AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

CONTAINING
ILLUSTRATED ARTICLES DESCRIPTIVE OF ELECTRICAL AND MECHANICAL APPARATUS, FURNITURE AND OTHER USEFUL ARTICLES, GAMES, PHOTOGRAPHY, MODEL MAKING, BOAT BUILDING, ETC., ETC.

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INDEX.

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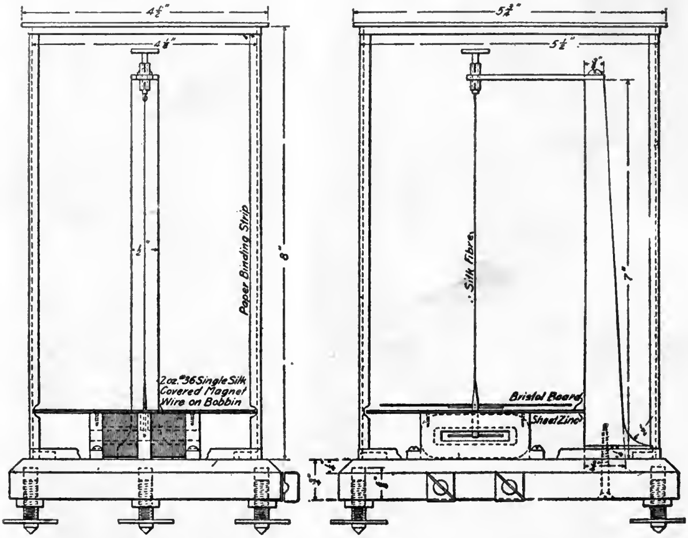
A SENSITIVE GALVANOMETER.

R. G. GRISWOLD.

In measurements of resistance by means of the Wheatstone bridge, to be described later, it is essential that the galvanometer used should be very sensitive, so that it may detect either the presence of an extremely small current or indicate the slightest variation in the strength of a current flowing. One of the most sensitive galvanometers which lends itself to easy construction is the astatic type, the magnetic system of which consists of two magnetic needles rigidly mounted on one vertical axis, with poles reversed. Its sensibility depends upon three conditions: Highly magnetized needles, small controlling force, and a large number of turns on the galvanometer bobbin. Two side elevations of this instrument are shown in Fig. 1, and a plan view in Fig. 2.



The bobbin, Fig. 3, upon which the wire is wound, should be made of some fine-grained hard wood, such as cherry. It can be worked out to the best advantage with a fret saw and a file. The construction will be greatly facilitated if the form is divided on the line *a b* and then glued together after the two parts are completed. Give it one coat of shellac and see that the space in which the lower needle swings is smooth and free from hairs from the brush, pieces of lint or other small obstructions that would interfere with the delicate action of the suspended system. Wind the bobbin with 2 ounces of No. 36 single silk-covered magnet wire, winding one side full first and then the other, so that the current will flow in the same direction about both coils.

Mount the coil upon the base, carrying the wires from the bobbin coil terminals down through holes to grooves cut in the bottom of the base, and thence to the binding screws on the side to the clips of which they are soldered. The dial

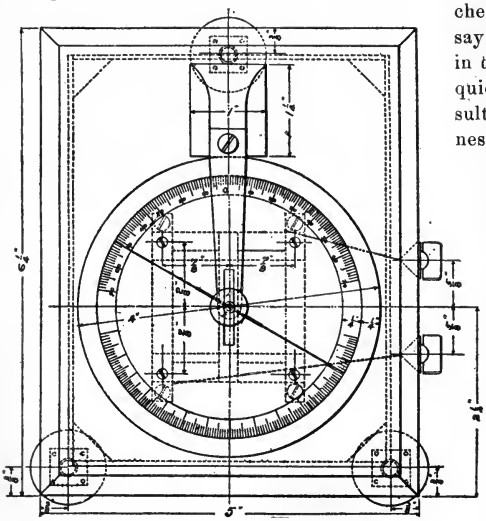


Fig. 2.

is made by gluing a piece of thin white bristol board or other hard-surface paper to a piece of sheet zinc. After the dial is cut to size the circles and divisions should be drawn thereon, numbering the latter by tens. As the instrument is not intended for measuring by deflections in degrees, it is not necessary that the divisions have any particular value other than that they are equal. Fasten the dial to the bobbin by the screws shown so that the center of the dial coincides exactly with the center of the bobbin.

The vertical post is made of wood and has mounted at the top a brass arm, Fig. 4 *a*, carrying at its end an adjustment device for the suspension fiber. A small piece of brass tubing which just fits the brass rod of the hook pin, is soldered in the end of the arm, and fine saw slits are cut at right angles in the top and bottom to permit a slight binding on the pin by squeezing them together slightly. The hook pin, Fig. 4 *b*, should work smoothly, but be held with sufficient friction to stay in any position.

The magnetic system, Fig. 5 *a*, is composed of four very fine sewing needles and a glass fibre mounted between two very thin pieces of mica by means of shellac. Secure four of the finest sewing needles possible, and file off the points and heads until they are 1 in. long. Get from some chemist or druggist a small piece of glass tubing, say 2 or 3 inches long. Heat about an inch of it in the middle in a gas flame until very soft and quickly pull it out at arm's length, which will result in a very fine thread of glass from the thinnest straight portion of which cut a piece 3½ in.

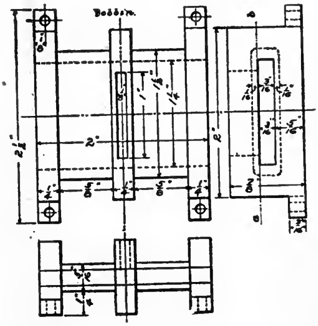


Fig. 3.

long. Cut a small piece of mica to the shape shown at *b*, Fig. 5, and with a very thin knife blade split off two very thin sheets. Draw the positions of the needles, glass fiber and mica stirrup on a piece of white paper. Fasten one strip of mica to the paper in the position drawn, by means of a little wax or soap, and then lay the needles and glass fiber on the mica in their respective positions, having first put a small drop of shellac on the spots where they cross the mica. Put a small drop of shellac on top of the needles and lay the remaining piece of mica on them, placing a small weight on it until the shellac has dried. Fasten the silk suspension fiber in the pointed end of the stirrup in the same manner, raising the lower side of the stirrup up by means of a piece of paper until the fiber is on a center line passing through the center of the needles. A small weight will serve to keep the two pieces of mica together until they have been firmly cemented to the fiber. Fig. 5 *c*, shows the end view of this stirrup drawn to a larger scale.

The silk fiber can best be obtained from a wire wound silk banjo bass string. By unwinding the wire from the string a long, fine fiber can be drawn out, which, being unspun, will have an equal torsional effect for either direction of swing from the zero point. The balance of the silk, as well as the fine wire, should be wrapped on a card for future use.

minute while the current is passing, and then with the *same* end of the magnet touch the end marked *N* of the lower set of needles for the same time and with the same amount of current. This will strongly magnetize the needles so that the corresponing ends of the two sets will have opposite polarities, and as the north-seeking end of one set is almost if not quite counterbalanced by that of the other set, the directive force of the system will be very small.

Adjust the hook so that it projects equally on each side of the split tube. Insert the lower needles in the slot in the dial and pass the fiber through the slot in the hook from the center outwards so that it will hang from the center of the

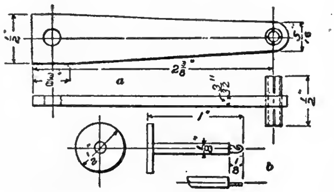


FIG. 4.

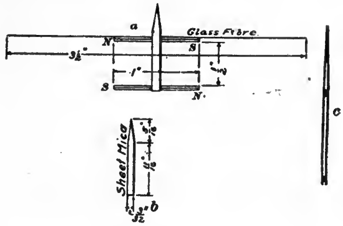


FIG. 5.

rod and not from a point outside of the center. Adjust the length of the fiber until the lower needles hang exactly in the center of the coils when looking through from the side and fasten to the hook with a small drop of shellac. As it is extremely difficult to make two sets of needles that exactly neutralize each other, one set will direct the system in a north-and-south direction and the instrument should be so placed that when the needle is at rest the pointer stands exactly over zero of the scale, and the axis of the coil has an east-and-west direction. The levelling screws will enable the galvanometer to be so adjusted that the pointer lies on both zeros of the scale and the center of the mica stirrup corresponds with the center of the dial. When the pointer is at rest on the zero division, give it a slight impulse and note whether it swings to the same division on either side of zero. If not, the fibre may have a slight twist which may be removed by turning the hook one way or the other until the deflections of the pointer are equal with respect to zero.

The galvanometer should now be provided

The levelling screws, Fig. 7 *a*, are made by forcing the unthreaded end of the screw into the disk *b*, soldering if necessary. The square piece *c* is threaded and fastened to the bottom of the base, $\frac{1}{4}$ in. holes being bored into the wood to accommodate the end of the screw.

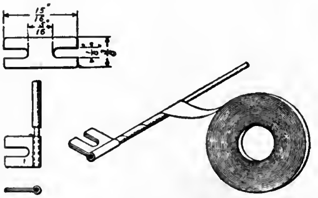


FIG. 6.

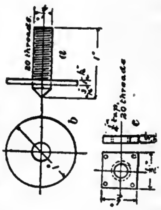


FIG. 7.

The instrument being finished and assembled, it is now ready to receive the magnetic system. To magnetize the needles, make an electromagnet by wrapping about 100 turns of No. 22 magnet wire around a quarter-inch rod, 2 in. long. Touch the end marked *N*, Fig. 5 *a*, of the upper set of needles with one end of the magnet for one with a glass case to protect it from dust and air currents. This case is made from five pieces of clear window glass, bound together at the edges with strips of gummed, black paper, such as is used for binding magic lantern slides and passa-partout pictures. Four small triangular blocks are glued to the base to prevent the case from slipping off. Great care should be taken to thoroughly insulate the bobbin wires where they pass through the base by making a small tube of paper to line the holes. Thoroughly coat the grooves underneath with shellac before the wires are put in and then give them a good coat. In instruments where such high resistance windings are used, small leakages of current that might occur across a moist surface or a thin layer of dust would so reduce the efficiency that proper indicacations will not be made. For this reason all places of probable leakage should be given good coats of shellac spirit and baked, if possible. Shellac is one of the best insulators and is easily applied.

In connecting various electrical instruments together, much annoyance is caused by the stiffness of wires of sufficient cross section to carry the current without appreciable loss. The connecting wires can be made of flexible lamp cord or several small copper wires, say No. 32 gauge, twisted together and insulated by winding tape around them. The ends should be soldered into a copper clip, as shown in Fig. 6, which is easily slipped under the head of the binding screw and insures good contact. If several of these connecting wires are made of different lengths much time will be saved during experiments in making connections.

A number of the clips may be made at once by clamping several pieces of sheet copper in a vise and working out the screw slots of all at the same time. Tin them on the inside of the bend before winding about the wire, by rubbing a hot soldering iron over the spot with rosin as a flux. Then tin the end of the wires. When the clip has been bent around the wire, squeeze it in the vise so as to make it lie close. Heat the tinned portion in a flame, when it will be firmly soldered to the wire. The tape may be secured from any electrical house for a few cents.

NOTES ON WIRELESS TELEGRAPHY.

L. T. KNIGHT.

II. Transmitting Instruments of a Wireless Telegraph Station.

The transmitting instruments of a wireless station comprises the induction coil, interrupter and primary battery, a key for sending, the Leyden jar battery, adjustable spark gap and a variable self-inductance. In general appearance the induction coil is similar to the X-ray and experimental coil, and right here at the start arises a difference of opinion as to whether the secondary shall be wound for extremely high potential or simply a normal one. There seems a preference in the German systems for coils of much less potential than the commercial X-ray coils, because a high charging power is required to charge the Leyden battery, which is continually discharging across a small spark gap. Any ordinary Rulmkorff coil will suffice for such experiments as the reader will probably care to make while following these articles; in many instances the amateur will find it to his advantage, financially, to construct the coil himself.

Referring to the last chapter, we note that the electrical "blows" were to be struck in *even* time. So with the interrupter of the spark coil, the interruptions must be steady, even and without variance. Vibrators that vary in frequency because of unreliable contacts at the make and break points, will not give the satisfaction of the higher grade vibrators, or the chemical or mercury break.. It is, therefore, essential in selecting an interrupter, to choose one that is permanent and true in action.

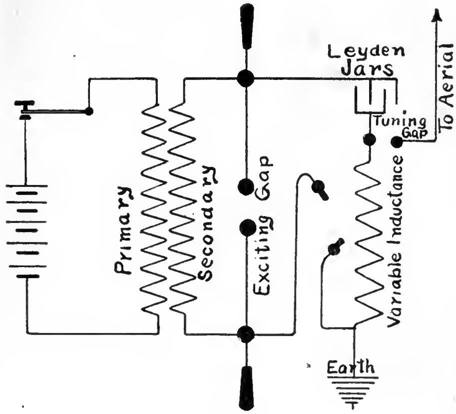
The variable inductance consists of bare wire turns about an insulated cylinder or open frame work, arranged in such shape that connections may be made with pegs, clamps or otherwise, on any part or turn of the coil as required. The

Leyden jars are connected in multiple.

In the elementary diagram here given is shown the transmitting circuit. The lower end of the inductance coil is connected to a secondary spark gap and also to the outer terminal of the Leyden jars. Two variable points or clamps affixed to flexible conducting cords are also provided. Their location is plainly shown in the diagram, and it is patent that with these two cords any portion or all of the inductance coil may be cut out, thus varying the capacity and inductance and determining the length of wave which the station will transmit.

The proper adjustment of the spark gaps having been once acquired, few changes in their position will have to be made. Generally speaking, the farther it is desired to transmit the longer the spark gap, and the stronger the current required in the primary of the induction coil. The spark, however, must be kept white and snappy, and frequent usage will make one familiar with that particular spark length and primary current which gives the most satisfactory results.

In such a transmittiug circuit as is here described, the secondary charges the Leyden jar battery until the potential is high enough to jump across the spark gap. Then oscillations are set up through the Leyden jars, the induction and spark gap. As a thorough description of this part of the circuit will be necessary in explaining



the receiving circuit and the adjustment of the receiver and transmitter to meet the proper communicating conditions, further comment will be postponed until the receiving station has been dealt with in the next chapter.

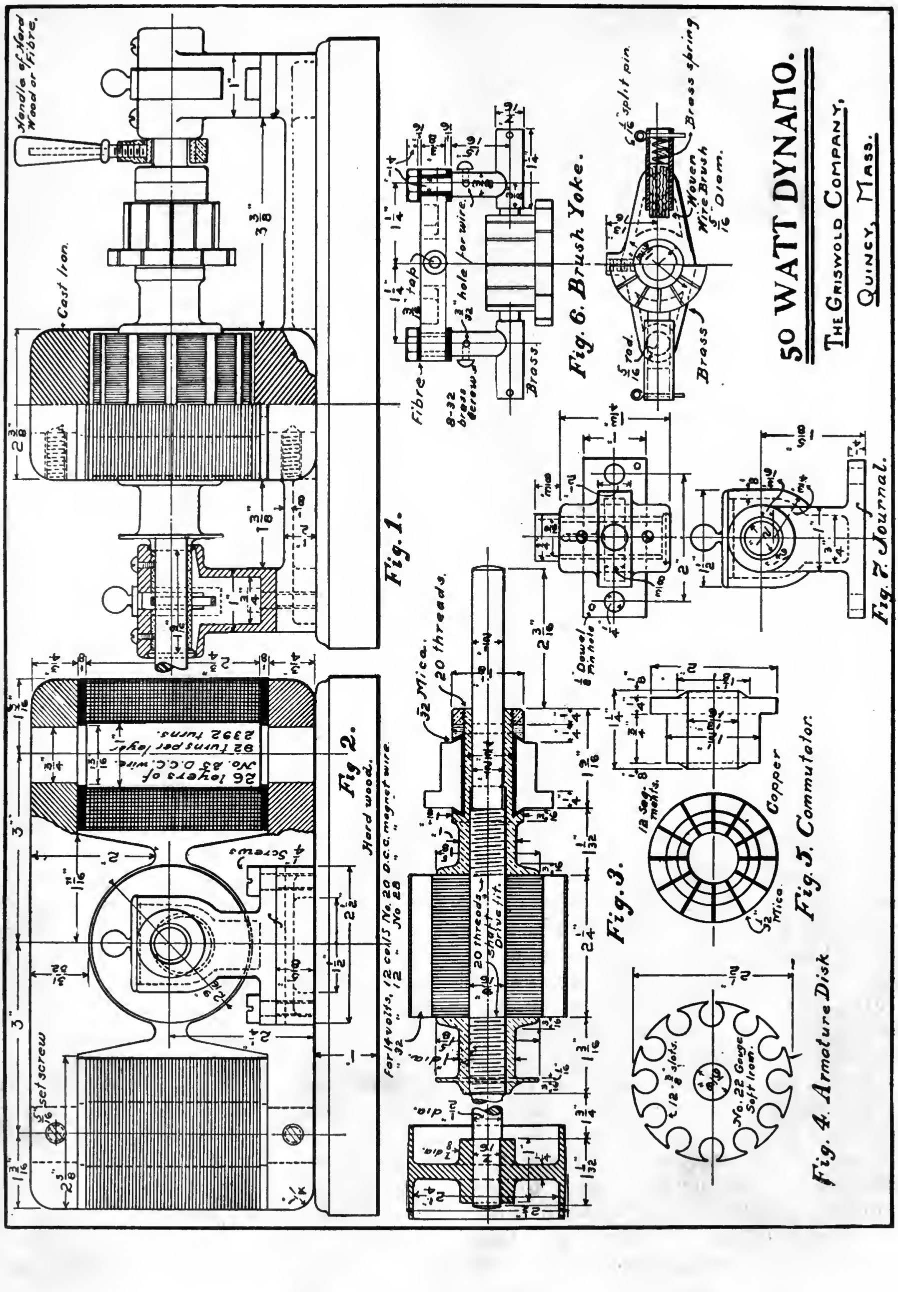
A 50-WATT DYNAMO.

R. G. GRISWOLD.

Although the majority of dynamos and motors of very recent design are of circular yoke type with radial poles, the Manchester type of field magnet has many points of merit, particularly in machines designed for amateur construction. Although there is a little more actual machine work to be done on this type of machine, it is of a character that is more easily performed than that necessary on the circular yoke type, and for this reason, more than any other, this type of machine has become such a favorite among amateurs.

Fig. 1 is a partly sectional side elevation of the field magnet frame together with the base and journal pedestals, showing the relative positions and dimensions. In Fig. 2 is shown a transverse sectional view of the field-magnet pole-pieces, mounted on the magnet cores. These magnet cores are turned from a 1 in. bar of soft wrought iron to the dimensions given, and the ends which fit into the holes in the field-magnets should be a very snug fit therein. The magnet cores are provided with flanges of $\frac{1}{8}$ in. fibre forced on, and it is well to provide a small shoulder $\frac{1}{8}$ in. deep by $\frac{1}{32}$ less in diameter than the core, against which this washer may be forced.

Fig. 3 is a sectional drawing of the assembled armature, commutator and shaft with pulley. The armature core is of the usual laminated type, the disks being $2\frac{1}{2}$ in. in diameter and of the shape shown in Fig. 4. The coil holes in the armature discs are $\frac{3}{8}$ in. in diameter and have a $\frac{3}{16}$ in. slot cut through to the periphery to facilitate the winding. The central hole is $\frac{9}{16}$ in. in diameter and is not provided with a key slot, as it is in-



50 WATT DYNAMO.
The Griswold Company,
Quincy, Mass.
Fig. 1.
Fig 2.
Fig. 3.
Fig. 4. Armature Disk
Fig. 5. Commutator.
Fig. 6. Brush Yoke.
Fig. 7. Journal.
Handle of Hard Wood or Fibre.
Cast Iron.
Hard wood.
26 layers of No. 23 D.C.C. wire.
92 turns per layer.
2392 turns.
For 14 volts, 12 coils No. 20 D.C.C. magnet wire.
20 threads
Mica
Copper
12 Segments.
No. 22 Gauge Soft Iron.
Fibre
Brass
Woven Wire Brush
Brass spring
split pin
Dowel pin hole
set screw
Screws
Drive fit.

tended that these disks should be forced on the shaft, which is made a tight fit in the hole. With every one of the disks thus pinching the shaft, there is little danger of the torque twisting the armature on its shaft.

The disks are clamped between two flanged collars, the flanged portion being $1\frac{5}{8}$ in. in diameter and being well rounded as shown. The shaft is provided with threads as shown, onto which these collars are screwed, hard up against the disks, firmly pressing them together. If greater security is desired a $\frac{1}{8}$ in. hole may be drilled through from end to end every 120° and bolts passed through these holes provided with nuts let into counterbores, but this is hardly necessary on so small a machine. The flange on the outer end of one of the collars is provided to prevent any oil finding its way to the armature by creeping over from the bearing. The magnetic portion of the armature is $2\frac{1}{4}$ in. long. The pulley, owing to its small diameter, is cast with a solid central web instead of spokes.

The commutator is of a design familiar to those acquainted with dynamo construction, the segments being bevelled at each end to fit under the bevelled groove in the collars. The clamping collar at the front end of the commutator fits smoothly over the core, but is not threaded; it is forced into place by an auxiliary nut on the core back of it. A layer of fibre or mica is laid between the segments and collars, that between the bevelled ends and the collars being in the form of a washer. Fig 5. is a front view of the commutator which is $1\frac{1}{2}$ in. in diameter. These lugs are $\frac{5}{16}$ in thick axially.

The brush holder, Fig. 7, is of the adjustable type and carries two brushes of either woven copper wire or carbon, which act in a radial direction against the commutator. They may be easily shifted while the machine is in motion and clamped in position by the small handle which terminates in a $\frac{3}{16}$ in. screw. The brush clamps need no special description as the detail drawing gives all dimensions. The actuating springs are made of No. 26 spring brass wire (B. & S.) and inserted behind the brushes, being held in place by the split pins shown. These springs feed the brushes to the commutator as they wear.

The journals shown in Fig, 7, and also in Fig 1., are of the self oiling type, having oil rings 1 in. in diameter outside and $\frac{13}{16}$ in. in diameter inside, by $\frac{1}{4}$ in. wide. These rings dip into the oil well below the shaft and keep the bearing well oiled by revolving with the shaft. The brass bushings are held in place by two 8-32 machine screws put through from the top.

This machine can be built in either of two windings; one for 14 volts and 3 amperes, and the other for 32 volts and $1\frac{1}{2}$ amperes. The 14 volt winding consists of 12 coils of No. 20 double cotton-covered magnet wire, each coil containing 22 turns of wire. The armature winding for 32 volts consists of 12 coils of No. 28 wire, each coil containing 54 turns of wire.

Each field coil contains 56 layers of No. 25 double cotton-covered wire, each layer containing 92 turns, so that there are 2,392 turns of wire in each coil. The two field coils are connected in multiple when used in connection with the 14 volt armature winding, and in series when used with the 32 volt winding, the fields being connected in shunt with the armature. The speed of the machine for 14 volts is 2,400 revolutions per minute; for 32 volts it can be run slightly slower than this.

The machine work on this dynamo is of the simplest possible consistent with practical results, and all of the fitting except the brush holder is plain lathe work.

The English newspapers report a new application in Australia of the principle of the eoin-in-the-slot machine, stating that if a stamp cannot be purchased conveniently it will be possible in the future to drop a letter into the orifice of a postal box and a penny into a second orifice, and the words "one penny paid" will be found impressed on the envelope when the box is opened by the post-office authorities, thereby securing the transmission of the letter.

The Grand Trunk Railway Company will substitute electricity for steam in the Sarnia tunnel, and will install a plant for that purpose to cost $500,000. The third-rail system will be used.

An excellent lubricant for drills and metal cutting tools in general can be made by mixing turpentine with machine or lard oil in equal proportions. The turpentine causes the tool to cut very keenly.

TELEPHONE CIRCUITS AND WIRING.

ARTHUR H. BELL.

VI. Central Station Systems.

Believing that amateurs who have followed this series of articles, and have made experiments in connection with them, would like to become familiar with the rudiments of practical telephony and continue, step by step, to the higher branches of the art, the writer will describe some of the simple apparatus and connections common to the many systems.

When the drop falls the operator places a "plug," connected with the operator's instrument, in the "jack" and talks with the party calling.

Fig. 2 illustrates a plug and a jack. The plug is, for convenience, built of round brass rod, so that it requires no particular position when entering the jack. Earlier styles of plugs were constructed of two flat strips insulated with hard

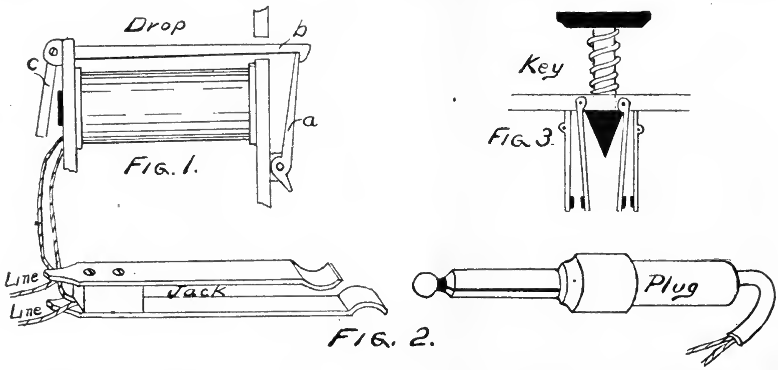


Fig. 1.

Fig. 3.

Fig. 2.

It is the custom, in certain types of exchanges, to signal the central office by turning the crank of the magneto generator of your instrument. The current generated passes over the line wire to the central switchboard, where it energizes an electro magnet device called a "drop". There are several styles and shapes of drops, but the fundamental principal is that of the electro magnet, wound with very fine wire to a resistance of 500 or more ohms, as the requirements may be.

Fig. 1 illustrates a drop. The shutter *a* is locked in place by the trigger or tongue *b*, which is part of the armature *c*. When the magnet becomes energized the armature, which nominally is a small fraction of an inch from the core, and consequently the tongue attached to it is moved upward an eighth of an inch or so. The shutter is inclined somewhat outward and drops when released by the action of the armature.

wood or rubber, but these are now seldom used except in telegraph circuits.

It will be seen that when the plug, with its conductiug pair of flexible wires, is inserted in the jack, which likewise has connection to a pair of wires, that whatever may be electrically connected on the plug side is given connection with whatever may be affixed to the jack wires, and the means of connecting or disconnecting is controlled by the hand that manipulates the plug. And if there were two distinct lines, each ending in a jack, and a cord bearing a plug at each end was inserted the two jacked lines would be given metallic connection with each other through the plugs and flexible cords. Flexible cords are made of tinsel, like electric light cord, for example, and electrically are equal in conductivity to solid wire which, of course, could not be utilized for the purpose.

If we were to devise an experimental central office for the purpose of studying the early principles of switchboards, we would require a special plug and cord attached to the central operating instrument, with which calls would be answered. The plug would then be removed and the subscriber conneted with the line called for by the double plug and cord device. Such an arrangement would not suffice in actual telephony at the present time, yet such was the method used up to the day the "key" was introduced, a score or more years ago. A key is a switching device, and its purposes are many. Fig. 3 illustrates a key adaptable to the foregoing circuits. By pressing down the button the rubber plunger is forced against the two inside springs, to which are affixed wires leading from the telephone used by the operator. To the outside springs are connected the plugs and cord device mentioned in the last paragraph. Further pressure on the plunger forces the inside springs against the outer, and places the operator's telephone in direct communication with the station jacks in which she may insert the plug or plugs. When pressure is removed from the key the operators' set is removed from the cord circuit.

PATTERN MAKING FOR AMATEURS.

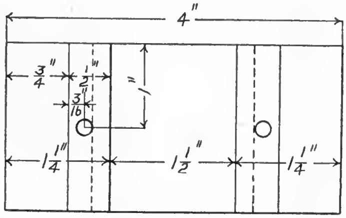
F. W. PUTNAM.

IX. A Hollow Tray.—Using Loose Pieces With Pattern.

The next pattern to be described is for a hollow tray. Large trays of the same style are frequently used on machines for holding tools and are then known as tool trays. Fig. 55 shows the pattern which is to be made with a vertical core. It will be noticed that the tray is hollow or recessed; the green sand core which forms this, projecting downwards from the cope.

The hub *A*, Fig. 55, is turned, together with the core prints, from one block of wood, as shown in Fig. 56. The plate, or bottom of the tray, is made from a piece of wood $\frac{3}{16}$ in. thick, as shown in Fig. 57. A hole $\frac{3}{4}$ in. in diameter is bored through the center of this plate to receive the two parts of the hub, which are made with shoulders $\frac{3}{8}$ in. in diameter to fit this hole. The shoulder is clearly shown at *B*, Fig. 56, the block, after being turned, being cut in two pieces at *D* with a back saw. The sides of the tray are shown in Fig. 58.

It will be noticed that the sides are bevelled $\frac{1}{16}$ in. to allow the green sand core to be removed easily from the mold. These pieces are so small that care must be taken in planing them. It will probably be found advisable to use two pieces of stock about 8 in. long, each piece being later cut



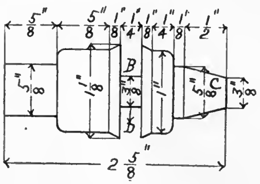
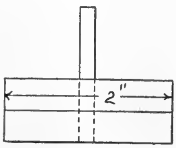


Fig. 56.



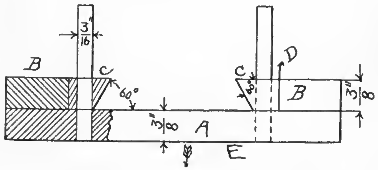


Fig. 60.

up for one long and one short side. These sides are to be glued and nailed to the plate, or base piece. The corners are mitred; the ends of the side pieces being, of course, cut off at 45°. The two parts of the hub are fastened to the plate sim-

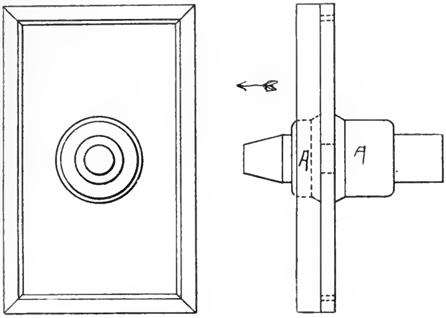


Fig. 55.

ply with glue. This will prove amply sufficient, if the shouldered ends fit tightly in the center of the plate.

Fig. 55 should be carefully studied before the hubs are glued together. The tapered part of the core print *C*, Fig. 56, is to come on the top side of the plate, as shown in Fig. 55. The arrow in Fig. 55 shows the direction in which the pattern is to be withdrawn from the sand. This draft should not be made until the sides have been final-

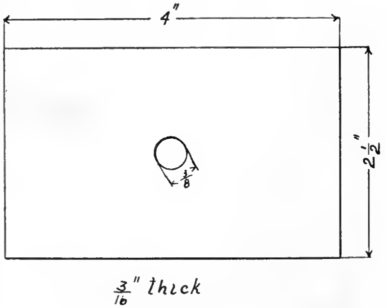


Fig. 57.

ly fastened to the plate. The hub and bottom core print being round, may be made without draft, if they are sand-papered to a very smooth surface, but care must be taken that there is no back draft at these points.

The next pattern brings in a new principle; that of using loose pieces with the pattern. Fig. 59 shows the casting of a small V way, as it is called. These V ways are in very common use on machines. Sometimes the tail stock of a wood turning lathe or machine lathe has a V way for a base piece, being similar to the one shown in Fig. 59. This V way slides along a dove-tailed track and has the advantage over the ordinary tail stock of never raising from the shears.

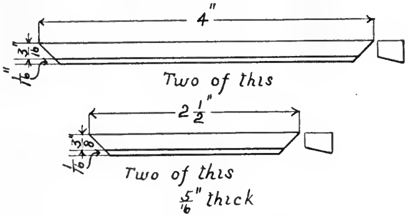


Fig. 58.

Fig. 60 shows three views of the pattern for this casting. The pattern is made up of seven parts; *A*, Fig, 60, is the base piece; *B* is the end piece, which is fastened to the top surface of *A*; *C* is the loose piece, made separate from the rest of the pattern, and used to form an angle of 60° with the top surface of the base. The stock

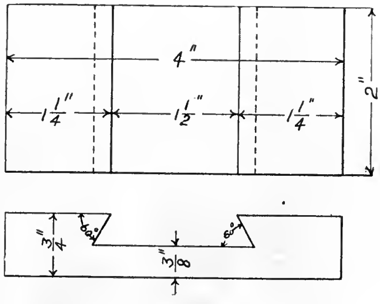


Fig. 59.

should be taken wide enough to make both *B* and *C*, and should be planed to the required thickness, $\frac{3}{8}$ in. The bevel of 60° is planed on one edge and carefully tested with the T-bevel.

The block which should be long enough to make both sets of pieces, *B* and *C*; *B* can then be readily planed to the required width, $\frac{3}{4}$ in. The edge of the piece *C*, left rough by the saw cut, must also be planed so as to leave the stock $\frac{1}{2}$ in. in width. Having sharpened the planer blade, next clamp *C* in the vise very carefully so as not to crush the block and plane down this rough edge. If a good vise with a perfectly smooth jaw is not available the piece *C* may be drawn over the bottom surface of the plane by hand. *C* must fit tightly against *B*, so that a close joint may be made at *D*, Fig. 60. These loose pieces are necessary because the parts *C*, Fig. 60, overhang, so that the pattern cannot be removed from the sand in any direction. In cases like this the overhanging parts are fastened loosely to the main part of the pattern by wires or wooden pins.

After the pattern has been rammed up in the nowell, the base part *A*, Fig 60, is moved in the direction of the arrow, the parts *C* being still left in their positions in the sand. These are next carefully moved towards the center of the opening and lifted out. It is evident that the loose pieces must be easily separated from the main body of the pattern and should, therefore, be fastened by pins, so that they can be readily removed.

Fig. 60 shows the holes that are to be bored to receive the wood pins. These pins are $\frac{3}{16}$ in. in diameter. They may be made slightly smaller, but if this is done care must be taken that the pins do not twist off when the pattern is molded. No draft should be made on the pattern until all parts are complete. Instead of tapering the loose pieces slightly for draft, they may be squared off $\frac{3}{64}$ in. less in length than the width of the base piece.

A SIDEBOARD.

JOHN F. ADAMS.

While the illustration of the sideboard here shown may give one the impression that it is a very plain piece of furniture, it will be found by anyone making it that the design and general appearance will be quite satisfactory. Of course the wood, quartered oak, should be carefully selected, all joints well made, and the staining so done that the markings of the grain will be brought out to the best advantage.

The framework for the top, containing the mirror, 40 x 16 in., is made separately from the under or cabinet part. A wooden panel may also be substituted for the mirror, but as the mirror adds much to the appearance, this is not recommended.

For the corner posts four pieces $40\frac{1}{2}$ in. long and $1\frac{3}{4}$ in. square are required. Mortises are cut for the cross pieces of the end panels, the lower ones being located to bring the under edge of the cross piece $7\frac{1}{2}$ in. from the floor and the top edge of the upper ones flush with the top. The mortises are 3 in. long, $\frac{1}{2}$ in. wide and 1 in. deep, and cut to bring the outer edges $\frac{1}{2}$ in. from the outer edges of the posts. Grooves $\frac{1}{4}$ in. wide and deep are cut for the edges of the panels, which are made of stock $\frac{1}{4}$ in. thick and with their outer sides $\frac{1}{2}$ in. from the outer edges of the posts. The cross pieces are $21\frac{1}{2}$ in. long and $\frac{7}{8}$ in. thick; the upper ones $5\frac{1}{2}$ in. wide, and the lower ones $4\frac{1}{2}$ in. wide, these lengths allowing $\frac{7}{8}$ in. on each end for tenons. Grooves are cut for the ends of the panels. The lines for the mortises and grooves should be laid out with a marking gauge to ensure close fitting joints. The panels are 23 in. long, $19\frac{1}{2}$ in. wide and $\frac{1}{4}$ in. thick, these dimensions giving a slight allowance for trimming.

The cross piece under the silver closet is $33\frac{3}{4}$ in. long, 3 in. wide at the ends, 2 in. wide at the narrow part, and $\frac{7}{8}$ in. thick. The wider ends may be secured by gluing on short pieces curved on the inner ends, as shown. Frames are made of $\frac{7}{8}$ in. stock to go between the silver closet and lower drawer, between the two drawers and above the upper drawer, those under the drawers having an oak front piece and forming the runs for the drawers. These frames should have mortise and tenon joints and be fitted around the posts, sawing into the latter a little to take the corners of the frames, thus adding stiffness to the construction. The floor of the silver closet is made by gluing up two $\frac{3}{4}$ in. brads, the upper sides of which should be flush with the top edge of the cross piece, and the inner edge set in $\frac{1}{2}$ in. to allow space for the back panelling. A similar allowance for the back panelling should be made with the frames above mentioned.

The top is 48 in. long, 24 in. wide and $\frac{7}{8}$ in. wide and $\frac{7}{8}$ in. thick owing to the width; it will have to be glued up from two pieces. Care should be taken to secure a good match on the grain and color of stock used. A neat moulding is run around the under side, as shown. It is fastened by screws put up through the upper frame. The two small drawers are 20 in. long, $4\frac{1}{2}$ in. deep and 21 in. from front to back. A division piece $\frac{7}{8}$ in. thick is placed between the two upper frames and nailed in place before putting on the top.

The large drawer is 41 in. long, $7\frac{1}{2}$ in. deep and and 22 in. wide. Strips will have to be placed on the frames, at the outer edges of the drawers to keep the latter in place when being pushed in.

The two doors are $15\frac{1}{2}$ in. high and $20\frac{1}{2}$ in. wide, the stiles and rails being made of $\frac{3}{4}$ in. stock, $2\frac{1}{2}$ in. wide, with a $\frac{1}{4}$ in. groove for the panel. The panels are 16 x 14 x $\frac{1}{4}$ in., with V markings $2\frac{1}{2}$ in. apart to represent matched strips, or matched stock $2\frac{1}{2}$ in. wide may be used. In hanging the doors, they should be set in about $\frac{1}{4}$ in., a stop block being glued to the bottom of the closet to hold the inner ends at the right place. The usual catches and knobs are added. A thin strip is is placed on the door at the right, to cover the crack.

The framework for the top part requires two front corner posts 23 in. long, and two back ones 29 in. long, all being $1\frac{3}{4}$ in. square. The two cross pieces at each end are 2 in. wide, $1\frac{1}{4}$ in. thick and 22 in. long, allowing for $\frac{7}{8}$ in. on each end for tenons. The lower cross pieces are 2 in. above the top of the cabinet, and the upper ones $1\frac{7}{8}$ in. below the top of posts. The corner posts of the top part should fit exactly over those of the lower part, and are attached thereto by $\frac{1}{2}$ in. dowels, the holes for same being bored in the top board of the cabinet when the top part is completed. The tops of the posts are bevelled slightly. The shelf over the mirror is $43\frac{1}{2}$ in. long, $19\frac{3}{4}$ in. wide at the ends, and cut in with an easy curve to 12 in. wide. The frame for the mirror is made with mitred corners, the top and bottom pieces being 2 in. wide and the end pieces $11\frac{1}{4}$ in. wide. A rabbet $\frac{1}{4}$ in. square is cut for the mirror, the latter being well protected at the back, first by a layer of thick paper and then back with well fitted picture backing. The board at the back of the shelf is 5 in. wide, $\frac{3}{4}$ in. thick and 42 in. long, allowing $\frac{1}{2}$ in. at each end to fit into grooves cut in the corner posts. A plate guard 1 in. wide, $\frac{1}{2}$ in. thick and 45 in. long is placed at the top, as shown. The detail of making the drawers, and some other minor matters is not given here, as such work has been quite fully covered in previous articles.

The most effectual means for the removal of bolts that have rusted in, without breaking them, is the liberal application of petroleum. Care must be taken that the petroleum shall reach the rusted parts, and some time must be allowed to give it a chance to penetrate beneath and soften the layer of rust before the attempt to remove the bolt is made. Bolts and studs on which the nuts are fixed with rust are often broken off through impatience. In most cases a small funnel built round a stud or bolt end on the nut with a little clay and partly filled with any of the searching petroleum oils, and left for a few hours, will enable the bolt or nut to be moved.

Renew your subscription promptly.

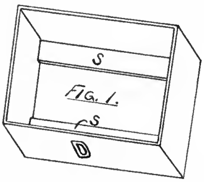
HOW TO MAKE PHOTO' TRAYS.

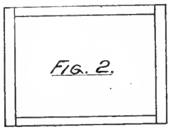
W. S. STANDIFORD.

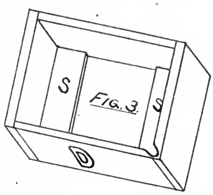
The amateur photographer, at the beginning of his experience with the camera, usually has an idea that a costly outfit of trays for developing, toning and fixing, is necessary for the making of good pictures. Now nothing could be further from the truth, as cheap but excellent trays can be made by any person who can handle the few tools needed for their construction.

The writer of this article is an amateur of years experience, and knows that many prospective amateurs are deterred from purchasing a camera on account of the expense of the outfit, as they naturally do not care to put much money in their first camera and photographic material—not knowing whether they will like the work.

Take a piece of white paper 1 in. square, and with pen and ink mark the letter "D", pasting the paper on the side of the box. Buy one-half pound of paraffine and one-half pound of beeswax at a total cost of 30 cents. Melt both in an old tin tomato can or dish, pour it into the tray so as to make the wax flow over the bottom and up the sides, getting it as near the top as possible. Then take a brush dipped in the melted wax and finish waxing the inside, sides and bottom. When cold it is ready for use, being unaffected by the usual acids and alkalies in the developing, fixing and toning baths used in photography. Fig. 1 shows the tray as finished, the strips *S S* being used to keep the plate from sticking to the bottom; they also strengthen the tray. The letter *D* on the side shows that the tray is to be used for developing. The letter paper box of the indicated size makes a most admirable dish for 4 x 5 negatives and smaller, being compact and light. Of course various sizes of cardboard boxes could be used to make trays suitable for different sizes of negatives.







To the prospective amateur photographer the writer would, therefore, recommend the following trays as being extremely handy, easy to make and cheap, they being able to stand considerable rough usage. The lighter pasteboard dishes could be made of sufficient lengths and diameters, to fit one within the other, thus occupying small space, and also being light in weight for traveling. We will first make a tray out of a cardboard box that contained two dozen sheets of writing paper and the same amount of envelopes. Both bottom and cover can be used, thus making two dishes—one for developing and the other for fixing.

The average size of a box containing letter paper is $5\frac{1}{4}$ in. wide, $6\frac{1}{4}$ in. long and $1\frac{1}{4}$ in. deep. Take the lid off a cigar box, cut two pieces one-quarter of an inch wide an $6\frac{3}{4}$ in. long, and glue them lengthwise in the pasteboard box—each strip being one inch from the sides. After this is dry paint the inside and outside with asphaltum varnish and let dry.

There should be no difficulty in getting suitable boxes of heavy cardboard, as most all of the large dry goods stores are, generally speaking, only too glad to get rid of them. When a larger box is to be made into a tray, should the sides be higher than desired, they can be cut down—first marking with a pencil a line on the side of box, line to be of equal distance measured from the bottom, and then cutting with a knife or scissors along the line.

We will now take up the construction of wooden trays which, although heavier than pasteboard, are more durable. They are also far superior to the hard rubber and fibre goods sold in the stores, which are very brittle and have to be handled carefully lest a piece should be broken out. From this fault the thin flexible rubber trays made in small sizes up to 4 or 5 inches are excepted, it being very difficult to break them.

To make a good developing dish of wood proceed as follows; Suppose it is desired to make a 5 x 7 in. tray. The first article needed is the wood, which we get by making a raid on the cellar of our grocer, or some cigar dealer. The dealer generally has a fine collection of boxes with thin boards and is found willing to give away a few of them. Selecting boards about ¼ or ⅜ in. thick and 5 or 8 in. wide, free from knots, smooth them off with a plane or if one is not handy, take a piece of coarse sandpaper and tack it around a block of wood and smooth the piece with that. After the roughness is taken off, two strips 1¼ in. wide, ¼ in. thick and 5¾ in. long are made. Also cut two more strips of wood the same thickness and width, and 8 in. long.

Now take the two 8 in. strips, one of the 5¾ in. strips, fasten the latter across the top of the longer pieces, one on each end, by the aid of wire brads; then nail the other strip across the other end. You then have a frame shaped like Fig. 2. Next we cut a piece for the bottom of the tray, 8½ in. long and 5¾ in. wide; if a board of the correct width is not at hand use two narrow pieces of sufficient width to be level with side of dish when the bottom is nailed on with the ¾ in. brads, spacing about ½ in. apart.

Take your knife and cut in one corner on the inside of tray, diagonal to the sides, a lip for pouring out the solution. Cut two narrow strips ¼ in, wide and 5¼ in. long out of a cigar box lid and glue them on the bottom at a right angle to the sides, each strip being placed 1½ in from the end of tray. Carpenter work finished, we next proceed to mark the letter "D" on a piece of paper one inch square, and then glue it on the side. Also glue a heavy piece of writing paper across the joint, if two boards have been used instead of one.

Coat the top, bottom and sides with asphaltum varnish; when dry, coat with the mixture of paraffine and beeswax in the manner previously described. Fig. 3 shows the finished tray. The construction of various sizes of wooden dishes for developing, toning and fixing baths can be designed by the amateur photographer to suit his needs by following the above methods of procedure.

These articles, if carefully made, will last many years and give good satisfaction. A fixing tray should be made to hold six to twelve negatives. Those living in tropical climates will find it best to use the following composition to coat the trays with instead of using the wax: Put litharge, finely powdered, into glycerine to make a semiliquid paste. Mix the two thoroughly and pour into the bottom of dish, levelling it with a piece of pasteboard bent into L shape. Grease the piece with oil or vaseline to prevent it from sticking. This cement will be found to be waterproof. Mix the ingredients as needed, as it hardens very rapidly. When the bottom is hard coat the sides in the same way. When the cement is thoroughly dry give it a couple of coats of asphaltum varnish. After that has set wash the tray well, putting in a pinch of washing soda with the first wash water to cut the grease. It is not necessary to put the cement on the outside, the varnish being sufficient to keep it from rotting.

At a recent meeting of the Academy of Science of France, held at Paris, M. Henri Moissan presented a paper concerning the preparation and characteristics of a new carbon compound containing molybdenum. This compound is obtained by heating charcoal with melted molybdenum and aluminum in an electric furnace. The resultant metallic mass is treated with a concentrated solution of potash, and needles of well-defined crystals of the new carbon compound are obtained.

The substance is very hard, is hardly attacked by acids other than nitric and is not decomposed by water or steam at a temperature below 600° C. It resembles the carburet of tungsten, already known, which is not considered surprising, as the metals tungsten and molybendum are much alike. It is thought that this new compound may play a role in molybdenum steels.

The method of preparation shows that even at a rather high temperature (that of boiling aluminum) a molybdenum compound is obtained which contains twice as much carbon as the compounds formed at the highest heat obtainable in an electric furnace.

Osmon, a new fuel, is made from peat. The peat used contains 90 per cent of water, of which 20 to 25 per cent is removed by means of an electric current. The peat is then further dried and passed through a machine which breaks it up and forms it into brinquettes, or nut shaped pieces.

AMATEUR WORK.

DRAPER PUBLISHING CO., Publishers,

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A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month for the benefit and instruction of the amateur worker.

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Single copies of back numbers, 10 cents each.

TO ADVERTISERS.

New advertisments, or changes, intended for a particular issue, must be received at this office on or before the 10th of the previous month.

Entered at the Post Office, Boston, as second class mail matter Jan. 14, 1902.

NOVEMBER, 1904.

The increase in Manual Training instruction is very encouraging in some sections of this country, while in others such instruction is sadly neglected. Those who are familiar with the practical benefits to be derived from manual training, when accompanied by a proper equipment and under the direction of skilled instructors, know that it has, in the few years during which it has formed a part of the school curriculum of our largest cities, more than demonstrated its value, and that those places which do not provide such instruction are not properly serving the educational requirements of their communities. The greater expense required for the equipment for such instruction is undoubtedly responsible for its lack in many places, but undue economy in this line causes a direct loss to a very considerable portion of the school attending population. How great this loss is cannot be realized by those who have not given the subject proper investigation, but that it is great will be admitted by any one at all familiar with the subject. Our object in mentioning the lack of such instructian is to encourage the study of its great practical value as a part of the educational system of the country, with the hope that every community in which there is a sufficient number of pupils to warrant such instruction, will cause strong and continued efforts to be made until it is secured. In furtherance of this idea we shall be pleased to advise any of our readers who may desire information upon the subject.

BOOKS RECEIVED.

Care and Handling of Electric Plants. Norman H. Schneider. Spon & Chamberlain, New York. $6\frac{1}{2}$ x 4 $\frac{1}{2}$ in. 100 pp. Flexible leather leather covers, $1.00.

This manual is intended as a handbook of practical information for those who are called upon to operate a commercial or military electric plant without having had previous experience, while it will also be found to contain much of value to the engineer. It is written with the aid of notes actually obtained in handling the apparatus described, the chapter on incandescent lamps being especially notable, as this chapter has not been given in other works the prominence it deserves. In the selection and composition of the tables the author has endeavored to make them applicable to both American and foreign practice. The text is very fully illustrated, making the manual of exceptional value. The book is strongly commended to those desiring information on this subject.

