likely that the Egyptians were familiar with the effect I had discovered, and believing this was why they used straw in making brick and were successful in substituting stubble for the straw, I called clay so treated "Egyptianized Clay."

The effect of organic matter, as typified by tannin, in producing deflocculation and a resultant colloidal state of clay is very readily shown; for instance, I have here some powdered kaolin, a small quantity of which I will place in a test tube, add water, and after shaking, set aside. Another portion of the kaolin I will put into a beaker, and moisten with a water solution of tannin, to which a small amount of ammonia has been added. After a thorough mixture has been made, using a glass rod to stir with, to eliminate as much as possible any grinding action, I will add more water and divide the contents of the beaker between two test tubes. To one of the tubes containing tannin-treated clay I will add a little common table salt. The three tubes I will place here before you, that we may examine them later.

In the summer of 1906 I succeeded in making artificially a high grade graphite which I wished to make applicable to all kinds of lubrication. To meet the various demands, it would be necessary to have it remain diffused in liquids lighter than itself; for instance, water and petroleum oils. Recalling the effect of tannin on clay, which caused it to remain diffused in water, I treated a sample of my graphite with tannin, and found the same effect occurred. The graphite being black, it makes a better lecture demonstration than the clay I have shown you, and I will repeat my experiments, using graphite. I have here a sample of artificially-made graphite, which has been disintegrated to a fineness that will permit it to pass through a sieve having 40,000 meshes to the square inch. I will introduce a small quantity of it into a test tube, add water, and after shaking, set aside. Another sample I will place in a beaker and moisten with a solution of organic matter, and after thoroughly stirring with a glass rod, I will add water and divide it between two test tubes, to one of which I will add table salt. These three tubes I will place beside those holding the clay, to be examined later.

The actual amount of deflocculating effect produced on the graphite in the beaker is very small indeed. In commercial work considerable mastication and time are required. I have here a bottle containing water having two to three tenths of one percent of its weight in deflocculated graphite, the deflocculation having been produced by a treatment similar to that I have applied to the graphite in the beaker, and a little of it being poured on a filter, you see the black liquid running into the test tube below the filter. The paper retained none of the graphite on its upper surface, all of it having passed into and through the paper. I will now add two or three drops of acid to the black liquid in the tube, and after warming over a spirit lamp, will throw it on another filter paper, and you now see a clear, colorless liquid descending into the tube below the filter. This is the water in which the graphite in a deflocculated condition was diffused; the graphite having been flocculated by the acid is now retained on the upper surface of the filter paper. The effect I have produced with the acid could have been produced with a solution of salt, lime water, or any one of that large list of substances known as electrolytes, even so weak an acid as carbonic acid, if caused to bubble up through water carrying deflocculated graphite, will cause flocculation and sedimentation.

Upon being deflocculated, the graphite is diffused through the water in a colloidal state, and I have samples of deflocculated graphite in water which have stood for more than two years without showing any settling, notwithstanding the graphite is two and two-tenths times heavier than water.

I have been able to obtain this same effect on natural graphite, amorphous alumina and silica, lamp black, and my manufactured product—Siloxicon, which is an amorphous body having the formula

Si_2C_2O. The effect can be produced with a long list of organic bodies; for instance, tannin, or organic substances containing tannin, also with solutions containing the gum of the peach and cherry tree, or extracts from straw and grass. The drainage from the barnyard proved to be very efficient. I speak of these organic substances as agents when used to produce deflocculation, and they act as protective colloids to the deflocculated body.

Some minutes have now passed by, and we will examine the tubes containing the clay and the graphite. We find the clay that had been mixed with plain water has settled. The mixture of clay, water, organic matter and salt has also cleared, while the tube containing the clay, water and organic matter remains muddy. In like manner, the tube containing the disintegrated graphite in water has cleared; the second one containing water, graphite and organic matter remains black; while the third tube, which was set up the same as the second, but had a little salt added to it, has cleared. Apparently a great affinity existed between the organic and the inorganic substances introduced into the water. The inorganic body abstracted the organic from the water, and in doing so, was deflocculated. Each particle as it was thrown off was enveloped in an aqueous jelly of the organic agent, or at least such was the working hypothesis I followed to arrive at my results, and I find it difficult to think of this breaking up stopping short of the final subdivision with the resultant separation into individual molecules, or the smallest particles into which a body can be subdivided without loss of identity.

As I have already stated, I deflocculated clay in the year 1901 and graphite in 1906, and immediately afterwards a number of other bodies. I early understood I was producing colloidal conditions of these bodies, but not until the summer of the present year, 1911, did I read any treatise on colloids, being familiar with this state of matter only in a very general way. During the summer I procured a copy of the book, "Colloids and the Ultramicroscope," as written by Dr. Richard Zsigmondy and translated into English by Jerome Alexander of New York. I found the book extremely interesting, and at once wished to have a sample of my deflocculated graphite subjected to ultramicroscopic examination. Mr. Alexander kindly undertook the examination. He found the graphite in the deflocculated condition to be in a true colloidal state, the particles being in rapid motion, and he estimated their average size in linear dimensions to be 75 millimicrons. Seventy-five millimicrons are seventy-five millionths of a millimeter, and it would require slightly more than 13,000 of the particles to extend one millimeter. Now, the particles of disintegrated graphite used as the crude material from which to produce deflocculated graphite, pass, as I have stated, through a sieve having 40,000 meshes to the square inch and their maximum linear dimensions is such that it would require thirteen of them to extend one millimeter. Hence, the particle of disintegrated graphite is one thousand times greater in linear dimension than the deflocculated one. These are figures that certainly test our powers of appreciation.

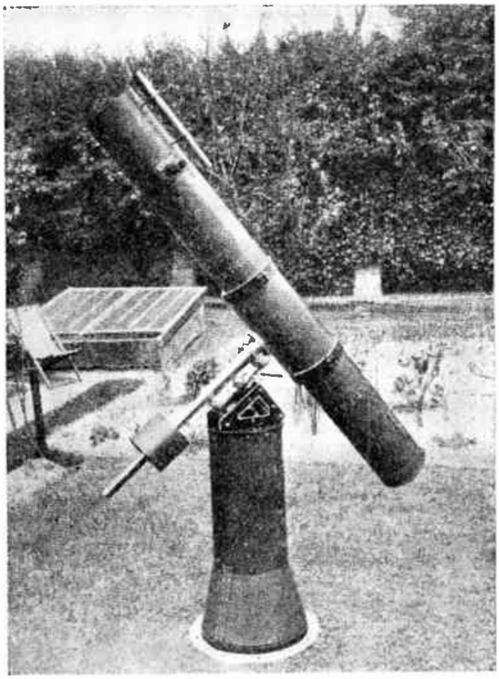
I have been asked, "Why don't you speak of the graphite as colloidal?" Knowing now that it is in a colloidal state, I speak of it as being colloidal, but when I am speaking of my process I am talking of a method of producing deflocculation. When does that process of deflocculation stop? Is it short of the final subdivision and the throwing off of the molecule? I think not. I believe we are here dealing with molecules. Their size may not agree with what they should be as computed in accordance with accepted theories, but, nevertheless, I cannot conceive the subdivision once started, in the presence of sufficient deflocculating agent, will stop short of the final, with the freeing of the molecule and the creation of the colloidal state.

How did all this I have been telling you come to happen? The following quotation aptly tells how:

"It's generally the fellow who doesn't know any better who does the thing that can't be done. You see the blamed fool doesn't know it can't be done, so he goes ahead and does it."

I honor the man anywhere who in the conscientious discharge of what he believes to be his duty dares to stand alone. —CHARLES SUMNER.

AN ASTRONOMICAL TELESCOPE



The photograph illustrates an astronomical telescope of the reflecting type, with a speculum or reflector of 70 in. focus and 7 in. diameter.

Fig. 1 (not to scale) illustrates the principle of the reflecting telescope. *A* is the speculum, which receives the light from a star or other object. The image is transmitted to the eyepiece *B* by the small elliptical mirror *C* suspended in center of tube.

The telescope was designed with a view to simplicity of parts, ease of construction, and low cost. All the machining can be done on a small lathe (the writer used a Drummond 3½ in.). The instrument is mounted equatorially, which, briefly explained, is that the main *a* is inclined so as to be parallel to the axis of the earth; and by mounting in this way, it obviates the necessity of having to follow an object in the field of view in a vertical and horizontal direction, as with a simply-mounted telescope.