The How and Why of Electricity. Charles Tripler Childs. Electrical Review Publishing Co., New York. $7\frac{1}{2}$ x 5 in. 127 pp. Cloth, $1.00.

While there are many books treating of electricity, there is still room for this one. The various phases of the subject are treated in a plain yet very readable manner. While each chapter is necessarily short, because of the size of the volume, the general principles and application are set forth in a readable way, and to those desiring to read up on the subject, without making an extended study, this book will be found very serviceable.

Photography in Advertising, Figure Composition, Home Portraiture. Nos. 63, 64, 65. Photo-Miniature. Tennant & Ward, New York. 25 cents each.

The high standing of contributors writing these manuals in this series of booklets has long ago given them a prominent place in the literature appertaining to photography. The mention of the particular subject covered in each number is all that is now required to assure the purchaser that it is one in which he may be interested and will find of value.

A GASOLENE TOURING CAR.

R. G. GRISWOLD.

I. The Gear Case.

The design of a car printed in the September issue is, in many respects, very difficult for the amateur, if not almost prohibitive. There are many parts that could hardly be handled by the amateur of limited facilities, while in other respects there are many features that could be vastly improved. A car like the one to be described in the following series of articles can easily be constructed in five or six months by a man or boy of ordinary mechanical skill, as the entire car has been redesigned to meet the needs of amateur builders that are not fortunate enough to possess an *entree* to a well equipped machine shop.

This car, as here illustrated is of the popular detachable tonneau type that can easily be changed to a runabout in a few minutes. It will carry five persons with comfort, while seven can be accommodated by using corner seats in the front of the tonneau. The body is built on very graceful lines, and while it is extremely roomy, it is not at all difficult to build, provided the directions are closely followed. The painting and trimming will be taken up in due course.

This machine has proven itself extremely satisfactory in every respect, and has ample power to climb any ordinary grade on the high or intermediate gear, while on the low gear it has an abundance of power to negotiate very steep hills. It is easily handled and is geared for the following speeds when the engine is turning 1,000 revolutions per minute; twenty-five miles per hour in full gear, twelve and one-half miles on the intermediate, and four miles on both the low speed and reverse.

In general the car is of the latest accepted practice, a double opposed cylinder engine being placed under the hood in front, coupled to the driving shaft by a positive acting expanding clutch, which runs in oil and works metal to metal. The change speed gears, which give the changes mentioned above run in oil in an oil-tight gear case. The greater part of the machine work can be performed on an eleven inch foot-power lathe and bench drill capable of taking a half-inch drill. The operations requiring outside work are very few and inexpensive.

One of the greatest advantages of this design is that castings and forgings of almost every part detailed and described may be readily obtained at a lower cost than the amateur could afford to build the patterns for and have them cast. These castings have been made as nearly to size as possible in order that the machine work on them may be reduced to a minimum, and the fact that so little work is necessary greatly enhances their value.

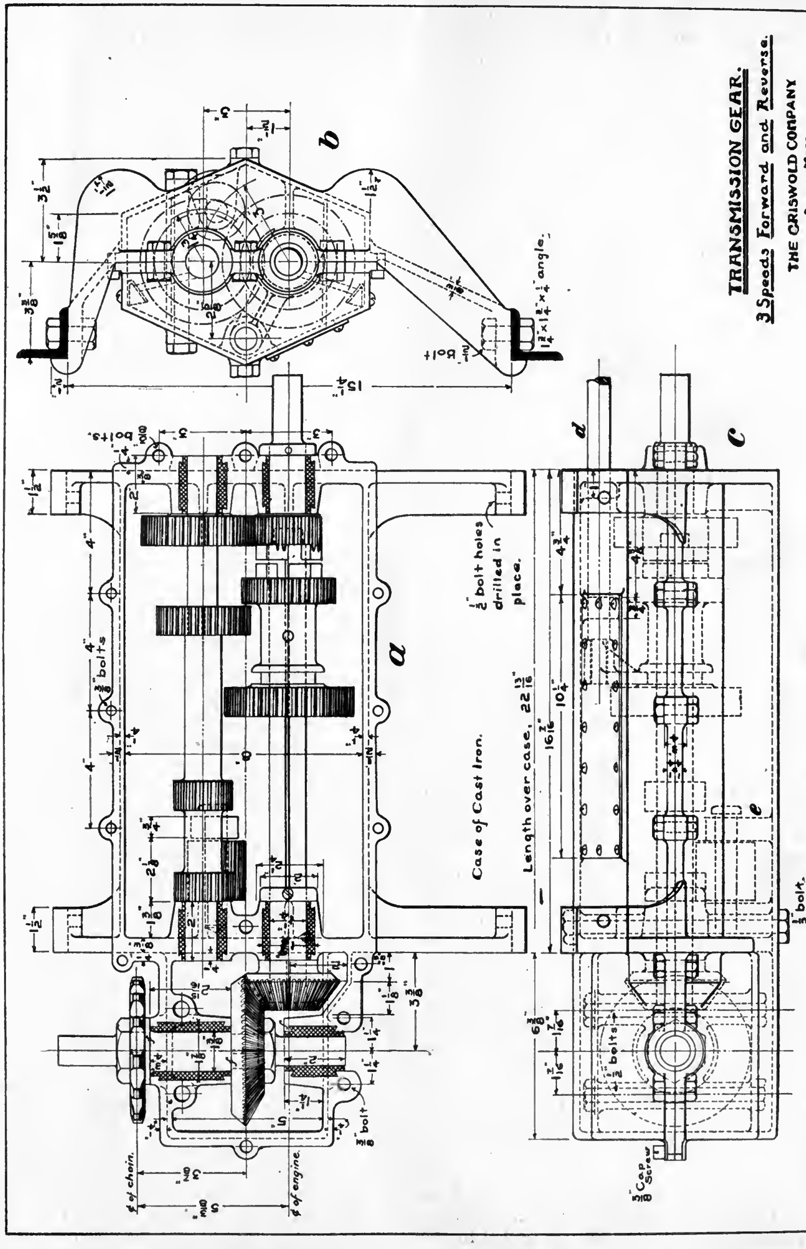
It has been thought best to begin with a description of the various details of the car, taking up the hardest and most tedious work first, and gradually building up to the finished car. An advantage of this system is that the working room of the builder is not taken up by the body of the car while the small parts are being made, and when the running gear and body of the car are in process of construction these parts may be incorporated in their proper places. Owing to the lack of space the full design cannot be given in this issue.

Perhaps the gear case will be as good a part to commence on as any. This transmission is the popular sliding spur-gear type, three speeds forward and reverse. There are no driving spurs in mesh on the high speed, and the bevel gears are absolutely necessary in any type of car where the power is transmitted from a longitudinal shaft to a transverse driving axle. This change must be made either in the gear case or in the differential on the rear axle, as in the propeller drive. This is one great fault with the gear shown in the September issue. It is impossible to drive the car without transmitting the power through two sets of gears on high speed, where the effort should be transmitted as directly as possible. When spur gears are driven at a high rate of speed they make a good deal of noise unless they are very well fitted, and the wear soon gives clearance between the teeth. Bevel gears are not so apt to do this.

As stated before, the gear shown in Fig. 2 is designed particularly to meet the needs of those unable to command a large machine shop where the planing of the two halves is generally done, as well as the boring for the shaft bearings. It is as light as is consistent with the duty required of it, while the gears and shafting are made unusually stiff and strong to obviate as far as possible excessive wear.

The upper half, or cover, Fig. 2 *a*, is provided with a cored hand-hole through which examination of the gears may be made without removing the gear case from its position in the car. This opening is closed wish a brass plate *b* 1-16 in. thick, secured by 8-32 round-head brass machine screws spaced about every two inches, a gasket of heavy cotton cloth or thick manila paper being placed in the joint, to render it oil-tight. The surface of the slightly raised edge around this hole can be easily dressed to a good surface with a file.

The joint between the two halves of the case, which is usually planed to a true surface, can be readily made with a large file in the following manner. The


TRANSMISSION GEAR.
3 Speeds Forward and Reverse.
THE GRISWOLD COMPANY
Quincy, Mass.
Case of Cast Iron.
Length over case, 22 13/16"
1/2" bolt holes drilled in place.
1 1/4"x1 1/4"x1/4" angle.
3/8" bolts
3/8" Cap Screw
℄ of chain.
℄ of engine.
a
b
c
d
e

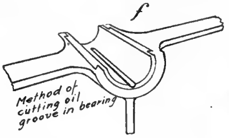
castings have been given very little finish at the adjoining surface to reduce the work of fitting. Of course the best job can be done by planing or milling, but a very satisfactory fit can be made by hand. Fasten the upper half to some firm bench by means of the little feet cast on the case, and with a large, sharp file work the surface down until a straight edge touches at every point on either side and ends. A fourteen inch file is about the size to use so that it will reach across from side to side. As to the accuracy of the joint, this may be tested by planing up a plank of hard wood 28 x 9 x 2 in., so that a practically true plane resul*s. Then, by laying this improvised surface plate on the work, any high or uneven places may readily be detected.

Fig 3.

e

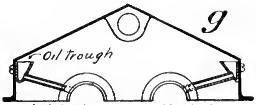
Method of supporting Sprocket shaft while pouring the Babbitt metal.

f



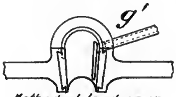
Method of cutting oil groove in bearing

g



Sketch showing method of securing oil troughs

g'



Method of leading in oil tube from trough

When the upper half is finished the joint surface of the lower half is finished in exactly the same manner. Then the finished surface of the top half is given a very thin coat of red lead in oil, and any excess rubbed off with the finger. The two pieces are then laid together in position and the upper piece given a *very slight* movement to and fro. This action will mark the high spots or points of contact on the lower piece, which are then dressed down with a smooth file when the cover is removed. This process is repeated until a perfect bearing is obtained.

The holes for the various bolts are then laid off on the finished surface of the upper half and drilled from the inside, with the piece resting on its feet. This half is then used as a jig and is laid down on the bottom half, clamped firmly in place and the holes in the lower half drilled by running the drill through the holes in the top. This insures that all holes will be exactly in line and match. The bearing for the nuts should be faced so that the nut will have a good seating. The holes for the bolts securing the case to the frame may also be drilled at this time.

The hole for the gear shifting rod *d* in the upper half is drilled with a ¾ in. drill, either from the inside, using a small ratchet, or from the outside on the drill press.

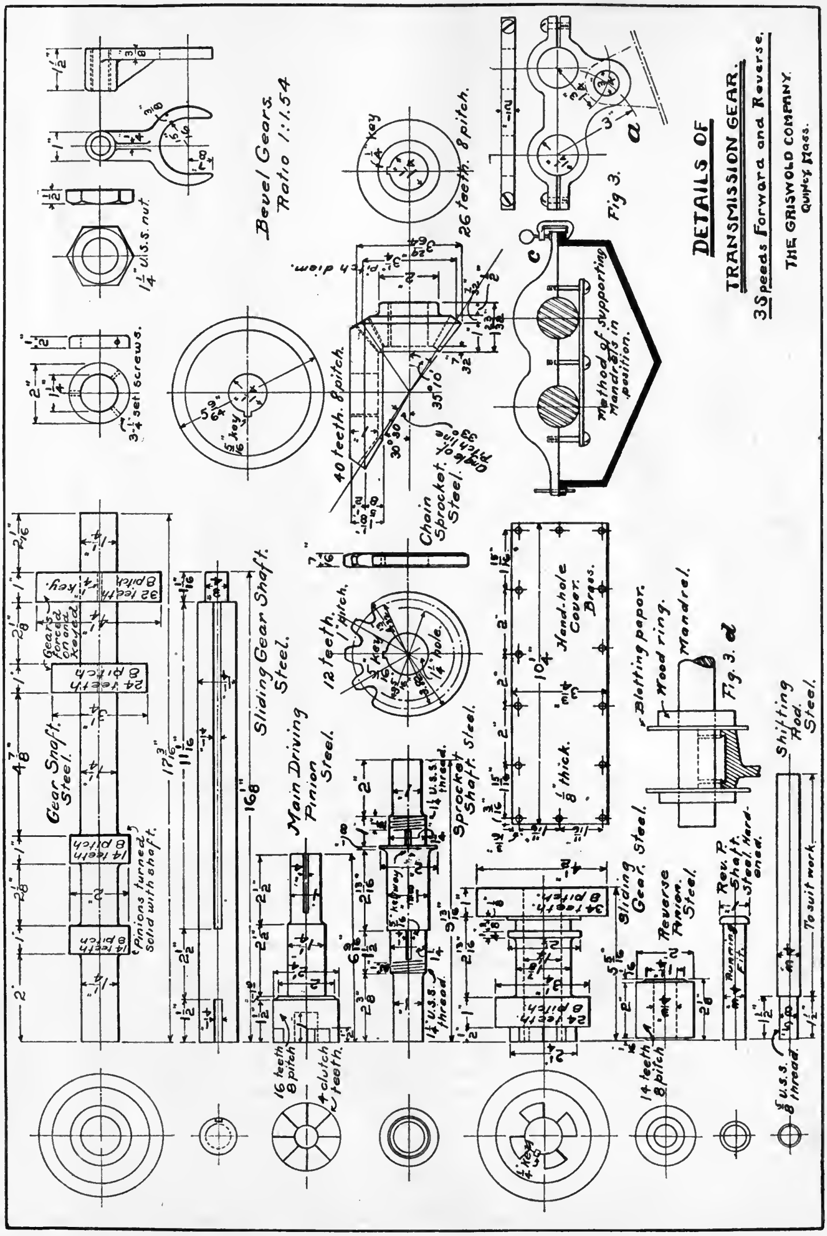
On the lower half the same directions apply as to the ¾ in. hole for the reverse pinion shaft. If drilled on a press a hole should be laid off and drilled in the front of the case to admit a ¾ in. round bar of steel flattened on the end and ground as a flat drill. When this method is used it is well to wait until the shafts or mandrels are in place and then use the small jig shown in Fig. 3 *c*. The holes in this jig are bored exactly to size, with their location carefully laid off, the piece split, as shown, with a saw, and the screws fitted to clamp the mandrels firmly. Then when the mandrels are babbited in place, this jig is clamped to them so that the drill guiding hole comes before the projection *e* in the lower half of the case. This forms a guide which controlls the action of the drill and insures that the pitch lines of the reverse pinion and meshing gears are exactly in contact.

The case is now ready for the bearings. These are made of Babbitt metal, which is the best metal that can be used in this place, especially since the bearings are subjected to very hard duty. They remain very cool under load and do not grip when heated, as do brass bushings. They have a comparatively long life and are readily replaced by the owner of the machine when badly worn by chipping out the old metal, relining the shafts and again pouring in new metal.

Chip and clean the recesses cast in the case so that the metal may have a good hold. Prepare two mandrels about 1½ in. longer than the bearings from the extreme end of the outside to the opposite extreme end of the inner ones and 1¼ and 1½ in. in diameter, respectively. Polish the bearing portions as smoothly as possible. The extra length over that of the shafts allows the washers to be clamped tightly against the bearings to keep the melted metal in place.

Now make the jig or yoke *b*, Fig. 3, by first fitting the two pieces together perfectly, as shown, securing them by two 3-16 in. screws at the ends. The joint must be perfectly straight. Now lay off the holes with centers exactly 3 in. apart and bore to size on the lathe face plate. If the lathe will not swing them, have them bored in some shop, which should cost only a trifle.

When finished two yokes are provided for suspending the mandrels in place and a small ⅛ in. strap secured by three small screws, as shown in Fig. 3 *c*, will hold the mandrels firmly in place. Now lay the mandrels in position in the upper half of the case and adjust them accurately parallel with the center line of the case.


DETAILS OF
TRANSMISSION GEAR.
3 Speeds Forward and Reverse.
THE GRISWOLD COMPANY
Quincy Mass.
Bevel Gears.
Ratio 1:1.54
26 teeth. 8 pitch.
40 teeth. 8 pitch.
Chain Sprocket. Steel.
Method of supporting Mandrels in position.
Fig 3.
Hand-hole Cover. Brass.
Sliding Gear Shaft. Steel.
Gear Shaft. Steel.
Main Driving Pinion Steel.
Sprocket Shaft. Steel.
12 teeth. 1" pitch.
Blotting paper.
Wood ring.
Mandrel.
Fig. 3. d
Shifting Rod. Steel.
Sliding Gear. Steel.
Reverse Pinion. Steel.
To suit work.

Clamp the yokes securely at one end, drill a 3-32 in. hole through the opposite end and flange to take a dowel pin, as shown. Then see that the ends of the bearings are properly dammed with a piece of blotting paper held securely against them by a wooden ring forced over the end of the shaft as in Fig. 3 *d*, the ends of the bearings having been previously filed smooth and square, and to the same length in both halves that match. Have the metal quite hot and the mandrels smeared with a very thin film of graphite to prevent the Babbitt metal from adhering thereto. When cold remove the mandrels and file off the top of the Babbitt metal until flush with the joint of the case. Each half is similarly babbitted.

Before pouring the other half, lay them together and put two bolts through opposite holes. Then run the 3-32 in. drill through the undrilled flange, using the already drilled hole as a guide. Now reverse the positions of the yokes on the mandrels so that they may be used on the same ends in each case, and pour the bearings in the remaining half. The dowel pins will thus locate the position of the shafts exactly, so that when the two halves are bolted together the bearing will be a truly cylindrical hole, and the pressure of the bolt will not draw the halves to one side or the other, thus cramping the shaft.

The shaft for the large bevel gear and sprocket may now be linned up. In lining up this shaft the other shaft with its bevel pinion should be in place so that the two gears may be made to mesh exactly. It may be supported in position by two centers made of ⅛ in. rod fitted in two blocks, as shown in the small sketch, Fig. 3*e*. This enables the two shafts to be turned while setting, and the exact position determined. Of course when the case is machined the trial setting is unnecessary, but for the amateur this method is both quick and accurate. When properly set, dam the bearings with putty and pour in the hot metal, having previously covered the shaft with graphite.

Now chip a small, half round groove, opened at the inside end, in the bottom of each bearing, Fig. 3, *f*, so that the oil will drain to the inside of the case instead of running outside. This is in the bearings of the bottom half only.

In the bearings of the upper half chip a similar groove, but closed at each end. Then drill a ¼ in. hole through to the inside, as shown, Fig. 3 *g*. A ¼ in. brass tube leads into this from the oil trough on the side, thus flooding the bearings with oil. A similar device is used to oil the bevel gear shaft, as shown. The troughs are simply strips of brass bent into a "V" shape and secured to the side by screws passing through. They catch the oil draining down from the inclined top where it is splashed by the gears.

The machine work on the other part requires no particular description, as it is very simple and the gears can be cut at a shop fitted for such work, or they may be purchased already cut. For those not wishing to go to the expense of cut gears, a set of cast gears has been prepared which can be made to run very smoothly by finishing the working faces of the teeth with a file. Of course cast teeth do not work as well as cut, neither are they as strong, but for a light car they do quite well and are cheap. The various details of the gear are shown in Fig. 4.

The length of the shaft attached to the clutch shaft is merely long enough to take a muff coupling, the intermediate length to the clutch being fitted when the gear and engine are in place.

TWIST DRILLS; THEIR USES AND ABUSES.

By Courtesy of the Cleveland Twist Drill Company.

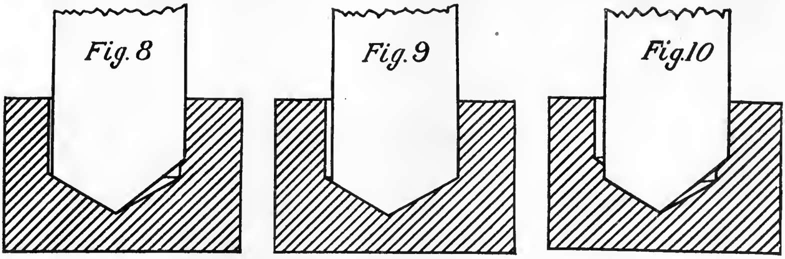
Next to a drill being properly made and tempered, it is of the utmost importance that its cutting edges be properly ground to get the maximum results in drilling. This means that both cutting edges must have the same inclination to the axis of the drill, and be of exactly the same length; this will, of course, bring the center of the cutting edges in the true center of the drill and will produce a round and smooth hole. To get maximum results all these requirements must be carefully observed. It is not sufficient to have one condition correct, but all of them. If the point be central but the angle of the cutting edges different, the drill will bind on the side of the hole opposite to that side of the point which is cutting, will drill too large a hole, and all the work will fall on the one cutting edge. Fig. 8 illustrates this, while Fig. 9 shows a point ground with equal angles but of different lengths, which will result in the hole being too large.

When both angle and length of cutting edges are wrong the drill will be laboring under the severe conditions shown in Fig. 10, and the support spoken of n paragraph on " diametric support " entirely lost.

Another very important feature of grinding a dri l point is the lip clearance or proper backing off of the cutting edge. To do this correctly, even on a machine, is a difficult problem. Our idea of the correct form to which the lip of a drill should be ground is that of a segment of a cone whose axis is on line *a b* Fig. 11, and at an angle *b d c* to the axis of the drill. There is, however, a difference of opinion among engineers as to just what shape this end of the drill should be, some favoring that shape which corresponds to a segment of a cylinder, some an inverted cone, and still others a cone of irregular contour.

The machines which grind on the last named system nearly all come under the head of form or cam machines, that is, the shape is produced by copying a template or the motion of a cam.

In Fig. 11 the dotted lines show the complete frustrum of the cone; by comparison that of Fig. 12 will be seen to be too near the center, and the curvature at that point correspondingly more, which we found to consume about 20 per cent more power than that of Fig. 11. Fig. 13 illustrates the point whose surface is a segment of cylinder, and Fig. 14 represents the inverted cone with an axis on line *a b*, dotted lines show the frustrum complete. In both these forms of point. (Fig. 13 and 14) the curvature is too small at the outside periphery compared with that of the inside or center when the clearance angles are correct. Increased durability is claimed for this form of point, due to the support the cutting edge has from the small curvature at the periphery where the most severe work is done.

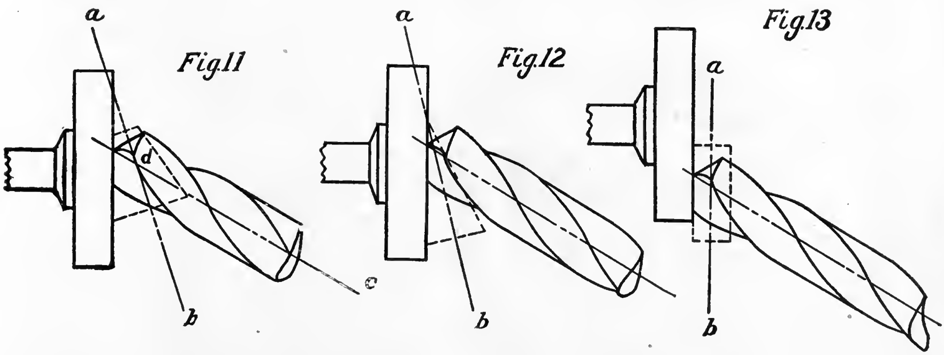


This is probably true, but is in turn offset by the fact that when the curvature at the periphery is correct for good work, that of the center is excessive, and under heavy feed pressure the edge chips out and breaks, evidence of which we are constantly brought in contact with.

There are various shapes of flute and angles of spiral on the drills made by different manufacturers, the shape of flute varying only by a small amount, while the angle of spiral ranges from 18° to 35°.

Theoretically the finer pitch of the spiral grooves or the greater angle of the spiral with the axis, the easier it should sever and bend or curl the chip; but practical considerations arise which counteract the mere saving of chips, and it becomes advisable to make this angle somewhat more acute than would otherwise be the case. Among the practical objections to a very fine pitch of spiral may be mentioned the weakness of the cutting edge and its inability to carry off the heat generated. It also packs up with chips more readily.

From a large number of tests made we have found that the practical limit to this angle of spiral for the regular commercial article is between 30° and 25°, assuming that the average drill is to drill a hole from one to three diameters deep. For deeper holes than this a smaller angle might be advisable, and for shorter holes a greater one. The difference in torsional stress on the drill does not vary any considerable amount when the angle of spiral ranges between 30° and 25° with the axis. We therefore use an angle of 27½° for reasons which facilitate the operation of milling the grooves and to simplify the curves on the cutter, to produce a straight lip of the form shown in Fig. 5. This angle of 27½° with the axis makes the spiral groove of all drills start at the point with a pitch equal to six diameters of the drill blank. This with a uniform web increase retains a strict uniformity in the pitch of grooves, and curves of cutters for the entire system of regular drills



and is the form which our experience has shown to be the most effective for the average work a drill is called upon to do.

The subject of the speed at which a drill should run and the feed per revolution is one on which engineers differ very radically, and the extremes of heavy feed with slow speed and light feed with fast speed are both supported by indisputable data. No rule can be given to cover all cases, and the ordinary tables published should be considered as guides only; the correct speeds should determined by good, sound judgment for each particular case. One thing is certain, if the drill chips out at the edge there is either too much lip clearance or too much feed, and a drill split up the web is sure evidence of improper grinding or excessive feed pressure, and no drill manufacturer ought to be expected to replace a split drill unless there is a "flaw" apparent in the break. Fig. 15 illustrates the angle of lip clearance; 12° is the best for the average rate of feed; for heavier feeds this angle may be increased to 15°. Observing the end view of this figure, the center of the drill will be found to be at an angle with the cutting edges, and should be approximately as shown.

The remedy for drills that are properly ground, chipping at the cutting edges is to decrease the feed and increase the speed, which, if a little care is taken to arrange properly, will produce as much work as before, with a longer life to the drill. When the extreme outer corners deteriorate too rapidly, it is evidence of too much speed, so that the best performance of a drill will be found where the effect of the work on the tool is somewhere between these two conditions.

If no table is at hand or operator is in doubt as to correct speed for the drill, start with a periphery speed of 30 feet per minute for soft tool and machinery steel,

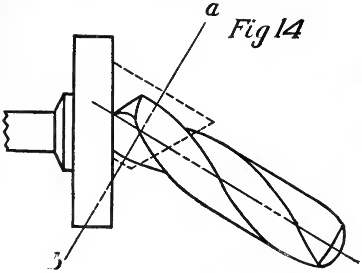


Fig 14

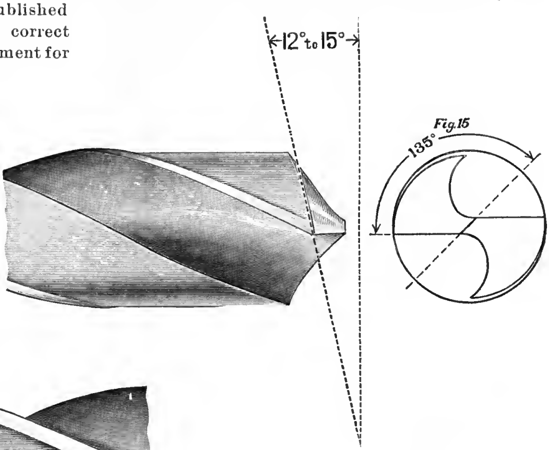


Fig. 15

Fig 16.

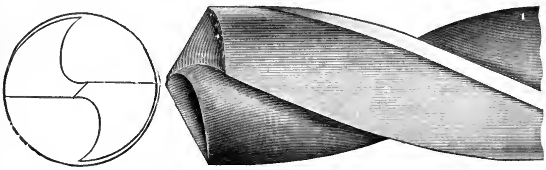
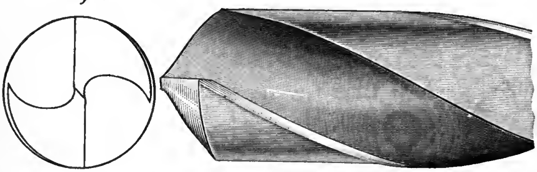


Fig 17.



45 ft. per minute for cast iron, 60 ft. for brass, and a feed of from .005 to .007 of an inch per revolution, and then attain maximum results by noting conditions of the drill and following instructions in preceding paragraph.

We have seen 50 point carbon steel drilled with one of our 2 in. drills at a periphery speed of 60 ft. per minute and a feed of .005 inch per revolution, but we do not think it is good practice, as we have found in our own work that the majority of cases are better suited to high speed and light feed carried to the point at which the outside corners commence to wear away.

For automatic machines where holes do not exceed two diameters of the drill in depth, and under a flood of lard oil, high speeds and light feeds are especially recommended. For holes deeper than this it becomes a matter of getting rid of the chips, and a form like Fig. 5 is efficient with slower speeds and heavier feeds, as the bottom of the hole is approached. Always endeavor in automatic drilling to get a small compact roll to the chip, and if possible keep it intact the entire depth of the hole.

A heavier feed should be used in drilling brass, especially in automatic machines, to insure chips working out, and if lubricated at all it should be *flooded.*

High speeds in cast iron tend to wear away the small portion of the drill that represents the diameter—see Fig. 2—and we think that 35 ft. per minute should not be exceeded. Feed may be from .007 in. to .015 in. per revolution, according to the kind of metal drilled.

The drilling of hard material is facilitated by reducing angle of spiral with the axis, as shown in Fig. 16, so as to permit of heavier feed pressure without chipping the edge, and using turpentine as a lubricant, but extreme care and judgment is needed to do this without unfitting the drill for further use. This form of drill will be found efficient in drilling soft material where the regular form has a tendency to "hog in". Drills are made to feed to their work easier by thinning the extreme point. This is a delicate operation and requires some skill on the operator's part, but is a decided improvement in hand feed drilling. To thin this point properly a round face emery wheel is necessary, and the drill should look like Fig. 17 when finished, care being taken to preserve the true center of the drill and not weaken it by extending the ground portion too far back.

CONCLUDED FROM OCTOBER NUMBER.

TOOL MAKING FOR AMATEURS.

ROBERT GIBSON GRISWOLD.

IV. Lathe Tools and Their Cutting Action.

The essential requirements for lathe tools, especially those used for general work, are hardness of cutting edge combined with a toughness in the metal. There are many special uses to which lathe tools are put that require a very hard edge, but such an edge must have very little clearance or the pressure of the work would soon crumble it off. This degree of hardness can be increased by special methods of hardening, to almost that of a diamond, but for the general line of work pursued by the amateur this would result in a great loss of time at the wheel, for the edges will chip off if at all thin. Especially is this true of the self-hardening steels. It is very difficult to put on them a finishing edge that will stay and give to the work a smooth finished appearance, although for the roughing cut they cannot be excelled.

For this reason a great many machinists do the roughing work with self-hardening steels and take the finishing cut with a high-carbon steel such as Jessop's. These tools hold a beautifully fine edge, keen and smooth, especially after being oil-stoned.

The tempering of lathe tools is generally done in the yellows, as noted in the table given in the first chapter. It must be remembered that the soft metals will pull a fine, keen edge into them if much rake or clearance is allowed, and for this reason they should not be left very hard, as this strain will snap off the edge.

The amateur will have need of as large a set of tools as he can afford. In fact, his set should comprise a form for every ordinary operation, to be time-saving. A great deal of time can be lost by attempting to force one tool to perform the work that should be done by one of another form. Thus, a diamond point tool can hardly be used as a thread tool and result in a very fine piece of work. Neither can a side tool be forced to do cutting off satisfactorily.

It has been the aim of the writer to illustrate in this article only the most frequently used and necessary tools, commencing with those used for the more common operations. Other forms will be taken up under the head of special tools.

In the first place, it will be well to consider the grinding of the tool and the terms "rake" and "clearance" and their effect on the resultant work.

In Fig. 1 is shown the action of a tool with a perfectly square edge. It requires a great pressure to force it through the work, and instead of cutting crushes the metal in front of the tool. The action of all cutting tools depends on a wedge action, and the keener the wedge the easier does it become to push it through the work.

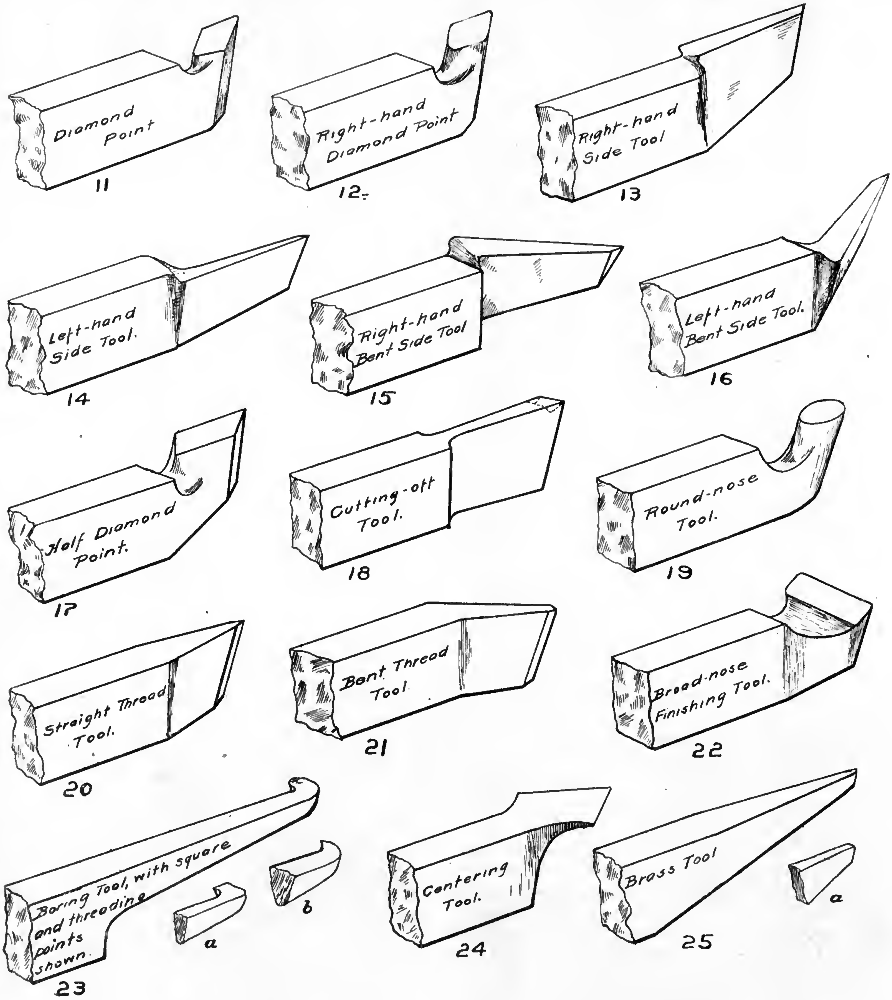
If we decrease the angle *o* in Fig 1, the cutting angle *o* begins to approach a wedge and the advancing face falls away from the perpendicular, making the angle *r*, Fig. 2, less acute. Upon this angle *r* depends the ease of cutting, as the material is then cut off instead of being crushed, as in Fig. 1. But when the angle becomes as acute as in Fig. 3, there is great danger of the edge being cracked off by being forced downward by the pressure of the chip above, as shown by dotted lines, somewhat exaggerated. The angle *r* is known as the "angle of rake."

But when the tool is lying flat on the work, as in Figs. 1, 2 and 3, it is impossible to press the cutting edge into the work, and the chip will continue as started, or the tool will have a tendency to work out. If the metal under the tool is now removed, as in Fig. 4, the cutting edge is relieved and can be pressed into the work, the cutting action remaining the same.

This small angle *c* is called the "clearance angle" and is given to all tools so that the edge may be made to cut as it is fed to the work. But this edge must not be made with too great a clearance or the result will be a tool something like Fig. 5, in which both the rake and clearance are excessive. It can be readily seen how very little support the cutting edge of this tool really has, and with a chip of any thickness the edge would be bent downward and snapped off.

Let us now consider the above principles as applied to the lathe tool. In Fig. 6 is shown the action of a square edge tool when acting upon a circular piece in the lathe. When acting on the center line *a d* it may be fed into the work by exerting a great deal of pressure, which will have a tendency to spring the be the tendency for the work to spring up and "walk" out onto the tool. This action is especially evident with cutting off tools when the cutting edge is very wide and the stock not stiff enough to hold the work in place.

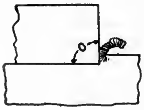
In Fig. 7 the tool has been given top rake so that the



work. If the tool is raised any above this line it will not cut at all because the edge is above the point of contact, as shown in the dotted position *b*. On the other hand, if this tool is lowered below the center line its action will be that of scraping and the nearer it approaches the position indicated by *c* the greater will chip is cut off more easily, and it also has been given clearance so that it will feed into the work easily. This form of cutting edge is easily preserved by grinding. In Fig. 8 the same tool is shown placed above and below the center line. When placed above the center line the cutting action is very smooth but it will cut only as long as the point touches the periphery of the piece below the normal to the front of the tool, or the line *oe*. For this reason the tool will not cut to the center unless its position is changed. When the tool is placed below the center line its action becomes a scraping rather than a cutting one as the upper face approaches the perpendicular to the surface, and the condition is similar to that shown in Figs. 1 and 6. The point will surely go in this case if much pressure is applied, as there is no metal beneath to support it.

any, top or side rake, while the tools for iron, steel or cast iron will be provided with a rake varying from 3° to 10° as experience dictates. There can be no set rule for this angle, owing to the varying character of the materials being worked.

Fig. 11 shows the diamond point tool which is, perhaps, used to a greater extent than any other single tool. Its chief work is that of taking a roughing cut, and for this particular work it cannot be equalled. It cannot work up to a shoulder, however, without being



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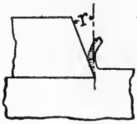

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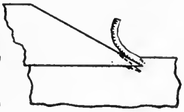

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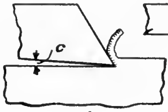

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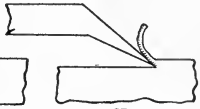

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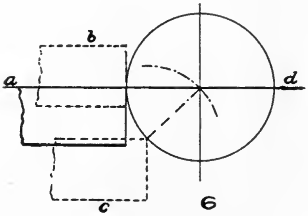

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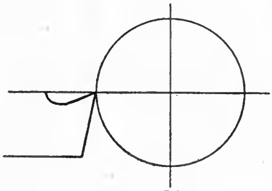

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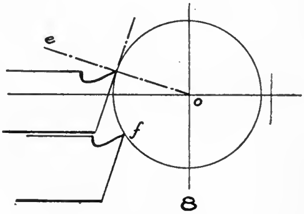

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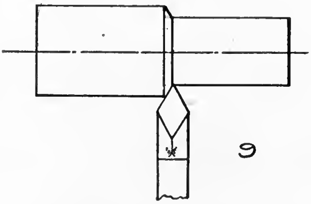

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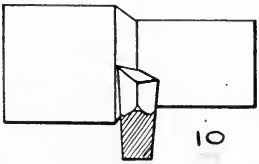

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In Fig. 9 is shown the top view or plan of a diamond point tool working into a cut. This tool is given both top and side rake as shown in Fig. 10, which is a view looking along the stock from the tool post, the stock having been broken away. This also shows the side clearance necessary to enable the tool to advance along the piece being turned.

It is evident then, that in order to make a tool cut easily and reduce the work done by the lathe, the tools should be given top rake when cutting in a radial direction, and side rake, or both, when cutting longitudinally. Also that clearance should be provided both in front and on the sides when the tool is used either for radial cuts, as in a cutting off tool, or on the side, as in a diamond point or side tool. The angle of clearance may vary from 3° to 5°, seldom more. The angle of rake depends upon the quality of metal to be worked, the softer metals, such as lead, babbitt, brass and copper being turned with tools having little, if

set at an angle in the post, and for this reason the right hand diamond point is sometimes provided. They are both given top and side rake, as well as front and side clearance.

In Figs. 13, 14, 15 and 16 are shown the right and left hand side tools, both straight and bent. These are used for finishing the ends of cylindrical pieces and flat surfaces generally that are faced in the lathe. As it often occurs that the straight tool will not conveniently reach the center of the work without bringing the tool post in contact with the work, the side tools are provided for such emergencies. They are given considerable side clearance and the top rake is at least 10°. This gives them a very keen edge that can be honed to render the finished surface perfectly smooth and free from scores or scratches. The work that a well sharpened tool will do when properly set is remarkable. The extreme point should be relieved slightly so that it will not leave a line on the surface, as a sharp point will sometimes do. No great amount of stock is to be removed with these tools; use a diamond point for that work and finish with the side tool.

The half-diamond point shown in Fig. 17 is in reality a simple form lying between the side tool and the diamond point, and is used principally for cutting to a square shoulder.

In Fig. 18 is shown a cutting-off tool whose purpose is the cutting off of cylindrical pieces in the lathe. It is made deep under the cutting edge to give it the necessary support, while the extreme point is the widest part, the sides being relieved so that the tool will not bind in the groove. Owing to the confined cutting area it is not practicable to give this tool very much top rake, as the cutting edge is decidedly weakened thereby and likely to be broken off. On the other hand, if the edge is left perfectly square it requires considerable work to push it into the metal, and the piece will generally break off before the cut is finished. This can be obviated by making the cutting edge very narrow. The writer uses a tool slightly less than 1-16 in. wide and 1 in. deep for short cuts, say up to ½ in., and for larger pieces up to 2 in., a tool about 3-32 in. wide, with a groove round in the facing edge which breaks the chip into two thin strings which do not bind in this groove and relieve the tool of any great strain. This tool never shows any tendency to run to either side. The thinner the tool the less power required to drive the lathe.

Fig. 19 shows the round nose or filleting tool. Its principal use is for rounding fillets in corners. Several tools of different radii should be made, say 1-16 ⅛, 3-16 and ¼ in.

The thread tool is shown in Fig. 20. The point is made by grinding the face to a certain angle which will make the angle at the cutting edges exactly 50°. This angle varies with the front clearance, but if the tool is once ground correctly so that a 60° gauge will fit the point exactly. This angle varies with the front clearance, but if the tool is once ground correctly so that a 60° gauge will fit the point exactly, the only grinding that should ever be done again to sharpen it is to grind it flat on the top face. The cutting angle is thus preserved and the threads are bound to be exactly 60° between the sides. Sometimes the straight tool cannot be used to a shoulder; the bent thread tool is then brought into use, Fig. 21. It is ground in a similar manner to that shown in Fig. 20.

For finishing turned work the broad nose tool is used. This tool is very difficult to use on account of the chattering that will set up if there is the slightest looseness anywhere in the lathe. In light lathes it is better to use a tool not more than ¼ in. wide and have the corners slightly relieved, as shown. The top rake need not be great. It should be used with some fluid such as oil or soda water.

The inside boring and threading tool is shown in Fig. 23. It should be forged to a long, tapering end and the extreme tip bent to the left, as shown. This point is sharpened either as a diamond point or small square point, as shown at *a*, which will work into the corners. In fact, three of these tool should be made, so that the three points shown could be always in readiness. The thread tool is ground to a 60° angle.

In order that a drill may be started in work held in a chuck or strapped to a face plate, a center must be made first. This can best be done with the tool shown in Fig. 24. The edges of the angular point are ground to the drill angle (not always 60° and sometimes as great as 100°) and backed off on opposite edges until they form a drill or, in other words, until both edges will cut when the tool is pressed into the work. When a center has been spotted the drill may be started and it will then follow in the exact center.

The tool shown in Fig. 25 is mostly used for turning brass. It is drawn to a narrow point and may be made either round or square or, better still, two tools should be made. As brass is run at a high speed these tools will remove a large quantity of metal in a very short time and the cutting edges are not provided with top rake on account of the danger of drawing the tool into the work. Clearance is given, however.

JUNIOR DEPARTMENT

For the Instruction and Information of Younger Readers.

ELEMENTARY MECHANICS.

J. A. COOLIDGE.

X. Compressed Air.

Gases and liquids, because of their similarity in some respects, are called fluids. They are carried in vessels of any shape, have no difficulty in adapting themselves to the form of vessel into which they are put, and may be forced through pipes many miles in length. They have some points in which they differ widely. While liquids are almost incompressible, an immense force exerted on a cubic foot of water hardly diminishes its bulk so that any difference is noticeable; a cubic foot of air, on the other hand, may be easily made to occupy a space one-half or even one-fourth as large. Then, again, the density of gases is very much smaller than that of liquids. Many solids may be be found lighter than the lightest liquid, but the lightest liquid is probably as many as a thousand times as heavy as any gas known. Our work in this issue deals with both gases and liquids, some of their characteristics and how they are related.

EXPERIMENT XXVIII.

For all who have a bicycle pump an interesting experiment may be performed illustrating several things. A large. strong bottle, fitted tightly with a rubber stopple, and having a valve from a bicycle tire with the valve stem fitted in, as in Fig. 30, will serve as apparatus. It may be necessary to tie the cork in with a stout thread. First, weigh the bottle with cork and fittings, next, fasten to the pump and pump in several strokes. Weigh again and notice the increased weight. The bottle, filled with condensed air, weighs more than before. Follow out this reasoning and you will see that the bottle, without any air, would weigh less, and that the air in the bottle has a definite

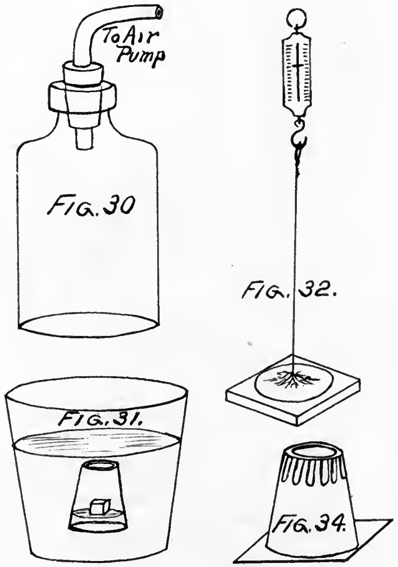


FIG. 30

FIG. 32.

FIG. 31.

FIG. 34.

weight. Let some of the air out of the bottle and notice the force with which it escapes. If there were more of it, and the supply could be maintained, almost any kind of mechanical motion might be produced. Recall some of the uses of compressed air. Brakes on cars are made to act, packages are sent flying through pneumatic tubes, and cars are made to go by means of compressed air. Plunge the bottle, filled with compressed air, into a tub of water and again open the valve. Instead of seeing the water enter the bottle the air comes bubbling out. Imagine our bottle to be a tunnel under a river, as we have in Boston, under the harbor. If air is forced into the tunnel and kept there compressed, a small leak will not let water through, because the pressure of air against the hole trying to get out is greater than the force of the water trying to get in. Such a condition is today quite frequent. A diving bell filled with compressed air has the power to prevent the entrance of water from below. A simple illustration of this may be seen in the forcing of an ordinary glass tumbler, inverted, down into a pail of water. See Fig. 31. A little block of wood under the glass makes it more apparent that the water does not enter the glass but is prevented by the air already there.

The air all around us exerts pressure upon all things although, for the most part, this pressure is unnoticed Its pressing force is felt when we try to open a bottle or to take the top off a glass covered fruit jar.

EXPERIMENT XXIX.

Place a small quantity of water in a bottle and then place the bottle in a pan of moderately warm water. Bring the water to the boiling point and when boiling briskly remove from the fire. As soon as the water ceases to boil cork the bottle tightly snd allow it to cool. After it is cool you can see that the cork has been driven deeper into the neck of the bottle, that it requires considerable force to removed it and, that when pulled out, the air rushes in with a slight explosive sound. The air presses upon the cork with a force great enough to push it down into the bottle; the steam, when cooled off, is condensed into water and occupies so much less space than as steam that there is a partial vacuum into which the air rushes when the cork is pulled out.

EXPERIMENT XXX.

A circular piece of thick leather, two inches in diameter, with a string passing through the center and knotted, makes what is known as a "sucker". Make the knot as flat as possible by pounding, soak the leather in water and press it firmly upon a very smooth, flat stone or pane of glass, so that no air shall be left between the leather and the glass. Make a loop in the string and fasten to the spring balance (see Fig. 32) and see how many ounces you can pull before the leather is separated from the glass. Make at least three trials. The air pressure upon the leather is so great that an opposing force still larger must be used to overcome this.

EXPERIMENT XXXI.

The effect of heat upon a body of air may be seen in this experiment. Take the bottle used in Experiment XXVIII., remove the valve from the stem, connect to the stem the rubber tube of the pump after unscrewing it from the pump, and plunge the bottle in a pail of warm water, holding the open end of the tube under water, as in Fig. 33. The heat expands the air and causes it to force its way out through the opening A. This expanded air, being less dense, will rise. The air around a stove being heated rises, and cooler air rushes in to take its place. The products of combustion in our stoves, consisting of heated air and gases rise, pass out one chimney, and are replaced by cool air coming in at the bottom of the stove. The hot air in the top of a furnace rises because of the pressure it exerts, the cold air comes in to take its place, forcing it up and thus the air is carried through the pipes to the rooms of the house. The expansion of gases due to heat, the pressure of colder, heavier ones crowding down to take their place, explains the principle of chimneys and ventilators.

EXPERIMENT XXXII.

Take a common clay pipe and a thin piece of sheet rubber about two inches square. The rubber can be obtained from any dentist. Tie the rubber with a thread so as to make a diaphragm covering over the

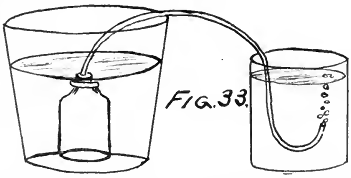


FIG. 33.

open end of the pipe. By drawing in the breath the air may be removed frem the inside of the rubber diaphragm, leaving the air on the outside free to press as it will. No matter what the direction of the bowl of the pipe, the diaphragm is pressed in whenever the air on the inside is drawn out, and returns when the air is allowed to flow in. This experiment. perhaps, better than any other, illustrates the fact that air presses in all directions.

EXPERIMENT XXXIII.

Take a tumbler and a piece of cardboard just covering it. Fill with water, cover the card and invert, holding the hand on the card until level. See Fig. 34. The card does not fall off; the water does not run out. If done correctly considerable force may be used to jerk the card off without causing it to fall. Of course the water and card would fall of their own weight were they not held in place by a larger force pressing up. This upward force must be the air, as there is nothing else there that can do it. We have seen some illustration of air pressure; in our next paper we will try some experiment with siphons, pumps, etc.

A SIMPLE RHEOSTAT.

HENRY C. WALL.

Quite frequently the strength of battery current in use on a given piece of electrical apparatus has to be varied or regulated to meet certain conditions. Unless the amateur possesses a set of resistance coils arranged for easy handling, the task is likely to be a difficult one, especially when the exact amount of resistance to be applied is to be ascertained only by experiment.

The writer not long ago, in connection with wireless telegraph experiments, felt the need of a suitable device with which he could increase or decrease gradually the flow of current in his coherer circuit, and as the device, when completed, gave good satisfaction, a description of it is here given for the benefit of AMATEUR WORK readers. A piece of round hard wood, about one inch and a half in diameter and twelve inches long was procured. Such pieces may be readily purchased at furniture stores where portiere poles are sold.

A small metal binding post was fastened to one end of the piece. A piece of No. 30 German silver resistance wire was soldered to the binding post. If the German silver wire is not to be had in your vicinity the same gauge of bright steel wire will suffice. Fastened at the binding post along with the wire is one end of heavy silk thread, or black linen might answer. The thread and the wire are to be wound around the wooden cylinder, parallel with one another, so that at all times an insulating thread is between the wire turns. In this way, by winding evenly, a good amount of resistance wire may be placed in a space. The entire winding is then given a very thin coat of shellac and when thoroughly dry, the wire brightened by rubbing with an old piece of fine sand paper.

The amateur will now observe how this coil, when inserted in a circuit, may be used as a veritable resistance, to be determined by the portion of the coil that is included in the circuit.

It is necessary, therefore, to provide a sliding contact to slip back and forth as desired. This may be made of a block of wood with a 1¾ in. hole in it, or of fibre tubing. Inside the tubing is placed a strip of spring brass, bent inward in such a position that the wire wound on the cylinder is rubbed by one end of the brass strip as the "rider" is moved back and forth, and to this rider is soldered another binding post. Whenever this device is introduced in a circuit, the amount of current is varied according to the amount of resistance; that is, the number of resistanoe wire turns included in the circuit.

Instead of using a cylindricel rod, the amateur might cut out a thick ring of pine or other wood and use one-half, one-quarter, or as much of the curve as desired, to wind on, and instead of the riding contact described above, arrange a swinging wipe contact similar to the switch arm used on ordinary single piont switches. This would entail additional work, however, and unless the amateur is provided with tools suitable for cutting out the circle, it is advisable to follow the simpler method.

The Goodell-Pratt Co., Greenfield, Mass., have long been known to the trade as manufacturers of labor saving tools of the highest grade. The tool set advertised in this issue is but one of the many tools which the amateur mechanic or eleetrician will find useful in his work. The catalogue of this company, which may be obtained upon request, shows hand and bench drills, chucks, bit braces, gimlet bits, and many other tools.

AMATEUR WORK

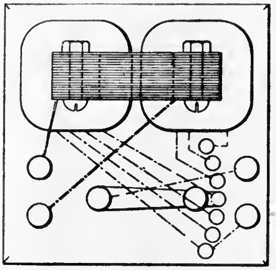
A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

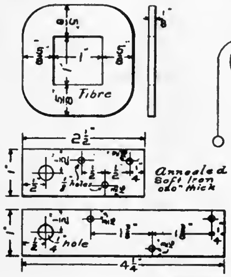
Vol. IV. No. 2. BOSTON, DECEMBER, 1904. One Dollar a Year.

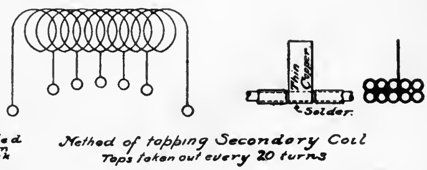
100-WATT TRANSFORMER.

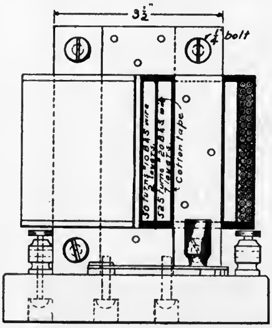
R. G. GRISWOLD.

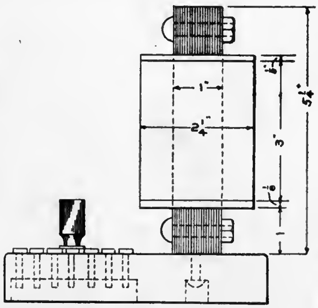
The transformer described in this article is intended for amateur construction and amateur experimentation. The materials are such that they may be readily obtained, and the entire piece of apparatus requires a very small outlay.











The capacity of the transformer is approximately 100 watts, and is designed for transforming from 100 volts to 10 volts on 125 cycles. This voltage is a very convenient one for light experimental work, and the instrument is so designed that several different coils may be wound and placed on the same core, as it is made in removable sections. The secondary is also tapped in five places, thus making it possible to obtain different voltages from the single winding.

The core of the magnets is laminated, or built up of strips of soft iron 1 in. wide by about .015 in. or .020 in. thick, and of the lengths given in the drawing. These strips are laid up, one on top of the other, until a pile 1 in. thick is built up. The strips are placed directly on top of each other, but with one end of one lapping over the lower one by 1 in, the next one lapping over by a similar space at the opposite end. This provides the ends of each section with a series of tongues and slots, which will slip into a similar arrangement on the next section. This makes a very good magnetic joint, and the several ends are clamped firmly in contact by the ¼ in. bolt running through as shown. This arrangement affords the shortest possible magnetic circuit, and also permits an interchange of coils for other experiments or voltages and outputs.

When the pieces are properly laid, one on top of the other, as directed, they are riveted together by three $\frac{1}{8}$ in. rivets, as indicated. The four pieces are then bolted together and the ends finished off smoothly with a knife. Then place the four pieces, either bolted together or separate, in a fire and heat to a dull red for an hour. Remove after one hour and allow them to cool *very* slowly by burying in ashes. This anneals the iron and, while it is not absolutely essential, it is advisable to do so, as the magnetic qualities of the iron are benefited by the treatment.

The fibre washers are now forced into place. Next, wrap the two cores holding the magnet coils with cotton tape ($\frac{1}{2}$ in. wide) beginning close up against the fibre heads. The tape should half lap over itself on each turn, so that there may be no spots left bare. When the first layer is finished it is thoroughly soaked with shellac varnish and the tape carried back to the starting point in another layer, which is also soaked in shellac. The cores are now placed in an oven and baked for five or six hours, thus hardening the shellac.

The cores being completed the winding of the primary coil is begun. This winding is determined from the formula

$$\text{E. M. F.} = 4.44 \frac{\text{B N F}}{100{,}000{,}000}$$

in which

E. M. F. = electro-motive force in volts.
B = magnetic flux in lines per square in.
N = number of turns in winding.
F = frequency of cycles.

Since it is the number of turns required that is to be determined, we can solve for N by transposing

$$\text{N} = \frac{100{,}000{,}000 \text{ E. M. F.}}{4.44 \text{ B F}}$$

The frequency is generally known and in this case is 125. The magnetic flux must be taken with regard to the cross section of the core, and with this frequency it is not advisable to use a magnetic density in the core much higher than 20,000 lines per square inch. Owing to the laminated structure of our cores we can hardly count on more than 90 per cent of the total cross section, as there is always a slight space between the strips. Counting on 9 square in. the total magnetic flux through the core will be $20{,}000 \times .9 = 18{,}000$ lines. Assuming the primary voltage to be 100, we have

$$\text{N} = \frac{4.44 \times 18{,}000 \times 125}{100{,}000{,}000 \times 100} = 1{,}000 \text{ turns approximate.}$$

For an output of 100 watts, neglecting the losses and magnetizing current, the primary current would be $\frac{100}{100} = 1$ ampere, and in order to prevent overheating in the coils, the primary should have a cross-sectional area of 1000 circular mills per ampere. No. 20 B. & S. wire has an area of 1021 circular mills, so that this wire is used. This wire should be double cotton covered, which gives it an outside diameter of about .040 in. and about 25 turns can be wound per inch of core length. As each coil is to contain about 500 turns, and each layer will take 75 turns, it will require 6.6 layers to contain the number of turns, but since even layers are desirable, the last layer will be finished, making 7 layers and about 525 turns.

As each layer is wound on it is given a coat of shellac and the finished winding thoroughly baked. Then three layers of linen soaked in shellac are wrapped over the primary coil and baked until dry.

The next operation requiring attention is the secondary coil. The secondary voltage is to be 10 volts with a primary voltage of 100. The secondary current of this transformer at full load is found close enough for the present purposes from the following formula:

$$\text{S. C.} = \text{P. C.} \times \frac{\text{P. V.}}{\text{S. V.}}$$

in which S. C. = Secondary current.
P. C. = Primary current.
P. V. = Primary voltage.
S. V. = Secondary voltage.

Therefore

Secondary current $= 1 \times \frac{100}{10} = 10$ amperes.

The number of secondary turns is found as follows:

$$\text{Secondary turns} = \text{primary turns} \times \frac{\text{S. V.}}{\text{P. V.}}$$

Hence for this transformer,

Secondary turns $= 1000 = \frac{10}{100}$.

Allowing 1000 circular mills per ampere, this secondary will require a cross section of 10,000 mills, which is very nearly covered by a No. 10 B. & S. wire. The 100 turns will be equally divided between the two coils, or 50 turns to each, which can be wound on in two layers. These layers are also shellacked and baked after placing the taps in as shown.

These taps are made of thin copper, about No. 24 B. & S. guage and $\frac{1}{2}$ in wide. They are soldered to the primary coil on every twentieth turn, as shown in the drawing. The taps from the lower layers are brought out between the turns of the upper layer, and the leads to the switch points on the base are soldered to the protruding ends.

The arrangement of switch and binding posts on the base may be altered to suit the the requirements of the user, so no special instructions are necessary on this point; the base is made of a block of some hard wood and, as far as possible, all connections should be made beneath the base, as shown. Two $\frac{3}{8}$ in. screws should pass through the base into the lower segment of the magnet to secure it.

If the transformer is operated on 60 cycles instead of 125, the effect will be to increase the heating somewhat, but if the iron is of good quality the heating will not be large because the low density of 20,000 lines per square inch was assured. The no load current taken by the primary will be increased because a greater magnetizing force will be required to set up the magnetic flux. This will tend to increase the heating in the primary coil. The net result, therefore, of operating the transformer on 60 cycles would be to make it run somewhat warmer. Owing, however, to the intermittent load usually used in experimental work, the transformer should not run very warm. The secondary voltage would not be affected by a change in the frequency so long as the primary voltage and the ratio of primary voltage to secondary turns are not altered.

Owing to the construction of the core, the latitude of voltages of output may be easily varied by winding separate coils to slip over the cores, mounting the fibre heads on a square-formed tube of thin sheet iron.

If the primary is to be wound for 50 volts and the secondary for 10 volts, use 240 turns of No. 17 B. & S. on the primary and the same winding on the secondary, as below.

For a primary voltage of 100 and a secondary voltage of 5 with an amperage of 20, use the same winding as before for the primary and 25 turns of two No. 10 wires in parallel for the secondary on each spool.

The small transformer will be found useful for a number of purposes, especially if it is used in connection with a small rheostat by means of which the secondary current may be regulated. For operating miniature lamps, supplying current for operating small alternating-current motors or, in fact, for any purpose where a small alternating current at low voltage is required, it will be found very convenient. It is specially handy for experiments illustrating the heating effects of the electric current; it will fuse a considerable length of No. 18 wire without difficulty.

If a 5 volt secondary winding is used and taps brought out every 5 turns, it makes a good appliance for heating the cautery knives used in surgical work. The five volt secondary with taps every 5 turns, gives 10 steps of $\frac{1}{2}$ volt each, which is close enough adjustment for most work.

NOTES ON WIRELESS TELEGRAPHY.

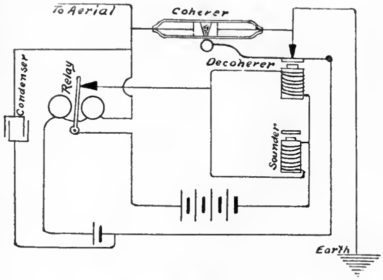
L. T. KNIGHT.

III. Receiving Instruments of a Wireless Telegraph Station.

The receiving set of a wireless station comprises the coherer, the relay, the decoherer, the sounder, the weak current and strong current batteries, coherer condenser and the tuning coil. A switch is arranged to connect the receiving set to the aerial wire when desired.

One form of coherer consists of an exhausted glass tube containing two silver plugs fitting snugly in the tube with well polished and slightly sloping ends. The space between the plugs varies from 2 to 4 millimeters in length and contains the filings of pulverized and oxidized silver and nickel alloy. The silver plugs are connected to metal tips or caps at the end of the coherer, which serve as connecting points. The coherer is not adjustable so far as the location of the plugs is concerned, but the sensitiveness is the greatest when the narrow part of the wedge is down. But this is not always the best working position for regular receiving.

The best relay is of the polarized type, with the coils of the magnet wound to a resistence of from 4,000 to 10,000 ohms. The relay must be well balanced, absolutely sure in action and quick to start. A first-class relay will operate with one volt difference of potential through a resistance 50,000 ohms.



The decoherer is a high frequency vibrating hammer constructed on the ordinary vibrating door-bell principle. The weak current battery used in the coherer operation is a dry cell of very low amperage and one to one and one-quarter volts. The coherer condenser bridges the relay windings and battery, is of very small capacity, and when properly placed serves to shut off any static charges that might flow in from the aerial wire to and through the coherer and relay and prevent operation.

The sounder is the ordinary Morse device, operated by several cells of dry battery. The tuning coil is a variable contact device patterned after the one described in the previous chapter.

The adjustment of receiving instruments requires care and patience, particularly in the relation of the relay and coherer, and the sounders and the decoherer. The sensitivity of the coherer varies with the degree of oxidization of the silver-nickel fillings, as well as the size and distance between the plugs. The normal resistance of the coherer is very high and the amount of current from the little dry battery is not sufficient to pass through to the relay windings. But when the wave enters by way of the aerial wire this high resistance is broken down by the critical potential and becomes approximately about 3,000 to 5,000 ohms. In this state the current is allowed to pass into the relay circuit and operate the relay. This, in turn, throws in the sounder and the decoherer, the circuits of which are shown in accompanying sketch. When the decoherer operates the relay circuit is opened and the relay returns to its normal position, and of course at the time the decoherer operates the sounder also operates. The decoherer is more active in operation than the sounder, and this permits the relay and decoherer to cause the sounder to give dashes as well as dots.

ELECTRIC LIGHTING OF CHRISTMAS TREES.

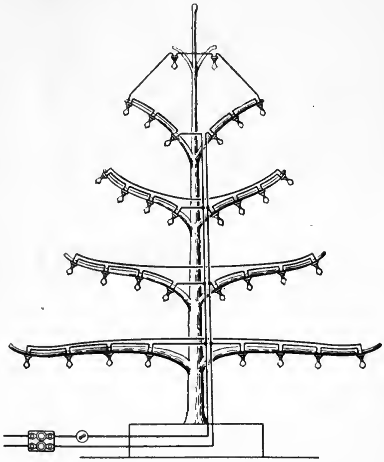
FREDERICK A. DRAPER.

The greater safety attending the lighting of Christmas trees by electricity makes this method far preferable to that of the familiar candles, with the possibility of igniting the inflammable trees and decorations. By following the directions here given any one possessing ordinary skill can make and arrange the necessary fixtures to produce a very pleasing effect, and at a most reasonable expense.

The first consideration is the source of current; whether from the lighting circuit in a building lighted by electricity or, where such current is not available, by battery. The former will first be described, but before doing so it is well to mention that in some places the restrictions imposed by insurance authorities are very stringent and should be ascertained before commencing work, that the regulations may be properly complied with. Where battery current is used this trouble is avoided, as the current is of such low potential that no trouble would follow should short circuits occur, other than a quick exhausting of the battery and a failure to keep the lamps up the proper brilliancy.

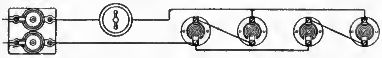
Assuming that the current is to be taken from the wires of a regular incandescent lighting circuit, the voltage of which is between 108 and 112 volts, the first requisites are: Plugs for the sockets in which the lamps are affixed; enough two cord flexible wire to reach from the socket to the base of the tree; 100 feet or more of annunciation wire, divided equally between two colors to facilitate wiring; the necessary number of 14 volt *series* miniature bulbs of 3 C. P. aud an equal number of porcelain sockets.

An examination of the tree having been made and the location and number of the lamps decided upon, a wiring diagram should be drawn showing the wires, lamps and connections, as it will probably be necessary to run the connecting wires from one branch to another to make up the complete circuits of eight lamps each. It will be noted that eight 14 volt lamps, "connected in series" make a total voltage of 112 volts, a slightly less voltage of the main circuit having but little effect on the several lamps. For each eight lamps on the tree, therefore, a separate plug and connecting wires will be required, unless one is sufficiently skilled in wiring to make a double connection and circuit through one plug, in which case other lamp on the same line circuit should not be turned on, to avoid overloading the line. All joints should be soldered and well insulated with electricians tape, except at the sockets, where a complete turn of the wire around the screw will answer, but at these points care should be exercised that the ends of wires are separated sufficiently to avoid short circuits. The lamps should be located in open spaces to secure the maximum effect and be visible to as large a portion of the room as possible, the general arrangement being that of a pyramid. A defective lamp will prevent the lighting of all and will have to be located and replaced with a good one when all will be illuminated. The number of lamps required will vary with the size of the tree; a small one requiring at least eight, and double the number can be used to advantage, and a large one is only limited by the time and money which may be available for the purpose. Colored bulbs add much to the effect; three red and three green for each ten white ones being a good proportion, the colored giving less light than the white ones. Directions for coloring bulbs were given in the January, 1903, number of this magazine, so will not be repeated here.

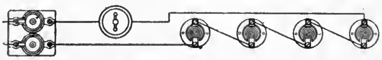


Where a commercial lighting circuit is not available and resort must be had to a battery current, the type of battery most suitable and easily constructed is that known as the bichromate plunge battery. The one described in the May, 1903, number, with an additional pair of plates, will be found satisfactory. The only alterations will be to lengthen the box 5½ in. If made for only temporary use, exact work is not needed other than to make sure that the joints are perfectly

Multiple Arrangement for 8 C P: Multiple Lamps.



Series Arrangement — Two Lamps in Series.



Series Arrangement — Four Lamps in Series

tight. One battery as described will furnish ample current for about 24 1-C. P. 14 volt lamps connected in multiple on three separate circuits, the leads for each circuit being connected to the terminals of the battery which is connected in series, giving a full 14 volts. It will be necessary to have the windlass attachment so that as the current is continued the zinc plates may, at intervals, be lowered into the solution. At first the zincs should be lowered only sufficiently to bring the lamps to the full brilliancy, and there remain suspended until the lamps begin to dim slightly, when a little further lowering of the zincs will immediately bring them up again. On this acaccount it will be advisable to have the battery located under the tree, concealing it with paper or other decorations. The necessary supplies for all the fixtures, including thebattery can be ordered through any large electrical supply house, though it is probable that the battery parts will require a little time for filling the order and should, therefore, be ordered sufficiently in advane of the time wanted to avoid disappointment.

NOTE.—Any one having difficulty in securing the supplies for the above work can, by communicating with the editor, obtain the names of firms from whom they may be ordered.

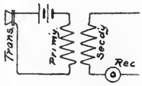
TELEPHONE CIRCUITS AND WIRING.

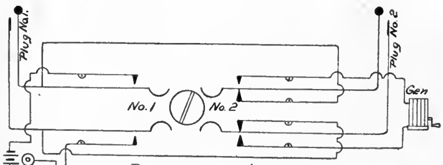
ARTHUR H. BELL.

VII. Central Station Systems.

In the last chapter was described the subscribers' drop and jack wiring. An illustration is here shown of another form of key for the cord circuit which has decided advantages over the one previously mentioned, in-as-much as the operator is enabled to answer a call with one cord of a pair, make connection with the party desired with one movment of the key, and listen in on the line when desired.

Two Part Plug.





Ringing and Listening Key Circuit

The key here shown is constructed of spring-brass strips and silver contacts. The circular plunger between the strips is actuated by a pivotal handle, so that the operator may at will force the plunger between the strips, thereby opening off one circuit and connecting with another. The plugs are what is commonly described as two part plugs and are connected to the key springs exactly as shown in the drawing. When the drop falls, thereby signalling the operator, the plug No. 1 is inserted and conversation established by pressing the cam lever so that the plunger is forced between the No. 1 springs and away from the springs of No. 2 for the time being, placing the transmitter springs in contact. When party No. 1 is to be connected with the party called, the plug No. 2 is inserted in the desired jack and that party signalled by again moving the ringing key, but this time in the opposite direction, and ringing on the line by whatever device may have been provided for the purpose. Then the plunger is released and when in the normal position party No. 1 is in communication with party No. 2. The operator may at any time throw her set in upon the line and enter into conversation.

The operator's set consists of the primary side of a telephone induction coil in series with battery and a transmitter. The receiver circuit comprises the scondary of the induction coil, closed through a telephone receiver. It must be remembered, however, that there are many styles of keys used in connection with cords of a switch board, each possessing some particular fitness for the circuit involved. There is one drawback to the one here described, as the operator can ring on only one cord of a pair and, the receiver being in the secondary circuit, there will be a variance in the hearing qualities, all of which can be perfected according to the ingenuity of the amateur electrician, who will find it greatly to his advantage to construct one of these circuits in his workshop.

Often times it is not desirable to place the transmitter set directly upon the line, and recourse is taken to a modified form of the induction coil, in which the transmitter, battery and primary winding constitute one side of the set and the secondary winding, in series with the receiver, becomes the side which is placed directly upon the cord circuit when the key springs are actuated by the plunger. A condenser of low capacity might also be connected in parallel with the receiver in the secondary and benefit transmission.

The induction coils in common use in transmission are constructed of No. 23 D. C. C. wire wound in turns about an iron core to a resistance of about one and one-half ohms. The secondary is of much finer wire, preferably No. 36, wound in turns over the primary, to a resistance of at least 150 ohms. Such a coil is adaptable to long distance transmission where the potential raising value of the secondary is sufficient to overcome the resistance of the line and equipment. For strictly local usage it may be desirable to use No. 28 wire in the secondary and wind to a resistance of 10 ohms in the primary and 20 in the secondary, the exact efficiency being found by experiment.

In the next chapter will be described a few circuits pertaining to central energy work, where all the signalling and talking battery is derived from a central supply instead of batteries and generators being required at each telephone.

ELECTRIC CAPACITY.

JOHN E. ATKINS.

There is a property inherent in electrical circuits which plays an important part in the amount of current. This property is called capacity. All conductors will absorb and hold a certain quantity of electricity, and one of the simplest illustrations of this is the Leyden jar, familiar to all students. When the terminals of a Leyden jar are connected to the leads of a strong generator, a certain amount of current appears to flow into the jar and become absorbed, and it is a common experiment to "charge" these jars and discharge them at will by touching the terminals together.

This ability to store electricity is called capacity, and by experiment we learn that a number of things beside the electric current used in the charging, contribute to the capacity. First, as will be readily inferred from the experiment with the Leyden jars, the larger the jar, that is, the greater the tin foil surface, the greater the capacity. Second, we must consider the voltage of the charging device; the greater the voltage, the greater the saturation. Third, the composition of the medium used as an insulator between the metallic surfaces of the condenser. Fourth, the distance one of these metallic surfaces is from the other, that is, the thickness of this insulating medium.

But it must not be construed from the foregoing that the "volume," that is, the thickness of the *metallic* substance is a factor in capacity, for it is believed that the electricity is not held in the metal itself, but is stored upon the insulating medium used in building the condenser. This may be proved by constructing a simple condenser of two tin plates and a piece of glass and, after charging, remove the plates with an insulated handle, and not until they are returned to the original position will there be any manifestation of electricity. Believing this to be the case in all condensers, it is easy to presume that the capacity is proportional to the area of the conductor and not to its volume.

And it is easy to understand that the capacity of a condenser is inversely proportional to the thickness of the insulating substance separating the metal plates, that is, in constructing a Leyden jar one would choose a glass jar of thin wall instead of one of extra thick glass, because thick glass would separate the metallic surfaces at such a distance from one another that very little induction could take place from one to the other.

In low voltage work, where the voltage is less than will cause a spark to jump through a thin insulating medium, paraffine waxed paper serves very well as condenser material, not only because of its excellent insulating qualities, but because of the large surfaces of metal that can be brought close to one another without touching. And to obtain the maximum capacity with a minimum of expense and bulk, most of the condensers in the market are made of paraffine paper and thinnest tin foil. The best standard condensers are made of mica sheets and metal foil, and are much more expensive than the paraffine paper ones.

When we consider the subject of condensers to be connected for capacity affects across a circuit of high voltage, such as the secondary of an induction coil, for instance, it would never do to use one of waxed paper, because the paper would puncture at the very first discharge.

So we must resort to sheets of glass of the right thickness, or mica sheets stuck together with paraffine or shellac.

The current from the secondary may be presumed to be alternating, and when the secondary terminals are connected to a properly designed condenser, the condenser sheets are alternately charged and discharged as the direction of the current changes. And the application of a condenser across and in parallel with the spark gap of an induction coil, provided the condenser is of the right capacity, will greatly increase the fatness of the spark discharge and, proportionately, cut down its length.

PATTERN MAKING FOR AMATEURS.

F. W. PUTNAM.

X. A Small Jack. — A Small Hand Wheel.

Fig. 61 shows the castings and Fig. 62 the pattern for a small jack requiring a balanced horizontal core. A split pattern is used, and is turned in the same manner as the pattern for the recessed cylinder previously described. It will not be necessary to go into a detailed account of this pattern, and I shall confine myself to a few simple directions which may aid the amateur in easily constructing the pattern.

Be very certain that the two blocks which are to form the pattern are planed to a smooth, even surface, so that when they are dowelled and clamped together there will be a perfect joint formed. Care should be taken in locating the centers for the dowel holes, as well as in seeing that the holes are not bored too deep into the second block. That block, when ready for turning, should be very carefully centered in the lathe so that the pattern when spread apart will have both faces equal. The core-box for this pattern is shown in the isometric drawing, Fig. 63. Six blocks are required to form this core-box, as can be readily seen by reference to the figure. *A* and *F* are simply the end pieces, and are glued and nailed to pieces *B* and *E*. The pieces *B*, *C*, and *E* are to be cut out and finished with a gouge, the same as for the core-box for the recessed cylinder previously described. The piece *D* is $\frac{1}{8}$ in. thick, and can be readily brought to almost the required shape with a sharp knife, the surface being finally finished with file and sand-paper. When the six pieces are to be fastened together, see that the centers of each and of the blocks come in one straight line. If this not done the core made from the core-box will be very likely to leave an uneven center in the casting.

If we look at Fig. 61 we will notice that the hole does not run way through the casting, it being intended that the top hole shall be drilled out after the casting is made. This leaves one end of the casting solid and so a balanced core is necessary.

No absolute rule can be given for the relation of length to diameter in the case of the projecting core print. It will be found that the dimensions given in Fig. 62 are in about the right proportion. This proportion works so as to give the length as about two and one-quarter times the di-

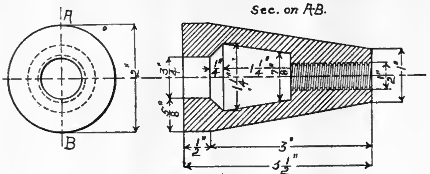


Fig. 61.

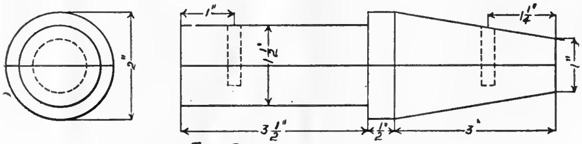


Fig. 62.

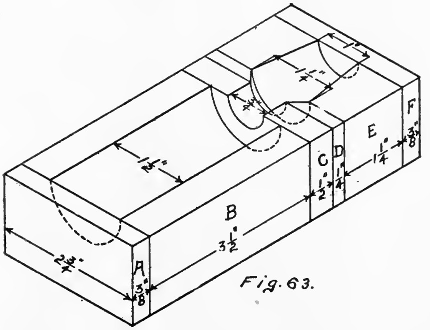


Fig. 63.

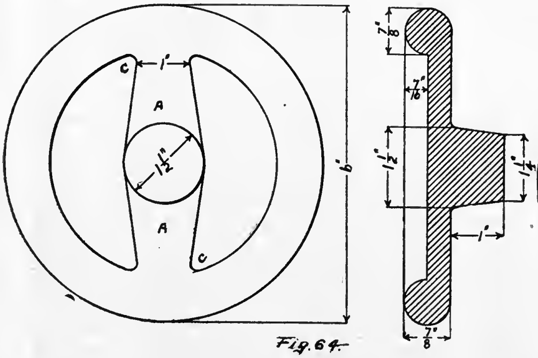


Fig. 64.

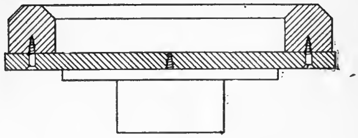


Fig. 65.

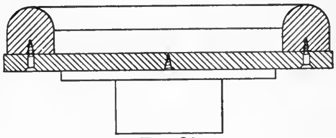


Fig 66.

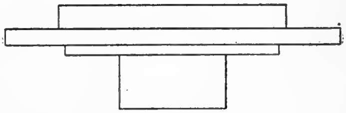


Fig. 67.

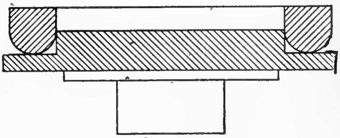


Fig. 68.

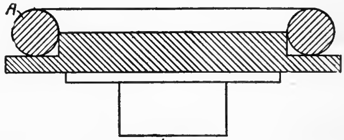


Fig 69.

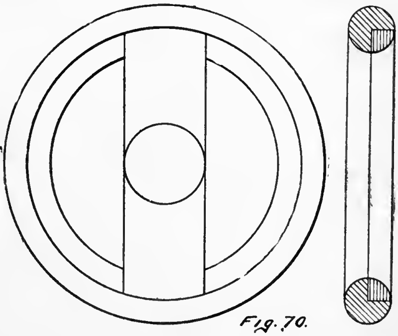


Fig. 70.

ameter. It will be found by trial that for a pattern of this size any smaller ratio is insufficient.

The core-box is a half core-box only, and so two half cores are made, baked and then pasted together. The largest diameter of the core is 1½ in. while the smallest diameter, which comes not very far from the middle of the length of the core, is but ¾ in.; so that it becomes necessary that extra care be taken in finishing the various pieces forming the core-box in order that the sand forming the core can be easily removed from the core-box without breaking away in the slightest degree. Of course small wires could be used in making these cores to aid in holding the sand.

Fig. 64 shows the drawing for a small hand wheel so constructed that the rim may be built separately, the arms, *A*, Fig. 64, being inserted after the wheel is built. First, cut from a piece of clear, dry pine 1 in. thick a circular block $6\frac{13}{16}$ in. in diamter. Fasten this carefully to the square center plate, and first true up the front surface of the block. Prepare some pine stock ¾ in. in thickness and lay out on this board quarter circles to be used for building up the rim, allowing ½ in. extra stock for turning. The outside radius, therefore, should be about 3¼ in., and the inside radius about 1¾ in. Carefully saw out this segment and, using it for a pattern, mark out seven other pieces and saw them out to the lines. These segments are to be joined endwise around the circumference of the wood face-plate previously turned. Be sure that each two segments meet in a perfect joint. The edges are to be carefully glued together, and the segments are fastened to the face-plate by screws of small wire brought through from the back of the face-plate. It will, of course, be necessary to put a layer of paper (either brown paper or newspaper is good for this purpose) between these segments and the face-plate. Otherwise the rim would become glued to the face-plate and could not be removed after the turning was completed.

Having completed the first set of segments, put the face-plate on the lathe and turn the front face of the segments true. The other four segments are next glued to the first set, comprising what is known as the second course. These segments should be placed so that the joints will not come directly over the joints of the first set. In other words, the second set of segments will lap over the first, forming a lapped joint. This second course is fastened to the first form with glue, and must be clamped together until the glue is thoroughly set.

Next, place the face-plate on the lathe again and remove the front surface of the second course of segments until the required thickness, $\frac{7}{16}$ in. is reached. The outside diameter, 6 in., is next turned, and the inside diameter made 4½ in. The corners of the segments are then cut away with a skew chisel so as to form the circular groove required in Fig. 64. Fig. 65 shows the corners removed, and Fig. 66 shows the required half circle.

Carefully sand-paper the pattern when this work has been completed, and next remove the screws which fasten the wood face-plate. The wood face-plate is next to be turned down until the shape shown in Fig. 67 is reached. The pattern is then to be forced on to this face-plate, as shown in Fig. 68. The outside corners are next to be removed, so that finally the pattern will take the shape shown in Fig. 69, when it is to be sand-papered. Before the pattern is removed from face-plate, make a line at the point marked *A*, Fig. 69, with the acute point of the skew chisel. This line is to be used later in centering the hub. By this I mean locating the center of the hub on the arms after they are inserted in the pattern. The arms are made from stock $\frac{7}{16}$ in. in thickness and 1½ in. wide.

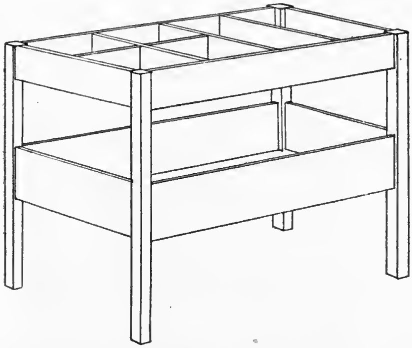
Having set the dividers at the radius of the circle marked on the rim, make lines on each end of the piece to be used for the arms, these lines corresponding with the centering circle. Carefully cut out the block on these lines, and next place the arm in position on the rim, marking out the edge of the piece so as to outline the rabbet or pocket which must be cut in the rim in order to receive the arms. Next, cut down to this centering circle and to the other lines, those marked rabbet or pocket being cut half way through the rim. This piece is next set in position, as shown in Fig. 70. The hub, as shown at *B*, Fig. 64, is now to be turned to the required dimensions. A shoulder may be turned on the hub and a corresponding hole bored in the pattern, or the hub may be simply fastened with glue and nails to the outside surface of the pattern. Finally, cut down the arms to elliptical form, as shown in Fig. 64. The pattern is then to be sand-papered and shellacked.

EASILY MADE FURNITURE.

JOHN F. ADAMS.

A SEWING TABLE.

The sewing-table here described will be found a convenient receptacle for the numerous odds and ends required for the household repairing and dressmaking. It is of light construction permitting of being easily carried about the house, and yet has abundant room in its several compartments for the separate storage of buttons, thread, yarns, etc., in the upper part, and the



work in the lower one. Gum-wood is recommended with which to construct it, being of fine, even grain, sufficiently dark not to soil easily and presenting an attractive appearance with a natural finish. The required stock is as follows:

4	pieces	30	in.	long and	1	in.	square.
2	"	$28\frac{1}{2}$	in.	" "	4	in.	wide.
2	"	$18\frac{1}{2}$	in.	" "	4	in.	"
4	"	$18\frac{3}{4}$	in.	" "	$3\frac{5}{8}$	in.	"
2	"	$28\frac{1}{2}$	in.	" "	6	in.	"
2	"	$18\frac{1}{2}$	in.	" "	7	in.	"
2	"	$28\frac{3}{4}$	in.	" "	$18\frac{3}{4}$	in.	"
1	"	32	in.	" "	21	in.	"

All the stock, except the corner posts, is $\frac{5}{8}$ in. thick. The wide pieces for the top, and the bottom boards of the trays will have to be glued up.

The illustration shows pretty clearly the method of construction, but gives the appearance of a larger table than it really is. The side pieces are mortised into the posts, full size, to a depth of $\frac{1}{4}$ in., the space between the upper and lower trays being 7 in. These pieces are also set in $\frac{1}{4}$ in., as shown. The upper tray is divided into four sections with cross-pieces, and two of these sections are again divided, making six pockets, but any other arrangement can be adopted that the maker chooses. These divisions are made with the strips $3\frac{5}{8}$ in. wide, thus allowing $\frac{5}{8}$ in. on the under side for the bottom board, measuring $28\frac{3}{4}$ in. which is nailed through from the sides and ends and also into the division pieces. The bottom of the lower tray is nailed in places in the same way.

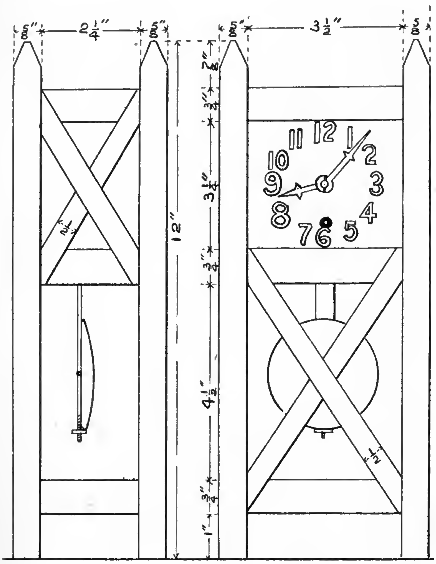
The top is strengthened with cleats at each end placed so as to fit snugly inside the end pieces thus holding it in position when on, and yet allowing it to be lifted with work upon it, without being obliged to remove the latter, as would be necessary with hinges.

A MANTEL CLOCK.

The design here given for an old Dutch mante clock is suitable for making up for a Christmas present, and on that account will undoubtedly be welcomed at this time. The movement for which the dimensions are given is an eight day, front winding, $3\frac{1}{2}$ in. pendulum movement of low cost, manufactured by the Seth Thomas Clock Co., Thomasville, Conn., but any other movement about this size can be used. That of an ordinary alarm clock will do, if the absence of the pendulum is no objection, though this adds much to the appearance. The wood should be oak, stained a dark green or brown, as preferred.

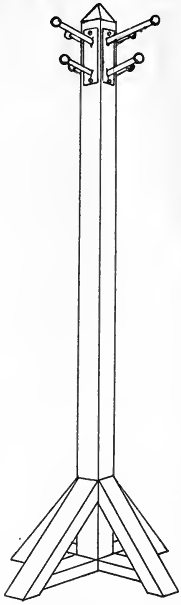
The dimensions of the various parts are clearly shown in the illustrations. The cross-pieces are mortised into the posts about $\frac{1}{4}$ in., and are set back $\frac{3}{16}$ in. from the outer edges of the latter. The diagonal cross pieces on the front and sides are $\frac{1}{8}$ in. thick and nailed to the cross pieces with escutcheon pins, with the inner ends bent over to hold securely.

The case for the works is made from thin stock the bottom being left open. The dial is also made from a piece of thin stock, stained to match the rest of the frame and is held in place by small, round-head brass screws, one in each corner, which are put through the dial into blocks fastened to the sides of the case to receive them. The works have lugs at the back for fastening to the back of the case with screws, and should be put in place before fitting the dial. Care should be taken that the works are exactly "in beat" when in place, otherwise the clock will not run satisfactorily.



The figures on the dial can be cut out of thin white holly with a fret-saw, or pattern makers' metal figures may be used, but the latter are liable to tarnish. Lacquered brass figures are desirable when same can be obtained. They should be of the size known as $\frac{1}{4}$ in. Gothic; the spacing can be taken from any clock, a circle being marked with dividers. The pendulum should be stained with the same stain as that for the frame, and a thin strip $\frac{3}{8}$ in. wide attached to the wire pendulum rod with glue, which also should be stained. A wax finish is most suitable, but an oil and varnish finish may be used if desired.

A CLOTHES TREE.



A very convenient piece of furniture is easily made, and any one in need of it will welcome it as a holiday gift, even if the maker is also the recipient.

The post is 4 ft. 6 in. long and $2\frac{1}{4}$ in. square. The top is mitred, as shown, and the bottom is cut down to form a tenon $\frac{3}{4}$ in. square and $1\frac{1}{4}$ in. long. The four legs are 15 in. long, $2\frac{1}{4}$ in. wide and $1\frac{3}{4}$ n. thick, and cut to a bevel to fit the post, the upper edges of which are $8\frac{1}{2}$ in. from the extreme lower end of the post.

The cross pieces under the post and connecting the legs are 16 in. long, $2\frac{1}{4}$ in. wide and $1\frac{1}{4}$ in. thick; the joint under the post being halved and tenons cut on the ends $\frac{1}{2}$ in. wide and the full thickness of the pieces. The lower edges of the mortises for same in the legs are 3 in. from the ends. A mortise $\frac{3}{4}$ in. square is cut in the center for the tenon on the foot of the post. These mortise joints are pinned with $\frac{1}{8}$ in. dowel pins, holes being carefully bored for same, and good fits secured to make them as inconspicuous as possible. The clothes hooks at the top should be of black iron if same can be procured; otherwise use square wooden rods $\frac{1}{2}$ in. diameter with 1 in. bottons on the ends. The finish should be dark brown or green stain, rubbed out to show the markings of the grain, with wax or rubbed oil finish.

The amateur pattern maker is quite likely to experience trouble in his first attempt at mixing lampblack and shellac, owing to the tendency of the former to form lumps, thus preventing a thorough mixture of the two ingredients. If the lampblack is first made into a soft paste with alcohol, thoroughly working out the lumps with a wooden or metal spatula, the shellac can then be added and a smooth working shellac result.

PHOTOGRAPHY.

CHRISTMAS SUGGESTIONT.

A brief resume of what can be easily and quickly done in a photographic way for making up attractive Christmas gifts, will, it is hoped, be of interest to those who, having a camera, have not as yet passed beyond the "press the button" stage, and consequently know nothing of the delights, as well as tribulations, of developing, printing, toning, etc. It may possibly come to pass that there will be those who, reading these lines, will be encouraged to attempt one or more of the simple processes here mentioned, and, meeting with the success easily possible, be thus encouraged to more serious and instructive work. Let us hope.

The ever present evidence of a frugal correspondent, the postal card, is at once the easiest and cheapest way of sending a Christmas greeting, and when bearing the portrait of the sender, friend or relative, or a landscape which recalls pleasant or historical associations to the receiver, is very effective. Cards already sensitized and ready for printing from the negative can be purehased in packages. Velox cards giving a black print and printing by gaslight, and sepia cards giving a brown print and printing by sunlight, are to be found at about all supply dealers. Complete directions for using are given on each package.

A variation of the above mentioned photo-postals is that of cards with embossed borders and a place for mounting a print $2\frac{1}{2} \times 1\frac{1}{2}$ in. in size. These are to be had in different colors and patterns of embossing and are very attractive.

The sensitizing solution for paper or cloth is not new but is mentioned, as it may be suggestive of new applications to some readers. Correspondence paper, envelopes and calendar mountings are the most popular channels for its use at present. For a blue print it is to be had in powder form, requiring but the addition of water; for the silver print (brown) it is in liquid form. As applied to correspondence paper it can be used to uce the most novel and pleasing effects, and is limited solely by what may be possible with the camera in use. For those sufficiently familiar with photographic processes to make up and use their own solutions, the following formula is given:

Light Sensitive Postal Cards.—Apply the following solutions to the cards with a brush:

Iodide of potassium	1.6 g.
Bromide of potassium	6 g.
Arrowroot	2 to 2.5 g.
Distilled boiling water	120 c.cm.

When the cards are dry float them in the dark upon a 5 per cent. nitrate of silver solution. When dry they are ready for printing. If exposed in artificial light, they require about a second. Rodinal is best for development.

Another formula is:

Nitrate of silver	1 g.
Nitrate of uranium	10 g.
Alcohol	40 c.cm.
Distilled water	10 c.cm.

The washed print is put into a weak muriatic acid solution, and is finally washed for 30 minutes in running water.

As a suggestion for a useful and accceptable present for any novice in photography may be mentioned an "exposure metre" or scale, by means of which the length of exposure may be accurately determined for all kinds of weather, hours of the day and rapidity of plates. The Wager scale, sold for 50 cents, is probably best adapted to beginners, as it is complete in itself, requiring no print paper preliminaries; simply sliding the several sections to agree with the conditions existing will, after a few trials, enable the length of exposure to be accurately determined. The matter of correct exposure is a more vital matter than beginners generally think it to be, and not until its importance is realized to the extent of studying the degree of light prevailing, will correct exposures be the rule rather thau the exception. It is because the simple device above mentioned can be of so much value to a beginner, and even one of some considerable experience that it finds a place in this list of seasonable suggestions.

AMATEUR WORK.

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TO ADVERTISERS.

New advertisments, or changes, intended for a particular issue, must be received at this office on or before the 10th of the previous month.

Entered at the Post Office, Boston, as second class mail matter, Jan. 14, 1902.

DECEMBER, 1904.

The interest shown in magic-lantern work by many of our readers leads us to propose the following plan for an exchange of lantern slides: Any subscriber may send their name and address and a list giving the subjects of three slides, of which the owner will send duplicates in exchange for other slides desired by him. These addresses and lists will be published as received, and those interested can then correspond directly with those having slides which they desire. In addition, anyone may send in a list of slides wanted, but the latter lists will be limited to not over five in any single month. The subjects for exchange should be those most likely to interest the largest number.

To present the matter so that readers may obtain a correct idea of the slides, we will offer the following monthly prizes for photographs of the most interesting subjects which the competitors have for exchange:

First prize, Premiums given for three new subscriptions.

Second prize, Premiums given for two new subscriptions.

Third prize, Premium given for one new subscription.

In awarding the prizes, the subjects of the slides, the excellence of the photographs and resulting slides will all be considered. For that reasan, we reserve the right to request competitors to send slides when the rendering of an award may require it. This department will be confined strictly to an exchange of slides, and sales of slides will bar those engaging in it from the publication of their lists.

The approach of the holidays and the near advent of another year is usually the occasion for forming new resolutions for improvemeut in some way best known to ourselves, and we, like our readers, have certain thoughts in this line. We hope to make this magazine of greater interest and value than in the past, and most earnestly request suggestions regarding subjects of interest, which will be utilized in the preparation of articles, so far as it is possible to do so. In turn, we hope our readers are utilizing the information and directions presented in the sucessive numbers to some practical purpose, thereby increasing their fund of knowledge and experience, which cannot prove other than of direct value, even if the way of it may not at the time be evident. It is the acquiring of a large stock of miscellaneous information on many subjects which distinguishes the ingenious and skilled mechanic from the ordinary workman, and makes the former in demand when the latter can find no opening. To help those who would help themselves is one of the chief aims of this magazine.

Mr. Heit, a French inventor, has recently patented a compass which automatically registers minute by minute. The compass card is fixed on a steel pivot. which rests on a fixed agate, instead of having at its center an agate resting on a fixed steel point. The fixed agate is immersed in a drop of mercury, which serves as a condnctor for the electric current that causes the movements of registering.

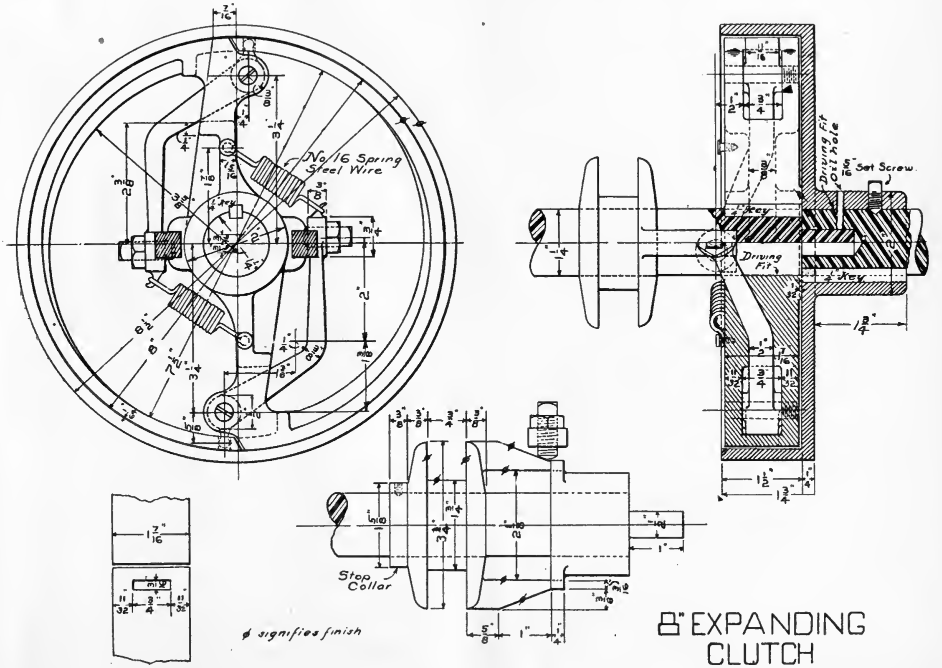
A GASOLENE TOURING CAR.