The first thing was to make rough drawings of each part, then a set of scale drawings with all measurements. Wooden patterns were made for all parts constructed from castings. The stand is made from No. 16 gauge planished steel plates,

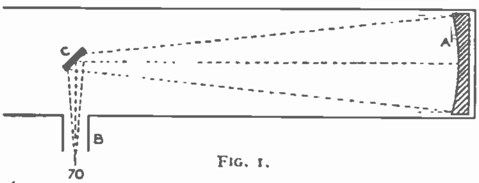


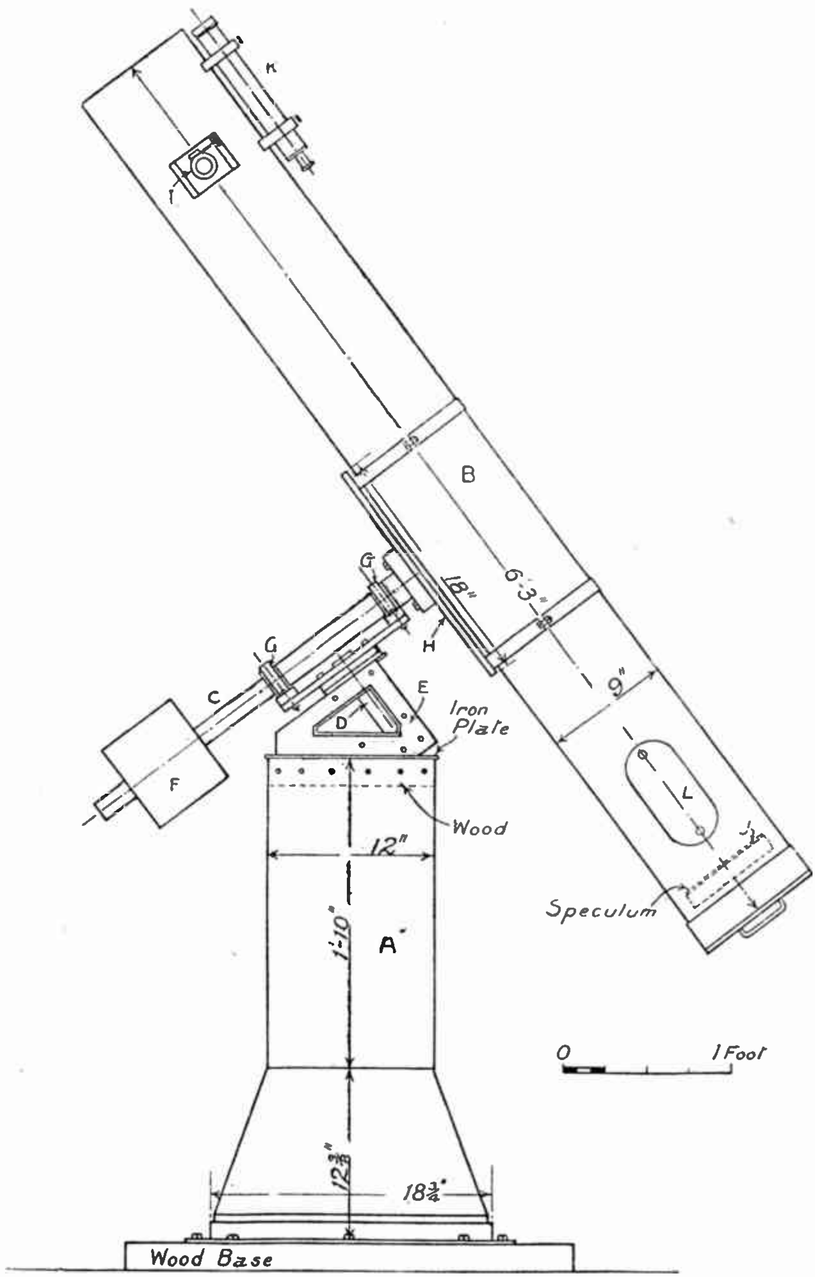
FIG. 1.

riveted with flush joints and a flange at foot, for screwing down to wood base. The top of stand is sheet iron, ⅛ in. thick. The tube, 6 ft. 3 in. x 9 in. inside diameter, is made from No. 20 gauge steel plates, in three pieces, riveted with flush joints. The declination *a* is a hollow steel shaft of seamless steel tubing, 1½ in. outside diameter. The polar *a* is the same material. The triangular frame, which carries the whole mount, is made from iron castings, bolted together. On the top end of the polar axis is a forging, on which is mounted the declination axis in cast iron bearings bushed with brass.

The cradle which carries the main tube is secured to the end of the declination axis. The tube is held in the cradle by steel straps, 1/16 in. thick, as shown in sketch. The eyepiece requires no special description. For the speculum, I obtained two circles of ordinary plate glass, 7½ in. in diameter, and 1½ in. thick, with top edges beveled. They are ground together entirely by hand with various grades of carborundum powder and finally with jewellers' rouge, the result being, one is ground concave and one convex. The concave one is the speculum, which is finally silvered on the surface. The process of grinding is extremely interesting and really not difficult.

The small elliptical mirror, shown in drawing, is mounted in a small brass fitting and suspended in the tube at 45 degrees. The theoretical diameter of the minor axis of small mirror is 1 in., but is made slightly larger in practice. The reason why it is elliptical is that a cone cut at 45 degrees gives an eclipse for a section. Hence the smallest shape that will transmit all the rays of light at a right angle would be an elliptical mirror of this section size. Viewed

(*Continued to page 59*)


K
I
B
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18"
6'3"
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9"
C
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Iron Plate
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Wood
12"
Speculum
1'10"
A
0
1 Foot
12⅜"
18¾"
Wood Base

MAN-CARRYING KITES IN WIRELESS SERVICE

FRANK C. PERKINS

The young Boston kitor, Samuel F. Perkins, is seen, in the accompanying illustration, at an altitude of 350 ft., on his man-carrying kites at St. Louis. It is held that in future wars, or war maneuvers in times of peace, the man-carrying kite is likely to play an important part. The recent experiments were made at Boston of the man-carrying kites, whereby a one-wire aerial was carried aloft and proved a most successful medium for the receiving and sending of wireless messages. In the wireless experiment the aerial was carried aloft several hundred feet, and it was a revelation to know how easily and quickly an emergency wireless station could be established in time of war. Messages were sent to the office of the Los Angeles Examiner; and stations such as those at San Diego, Catalina and San Pedro wondered what station was interfering with their calls. Another thing that the man-flying kites have done and may do further, is to furnish a target for the practice of sharpshooters carried in aeroplanes. The kites can be made to bob about in a manner to keep the sharpshooter on the alert to make a hit, and they can have attached life-sized figures as further targets.

It is stated that the altitude record made in California was 385 ft., this being also a duration kite record, the designer of these man-carrying kites staying up in the air for 90 minutes. The young Boston kitor owes his life to the fact that several of the many kites by which he was suspended at Los Angeles, parachuted and prevented him from dashing to death on the earth. He was 200 ft. in the air when the accident occurred in which aviator Chas. Willard collided with and cut the cable with his bi-plane, thus severing all connections of the kites with the earth. Aviator Willard injured his front control, but was able to land immediately and safely. Although three kites were wrecked the kitor Perkins in dropping 200 ft. landed without serious injury, the remaining kite acting as parachute.

An Astronomical Telescope

(*Continued from page* 57)

through the eyepiece, the mirror appears circular.

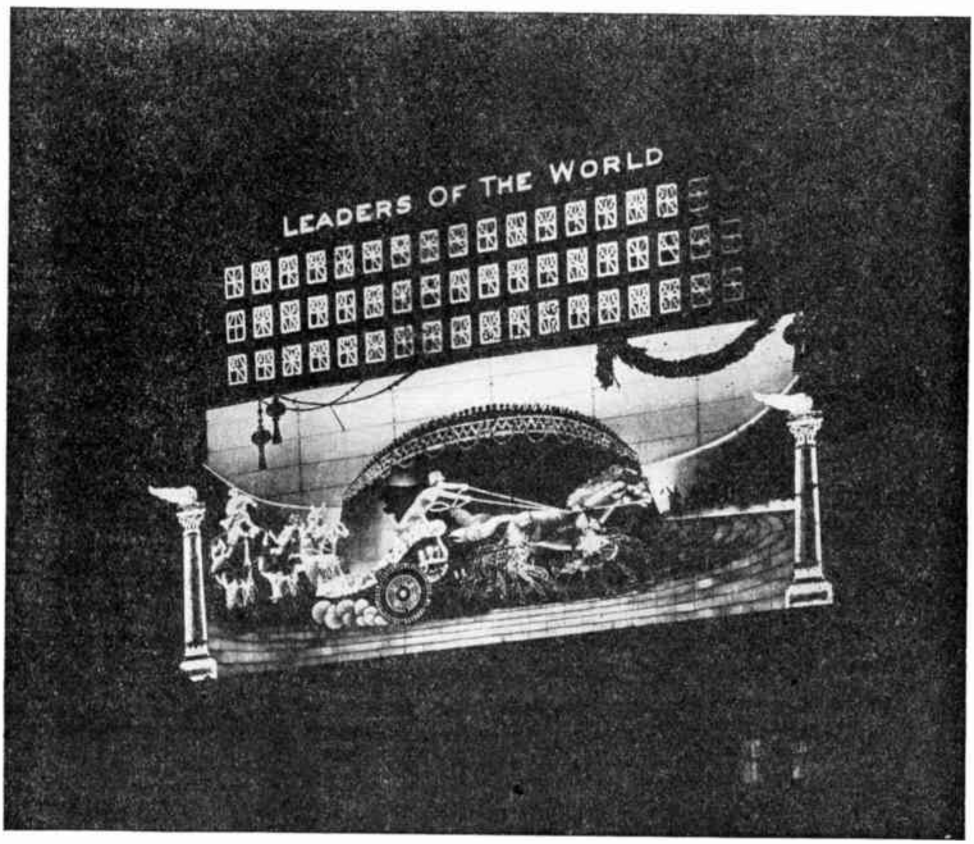
There are many improvements which might be added, such as worm wheel and rack for rotating the instrument, or clockwork might be substituted for the same purpose. Then graduated circles could be mounted on the axes—the one on the declination axis divided into degrees; and the one on the polar axis divided into 24 hours. Then the position of a star being known in right ascension and declination, or in other words, latitude and longitude, it is only necessary to adjust the instrument till the pointers on the circles indicate these positions, when the object will appear in the field of view. Then again, a camera may be fixed to the eyepiece and many interesting photographs taken, especially if the telescope has clockwork motion to enable it to automatically follow the object being photographed, though this is not absolutely necessary.