R. G. GRISWOLD.

II. Eight Inch Expanding Clutch.

The object of a friction clutch is to provide a ready means of throwing a machine or other mechanical device either into or out of engagement with the source of power. The requirements for the general run of clutches are sufficient area of contact surface to cause the two engaging parts to hold without undue pressure ; ability to engage slowly and without taking hold suddenly, depending upon the pressure used, and sufficient strength to transmit the full power required without slip.

But with this design of clutch, which is used to a great extent on automobiles, it is necessary to make it of very large diameter in order that it may hold the load. The cone is generally forced into engagement and held there by a spiral spring, the pressure of the foot on a lever releasing the cone and pushing it back clear of the seat. These clutches depend for their successful action upon the condition of the leather or other lining material, and the presence of oil on the surface lessens the friction very considerably. Then, if



8" EXPANDING CLUTCH

The number of designs is legion, and many of them are exceedingly clever, but the simpler a clutch may be made generally the better. The fewer parts used, consistent with the work required, the fewer joints there are to wear loose and rattle. Perhaps the simplest design is that of the cone fitting into a similar cone, either piece being lined with leather or other similar material, or finished contact surface being left so as to work metal to metal.

the clutch is thrown in slowly, the swiftly revolving surface generates sufficient heat to burn the lining, or at least to glaze it and render it unfit for service. Where it does act well, however, it is a very satisfactory device, but can be very easily injured.

With a clutch operating metal to metal, the surfaces in contact may be coated with a film of oil or other lubricant which will prevent their cutting during the periods that slipping does occur, as it always does when the clutch is thrown in. But the greatest feature, probably, of any metallic contact-surface clutch is the positive action that may be secured with greater ease than on conical types held in by the action of a spring. For instance, the clutch about to be described can be expanded with such pressure that the keys in the shaft can be easily sheared without slipping the two members, and some recent experments with this particular clutch positively determined its excellence.

A shaft was fitted in a lathe carrying one of the members. In the clutch was fastened the driving member. The back gears were thrown in and the belt put on the largest cone, giving a tremendous pull. The lathe was started and tests made to determine the holding power of the clutch. As the sliding cam was pushed in with a tool held in one hand, the friction began to increase with a perceptible slowing down of the spindle, and when the cam was forced entirely home the lathe was stopped and the belt slipped off the pulley. The test was especially severe as the speed of rotation was very low, not more than ten or twelve turns per minute, while the clutch is designed to transmit about twenty-horse power at 1,000 revolutions per minute. One feature was very noticeable, and that was the readily controlled grip. In a great many clutches, it is difficult to throw them in easily as they take a full grip or none. As the cam was thrown in the expanding ring gradually took hold and the slipping was smooth and without cutting, owing to the lubricated surfaces. Very little pressure was required to operate the cam, and the pressure of a finger would make the clutch grip, while very little more served to lock it fast.

The driving member is a plain drum of cast iron, turned on the inside and outside peripheral surfaces. It is keyed to the engine or other driving shaft by a 5-16 in. key two inches in length. It is also further secured from slipping by the ¼ in. set screw shown.

The expanding member is also of cast iron, and consists essentially of a ring of metal carried by a spider. This spider is also keyed to a shaft, and this shaft is provided with a ½ in. journal running in a bearing in the driving shaft. This serves to center the inside ring which has about 1-64 in. clearance. As the clutch is generally engaged, leaving very little time when the engine is running idly, there is little work for this bearing to do, hence little chance for wear or cutting. It is, however, provided with a Babbitt metal lining, and the hole is continued to a sufficient depth to allow a lump of some bearing grease to be put in before assembling. Should the bearing begin to heat from any cause, this grease will melt and lubricate the surfaces. An oil hole is also drilled and provided with a screw plug for ordinary oiling.

This ring is entirely finished before cutting apart at the points over the levers, which is accomplished with a hack saw. The pins upon which the levers turn should be hardened and are held in place simply by a small split-pin. The levers are simple forgings of steel. It would be unwise to use cast iron for this purpose, owing to its comparatively low tensile strength. The forgings are very simple, however, and can be easily made by any blacksmith. They are provided with hardened set screws and jamb-nut for adjustment ; the end of the set screw is rounded and polished where it bears on the fingers of the cam.

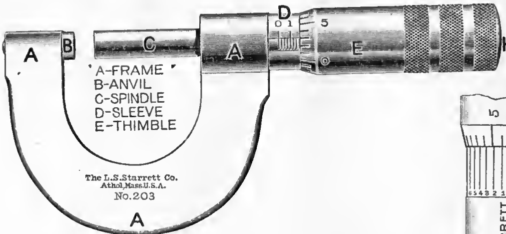
The cam has been provided with exceptionally large thrust surfaces to take care of wear. This is necessitated by the high speed at which the clutch runs. It was primarily designed to be held in by a spring and released by lever pressure, but the reverse may be just as easily done. The throw of the cam is 1¼ in. and a small flat is left on each finger to form a positive rest for the lever in case the cam is not spring-actuated. Each lever is attached to a stiff spring, which overcomes the centrifugal action. Were these not provided it is possible that some difficulty might be experienced in releasing the clutch at high speed owing to these levers flying and remaining in that position.

HOW TO READ A MICROMETER.

By Courtesy of The L. S. Starrett Company.

The spindle *C* is attached to the thimble *E* at the point *H*. The part of the spindle which is concealed within the sleeve and thimble is threaded to fit a nut in the frame *A*. The frame being held stationary, the thimble *E* is revolved by the thumb and finger, and the spindle *C* being attached to the thimble, revolves with it and moves through the nut in the frame, approaching or receding from the anvil *B*. The article to be measured is placed between the anvil *B* and the spindle *C*. The measurement of the opening between the anvil and the spindle is shown by the lines and figures on the sleeve *D* and the thimble *E*.

The pitch of the screw threads on the concealed part of the spindle is 40 to an inch. One complete revolution of the spindle, therefore, moves it longitudinally one-fortieth (or twenty-five thousandths) of an inch. The sleeve *D* is marked with 40 lines to the inch, corresponding to the number of threads on the spindle. When the micrometer is closed, the beveled edge of the thimble coincides with the line marked 0 on the sleeve, and the 0 line on the thimble agrees with the horizontal line on the sleeve. Open the micrometer by revolving the thimble one full revolution, or until the 0 line on the thimble again coincides with the horizontal line on the sleeve ; the distance between the anvil *B* and the spindle *C* is then 1-40 (or .025) of an inch, and the beveled edge of the thimble will coincide with the second vertical line on the sleeve. Each vertical line on the sleeve indicates a distance of 1-40 of an inch. Every fourth line is made longer than the others and is numbered 0, 1, 2, 3, etc. Each numbered line indicates a distance of four times 1-40 of an inch, or one-tenth.

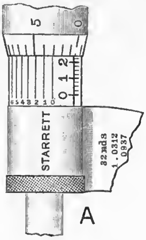


The beveled edge of the thimble is marked in twenty-five divisions, and every fifth line is numbered from 0 to 25. Rotating the thimble from one of these marks to the next moves the spindle longitudinally 1-25 of twenty-five thousandths, etc.

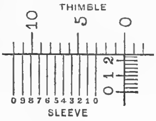
Twenty-five divisions will indicate a complete revolution, .025 or 1-40 of an inch.

To read the micrometer therefore, multiply the number of vertical divisions visible on the sleeve by 25, and add the number of divisions on the bevel of the thimble, from 0 to the line which coincides with the horizontal line on the sleeve. For example, as the tool is represented in the engraving there are seven divisions visible on the sleeve. Multiply this number by 25 and then add the number of divisions shown on the bevel of the thimble, 3. The micrometer is open one hundred and seventy eight thousandths. (7×25=175 +3=178.)

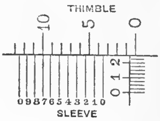
Readings in ten thousandths of an inch are obtained by the use of a vernier, so named from Pierre Vernier, who invented the device in 1631. As applied to a micrometer this consists of ten divisions on the thimble. The difference between the width of one of the ten spaces on the sleeve and one of the nine spaces on the thimble is therefore one-tenth of a space on the thimble. In engraving *B* the third line from 0 on thimble coincides with the first line on the sleeve. The next two lines on thimble and sleeve do not coincide by one-tenth or a space on thimble; the next two, marked 5 and 2, are two tenths apart, and so on. In opening the tool, by turning the thimble to the left, each



A



B



C

space on the thimble represents an opening of one-thousandth of an inch. If, therefore, the thimble be turned so that the lines marked 5 and 2 coincide, the caliper will be opened two-tenths of one thousandth or two ten-thousandths. Turning the thimble further, until the line 10 coincides with the line 7 on the sleeve, as in engraving *C*, the caliper has been opened seven ten-thousandths, and the reading of the tool is .2257.

To read a ten thousandths micrometer, first note the thousandths, as in the ordinary micrometer, then observe the line on the sleeve which coincides with a line on the thimble. If it is the second line, marked 1, add one ten thousandth; if the third, marked 2, add two ten thousandths, etc.

OUR OPPORTUNITIES.

Abstracts from an address to the graduating class of Stevens Institute of Technology by Mr. Walter C. Kerr.

"We hear much about opportunities. They are everywhere plentiful. Remember, that your opportunity is the little one that lies squarely in front of you, not the larger one which you hope to find farther along. Many a man is surrounded with opportunities who never seizes one. There are traditions that Adam, William Tell and Sir Isaac Newton each had an affair with an apple, but with different results."

"Your first duty is always to that which lies across your path. The only step which you can take in advance is the next one. This leads to a simplicity of action which is commendable. Don't ramble."

"Cultivate singleness of purpose. This is more important than you may think. It is intuitive with the comparatively ignorant, and often absent in the highly trained. We are frequently surprised at the great competency of the ignorant contractor or foreman, on whom judgment is passed by saying that he is a practical man and gets results. Analysis will show that his best quality is singleness of purpose, which leads him to vigorously do the one thing before him without distraction following from knowing or thinking about too many other things."

"When you are getting what you go after, get it all. Avoid the mediocrity of compromise. Be thorough and stand for full competency in everything, from main essentials to details."

"Much of our engineering is only done once, and it must be done right that once. A man who has learned by experience to do a thing deserves no credit for doing it right. He is then only a repeating machine. Real power is characterized by ability to perform right the first time that which a man never did before. Such performance involves the power to assimilate and adapt experiences, of more or less like or unlike kind, in a way to bring forth correct results. This is the true use of experience, wherein a man is a thinking, active power, and not a mere repeater."

"A point of view is involved in the power to rationalize. This is a thing which each man does for himself in his own best way, and its essence consists in asking one's self whether the thing is reasonable. It is a great check upon error. It is the power of the human mind, after performing in more or less systematic and conventional ways, to stand off and look at results and ask one's self whether they are reasonable. One man will figure that certain material weighs two hundred tons, and believe it. Another will say that there is something wrong in that, for it all came on two freight cars."

"It is well for a young engineer to cultivate his vocabulary and learn to use words in their right sense. They are then usually understood, even by those who have less knowledge. . . . . . Engineering documents, specifications aad letters are full of m sstatements due to the careless use of language. Conciseness cannot be overestimated. Brevity is desirable, but not at the expense of clearness. Conversely, a certain degree of facility should be acquired in reading the words of others."

"One of the worst attributes in engineering, and which is fundamentally born of conceit, tends to fasten error, censure and responsibility on others. There are times when a man needs to stand himself up in front of himself and ask; 'What is the matter with me?' The capacity of any man to admit his own error and frailty of judgment is a measure of strength rather than weakness."

"When you start your practical work, you will doubtless try to improve things. That is a legitimate purpose, if not overworked. I am not going to attempt to tell what needs improvement, but the one improvement that things need is in the line of sufficiency. You can think this over for yourself and apply it where it fits."

Remember that all the good you accomplish is going to come out of yourself. You cannot borrow it and you cannot make it out of that which has been poured into you by education or otherwise. All that you receive is only a certain quantity as knowledge, acquired by education, experience or other training, which will have a certain influence upon what comes out of yourself as your own. It is the inherent capacity to perform with your own brain which will make you what you become, and not the mere transmission of that which you have acquired. . . . . . Some have gone through experience without acquiring it, and many a man who has received an education has not got any because he allowed it to be a thing apart from his personality, and it slipped away."

American Electrician.

TOOL MAKING FOR AMATEURS.

ROBERT GIBSON GRISWOLD.

V. Special Tools for Lathe Use.

There are many special forms of tools for lathe use, the designs of which had their origin in some particular difficulty experienced while using the common or straight tool. This is especlally true of the special spring thread tool about to be described. Many of the readers have doubtless experienced difficulty in cutting smooth threads on the lathe, especially when the material was very tough or hard, or possessed both characteristics. It is almost impossible to get a perfectly smooth thread, no matter how keen the tool is kept or how caretully the tool is fed to the work. This difficulty arises from several causes, which may be : a slight looseness in the tool carriage or post, slight play in the head spindle, or the "springy" nature of the piece upon which the thread is being cut. The latter cause is, perhaps, most frequent, and results in the point of the tool digging into the work and then slipping, leaving the surface either torn and ragged or full of chatter or ripple marks.

The spring tool illustrated in Fig. 1 was primarily designed to overcome the tendency of the tool to dig in, and just how well it performs this function may be realized when the reader is told of a four-inch, double-threaded tap made very recently of a high grade tool steel in which the last or finishing cut left the surface of the thread so true and smooth that perfect reflections could be seen in it of objects held close to it. Repeated attempts had been made to finish it with the ordinary straight tool for roughing out the thread, but to no avail, for no matter how slowly the work revolved or how much lubricant was added, the chattering would persist. The writer has seen some remarkable finishing cuts taken with just such tools, especially when the edge is ground so that it stands at an angle to the horizontal plane through the center of the piece. This will take a shearing cut and leaves the surface remarkably smooth. There may be those who will differ with the writer in this, but he is speaking from an extended experience with some very high class work in which this tool only could be used to secure the desired result.

The shank *a* is forged from a piece of tool steel to the general outline shown, but without the hole *b* or slot *c*. The rough forging is first finished all over; then the hole *b* is drilled with a $\frac{3}{8}$ in. drill and the slot *c* cut with a milling cutter if possible, or with any other means that the amateur may find at hand. A $\frac{1}{4}$ in. hole is then drilled in the end *d* to take the tools *e*. This hole should be reamed so that the tools will be a snug fit therein. A small set screw *f*, bearing on a flat in the top of the tool *e* serves to bind it firmly in place. After all work is done on the tool it is hardened and the piece drawn to a spring temper. The tempering of the points *e* needs no special mention.

length, it is case-hardened. This process is accomplished by heating the piece in a length of iron pipe about two inches in diameter and five inches longer than the bar. The bar is placed in the center and packed all around with a mixture of charcoal and bone-dust, or in place of the latter scraps of old leather mixed with a little ferro-cyanide of potassium. The ends are stopped with clay, and the whole put into a fire and heated to a cherry red for four of five hours; the bar is then removed and plunged into water, care being exercised to lower the water in a vertical position, quickly, and afterwards rapidly agitating the water by moving the piece to and fro. This should prevent the bar from warping, as it most certainly will if dropped in sideways.

The hole *f* is put in at an angle in order that a point

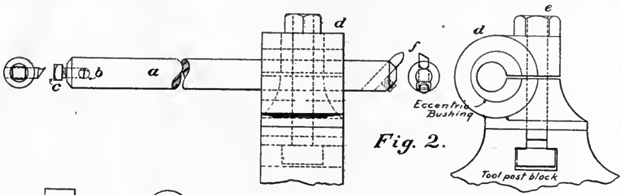


Fig. 2.

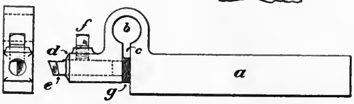


Fig. 1.

When in use, unless on very light work, a small block of wood, such as a piece of cherry, is fitted in between the sides of the slot, as at *g*, which prevents too great vibration, and yet is yielding enough to allow the tool to recede slightly from the work when a hard spot is run into. Then, when the same spot is reached again, the tool will not back off as much and the piece will be finished very smoothly. Other points besides the thread cutting tool may be used with equal facility.

Probably many of the readers have experienced some difficulty in boring out cylinders of any great length on a small lathe, owing to the spring of the tool when cutting so far away from the point of support. The cut must be very light and the feed very slow if even a fair job is expected. To overcome this difficulty a boring bar having great rigidity is used.

The bar, Fig. 2 *a*, may be made of a piece of $\frac{3}{4}$ in. machinery steel for nine and eleven inch lathes, and perhaps a 1 in. diameter for a thirteen in. lathe. The greater stiffness possessed by this bar the better work will it perform. This bar should be provided with a $\frac{1}{4}$ in. or $\frac{3}{8}$ in. hole in each end as shown, for the reception of the various points to be used with it. A set screw is also provided for clamping the point firmly, and these points may be cut from a piece of Stubb's drill rod, ground to shape and hardened, no forging being necessary. After the bar is finished as smoothly as possible, and of even diameter throughout its

may be used up into a corner. Thread points may also be used for cutting internal threads. Of course the size of the bar limits the diameter of the hole to be bored to slightly more than its own diameter, plus the length of point protruding from the side. For smaller holes than this it is well to have a half-inch bar with a large shank or a split bushing to fit into the clamp *d*.

The clamp *d* is made of cast iron and fits the tool post block. The same bolt *e* that secures it to this block also serves to clamp the bar firmly. The block *d* should have a tongue fitting into the tool-post slot which will prevent it from turning when the tool begins to take a cut. As the feed screw forces the tool into the work there is a great sidewise pressure which tends to twist the block *d* and thus relieve the pressure. It should always be remembered in boring that the tool support should be as near the cutting point as possible, as every bit of overhanging bar that is unnecessary gives the bar just that much greater tendency to spring.

The excavations at Pompeii have brought to light a piece of bronze wire rope nearly 15 ft. long and about 1 in. in circumference. The rope is now in the Musio Borbonico at Naples.

HOW TO BUILD A POWER LAUNCH.

CARL H. CLARK.

I. Laying Out the Lines.

The launch to be described is of a type which has lately become very popular among users of launches. It is 21 ft. long, 5 ft. 8 in. wide, and draws about 2 ft. of water. It is a very comfortable boat for pleasure sailing, as, while sufficiently seaworthy to endure severe weather, it is not so large as to require a large, heavy and expensive engine with the consequent heavy expense for fuel. The small cabin will shelter five or six people in a shower, or will afford comfortable cruising accommodations for three. The cabin, if not required, could be omitted and the awning and seats run forward instead. The boat is exceptionally roomy for one of her size and is of very easy form, which materially lessens the labor of building and brings it within the scope of amateur builders.

While the building of this boat is more complicated than any of the others which have appeared in these columns, there is no reason why any amateur who is used to tools should not be able to build it, especially if he has followed the previous descriptions and, perhaps, built some of the boats outlined therein. It is hoped that even those without previous experience in boat building will find the directions entirely clear.

Plate 1 gives the usual drawing of the "lines" as they are usually given to boat builders. These will be familiar to all from the previous descriptions, and the first work will be to reproduce, in full size, as much of this drawing as is necessary to obtain the shape of the various moulds used in the building.

The first step will be to lay out the outline of the keel and stem and of the moulds full size on a smooth floor. This is accomplished from the dimensions given in the "laying off table". The space chosen must be at least 22 ft. long and 6 ft. wide. A base line is drawn near one edge, and care must be used to have this line straight, which can be done either by snapping it in with a chalk line or by stretching a thread and marking several points and connecting these with a straight edge. It is very convenient to fasten a straight batten with its edge at the base line, thus enabling measurements to be laid off more easily, as the end of the rule may be placed against the batten, with the certainty that it is always even with the base line. The l. w. l. is next laid off 2 ft. 3 in. above the base line and parallel with it, water lines 1*a* and 2*a* are drawn 4 and 8 in. above the l. w. l, and water lines 1*b*, 2*b* and 3*b* are drawn 4, 8 and 12 in. below it and parallel with it. The cross seetions, or mould lines, are drawn square with the base line and 2 ft. and 6 in. apart, numbering them as in the drawing. This drawing may, if desired, be done on a large sheet of paper, one 5 ft. wide being sufficient, with the base line at its extreme edge. For drawing curved lines a batten, of pine or other flexible wood, about 1/2 in. square will be required; it is held in place by small wire nails driven through it into the floor. The outline of the keel bottom is first obtained from line 3 of the laying off table, by laying up from the base line on each mould line the distance given under the number at the top; for instance, on mould line No. 1, we should set up 1 ft. 9 1/2 in,; on No. 2, 9 in.; on No. 3, 7 in. and so on. It will be noted that the keel is straight from the after end as

TABLE OF OFF-SETS.

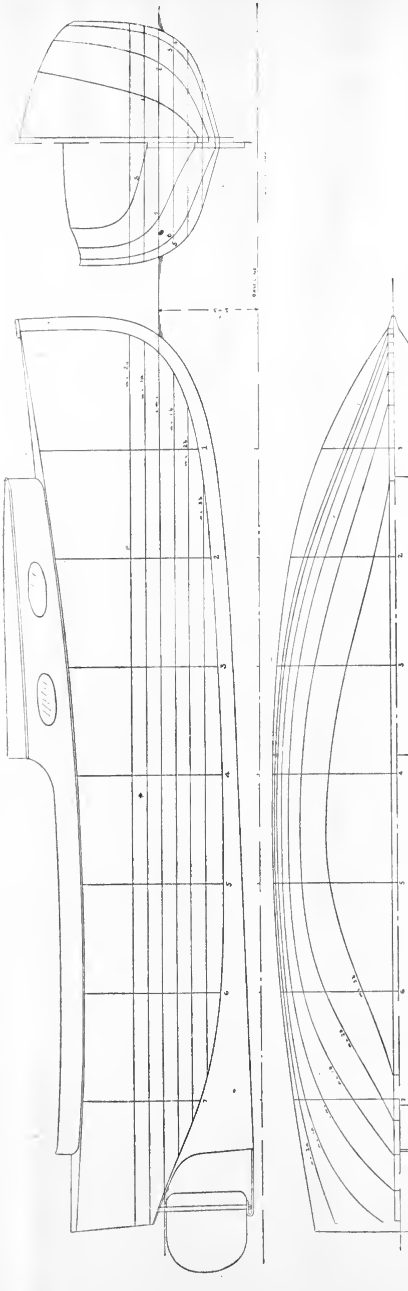
	Numbers of Moulds. 1	2	3	4	5	6	7	Stern
Ht. of sheer line above base line	5' 0"	4' 7 5/8"	4' 4 1/8"	4' 1 7/8"	4' 0 3/4"	4' 0 1/4"	4' 4"	4' 3 3/8"
Ht. of rabbet line above base line	1' 4 1/8"	1' 1"	0' 11 3/8"	0' 10 1/8"	0' 10 1/8"	1' 11 1/4"	1' 4 7/8"	2' 6 1/4"
Ht. of keel bottom above base line	1' 0 1/2"	0' 9"	0' 7"	0' 6"	0' 5"	0' 4"	0' 3"	2' 5"
Half breadth on deck	1' 8"	2' 4 3/4"	2' 8 1/2"	2' 10"	2' 10"	2' 8 1/4"	2' 4 7/8"	1' 11 3/8"
Half breadth on w. l. 2*a*	1' 2"	2' 1 3/8"	2' 7 1/4"	2' 9 3/8"	2' 9 3/8"	2' 7 3/8"	2' 3 1/2"	1' 6"
Half breadth w. l. 1*a*	1' 0 3/4"	2' 0"	2' 6 1/2"	2' 8 5/8"	2' 8 5/8"	2' 6 5/8"	2' 1 5/8"	0' 4 3/4"
Half breadth l. w. l.	0' 11 1/8"	1' 10 1/4"	2' 5"	2' 7 1/2"	2' 7 1/2"	2' 5"	1' 8 1/2"	
Half breadth w. l. 1*b*	0' 8 1/2"	1' 7 3/8"	2' 2 3/4"	2' 5 1/2"	2' 5 1/2"	2' 2"	1' 0 1/2"	
Half breadth w. l. 2*b*	0' 5 1/4"	1' 2 3/8"	1' 10 1/2"	2' 2"	2' 2"	1' 7 7/8"	0' 4 1/4"	
Half breadth w. l. 3*b*		0' 5 7/8"	1' 1 1/2"	1' 6 1/2"	1' 6 1/2"	0' 9 7/8"		

TAKING OFF TABLE

Water lines are spaced 4" apart. Moulds are spaced 2' 6" apart. Base line is 2' 3" below l. w. l.

TABLE FOR LAYING OUT STEM.

		Rabbet.	Face of stem.
Deck		2 ft. 8 1/2 in	3 ft. 0 in
W. l.	2*a*	2 " 7 1/2 "	2 " 11 1/2 "
W. l.	1*a*	2 " 5 5/8 "	2 " 9 3/4 "
L. w. l.		2 " 2 1/2 "	1 " 7 3/8 "
W. l.	1*b*	1 " 9 "	2 " 3 1/4 "
W. l.	2*b*	1 " 0 "	1 " 9 3/8 "
W. l	3*b*		0 " 11 1/4 "



far forward as No. 3 when it begins to curve upwards and merges into the curve of the stem.

The outlines of the outside of the stem and the rabbet in the stem are next to be laid off; these are obtained by setting out horizontally from mould station No. 1 on each waterline the distances given above.

The top of the stem is 5 ft. 5½ in. above base line, and this height will first be laid off; then the distance 2 ft. 8 ½ in. from the table will be measured off horizontally from mould station 1 at this level for the upper end of the rabbet line, and 3 ft. 9 in. for the upper corner of the stem. Coming down now to w. l. 2*a*, the distances 2 ft. 7½ in. for the rabbet and 2 ft. 11½ in. for the face of the stem are laid off in the same way along w. l. 2*a*, and so on until all are measured off. The two curves are then struck in with a limber batten, the outer one joining that of the keel bottom already drawn.

The rabbet line is next laid off from the dimensions of line 2 in the table, in the same manner as the keel bottom. It crosses the l. w. l. 2 ft. 1¼ in. back from mould No. 7 and ends on the stern 2 ft. 10⅛ in. back from No. 7 and, as noted in the table, 2 ft. 6¼ in. above base line. The curve can now be drawn in, joining that already drawn at the bow. It remains now to draw in the outlines of the stern post. The end of the stern post is on such an angle that if it were continued to the l. w. l. it would cut it 1 ft. 3½ in. back from No. 7. The outline of the under side of the overhang should run along about ¾ in. below the rabbet and curve into the straight of the stern post, as shown in the line drawing. The line giving the angle of the sternboard should also be drawn, the top of it being 4 ft. 3¾ in. above the base line, and 5 ft. 9 in. back from No. 7.

The shape of each mould is now to be laid out from the table. The base line, water lines and a center line square with them, as laid out; turning to the table and taking mould No. 4 as an example, we find the height at sheer line from line 1 to be 4 ft. 1⅞ in., and the half breadth at the deck height from line 4 to be 2 ft. 10 in. These two locate the upper end. Coming down to w. l. 2*a*, we find the half breadth in line 5 to be 2 ft. 9⅝ in. and on w. l. 1*a* from line 6 to be 2 ft. 6⅝ in. and so on for the remainder of the water lines.

Since the mould line ends at the rabbet line, the height of the rabbet line 2 will give the lower end of the mould line, and as the keel is 3 in. thick, this lower ending will also be 1½ in. out from the center line. The remainder of the moulds and the stern outlines are laid out in the same manner. As the "lines" are laid out to the outside of the plank, and we desire our moulds to the inside. we must take off the thickness of the plank, ¾ in., parallel with the outline just drawn. It is to this outline that the mould is to be made. It will be noticed that Nos. 4 and 5 are alike except in the height at the upper end, thus enabling one pattern to serve for both.

A pattern or mould of thin stock is to be made, of the stem, keel and deadwood, to the form laid out on the floor. It should be of the shape enclosed by the keel bottom and the rabbet, one edge representing each. The same is true of the stem mould, the outside edge representing the face of thc stem, and the inside representing the rabbet. The stem mould should be joined to the keel mould in the proper position, and well braced so that it may be carried abont without danger of springing out of shape. A short piece also should be fastened at the after end to show the angle of the stern board. A mould must also be made to the shape of each cross-section. They are made of rough stock and are, of course, double for both sides: they must be strong and well braced as they are depended upon to hold the shape of the boat during building.

The next issue will deal with the getting out of the keel and stern and setting up the boat.

SMALL FLASH BOILER.

H. D WATERHOUSE.

Flash boilers are of very small size for the power which they are capable of generating. Their value is due to the very high working pressure, and the instantaneous generation of steam, and light weight. Boilers of this type are capable of such power only because the entire energy of the fire is used on the volume of steam required at the particular moment of intake of the engine. They do not keep a mass of water under steam for the sake of what the engine may require at any particular moment.

They are, however, unable to respond to sudden abnormal demands for power, because they have no considerable amount of super-heated water ready to burst into steam at once. That is to say, they do not contain any amount of stored power, as in the ease of the ordinary tubular boiler. For this reason the fire must be very closely regulated according to the amount of power needed.

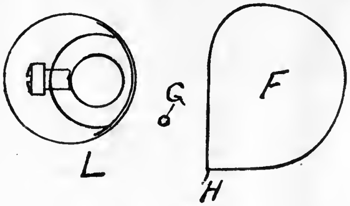
In the construction of the boiler here described the materials necessary are: — 20 ft. of seamless drawn copper pipe, ⅛ in. iron pipe size, and walls 1-16 in. thick; also six brass couplings, 1-8 in. iron pipe size. These are sizes in name only, the pipe being actually a little over ¼ in. internal diameter.

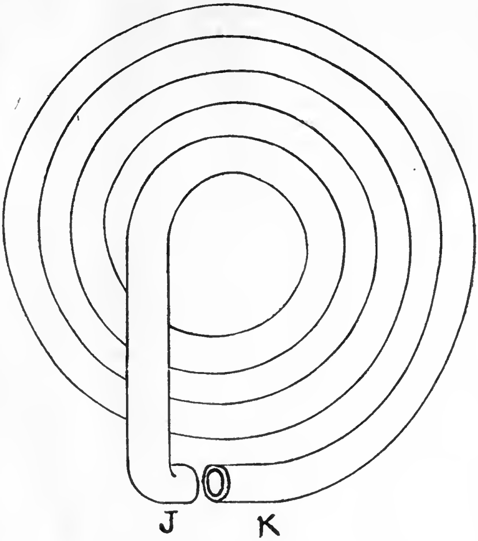
A force pump of small diameter is also needed; if one is not at hand it may easily be made. First make a piece of wood *F* of the shape and one third larger than the drawing. Nail this in the middle of a piece of board. Take one end of the copper pipe and lay it against the straight side and drive a nail in to hold it at *G*. About 2 ½ in. of pipe should be left for connections from the point *H*. Make a mould of wood for casting a strip of lead ½ in. wide, ½ in. high, and about 5 ft. long, with a little taper at one end. Next make one turn of the pipe around *F*, then place the tapered end of the lead strip between what would be the two inner sides of the first and second turns of pipe, and wind on the pipe and lead strip, keeping the lead strip placed with smallest diameter always between the turns of pipe. Make three concentric turns of the pipe and bring the ends together at the same side of the coil as in the elevation drawing.

Thread the ends and bend to the proper angle. The beginning of each coil *J*, and the ending *K*, should be threaded respectively with a right and left hand thread, fitting couplings. Make five coils in this way, pue join tight with couplings. The boiler is then complete except for threading, at the delivery end, a steam gauge. safety valve and throttle. The intake end of the boiler is connected to the delivery of the force pump. The coils are then mounted in a shell or casing made of heavy sheet iron in two layers with a thick layer of asbestos between. The burner, which should be for gas, gasolene or kerosene is to be mounted under the coils. The pump is made as in drawing, No. 2; i. e., just an ordinary force pump with ½ in. piston, drivən by an eccentric on the engine shaft.

It differs, however, by having a spring between it and its eccentric of slightly less force than that in the safety valve. In this way only enough water is let in to make steam enough to pop the valve and no more, as when the steam is at that point, the spring *C* in the pump compresses, the collar *B* slides over the piston, and no water is forced ahead. The eccentric *L* is illustrated in the drawing, and has a ½ in. throw. It is located on the main shaft of the engine. The boiler may be heated in any way so long as there is heat enough. A good burner may be made by making coil of iron pipe like the boiler coil. This is for vaporizing the kerosene which is to be used for fuel. Underneath this is a coil of iron pipe single turn, in which very small holes have been drilled on the upper side about an inch apart.

To operate the boiler, pour a little kerosene in the base of the burner and let it burn out, this will heat the vaporizing coil. Now slowly turn on the kerosene which is under a pressure of about 15 lbs. and as it spurts up light it. When the lower tubes of the boiler get red hot, which will be in a very short time, give a few strokes of the pump slowly and steam will be raised to 300 or 400 lbs. pressure instantly. Then turn the engine over a few times by hand and open the throttle. The engine will then start. When engine is stopped the burner should be turned low.





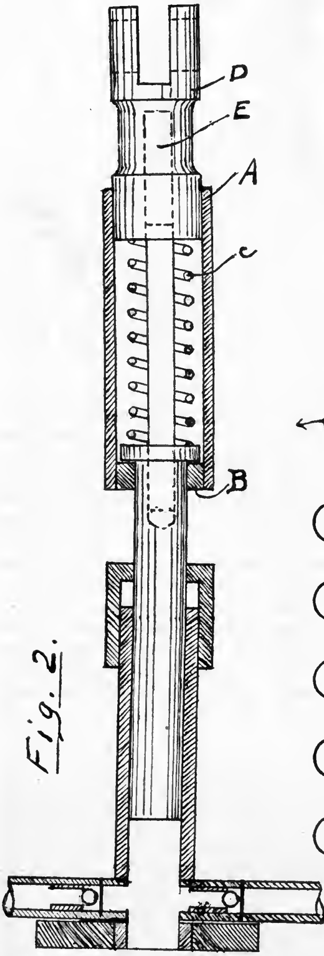


Fig. 2.

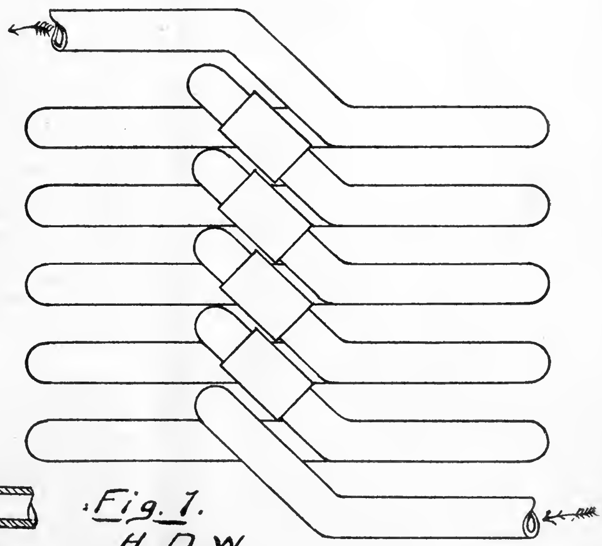


Fig. 1.
H. D. W.

SIMPLE ELECTRO-MAGNETS.

One of the first pieces of apparatus the amateur electrician desires to make is an electro-magnet. As some of the materials generally used are not obtainable except in the large cities, resort must be had to substitutes, of which those mentioned below can be obtained in every place in which a blacksmith shop is to be found.

For the cores the softest iron is necessary. Norway bar iron is the best kind to use, and in buying it be sure that it is iron and not a low carbon steel, as much of the so-called iron now sold is in reality steel and not iron. If Norway iron cannot be had, the next best is to apply to the blacksmith shop for some rivets of the required size. To ensure that these are as soft as possible they should be annealed by heating to a red heat in a stove or furnace, and then allowing them to cool slowly by packing in ashes.

A yoke is made from a piece of flat bar iron, holes being drilled of the right size to receive the rivets with a drive fit, and spaced the proper distance apart to allow of a slight space between the coils. Each coil must be insulated from the core. This is done by winding several turns of paper around a round piece of wood, which has been previously covered with soap, giving each turn of paper a coating of thin shellac. The soap prevents the shellac from attaching the paper to the wood. At each end of the paper tube thus formed attach with shellac a piece of thin, round or square wood with a hole in the center just fitting the tube. Suitable pieces can be cut from a piece of cigar box wood. These ends are also coated with shellac, and the coil bobbins are complete.

One bobbin, with the wooden rod still remaining therein, is then mounted on an empty box, on the edges of which notches have been cut to hold the rod in position. A piece of wire bent to form a crank handle is then added to one end of the rod and the wire then wound on in even layers. Unless currents of considerable potential are to be used, no insulation of other than the wire covering will be be needed, thus allowing the wire to be removed for other uses, should the maker ever desire. To start the winding, bore a small hole in one of the ends, close to the paper tube. Put through the hole from the inside of the wire and then, slowly turning the handle, wind on the wire in even layers, back and forth, until the coil is wound, carrying the outer end through another hole bored in the other end piece at the proper place. The other coil is made in the same way, with the exception that the wire is wound in the *opposite direction.*

The two coils can now be placed on the cores, first coating the latter with shellac, which will hold the coils firmly in place. The ends of the coils having the inside ends of the windings should be placed next to the yoke, and these ends connected. The outer ends of the windings can then be connected with the current supply, and the magnet is in working order. For magnets which are to be used for simple experiments, No 20 to 24 gauge wire is about right; larger wire uses up the battery too rapidly.

PHOTOGRAPHY NOTES.

Production of Duplicate Negatives.—To produce a negative of equal size from a negative, the Eder-Pizzighelli formula is for the amateur probably the simplest. For this purpose an ordinary thin film is bathed for two minutes in a solution of

Bi-chromate of potassium	10 gr.
Water	250 gr.

and the same is thus left suspended in the dark room to dry. The negative, which we obtain later on upon the film, is reversed. The application of films instead of plates has the advantage that, when printing the duplicate negative it can be inserted from the reversed side and a correct print can thus be obtained. After the chromated plate has become dry it is printed under the negative to be reproduced. Expose until the details of the picture can be seen and then wash for an hour. Now put the film into one of the usual developer solutions—hydrochinon, pyrogallic acid, or oxalate of iron, and thus a negative is obtained. The process is, that the exposed parts thrust off the developer solution, as the same acts only upon picture parts of very little or no exposure. Finally, the plate is put into a fixing soda solutien and washed as usual.

To avoid halos on interior exposures, when windows are in the line of the objective, the following method is recommended. To avoid the over exposure of the window, particularly when a fine landscape is visible through the open window, make first a short exposure for the window. Close now the shutters and darken the room as much as possible and make a flashligbt exposure of the interior without changing the position of the camera. The natural and artificial illumination should, of course, agree as much as possible. If the plate is now developed, it will be seen that landscape through the window and interior have obtained the correct exposure. In case there are no shutters the interior exposure may be done after nightfall. If plates are used for this work which are strongly colored yellow in the emulsion, a satisfactory picture will be the result.

A new and ingenious piece of mechanism has been devised by the secretary of the London Hospital for a purpose not unfamiliar at that institution. A clock-face, bearing a statement that the hospital costs one penny per second to maintain, and inviting the visitor to take the entire cost of the hospital on to his shoulders for one second, contains a small automatic machine by which the clock-hand is advanced one second when the penny is dropped in. The secretary hopes shortly to add a grammaphone, which shall say "Thank yon," in the King's voice for every gift.

SCIENCE AND INDUSTRY.

The bituminous coal measures at Coleman, N. W. T., are of the largest size. In Pennsylvania the largest in the famous Connelsville mine is 6 feet thick, while one of the seams at Coleman is fully 18 feet in thickness. The Coleman mine is clean, being free from slate and other foreign substances and especially adapted for cheap mining for several generations. Unlike the Pennsylvania coal, the coal at Coleman can be mined and extracted by gravity, compressed air being utilized in hauling the cars. As the mines will be self draining no pumping plant need be maintained.

Consul Frank Mahin transmits from Nottingham, England, the following information relative to a new cloth fireproofing material:

In a paper read at a meeting of a society of dyers in Manchester, titanic acid (the oxide of litanium) was claimed to possess remarkable fireprooffing properties, and evidence was produced in the shape of experiments by the reader of the paper. He took, for instance, some pieces of flannelette which had been treated with titanic acid, and put a lighted match to them. The incipient fire in the material smoldered and went out, refusing to burst into a flame. The experimenter claimed that all inflammable textiles could thus be rendered fireproof, and that dyeing, boiling or washing would not remove the acid, it becoming, in fact, an integral part of the fabric.

A radium clock which will keep time indefinitely has been invented by Harrison Martindale, of England. The clock comprises a small tube in which is placed a minute quantity of radium supported in an exhausted glass vessel by a quartz rod. To the lower end of the tube, which is colored violet by the action of the radium, an electroscope formed of two long leaves or strips of silver is attached. A charge of electricity in which there are no beta rays is transmitted through the activity of the radium into the leaves, and the latter thereby expand until they touch the sides of the vessel, connected to earth by wires, which instantly conduct the electric charge, and the leaves fall together. This simple operation is repeated incessantly every two minutes until the radium is exhausted, which in this instance it is computed, will occupy 30,000 years.

The *Lancet*, London, says editorially: "The unrestricted sale of articles made of celluloid, which is practically guncotton, for any purpose whereby such article is liable to come into contact with fire, should on no account be allowed. We believe there are other dangerous substances related to guncotton which go under other names and which are also used for similar purposes and should be likewise banned. It may be that the inflammability of celluloid is sometimes somewhat counteracted by the admixture with substances with an opposite tendency, but the difficulty is to distinguish the combustible from the incombustible. At all events, some warning should be inscribed on the articles made therewith, and they should be marked 'highly inflammable' or with some equally premonitory and protecting device. It is time, also, that the fire insurance companies should formulate and promulgate warnings and prohibitions in connection with their policies of insurance, in order to avoid vexatious questions as to compensation for losses sustained by the use and abuse of celluloid articles, after the manner of the by-laws of the railway companies in respect to the carriage of explosives. The dangerous use of celluloid is due in great measure to the fault of the public themselves."—*Literary Digest.*.

The Gautemaulan turkey is the latest discovered foe to the cotton boll weevil, and the Department of Agriculture will at once begin the importation of these birds for distribution through the plantations of the infected zone. Secretary Wilson states that the Gautemaulan turkey feeds chiefly upon the cotton boll weevil. "Our agents in Gautemaula have recently discovered in their study of the life history of the ants and the boll weevil that the turkey is an enemy to the weevil, and it proposes to give it a trial in the United States. The turkey of Gautemala is smaller than our own variety, and is very tame. It is also very good for food. In fighting the weevil the department will spare no expense." Secretary Wilson denied that experiments with the ants imported from Gautemala had been disappointing. He said the study of the little ant would be continued as assiduously as ever, and that those brought to this country had met expectations.

Dr. Leduc, of the Facul e Medecine in Paris, has found a way of utilizing a current of electricity to produce insensibility, in place of chloroform or ether. A series of experiments on animals, dogs, rabbits and pigeons, where a current of from 10 to 30 volts, alternating 100 to 200 times per second, was directed to the back and top of the head, was found to produce insensibility without harmful results. The success of the experiment so encouraged Dr. Leduc that he determined to try the effect on a human being, choosing himself as the subjeet. The current pressure was raised to 50 volts. The electrodes. wetted with salt water to obtain a good contact, were applied, one to the forehead and the other on the back, in order to act on the brain and spinal cord. The operation lasted about ten minutes, at the end of which time insensibility was complete. The doctor says he felt none of the inconveniences which follow the inhalation of chloroform. As soon as the current was cut off the awakening was immediate, coupled with a sensation of vigor. Other experiments are about to be tried, in the hope of arriving at a happy solution of the problem of inoffensive anstheticæcs.

Renew your subscription before you forget it.

JUNIOR DEPARTMENT

For the Instruction and Information of Younger Readers.

ELEMENTARY MECHANICS.

. A. COOLIDGE.

X. Compressed Air.

Fig. 35 represents a student lamp chimney which may be procured at a grocer's or hardware store, with a piston *P* just large enough to move easily in the tube. The piston may be cut out of cork or soft wood, and will work better if it is made to fit loosely and then wound with soft string to a fairly tight fit. A rod and handle *H* must be fastened to the piston *P*. This can be done by boring a hole not quite through *P* and fastening in with a long, slender screw.

EXPERIMENT XXXIV.

If the piston *P*, resting on the level of the water, is raised, as no air can pass through it, the space *O* below it will be either a vacuum or will be filled with water; we find the latter to be the ease, and also that the water will rise as long as the piston is lifted. Some force drives the water up after the piston.

EXPERIMENT XXXV.

Take the discarded bulb of some electric lamp and holding its tip under water, break it off with a pair of pliers. If a small hole is made the water enters in a little fountain shaped spray until the bulb is filled, The force driving the water upward in both of these cases is the weight of the air pressing upon the surface of the water and, as we have before learned in all fluids, changing its downward pressure into lateral and upward pressure; it drives all fluids before it and forces them to enter any spaces not already filled with other matter. Could our lamp chimney be made 34 ft. high, and be strong enough, the water would rise to that height and then refuse to go further. A tube of the same kind in a jar filled with mercury or quicksilver need be but a little over 30 in. long for a similar experiment and illustrates the action of a barometer We should make one for ourselves from a description published in the September, 1903 number of this magazine, to which readers are referred or, at any rate, study its construction from one already made.

It will be noted that the tube contains a column of mercury about 30 inches high. The space above the mercury is a vacuum, *i. e.*, it contains nothing except a very little mercury that has changed to a vapor. As the word barometer signifies an instrument for measuring air pressure it must be shown in a rise or fall of the mercury. If the air becomes heavier the mercury ises; if lighter, the mercury falls. But what causes any change in the airs' weight or pressure? Any change in the amount of vapor in the air causes a change in the air pressure. A falling barometer indicates a storm, although many local distubances may occur without such a change in the weather. A rising barometer foretells pleasant weather.

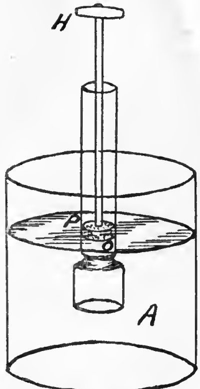


FIG. 35.

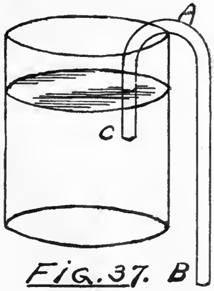


FIG. 37.

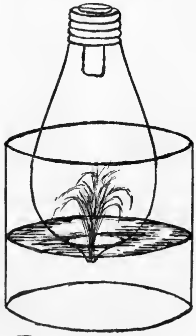


FIG. 36.

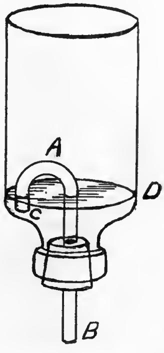


FIG. 38.

Another use of our barometer is to tell the height above the sea level of different places. As it is the weight of the air pressure upon the mercury in the cistern that balances the weight of the mercury in the tube, any change in the weight of air will make the mercury column higher or lower. Therefore, the higher one ascends, as in climbing a mountain or in a balloon, the less air there is above, consequently the less will be the pressure or weight of the air on objects. The mercury in a cistern of a barometer will have less pressure on it the higher we ascend, and consequently the column of mercury in the tube will be shorter.

Suppose we should start at the foot of a high hill and with a convenient barometer ascend the hill. If the barometer column were 30 inches when we started, and as we climbed the hill fell to 29 inches, we should know that we had climbed a vertical distance of over 940 feet, and the barometer would register one inch less for every such distance we climbed.

On Mt. Blanc, about 3 miles high, the barometer is only 15 inches, and we see by this that the above rule for one inch fall holds good only for a short distance. We see also that if the barometer is only half its usual height on Mt. Blanc, that one-half the earth's atmosphere is within three miles of the earth's surface and that it is very thin above that distance. The distance in level of the top and bottom of a high building will show itself in a barometer.

A more convenient form, called an Aneroid barometer, in the shape of a small clock, is made. This is the form usually carried by mountain travellers. Some are even as small as a large watch. They have a single hand or index and contain within a small tin metal box from which the air has been exhausted. The air presses upon this box and shows an increase or decrease by moving the pointer of the barometer. The barometer's height in inches is marked on the dial, as the hours are marked on the face of a clock. Such a barometer can be carried in the pocket and is an instrument of much convenience and value to a mountain climber.

In some of our former experiments we used a piece of rubber tubing about two feet long. If we do not have one a three or four feet length of common garden hose will admit of the following experiment being tried on a larger, coarser scale. A glass tube, 12 inches long, as shown in Fig. 37, bent so as to have one arm longer than the other, will allow us to see better what takes place in the operation of a syphon.

Experiment XXXVI.

Fill the tube with water and with the thumb covering the opening *C*, put it down into a jar of water. There is more water in the arm *A-B* than in the other arm, *A-C*, consequently the greater downward force is in the arm *A-B*. The water in *A-C*, instead of flowing out at *C*, is forced by the air pressure to rise toward *A*, and this continues as long as there is water in the jar above the opening, *C*. With a rubber tube a tub or barrel may be emptied. Syphons are of great use in emptying barrels where there is a sediment in the bottom, such as vinegar. The liquid is drawn off through the tube without stirring up the dirt at the bottom.

A very interesting form of syphon is what is called an intermittent spring. In one of our former experiments we had a large-mouthed bottle with the bottom removed; with a small glass tube, bent as in the figure and run through a tightly fitting cork, our apparatus is complete. Water may be poured into the bottle without running out until it rises above the level *A*. Then it begins to run out at *B* and and continues to run until the leveal again reaches the opening of the tube *C*. It will then cease running until the level *A* is again reached.

An intermittent spring may be flowing in dry weather and dry in rainy weather, because, as the water in some natural reservoir has not had time to fill the cistern, and as it may not rise above the bend in the natural bent passage or syphon tube until long after the rain has ceased, the water will not begin to flow until the level corresponding to *A* in our figure has been reached. This may take so long after the rain that a spell of dry weather comes, and the reservoir may be so large that the water will continue flowing through a period of very dry weather, and ceasing to flow only about the time that another rain storm appears.

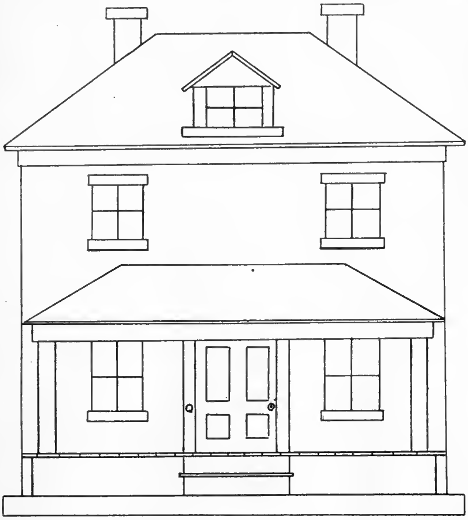
A DOLL HOUSE.

The younger readers of Amateur Work who may be able to use woodworking tools fairly well, and it is assumed that all are in possession of the tools more commonly used, will find the making of the doll-house here described excellent practice in fitting and giving much pleasure to the maker as well as to his younger sister, who will welcome it as a Christmas present *par excellence*.

The general dimensions are 22 in. across the front, 18 in. deep, 18 in. from the base to the eaves, the roof being 6 in. higher. A visit to the family grocer will usually be productive of several boxes made of clear pine about ¼ in. thick ; those in which spices and seeds are packed serving nicely. The cost will not be great, however, if lumber is purchased of a lumber dealer, in which case get whitewood or pine ¼ in. thick, about 15 feet 9 in. wide being needed. Also, for the floors, 6 feet of ½ in. stock 9 in. wide will be needed.

The general design is shown in the drawing and is made as one would make a plain box, after marking and cutting out the spaces for the doors and windows. The back of the house is made detachable, so that when playing it may be laid aside, opening the whole interior at the rear. In marking out the doors and windows, have them of rather large size, that observers or others of sister's playmates may participate in the play. A fret saw will be found handy for this work, but lacking one bore holes in each corner end use a key-hole saw, smoothing up the rough edges with a sharp knife or file. The joints of the hip-roof must be bevelled, and some fitting will be necessary to get good joints. The piazza is added after the rest of the work is done. It is all then mounted on a flat board 24 x 20 x ⅞ in. Hinges for the front door can be made of cloth, or taken from a cigar box, certain kinds of the larger sizes having small brass hinges on them-

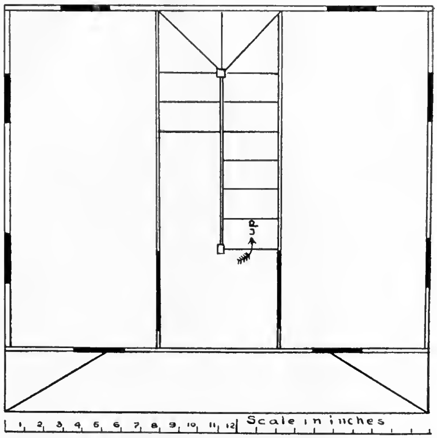
The windows are plain pieces of glass, fitted in rab. bets cut along the edges of the openings with a chisel if a nice job is desired, or held by tacks, if time does not permit of the other way. The sash markings are done with a tube of dark green paint and a small brush, thinning with oil or turpentine. The balance of the tube is then made quite thin with oil and used for the roof of the house and piazza. The latter work is not done until the body of the house has been paiuted, the color being as desired by the maker ; a 10 cent can being quite large enough for the whole house.



The interior partitions are made of pieces ol large cigar boxes or similar thin stock, the stairs requiring the thinnest obtainable. The size and step of the stairs are ⅝ in. each. Round tooth picks or matches are used for the stair posts The sills to the windows are also made from thin stock, as well as the floor and roof of the piazza. The front door is panelled by cutting down with a narrow chisel or carving tool, a glass bead put on with an escutcheon pin serving for a door knob. A similar arrangement at the side can be made to press against a thin strip of brass, closing a circuit and ringing an electric bell, the cell from a night lamp battery and a small "buzzer" completing the outfit. The chimneys are made of strips of cigar boxes wrapped with red paper, and the bricks marked out with white paint or white India ink, if one has a drawing pen, fastening in position only when completed.

Should the reader desire a more pretentious house, one twice or three times the size given can be made, and other features can be added, such as electric lighting from miniature lamps with current supplied from the home main or by battery,

According to Sven Hodin, the explorer, the Chinese invented the process of making paper. On one of his journeys to the interior of China he found evidence that paper of a very fair quality was in use by the Chinese in about 275 A. D. There is a mill standing in the province of Chilitung where paper was made in 289 A. D., and in the village of Langtikiang, in a suburb of Canton, the ancient town of Kwangtiu, Mr. Heddin discovered a hand mill where paper was made from tree leaves several hundred years before Christ. But this process was very expensive, and the product was used only by the very wealthy. He secured one ancient



document written on paper made in this hand mill. The date of the document is 346 B. C., figuring on the time of the Chinese calendar.

Some surprislng results are said to have attended a series of investigations made by a medical man in the mining districts of Upper Silesia. The curiosity of the doctor was aroused by the fact that among the many illnesses prevalent in his district lung diseases occupied proportionately a very low place, and that consumptive persons on coming to reside near the coal mines recovered their health after some time without any special cure. These facts he is prepared to verify by statistics. The cures are attributed by him to the coal dust contained in the atmosphere, which he alleges has a drying and disinfecting influence on tubercle development in the lungs. It is now proposed to erect a sanitarium for consumptives in the district referred to, in order practically to test the efficiency of the new cure.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

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BATTERY LIGHTING OUTFIT.

FREDERICK A. DRAPER.

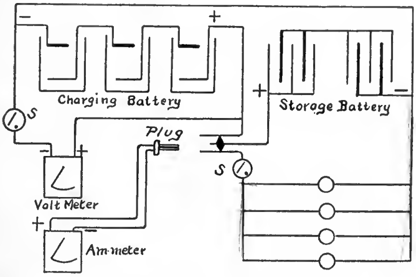
A very common desire of amateurs interested in electricity is that of a small lighting outfit, with accumulators or storage battery as the source of current. Many have hesitated to attempt setting up such an outfit, being deterred from so doing by the supposed difficulties of charging the battery, as they do not have recourse to a charging dynamo or lighting circuit. Where the above condition exists a charging battery composed of "gravity" or other cells, can be used, the chief objection being the long time required for charging. As the demand on the storage battery is generally but a few hours at a time, the charging battery has the remainder of the time for keeping the storage battery fully charged, so the matter of time is not as important here as it otherwise might be.

The outfit to be described contemplates the use of 10-volt, 6 C. P. lamps fitted with full size base, thus allowing standard plugs, sockets and fixtures to be used, which may be purchased at less cost than those known as "miniature." This voltage will require five cells of storage battery, and as a serviceable and easily made type was described in the June, 1904, number of this magazine, readers are referred to that article for directions for that part of the work. The making of a "gravity" battery was also described in the November, 1901, number, and as quite a number of cells are required, they can be made at a considerable saving if materials can be readily and cheaply procured; otherwise it would be best to purchase them complete.

The storage battery mentioned is of 15 ampere hours capacity; that is, it will furnish a continuous current of one ampere for 15 hours, two amperes for half that time, etc. As the lamps mentioned above require from .7 to .9 ampere each, we can easily calculate the number of lamps and the length of time for which the battery will supply current. Neglecting the resistence of the circuit, which would be small, it would be well to allow one ampere per lamp per hour, and as too fast a discharge rate is injurious for the battery, four lamps is about the largest number that can be used at a time, as nearly four hours could be obtained from each charging. As the charging battery is constantly at work the service mentioned can easily be obtained. By using lamps of less voltage and candle power, fewer cells in both storage and charging battery would be required. For lamps of 6 volts and 3 C. P., only three cells for the storage battery would be necessary.

In calculating the number of "gravity" or charging cells required, it is necessary to first determine the discharge rate of the storage battery. If the latter is to be used to about its full capacity each evening, the charging battery must have a greater number of cells than would be the case if only half the capacity was used each evening or the full capacity every other evening, and it may be well to state that if fitted up for the service last mentioned it is perfectly feasible to have service in either of the two ways. If the storage battery is used one evening to its full capacity, double the time is required for charging with the smaller battery as with the larger. With this explanation we can now determine the number of cells needed for the charging battery.

The discharge rate of a single "gravity" cell is about .5 amperes, at a trifle under one volt. The charging current should be about 2.5 volts per cell, making the voltage of the charging current 12.5 volts; which is what is obtained from 14 "gravity" cells when connected in series. At the rate of .5 ampere, 30 hours would be required to charge the storage battery; double the number of "gravity" cells connected in series-parallel; that is, two sets of 12 each in series connected in parallel, would do it in 15 hours. The reason is plain, therefore, why such a large number of charging cells are required.



WIRING DIAGRAM.

The battery described in the July, 1903, number of this magazine should work well as a charging battery, although the writer has had no personal experience with its use in this way, and has been able to obtain a discharge rate of a trifle less than 1.5 amperes, but even at this rate only 10 cells would be required to charge the storage battery to its full capacity for daily use. Those making up all the outfit are recommended to give this type of cell a trial, as the cost is very little

Having completed our batteries, the next thing to require attention is the assembling and wiring, together with the necessary switches, etc. A volt and am-meter of suitable capacity would add much of interest in the operation of the outfit, and as well-made instruments of the required capacity can be obtained at little expense, they should certainly be included. The batteries should be placed in a suitable cupboard, the interior having first been painted with asphaltum paint, making it acid-proof. Two large shoe packing cases fitted with shelves will answer the purpose excellently. The wiring and several connections are clearly shown in the accompanying diagram. It will be noted that the lamps are connected in parallel. Ordinary annunciator wire, No. 16 gauge, will answer for wiring if not over four lamps are connected, the wires being separated an inch or more and wrapped with electricians' tape, where tacked to supports or, better, carried on small insulating knobs. Sold erall joints, as twisted joints are apt to corode and cause unnecessary resistance.

Having assembled the batteries and completed the wiring, the electrolyte poured in, charging should be started at once and continued without interruption until the plates are formed. About two days will be required for the first charging, a less time with each subsequent charging, until the normal working condition is reached. At first the positive plates will quickly become a dark brown color, changing to a lighter color, and then gradually darkening to a deep brown. The negative plates will, at the same time, turn to a dark grey and are then fully charged. They should be immediately discharged by means of the lamps, not by short circuiting, and then charged again. If time will permit before the second charging, it is of considerable benefit to the life of the plates if they are taken out, thoughly washed in water and allowed to dry for a couple of days before again being placed in the electrolyte.

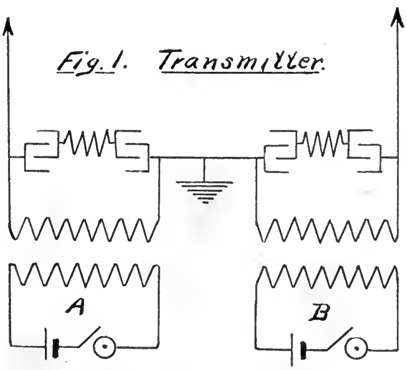
William Henry Bishop, U. S. Consul at Genoa, Italy, reports: There was established here some five years ago by private parties an enterprise called the Controllo Permanente Italiano, the Italian Society of Permanent Chemical Inspection, for the analysis of food products and official certification of their purity. The commercial firms subscribing to it stamp their food products with its guarantee, and a purchaser has at any time the right to request free an analysis of any sample he may send in. The enterprise has obtained the adherence of a very considerable number of the best houses and controls food preparations to the number of 500 different kinds. It is expected that the confidence thus aroused will give the subscribers a great advantage over others in the market; and should the system become general it would greatly smooth the way of the inspection of Italian food products in the United States.

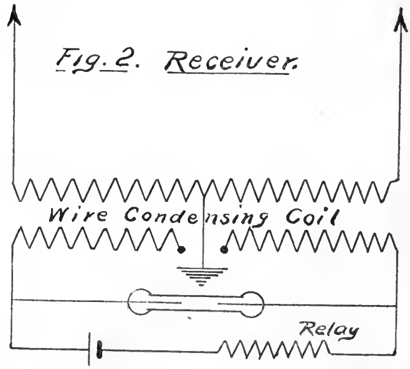
NOTE.- Owing to an accident to toe drawings, the chapter describing the engiue for the touring cor, by Mr. R. G. Griswold, is omitted but will appear in Feb. issue.

WIRELESS TELEGRAPHY EXPERIMENTS.

H. E. DILL.

The writer, not long ago, when experimenting with devices to gather in the waves at the receiving end of a wireless station, utilized the receiver and transmitter illustrated in the following diagrams. A description is here given, not so much to exploit results accomplished, as to give to the hundreds of Amateur Work readers now studying along the same lines the value of a co-worker's efforts. The receiver, while not perfectly satisfactory at all times, has proved more sensitive than any coherer it has been the writer's pleasure to make, but needs further development before it will be susceptible to systematic tuning.





In the study of condensers we find that the value of the unit of capacity is derived from the relations between the charging current and the E. M. F. produced by it at the terminals of the condenser. And we find the time element a factor in computing condenser capacity, inasmuch as the current strength has to be multiplied by the duration of the charge in seconds.

It is to be presumed that a receiving condenser to operate successfully as a collector of disperser waves must be constructed to operate in harmony with the radiating waves at the dispersing end. Therefore, we must first note the character of the originating high potential discharge, which is of high frequency from the one coil and low from the second. The primary voltage is 20 and amperage 10 in each case. The interruptions in coil *A* are always exactly proportioned to the interruptions in coil *B*. This is brought about by mechanical means.

The capacity across the secondary gap in each coil is .0005 M. F. With this duplex sending device a distinctive wave is emitted which, varying in prearranged frequency and differing in penetrative character from any wave that may be dispersed from one coil, makes it a powerful wave to send and a difficult wave to intercept.

At the receiving end two wires also are erected as in Fig. 2. The receiving condensers consist of twin No. 40 covered magnet wire coiled on a glass tube and the entire device immersed in kerosene oil. The receiver itself is connected in series with the condensers and consists of platinum wire points in a vacuum tube about the size of common thermometer tubing. Bridged in parallel with the receiver, is a battery of 50 volts and 8 amperes and on the reception of the wave at the condensers, a discharge (invisible) takes place at the platinum points, and a restricted portion of the heavy battery current finds its way across the gap, thus completing a circuit through the 5,000 ohm relay which, in turn, controlls a recording device, as in other systems.

The writer finds that a wave from the Slaby-Arco-Braun equipment, such as is in use at U. S. naval stations, will enter on either or both receiving wires and pass to earth without operating the receiving circuit, for reasons plainly evident in the diagram. But the two distinct waves that blend in their course from the duplex coils to the receiving station, seek a natural course down the wires arranged for each wave when they reach the receiving arials. And not until the same conditions of syntonism prevails at the receiver as at the transmitter is the relay supposed to respond.

THE LEYDEN JAR.

JOHN E. ATKINS.

When two sheets or plates of metal are arranged parallel to each other and but a small distance apart, and then connected with a source of direct electrical current, the plate connected to the positive supply lead will receive a positive charge of static electricity, and the other plate a charge of opposite or negative polarity. If now the source of supply be stopped the plates will discharge back again to their original condition. The property of retaining such charges is termed "capacity" and is in evidence wherever two current bearing circuits are in proximity. The unit of capacity is the Farad. Capacity depends upon the area of the plates, the kind of insulation separating them, and also the nearness of the plates to each other. As the plates touch the insulating material, the nearness of the plates equals the thickness of the insulating material.

It is possible by mathematics and reference to a table giving the specific inductive capacity of the dielectric or insulating material, to calculate the capacity of any condenser. For example: Capacity in farads equals .000000000000225 times the area of the facing surface of one of the plates multiplied by the specific inductive capacity of the dielectric, divided by the distance between the plates. From this equation we may compute that a condenser of one farad capacity would be an enormous affair, being possibly 500,000,000 square feet, when constructed in an ordinary way. The unit, one farad, is too large to deal with in practical work, therefore one-millionth of a farad (micro-farad) is the practical unit. This gives us fewer figures to handle in computing the capacity of Leyden jars or glass plate condensers.

The specific inductive capacity of glass varies from three, for ordinary glass, to 10 for extremely dense flint stock, and for ordinary calculations it is well to figure on a basis of six, which is a fair average. Consequently, assuming that we have two thin metal plates, size 5 x 8 in. and separated by a sheet of good glass $\frac{1}{8}$ in. thick, and having what we will assume to be a specific inductive capacity of six (although we may be cut a point or two in our assumption), we have this equation:

Capacity in micro farads equals .000000225 (5 x 8 or 40) times 6, divided by $\frac{1}{8}$.

In the construction of a Leyden jar, which is more compact than a glass plate condenser, the same rule follows. The thicker the glass, the less the capacity. The less dielectric or insulative value to the glass jar, the less the capacity. The larger the surface of the metal or tinfoil, the greater the capacity. Note the word "surface." Thickness of the metal has no value. In fact, some theorists claim the static charge refuses to stay on the metal at all, but clings altogether to the dieletric substance.

Now let us construct a Leyden jar of a battery jar that measures just 4 x 5 in. inside and $\frac{1}{8}$ in. thick. The glass is hard, and when rubbed briskly with a silk cloth gives a spark noticeable in a dark room. We may presume the specific inductive capacity to be 6, although it may be 5 or even 4, or possibly more than 6. We propose to coat the jar and sides up to 4 in. of the top with foil, both inside and out. This figures out, bottom area or facing surface, 4 x 4 x .7854 equals approximately 13 sq. in. Side surface, 3.1416 x 4, or 13, multiplied by 4 high, equals 52 sq. in. The sum of 13 and 52 equals 65 sq. in. total surface of one plate.

By simple mathematics we ascertain that the capacity of the Leyden jar will be approximately .0007 M. F. The amateur will now note that it would require an exceedingly large glass jar to build anywhere near a 1 M. F. jar, consequently if such a capacity is desired we must give up the glass jar pattern and build a condenser of the thinnest tin foil and the thinnest dieletric that will stand the electric pressure. Mica is thinner than any glass we can procure and will not break, and the specific inductive capacity equals the best of glass. So we are enabled to increase our capacity in two ways; by employing a dialetric one-eighth the thickness of a glass plate, and by employing a dialetric that possesses one-half more specific inductive capacity than most glass. Thus there is an enormous gain in capacity by using mica plates and a greater expense because of the cost of mica over glass. Mica in sheets larger than 3 or 4 inches square is extremely expensive, and manufacturers by patented processes have constructed sheets of thinnest mica pieces stuck together with shellac, etc., which in many cases answer as well for dialetrics as ordinary grades of pure mica.

For condensers to give 1 M. F. capacity, it is usually the case to intermesh many small sheets of tinfoil and mica, and connecting the conducting material alternately, thereby obtaining considerable capacity within a small space. To calculate the capacity of such a condenser, multiply the surface of one metal plate in square inches by the inductive capacity of the mica, which varies, as we stated before, and multiply by the number of dialetric sheets used. Divide this by thickness of the mica in inches, say 1-64th of an in. and multiply by .000000225.

VOLT-METER MEASUREMENTS.

OSCAR F. DAME.

First of all, among electrical testing instruments, is the volt-meter, which, as the name implies, serves to measure the voltage or electromotive force of any source of electricity.

In the absence of a complete testing outfit comprising wheatstone bridge, balances and galvanometer no one instrument combines so many advantages, and for the measurement of battery strength and testing the resistance of all sorts of electrical appliances and circuits, the amateur who has become familiar with this instrument, will use it in ordinary work in preference to all others on account of its convenience and time-saving advantages. While not possessing the extreme accuracy of the expensive bridge, the accuracy of the volt-meter is close enough for all practical purposes.

The calculation of resistance with a volt-meter depends solely upon the falling off of the battery voltage when a resistance is connected in series with the test battery and instrument. A simple formula serves to reduce the difference in voltage to ohms, and as the falling off of the battery voltage is in exact proportion to the resitance of the circuit or device being measured and the resistance of the volt-meter, the following method is the simplest:

Calling the full battery voltage E, the voltage through the external resistance, e, the unknown resistance X and the resistance of the volt-meter, r, our formula becomes

$$X = \frac{E \times r}{e} - r$$

or, multiply the voltage of the battery by the resistance of the volt-meter, and divide this result by the second voltage obtained through the resistance under measurement and then subtract from this the resistance of the volt-meter. The result will be the resistance desired, in ohms.

Example. Resistance of the volt-meter, 1,600 ohms (different types of meters vary in this resistance); test battery measures 10 volts. With a coil of unknown resistance looped into the circuit in series the meter indicates a reading of 4. What is the resistance of the coil of wire?

Solution. $E = 10$, $r = 1{,}600$, and $e = 4$; therefore $(10 \times 1{,}600)$ divided by $4 = 4{,}000$. Subtract 1,600 from this and 2,400 equals the resistance of the coil in ohms.

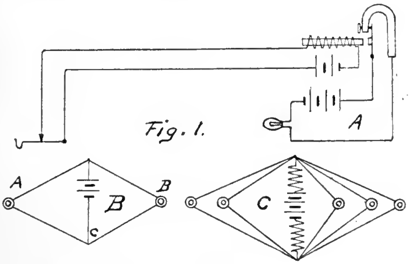
By studying this formula closely the amateur will note that when the battery used for testing is constant in voltage, that is, remains right at so many volts without any noticeable variance, the quantity $E \times r$ becomes constant also, and the only variable quantity is the unknown resistance, so that by working out a number of examples a table can be compiled by which one may tell, as soon as the volt-meter needle comes to rest, just what the resistance is without further mathematics. We find, therefore, that (E = 10) × (r = 16,000) = 16,000. This never changes if the batteries are kept at standard.

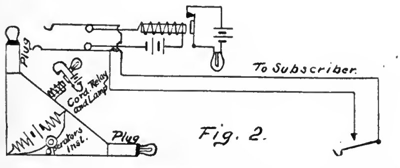
TELEPHONE CIRCUITS AND WIRING.

ARTHUR H. BELL.

VIII. Central Energy Systems.

One of the great difficulties with magneto circuits when telephone instruments are in constant use, is the exhaustion of the battery supply at each instrument. To improve these conditions telephone electricians sought means of centralizing the batteries at one point, and systems so designed bear the name of "common battery" or "central energy" systems.





Inumerable circuits have been designed within the past dozen years to simplify the central office equipment, and the method of the "light" system, by which the operator is signalled visually by means of a small incandescent lamp, when the subscriber removes the telephone receiver from the hook, may properly be considered at this time.

The ordinary electric doorbell circuit, comprising a bell, a battery, a push button and some wire, is familiar to all. Let us presume that the doorbell is at the central office with the battery connected to it, and the push button is at the subscribers' station. The bell wire and the telephone button are analogous. By touching the push button the signal is given at central. But supposing the station is a long distance from central. Then the battery current traversing the wires will not be sufficiently strong to ring the bell.

Here enters the relay. Telephone relays act similar to telegraph relays, although their design is different. We all remember how a very feeble current reaches the relay and, after coursing the many turns on the electro-magnet, so energizes the magnet that the armature is attracted to it and thus a local circuit is caused to operate. Let us substitute a relay for the doorbell, and also bear in mind that the subscriber's receiver off the hook acts the same as a depressed push button. With the receiver off the hook the relay at central operates, and at once the local circuit, comprising battery, wiring and a miniature electric lamp, is operated. This attracts the operator's attention, because the lamps are in rows on the front of the switchboard near the "jacks" into which she "plugs in" when answering calls.

The subscriber's instrument is thus simplified by the removal of the ever-falling drops, which had to be restored by hand in many instances. Now, when the subscriber hangs up his receiver the relay armature is released, and the local lamp circuit is opened. This is clearly shown by diagram *A*, Fig. 1.

Referring to diagram *B*, Fig. 1, which can be best understood by actual experiment, we find that in a circuit so arranged *A* cannot talk with *B*, but if we insert another telephone at *C* in series with the battery, *C* will hear *A* or *B* nicely, and A will be able to converse in a fairly satisfactory manner with B. The reason for this is, that the construction of the receiver, with its iron core and turns of wire, permits its use as an impedence coil, by which the pulsation of the *transmitted* current are impeded or choked off the battery, as they endeavor to return *via* the battery supply, while the strength of direct current is reduced only by the resistance of the circuit through which it passes. Telephone electricians, therefore, use the impedence coil in its many forms to utilize one set of batteries, as outlined in diagram C, Fig. 1. To thoroughly understand these circuits the reader should experiment with them.

Fig. 2 represents a more complete line circuit. It will be noticed that the jack has two inside contacts which are opened off from the springs when the plug is inserted. This operation removes the line relay and lamp circuit from the line, for the battery for talking is derived from the battery always to be found on common battery switch board cords. When the subscribers are talking the miniature relays in the cord circuit are operated, and thus the lamps' glow assist the operator in watching her subscribers as they finish conversing and hang up their receivers. This circuit will bear considerable study.

At the subscriber's station the magneto bell is often bridged across the line with a condenser in series, to keep the direct current from the exchange line relay circuit from completing a circuit and keeping the lamp lighted, and sometimes the bell is bridged between one side of the line to the ground, in which case the central operator rings with one side of her plug grounded when signalling the subscriber. In the next chapter will be given a number of diagrams, with brief explanation of each, by which any amateur possessing a few telephone parts may make apparatus suitable for practical and experimental use.

PATTERN MAKING FOR AMATEURS.

F. W. PUTNAM.

XI. A Small Hand Wheel Requiring Three-part Flask.

The next pattern to be taken up is that of a bevelled wheel suitable for a turn-table and is shown in Fig. 71. If we examine the top view of this figure we shall notice that the pattern will require a three-part flask. One great principle in pattern making, which should always be remembered, is to use as few loose or separate pieces on the pattern as possible and so make the parts with the greatest amount of metal inserted in the lower half of the flask. Let us examine Fig. 71 to see how this rule may be applied to the pattern under consideration.

Make the rim of the pattern at the smaller end, A, as a separate or loose piece. We shall find that, if the pattern is to be carefully made, it will be advisable to start at that part of the pattern known as the web shown at A, in Fig. 72. First, build up that portion of the wheel which will be molded in the nowell. This will be the largest side of the wheel. Saw out of boards circles sufficiently large for the work, gluing the pieces, one on top of the other, until the required thickness is obtained; remembering that where a pattern is built up the successive layers of stock are to be placed with the grain running in the opposite direction, so to prevent warping. If a larger pattern for a bevelled wheel were required, the better way would be to glue up the rim in sections or segments, as they are called. In such a case the hub would be the only solid part of the pattern and the hole for the shaft would, of course, be cored out. Having built up the stock for the pattern, the glue having become thoroughly hard, fasten the block into a chuck and turn to the required size. It will be found advisable to make two templets, as shown in Fig. 73 to 75.

The templets shown in Figs. 73 and 74 should be used first in truing up the faces and turning down the rim to the proper dimensions. The part marked A in Fig. 74 should be very thin, not over $\frac{1}{8}$ in. in thickness, and may be nailed or glued to the other piece. This part, A, is exactly the same shape as the pieces B in Fig. 72. These pieces are to be cut out on the other side of the block, and the edge of the rim at *C*, Fig. 72, is to be turned. The pattern is now to be removed from the chuck and the other side built up, the block being first chucked so that the web may be evened off to the required thickness. Next build up the pattern so that the total thickness will be slightly greater than the finished pattern. It will be found advisable to build up the pattern while it is fastened in the chuck. When the pattern and should be carefully made. The loose rim must turn freely, having a very small amount of glue, as it is glued so as not to stick to the main part of the pattern.

The core prints are, of course, turned separately and fastened to both sides of the pattern. The core box is not shown, as it involves no new work and no trouble should be experienced in making it.

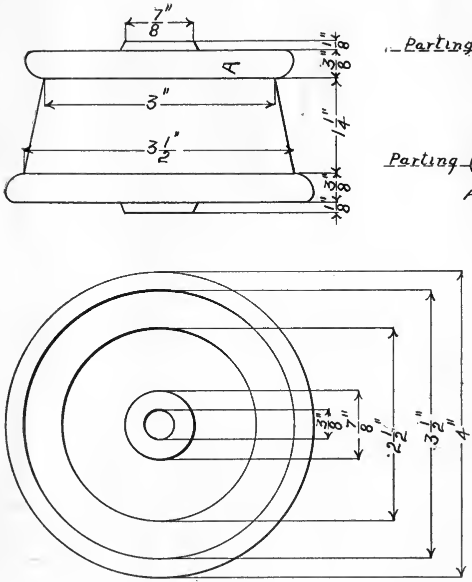


Fig. 71.

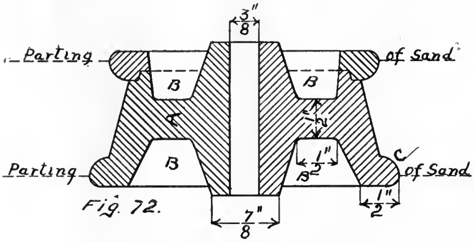


Fig. 72.

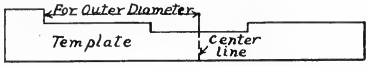


Fig. 73.

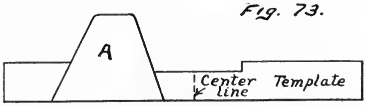


Fig. 74

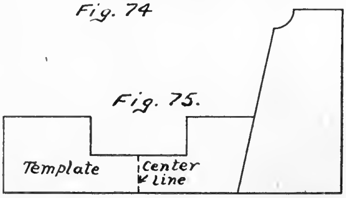


Fig. 75.

has been built up and the glue has become thoroughly dry, face up and true off both the inner and outer edges. Be very careful in turning the shoulder on which the loose rim is to set, so that perfect joint may be made when the loose piece is finished. The loose piece may be made in one piece, though it is far preferable to make it from at least two pieces, so as to prevent warping to as great an extent as possible.

The stock for the loose rim should be chucked and turned down so that the rabbet, which is necessary in order that the loose rim may be set on the rest of the pattern, will fit evenly to give the exact thickness for the total pattern.

The templet shown in Fig. 75 is used to test the exact shape of the outside of the bevelled wheel,

The use of blast furnace gas for engines has made considerable growth in the last ten years. It is estimated that a furnace making seven tons of iron per hour, or 168 tons per day, generates enough gas to furnish 5880 horse-power continuously, not counting the gas used for heating the blast and operating the blowing engines. Engines suitable for this work can now be obtained direct connected to electric generators of 6000 horse-power capacity, and it pould seem that tnis form of engine might come to be used extensively for power purposes.

The stationary gas engine, as power for small plants, is frequently replacing the steam engine.

A SMALL DESK.

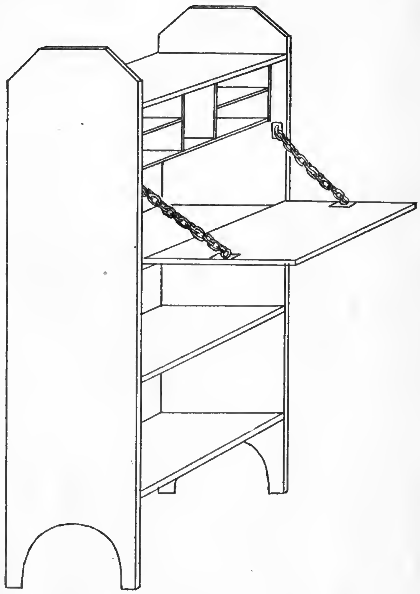
JOHN F. ADAMS.

The design for the small desk here described is such that the construction is easy, and may be attempted with confidence by anyone having but ordinary skill in wood working. If care be taken in cutting the pieces to the right lengths and with square angles, a very satisfactory job will result. For these reasons it is thought that many readers, who are students in manual training, will find the design one which can be utilized by them in the construction of a useful piece of furniture. Oak is the most suitable wood, although gum wood is excellent.

The side pieces are 50 in. long, 12 in. wide and 7/8 in. thick, the curved openings at the bottom being 6 in. high and 8 in. wide. Have these sawed out at the mill, sending a drawing with the order. The bevel at the top is 3 in. each way or 45°. The four cross-pieces are 24½ in. long, 7/8 in. thick; two 12 in. wide and two 11½ in. wide. The wider pieces are for the top and bottom pieces and have ¾ in. rabbets cut on the back inner edges for the backing, which is of ½ in. matched stock. Grooves ¼ in. deep are cut in the side pieces to receive the ends of these cross-pieces the upper piece being 5 in. from the top, the second 14⅛ in. below the top one; the third and bottom one are spaced 10 in. apart, leaving a 8½ in. space under the lower shelf.

The drop-shelf is 24 in. long, 14⅛ in. wide, and will have to be glued up from two pieces. At each end cleats 2 in. wide and ⅝ in. thick should be fitted to corresponding rabbets cut on the upper side. These cleats should be carefully fitted, glued up and kept in clamps until the glue is thoroughly dry.

The pockets inside for paper, etc., may be made of maple, finished natural to give a contrast, or of oak and stained, as preferred. The stock is ⅜ in. thick and 10 in. wide. Two pieces 23¼ in. long, two pieces 9 in. long, two pieces 6¾ in. and two pieces 6 in. long, are needed. The two end pieces should be nailed to the ends of the cross pieces, the other two vertical pieces are then nailed in place after nailing to them the ends of the two short shelves, the other ends of the latter then being nailed through the end pieces. This frame is then attached to the desk with screws put through from the inside. It may also be supported by a ½ in. square strip screwed to the backing when the latter is in place. The backing should be in strips 36½ in. long and enough is needed for a width of 24 in. and is nailed on with small finish nails.



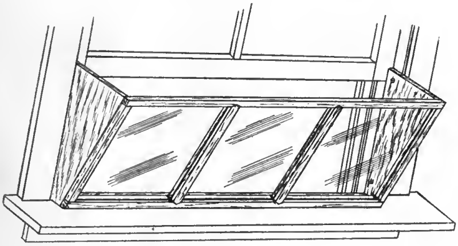
The drop leaf is attached with ornamental T hinges of brass or black iron, as may be most conveniently obtained, and also with suitable side chains, as shown in the illustration. A lock is fitted to the outer edge. Stop blocks are glued to the inside upper corners of the case to hold the drop leaf flush when same is lifted.

Hhlland has abolished ail restrictions regarding the speed of automobilns in the country, thus placing the entire responsibility upon the driver.

A WINDOW VENTILATOR.

JOHN F. ADAMS.

The proper ventilation of the living and sleeping rooms of a residence during snowy or rainy weather, requires some arrangement which will permit the fresh air to enter and yet keep out snow or rain. It is also desirable to be able to close the window without having to remove or adjust the ventilator. The arrangement here described possesses these requirements, and is also quite easily made at small expense. Its general construction can be seen from the illustration, and as windows vary so greatly in size no dimensions will be given, as anyone making it can readily determine what they should be to fit the windows where they are to be used.



It will be noted that the front side is at an angle of about 65° from the vertical, so that the simple raising or lowering of the window is all that is needed to regulate the volume of air entering the room. Also, as the upper edge of the ventilator is higher than the lower edge of the window, the air current takes an upward turn, and snow or rain will fall against the glass front and thence to the bottom. In very windy weather the window is raised only sufficiently to admit the air.

For windows of ordinary size the height of 10 in. will answer; the two end pieces then being 10 in. high, the upper ends $6\frac{1}{4}$ in. wide, and the lower ends 2 in. These are connected with a narrow piece at the bottom 2 in. wide and $\frac{1}{4}$ in. thick. The frame for the panes of glass are made of strips $\frac{7}{8}$ x $\frac{5}{8}$ in., in which $\frac{3}{16}$ x $\frac{3}{8}$ in. rabbets have been cut where necessary. The corner joints at the ends are halved; the two dividing pieces are fitted with V-shaped ends, the proper grooves being cut in the long pieces to receive them. They are permanently fastened by boring $\frac{1}{8}$ in. holes and pinning with dowel pins glued in. The frame is then fastened to the ends and bottom strip with wire finish nails.

The panes of glass are held in place with strips of wood, which should just fit the remaining space so that the edges will be flush with the frame. These strips are nailed with small brads. Those on the lower part should be bevelled to avoid forming a ledge, which would hold the rain or snow running down the glass. For the same reason, the bottom board might be inclined slightly. The only varnish which will stand the elements is spar varnish, two coats, at least, being necessary. The ventilator is fastened to the window by two screws put through each end piece, one near the top and the other near the bottom.

What is said to be the largest tree in the world is reported from Tulare County, Cal. This giant sequoia measured 36 feet in diameter and 113 feet in circumference 4 feet from the ground. According to the press dispatches announcing the find, the mill man who discovered this majestic forest monarch will turn it into lumber. This is unquestionably a commercial age, and dollars and cents largely constitute the criterion by which almost everything is judged, yet it certainly seems that some means should be provided to prevent the destruction of such a patriarch. For 4000, possibly 5000, years this sturdy, symmetrical shaft has reared its green head, braving alike the lightning's bolts, the fury of the tempest and the fierce rays of the sun, standing today as the most inspiring example of that great pulsating life that seeks expression everywhere in nature.

A little work during leisure time will secure premiums of useful tools.

PHOTOGRAPHY.

CHOICE OF A DEVELOPER.

JOHN EVERARD.

The amateur photographer, still on the threshold of our fascinating art-science, often finds himself in a predicament when necessity demands that he should purchase a fresh supply of developer, the supply included in his newly acquired outfit being exhausted. Should he be unacquainted with a seasoned photographer from whom to seek advice, he will probably rely on the dealer's recommendation, and, although the assistance given by the latter gentleman is often of considerable value, the vendor of the developer cannot be expected to burden himself with the cares of the newly-born amateur. Therefore, it very often happens that instead of obtaining a developer of easy manipulation, and possessing these possibilities of control so essential to a beginner, he is hurried towards failure by using an unsuitable developer—unsuitable because in his embryonic stages he lacks the technical knowledge required to use that particular developer to the best advantage. It is said that "patience is a virtue" in all occupations, but so few pursuits require so much endurance as photography, particularly the development of film and glass negatives. But development is the stage in the operations wherein the greatest impatience pervades the mind of the amateur, who is naturally aglow to see the result his efforts. And, because that impatience may be quickly overcome by the employment of a rapid developing agent, he gratifies the desire to "see what it is like" by purchasing a "quick-action" developer, being entirely ignorant of the fact that, to use such developers successfully, the worker must possess a considerable amount of skill. I refer particularly to those agents with which a correctly exposed plate may be fully developed in two minutes or thereabouts, and by their rapid action completely turning the mind of the inexperienced worker into a chaos of misgivings as to whether the plate is over-exposed or only fully developed. It may appear to the reader that I would discourage the use of such developers; for the raw beginner, yes; but not for the practised worker acquainted with their characteristics.

Let us suppose we are in the dark-room, standing by the side of a few-days-old amateur, and that he is using a metol developer. He slowly measures out the prescribed quantity of solution, finally adding a drop or two of bromide restrainer. Next, carefully, but seldom quickly, (although it is very necessary to cover the whole surface of the plate quickly when using this developer), he pours the solution over the plate. A few seconds pass, then the high lights appear; another few seconds go by, and the image is fully developed, but, because of the rapidity with which the detail has appeared, he cannot make up his mind whether the plate is over-exposed or merely fully developed. If such an occurrence takes place when treating a correctly exposed plate, how much more difficult his task will be when too much or too little exposure has been given.

But imagine him developing a negative with a slow developer. The coming of the high lights and the subsequent attainment of density are very gradual, allowing frequent examination, and the interval between the first appearance of the image and the final degree of density is such that it will give the untried worker reasonable time to consider whether the plate is fully developed, over or under-exposed, and to treat it accordingly. For the sake of precision, and to assist the amateur in elucidating these remarks, concerning the use of slow and quick-action developers, I will resort to the system of classification, although it cannot be expected that every agent will be fully dealt with.

These are the most universally used slow developers, though, especially in the case of the first named, the quantity may vary considerably, thus lessening or lengthening the time of development. As an ideal developer for the early worker and one that will allow him plenty of time, pyro cannot be beaten; and, although there are many who will probably disclaim its use for the beginner, in my opinion such repudiation is unnecessary. The very fact that the greater proportion of professional photographers still use pyro should be sufficient inducement to the amateur to do likewise. Its staining properties may be guarded against, whilst its suitability for all printing processes is a well-known fact. The correct proportion of pyro-soda and other developers are given below.

Hydrokinone is also very slow in its action, but has the peculiar property of adding density very quickly, once the image appears, and, unless the plate is continually examined, produces a hard negative in a very little while. It is so easy to over-develop with hydrokinone that beginners should be extremely cautious, and use it warily. Much the same advice may be given to those who would adopt eikonogen—over-development being very frequent unless care is exercised. The addition of metol to hydrokinone, and the combination of hydrokinone with eikonogen, seems to have the effect of decreasing the chances of over-development, at the same time increasing the rapidity of action.

These are probably the most rapid developing agents extant, and the first named is so energetic that a raw beginner will experience difficulty in exercising the necessary control. Amidol, although very popular in bromide work, is often retailed as a developer for negatives, but because it has a tendency to deteriorate when made up in solution, its use will never become so general as the first-named agent. Ortol is often recommended as a developer for films, and I have found it exceedingly useful for that purpose; nevertheless, its energetic action will scarcely commend itself to other than practiced workers.

There are numerous other agents which, in the hands of seasoned amateurs, are capable of producing the finest results. I refer to adurol, rodinal, glycin, edinol, etc., but these may be classed as rapid-aetion developers. The combination known as pyro-potass-metol is, without doubt, a most successful developer for snap-shot work, and, when the embryo has mastered pyro-soda, he should use the former for developing his instantaneous exposures. Being a quick-action developer, he should not use it at the outset, lest its energy promotes confusion.

The chemicals contained in the following formulæ are intended to be mixed: the ingredients of each formula with two ounces of water, which quantity is sufficient to develop one half-plate:

PYRO-SODA.

Pyrogallic acid	4 gr.
Sodium sulphite	16 gr.
Sulphuric acid (not necessary if developer is for immediate use).	
Sodium carbonate	22 gr.

HYDROKINONE.

Hydrokinone	6 gr.
Sodium sulphite	36 gr.
Potassium carb.	44 gr.
Potass. bromide.	½ gr.

EIKONOGEN.

Eikonogen	7 gr.
Sodium sulphite	42 gr.
Sodium carb.	74 gr.
Potass. bromide	¼ gr.

METOL.

Metol	4 gr.
Sodium sulphite	44 gr.
Sodium carb. crystals	26 gr.
Potass bromide.	2 gr.

AMIDOL.

Amidol	10 gr.
Sodium sulphite	100 gr.
Potass. bromide	1 gr.

ORTOL.

Ortol	4 gr.
Sodium sulphite	32 gr.
Sodium carb.	32 gr.
Potass bromide	1 gr.

PYRO-AMMONIA.

Pyrogallic acid	4 gr.
Potass. bromide	¼ gr.
Ammonia liq.	.880, .16 m.

METCL-HYDROKINONE.

Metol	2 gr.
Hydrokinone	2 gr.
Sodium sulphite	48 gr.
Sodium carb.	30 gr.
Potass. bromide	¼ gr.

PYRO-POT.-METOL.

Pyro	1 gr.
Metol	2 gr.
Sodium sulphite	12 gr.
Potass. carb.	12 gr.
Pot. bromide	⅛ gr.

EIKONOGEN-HYDROKINONE.

Eikonogen	6 gr.
Hydrokinone	1 gr.
Sodium sulphite	54 gr.
Potassium carbonate	28 gr.

In every case the preservative should, first of all, be dissolved; then the agent, and, lastly, the potassium bromide or restraining agent.

The following notes concerning the characteristics of developers, such as tint of negative obtained, of developers' keeping qualities, etc., etc., are inseparable in this treatise, and the beginner will do well to instill into his mind the peculiar properties of each. It is common knowledge that the tint of the negative is an important factor in printing, and a yellow-tinted but under-exposed negative will often give a better print than an under-exposed plate of a grey-black tone.

Pyrogallic Acid.—The brown-yellow image obtained with this agent is suitable for any printing process now on the market, and it is because of such utilization that pyro has enslaved the affections of the professional photographer. Pyrogallic acid is generally used with sodium carbonate and sulphites or liq. ammonia. Exposure to air will turn pyro in solution, yellow, and in this state it will considerably deepen the tint of the negative. An excess of pyro will produce a yellow stain, at the same time accentuating contrasts' Too great a proportion of the alkali (sulphite' etc.) is productive of flat, weak negatives.

Hydrokinone.—Hydrokinone produces a brown-black image, and unless the negative is examined very frequently, over-development (causing density and too much contrast) will mar the result. Like pyro, hydrokinone, when made up in solution, will turn brown on exposure to air, but in this case the discoloration does not affect the energetic properties of the developer. The alkalies generally recommended for hydrokinone are caustic soda and potass. carbonites and sulphites. Regarding the former, too free a use of the caustic will soften the emulsion of the negative. and excessive forcing often produces a disagreeable yellow stain.

Eikonogen.—Grey-blue negatives are obtained with eikonogen; the alkaline solution being generally composed of neutral sulphite and carbonates. In all other particulars it resembles hydrokinone.

Metol.—Metol produces a grey-black negative, and is used with alkaline carbonates. In solution metol keeps well. As a developer its use is very popular, both for plates and bromide papers.

Amidol.—Negatives of the grey-black tint are obtained with amidol. It is an ideal developer for bromide papers, but in solution its keeping qualities are not good. If the solution assumes a a reddish tint, it should be thrown away, for in this state its energies are practically exhausted.

Ortol.— Ortol possesses similar properties to metol, and is used in much the same manner.

I believe it has been pointed out before in these pages that exactitude is essential, but I should also like to add that unless the observance of this rule is rigidly self-enforced, defective negatives will often make their appearance. Should you use more of the principal agent than is recommended, you will find too much contrast in your negatives, and the light portions will be clogged. Again, if too little is used your negative will lack brilliancy and you will generally find development unnecessarily prolonged.

If you will add more than the prescribed quantity of alkali, you will certainly accelerate development, but your negatives will be flat and dense while fog and granulation may also make their appearance. Be sure that you are using only the recommended quantity of water; also that the temperature of the latter is approximately 70° Fahr. A warm developer produces fog; a cold one, flatness.—*Focus.*

An experiment in botanical surgery is proceeding in California. The oaks which grow in the grounds of the University of California are of world-wide fame. Lately, however, a dry rot has caused the trustees to fear their extinction. So Prof. W. A. Setchell, of the Botany Department, set to work to operate. First, he cut out all the disease and left large cavities in the trunks. Then he filled these with cement up to the inner edge of the bark. He reasoned that if the stopping were filled in until level with the outer surface the bark would not be able to grow over it. As it is, a smooth surface is left level with the wood itself, and he expects that the bark in time will cover it. If so, it will be hard lines, in a generation to come, on the teeth of the circular saw that gets to work on them.

The moon moves with a mean velocity of 3,350 ft. per second—not so very much faster than the projectiles of our best guns travel when on business. We may in time beat the moon in the race.

AMATEUR WORK.

DRAPER PUBLISHING CO., Publishers,

88 Broad St., Room 522, Boston, Mass.

A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month for the benefit and instruction of the amateur worker.

Subscription rates for the United States, Canada, Mexico, Cuba, Porto Rico, $1.00 per year.

Single copies of back numbers, 10 cents each.

TO ADVERTISERS.

New advertisments, or changes, intended for a particular issue, must be received at this office on or before the 10th of the previous month.

Entered at the Post Office, Boston, as second class mail matter, Jan. 14, 1902.

JANUARY, 1905.

A new premium list is in preparation and wil probably be ready for distrubution to our readers with the February issue. It will include a large number of new premiums, which we are confident will be found of value by those who are willing to put in a little personal effort in calling the attention of their friends to this magazine. Many of our subscribers have obtained numerous additions to their tool outfits in this way, and many others could do the same were they to give the matter attention during their leisure time.

Our premiums are all of the very best quality obtainable, and should not be compared with the inferior articles offered by some mail order houses. We have received numerous letters from those receiving premiums, expressing their highest appreciation of the value of the premiums received. Our forthcoming list will include a wide variety of useful and instructive tools and instruments, and our readers should be able to secure some of them with but little effort. In this way they will be rendering a double service, as the new subscribers will be pleased to have the magazine called to their attention, and they will personally benefit by receiving an appropriate reward for having done this. Those who have not as yet done anything in this line will find it to their direct benefit if they make the effort.

We have received several requests for a description of a small, easily made runabout. We shall be pleased to publish a description of such a vehicle, provided a sufficient number of readers should express their desire for the same. One of our readers has constructed a light carriage fitted with a 3 h. p., air cooled motor, and with wheels of the size and type used on auto-bicyles. It will carry two adults at a good speed over the roads to be found in this country, and a similar one may be made by any one of ordinary skill at a total expense of not over $100. He has cheerfully volunteered to give us the complete description, should we desire it. We shall be pleased to have those of our readers interested in such a vehicle, write us regarding the publication of a description of the same, and if a sufficient number of requests are received, the first chapter will be given at an early date.