An instrument of this size, though fairly portable, would be better mounted in a small wooden observatory. The amateur will find the construction and assembling considerably easier than the delicate work entailed in model work.—*Model Engineer and Electrician.*

THE LARGEST ELECTRIC SIGN IN THE WORLD

L. E. ZEH

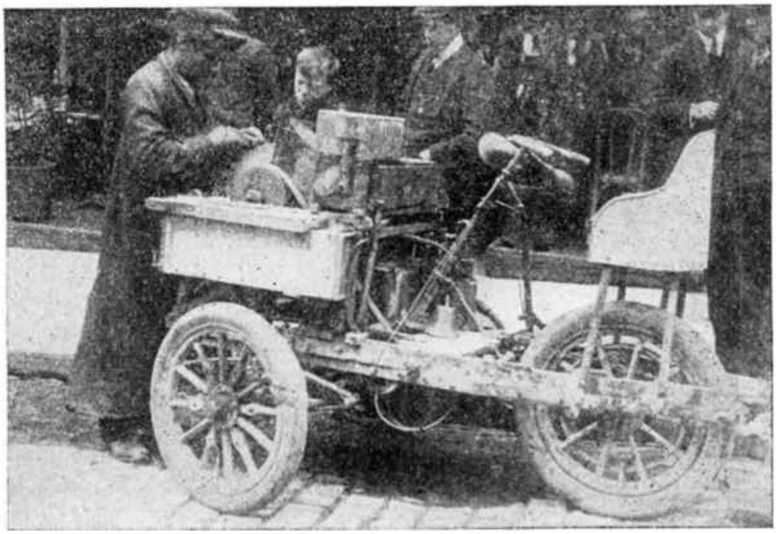
The largest electric sign in the world with marvelous motion effects and most elaborate in construction is one of the night wonders to be seen along the "Great White Way," of Broadway, New York. This monster picture sign is 100 ft. long by 70 ft. wide, and shows in brilliant and flaming colors the arena of a Roman amphitheatre as bright as day, with a chariot race in headlong progress. In the center of the picture is the leading chariot, flying along to victory and showing brilliantly against the dark background of the arena wall, the top of which appears crowded with spectators. Behind on the arena path appear other chariots, striving to overtake the leader. The horses all appear to be running at break-neck speed, yet never overtaking the main chariot, which represents the "Leaders."



The Largest Electric Sign in the World, Roman Chariot Race in Action

The great race takes place for about half a minute, then it is in darkness for an equal time, this being repeated during the entire evening.

Directly over the race is suspended a great steel curtain that is 20 ft. high by nearly 100 ft. long, about 2,000 sq. ft. of surface. Mounted on the top of this curtain is the title of this great display: "Leaders of the World"—made entirely of electric bulbs, which remains illuminated continually. All during the evening there appear continuously on this curtain the announcements of the different business concerns; the one leading concern in various standard lines of business is shown as the "Recognized Leader of the World." Every one of the 40 announcements appearing on the display is repeated every 9 to 10 minutes during the entire evening. Over 95 miles of wire was used to complete this sign. Altogether there are 20,000 electric bulbs in the sign, which consume about 600 h.p. There are 70,000 separate electrical connections. About 2,750 electric switches are employed, and the lamps are flashed at the rate of 2,500 flashes per minute. A number of Broadway night pedestrians have acquired the habit of setting their watches by the big electric clock. The minute hand of the electric clock alone weighs 140 lbs., and the hour hand weighs only a few pounds less. The full size of the sign is 62 x 50 ft. Diameter of the dial is 20 ft. The numerals are each 4 ft. long. The minute hand is 9 ft. long, and the hour hand 7½ ft. long. The clock is connected with the hands by a shaft 40 ft. long. The weight on the drum of the clock is 125 lbs., and the counter balance on the minute hand weighs 62 lbs. At night the great clock, one of the largest in Manhattan, is lighted by 3,368 electric lamps.



The Electric "Scissor-Grinder"

F. J. KOCH

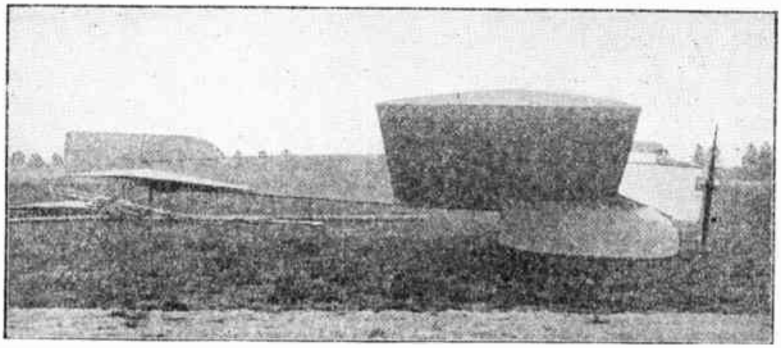
Vail, forever, to the old familiar tocsin of the scissor-grinder's bell and his harmonicals: "Scissors to grind; butcher-knives to sharpen!"—for an enterprising Frenchman has devised an automatic device, whereby electricity drives the cart, or what you would, on which the sharpening apparatus is mounted, gives the tender a ride, and works the stone as well. According to informant, as soon as the motor is set in motion, the grindstone revolves.

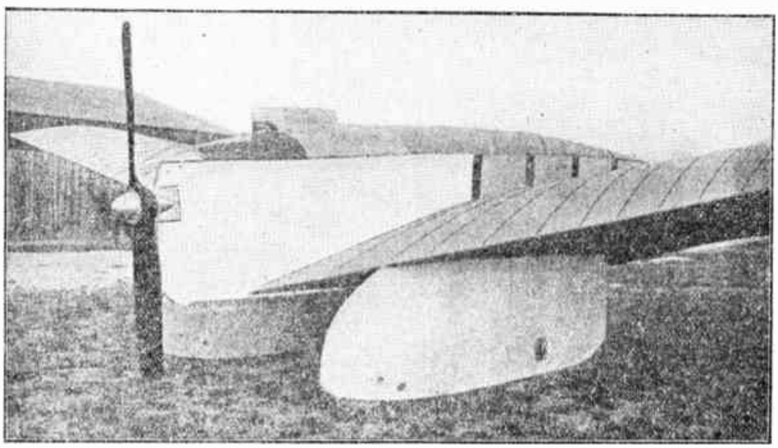
Clip from the newspapers interesting articles you want to read but have no time for at the present. Slip them into a large envelope, and when you make a journey put this in your bag. You can then enjoy them leisurely.

Tufts Wireless Club

Installation of New Outfit Increases Membership of Society

With plans completed for the installation of a portable wireless outfit, similar to those used by the United States Signal Corps, interest in the Tufts Wireless Club is on the increase. The organization has been offered the services of such an outfit by Captain Harry G. Chase of the Massachusetts Volunteer Militia Signal Corps, the outfit being used successfully in the recent maneuvers. Captain Chase is professor of physics at the college. The outfit will be placed at once in Robinson Hall, and in a few weeks the members are planning to set in active operation a station enjoying a sending radius of from 400 to 500 miles. Already nearly fifty applications for membership in the club have been received.