All previously accepted conclusions as to the therapeutic value of metals are challenged by a communication made to the Acadamy of Medicine, says the *Echo de Paris*, by M. Albert Robin. He declares that metals, when administered to the human subject in doses so minute as to be altogether inappreciable, exercise an influence that is almost magical and quite inexplicable by any theories hitherto known to science. The action of the infinitesimal atoms is apparently analogous to that of organic ferments, which, as is well known, possess some mysterious power quite irrespective of their quantity.

The whole region of the Great Lakes is undergoing a slow tilting. The waters of each lake are rising on the southern and western shores. At Toledo and Sandusky the advance of the water amounts to eight or nine inches in depth in a century.

TOOL MAKING FOR AMATEURS.

ROBERT GIBSON GRISWOLD.

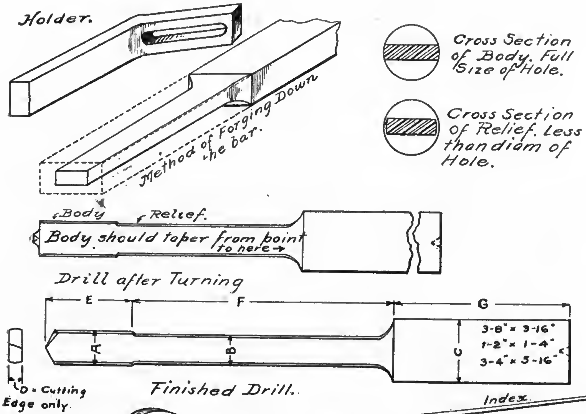
V. Set of Chucking Drills,—Test Indicator.

Any amateur who has tried using a twist drill of large diameter in a small lathe has, perhaps, experienced a few of the difficulties attending that operation, especially when the drill begins to break through; the drill is generally drawn off the tail center, canted in the hole, catches on the tool post, and frequently ends the performance by springing the piece out of the chuck or tearing it from the faceplate, provided the drill does not break. Aside from this, a twist drill is apt to feed into the work, if of brass, owing to the shape of the lip. It is true that this may be obviated by grinding the lip nearly parallel with the drill axis, but that destroys its cutting action in iron or steel, and that much of the drill has to be ground away before a proper edge can again be had. Another very important objection to twist drills of diameters above one half inch is their great cost, especially if a set of any considerable number is purchased.

The object of this article is to explain how to make a set of very satisfactory chucking drills at a very low cost. They are simply flat drills with a center at one end in which to rest the tail center. The opposite end is forged down to the size desired, which should be slightly longer than the largest dimension of the shank, and ground to a fine, true edge after hardening and tempering.

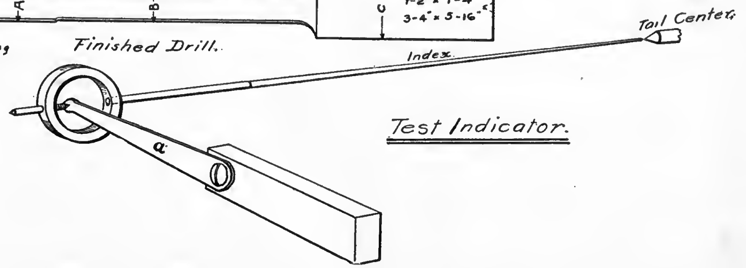
It is surprising what extremely accurate work may be done with these drills if properly sharpened and kept in good condition. Suppose we make a set ranging from ¼ to 1 in. varying by 1-32 in. up to ½ in., and by 1-16 in. from ½ to 1 in., which gives us a set of seventeen drills, as follows: ¼, 9-32, 5-16, 11-32, ⅜, 13-32, 7-16, 15-32, ½, 9-16, ⅝, 11-16, ¾, 13-16, ½, 5-16, 1 in. For the drills up to ½ in. we will use flat tool steel, 3-16 x ⅝ in., and make them all six inches long, which will require about 4 ft. of this stock. Cut the pieces off for each drill *after* the end has been drawn out by forging. This drawing increases the length and saves material. Make the 9-16, ⅝ and 11-16 in. drills of ½ x ½ in., and the remaining four of ¾ x 5-16 in. stock, each finished drill being about seven inches in length.

Forge each drill down to a size a little above the finished size and make it flat, as shown in the sketch. This flat is necessary in order that the chips may clear



DIMENSIONS OF DRILLS.

SIZE	A	B	C	D	E	F	G
1-4			3-8	1-16	1-2	3½	2
9-32			"	"	"	"	"
5-16		1/32" Less than Drill Size A	"	3-32	"	"	"
11-32	Same as Size of Drill.		"	"	"	"	"
3-8			"	"	"	"	"
13-32			"	"	"	"	"
7-16			"	"	"	"	"
15-32			"	"	"	"	"
1-2			"	7-64	5-8	"	"
9-16			1-2	"	"	3⅞	2½
5-8			"	"	"	"	"
11-16			"	"	"	"	"
3-4			3-4	1-8	3-4	3¾	"
13-16			"	"	"	"	"
7-8			"	"	1	3½	"
15-16			"	"	"	"	"
1			"	"	"	3	3



Test Indicator.

and have a chance to get out. The cutting edge may be made somewhat thinner, but not so much as to weaken it while cutting. Then cut off the drill, center both ends and place in lathe. Take a cut for the distance indicated in the table to give the drill a true body, and then relieve it slightly, as shown. This makes the drill follow in a straight hole. Unless the amateur has some means of grinding these bodies after turning, a very fine finishing cut had best be taken with a keen finishing tool wet with oil. One cannot file an irregular piece in the lathe to make a good job. The flat dimension of the drill should gradually taper from the dimension *D* to 2 x *D*, where it runs into the stock.

When finished to the desired shape, file down the point approximately to the angle desired, afterwards drawing the temper to a dark straw. Then grind the final cutting edge, exercising care to see that the same angle is used on both sides, and that both cutting lips are of the same length. Now make three holders, as shown in cut, one for each size stock. In using the drills these holders are fastened in the tool post, the drill stock passed through the slot, which should be slightly larger, and rested on the tail center. The point of the drill is then brought against the revolving work and fed by means of the tail or spindle. The holder permits the drill to move axially without revolving with the work. If the lips have been carefully ground, very straight, true holes can be drilled, and and the drill will not draw in when breaking through.

A very handy wrinkle to prevent the drill dropping off the center when through the hole, is to drill a hole through the stock and drive in a pin, over which latter a heavy rubber band is slipped and passed over some projection of the tail stock. If tightly stretched it will draw the drill out with it. Another scheme is to back the holder up against the pin and move the carriage with the spindle.

This set, while highly efficient and capable of good heavy work, is very much cheaper than a corresponding set of twist drills, and for all practical purposes is every bit as good.

In order that a piece may be so located on a faceplate that a hole may be drilled or bored in any definite position, it is necessary to apply some instrument that will indicate the exact amount that the center of the hole (already laid out on the work) is out of truth and in what direction. Such an instrument is called an indicator, and the one herein described is accurate, durable, cheap and easily constructed.

Make a ring of brass or steel 1⅛ in. outside diameter and 13-16 in. inside diameter by ¼ in. width. Drill and tap two holes diametrically opposite for a ⅛ in. screw with 40 threads, or any other tap of that diameter. Thread ¼ in. of one end of a piece of ⅛ in. drill rod ⅝ in. in length, and sharpen both ends down to a 60° point: then harden the ends. Make the other extension in this manner. Cut a piece of the same drill rod six inches in length and thread one end for 3-16 in.; in the other end drill a 3-32 in. hole about ½ in. deep. Screw both of these pieces into place firmly. Now make an index out of a piece of straight-grained pine or spruce about 10 in. long, and taper it down as shown, fitting the larger end snugly to the 3-32 in hole. This pointer is very light and will move quickly without vibration. The ratio of movement is as .75 : 14= 18.66, and the end of the pointer will magnify the error in setting 18.66 times, generally a sufficient amount for all practical purposes. An error of .001 in. in the setting will be multiplied to .01866 in., or nearly 1-50 of an inch. If greater accuracy is required the short piece may be made ½ in. long, when the multiplication of error will be 28 times.

A holder is made as shown to press the point against the work. This holder is fastened in the tool post, and the vertical adjustment made by moving the spring *a* up or down, while the horizontal adjustment is secured by moving the tool-post block. Only sufficient pressure to hold it to the work should be applied.

To use the indicator, strap the piece to the face plate with the center of the hole in approximately the correct position. Then apply the indicator, adjusting the holder until the end of the wooden pointer coincides with the tail center. Now revolve the face-plate through half a revolution and move the carriage so that the pointer will approach the center by half the discrepancy. Then lightly tap the block until the pointer again coincides with the center. You have then moved the block the distance that it was off the center in that direction. Then turn the face-plate a quarter turn and repeat the operation. The block will then be practically correct, and by light taps in one direction as the other may be brought to the desired position, when there will be no movement at all at the end of the pointer. Then firmly clamp the piece in position and try again to see that the bolts have not drawn the piece out of true or sprung it.

A radium clock which will keep time indefinitely has been constructed by Harrison Martindale, of England. The clock comprises a small tube in which is placed a minute quantity of radium supported in an exhausted glass vessel by a quartz rod. To the lower end of the tube, which is colored violet by the action of the radium, an electroscope formed of two long leaves or strips of silver is attached. A charge of electricity in which there are no beta rays is transmitted through the activity of the radium into the leaves, and the latter thereby expand until they touch the sides of the vessel. connected to earth by wires, which instantly conduct the electric charge, and the leaves fall together. This simple operation is repeated incessantly every two minutes until the radium is exhausted, which in this instance it is computed will occupy 30,000 years.

SOME DIFFICULTIES IN GETTING ON.

JAMES SWINBURNE.

Abstracts from an address delivered to the students of the Brtish Institute of Engineers.

Each of us is confronted with the question: "What is going to be my work?" I say "us," because the difficulty in many cases is permanent; one never knows what he will be called upon to tackle in the future. The difficulty is much greater, however, in the case of a young man, because he has probably the vaguest idea of what his life's work will be, and that idea time will show to be quite wrong.

In engineering it is quite impossible for any one to start out with a definite career before him. He is like a particular particle setting out across a containing-vessel of gas. He cannot career straight across. He is buffeted about and frequently goes in quite the wrong direction. A man who has made a specialty of electrical waves gets his first appointment as inspector of meters to an electric light company, and so on. A well-known engineer remarked to me the other day that he found his knowledge of differential equations, and his experience in the correct analysis of the rare earths was of little use in putting in sewage plant. Yet he had made lots of use both of his mathematical and chemical analysis in his time.

Probably each man should have a general knowledge of applied physics and chemistry and mathematics, and a special knowledge of one or two subjects. The special knowledge may never come in useful; but the chances are that in the blind stumblings we call our careers a specialty may be valuable. If you glance round at the work of some of our big men you will be surprised to see how many have made their reputation by doing one small thing, but doing it well.

One of the great difficulties is to keep knowledge in a polished state ready for immediate use. In practice it may have to lie idle for long periods and then be wanted very much on short notice. This fact is overlooked by people who suffer from the modern craze for writing about technical education. For instance, we are told that all engineers ought to have the calculus at their finger ends, and so on; but it is forgotten that though an engineer ought to be well up in mathematics, he only makes a calculation requiring higher mathematics once in several years, perhaps; and it is impossible for him to keep his mathematics in working order down to minutest details. All he can do is to keep general principles in his mind. The great thing is to master a certain number of broad fundamental principles which give a starting point for refreshing old knowledge or acquiring new. For instance, in physics, the law of conservation of energy and all that follows from it; the principles of the kinetic theory of gases; the ideas of lines or tubes of force; the principle of interlinked circuits; the principle of the growth of entropy in all thermo-dynamic changes.

Science, for which no use has been found, or which is not applied, is called "pure science," whereas it is really the raw material, and should be called "raw" or "crude science." There is an assumption of superiority in the term "pure science," and generally the term "science" is appropriated by workers in raw science in much the same way as the term "workingman" is appropriated to the exclusion of brain workers. There is supposed to be something noble and superior about "raw science," and its study is treated as the unselfish devotion to the interests of man, which is obviously entirely the wrong way round. The so-called "scientific man" thinks that engineers and manufacturers are ignorant and unscientific, and that their practical knowledge is of no account; and that the cure for all industrial evils is more technical education, more universities and more power to science masters. Though there are in existence a few practical science teachers, they are rare. Perhaps no one would be more surprised than the average science master if you told him he was unpractical and was, by his attitude and example, hindering science. He does not mean to. He is as keen as possible to do just the reverse, and is generally exceedingly anxious for the spread of science or technology; but, unfortunately, he has got a wholly wrong view.

It is often said that the pursuit of knowledge has a nobility of its own. But what knowledge? No knowledge is worth obtaining for its own or any other sake, unless it is or will probably be useful to man.

A man's value to the world at large may generally be roughly estimated by the income he earns. Where position is earned at the same time, the money income is in proportion less for a given usefulness; but taking such disturbing elements into account, the rule is broadly true. The business man comes out far away above the engineer. He employs the engineer; the scientific man is his servant. Just as the raw scientist looks down on the engineer, and the engineer looks down on the business man, so the business man has a contempt for the engineer; and the engineer in his turn looks on the raw scientist as an unpractical crank. So much is this the case that the business man will not trust the engineer more than he can help. He assumes that if you know anything about anything you can not possibly be a business man.

If you examine the large industries you will find the commercial or business man with little or no technical knowledge at the top of the tree. If you confine your attention to engineers you will find the engineers who make the biggest incomes and occupy the most important and responsible positions are those who have most business and practical knowledge. Our leading consulting engineers do not spend a large portion of their lives plotting curves, counting electrons, or even making anything more than arithmetical calculations. They spend their time dealing with large questions on purely commercial lines; and, as a rule, the bigger the engineer the more he knows about practice and business, and the less he knows about text-book science. I do not for a moment mean to say that text-book science is not of priceless value; of course it is; and the more scientific knowledge you or I, or still more, the leading engineers have, the better; but most of us suffer from too little common sense in proportion to our scientific knowledge.

The engineers occupying smaller positions, assuming the same age in both cases, are not necessarily deficient in technical knowledge; but they are generally wanting in business attainment and less able to take responsible positions. It is often said that to be a good master you must have been a good servant; but a good servant does not necesaarily make a good master, generally the reverse. There is a wide distinction between the man who can earn a few hundreds a year and the man who earns as many thousands. It is a very curious thing that there is hardly anything between. One type of man will either earn his few hundreds a year all his life, remaining permanently an assistant, or he will undertake responsible work and get into fair figures. The engineer who is worth $3500 a year seems hardly to exist, except for a short time on his way from one class to another. This is what is meant by the saying that there is plenty of room at the top of the ladder. It is not that the men who remain as assistants permanently are ignorant of science; quite the reverse. The business man can rent a profound mathemetician for a very few dollars a week if wants him; but he probably does not. The real point is that the assistant is wanting in business knowledge or in push. If he is wanting in ambition or lazy, nothing I can say is to the point; but he may be suffering from a false notion of the relative value of raw science, technology and business knowledge.

In the charter of the Institution of Civil Engineers the engineer is defined as " directing the great source of power in nature for the use and convenience of man." With all respect to this august body, and its often quoted definition, I would humbly suggest that it is bad. It is really the definition of a scientific man. It is incomplete as applied to an engineer, because it does not take into account the sordid element of price. An American definition is much better—" an engineer is a man who can do for one dollar what any fool can do for two. " This is not poetical and is useless for oratorical purposes; but it is right. It is no use being able to design most complicated alternating-current machinery, or being able to explain it with the help of a wilderness of clock faces and several issues of the technical journals, unless the machine, when made, is cheaper than its rivals. Every design, every engineering manufacturer, and every piece of engineering is only a question of price. It is unpleasant, perhaps, but is a hard fact, and we have got to face it.

If one of us does $750 worth of work a year and earns $800, he is efficient; if he only does $450 worth he is an inefficient machine and will come to grief. He is like a ninety-kilowatt alternator which takes 100 kilowatts to excite, though the analogy is not close. If he does $75,000 worth of work and gets $50,000 he is an efficient machine of much larger size, and his efficiency is much more satisfactory to himself. I may mention, in passing, that an efficient man must do more work than he is paid for. This is not always realized. A man who only did what he was paid for would be of no use to the world at large. His efficiency is zero; his consumption being equal to his output. The man who does $75,000 worth of work and gets $50,000 consumes two-thirds of the work himself; so his efficiency is only thirty-three per cent; which is very high, even for an engineer.

We see, then, that the business man is the master; the engineer is his good slave; and the raw scientist is not good enough even to be the slave of the engineer; he has no market value at all, except as a teacher of more raw science. The raw scientist will remain at the bottom of the tree until he gets rid of the professional cant which pretends that raw science is pure, or nobler and superior to science as a whole; and the engineer wil remain in the middle position as long as he takes the middle view and considers engineering as something superior to money considerations, and as long as he looks down on business and commercial methods.

Views like these put forward in addresses do not alter the world at large, and they do not expect to do so. They are put strongly to warn you, who are young, and therefore inclined to be enthusiastic, against one of the greatest difficulties in getting on; that is to say, a poetic idea that there is something degrading or deteriorating in taking a money view of everything. You may say, " we take higher views of life than that; there is something better for us in our careers than money grubbing." So there is; I heartily agree with you; and when you have grubbed some money and are at liberty to attend to higher things, I would ' e to be allowed to join you.

It is cant to profess contempt for money. The poet professes to work for ame, and so does the musician, the artist, the philosopher, the scholar or the man of letters. They generally like money; but apart from that they are merely satisfying their proper vanity or love of approbation, by getting ahead of their fellows. But that is all you want to get on for. Money is nothing in itself, it is only a means, and making it is merely a way of getting ahead of your fellows. People who cannot make money do not like it being used as a criterion, so they run it down. Every one thinks the world ought to be judged by what he can do best himself. If you want to be poets you have my sympathy, but I can not deal with you in this address. I can only ask you to eschew cant.

You may, on the other hand, ask "how are we to get business and commercial knowledge?" You may say, "you are much older than we; you were practising engineering several years before any of us were born. How did you get all your practical knowledge and become an engineer?" I can only answer, "I am only a very little bit of an engineer." I know I will never be much of an engineer. This is mainly because this practical difficulty in getting on has always been in my way. I am entirely out of sympathy with the whole of this part of my address to you. I so much dislike saying it all that I know it must be true.

I can not tell you how to be engineers, because I do not know. All I can do is to make you realize some of your wants; and if you know what you want you are more likely to get it. One of the greatest difficulties in getting on is to find a good opening. Then, as to the different branches of the business— business is really a higher title than profession—in which are you to find openings? From the number of applications I receive from young fellows, it seems to be a common idea that consulting engineering is a good thing to begin upon. This is a curious notion. A consulting engineer is supposed to be a highly skilled engineer, with so much experience that he is an authority. I should have thought at least twenty or thirty years' experience, apart from school and college training, was necessary for a consulting engineer to be worth his salt. But there are various grades of consulting engineer; and I am entirely at a loss to know what the qualifications of the consulting electrical engineer really are. Then still less do I know what the consulting electrical engineer will be by the time you have had twenty or thirty years' experience.

In manufacturing work there is the designing of dynamos, motors, transformers, and so on. This was considered high grade work when I was a young man; and even very able men built some very queer machines in those days; we were all pretty ignorant. There are many openings to be had in central station work, and stations are growing bigger and more important every day. Central station work in a position of responsibility is very anxious. I do not think it is very well paid, either.

A large number of young men go in for installation work—which sounds as if they started bishops on their episcopal careers—but really means that they do what is, in fact, electrical plumbing under an unnecessarily imposing name. There are a great many of them and they seem to spend most of their time going into and out of partnership with one another, like ions, and sending notices round to that effect. At other times they go bankrupt and send no notices. The upper grades in teaching science are well paid, more especially as a position goes with an appointment, and there is time and facility for original research, which is a luxury and brings reputation. Moreover, a steady income with no expenses is a very blessed thing. But the lower grades are very poorly paid in proportion to their ability.

All this may sound rather discouraging, but I am dealing with the difficulties of getting on, and I am sure it will not discourage anyone who is worth his salt. At first it is very discouraging to make very little, and the good man has little chance of showing his superiority to the common run. But he should always remember that income, as a young man, is very little criterion of real value. There are many careers in which a young man can make something almost at once; but in all cases the income increases very slowly. In such a business as engineering a man of first-rate ability may be quite unable to make enough to marry on until he is thirty, or enough to be comfortable on until he is forty. An eminent engineer, whose name you all know, said that he did all the hard work of his life for $7.50 a week, and when he was well on in life money came rolling in of its own accord. I have reason to believe that one of our foremost engineers, now dead, never made $2,500 a year until he was over forty.

Though you may not like it, a hard struggle is very good for a young man who has anything in him. It gets him into ways of overcoming difficulties, so that when he gets above the small obstacles he goes on overcoming large ones from the mere force of habit. Nearly all great men rise from almost nothing with infinite trouble in their youth. There is nothing worse for a young man than to have about $1,000 a year of his own. He lives comfortably and does not worry; and when he is thirty he wants to marry and finds he can not, and is too late to begin life seriously then. If any of you have this sort of private income he had better go into partnership in installation work for a year or two and then begin business seriously.

I have only mentioned a few of the difficulties of getting on. I am sorry to say there are many more, which you will find out in good time.—*Electrical Review.*

A recent study of the qualities which gasoline ought to possess for advantageous employment in automobiles has reached the following results. It should be very limpid, possessing a density of 0.680 to 0.590 specific gravity and perfect homogenity. It should also have a low flashing point. The flashing point of American oils varies from 73° to 110° Fahr. It should not be forgotten that a motor employing oils having a low flashing point will work better than if using the higher. This quantity must be kept in view in the use of petroleum oils in motors.

Renew your subscription promptly.

ZINC ENGRAVING OR ETCHING.

N. S. TINKER.

In presenting the following instructions for the rapid etching of zinc printing plates, it is the intention to make them as clear as possible, so that even a novice can easily produce a good printing plate with very little practice.

The first process considered will be outline cuts. These are much the quickest and easiest to make.

Procure a piece of ordinary tinner's or, better, engravers' zinc, polish it thoroughly with powdered pumice stone or engraver's charcoal, and a wet cloth, being careful to remove all grease and stain. Then draw the required design on the zinc with a mixture of fine, black job printing ink, three parts, and oil of sassafrass, one part, using a No. 1 Spencerian pen for the purpose. You can fill in the heavy places with a camel's hair pencil. All straight lines across the face or "background" may be drawn by elevating the rule at both ends; a short piece of printers' column rule may be used nicely for drawing. You can determine whether the ink is too thick or too thin by trying it on a separate piece of zinc. If the ink is of the right consistency you will be unable to make quick strokes. Should there be too much oil in the ink the lines will spread when heat is applied to the plate.

When the drawing is finished to your satisfaction powder with a mixture of powdered asphaltum, two parts, and powdered dragon's blood, one part. This must be very fine to produce good results. After thoroughly powdering the lines drawn, dust off the superfluous powder, brush in all directions with a soft camel's hair brush and the design will appear as clear as before the powder was applied.

Heat the plate by holding it over lamp, gas jet or on stove top, until the lines turn black or until the ink fuses the powder onto the zinc. The correct heat will be indicated by a slight smoking of the powder.

Varnish the back of the plate with asphaltum varnish made thin with beuzine or shellac. Uee a quill brush for the purpose, and let the plate bry thoroughly.

Put the plate into a glass or porcelain dish into which has been put a mixture of one part of commercial nitric acid and ten parts of water. Have the acid thoroughly mixed with the water before immersing the plate. Move the dish so as to produce a washing or rocking motion, and let the acid eat the plate until you see the finest lines are being eaten away.

Wash plate off, remove from bath and rinse thoroughly in water; clean face with alcohol. With a roller put a coat of black printing ink on a piece of cardboard and lay face of plate on it and apply an even pressure. When the lines are well mixed, powder as before, brush in all directions, which will cause the powder to sheer to all sides of the lines; then heat as before directed.

Before immersing in the acid solution again, protect the fine lines that have been sufficiently etched by giving them a coating of asphaltum varnish. Etch about one-half through the plate, then re-ink, powder and heat as before. Use a heavier coat of ink this time to protect the sides. After etching nearly through the plate, rinse, clean face with alcohol, and back with benzine. A drop or two of the potash solution mentioned farther on will readily cut the composition on the face. Be careful not to injure face while cleaning. It is advisable to rub with ball of the fingers when cleaning. Trim plate close to lines, saw a block to size required and with a piece of soft paper between, glue plate to block with a thin coating of strong glue containing a small quantity of alcohol. When dry reremove large open places and sink the smaller if necessary. This kind of cut can also be fastened to the base with small brads.

To make a lithotint cut, which is much easier than the outline cuts, follow the same instructions except that before fusing (heating the plate) you deposit a fine dust of asphaltum and dragon's blood on the plate by making a box thirty inches high and about eight inches square; have a door about four inches from bottom and across one side and even with the bottom of door stretch a few wires to act as a shelf for the loose-fitting slide on which you put the plate. Put about four ounces of the powdered asphaltum dragon's blood mixture in the box and, after shaking it from end to end several times, open the door and insert the slide containing plate. Withdraw in about eight seconds and, if not satisfactory, brush plate and try again. A heavy shower of dust will bear deeper etching than light showers.

After the dust particles have deposited themselves evenly on the plate, fuse as in the outline cuts. By re-inking the lithotint plate once, as described for outline cuts, you will avoid ever having a blurred lithotint cut on your press. Owing to the quickness with which these cuts can be made they are of special value to printers who are located where engravers are not readily accessible, and with a little experience you can imitate a half-tone surprisingly well. A border should always be used around lithotint cuts, as it adds much to the appearance.

Select the cut or matter to be reproduced, put in a job-press, take a heavy and well-inked impression with a good, black job ink on unsized paper, lay face down on zinc and subject to heavy pressure. Remove paper, and if the quantity of ink on paper was sufficient you will notice the design or letters distinctly transferred to zinc. Powder and etch as previously described. There is more or less difficulty in reproducing from type smaller than a bold-face 12-point or from a high-grade engraving drawn in fine, close lines, as this process is not intended for work, although good results may be obtained by persistent efforts.

To make a transfer to zinc of a cut, etc., which has been printed on an ordinary paper with news or job ink, first go over the pages with a solution of two parts caustic potash and three parts of alcohol. Then immediately immerse in the etching bath. Let it soak thoroughly, then remove from bath and absorb loose fluid with blotters, lay face down on the zinc and with a piece of stereotyper's cloth on top, subject to heavy pressure, using a paper cutter clamp or copying press to get sufficient pressure. Then proceed as described. Photographs, and the like, which will not transfer as above, will have to be gone over with the tracing ink and then transfered.

To make a plate of manuscript, or other written matter, transfer to zinc in the ordinary way, trace with the prepared ink and proceed as usual. Sometimes, when the manuscript is very old, it is necessary to go over it with India ink to make it transfer. By means of a photograph a tracing can be made and quickly transferred to zinc. Judgment should be exercised in fusing a lithotint cut, because, should you burn the powder its then easily affected by the acid in the bath.

After transferring, should any particles of paper remain in the zinc let them dry, and remove by carefully rubbing with a soft, clean cloth. Keep all the chemicals fresh and clean and, when not in use, in tight stoppered bottles. The bath wastes away in open air and has to be renewed freqnently when in use. In etching, as in other vocations, he that would attain to eminence must persevere and he who "tries again" is soon cognizant of the fact that "Success" is a companion to "Diligence." This process of engraving opens up a new vocation for the young people, and where newspapers are published there is a constant demand for illustrations of current events.

VIBRATOR FOR INDUCTION COILS.

H. C. BURNHAM.

The difficulties encountered with vibrators of induction coils are, that the contacts are liable to fuse or burn, and that the core is not fully magnetized so that the full power of the coil is not produced in the sparking. To overcome the first we must have a spring that upon magnetizing the core will break the circuit quickly. To overcome the latter we must have a vibrator that will work evenly and be slow enough to allow the core and primary to become fully energized, thus securing the best results in the spark of the secondary.

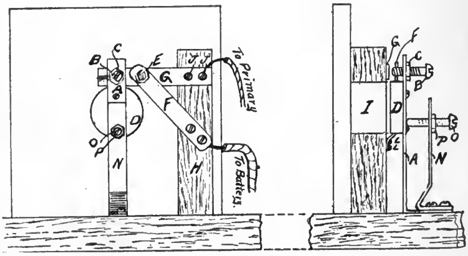
The vibrator here described will accomplish these results. To make it procure a strip of spring brass, *A*, 3 in. long by ½ in. wide. (It must be very springy and so that it will bend with a very slight pull.) At one end measure off ⅝ in. and bend to a right angle. Drill two holes in this short bend for screws ; at the other end, ½ in. down and in the center, drill a hole 3-16 in. in diameter.

Next, get from a hardware store a small brass machine screw ⅛ in. diameter, with a nut to fit. Solder this nut *c* over the hole just mentioned. Also obtain a round piece of soft gray iron, *D*, ⅞ in. in diameter, saw off a piece ½ in. thick and rivet it on to the spring *A* so as to be exactly opposite the end of the core and directly face to face with it.

Next, get a piece of cherry *H*, 2⅝ in. wide and of the same thickness as the end of the core which projects from the end of the coil. On my coil this is ½ in. Screw this to the brass so that it fits snugly against the end of the coil, and is ⅛ in. from the outer edge of the coil head, as shown in the illustration.

Procure a piece of very heavy spring brass *c* 1⅝ in. long and ½ in. wide. Drill two holes in this piece for the screws *J J*. Screw this piece to the block *H* so that it is long enough to go about ⅛ in. beyond where the screw *B* strikes it. One inch from the outer end solder a piece of sheet platinum about 3-16 in. square in the center of the point of contact with the spring *F*.

Now take a piece of brass 1½ in. long by ½ in. wide



and 1-16 in. thick. Drill two holes for the screws *L L*. At the other end drill a hole 3-16 in. diameter and 3-16 in. from the end. Get another brass machine screw 1-8 in. wire, with nut to match. Procure a piece of No. 12 platinum wire 1-8 in. long. Solder this to the end of the machine screw, then solder the nut to *F* so that it centers on the 3-16 in. hole previously drilled near the end. Mount this piece of brass so that the platinum tipped screw E centers on the piece of sheet platinum soldered on to *G*.

Take another piece of brass 2 in. long by ½ in. wide and 1-16 in. thick and a brass machine screw 1-8 in. wire with a nut to match. Drill a 3-16 in. hole ½ in. from the end and solder this nut *p* over it. Bend this piece so that the screw-hole will stand out about ¼ in. from the piece *A*. Mount this piece *N* with the same screws that hold the piece *A*.

Now for the adjustment. Mount the spring *A* so that the iron disk *D* is about 3-64 in. from the core *I* and is directly line with it. Mount the strip of cherry so that the screw *B* hits the spring *G* about ¼ in. from the end. The strip *F* is to be mounted on the piece of cherry so that the screw *B* hits the spring *G* about ¼ in. from the end. The strip *F* is to be mounted on the piece of cherry so that the platinum tipped screw centers on the piece of sheet platinum. See that the spring *G* bears strongly against the screw *E*. Adjust the screw *B* so that just before the iron disk *D* touches the core *I*, the screw *B* will strike the heavy spring *G*. Adjust the piece *N* with the screw so that the weak spring *A* can only fly 3-64 in. back from the core *I*.

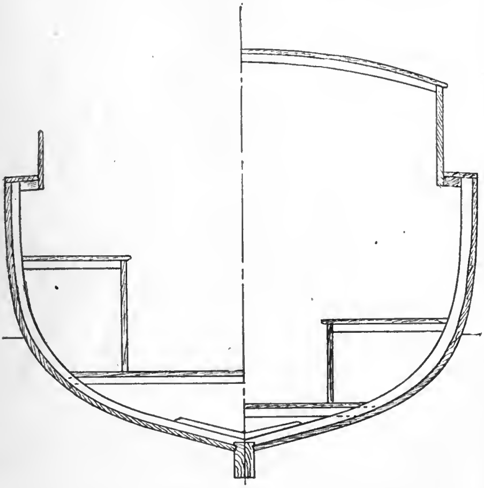
Now for the connections. Under the screws *JJ* solder a wire and connect it with one of the primary wires. Solder a wire to the piece *F* and run it to the binding post for the battery.

HOW TO BUILD A POWER LAUNCH.

CARL H. CLARK.

II. Laying Out the Lines.

The keel is a straight piece of oak 3 in. thick, 5 in. wide and 17 ft. long. It should have a slight upward bend forward, to conform to the shape of the mould already made. The deadwood and stern post are built up in the manner shown, and the horn-timber forming the overhanging stern is fitted on the top and fastened down through. The deadwood is swelled slightly around the shaft hole. The stern-post should be mortised into keel and horn-timber to hold it firmly in place. The hole for the shaft is 1¼ in. in diameter.



It had better be bored before the keel is set up, as it is more accessible then. It should be located as follows: Measure up on the after side of the stern post 12 in. and at section No. 6 measure up 15 in.; a line drawn between these two points locates the center of the hole. This line is then drawn on the deadwood and used as a guide in boring. Care is to be taken that the hole is in the center of the deadwood, and it may be well to bore a small hole before putting the large one through. A ship carpenter's bit should be used for this work, as it is longer and bores straighter than the ordinary ones; it is not expensive.

The stem is a natural crook knee which is fitted and scarphed to the forward end of the keel. It is 3 in. thick and has a rabbet cut in it to agree with the line marked on the mould for that purpose. The rabbet should be at least roughed out before fastening to keel, and the forward edge bevelled off from the rabbet to about ¾ in. thick. It is fastened to the keel by several ⅜ in. galvanized iron rivets. The form of scarph should be noted, as it prevents the drawing apart of the two pieces.

The after end of the keel and stern post should be thinned down to about 2 in., and the corner slightly rounded except at the shaft hole, where it is left full thickness and square, to give fastening for the stern bearing. In every joint of the frame stop-waters should be fitted, as has been before explained, to prevent the water running along the joint and into the boat.

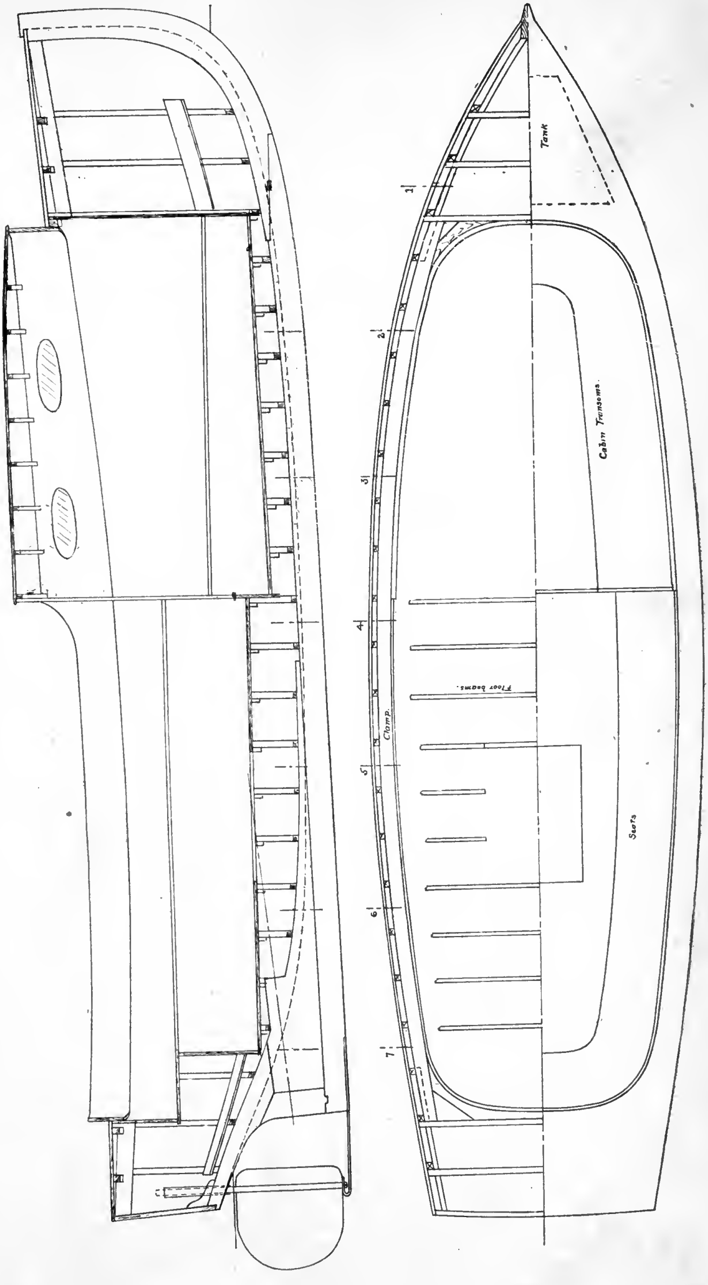
When the foundation is complete the mould should be laid on and checked up to make sure that it is correctly put together. The water line and mould positions are also marked across stem, sternpost and keel. The rabbet in the keel and deadwood can be cut approximately now; as will be noted, there is a back rabbet above the plank of about ½ in; this is to give a solid backing for the calking to bed against and makes the boat more durable. It can be roughed out now and trimmed out fully after the moulds are set in place.

The keel may now be set up on blocks with the water line horizontal; the blocks must be well braced and the keel have a good bearing on all so as to remain straight. The stem must also be plumb when looked at from forward. Bracing beams are run from the top of the stem to the beams overhead.

The stern-board is gotten out next from a piece of $1\frac{1}{4}$ in. oak plank, not forgetting to deduct from the outline the thickness of the plank. It is to be noted that the form given is for the after side of the stern-board and, owing to the sloping sides, the forward face of the stern-board is larger than the after face; for this reason the edges of the stern-board must be left with a considerable amount of bevel, to be trimmed down to the correct angle after the ribbands are in place.

The sternboard is now to be fastened to the end of the horn-timber and at the correct angle, as shown by the template. It is set into the end of the horn-timber, as shown in the sketch, being set down to within $\frac{3}{4}$ in. of the rabbet. This is necessary, as the rabbet represents the outside of the plank, while the stern-board goes inside. A knee is fitted in the angle between stern-board and horn-timber and well fastened to both. Care must be used in setting the stern-board to place it square with the keel and with its center line vertical. A line should be stretched from its center line vertical. A line should be stretched from the center-line of the stern-board and that of the stem, and care taken that it is directly above the center line of the keel. These two govern the fairness of the hull and must be correctly adjusted.

As before directed, the moulds are made of any rough stock, but must be strong. They are now to be set up in their proper places on the keel, the foot being cut out to allow the lower corner to come to such a



point that when the plank is laid on, the lower edge will come to the rabbet line. The moulds are to be very carefully set, vertically and square with the keel, and fastened to it securely. When the moulds are correctly set the L. W. L. as marked on every mould should be in the same level line. Ths line between the stern-board and stem will aid in setting the moulds, the centre line of each mould being brought directly under it.

When the moulds are all set they must be securely braced in each direction. There is considerable strain on the moulds during the process of timbering and they must be strongly braced in order not to be forced out of position. Ribbands about $1\frac{1}{4}$ x 2 in. are now bent around the moulds from stem to stern and fastened to each mould with screws. These ribbands should bear fairly across all the moulds, and if they do not there may be either some error in laying off the moulds or in setting them up, and the error should be looked up and carefully rectified before going further.

The frames are of oak about $1\frac{1}{4}$ x $1\frac{1}{4}$ in. and are spaced 10 in. in the boat. Stock for this purpose must not be too dry, or it will break when bent, even though it is steamed. The frames should be sawed out to size and long enough to reach from keel to gunwale. They will, of course, require steaming before bending, and a steam box will be necessary. It should be a fairly tight box about 6 x 12 in. and long enough to accommodate the longest pieces. It will be well to make it about 12 ft. long as there will be some long pieces to steam later in the work. It is connected to some source of steam, a small boiler, of course, being the best, but for want of this a teakettle and oil stove will answer. A considerable amount of steam is, however, required, and it must be as hot as possible, to be effective. The frames are notched out to fit the keel at the heel, which should be done before steaming. As many as possible should be placed in the steam box, which is closed tightly and steam turned on. They are steamed until thoroughly limber. The frame points should be marked on keel and ribbands, being so spaced that each mould will come in between two frames. As the frames are taken from the steam box they are first bent over a form to a greater curvature than desired, and are then put into place and clamped to the ribbands; the two corresponding frames should be put in at the same time, thus keeping the strain equal. It is well to fasten the tops of the opposite frames together with a piece of rope to overcome any tendency to spring outward.

The frames should be allowed to set and thoroughly dry out in place before any of the fastenings are disturbed. If the frames have been well steamed there should be no tendency to spring after a day or two. The clamps may then be taken off and the ribbands fastened to the frames with screws, as the clamps will be needed for other purposes.

The rabbet should now be trimmed out to the proper angle, that the planks may lie on the frames and bed fairly. It is then ready for planking, which will be the subject of the next article.

NOTE.—In the laying off table published in the last issue the following corrections should be made:

In ht. of sheer above base line read	4′ $4\frac{1}{4}$″	for	4′ 4″
" " rabbet " " " "	0′ $11\frac{1}{4}$″	"	1′ $11\frac{1}{4}$″
" " keel " " " "	2′ $5\frac{3}{4}$″	"	2′ 5″
" half breadth, L. W. L. " "	1′ $8\frac{7}{8}$″	"	1′ $8\frac{1}{2}$″

PHOTOGRAPHY NOTES.

To one whose lot brings him in constant contact with beginners and their productions in the photographic line, nothing seems more of a hindrance to their advancement than their uniform inability to determine whether certain results are due to under or over-exposure on the one hand, or under or over development on the other. Often I am sent prints that are clearly faulty from over-development in an unsuitable developer, and yet the sender goes to the trouble to explain that he is aware that the plate is over-exposed because the high lights are so chalky. Another will send in a print from a sadly over-exposed negative; one so badly over-exposed that the securing of proper density was out of the question except by most careful treatment, and he will explain that owing to the exposure being too short for the poor light everything comes out black in the print. It would seem needless to point out that both are wrong, and yet the error is a most common one. Let us go over the matter of a few negatives. One that gives a chalky looking print is clearly an under-exposed negative, or else it was correctly exposed and developed too long or with a too strong developer, possibly both. If you find yourself making such negatives, I would advise the employment of a more dilute developer, particularly during the warmer months, when the action of all the chemicals is accelerated by the increase in the temperature. If you have been using one of the ready prepared developers, try using Rodinal, diluting it to the limit advised on the formulæ sheet. Should development beceme too prolonged it is an easy matter to add a little of the concencrated solution. On the other hand, if your negatives have an inclination to be of character that gives you very dark prints with no high lights where they should be in the print, you are evidently giving exposure of too long duration. Try a developer that is stronger, and if possible cut down the amount of alkali in the formula used. Of course you will shorten your exposures, but there is another cause that may be to blame for the unsatisfactory nature of your negatives. Their thinness may be due to fog caused either by a leak in the camera, or through the use of an unsafe developing light. Carefully covering the camera with a focussing cloth will guard against the first, and covering the tray during development will guard against the second, at least for an exposare or two, to determine where the fault lies.—*Fayette C. Clute in Camera Craft.*

JUNIOR DEPARTMENT

For the Instruction and Information of Younger Readers.

ELEMENTARY MECHANICS.

J. A. COOLIDGE.

XI. Pumps.

In our last paper we studied barometers and siphons and learned that the air exerted such a force downward that a column of mercury 30 in. high would be held up in a barometer. If we wished to make a water barometer we should need a tube over 34 ft. long. Such a barometer has been made, but is too clumsy to be of any practical value. We also find air pressure playing an indispensable part in our common lifting or water pumps, and many a column of water in a pump is held there by the pressure of air upon the water in the well.

Let us make a rude model of a pump in order to study better the working of larger pumps. A lamp chimney from a students' lamp should be fitted tightly at its small end with a disc of wood about ½ in. thick. In this a hole from ¼ to ⅜ in. inches in diameter should be bored. A piece of tubing, *C*, glass, if possible, (a piece of metal will do. Even a piece of a "bean-blower" would answer) about 5 inches long should be fitted in *A* and a valve *V* to cover the hole should be made from a piece of leather and should be fastened by a tack in the upper part of *A*.

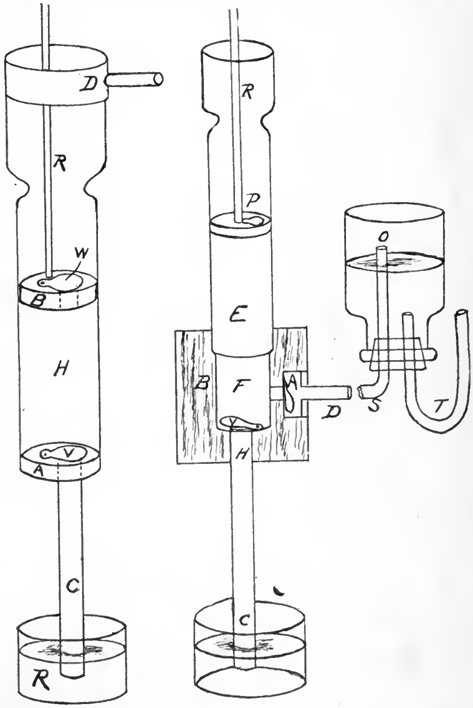
The piston *B*, made similarly to *A* but fitting more loosely into the chimney, should be attached to a rod *R* and should have a hole of the same size as in *A* with another leather valve covering this hole.

If we are content to let the water run over the top of the pump and do not care where it goes, our pump is complete. If, on the other hand, a spout is desired, one may be made in the following manner:

A collar of paper or pasteboard or several thicknesses of paper (see *D* in the figure) should be glued tightly to the top of the glass chimney and extend above it 1½ inches. In this a spout should be fastened as in the figure. A piece of some substance, as *C*, about one inch long is sufficient. This collar should be thoroughly varnished or waxed, so as not to soak water. If one prefers to bore a hole through the chimney instead of making such a collar, he can do so with a rat tail file and turpentine. It is a laborious task to make a clean hole large enough, but will repay for the work done.

EXPERIMENT XXXVIII.

Place the pump with tube *C* under water. Push down the piston *B*. If *B* fits tightly in the pump cylinder or chimney, the air in the cylinder below *B* and above *A* will be compressed and exert a strong downward pressure upon valve *V*, and equally strong upward pressure upon the valve in *A*. The result of that pressure is to shut *V* more tightly than ever and to push open the valve in *B*. The air in *H* escapes. On the upward stroke of *B* the size of the space *H* is increased and the air above tries to rush in fill this space. It cannot succeed as it merely pushes down upon the valve *W* and closes it, the air pressing upon the water



in the cistern *R* pushes it up through *C*, forces open the valve *V* and enters *H*. The next downward stroke of *B* causes *V* to shut and the water in *H* forces its way through *W* and above *B*. The next upward stroke lifts the water above *B* until it flows out through the spout *D*. Water from the cistern will continue to flow in through *C* as long as the water is lifted from *H*. The most difficult thing to understand is how the air pressure downward, caused by the weight of the air upon the water in *R*, can be transformed into an upward push of water in *R* and in the tube *C*. But as fluids exert pressure in all directions, this change of directive force is similar to the weights on the two pans of a beam balance. The air upon *R* balances the water in *C*, and as long as the tube *C* furnishes the opportunity the pressure on *R* will force the water through *C* until there is a balancing of weights. If everything were perfect the water would rise 34 ft. in any tube from which the air were removed. In an actual pump, because of imperfections, 24 ft. is about as high as the water will rise in the pump log.

In case our pump will not work at first because of *B* fitting too loosely, a little water may be poured in the top as is often done with an actual pump by a roadside in the country.

THE FORCE PUMP.

Take a block of wood at least 3 in. square and with an extension bit [Such a bit may be had of AMATEUR WORK for a reasonable price], bore a hole *E* 2 in. diameter 1 in. deep, with the same center, continue this hole *F* 1 in. diameter another inch, and with a bit large enough to hold the tube used in the common pump finish this hole through. In this hole the tube *C* is to be fastened. At the upper end of *H* a small leather valve *V* is fastened by means of a tack. In one side of the block bore another hole *A* 1 in. diameter and 1 in. deep. Continue this with a $\frac{3}{8}$ in. bit through to *F* and make another valve that will drop and cover the hole, as in the figure. Make a $\frac{3}{8}$ in. plug to fit this hole and fit into this a tube, *D*. After making these holes it would be well to paint our block inside and out with melted paraffine. One inverted chimney will fit in the hole, *E*, and may be fastened in with putty. The others should fit very tight and can be stuck in with shellac. If these joints are waxed with paraffine they will be waterproof.

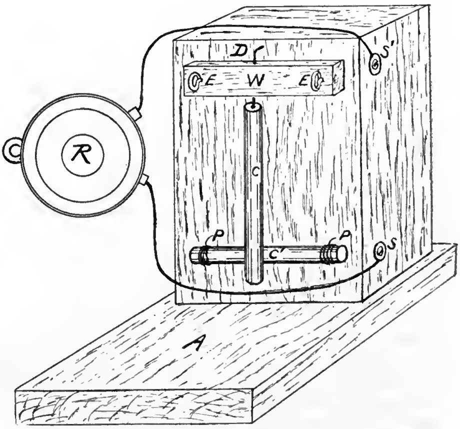
A piston, *P*, similar to the one used in the tube but of *solid wood*, should be made and fastened to a rod *R*. Our pump is now ready for work. As made it may not not pump air, but should pump water. Invert the pump, pour water through *C* until *E* and *F* are filled with water and water runs out through *D*. Hold the fingers over the end *D* and set the pump upright in a vessel of water. Push down the piston *P* and the pressure of water in *E* will close valve *V* and send out a stream through *D*. Raise the piston *P* and the pressure of air outward will press against *A*, shutting valve there, but will force the water up through *C* and valve *B*. Upon each downward stroke of *P* water will be forced out at *D*, and on each upward stroke water will be pressed up through *V* and fill the space *E* and *F*.