THE NEW MILITARY ANTOINETTE MONOPLANE

The Antoinette Company have recently produced a monoplane designed solely for military purposes. For this reason all vulnerable parts had to be eliminated. Accordingly, the new monoplane has no stay-wires, and the wings consequently have been greatly increased in thickness to take the additional strain. The wings are flat on their under-surface, and inclined at a considerable dihedral angle. The wheels are encased in sheet metal shields, designed to diminish head-resistance and to act as a "keel-plane" at the same time. This double device for maintaining lateral stability—dihedral angle combined with keel-plane—is by no means recent and has lately come in for strong condemnation on the score of its bad effect in disturbed air. There is a pronounced fore-and-aft. dihedral angle. The body is entirely encased in metal, the forward portion (containing the motor and pilot) in steel plates. The pilot obtains his view through the loop-holes at the side and through the floor which is transparent. The following are the dimensions: span, 52 ft.; length over all, 38½ ft.; plane area, 602 sq. ft.; weight net (without fuel or passengers), 1,870 lbs.; net loading, 3 lbs.; 100 h.p. motor.—*Aeronautics*.

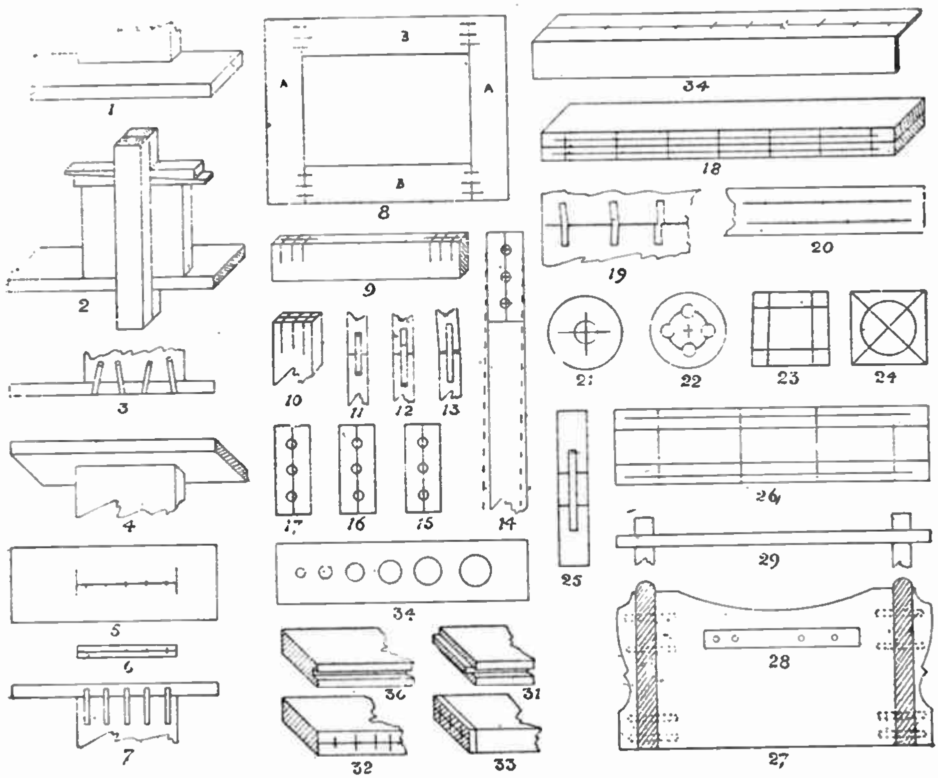
DOWEL JOINTS AND HOW TO MAKE THEM

The system of fixing joints together by means of dowels, or small round pieces of wood fitting tightly into each of the two pieces of wood to be joined, is a very good one, being strong, easy to do, and adaptable to almost any kind of joint in use. At the same time, easy as the method of doweling appears to be, and perfect as a good doweled joint is when finished, unless the several operations are set about in the right way, and carried out correctly, the result will probably prove a greater failure than any other form of joint would be under the same conditions.

In this article it is our purpose to show how to properly carry out the operations necessary to success, as well as to show how and why failures occur.

In Fig. 1 we show an upright standing on a flat piece, level at the back, a condition which often occurs to anyone making an article of furniture. To make this joint successfully with dowels, the best plan is to clamp the two pieces firmly together in their correct positions (as in Fig. 2) and bore a series of holes through the flat piece into the other, and drive in the dowels, gluing them, of course. When dry, this joint will be found very strong, and if the holes are bored so that the dowels spread both ways (as in Fig. 3) it will be stronger still.

The disadvantage of the above is, the ends of the dowels show in the finished work, and in many cases this will rule it out of order, as it would have to be in a case as Fig. 4, where the flat piece rests on the thin upright. To set out for this doweling the positions should be reversed, so that the upright stands on the flat, it can then be marked closely round, a middle line made, and the positions of the dowels marked on this line, as Fig. 5. The end of the upright must be marked in the same way as Fig. 6, and where the lines cross is the spot for the point of the boring bit, while Fig. 7 shows the section of the finished joint. In dealing with this thin wood in doweling, it is important that the holes should not be bored through, and equally important



that they should be bored as deeply as the thickness of the wood will allow, and in order to comply with both of these conditions, it is best to place a block or gauge on the boring bit, so that it can go so deep and no deeper.

INSERTING THE DOWEL PINS

In putting joints such as these together, the dowels should be driven into the *thin* part first; if the attempt is made to work the other way difficulties will be met with.

In doweling a rectangular frame together, it is best to lay the four parts on the bench in the position they have to occupy when finished, as, in Fig. 8, and then mark the position of the dowels across the joints, as shown. These marks are then squared across the edges of each of the stiles, *A*, as in Fig. 9, and the gauge mark crossing these marks, gives the spots from which to start the holes. The rails, *B*, must be squared over at the end, as Fig. 10, and the gauge mark made as before.

In boring holes for dowels in such work as this, great care must be taken to get them quite straight and parallel with the sides of the wood, also to make them an equal depth, so that there is just clearance room for the dowels, as in Fig. 11. Should the holes be too shallow, the joints will not come up at all. If too deep the dowels are buried in one part, leaving very little length in the other, as in Fig. 12; and if not bored straight, the effect is as in Fig. 13, and although this to a certain extent can be put right by the application of force, it is far better if it comes right without it.

ACCURACY OF POSITION

Another very important matter in this connection is that the holes be bored exactly in the right places. In Fig. 14 the middle hole is correct, the top one slightly to the right, the bottom one slightly to the left, the effect being to make the stile run as dotted lines, instead of as the solid lines, straight with the rail. The three holes should line exactly, as Fig. 15; if irregular, as Fig. 16, the result will not be what is required, and if bored all too much one way, as Fig. 17, the stile may be straight with the rail, but the joint will not be flush, consequently it means planing off the wood at both sides, making it thinner than it should be, and not only wasting time but timber as well.

In jointing two long pieces together they should be set out as in Fig. 18, laying them face to face on the bench, and squaring the marks across both edges, making the gauge marks along the middle. The holes must be made as true as possible both ways, or there may be a difficulty in making the joint come up close. Fig. 19 shows three very common faults in boring, all of which should be guarded against.

In jointing up thick wood, a double row of dowels may be used, as in Fig. 20, but the gauge lines should both be made from the face side of the wood, in case the two pieces are not exact in thickness.

In jointing timber endways dowels are indispensable, the general rule being to use one large one in the center, as Fig. 21. This, however, is not the best way, four small dowels, as in Fig. 22, being much more satisfactory. If the circle is struck from the center spot, as shown, and the four holes set out at equal distances on it, the two parts will come together correctly.

Should the timber to be joined be square in section, do not gauge round the four sides, as in Fig. 23, but work with a circle, as in Fig. 24. The latter method will come right in any case, the former only if the timber is at exact right angles every way, which is hardly to be expected.

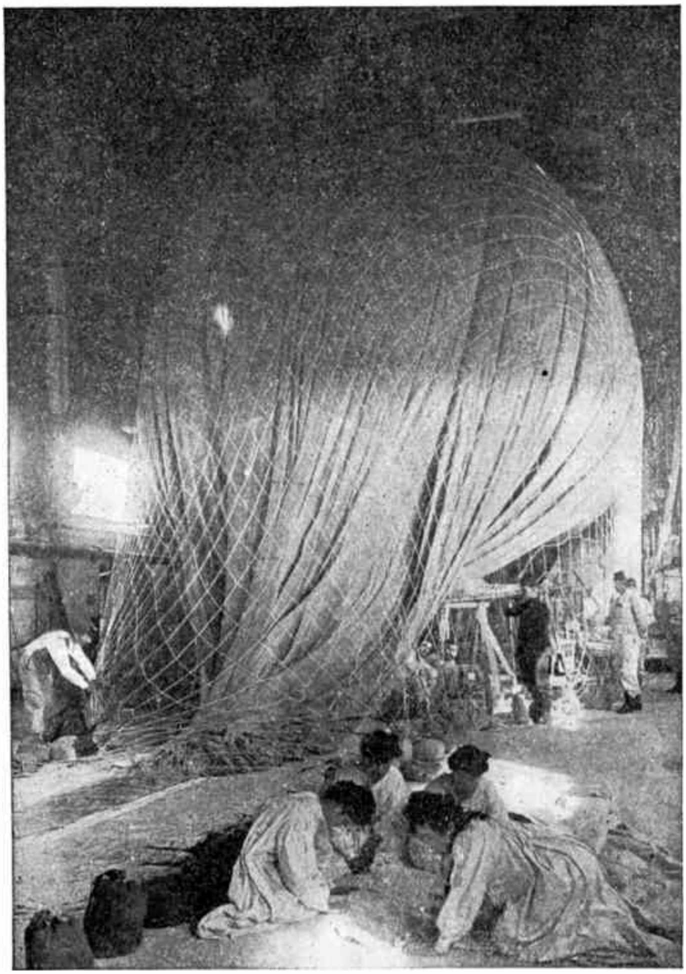
In doweling a narrow piece between two wider ones, as in Fig. 25, it is best to let the dowels run completely through the narrow piece, as shown, and to set them out by laying the narrow piece edgeways between the two wide ones laying flat, as in Fig. 26, the marks can then be squared across the edges of the middle piece, and the dowel holes *must* be bored from each edge. In putting together, the dowels should be inserted in the narrow piece first, leaving them to project at each edge, the other pieces will then go on easily.

The same method may be adopted in doweling together ornamental shaped boxes, such as would in fretwork be put together with a half-cut-through joint, the dowels passing through the sides of the box into the ends, and the continuation pieces fixing onto the end of the dowels, as in Fig. 27. In this case the dowels should be glued into the ends of the box first, the sides driven on, then the ornamental pieces. Fig. 28 is the edge of one of these latter, with the holes bored, and Fig. 29 shows the plan as seen from above.

In doweling together panelled framing, where the ends of the stiles and rails are as Figs. 30 and 31, the groove in the one and the tongue on the other make it difficult to bore the holes truly. This may be obviated by boring the holes before the tongue or the groove is made, and Figs. 32 and 33 show them set out for this purpose.

Ready-made dowels should always be used, but these do not always prove true to size, therefore a dowel plate is necessary. This is simply a plate of steel about ¼ in. thick, with a series of holes in it, as Fig. 34, corresponding to the various sizes of bits used. The dowels, after they are cut to length, are driven through the proper hole; there will then be no fear of their proving too tight when putting the work together.

The arrangement shown in Fig. 35 is sometimes used to set out the dowel holes. It is made from brass or iron, and a small hole is drilled at each of the cross lines. The template is laid on the wood and the holes marked through the perforations.—*Hobbies*.



Inflating a French Military Balloon

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.

1701. **Electric Locomotive Engineer.** R. H. H., Lancaster, Pa., asks where a person can learn to be a first-class electric locomotive engineer. Ans.—It is not so much or alone a matter of education, but of training and employment. You should of course have at least a high school education, and no defects in eye-sight, especially in the accuracy of detecting colors. You should have some facility with machine tools. It would be well if you obtained employment in the railway shops of either the Westinghouse or General Electric Company. It would do no harm when making application to state just what your ambition is. You should afterwards seek employment with a railway company, but this will not be difficult to obtain once you have the factory experience. We do not know what the pay is, but your aim should actually be not to remain in the engineer's grade, but to secure an executive position.

1702. **Induction Motor.** A. B. S., Chicago, Ill., has an induction motor, in which the rotor has a distributed winding with its three terminals connected to three slip rings. The name plate reads: "Westinghouse, Type F, 200 volts, 3-phase, 60 cycles, 30.5 amperes per terminal, 10 h.p. rotor circuit, 140 volts between rings, 32.6 amperes per ring." The correspondent wishes to make a three-arm rheostat, Y connected of proper resistances to fit the motor. Cast-iron grids will be the material. Ans.—The 140 volts between rings will be the case at starting only, when the exterior resistance is all "in." As the speed increases, you cut the resistance out, just as in the case of a direct-current motor. Finally it is all cut out, the voltage between ring approaches zero. It would be quite zero were it not for the resistance of the brushes and connections to the rheostat. This does not mean that 140 volts are used in driving the rotor current through its windings, for when the rotor is at full speed there is very little "slip," and the voltage induced in the coils is very much less. It will be a variable amount, however, dependent upon the load upon the motor. If the exterior resistance is to be regarded as non-inductive,—but with iron grids it will not be entirely ohmic,—the maximum resistance in each leg should be closely 140÷32.6, or 4.3 ohms. At the first step you should cut out nearly half of this, say let the remainder be 2.3 or 2.5 ohms. Have about 1.5 ohms left after the next step: then have .8 or .9, then .5 or .6; next .2 or .3, and finally zero.

1703. **Magneto.** H. B., Lyndenham, Ont., uses a low-tension magneto to light two 6-volt lamps, and to operate the induction coil on his boat. In trying to measure the output of the machine the voltmeter and ammeter are so unsteady as to prevent reading them. Lamps burn fairly bright, but rather unsteady. How can it be determined if any overloading is taking place? Ans.—We should say that if the lamps have a fairly long life, you are probably not running the machine at over voltage. The coil is supposed to endure 6 volts from a battery, and this ordinarily means a greater current than from a dynamo that gives the same voltage. The flickering may be due to the vibration of the engine that momentarily removes the driving power.

1704. **Chemical Rectifier.** E. S. B., San Francisco, Cal., sends a blue-print of a transformer and rectifier which he intends to build and asks the following questions regarding it: (1) Is the transformer correctly designed? (2) Is the rectifier correctly designed and the correct solution chosen? (3) What is a good book that it would be possible to get and in which it is explained how chemical rectifiers are made? Ans. —(1) With the one exception of the number of primary turns, we should say that your transformer is correctly designed. From the blue-print we assume that you propose to use the "Ferranti" type of construction, which is very popular among amateurs on account of its simplicity. The number of primary turns you specify would mean that the iron be worked at a rather high density, and we suggest that you increase the number of turns to at least 750 in the primary, with a proportionate increase in the number of secondary turns in order to bring secondary voltage to proper value. This would allow a working density of 30,000 lines for the core. (2) The rectifier will operate satisfactorily if made according to the specifications you give, although we have a preference for the four-cell type, as described in Mr. Thos. C. Stanleigh's article in our January, 1911, issue. The same article contains a description of a transformer similar to the one you propose to build. (3) With the exception of the article mentioned, we have no record of a work covering the subject.

1705. **Quenched Spark Gap.** W. J. H., Jr., Hartford, Conn., intends to make a quenched spark gap for use with a Clapp-Eastham ¼ k.w. transformer. He asks: (1) How many pair of 6-in. plates will be required? (2) Will ¼ in. brass be suitable, and if so, how deep should the grooves be cut? (3) What is the best method of clamping the gaps together? Ans.—(1) The best results will be obtained by varying the number from ten to fifteen. (2) The ¼ in. brass is perfectly suitable and the grooves should be made 3/32 in. deep. (3) Take two oak sticks, 1 x 2 x 9 in., and, placing the gaps between them, bolt the sticks together.

1706. **Transformer.** E. F. W., Chicago, Ill., wishes to know if the *Electrician and Mechanic* has at any time in the past published an article covering the construction of a small transformer of about 125 to 150 watts capacity, transforming 110 volts a.c., 60 cycles, to lower voltages ranging from 26 to 5 volts. Ans.—In our January, 1911, issue you will find an article by Mr. Thos. C. Stanleigh, covering the construction of such a transformer. We shall be glad to supply you with a copy of this issue on receipt of fifteen cents.

1707. **Arc Lamp.** E. C. B., Madison, Ill., asks: (1) How much resistance is needed in a 110-volt a.c. circuit, to work a simple arc lamp of hand-feed style? (2) Would it be advisable to make such a resistance from No. 14 galvanized iron wire, and, if so, how much wire would be required? Ans.—(1) The resistance required will depend upon the amount of current you wish to use; in other words, upon the intensity of light you desire. As you do not state this, we shall assume that you wish to use a current of 30 amperes, which is about the smallest it is practicable to use on an alternating current circuit, and still obtain a fairly steady arc. Placing the resistance of the arc itself at a low figure, as an alternating arc of this type should be very short, you would require a resistance of approximately 3 ohms in your rheostat. (2) Galvanized iron wire of No. 14 gauge would heat very quickly under such a load, and unless it were doubled, we do not advise the use of it. As we do not know the particular grade of wire you refer to, we are at a loss to state its resistance, and in lieu of this we give the resistance of the three grades known as "E.B.B.," having a resistance of 29.08 ohms per mile at 68 degrees F.; "B.B." having a resistance of 57.44 ohms per mile, and "Steel," with a resistance of 67.88 ohms per mile. If you double the wire in order to get the greater carrying load capacity, you must obviously use twice the length in order to obtain the same resistance. For the purpose you mention, a choking coil or step-down transformer would prove far more economical in current consumption, and you could get practically twice the light for the same amount of current used.