If a continuous flow should be wanted the tube *D* should be replaced by a bent tube, such as *S*, which should pass through a stopper into an inverted bottle. *O*. Another tube, bent as *T*, should pass through the same stopper. Holes may be made in a cork stopper by means of a rat-tail file, and bent tubes may be obtained at a druggist's, if no other dealer in town keeps them. With such an air chamber a continuous flow of water from the tube, *T*, may be obtained. The working of the valves is the same as above, but as the water passes from *S* into the chamber, *O*, and covers the opening of *T* the air in *O* is compressed and exerts a continuous pressure on the surface of the water in *O*. When the water is entering *O* through *S* the pressure is forcing it out through *T*; and when not entering, *i. e.*, the up stroke of *P*, the valve *A* prevents any water from being forced back through *S*, and the compressed air continues to keep the water running in a steady stream through *T*.

In some cases two pumps are connected with the same air chamber, and the piston of one is rising while the other falls, so that in any case there may be had a stream flowing uniformly from the hose or pump spout.

A MICROPHONE.

A microphone is one of the most important and interesting electtrical instruments which the amateur who is interested in electricity can construct. And, although extremely sensitive in its action, it is very simple in construction. For these reasons the one here described will be found of interest to those who are studying telephone work, as from it the principles governing the transmission of minute and varying currents can be readily studied.



The materials required include several short pieces of arc-light carbon, a cigar-box, two screw-eyes, a small three-cell battery such as used in night lamps, and a telephone receiver. The latter can also be made by the reader as described in the December, 1902, number of this magazine.

The illustration shows the general construction, *A* being a base board for holding the cigar-box upright, *C* and *C'* being pieces of arc-light carbon about 4 in.

long. A piece of wood W, 4 in. long and $\frac{1}{2}$ in. square is attached near the top with the two screw-eyes E, first boring holes $\frac{3}{4}$ in. from each end so that the screw-eyes will slide freely therein. Two small springs $\frac{1}{2}$ in. long are made of fine brass wire, which may be easily done by winding the wire around a wire nail of a little larger size than the serew-eyes ; the latter must be, therefore, about $1\frac{1}{2}$ in. long in the straight part, but may be of small wire gauge.

The piece of carbon C' is first attached to the box by winding two or three turns of bare copper wire P tightly around each end and then carrying the ends through holes bored in the box, and there joined together by twisting several turns close to the box and then connecting to the inside end of the screw or binding post S.

The piece of wood, W, also has a vertical hole bored in the center to receive a short piece of flexible telephone wire, D, the lower end of the latter being fitted into a small hole drilled in the end of the other piece of carbon C, and held firmly in place by a wooden plug or by soldering. It will be seen that by turning the screw-eyes in or out the pressure of the carbon C on the piece C' can be nicely adjusted. The inner end of the wire D is carried to one terminal of the battery, which is simply placed inside the cigar box. The other terminal of the battery is connected to the inner end of the screw S'. The telephone receiver R is then connected by flexible wires to the outside ends of the screws S and S', small washers having been placed under the heads to give greater and firmer contact.

In operation the microphone should be placed on a firm, level surface and the piece W adjusted by turning the screw-eyes E so that the carbon C rests very lightly on the piece C'. By placing the receiver to the ear the faintest sounds will be transmitted to the ear. A fly walking on the box will cause a quite audible sound, and the ticking of a watch on the top of the box will seem like a tremendous racket. By carrying wires connecting the receiver to another room, considerable amusement may be derived by having visitors guess the cause of the sounds that are heard in the receiver and then seeing their astonishment upon being told the real cause.

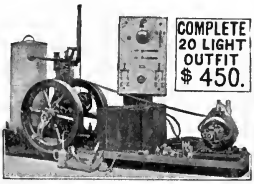
SCIENCE AND INDUSTRY.

In a paper read by Mr. F. S. Greene before the New England Cotton Manufacturers' Association, the claim is made that for power transmission in textile mills ropes are superior either to belting or electricity. The power may, he states, be thus economically transmitted a distance of 500 ft., and the two shafts coupled by the rope need not be in the same line. As compared with belting, a rope pulley is only half to two-thirds the width of a corresponding belt pulley. A rope drive is, moreover, noiseless, and electricity is not generated in the same way as it is with belting, with which constant trouble is experienced under this head in New England cotton mills. In cases in which 200 h. p. or more is to be transmitted, and where the shaft centers are more than 30 ft. apart, rope transmission is, he claims, much cheaper than electricity or belting. Estimates made for a mill in which a total of 1500 h. p. had to be distributed to three floors showed that the total cost of transmitting the power by ropes would be \$4941, by belting \$5999, and by electricity \$25,400. At need, shafts less than 30 ft. apart can be driven by ropes ; and Mr. Greene quotes a case in which 100 h. p. is transmitted by ropes (with a quarter twist) between shafts only 16 ft. apart and at right angles to each other. In this case, moreover, in order to get the requisite speed in the follower, it was necessary te use pulleys less in diameter than the usual standard minimum of 40 times the thickness of the rope. In fact, the small pulley is only 34 in. in diameter, and on it run ten $1\frac{1}{2}$-in. ropes, the speed being 5150 ft. per minute.

Palm kernels, which are the product of the palm-oil tree, are very important in the life and trade of the native African. They have a varied utility, but are principally used for making an oil called nut oil and a sort of butter called palm butter. Abroad they are used for the manufacture of soap, candles and artificial butter. The finest groves of oil palms are in Liberia at Cape Palmas, where for miles the graceful trees wave their branches. The decline of Liberian coffee has caused some farmers to consider the palm as a possible staple upon which to bestow their future labors.

We of the North are helping to ruin the next generation of Southern pines by lavish use for decorations of the young trees of about two feet high, crowded with the long drooping emerald needles. The little cut-off pine lasts a week or two in a parlor—it took four or five years to grow!

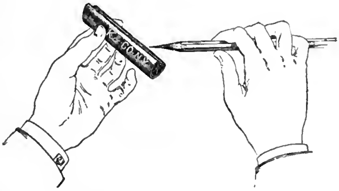
TRADE NOTES.



The illustration shows the No. 3, belted stationary, 20-light outfit sold by the Richardson Engineering Co., Hartford, Conn. This is but one o the many combination or isolated electric lighting plants shown in the catalogue of this company, and is a most compiete, usefnl and practical outfit for residences, farms, summer cottages, whether at shore or mountain, and for small requirements where simplicity and compactness are an object. This outfit will light five 16-c. p. lamps for 9 hours, or seven lamps for 5 hours, or three lamps for 16 hours on one full charge of the storage batteries. The size of house for which this outfit is designed will average three or four lights burning at one time, therefore one charge of the battery will last from four to six days and will require about one gallon of gasoline for operating the engine to charge the battery. It will be seen from this that the cost of operation is much below that charged for current by lighting companies, and merits the serious attention of anyone who is interested in lighting by electricity. Isolated plants for residence lighting are quite common in England, where commercial lighting rates are lower than in this country, and will undoubtedly be installed more generally here, now that complete outfits with the necessary directions can be purchased of one company.

Pattern makers, whether amateur or professional, will find many tools of interest in the catalogue of the Stanley Rule & Level Co., New Britain, Conn. The various tools manufactured by this firm are all of the highest material, workmanship and finish, so that a purchaser of any tool marked "Stanley" can rely on its being a good one.

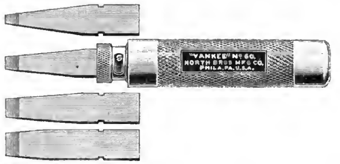
The "Duplex" Pencil Pointer, sold by Kolesch & Co., 138 Fulton St. New York City, as shown in the illustration, represents a great improvement over the ordinary sandpaper pads, while its extremely low price speaks for itself. It consists of a nicely finished and nickel-plated, semi-oval tin tube, which serves as a handle. Sliding in this and held by friction is a V shaped spring mounted with a piece of emery cloth, which serves as abrading surface. A circular channel at the bend of this spring serves as a receptacle for the lead filings, whence they can be easily shaken out without soiling the hands.



To sharpen a pencil, press the point slightly into the groove formed by the spring and draw it lengthwise from end to end, holding it steady when a flat point is required, and rotating it for a round point. The spring will adjust itself automatically to the proper contact and, owing to the curved abrading surface, a perfect point is obtained. The emery cloth will last for months ; if worn it can be easily renewed by removing the spring, in which a new sheet is inserted, whereupon it is replaced in the handle. This pencil pointer, on account of its perfection, simplicity, durability and moderate price, recommends itself to every craftsman or engineer.

The attention of readers is called to the advertisement of Hammacher, Schlemmer & Co., New York City, which appears on the front cover of this issue. This old and well known firm have lately occupied new and enlarged quarters on 5th Ave., corner 13th St., where they have every facility for displaying their exceptionally large and well selected stock of hardware and supplies. The firm has always made a specialty of orders received by mail, and intending purchasers can order with the satisfaction of knowing that all orders will receive prompt attention. A special department is devoted to manual training school needs, which will be greatly appreciated by purchasers for such schools, as it enables them to purchase all the tools and supplies of one firm. A personal visit to their new store will well repay any mechanic, either amateur or professional.

The pocket screwdriver here illustrated and manufacted by North Bros. Mfg. Co., Philadelphia, Pa., is the best thing of the kind on the market. Four different size blades are provided, all of which are contained



in the hollow handle when closed. The operation of selecting a blade and fastening in the handle is quickly done, and when in place the blade is rigidly fastened. They are now being supplied the trade and will soon be obtainable of any representative hardware dealer.

The new motors and dynamos recently advertised in these columns by Kendrick & Davis, Lebanon, N. H., are made in the same thorough and efficient manner which characterizes all of the product of this well-known firm. Every care has been taken to produce in these new machines the best which can be made. The prices at which they are sold are also quite as attractive as are the machines themselves. Every reader interested in electricity should send for the new catalogue No. 7.

The gas engines manufactured by the Carlisle & Finch Co., Cincinnati, Ohio, are particularly well adapted for running the dynamos of small electric lighting plants, or other requirements where small power is needed. They can be purchased completely finished and ready to run, or the castings in the rough or partially finished can be obtained by anyone desiring to machine their own engine.

The special attention of our readers is called to the advertisement of the Frasse Co., 32 Cortland St., New York City. In it will be found mentioned many useful tools which can be purchased, while the stock lasts, at exceptionally low prices.

E. C. Atkins & Co., Indianapolis, Ind., manufacturers of saws, knives, etc., are issuing a very artistic calendar which will be sent to manual training teachers upon request. It is well worth writing for.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

Vol. IV. No. 4. BOSTON, FEBRUARY, 1905. One Dollar a Year.

BURGLAR ALARM FITTING.

ROBERT N. STAPLES.

It is commonly supposed that burglar alarms are expensive to install, are complicated in construction, and require a considerable amount of electrical experience to maintain. Nothing could be more erroneous. Anyone who will carefully follow these directions may install alarms, and accomplish absolutely perfect results. Burglar alarms are suited for doors, windows and bulkheads of houses and workshops. and suitable apparatus may also be connected with gates, stairways, doormats and carpets, with wiring so concealed that it cannot be tampered with. By the aid of the following descriptions and diagrams, installations may be successfully made with very few tools.

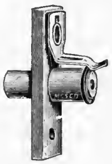


FIG. 1. OPEN CIRCUIT DOOR SPRING.

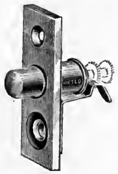


FIG. 2. CLOSED CIRCUIT DOOR SPRING.

Fig. 1 represents a type of open circuit door spring. This device is fitted in the framework of the door jamb, near the upper hinge, by boring a half-inch hole into the jamb. This device is just the reverse of a push button; that is, a push button, when pressed, connects two contact springs and completes the circuit through battery and bell. In the door spring the closed door keeps the button pressed way in, and the contact is only closed when the opening door permits the press knob to come out. In this device a door left open leaves the alarm in continuous circuit, so another device having a wide contact, or make and break device, Fig. 2, is designed to close the circuit through the bell while the door is opening and closing, but the bell does not sound when the door is completely open or closed. Another device to perform this same service is the door trip, Fig. 3, which is installed over the door on the inside, and announces the entrance of any one by ringing a bell when the door passes the trip, but is silent when open or closed.

Window springs, Fig. 4, are set into the window frame by boring or cutting a small hole in the frame itself, and a V-shaped cut made in the sash. When the window is closed the V-shaped part of the

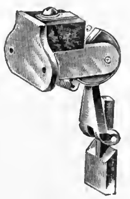
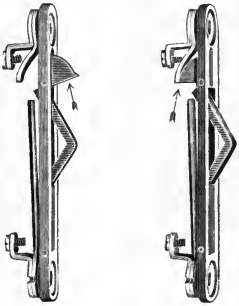


FIG. 3. DOOR TRIP.



Open. Closed.

FIG. 4. WINDOW SPRING.

device fits freely into the niche in the sash and the circuit remains open until the window is moved upward, when the V wedge is forced back into the device and rings a bell the same as any ordinary push button. This device makes one of the best burglar alarms for a store or office having a window out of the range of general observation.

Often times any of these devices may be connected to advantage to an automatic drop, Fig. 5, by which the alarm, once given, will continue ringing until the drop lever is replaced by hand.

It may be said to advantage, right here, that it is best to select an alarm bell that will keep dust proof and in perfect adjustment, and it is advisable to select a large gong, say 3½ or more inches diameter, with sufficient battery supply to bring out all the sound there is in the bell.

Electric burglar alarm matting is constructed along the lines of push buttons; that is, the carpet or matting has push button contacts all along the *under* surface, and the lightest tread on the matting rings the alarm bell. The matting is sold by the square foot and is used in front of safes, stairways and doors.

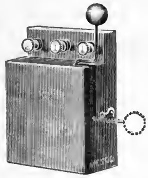


FIG. 5. AUTOMATIC DROP.

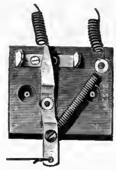


FIG. 6. ALARM TRAP.

Properly adjusted throughout a residence or store it proves a most satisfactory appliance. Fig. 6 illustrates a device which may be placed across a path or hall or

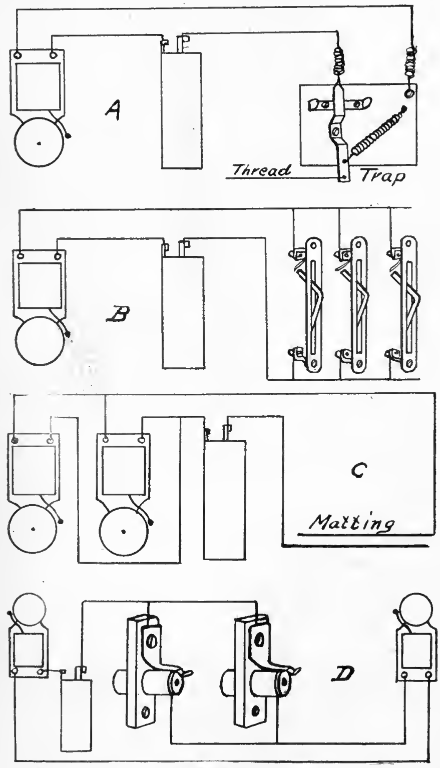


FIG. 7. ALARM CIRCUITS,

stairway, and by means of a dark and inconspicuous thread or string the alarm is set off electrically, should the thread be cut or pulled by a trespasser.

Now, as to methods of wiring. It was in the early days of bell wiring desirable that the batteries be placed on a shelf in the cellar or basement out of harm's way. But with the introduction of the dry cell much of this practice was done away with, because dry cells never leak or damage surrounding objects and may be stored on shelves or in any convenient place, at the owner's option. Dry cells are very popular for burglar alarm work and, because of their cheapness and cleanliness, are commended for this service. The best quality of insulated wire will be

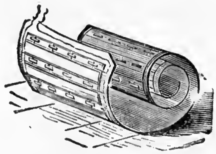


FIG. 8. ALARM MATTING.

FIG. 9. ANNUNCIATOR.

found the cheapest, and the gauge No. 18 is most desirable. Tacks should never be placed over two wires.

Fig. 7, *A*, illustrates a circuit comprising one burglar device, battery, wiring and bell. In *B* is shown one set of batteries operating one alarm bell connected to three burglar devices. In *C* we have two bells operated *in multiple* by one device and one set of batteries. Fig. *B* illustrates two bells and devices, one battery, and both bells ring when either device operates.

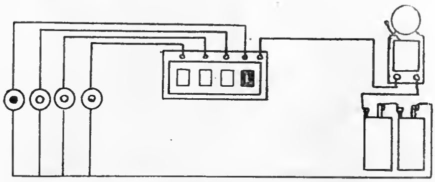


FIG. 9A. FOUR DROP ANNUNCIATOR CIRCUIT.

In connection with burglar alarms, where there are more than two doors or windows equipped it is often the practice to install "annunciators" to register the exact location of the alarm. Fig. 9 shows an annunciator of a reliable type. The names, or numbers, of the doors or windows can be noted on the shutters when desired. The cases are finished in polished hard wood and look well in any part of the house.

Fig. 9A shows an annunciator circuit for four devices which may be on doors, windows or matting as desired, a set of batteries, a loud ringing bell and an indicator for each device. Thus, the annunciator signal tells at a glance which signal has operated. By this system quicker action can be taken in time of emergency because the exact location of the trouble is known immediately.

OIL STONES.

HARRY MALONE.

The oil stone is such a simple thing that one is liable to neglect it and not give it the attention which it should have, and yet for the patternmaker it fills a very important place.

Until within a few years, all of the oil stones used were of the natural stone variety. Among the different stones found and used for sharpening tools, only two have ever found very extended use in this country. These are the Arkansas and the Waukesha. Both of these are fairly fine grained stones, of which silica is the principal ingredient. The prime requisite of any cutting stone is that it shall be composed of small angular particles of the cutting material, which are bound or cemented together with a suitable bond. This bond must be of such a strength that it will hold the particles until they have done a considerable amount of cutting and have become quite dull. When the particles have become dull enough to exert considerable resistance to the object being cut, the bond should give away and allow them to pass off with the material ground from the tool and this removal of the particles would expose fresh surface or cutting edges.

The object of oil or water on an oil stone is two-fold. First, it is used to remove the material cut from the tool in being sharpened; and second, for the removal of the particles worn from the stone. From this it is evident that the oil or other fluid used on the oil stone must be of such a nature that it will carry off these particles and that too without forming a gum which would smear and stop up the space between the cutting points. The trouble commonly known as glazing in an oil stone comes from the filling of the spaces between the cutting points, mainly with metal cut from the tool being ground, though the presence of some thick oils hastens the process greatly and the glazing material generally contains some of the particles ground or cut from the tool. To prevent glazing, a considerable amount of fluid must be used for carrying away the particles of steel and stone. The natural oil stones mentioned above possess especially fine cutting properties, coupled with an extremely fine grain, which fits them for fine work.

Natural stones, however, do not run uniform, and the stone beds are interlaced with small veins of quartz, which makes it impossible to obtain large stones clear from these quartz seams, and such seams injure the quality of the stone greatly.

The finer the oil stone, the greater care should be taken with it, and upon fine stones nothing but the best of oils should be used. Nothing will gum up an oil stone quicker than a thick, heavy machine oil. The best oils for the ordinary grades of oil stones are olive oil or sperm oil, the latter being preferable. Plenty of oil should be used and the surface wiped off frequently with a piece of waste or cloth. It must be remembered that the proper function of the oil is to carry away the cuttings and that this can not be done unless the oil itself is removed after it has become charged with the cuttings. Too many persons think that the oil is simply for a lubricant and seem to imagine that the material cut from the steel is going to evaporate in some mysterious way. If the bond of one of these oil stones is weak it sometimes overcomes all difficulty itself by breaking down readily under the heavy pressure necessary to overcome the partially glazed surface, and the necessary wiping of the tools with shavings or waste removes the oil and cuttings. But the best and highest grade oil stones do not break down as freely as this, and hence greater care should be taken with them. Frequently it is well to clean a stone which has become somewhat gummed up with gasoline or benzine. This will dissolve the oil and leave the stone with a fresh surface for work.

If the stone has become badly gummed with the heavy machine oil, it is necessary to soak the stone in a strong lye for several hours and then rinse it off in clean water and wipe it dry. The lye will cut the grease and serve to put the surface of the stone in better shape. In many shops where soda kettles are used, it is common practice for the men to dip their oil stones into the soda kettle to clean them.

If the surface of one of these natural oil stones becomes worn out of true it may be smoothed or trued up in any one of a number of ways. Small stones may be ground true very readily by applying them to one side of the grindstone. If no grindstone is at hand emery may be placed on a cast iron plate, water added, and the stone ground down by hand upon the iron surface. The plate should be planed true both to produce a true surface and to remove the scale so that the grains of emery can get a better grip on the iron.

A sheet of lead placed upon a true, flat surface, or a sheet of zinc may also be used to support the emery and water. If the stone is fairly soft, good sharp sand may sometimes be used in place of emery, but it will not cut it as fast. Where none of the above-mentioned metals are available, the emery and water are sometimes used on the surface of a smooth board. Sometimes an oil stone is dressed off by placing a sheet of sand paper or emery cloth upon a board, sprinkling it with emery, applying another coat of glue and another coat of emery, etc., until several coats have been applied and dried upon the surface. The oil stone may be very quickly trued upon the surface.

While all of the above named processes apply very well to natural oil stones, the artificial oil stones come under a very different class. There are three kinds of artificial oil stones now made. First, plain emery slips or blocks; second, Indian oil stones which are made from Indian corundum, and third, the carborundum oil stones. All of these are so hard that they cannot be ground or trued up on a grindstone. They may be trued, however, by using emery, corundum, or carborundum upon an iron plate or lap, as above described.

What has been said as to the use of oils on an oil stone applies equally well to the artificial stone, except that some of them will cut as well with water as they will with oil, providing plenty of water is used.

They say a good workman is known by his tools, but no good workman can keep his tools in good shape if he does not possess a good oil stone, and hence great care must be exercised to keep the oil stone in proper condition. No regular sharpening oil stone should be used without having a definite place to keep it, where it will be protected from the dust and dirt. For this purpose it is best to set the stone in a wooden block and provide a wooden cover for it. Some parties recommend the placing of a piece of hardwood, such as hickory, at each end of the stone and dressing it off level with the stone so that the entire surface of the stone can be used without fear of damaging the point of the tool by dragging it back off from the edge of the stone, as with the piece of wood flush with the surface of the stone the tool would simply glide over it. *Patternmaker.*

HOW TO BUILD A POWER LAUNCH.

CARL H. CLARK.

III. Getting Out and Putting On the Planking.

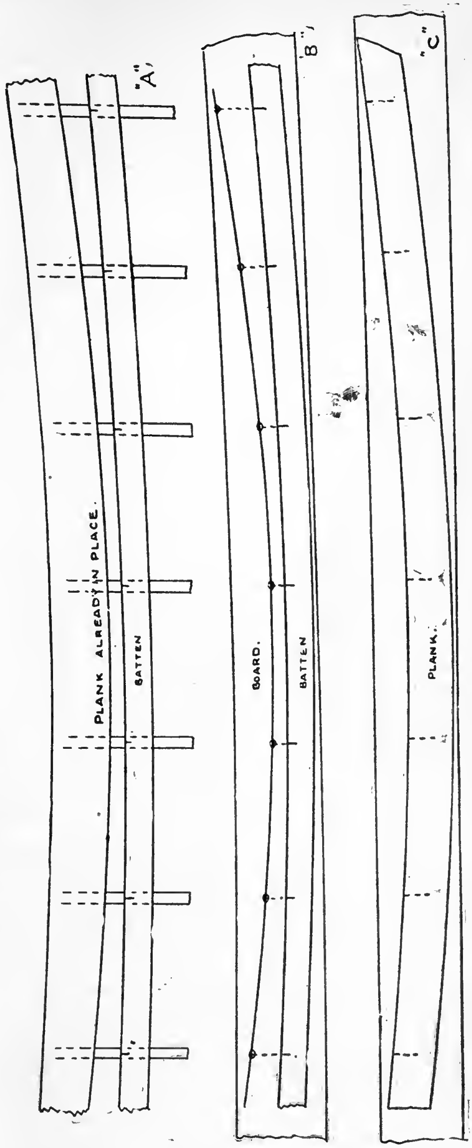
Great care must be taken that the frames do not change their shape after being bent into place. There is always a tendency for the frames to straighten out after a time, and this must be guarded against. The bilges are the points where this change is first noticed, as there will be a tendency for the bilge to become more round than when they are bent. This would give the boat less displacement than designed and be less satisfactory. It can be guarded against by laying short pieces in the bilge across the three frames between each two moulds and running a brace from them to the beams overhead. This will keep the bilges down into place and make the structure stronger during planking.

A floor, as shown in the cross section, is bent in on the top of each frame; this floor is a piece of the same section as the frame and about 24 in. long with the outer corners rounded off. It is steamed and bent down the throat of the frame and held there by a large nail driven through. These nails should be galvanized, 3 in. long and of the wire type, as they do not cut such a large hole in the floor as the cut type. It will be found necessary to bore for these rather smaller than the nail and yet have a good driving fit. In the forward end of the boat the angle of the frames will be so acute that the floors cannot be bent in, and either a natural growth knee must be used or a piece of ⅞ in. board cut to shape and fitted alongside of the frame and fastened through. At the stern, floors must be worked over the horn timbers, bent to shape or of a piece of board notched over the horn timbers and fastened alongside of the frames. These floors are a very important item in the construction, as they tie the two sides of the boat together and add greatly to its strength, although they are a matter which is often neglected by builders of small launches

The rabbet in the keel is to be trimmed out so that a ⅞ in. plank will lie on the frame and bed firmly into the rabbet. The angle will, of course, change at all points, and can be obtained by laying a piece of ⅞ in. board with square edges onto each frame and trimming out the rabbet until it fits squarely into it. The rabbet in the stern is trimmed to suit the squared end of a long piece which is bent around the frames about as the planks would run. The sternboard also must be bevelled off to the correct angles, as shown by the ribband bent around the frames and across the sternboard.

In planking, the top streak should be the first to be put on, as it will stiffen the boat, and is also the easiest. The height of the sheer, as marked on the moulds, is that of the deck or top side of the covering board, and since the covering board fits on the top of the top streak, we must fit the latter ⅞ in. below the marks already made in the moulds. A ribband should be clamped around the tops of the frames ⅞ in. below the marks already made and the sheer line marked on each frame, not only on the face, but on the sides. The plank may be either hard or soft pine, or cedar; the first is rather harder to work, but comes in long lengths and is a very strong wood, making a very smooth boat, while the two last are easy to work and fit, but come in short lengths, requiring many butts, but are, on the whole, more economical of stock. It is advised in any case, that the top streak be of oak, as it may be finished bright and is very ornamental. If possible there should be no butts in the top streak. The boards from which the planks are to be fashioned, must be much wider than the plank which they join. On account of the curvature of the plank, this width will sometimes need to be nearly double that of the plank so that the boards for this purpose ought to be 12 in. or so in width. To lay out the top streak, the boat is laid on the frames, bent around and clamped into place, the marks made on the sides of the frames are transferred to the plank, thus giving the curvature, the mould points are marked across the plank to enable it to be replaced in the same position, fore and aft. The plank is then removed and a line drawn through the points with a pattern. There will be a considerable amount of curvature to this plank so that it cannot be gotten very wide out of a single board; this width should, however, be made as great as possible, up to 7 or 8 in. The lower edge of the plank is also laid out, it being tapered somewhat toward the bow and rather narrow at the stern.

The plank is now sawed out and the edges planed carefully. It is then clamped on to the frames again and fitted to the marks, and necessary fitting done. Care is to be taken that it is replaced in exactly the same fore and aft position as when the marks were made. The forward end may be cut off to fit the rabbet; the angle can be obtained by laying a rule or straight edge across the plank and sighting it even with the edge of the rabbet. It should be cut off with a fine tooth saw, leaving a smooth end. The after end is left long for the present. In fastening the plank on, the forward end should first be clamped to the stern and pressed firmly into place then bent around and clamped wherever possible. All fastenings must be bored for and should be set below the surface of the plank ¼ in. by boring with a larger bit, the hole thus left being plugged later. At the stem and stern the fastenings are brass screws about 1⅛ or 1¾ in. long. The frame fastenings may be either copper rivets or galvanized iron nails. Brass screws are sometimes used, but the writer does not recommend them, on account of their brittleness. Galvanized iron nails are cheap and strong, but should not be too large wire, and should be clinched on the inside; this makes a very good piece of work. Copper rivets are, however, the most satisfactory fastening, although they cost somewhat more and are rather more work to put in. A boat fastened with copper is, however, more valuable, and this fastening is recommended with a washer on the inside. Nails for this purpose should be long enough so that there is about ½ in. to cut off before riveting, as in this way the strongest part of the nail is used, the point being so slim as to have but little strength. In fitting, the washer or burr is driven on to the rivet with a rivet set. This is a piece of steel with a hole in it rather larger than the rivet; and by using this and holding a heavy pointed piece of iron against the head, the burr, which should be a close fit for the nail, may be driven on tightly, drawing the plank and frame together. The end is then cut off, leaving about ¼ in to head over, which is done with a riveting hammer, the weight being held against the head as before. This makes a very firm fastening, when well done, but the hole for the nail must be a driving fit with no play, or



the nail will cripple or bend when riveted and a poor fastening will result. The top streak should be fastened thus along the lower edge into every frame and at intervals along the top edge; the latter is not very important at present. The second streak may also be put on, as it is desirable that some experience should be obtained before going to work on the more difficult planks on the bottom. On this plank it may also be possible to obtain the curvature by bending the board around and marking it, but practice should be obtained in taking the "spiling" or curvature by measurement. The space around each mould between the lower edge of the top streak and the keel should be divided up into the same number of equal parts of about the width which the planks will be. This is for use as a guide in making the several planks taper regularly towards the ends.

The method of laying out the plank is shown in the illustration; the batten is about 4 in. wide, so as to bend without springing sidewise, and about ½ in. thick. It is laid on around the frames near the edge to which the next plank is to be fitted, and clamped in place. Measurements are then taken from the edge of the planks and recorded in chalk on the bottom, together with a mark showing just where the measurement was taken; as shown in the figure, sketch *A*. It will be seen that this bottom simply locates a base line from which measurements may be taken. The bottom is then laid on the board from which the plank is to be cut, as in sketch *B*, and the measurements laid off onto the board. A line drawn through these points with a narrow batten is a very close approach to the true shape. The wide batten may now be removed and the lower edge of the plank drawn in, tapering the plank towards the ends, as before directed; the divisions already marked on the moulds will aid in making the taper equal on all the planks. When the plank is shaped it will look like sketch *C*, the mould points being marked in it to facilitate replacing it in the proper position. It is then cut out and smoothed up with a plane. The plank is then bent around in place and any discrepancies noted; the forward end is cut to fit the rabbet. It is taken down, the necessary fitting is done, and the planks may now be used as a pattern for the corresponding plank on the other side of the boat, which is fitted into place in the same manner.

The lower edge of the planks must be planed fair and true, as it will be impossible to alter it after it is fastened in place. The plank may be fastened with the nails, as before; it must be pressed firmly into the rabbet of the stem and fastened there first working from the bow toward the stern, fastening the frames in order. There should be three nails in each plank if it is over 4 in. wide, and four nails if it is 6 in. wide. The nails should be driven about ⅜ in. from the edge to make sure not to split the plank. While driving the fastenings the plank should be firmly pressed against the one above, either with clamps made for that purpose or shores from the floor; the joint should be as close as possible on the inside and just slightly open on the outside, to allow the insertion of calking without spoiling the edges. It will not be advisable to put on more than three streaks before beginning to plank at the keel.

The lowest plank, or garboard is probably the most difficult plank to fit on account of its curvature and twist. The spiling for it may be taken as already described, and it may be desirable to make an actual pattern out of ½ in. stock, which may be bent and fitted much more easily than the thick planks. This garboard will require very careful fitting, as this joint is the most troublesome of all in the boat.

The aid of shores from the floor is very helpful in holding the plank up into place during fitting. The garboard should be of about equal width the whole length, and should run to a point aft, being carried as far up the rabbet as it will go naturally, but care must be taken not to split the plank at the ends where it tapers off. The remainder of the planking can be completed in the same manner as just described.

It will be found that, owing to the curvature of the bilges, some of the planks will require to have their edges bevelled to bring them to bear, and the bilge planks will probably need to be hollowed out somewhat on the inside to fit the frames, as it will not be possible to curve the plank without splitting it.

If possible, the planks should be put on in a single length, but when the curvature is so great that a board cannot be obtained wide enough, it will be necessary to make a butt, or joint. The two pieces of the plank are to be fitted independently, and at the proper point the ends are fitted together midway between two frames, and a piece of board fitted in over the joint; the ends of the two parts are now fastened to the block, making a very strong joint. The joint should not be made on a frame.

The planking should not be a very difficult piece of work, although at first it takes a considerable amount of time, as it has been laid out here, the amateur will have obtained some little experience on the easy parts before taking up the harder parts. The fastenings of the garboard and lower stakes should be planned to go also through the floor timbers, which are on top of the frames and thus bind the plank, frame and floors firmly together.

After the planking has all been fastened and riveted it must be smoothed outside with a plane, all the uneven edges being taken off with a coarse set plane, then with a smoothing plane. The ends of the plank extending beyond the sternboard must be cut off and the ends smoothed down to the surface of the sternboard. It is hardly necessary to say that the fewer butts there are in the planking the better, and where they do occur those in adjacent planks should be in opposite ends of the boat and well shifted from one another.

After planing, the plank should be sandpapered smooth and round. All flat spots should be planed off and when finished the planking should present a perfectly smooth surface with no flat or straight spots.

The seams are now to be calked with a thread of cotton, which is driven in with a calking iron; the latter can be purchased of any dealer in marine supplies at a small cost; a mallet is used to drive it. In using, a single thread of the cotton is used, a small loop is gathered up and driven into the seams; an inch or so further along another loop is formed and driven in.

After a foot or two of length has been covered in this manner, it is gone over and driven in rather tightly. Where the seams are very small no loops may be required, the thread of cotton being driven in straight. The amount driven in should be according to the width of the seam.

Great care must be used in driving the calking, as it is possible to force the plank off the frames if it is driven too hard. It is also well to paint the seams with a very narrow brush before driving the calking, as it holds in place better when this is done. The process of calking will probably burr up the edges of the plank somewhat, and they should be gone over with sandpaper and the burr removed. It is advised that the plank should be well covered both inside and outside with a coat of linseed oil, letting it soak into the wood, this will prevent a large amount of shrinkage, especially if the boat is in a warm place. It will do no harm if the plank is painted one coat, priming paint being used.

TOOL MAKING FOR AMATEURS.

ROBERT GIBSON GRISWOLD.

VI. Making a Set of Arbors.

The tool chest of any amateur that has any pretensions at all in the line of nice machine work is not complete without a set of lathe arbors, known by some as mandrels. It is true that this set requires the use of a grinder, but one may be easily rigged up in the tool post of the lathe that will do admirable work, but the description of it will not be given until the next issue, as the lathe work of this set will require quite as much spare time as the amateur will care to put upon it in the interim.

All accurate turning upon pieces having central holes is done on these arbors, which are forced into the hole with some pressure, and the arbor is then swung between the lathe centers, being driven by a dog fastened to one end and driven by a face plate. The very truest work may be done on them, and their convenience more than pays for the expense of making.

Opinions as to the best material for this work varies, but the writer recommends the use of a good quality of tool steel, such as may be obtained in rolled steels. It is not well to trust to case hardening in such accurate tools, and a tool-steel arbor may be hardened and ground with great nicety, and it is very hard to destroy the finished surface by an accidental contact with the tool.

The sizes that will be found most useful to the amateur, together with the best lengths over all are given in the following list:

Diameter.	Length.
1/8 in.	2 in.
3-16 in.	2 1/4 in.
1/4 in.	3 in.
5-16 in.	3 1/2 in.
3/8 in.	4 in.
7-16 in	4 1/4 in.
1/2 in.	4 1/2 in.
6-16 in.	4 3/4 in.
5-8 in.	5 in.
11-16 in.	5 1/4 in.
3/4 in.	5 1/2 in.
7/8 in.	5 3/4 in.
1 in.	6 in.

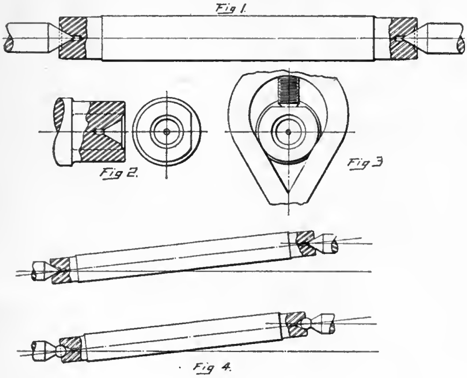
The diameter of the smaller sizes may be out of proportion for their lengths when very heavy cuts are to be taken, but if such work is intended another set of shorter arbors should be made that will stand the strain better. It is seldom necessary, however, to use the smaller sizes in heavy work.

In Fig. 1 is shown an enlarged view of how an arbor should hang on the lathe centers. The holes should be drilled deep enough so that the point of the center will not touch the bottom, thus tending to wear it to a blunt point instead of a sharp point. The depth of the taper should be such that a considerable portion of the center is taken in, so that the load will not come near the point, which in very heavy work would crack it off. Then the wearing surfaces are much larger and the wear on both the arbor bearing and the lathe center is reduced. The countersunk hole in the end does not end flush with the surface, for the following reason. When the arbor is driven into the piece to the turned, any blow on the end would cause the metal to be bruised or spread into the hole, thus causing it to run out of true. To obviate this, the end is provided with another counterbore, as shown, leaving a ridge of metal to drive on around the hole, which will prevent the hammer striking the edge of the countersink. Some mechanics prefer the edge of the hole to be rounded off in a fillet, while others prefer it terminating in a sharp edge, as shown.

The pieces of stock having been cut for the various drill in the end of the first three sizes a large 1-16 in. hole and a 3-32 in. hole in the ends of the larger sizes. Then place on the centers and take a light cut on each so that they may be run in the steady rest. Ream out the centers with a 60 ° reamer held in a drill chuck in the tail spindle, guiding the end of the arbor in the steady rest. Make this hole as true and smooth as possible, and with a tool relieve the metal for a distance of 3-32 in. away from the edge of the hole in the larger sizes, and about 1-16 in. in the smaller sizes. Then mount the arbors on the centers and turn to within about .012 or .015 in. of the finished size, this being left for grinding. The ends are turned about 1-16 in.

less in diameter than the body part, and a flat is filed filed on the side of each to take the dog screw. This is shown in Fig. 3.

All arbors are made with a slight taper in the body, the exact size being maintained in the middle, and one end is made about .001 in. small, and the opposite end



about .001 in. large. This small taper enables a very tight driving fit to be made in the piece so that the friction will hold it securely. In the sizes above ½ in. perhaps the difference may be made .0015 in. on either end. This taper need not be made in the turning, but the tail spindle should be set over sufficiently to make this difference when grinding.

Having turned all the pieces approximately to size, they are now ready to be hardened. Take time to heat them evenly throughout and then dip them in oil instead of water. In dipping, keep them perfectly vertical and do not move them to and fro, as that will have a tendency to make them bend out of shape. Move them up and down in a vertical line, while cooling. The temper should then be drawn evenly to a dark straw color, because if they are left too hard they are liable to crack when struck, or when the load is put on them.

The holes in the ends are now to be finished very carefully, because upon the accuracy of these depends the accuracy of the grinding to a great extent. Turn up a piece of copper to exactly 60° and hold in the drill chuck in the tail spindle. Then carry one end of the arbor in the steady rest and feed the copper into the hole, first covering it with very fine emery and oil. This forms a copper lay and will lap the hole out true and round if too much pressure is not used. Finish with a little crocus or rouge until a polished hole is the result. The opposite end is, of course, supported on the live center and driven by a dog. In order that it may not slip off, a strip of rawhide lacing may be tied tightly around the dog and then to the face plate.

The next operation is grinding the body, but the description of this process will be deferred until the next chapter. Prepare two ball centers, as shown in Fig. 4, making the balls about 3-16 in. in diameter and perfect spheres. Harden them and draw their temper to a purple, and polish the surface as smoothly as possible. These are to be used in grinding the arbors and correct the necessary errors introduced by setting over the tail stock. Balls can be obtained of dealers in machinists' supplies.

KEROSENE BURNERS FOR AUTOMOBILES.

J. FRAZIER BARD.

I have been experimenting on this line for the past three years. When I first took this subject up I was told by all the experts I asked for information on the subject, that it could not be done on account of the kerosene cracking under the influence of heat and clogging the passages with carbon, and also causing a smoky flame. They all said that the only practical method was that based on the spray or atomizing principle, either by pressure from the boiler or by compressed air. One of the engineers of the Westinghouse Air Brake Co., who was familiar with the attempts to burn oil in the locomotive fireboxes of several of the Southwestern railroads, told me that they had not been able to overcome these three objections—smoke, carbonization at the tip of the jet, and a loud, disagreeable, roaring noise.

I have already had some experience with jets of this type, and while I never had any trouble with carbonizing or smoke, I had never been able to suppress the roaring, and this alone made this form of burner useless on an automobile, as you could hear the burner for a quarter of a mile. Besides, it required either compressed air or steam to atomize the oil. Compressed air gives a better fire, but requires a constantly working pump to keep up the pressure in a supply tank, which should be heated by exhaust steam from the engine. Steam, while not giving quite as clean a fire, is much simpler to apply, only needing a pipe and valve from the boiler; but, on the other hand, to start the fire under a cold boiler requires air pressure to be pumped into the burner by hand until the fire has raised 15 or 20 pounds of steam. The best system of controlling the fire is to have the automatic regulator control the steam or air supply, and to supply the oil from a float-feed chamber, which would keep the oil supply level of the atomizer. I finally abandoned the atomizer principle, on account of the objection noted above, and turned to the Bunsen-burner principle.

I started out with a burner of standard design—*i. e.*, having air flues through the body of the burner. I soon found out that, except when the fire was burning very low, the pressure in the firebox was above atmospheric pressure, which caused a slight back pressure down the draught tubes in the burner. Evidently, under these conditions the tubes were useless for the purpose they were put there, and, if anything, they allowed the fire to down flash and retard the draught through the boiler rather than the reverse. I put a solid plate under the burner, practically closing the holes airtight, and the fire drew up into the boiler flues better, and gave no indication of smoke or lack of air. From this I deduced the first requirements of a satisfactory burner—viz.: that the proper amount of air for perfect combustion should be mixed with the jet of gas in the interior of the burner, and then driven by the pressure right through the firebox and up through the boiler flues. The burner being solid and the firebox airtight, and there being a slight pressure above atmosphere in the combustion space, the result is a forced draft, and there can be no such thing as back draught, even if the wind should blow straight down the stack.

I now found that my vaporizer was not making an invisible gas, but a misty sort of steam when the burner was on full, but when throttled down about one-half it was invisible, until the automatic valve shut down to its lowest limit, when the vapor again became visible. The vaporizer plainly was not heating the oil hot enough to make a superheated vapor, first when the valve was supplying fuel to the full limit of the nozzle, and secondly, when the pressure in the burner dropped and allowed the fire to drop down under the vaporizer. I now found that the jet and cooler parts of my vaporizer began to clog with carbon; but the hottest parts showed no signs of deposit. From this I argued that the vaporizer must be red-hot all the time, and not allowed to flood into a partly-cooled vaporizer to recondense the vapor and deposit the carbon. I had now found requirement number two.

As my burner could not very well be adapted to an inclosed pilot light to keep a continuous heat on the vaporizer, I began looking for a burner which had a pilot light built into the body of the burner. I found a burner on the market which seemed to embody both my requirements. I fitted one to my car, and with it I fitted an automomatic regulator which would control the oil supply before it reached the burner and cut it off entirely when the steam pressure rose so the predetermined point, leaving the pilot to keep the vaporizer hot. I soon found that increasing the oil supply up to a certain point would increase the fire correspondingly; but beyond that point the vaporizing tube would seem to be unable to take care of the oil, and would flood just like a flash boiler when more water is supplied than the fire can evaporate. I remedied this by increasing the length of the vaporizer coil, which consisted of a piece of seamless steel tube of 1½ in. pipe size.

The burner has been in use since August, 1903, and has driven my car upwards of 4000 miles. The vaporizer has never shown the least sign of carbon deposit, and the gauze strainer in the tip of the jet has only been examined three or four times, and each time only a few pieces of scale from the inside of the tube were found to have lodged in it. This, to me, is absolute proof that coal oil will not deposit any carbon when vaporized in a red-hot tube, and not allowed to cool or recondense before it is delivered to the burner. The burner itself shows no signs of carbon and burns a perfectly blue flame with never a sign of smoke. This method of burning the fuel is practically the same as in an internal-combustion engine, as after they have introduced the proper mixture of air and fuel, it is not considered necessary to have any additional valves for introducing more air during the combustion stroke, so why should there be any additional air introduced into the firebox under a boiler if there is already the proper proportion mixed with the fuel before it issues from the burner? This proportion is easy to obtain by simply varying the distance between the jet and the mixing-tube, and this proportion will remain nearly constant, automatically, as the airfeed will vary with the velocity of the jet of vapor. The fact that you have a combustion mixture in the burner would at first sight promise lots of trouble from back-firing into the interior of the burner; but, as a matter of fact, this never happened to me but once, and then was caused by the door in the casing being left open and the flame flaring out and igniting the gas at the jet.

To sum up, the requirements of a kerosene burner are:

1. No air supply to flame, except the proper proportion for complete combustion, which shall be intimately mixed with the vapor before ignition. This means a closed firebox.

2. All regulation of fuel to take place before vaporization. This means no cracked oil or condensed vapor in tubes, and hence no deposit of carbon.

3. Ample vaporizing coil kept at a cherry-red heat. This means perfectly dry vapor, no matter how hard the burner is forced by high pressure on fuel.

A burner which fulfils the above conditions will give satisfactory results and vaporize and burn kerosene oil for an indefinite period without any of the troubles which every one seems to think are inseparable from using kerosene. The above is not a "theoretical dream," but an actual demonstrated fact, and some day will put the steamer where it belongs, as the finest touring machine to be had.—*Horseless Age.*

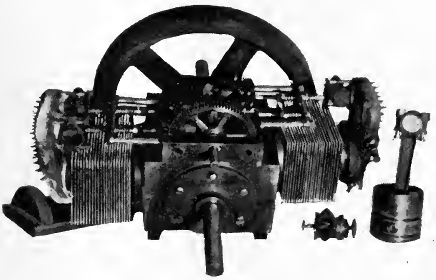
A GASOLINE TOURING CAR.

R. G. GRISWOLD.

III. Two Cylinder Air Cooled Engine.

As with every mechanism requiring a prime mover there exists a variety of motors that may be used for power purposes; in each class there also exists a number of types from which to select. The type adopted for this car has been chosen for several reasons, which will be enumerated.

As will be seen from Fig 7, it is a horizontal engine with two opposed cylinders. When well made this type of engine is in almost perfect balance, and runs at a high speed with remarkably little vibration, which can be scarcely felt in the car. The rating of any engine depends upon its revolutions, for one factor, while all others are supposed to remain constant. In this particular instance the rating is 15 h. p. at 1100 revolutions.



In regard to the cooling medium adopted, the illustration plainly shows that it is air. The air cooled motor, now being adopted by many of the largest automobile manufacturers, is free from many of the annoyances attending the water-cooled engine. There is no radiator, with its leaky tubes to bother with, no extra tank of water to carry, and no pump to drive. The saving in dead weight alone is a very important consideration.

The heat in this motor is carried away from the cylinder walls by means of copper flanges forced on. Copper has a high factor of conductivity for heat, and if sufficient area is given for the cooling action of the air, will keep the cylinder walls quite cool enough.

It is a popular fancy that a gasoline engine should be cooled down to a very low point, while the cylinders of a steam engine should be heated to as high a point as possible. But why so? They are both thermal engines, and certainly if the residual heat of the walls can be used to good advantage in the latter, why not in the former? The mathematical reasoning proves it to be a fact, so the fault must lie in some constructual feature if trouble is experienced. The greatest fault is here: The sliding surfaces of the cylinders and pistons must be lubricated, and the high temperature readily chars the oil; but now that oil manufacturers have given us high-test oils, if we can keep the wall temperature down to about 500° we need have little trouble. Beyond the lubricant problem comes the valve stem question. The high temperatures of the exhaust gases will often cause the stems to warp, if sufficient shield is not provided, and this readily allows leakage past the valve.