1708. **Condensers.** W. W., Montello, Mass., asks: (1) How many sheets of aluminum are required for a 0.005 microfarad rotary variable condenser, clearance between plates 1/32 in. and plates 3 in. in diameter? (2) How many sheets would be required, if all conditions stated in the last question were kept constant except the clearance and that was reduced to 1/64 in. (3) How many sheets of aluminum would be required for a 0.002 microfarad rotary variable condenser, clearance between plates being 1/64 in. and plates 3 in. in diameter? Ans.—We would suggest that you refer to our March, 1911, number, in which you will find an article by Mr. Ernest C. Crocker giving clear instructions for the calculation of the capacity of condensers.

1709. **Transparent Cement.** F. J. K., Rochester, N.Y., asks for a formula of a transparent cement to be used for wood and cloth. Ans.—There are several cements and glues on the market which would satisfy these requirements, but one of the easiest and simplest forms to use would be white shellac.

1710. **Batteries.** G. A., Burlington, Wis., writes that he intends to install an electric light on his bicycle, and which will be operated by dry batteries about 1½ x 1½ x 4 in. in size. He asks: (1) for a formula for making dry batteries. (2) Whether home-made cells would equal standard cells in length of life, etc. (3) An opinion on the use of a sal-ammoniac solution in a Gladstone battery to raise its voltage. Ans.—(1) The following formula is said to yield a serviceable filling for dry batteries: charcoal, 3 oz.; graphite, 1 oz.; manganese dioxide, 3 oz.; calcium hydrate, 1 oz.; arsenic acid, 1 oz.; glucose mixed with dextrine or starch, 1 oz. Intimately mix, and then work into a paste of proper consistency with a saturated solution of sodium and ammonium chlorides containing one-tenth of its volume of a mercury bi-chloride solution and an equal volume of hydrochloric acid. Add the fluid gradually, and well work up the mass. (2) Home-made batteries should equal standard cells in length of life, provided the home-made batteries were carefully made. However, as standard cells are sold at such reasonable prices it would probably be more satisfactory to buy them. (3) It would be inadvisable to use a sal-ammoniac solution in a Gladstone battery.

1711. **Transformer.** R. W. L., Detroit, Mich., asks: (1) How many layers of empire tape to be put over bare core? (2) How many pounds of primary wire would be fully sufficient to buy? (3) Transformer is to be operated on 110 volts d.c. with electrolytic interrupter. Would this alter specifications, and, if so, how many layers and yards of empire cloth would be required for insulation between primary and secondary? Ans.—(1) The wire core should be insulated with eight layers of empire cloth. (2) Between 3½ and 4 lbs. of No. 14 d.c.c. wire will be required. (3) For operation on 110 volt circuits with the electrolytic interrupter, we would suggest that you immerse the entire coil in a tank of transformer oil, as the insulation would not be sufficient to withstand high voltage otherwise. At least 20 layers of empire cloth should be used for insulation between primary and secondary. You can readily compute the number of yards required yourself.

1712. **Eight-inch Spark Coil.** H. M. G., Spencer, Mass., asks: Where can I get definite data to build an 8 in. spark coil. I have 13 lbs. of d.c. cotton magnet wire like enclosed sample (small one) and 8 lbs. d.c. cotton wire like large sample. I thought that may be, I would use this wire. I have 5 lbs. of pure beeswax (some from my own apiary) and can have the use of a lathe. I am sort of a general mechanic and do not believe but what I could build the above coil. Ans.—We refer you to a series of articles by Mr. Thos. C. Stanleigh on the "Design and Construction of a Six-Inch Induction Coil," in our February, March, April and May, 1911, issues for the information you desire. The general directions given would apply in your case with a few changes. We would suggest a core 1½ x 18 in., wound with two layers of the larger wire for primary; an insulating tube of mica; secondary sections not larger in diameter than 5 in. nor thicker than ⅛ in.; number of sections dependent upon your skill as winder; insulating discs of four layers of empire cloth between each section and its neighbor.

1713. **Telegraph.** E. H., St. Paul, Minn., has a telegraph line connecting three stations on the American Morse, or closed circuit, plan. Stations *A* and *B* are 1,150 ft. apart, and each has three gravity cells. *C* is 200 ft. from *B*, and has two gravity cells. Grounds at Stations *A* and *C* consist each of plates 1¼ in. x 2 ft., in the soil near stone walls. The cells at each station work the home instruments properly, but the line as a whole is not operative. What is the reason? Ans.—Without further data we cannot more than guess at the difficulty, and that is, that you do not have enough battery power. It is certain that however high the line or ground resistance is, and how insensitive are the instruments, you can overcome these troubles with more batteries. A better way may be to reduce the ground resistance. Certainly this would be the first and cheapest step to take. We do not quite catch the construction of your ground plates, but presume it is merely thin copper. Thinness is no objection, but, unless it actually rests in water, it is of rather meager dimensions. Can you not connect to a water pipe? That makes the most effective "ground." You did not state the size of the line wire you used, nor how it was insulated. Further, you may have only "sounders," in circuit, and these wound with too few turns. A resistance in each of at least 20 ohms will be needed, and "learner's" sets, having only 4 ohms resistance, would not work on very small currents. Your line is too short to require relays, but sensitive sounders will suffice. Let us hear if you are able to remedy the defect.

1714. **Motor-boat.** F. W. F., Brooklyn, N.Y., asks if it is possible to control a 2 h.p. gasoline engine in a boat from the bow,—the starting and variation of speed being accomplished without going to the engine itself? Can it be done without recourse to use of compressed air? Ans.—Perhaps you have in mind more than is conveniently possible. Since such engines are ordinarily of the two-cycle type, you will have difficulty and complication in trying to start other than by hand. The reversal of direction of rotation, too, is a matter for manual attention. Mere variation of speed can of course be accomplished in any one of several ways, and by simple means. You can put a sprocket wheel on the carburetor valve, use a section of plumber's chain to fit into it, and connect it to bow of boat by means of a brass wire or cable. Reverse pull may be applied through a tension spring, or a return wire. Several turns around a wooden cylinder will give the wire sufficient grip, or a second sprocket chain may be employed.

1715. **½ H.P. Motor for Vacuum Cleaner.** J. D. C., Cleveland, Ohio, asks: How to wind the motor, as described in the September issue for 3-phase 60-cycle, a.c. Ans.—In a three-phase motor there are three sets of coils, one coil per phase per pole. Each set must take the full voltage of the line. Therefore the number of conductors in each must be equal to the total number on the corresponding single-phase machine. However, each set needs only to carry one-third the equivalent single-phase current, so the wire has one-third the area and can be gotten in the same space. The current per wire $=\frac{5\text{ amp.}}{3}=1\frac{2}{3}$; No. 24 wire is suitable. Since there are 960 conductors and 8 coils per phase, there will be 60 turns per coil. Wind 24 coils and insert them as described. The direction of current is reversed between each coil of a phase. The six terminals can be combined in delta to 3, as described at various times in *Electrician and Mechanic*. The relation between the three terminals determines the direction of rotation. Reversing any pair reverses the motor.

CORRESPONDENCE

Dear Sirs: I may be a crank and perhaps I am not, but I will say I am not the only crank here in St. Louis or Oklahoma. I do a lot of traveling and every wireless station I run across I visit. I have gotten a great many to either subscribe or buy your magazine at the news-stand, but I am very sorry to say that it is not the same magazine that it used to be. Magazines, and everything else, should be specialized, as in medicine, to make a complete success a doctor specializes; and if you look into this you will see that every specialist is coining money, while the *general jack of all diseases is barely making a living.* Your magazine used to specialize two or three things and everyone was interesting, but now since you try to teach every thing, you will ruin the *very best* magazine published.

May I suggest that you specialize on the following subjects: wireless telegraph, wireless phone, aviation and perhaps *one* more subject, but no more, and charge $2.00 a year. I and every other subscriber would be willing to pay that for a magazine which specialized. I would be willing to pay $1.50 for the old-style magazine, but I don't think I care for the present one for 50 cents a year.

Yours truly,
CECIL A. WANNER.

Write to 50 of your subscribers if they like the new style better and see if 45 won't answer, No.

(The subscription list grows steadily, but we would like a few opinions of other readers on this subject.—*Eds.*)

Electrician and Mechanic is my ideal magazine and would be cheap at ten times the price.

Sincerely yours,
CHAS. H. COLLINS.

EDITORIAL

It is always the desire of the publishers of this magazine to supply to their readers such articles as are most desired, and will be of the greatest general interest. Since it is almost impossible to know what the readers really care for, unless they will make their wants known, we wish that any who may have ideas or suggestions to offer would send them in. Perhaps there may be a particular subject in which you are greatly interested, or some piece of machinery or apparatus which you would like to see described. If such is the case, write us about it, and provided the subject is one which would prove of general interest we will be glad to publish such an article at an early date. How would some of the following subjects appeal to you personally? A series of articles on Mechanical Drawing, starting with a description of the drawing instruments and some of the more elementary forms of work and continuing the subject through details, assemblies and isometric drawing. A department on Telephone Engineering, one on Wood-Working, one on Automobiles, and one on Boat Building. Articles on Marine Engines; Steam, Gas and Water Turbines and Oil-Consuming Engines. These are but a few of the departments and articles which we are considering publishing during the coming year, and if you would be particularly interested in any of them, be sure and write us a letter saying so.

We find that we can use to advantage good clean copies of July, 1908, issue. If any of our readers can send us this number in good condition we will be pleased to extend or enter a subscription for three coming months in payment for same.

Complaint has been made by certain readers that the articles on wireless telegraphy, published in recent numbers, have not included enough of an elementary character. A reference to the past files of the magazine will show that *Electrician and Mechanic* was the first popular magazine in the United States to satisfactorily treat of wireless telegraphy from the amateur's standpoint, and that our constructional articles have included practically every piece of apparatus which the average amateur might find useful and could construct.

As many of these articles can no longer be supplied by us, we are willing, if a sufficient demand exists, to treat subjects of general interest in the shape of new and up-to-date articles. We particularly request, therefore, that every reader interested in wireless telegraphy will write us fully his views on the subject, telling us what we could publish that would interest him. *Don't put this off and let the other fellow do it. Do it yourself, and now!*

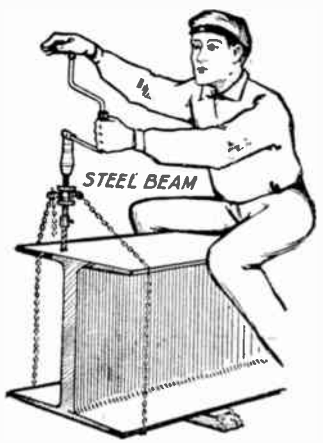
Many of our readers are sending us subscriptions for other publications and cannot always understand that deliveries are not made promptly by many of the larger publishing houses, owing to the fact that the mailing lists are closed several days in advance of publication, and the new names are often entered to begin with the following number. For instance, many of our orders now being transferred to other magazines it will be impossible to make deliveries on issues earlier than the January number and in some cases it may be well into the first of the year before the first number due in the year 1912 is sent out. We offer this explanation to protect ourselves, as the delay is not occasioned at this end of the transaction, but in the enormous volume of business that is turned at this time of the year, by some of the larger magazines, it is several weeks before the orders are reached in turn.

We would be glad to receive manuscripts which treat of subjects of general interest. Although it is not absolutely necessary that such articles be illustrated, yet articles which are accompanied by drawings, cuts or photographs are much preferred. Stamps must be enclosed if the return of unavailable manuscript is desired.

TRADE NOTES

"The Blitzen ¼ K.W. Transmitting Set," and "The Precision Potentiometer," are the titles of two circulars which have been recently issued by the Clapp-Eastham Company, of Cambridge, Mass. The transmitting set is quite inexpensive, costing $35.00; but the apparatus is of standard quality in material and workmanship, while being both efficient and of pleasing appearance. The set consists of the following pieces of apparatus: a Blitzen transformer, a plate-glass condenser, a helix of new design, a special zinc spark gap and a key. The entire set, with the exception of the key, is mounted in and on a very attractive mahogany cabinet, with binding posts provided for line and ground wires. The potentiometer has a resistance of 1,000 ohms, a sufficient resistance to prevent rapid depletion of batteries. The winding is of bare wire, spaced apart on a metal core from which it is insulated. The cost of the potentiometer is $4.00.

To drill a hole in a steel conduit box with an ordinary bit brace has been unsatisfactory to every electrician that has undertaken the job. It has always meant hard work, and unsatisfactory progress. No pressure, vise, or clamp is available, and all he has recourse to is to simply grind, grind, grind, till a hole of some sort was bored in the metal.



Most electricians still have a bit brace in use today, not knowing that a very simple appliance known as the **Red Devil** Chain Drill is being put on the market by the Smith & Hemenway Co., 150–152 Chambers St., New York City, the makers of the well and favorably known **Red Devil** electricians' tools, etc.

The **Red Devil** chain drill, an illustration of which is shown herewith, consists of an attachment for use with an ordinary bit brace and is practically a portable drill press. It is made of steel throughout and the operating principle is very simple. It is fitted with a Universal chuck which will accommodate a round or square shank drill, has an automatic ball-bearing feed and requires absolutely no pressure on the part of the operator to cut through the hardest metal, marble or slate.

The **Red Devil** chain drill has but recently been brought to our attention, and we find upon investigation that it is a very serviceable and practical appliance that the electrical worker will appreciate. It is small and compact, very light in weight, and can be easily carried in a tool bag.

The attention of our readers is called to the advertisement in this issue, and further information with regard to it can be had by addressing the makers.

We are in receipt of a pamphlet on the subject of the "Selection and Proportion of Aggregates for Concrete." The pamphlet is written in an attractive form and treats of a subject which is of great importance in connection with the manufacture of concrete. Copies of the pamphlet may be obtained by writing the Vulcanite Portland Cement Co., Fifth Avenue Building, New York City.

The Excello Arc Lamp Company of New York City have sent us a pamphlet on the subject of Flaming Arc Illumination. The story of how the "flaming arc" came to be developed, a presentation of the elementary principles of the "flaming arc" and a comparison of the efficiency of this type of arc with the "enclosed arc" are all included in the pamphlet. Readers who are interested can obtain one of the pamphlets from the Excello Arc Lamp Company.

Department of the Interior
Bureau of Mines announces New Publications

(List 6—October, 1911). Bulletin 13. "Résumé of producer-gas investigations, by R. H. Fernald and C. D. Smith. 1911.

Miners' Circular 5.—"Electrical accidents in mines; their prevention and treatment," by H. H. Clark. 1911.

Bulletin 24.—"Binders for coal briquets," by J. E. Mills. Reprint of United States Geological Survey, Bulletin 343.

Bulletin 26.—"Experimental work conducted in the chemical laboratory of the United States fuel-testing plant, St. Louis, Mo., January 1, 1905, to July 31, 1906." Reprint of United States Geological Survey Bulletin 323.

Bulletin 27.—"Tests of coal and briquets as fuel for house-heating boilers," by D. T. Randall. 45 pp., 3 pls. Reprint of United States Geological Survey Bulletin 366.

Bulletin 35. "The Utilization of fuel in locomotive practice," by W. F. M. Goss. 28 pp. Reprint of United States Geological Survey Bulletin 402. Copies will not be sent to persons who received Bulletin 343, 323, 366 and 402.

The Bureau of Mines has copies of these publications for free distribution, but cannot give more than one copy of the same bulletin to one person. Requests for all papers cannot be granted without satisfactory reason. In asking for publications, please order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D.C.

BOOK REVIEWS

The Copper Handbook: A Manual of the Copper Industry of the World. Vol. X, 1910–1911. Compiled and published by Horace J. Stevens, Houghton, Mich. Price, $5.00.

This massive volume of 1,902 closely-printed pages is one of the standard works of reference of the world, enjoying an authority in its field which is beyond question. The work is a monument to the industry and ability of its compiler, and is the result of many years' assiduous labor, the present edition containing about eight times as much matter as the first one. The first part of the book is devoted to chapters on the mining, refining and uses of copper, containing a complete summary of our present knowledge of the metal. Then follow a series of chapters on the copper fields of the world. The bulk of the volume is occupied by detailed descriptions of the copper mines of the world, in which no less than 8,130 mines and mining properties are described, the prospects and financial situation of each company being fairly discussed. The author does not hesitate to say harsh things of rascally promoters and some of the descriptions form very spicy reading. The book closes with exhaustive statistical tables, and is an indispensable reference book to all interested in its field. The publishers will send the book without advance payment on a week's approval to anyone ordering it.

Motion Study: A Method for Increasing the Efficiency of the Workman. By Frank B. Gilbreth. New York, D. Van Nostrand Co., 1911. Price, $2.00 net.

The author of this book is enthusiastic as to the value to the world of a well-directed study of the movements involved in any routine work, with a view to so adjust the work to be done and the means of doing it to each other as to produce the maximum amount of production with the minimum of fatigue. He analyzes all the variables of the case, drawing his illustrations and examples mainly from the work of the bricklayer, and draws the conclusion that the standardizing of the trades is a great problem for the government to undertake for the benefit of its people. An interesting and stimulating book on a vital topic.

How to Grow and Market Fruit: Practical Explanations and Directions for Making Fruit Trees Produce Profit. Published by Harrison's Nurseries, Berlin, Md. Price, 50 cents.

Out of the fullness of knowledge given by many years experience in propagating, growing and marketing fruit of all kinds, the publishers of this book have produced a most valuable manual for everyone who owns a home. It contains thoroughly practical descriptions of every phase of fruit-growing, simply written and fully illustrated. With the present prices of fruit, there is a greatly increased interest in this phase of agriculture, especially in the East, and the book is consequently most timely and useful.

The Boy's Book of Warships. By J. R. Howden. With over 100 illustrations from photographs. New York, Frederick A. Stokes Co., 1911. Price, $2.00.

Equally as fascinating as its predecessors on steamships, railways, and locomotives, this book is one which every mechanically-minded boy should possess and enjoy, and the elders will find it as valuable as the younger generation. The author sketches briefly the development of the fighting ship from the earliest times to the introduction of the steamer and the iron-clad, and then pursues in detail the development of naval types down to the present time. Every detail of the construction and equipment of fighting ships is fully explained and adequately illustrated, and the book is well calculated to impress the mind of a landsman with the importance and value of naval defence preparations.

The Law of the Air. By Harold D. Hazeltine. New York, George H. Doran Company, 1911. Price, $1.50.

It is at the present time quite generally believed that a state or nation should have a certain amount of control over the air-space lying above its territory, but as to how complete this control shall be and in what manner exercised authorities differ. Mr. Hazeltine treats this subject under three heads: The Rights of States in the Air-Space; The Principles and Problems of National Law and The Principles and Problems of International Law. A careful review of the best existing opinions is presented, together with some original ones held by the author, and the volume is really a most interesting one.

The "Mechanical World" Pocket Diary and Year Book for 1912. Manchester, England, Emmott & Co., Ltd., 1912. Price, 25 cents.

A most convenient, compact and useful little handbook on Mechanical Engineering has just been issued by Emmott & Co., Ltd., of Manchester, England. This is the twenty-fifth issue of this handbook and many new and interesting features have been introduced. The entire book has been thoroughly revised, and as the tables, illustrations and descriptions are excellent this work should prove of value to all who are in any way connected with or interested in mechanical subjects. The book is well bound in cloth and the price is remarkably low.

The "Mechanical World" Electrical Pocket Book for 1912. Manchester, England, Emmott & Co., Ltd., 1912. Price, 25 cents.

This little handbook on Electrical Engineering is similar in style to the "Mechanical World" Pocket Diary, and it is fully illustrated, well printed and strongly bound. The matter devoted to lighting has been entirely re-written and a number of new sections added. Among the more interesting of the sections may be mentioned the following: One, treating the principal defects of dynamos and motors, with suggestions as to remedies; one, describing the construction, rating and testing of high-tension apparatus, and one describing electrical measuring instruments. Numerous tables and a diary for 1912 are included in the book.

NEW MAP OF NORTH AMERICA

Forty-two Colors Shown on Map of the Continent Issued by United States Geological Survey. Work of Great Value to Scientists and Schools. Sold by Government at Nominal Price

The most notable map publication of the year is the large geologic map of North America just issued by the United States Geological Survey. It represents an exceptional type of engraving and lithographic color work, and is printed in four sheets, which fitted together and mounted make a map 6 ft. 5 in. high by 5 ft. wide, the largest piece of work ever issued by the Survey. The scale is 1 to 5,000,000, or 80 miles to the inch, and the plan of projection is in harmony with the universal world map on a scale of 1 to 1,000,000, in that it shows the units of publication of the world map, each of which embraces four degrees of latitude and six degrees of longitude.

Each Sheet Printed Fourteen Times

The color scheme of the map is a striking one. In all there are 42 color distinctions, varying from a brilliant red to pale tints approaching white. These were produced by 14 separate printings from lithographic stones, requiring in many places two or three combinations of color to produce the desired effects. If the weight of paper and heavy stones lifted back and forth in the printing of this job were to be computed it would run into the hundreds of tons. The accuracy of the "register," or fitting together of the color blocks in small areas throughout the map, is remarkable. The work was done in the Survey's own engraving and printing plant, and it is believed that there are few if any other establishments in the United States capable of turning out such a production. The 42 color distinctions represent as many divisions of rock strata. Thus the rocks of seven divisions of the Paleozoic era are each represented by a color, besides three separate colors for undifferentiated rocks, and there are other colors for the divisions of the Mesozoic, the Tertiary, and the Quaternary.

The coloring of the map is both effective and pleasing. The scheme is systematic in that the colors range in prismatic order from yellow in the upper portion of the geologic column through greens, blues and purples to pinks and browns at the base. The colors for the igneous rocks, both plutonic and volcanic, are mostly bright red. Viewed as a wall map, the map of North America shows only the larger geologic units, as the smaller divisions are represented by different shades and tints of the same or closely allied colors which are indistinguishable at a moderate distance.

Valuable for Detailed Study

Viewed close at hand these minor distinctions can be read and the map can be used for detailed study limited only by the scale. When it is used as a wall map the regions illustrating different types of geology stand out boldly. The great Canadian shield of pre-Cambrian rocks is represented by a subdued color in a pattern simulating crystalline texture. Parallel bands of darker colors from New Brunswick to Alabama mark the trend of the Appalachians, while the broad area of blue and gray colors to the west represent the coal fields of the interior, and a fringe of yellow colors to the east and south represent the Coastal Plain sediments. A brilliant vermillion coloring over much of the western part of the continent from Alaska to Central America strikingly portrays the volcanic activity in this region during the Tertiary period, and the broad area of green and yellow in the Middle West marks the last stages of deposition of sediments in the interior sea which covered that part of North America in Cretaceous time and in the continental depressions in Tertiary time, including many of the great coal deposits of the public domain.

The map embodies all the available published data and unpublished manuscript maps in the offices of the Survey and corrections from geologists in all parts of the country, based on a former geologic map of North America, published by the Survey in 1906, in co-operation with the Canadian and Mexican geological surveys, for the International Geologic Congress which assembled in the city of Mexico in that year. As an example of the interest taken in the publication of the present map, it may be stated that important corrections to the map of 1906 were received by the Survey from a leading geologist of France.

Sold at Cost of Paper and Printing

Not only will the geologic map of North America be indispensable as a wall map in colleges and schools where geology is taught, but each student will desire a copy for the study of broader problems in a real and regional geology and will wish to carry a folded copy on railroad trips across the continent.

This map is now on sale by the United States Geological Survey at the nominal price of 75 cents each. It is safe to assume that any private map-publishing house would charge $5 to $10 a copy for such a map.

Listing of Wireless Stations by M.I.T. Wireless Society

At the regular monthly meeting of the Massachusetts Institute of Technology Wireless Society it was decided that the society shall make a chart on which will be recorded all of the amateur wireless stations in the vicinity of Boston. The chart will also show the location, "call letters" and power of each of the stations. The reason for doing this is that at the present time no complete and accurate list of amateur operators is available, and it is important that such a listing of amateur stations should be made. Any amateur wireless operator whose station is located within one hundred miles of Boston is urged to send his "call letters," location, and the power of his station to Mr. E. M. Mason, Secretary of Mass. Institute of Technology Wireless Society, Boston, Mass.

ELECTRICAL

ELECTRICAL—Wanted, information regarding construction of chemical rectifier, taking about 30 amperes, suitable for 110 or 220 volts. State price. L. FIXEN, 1313 Carmen Ave., Chicago, Ill.

ELECTRIC WIRING AND LIGHTING—Knox-Shad, 192 pages; 150 illustrations. A working guide in all matters relating to electric wiring and lighting. Includes wiring for direct and alternating current by all methods approved by the fire underwriters; and the selection and installation of electric lamps for the lighting of buildings and streets. The utmost care has been used to bring the treatment of each subject within the range of common understanding, making the book especially suitable for the self-taught, practical man. Published by AMERICAN SCHOOL OF CORRESPONDENCE, Chicago, Ill.

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THREE-INCH COIL and 8 volt Exide storage battery; would exchange for transformer or 4-in. telescope. T. S R., 606 E. 3d St., Brooklyn, N.Y.

FOR SALE.—Enameled wire tuner. Double slide. Price, $2.50. L. E. VAIL, 2512 Sacramento St., San Francisco, Cal.

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MISCELLANEOUS

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MISCELLANEOUS

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INVENTOR'S LABORATORIES—Photographs wanted. Professional looking: plenty of instruments. Electrical, chemical, mechanical, wireless. $2.00 each, if accepted. VAN HAGEN, 34 West 129th St., New York City, N.Y.

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VOLUME	BOUND	UNBOUND	
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19 July '08 to June '09	2.00	1.50	
20 July '09 to June '10	2.00	1.50	
21 July '10 to Dec. '10	1.25	.50	(6 numbers)
22 Jan. '11 to June '11	1.25	.50	(" ")

All single numbers previous to January, 1909, are out of print, but we can sell for a limited time a few copies at 25c per copy to meet the demand for early numbers.

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