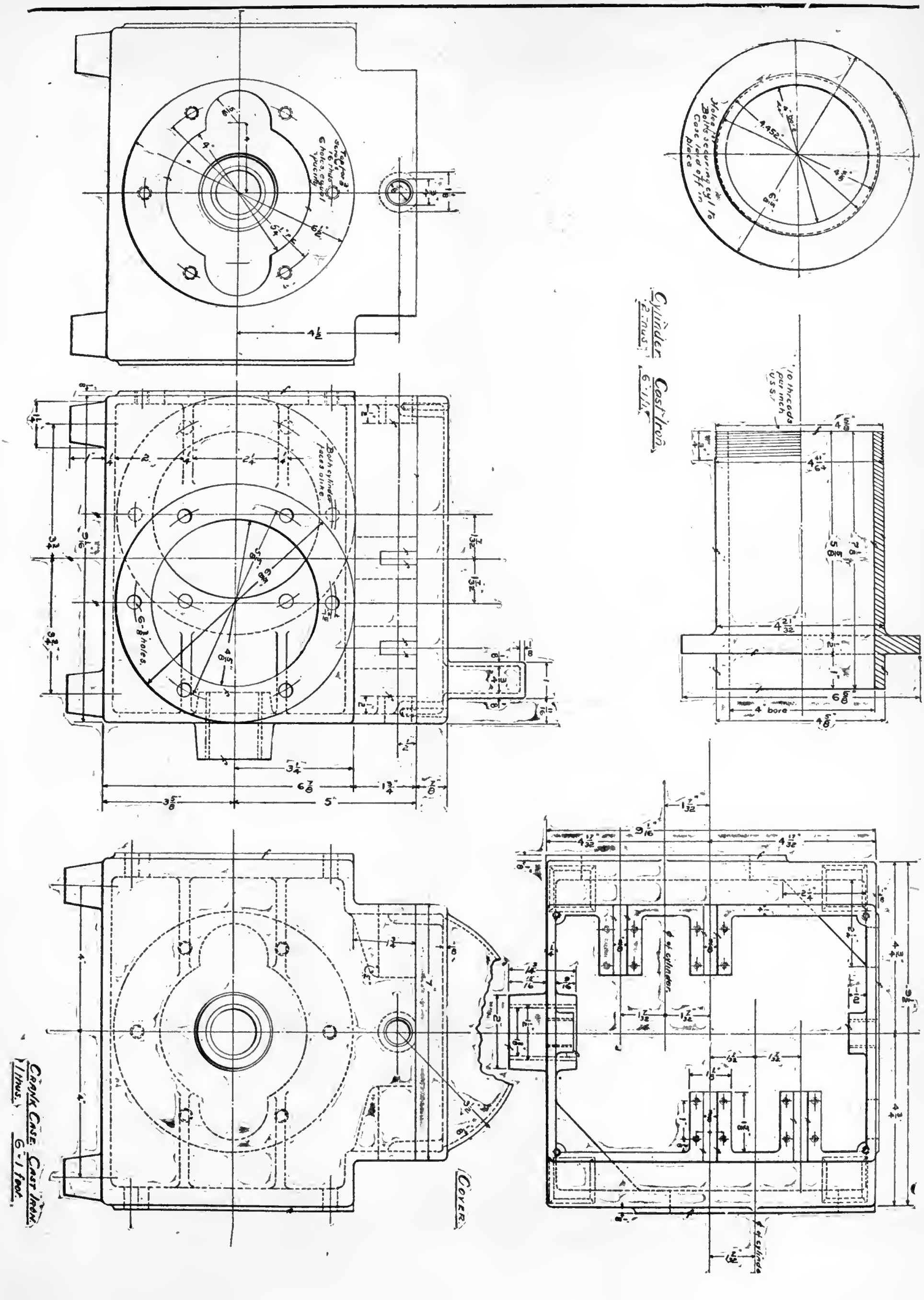
In this type of engine the reciprocating parts can be mechanically balanced without the adoption of web balance weights. Owing to this fact the parts may be made very light without materially reducing their strength. The advantages of the four cycle type may be obtained and still have an impulse every revolution by placing the cranks 180° apart. With the vertical types this is only possible with the cranks together, and both pistons travelling in sychronism, and owing to a balance being effected by means of web weights attached to the cranks, the effect of the reciprocating parts can be balanced at one speed only.

Furthermore, this method entails considerably greater work in machining the parts. If vertical two-cycle cylinders are used, the cranks may be 180° apart and two impulses per revolution obtained, but this necessitates a two-part crank case with a middle bearing and its consequent inaccessibility, together with a far more deficiently machined shaft. All points considered, the horizontal opposed type is probably the best suited for amateur construction.

The cylinders are cooled by means of copper flanges forced on to the cylinder shell. This method is considered superior to that employing cast ribs, on account of lightness and the greater conductivity for heat of copper over cast iron. In this engine the valves are each carried in a separate casing, which may be readily removed for regrinding by inspection. The heaps and valves may be removed and replaced without disturbing any of the valve gear.

The completed engine is shown in Fig. 1 with one one piston and its rod standing beside the cylinder. The engine measures over cylinders, 26½ in. and 12⅞ in. in height, while the the crank shaft may be made anything over 15 in. The fly-wheel is 19 in. in diameter with a 2 x 3 in. run.

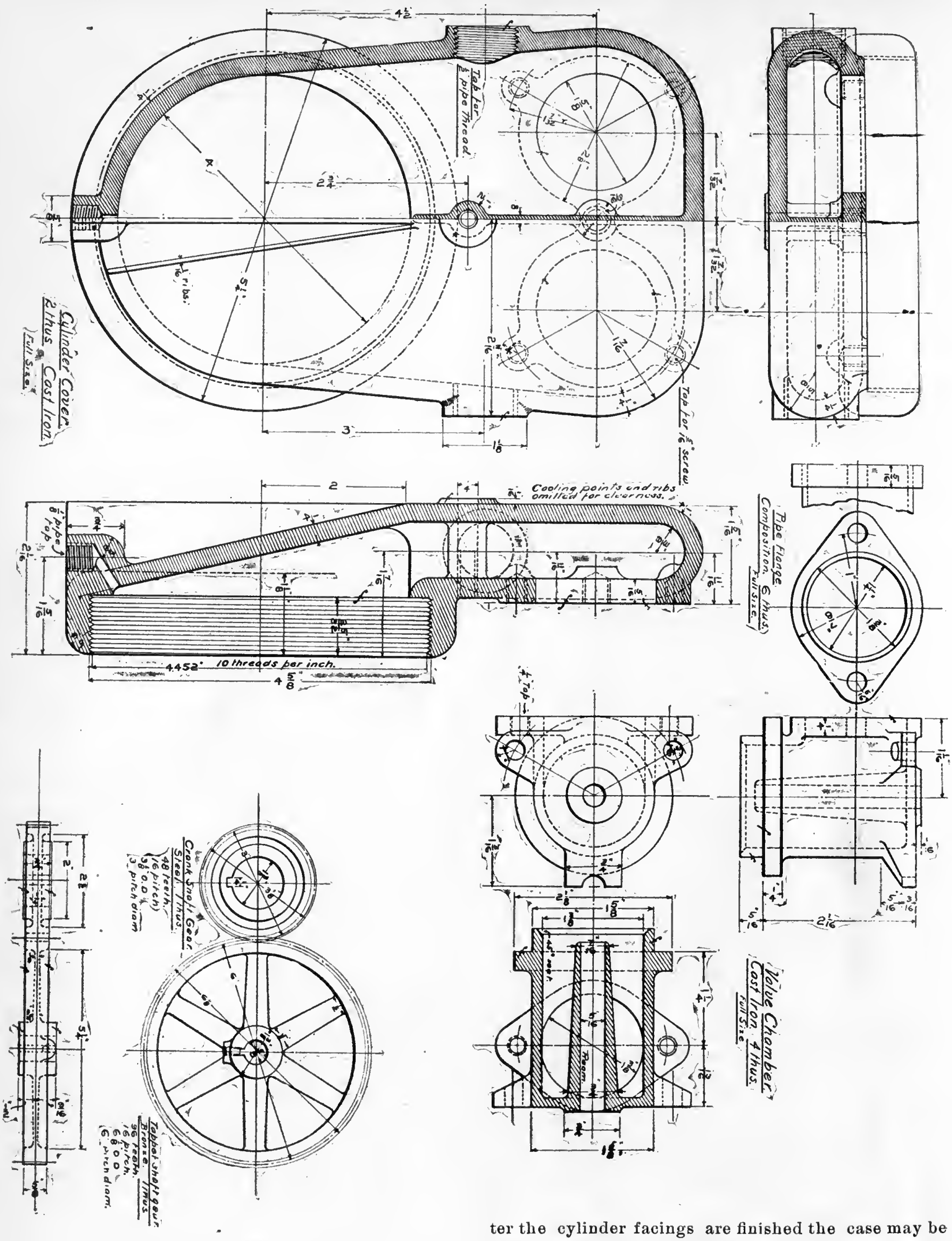
Fig. 2 shows the details of the crank case and cylinder. The bottoms of the feet should be planed first to give a solid foundation for setting while performing the other operations. Then face the seat for the crank shaft loose bearing. This gives a large surface to square by for facing and boring the cylinder seatings.



Cylinder Cast Iron 2 thus 6-1 lb.

Crank Case Cast Iron 1 thus 6-1 foot.

Cover.



The top cover joint may now be planed up parallel with the feet, and also the under side of the cover. After the cylinder facings are finished the case may be bored for the shaft, care being used to get the shaft bearings exactly square with the cylinders. The loose bearings will be shown on another detail sheet. The bolt holes may now be located and drilled, which will practically finish the case.

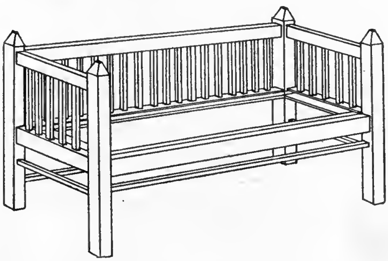
The cylinders are very simple pieces and require no intricate lathe work. The outside is given a very slight taper, so that the copper flanges, as they are spread on, will be a very close, tight fit. Upon this close fit largely depends their good heat conducting qualities. The bolt holes in the cylinder should not be drilled until the heads have been fitted and the cylinders put in place, when the holes may be laid on from the case.

Fig. 3 shows the details of the cylinder heads, valve chambers and valve gears. The heads are divided into two compartments, one carrying the cool, incoming gases, and the other the exhaust gases. The spark plug is situated in the inlet chamber, where the cool, incoming gases sweep by it and clear all carbon or soot deposit from it. The cooling points and vanes have purposely been omitted from this drawing for the sake of clearness. The head screws up against an asbestos gasket which cannot blow out. The valve chambers are readily machined and need no further description. The various other details will be shown in the next chapter.

A LIBRARY SETTLE.

JOHN F. ADAMS.

The settle here described, while more particularly suitable for the library, will also be found a very useful piece of furniture for sitting-room, den or hall. It is four feet long and can be made of oak, stained to match other furniture, or in mahogany or gum-wood will look well. The seat is upholstered and fitted with stuffed cushions made with a box edge, as with a bed mattress.



The corner posts are 45 in. long and 2 in. square; the top ends having a 2 in. bevel, leaving the ends ⅝ in. square. The cross-pieces are 1⅝ in. square; those for the back being 47 in. long, and for the ends, 15 in. long, allowing 1½ in. on each end for tenons. The spindles are 13½ in. long and made from ⅝ in. square stock spaced 1½ in. apart. There are 5 at each end and 21 at the back, thus requiring that the end spaces be 1⅝ in. wide. The mortises for the spindles should be slightly over ½ in. deep and accurately spaced and carefully cut to gauge lines made with a marking gauge.

The top cross-pieces are 2½ in. below top of the posts and those at the seat are 13 in. below the top ones. The smaller cross-pieces under the seat are also ⅝ in. square, and of the same lengths are the larger ones. The front one is 2 in., those at the ends 3½ in., and the back one 6 in. below the cross-pieces for the seat. Care should be used in making the mortises for these pieces that their direction is exactly square with the posts to avoid any bending when the frame is finally put together.

Inside the cross-pieces forming the seat is fitted a frame of 1½ x ⅝ in. stock, the upper edge of which is ½ in. below the top surface of the seat. To the frame are tacked the strips of webbing for the seat. The webbing may be of any width conveniently obtained, and should be woven after the fashion of willow seat piazza chairs, the ends being firmly tacked to the frame. A thin tufting of hair or jute can then be laid on and covered with cambric, also tacked to the frame. If cushions are not desired, the seat can be covered with leather, fastened with large flathead upholstering nails of a suitable enamel color. If such nails are used a piece of leather or carpeting must be placed on the head when hammering, to avoid breaking off the enamel. If casters are used, the legs should be cut off to make allowance for same.

Those who wonder whether wireless telegraphy is really practical should notice what Gen. Greeley, chief of the army signal service, has to say on the subject. He is enthusiastic over the success attending the installation of a wireless system in Alaska. Hundreds of messages are being transmitted daily between Cape Nome and St Michael, a distance of 160 miles across Norton Sound. "Very little has been said about it in the public press," writes Gen. Greeley, "but we are demonstrating every hour of the day up in Alaska that a practical, working wireless telegraph system is possible. Our system has been operated there for more than a year, and with most complete success. Thousands of messages have been transmitted between the two points, and not only the private citizens but the government officials of that neighborhood are now largely dependent upon it. It is no longer an experiment. It is used for commercial purposes as well as for government business.

AMATEUR WORK.

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Entered at the Post Office, Boston, as second class mail matter, Jan. 14, 1902.

FEBRUARY, 1905.

That the readers of this magazine are interested in the forthcoming description of a small, easily constructed runabout, is abundantly shown by the large number of letters we have received in response to the editorial inquiry in the January issue. We are, therefore, having a description of such a vehicle prepared, and the first chapter will undoubtedly be published in the March issue of this magazine. We are able to state at this time that the design will be one which will admit of construction with a minimum tool outfit; in addition, the machine work will be reduced to the least possible amount. In this connection we shall endeavor to give information which will enable those building the vehicle to obtain the various parts at the lowest possible cost, and have been successful in locating quite a stock of such parts, which will be offered to readers of this magazine at exceptionally low prices. This description will be, therefore, of more than ordinary value, as it will enable many of our readers to gratify their desire to be included in the ranks of automobile owners.

We anticipate that the number who will be interested in this description will be large, as there are many machinists working in shops where the tool equipment could be utilized during spare time for the necessary machine work, as well as an equally large number of advanced pupils in Manual Training Schools who are also fortunate in having the necessary tool equipment at their command. Both of these classes will find the work of constructing this car easily within their capacity, and we shall anticipate the pleasure of hearing from the makers of the "Amateur" automobile as the description proceeds. Special attention will be given to answering the inquiries of any one finding it necessary to make them.

It will be noted that this number appears in a uniform dress of type. The change to the smaller size throughout the whole of the magazine enables us to present the equivalent of about three additional pages of reading matter, which we are confident will be appreciated by our readers.

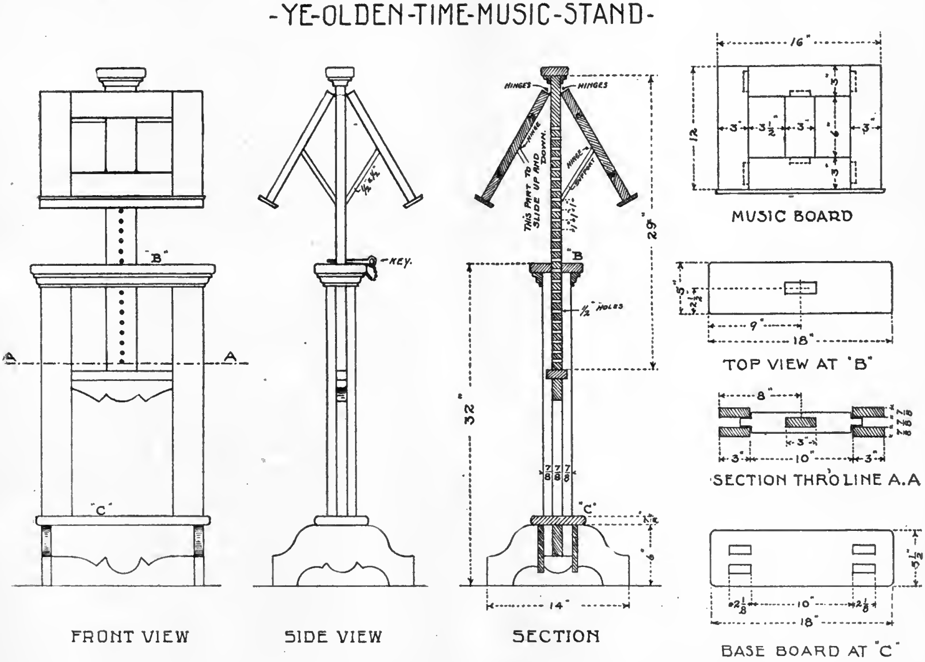
A new alloy of aluminum which is claimed to have special qualities has been produced in Germany. It is known as zimalium. The alloy is formed by adding small quantities of manganese and zinc to aluminum infusion. It is harder than pure aluminum and takes the tool better. A sheet of the metal shows a traction resistance of twenty-five to thirty-five kilos per square millimetre, which is double that of aluminum. The wire has a resistance of thirty to thirty-seven kilos per square millimetre and an elongation of ten per cent. In some respects it acts like brass wire. The cast metal is easily filed, forged and drilled. The alloy has a lower conductivity than the pure metal, but its price is ten to twelve per cent less.

A new electric furnace method has been invented by a Frenchman, M. A. Nodon. The electro-negative metal is fused and used as a cathode in an electric furnace with a non-attackable substance, as an anode and an electrolyte of a fusible, only slightly volatile, halogen compound of the more electro-positive metal. When a current is passed through, the ionization produces a combination of the metals with liberation of the halogen. Other metals can be incorporated, the precautions necessary and the factors controlling the proportions required being described.

YE OLDEN TIME MUSIC STAND.

THOMAS LLOYD.

This music stand is a very handy piece of furniture in the home where music predominates. On one side stands the instructor, on the other the pupil. It is preferably made of mahogany, but other woods can be used and stained as desired.



The music boards are made from ⅛ in. stock and well tongued into each other, as shown. They are to have strips ½ in. thick nailed to the lower edges to support sheet music, etc. These music boards are to be hinged to a supporting upright so that they can be moved to any angle desired. The boards are held at an angle by a small piece of wood ½ x ½ x 6 in. One end of this piece is hinged to the back of the center strip of the music board, the other end is pointed to fit in the holes made in the supporting upright.

The supporting upright is made to slide up and down in the main body frame. It is to have ½ in. holes bored into it, as shown, through its entire thickness, 1 in. from center to center. A key turned from wood is made to fit these holes to hold the sliding upright at whatever height desirable. This key may be fastened to the frame with a neat brass chain. All parts of the main body frame should be assembled in a workmanlike manner, so that the sliding parts will have free movement.

Among the more notable recent German inventions in the field of applied science is an electric resistance material for heating purposes, to which the name of "kryptol" has been given. The exact method of its preparation is not disclosed by the patent specification, but it is a mixture of graphite, carborundum and clay, and is made in four grades of coarseness. The property of kryptol upon which its efficiency depends is the fact that it offers to an electric current the requisite degree of resistance to generate a high degree of heat without destruction to its own substance. In its application to a cooking stove kryptol is sprinkled over an earthenware plate, and upon the current being switched on it readily generates sufficient heat to boil a kettle of water in three or four minutes.

PATTERN MAKING FOR AMATEURS.

F. W. PUTNAM.

XII. A Small Hand Wheel.

Fig. 76 shows a small hand wheel for a rapid-acting woodworker's vise, and Fig. 77 the pattern for same. It will be noticed that a hole ¾ in. in diameter is to be bored through the hub, and a small key-way cut out. This is done after the casting is made and does not concern tne pattern maker. This pattern may be made from one piece of stock 6¼ in. square and 1¾ in. thick. A circle 6 3-16 in. is marked on the block; and after the block has been cut to this circle it is placed on a screw center, and one side is turned up. The side which is turned first is the side *A*, Fig. 77. A templet should be made to fit the hollow at *B*. A templet to fit the arc of the circle at *C* will also be found useful. Care must be taken in hollowing out at *B* to get the depth exactly ¼ in. After the first side has been turned and sand-papered, a center mark is made at the center of the hub to serve for the hole for the screw center when the pattern is turned around. The opposite side is now to be turned, the rim being finished first. It will be noticed that the rim takes the shape of a ¾-in. circle; and it will be found advisable to finish this before the hollow at *B* is cut in. There should be left a thickness of ¼ in. for the arms or spokes of the wheel. The pattern is to be drawn out from the sand in the direction shown in the arrow and the hub should, therefore, receive a little draft. When the pattern has been finished in the lathe, the next thing to do is the marking out of the four arms. The grain should run parallel with two of the arms, thus leaving but two of the arms with cross grain. The top view of Fig. 77 gives the dimensions for marking out the hole necessary to form the sides of the arms. The arcs of circles

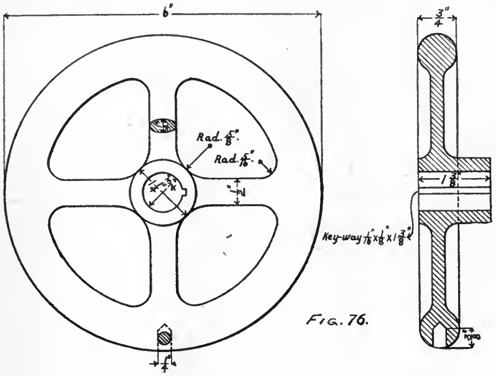


FIG. 76.

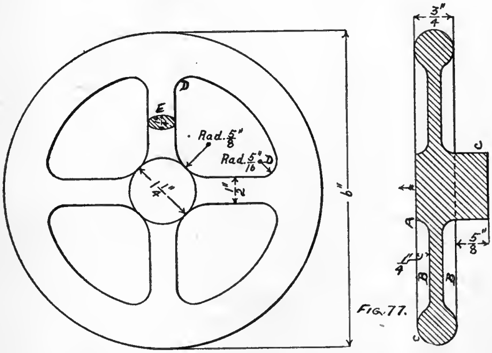


FIG. 77.

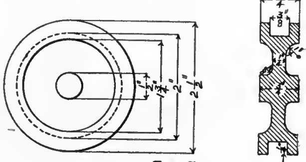


FIG. 78.

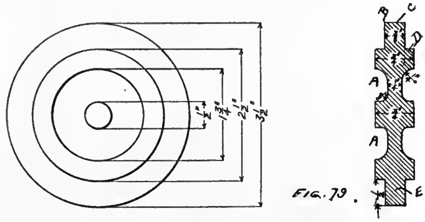


FIG. 79.

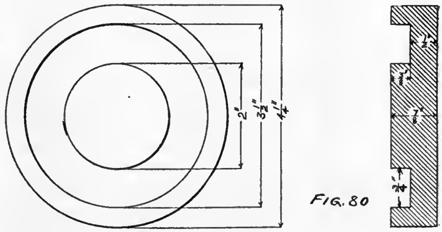


FIG. 80

at *D* may be bored, preferably with a Forstner bit. This bit has no spur and therefore the stock—which is but ½ in. thick—will not split so readily as it would if a bit with a spur were used. A small key-hole saw may be used for cutting away the remainder of the wood. The arms are to be round, as shown in the section at *E*, Fig. 77. This is done with a small half-round file. Care must be taken in filing the two arms having cross grain so as not to cause them to split. All holes should be bored before any extra material is removed. The filing is done after all surplus material is removed. The surfaces cut away should finally be sandpapered, and the pattern finished as usual. This pattern might have been made with inserted arms, as was done in the case of the small hand wheel described in the December number of AMATEUR WORK.

Fig. 78 shows the casting for a small wheel cut out at the rim to receive a small, round belt. This pattern requires a special sprue in molding, and the method of using this sprue will be taken up in a later article. The pattern, which is shown in Fig. 79, is to be turned first, and then the block is turned around so that the other half may be turned. Both sides of the pattern are alike and care must be taken to make all measurements the same on both sides. This pattern is molded so that the parting line between the cope and nowell comes at *B*, Fig. 79. A little draft will be necessary both on the surface *C* and at *D*. This pattern is much smaller than the one just described for the hand wheel, and trouble may be experienced when the block is turned around on the screw center for the turning of the second side, because of the running out of the block. If this trouble is experienced the block had better be chucked.

Fig. 80 shows the corebox which is used with the pattern shown in Fig. 79. The right end view is a section drawing made to show the shape of the body of the ring. A core made in this sort of a corebox is known as a ring core. It will be noticed that the core print, *E*, projects out from the pattern ½ in. The width of the core itself is ¾ in., showing that the casting is to have a recess of ¼ in to receive the belt. Care must be taken in turning the corebox on the screw center to have a little draft so that the core may be readily withdrawn from the box. The measurements must be exact. If the corebox were made a little too large, the core would not set down into the mold made by the pattern. For a pattern of this kind it is found desirable to use mahogany instead of pine, as the block is apt to warp after the first side has been turned up.

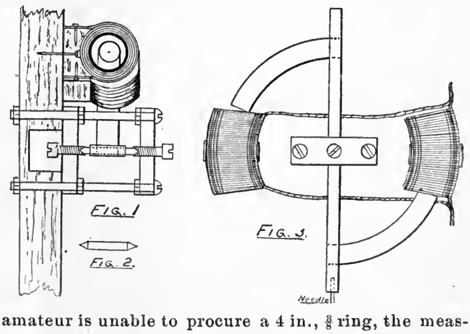
AN EASILY MADE AM-METER.

OSCAR N. DAME.

Every amateur should possess an accurate amater for measuring battery current and general laboratory testing. While the high grade instruments for sale by apparatus dealers are beyond the means of most students, it is possible to construct an efficient instrument for a small sum. Much of the construction can be done with ordinary household tools, but there are a few portions of the meter which require absolute alignment, and which will give better satisfaction if fitted by an experienced hand. This instrument is to be used in a vertical position, presumably fastened to the wall near the work bench or test table.

Upon the true workings of the bearings depends the accuracy of the machine. The style of pivot is shown in Fig. 1. With this conical indentation cut smoothly and accurately in the end of a machine screw with a fine jewellers' drill, and a hardened staff constructed of a piece of old clock staff, as in Fig. 2, there should be little friction. If, however, the reader should desire jewelled accuracy, I would advise him to construct all of the instrument except the pivot portion, and then send his machine screws to a jewel setter, who will insert ordinary jewels for about fifty cents each. While the dollar spent for this professional assistance may add greatly to the accuracy, I believe for ordinary purposes it is just as well to construct without jewels, as I did my first one, and attend to the improvements afterwards, if it does not meet all requirements.

Procure a soft iron ring 4 in. in diameter, of ⅜ in. stock. Such a ring is sold at all hardware stores for hitching posts, etc. Procure a piece of brass 5 in. long ⅜ wide by 3-16 thick. Measure one half inch from one end and center for a ⅜ in. hole, to be drilled there. Center also 4 in. below and drill a second ⅜ hole. It will be seen that these holes apply to a 4 in., ⅜ ring. If the



amateur is unable to procure a 4 in., ⅜ ring, the measurement given for holes will have to be altered to conform. Next, by two cuts of the hack saw cut out about 1 in. of the ring. This will permit slipping the rings into the holes in the brass rod. Solder is then carefully applied to hold the ring in place. Find half the distance between the inside edges of the ring and mark same on the brass rod. Here a 1/8 hole is to be drilled where the staff is to be placed and fixed with solder.

Procure a piece of clock steel, 1/8 stock and 1 in. long, and fashion as in Fig. 2. The ends should be hardened and polished. When this steel is soldered into the shaft there will be about 1/8 of an inch of each end visible. For bearings use two 8-32 machine screws 1/2 in. long. In the end of each drill smoothly to receive the end of the staff. For supports of this bearing take two strips of brass 1/4 x 1/2 x 1 1/2. Holes are drilled near the ends and in the center of these pieces and, with machine screws and nuts to fit, a support exactly like the figure is constructed. If the screws are quite long they will serve to pass through the base board. Next, with a tape measure mark off four inches of the ring at top and bottom and cut off this portion. See Fig. 1. Place pendulum in bearings and adjust to swing easily.

The two solenoids are formed of paper, fiber or hard rubber and should be fully 5/8 inside diameter and 1 1/4 long, smooth inside and bent to conform with the shape of the metal ring pieces which enter them. Each tube should be wound with four layers of No. 20 magnet wire. The tubes are then fastened to the baseboard, as in Fig. 3, by means of metal clips. Fig. 3 also shows the circuit connections. A small 1-16 in. hole is drilled in the lower end of the pendulum and a fine long steel needle inserted for a pointer. To grade this instrument accurately will require some experimenting. A step by step comparison with a standard instrument would be the best way, but with batteries of known voltage and amperage the instrument may be calibrated to meet all ordinary requirements by the insertion of variable resistances in one of the battery wires (thus increasing the resistance of this circuit).

Calculate by one of the formulas of ohms law: $\frac{E}{R} = C$

For instance: A new dry cell, as tested at the electrical stores, might show 1.4 volts and 7 amperes on short circuit.

Thus: $\frac{1.4}{7} = \frac{2}{10}$ ohms internal resistance.

Any resistauce inserted in the external curcuit will cut down the current. And from any standard wire table showing resistance of different gauges of wire per inch, one can prepare sufficient resistances to cut down the current to any desired degree. For example:—The resistance of our two coils is a very small part of an ohm and need not be reckoned with. With 1.4 volts and 2-10 ohms we have 7 amperes. By inserting 1 2-10 ohms additional resistance we have:

$$\frac{1.4}{1.2 + .2} = \frac{1.4}{1.4} = 1 \text{ ampere.}$$

NOTES ON WIRELESS TEEGRAPHY.

L. T. KNIGHT.

IV. Course of the Transmitted Wave and Frequency..

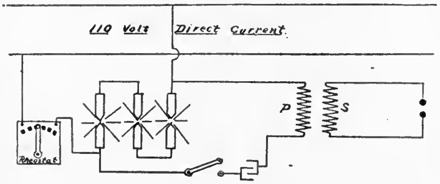
During the early experiments with telephone transmissions in the original installation between Boston and Providence, a distance of about 50 miles, an enormous battery supply was held in readiness for the first conversation, and it is said to the great surprise of all present in the room where the tests were made, the amount of voltage was cut down from 50 to that of two primary cells, and no harm to transmission resulted.

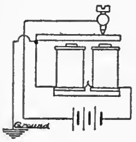
In the early Atlantic cable tests heavy battery soon gave way to weak battery because experts found the feebler currents more reliable. Now in the present era, with wireless telegraphy foremost in the mind of every transmission specialist, we find the different systems struggling for supremacy by the use of enormously high poles, ranging from 175 to 210 feet in height, and by transformed voltages reaching into six figures. Scores of systems have been patented at the patent offices of this and foreign countries, and in nearly every instance the systems have called for aerials stretching as far into the heavens as the skill of man will permit, following the theory that the effective part of the wire is at the upper end. And where single wires are used it is considered necessary to fit a huge wire capacity cage at the upper end, and the length of this aerial wire from instrument to peak is a factor in determining the wave length.

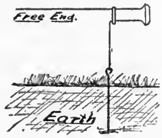
Presuming that the transmitted wave leaves the aerial at the peak, its course to the other station was construed to be in a straight line, and the expounding of this theory has filled chapter after chapter, and one of the recent books on the subject, in a full page illustration, scales out the course of Marconi's wonderful messages from Canada to Great Britain with dotted precision, explaining the curvature of the earth and the drop of many miles below the ocean's surface which the waves must have taken because of this curvature.

Those who have experimented exhaustively in this matter, find that a transmitted wave leaves the aerial wire perhaps at the peak, and perhaps a short distance from the peak, and its course to the receiving aerial is determined by atmospheric conditions and not by any B line from the top of a 180 foot pole to a 120 foot pole situated on a hill top. It is, therefore, worth prophecying that the high poles will soon be a thing of the past and waves will be energized by moderately high voltage and extraordinary frequencies. And at the receiving end the coherer and wave detector of the present will be superseded by devices tuned to receive frequencies and not wave volume or wave length.

One of the best systems of generating alternating currents of high frequency is here illustrated. Its design is simple, and any amateur possessing a few electric light carbons and a condenser of the Leyden jar type, may produce frequencies beyond 10,000 per second. The ordinary 110 volt current is tapped as shown in the illustration. The choke coil has a variable resistance. The capacity of the condenser should be 10 M. F.







To increase the secondary frequency still further, one may construct a frequency coil out of two battery or other smooth jars, one being 4 in. in diameter and about 6 or 7 in. high, and the other 8 in. in diameter and the same height. The smaller jar is wound with one layer of No. 36 bare or covered magnet wire from an inch at the bottom to the top, and each turn must be separated from the adjoining turn fully 1-16 of an inch. A hole is made in the bottom of the jar, and the lower end of the wire is brought up through to the top where it pairs with the other end. On the larger jar is wound in turns ½ in. apart, one layer of flat, thin strip metal, preferably of good conductivity. These strips may be ½ in. wide. This strip circuit is the primary side of the frequency coil, and is connected to the secondary balls of the induction coil. The inner jar is thoroughly insulated from possible moisture by filling the larger jar with insulating oil.

Such a frequency coil may be constructed on a skeleton framework of glass rods, instead of the glass jars, and insulated in any size of jar. Good results can be obtained by using it in connection with a small induction coil operated by dry batteries.

The task of designing an efficient frequency recorder is a puzzling one and will, perhaps, take the form of a device resembling the telephone receiver, worn constantly by the operator, who will receive by ear, or it may take the form of a balance which will become operative when the proper frequency reaches it.

Few amateurs can fail to find amusement and profit in noting the effect of currents of just ordinary frequency sent into the earth from an ordinary doorbell or, what is better, a buzzer. The connections are shown in Fig. 2, and the telephone receiver is used to pick up the tone.

In a review of the progress of aerial navigation, M. Octave Chanute says that the best shaped navigable balloon yet constructed was that which was made by MM. Krebbs and Renaud of the French War Department as long ago as 1885, and he thinks that this flying machine was superior in most respects, save that of motor equipment, to the well-known balloons of M. Santos Dumont, which have been built since. He also believes that better results than have hitherto been attained would have been reached by the Lebaudy airship had it not been destroyed; and the construction by the Lebaudys of another airship on the same line is therefore, an event of considerable interest. M. Chanute has no doubt that it is the improvement of the motor which is, and will be, the largest factor in the coming flying-machine, and this factor will apply with equal force to the airships of Santos Dumont, Lebaudy and Barton, or the aeroplanes of Prof. Langley or the Brothers Wright. In a general forecast of the flying-machine's future, he remarks: "The machines will eventually be fast, but they are not to be thought of as commercial carriers. To say nothing of the danger, the sizes must remain small and the passengers few, because the weight will for the same design, increase as the square. It is true that when higher speeds become safe it will require fewer square feet of surface to carry a man, and that the dimensions will actually decrease; but this will not be enough to carry much greater extraneous loads, such as a store of explosives or big guns to shoot them. The power required will always be great—say something like 1 h. p. to every hundred pounds of weight, and hence fuel cannot be carried for long single journeys. The North Pole and the interior of Sahara may preserve their secrets a while longer."

Postmaster-General Wynne and Baron Moncheur, the Belgian minister, signed a parcels post treaty between the United States and Belgium on November 10. Under this treaty the parcels are restricted to four pounds and six ounces each and fifty dollars in value. It is the third parcels post treaty negotiated between this country and European countries, and the twenty-sixth with any government, most of the existing treaties being with South and Central America. The present treaty will go into effect February 1. If we can have such postal facilities with foreign countries, is it not about time for the same service at home?

PHOTOGRAPHY.

COLOR VALUES.

HARRY L. SHEPHERD.

Recognizing the fact, from the school of experience, that practical information, for the busy amateur on the subject of ortho-chromatic photography is hard to find, I hope in this article to introduce the subject to those who are ignorant of the vast possibilities of color sensitive plates and perhaps to aid others who are struggling with the same plates in a haphazard way.

In trying to make the matter *very* clear, I may leave myself open to criticism at certain points, but please remember the article is principally for those who wish to get an understanding of the subject without recourse to text books on chemistry and physics.

The first question naturally asked by those unacquainted with the subject is, "Are ortho- or iso- (as they are also called) chromatic plates hard to work?" Now, to set your minds at rest, let me say right here that they are just as easy to "work" as ordinary ones, the only difference being that you must use more care with your dark-room light.

A few words of explanation. The popular idea is that ortho plates give a better rendering of the "color value" of objects than ordinary plates. Now, to set your minds at rest, let me say right here that they are just as easy to "work" as ordinary ones, the only difference being that you must use more care with your dark-room light.

A few words of explanation. The popular idea is that ortho plates give a better rendering of the "color value" of objects than ordinary plates. Now, the term "color values" is to many, misleading. It is not the differences of hue in objects that these plates render more correctly, but rather the "relative brightness" of objects one with another without regard to their color. You must see that you cannot render colors in monochrome. White light, as perhaps you know, is composed really of seven colors, viz.: red, orange, yellow, green, blue, indigo and violet. This you can see for yourself by darkening a room and allowing a ray of sunlight to pass through a narrow slit in the window blind. Let this ray or beam of light fall on a white screen, say a piece of white blotting paper. Now in the path of the ray of light, near the screen, interpose a glass prism and you will get the band of colors, called the spectrum, in the order I have mentioned above. It is an experiment well worth trying.

Besides the visible spectrum two sets of invisible rays exist, one located beyond the violet, called the ultra-violet, the other beyond the red, called infra-red. The ultra-violet rays are those which affect all photographic plates most and are thus said to be "actinically powerful." The infra-red really has no effect.

Now, the trouble with ordinary plates is this: They are so powerfully, *i. e.*, quickly affected by the ultraviolet, violet and also blue rays, that the green, yellow, orange and red rays do not get time, as it were, to act or impress themselves on the plate. If we give sufficient exposure for the green to red rays, then the blue, etc., are greatly over-exposed.

Try to render blue sky, white clouds and green grass on an ordinary plate. In your print the blue will be rendered as white paper; at any rate, there will not be any distinction between the blue sky and white clouds, and the green grass will be rendered many tones too dark. The reason is that blue affects the plate more powerfully or quickly than the green, and so in the negative the "blue part" is very dense and the "green part" comparatively thin, when to the eye the green grass may be only a shade or two darker than the blue of the sky. To overcome this defect certain dyes are mixed with the plate emulsion, before coating the plates—sometimes ordinary plates are bathed in the dyes—and this gives us ortho- or iso-plates which, according to the dyes used, are made more sensitive to green, yellow, orange and red. This property is strongly increased when in conjunction with the ortho-plates we use a ray screen, also called ray filter, which is usually placed over the lens and which to a great or less degree, according to its depth of color, absorbs the ultra-violet, violet, indigo and blue rays, *i. e.*, holds them back, as it were, thus giving the others a chance to impress themselves on the plate. In fact, it acts as a "compensator," and of course increases the exposure, the increase depending on the depth of color of the ray screen.

All ray screens are for the purpose of absorbing or "holding back" the rays at the violet end of the spectrum. They are made of yellow tinted glass or cells filled with a weak solution of bichromate of potash, and are made light or dark to suit certain work. For ordinary work screens to increase the exposure from three to six times are all that are required. Ortho-plates, *i. e.*, the "fast" varieties, are equal in speed to all ordinary "fast" brands of regular plates. They can be used in snap-shot work just as any other plate, but under ordinary circumstances for snap-shot work they are not any better than the regular plates, as the ultra violet rays affect them to too great a degree. If you possess a "fast" lens and say at snap-shot speed and stop f. 16. you get a properly exposed negative; then if you use a screen which increases the exposure four times and open your stop to f. 8, you may go ahead, and you will get the benefit of the ortho-chromatic quality of the plate. You see, you increase the exposure four times by using the screen, but with stop f. 8, you allow four times as much light to pas . Stop f. 8 is four times the area of stop f. 16.

If you wish to "catch" the clouds, use an ortho plate and ray screen, except, perhaps sometimes about sunset, when the yellow tint of the atmosphere acts itself as a screen.

In flower and fruit studies, in fact any place where we have to deal with colors, ortho-plates are a neces ity if correct results are required. In the case of flowers a ray screen is seldom necessary, except where blue and yellow are together, and then one to increase the normal exposure not more than six times is all that is necessary. If you use too dark a screen you are apt to reverse the color values in your subjects.

In fact, ortho plates should be used in flower and fruit studies, marine, autumn landscapes, clouds, interiors (where color has to be dealt with), portraiture, (subjects with golden hair), copying paintings and faded (yellow) photographs.

So, you see, their use ought to be pretty general.

I will now touch on their manipulation. Calculate your exposure as you would for an ordinary plate, *i. e.*, if your ortho-plate is of "fast" variety, such as Cramer Inst. Iso. If you use a ray screen which increases the exposure say four times, then give the plate four times the exposure you have calulated.

When handling in the dark room I use two thicknesses of orange tissue paper, and I do not allow any more light than necessary to fall on the plate at any stage. Now, don't imagine that you have to work almost in Egyptian darkness. Nothing of the kind; but use care and judgment. As ortho-plates are color sensitive, then they are more sensitive to the dark-room light than ordinary plates. During development I keep the developing tray covered with a piece of cardboard.

For developers, Pyro can't be beaten. The solution soon colors and protects the plate, and in the print you get "snap" that personally I can't get with other developers.

In conclusion, take my advice and buy a dozen Instaneous Iso-chromatic plates and a light ray screen to increase the exposure say four times (if the man you buy your screen from is not sure of the increase of exposure necessary you will have to experiment and find out), and expose them against a dozen ordinary plates of the brand you use. Try a flower study, such as pansies with yellow and blue in abundance, a couple of landscapes with clouds, an interior where you have to deal with color, etc., and if you work carefully and systematically your first dozen ortho-plates will convince you that in most cases they are far superior to ordinary plates and the "tales" you have heard of of their "hardness" of working is a myth.—*Western Camera Notes.*

The prediction of Edward W. Parker, of the United States Geological Survey, of a coal famine in fifty years, is disputed by the officers of the Reading Coal Company, who say that their company alone can supply the world with anthracite for the next fifty years. They estimate that in the virgin basin of hard coal extending from Pottsville up the Schuylkill Valley toward Tamaqua there are 5,000,000,000 tons of anthracite. "It is true that the coal supply in the upper part of the region has reached its limit," they say, "and more and more the great southern basin, owned exclusively by the Reading Company, must be drawn upon to a greater extent, but it is also strictly true to say that within ten miles of the Reading Coal & Iron Company's headquarters in Pottsville there is as much hard coal as has ever been mined." It was in this unmined region that hard coal was discovered, and it was also in this region that the utility of hard coal for blast furnaces was first established. The shallow veins north of this region proved cheaper to operate, and as a consequence the big basin of the Reading Company has remained almost untouched. The coal in this basin lies much deeper than the veins operated at present by the company, and the expense of mining will be correspondingly greater. This will not be superlatively cheerful news to the consumer. He may console himself, of course, that he will be able to keep himself reasonably warm for the next fifty years, but the realization that he will have to pay more each year for the pleasure of keeping warm will more than offset the consolation.

Later details show that the recent eruption of Mont Pelee was nothing out of the ordinary, and nothing of any great moment has occurred to the volcano since last October. Last year a great obelisk or needle was thrust out of the crater, to a height of a thousand feet. It suffered several subsidences, followed sometimes by new elevations, but finally collapsed or sank back into the funnel from which it had been forced in August of last year. Since then its place has been taken by a dome, and this dome has undergone similar changes in height, though on a lesser scale, to those exhibited by the obelisk. More than once the dome was blown out by eruptions, and during December last it sank about 90 feet. Since then, however, it has risen again, and now a new phenomena is making its appearance. The obelisk which disappeared a year ago, or else a new one, is being pushed up through the dome. It is being built up or thrust up slowly; but it has gained 100 feet in this year, and the mountain as a whole is recovering the height which subsidences took away from it in the winter.

REFINEMENTS OF MECHANICAL SCIENCE.

AMBROSE SWASEY.

Abstract of the President's Address at the Dec. 1904, Meeting at New York of the American Society of Mechanical Engineers.

For the subject of my address I wish to speak of a few of those methods and mechanisms which have been developed and perfected to such a degree of refinement that they may be considered as almost beyond the practical, and yet were it not for such refinements they could not possibly be made to serve the utilitarian purposes which make them of such inestimable value to us all.

The division and the measurement of time is today, as it has been for ages, one of the most important of the subjects affecting the welfare of mankind, and as time has rolled on and there has been a better understanding of the laws governing the universe, nearer and nearer has been the approach to perfection in the working out of these difficult problems, but the limitations surrounding them have always kept their full solution somewhere in the future.

The diurnal revolution of the earth, which gives the solar day, and the revolution of the earth around the sun the solar year, are the arbitrary divisions of time marked off with the utmost precision by the celestial bodies; and while the length of the solar day has, from before the Christian Era, been fairly well defined, the length of the solar year was but approximately known until within a few hundred years.

The length of the year as counted by the Julian calendar, was too long by eleven minutes and fourteen seconds, and this error amounted to ten full days in the sixteen hundred years from the time the Julian calendar went into effect until the introduction of the Gregorian calendar.

A few years ago when visiting the Vatican Observatory, I was particularly interested in the Gregorian tower, which forms a part of the Vatican Library Building. After passing through a number of rooms which are used in connection with the observatory, when near the top of the tower I was taken into the spacious and beautiful calendar room, the walls of which are covered with paintings of the highest order, executed centuries ago, under the direction of Pope Gregory XIII. In the center of the room, and forming a part of the floor, there was a large marble slab on which was cut a fine line exactly in the true meridian, and upon the line was a special mark which indicated the altitude of the sun at noon of a certain day. On the south wall, near the top of the room, there was a small aperture through which the direct rays of the noon, projecting a bright spot on the meridian line.

All of this had been planned and executed by the astronomers in order that they might demonstrate the necessity of reforming the calendar, and when at noon on March 23, 1582, Pope Gregory saw that the altitude of the sun as shown by the beam of light was not for that particular day, but for the day ten days previous, he directed that ten days be stricken from the calendar, and that day should be March 11 instead of March 23. With such precision had the astronomers determined the true length of the year, that our present calendar with its intercalculations will continue on for twenty thousand years, with an error not to exceed a single day.

The line on the marble slab and the aperture through the wall of the calendar room were devices simple in the extreme, and in this day of instruments such a method would hardly be considered, yet they served their purposes admirably, and the placing of that line on the true meridian, with an accuracy never before attained, was considered one of the greatest scientific achievements of that age.

The sun-dial is not only earliest but the most interesting of all the numerous arrangements that have been devised for measuring the divisions of the day. Notwithstanding its limitations, it has been a subject which has attracted the brightest minds for ages. Recently a new dial has been invented by which the rays of the sun will indicate the true mean time for each day of the year, with an error not to exceed one minute.

The hour-glass, which came later, was considered a much more practical method, inasmuch as it could be used either day or night, and because its use was not confined to a particular location; however, as a timekeeper it was not satisfactory, even in those early days.

The clepsydra or water-clock, which is supposed to have been invented by the Greeks, was found to be a much better timekeeper than either the sun-dial or hour-glass, and it was a great step in advance toward the accurate measurement of time.

These water-clocks are to this day used extensively in the East, more especially in China. In the city of Canton there is a water_clock which has been running for eight hundred years, and at the present time is is the standard clock of the city.

This clock consists of four water jars, each having a capacity of eight or ten gallons. The jars are placed one above the other in the form of a terrace, the three upper ones being provided with a small orifice near the bottom through which the water drops into the jar next below, and so on from one to the other until the water reaches the lowest or registering jar. In this there is a float to which is attached an upright having graduations for the hours and parts of hours, and as the water rises the time can be determined by noting the height of the float in relation to the cross-bar at the top of the jar.

In this improved form of water-clock the variation in the flow of water due to the difference in height is overcome by having a series of jars, the outlet of the upper being so graduated that there is but little variation in the height of water in the second jar, and in the third the height remains practically uniform, thus ensuring a constant head for the water which drops into the registering jar. At the beginning of each day the water is taken from below and carried up a flight of steps to the top.

That such an arrangement has some elements favorable to the accurate measurements of time, there can be no donbt. It certainly has the element of simplicity, and notwithstanding its long service the only wear noticeable was confined to the steps leading to the upper jar.

Clocks of the present type, although used as far back as the twelfth century and possibly earlier, were but fair timekeepers until several centuries later. Those which the astronomers used in their observatories at the end of the fifteenth century were so unreliable that modified forms of the clepsydras of the ancients were used, and as they did not prove satisfactory, most of the observations were made without the use of clocks.

Galileo's beautiful discovery of the isochronism of the pendulum from the swinging chandelier in the church at Pisa was of great value in many respects, but in none more so that in its application to the measurement of time.

Soon after this great discovery the English clockmaker, Graham, invented the mercurial pendulum, by which the variation in its length caused the difference in temperature was fully compensated, and some years later Harrison, another English clock-maker, invented a compensating pendulum, which consisted of a series of metal bars having different coefficients of expansion—so that two hundred years ago, as it is today, the pendulum was the nearest perfect of all the devices that have been employed for governing or controlling the motions of a clock mechanism.

Every part of the clock, down to the minutest detail has been the subject of study and improvement, and they are made and adjusted with such precision and delicacy in testing them, the question is within how small a fraction of a second they will run. Not content with their marvelous performance when under normal conditions, some of the finest astronomical clocks are surrounded by glass or metal cases in which a partial vacuum is maintained, and in order that the case may not be opened or disturbed, the winding is done automatically by means of electricity; the frequency of the winding in some cases being as often as once every minute. These clocks are set up in especially constructed rooms or underground vaults where they are free from jar or vibration, where the temperature and barometric conditions remain practically constant, and where every possible precaution is taken to further minimize the errors of the running rate.

A clock in the observatory at Berlin has run for several months under these favorable conditions, with a rate having a mean error of but fifteen one-thousandth of a second per day and a maximum error of thirty one-thousandths of a second per day.

From the time of the invention of Peter Hele, in 1477, of the "Nuremburg animated egg" or "pocket-clock," which required winding twice a day, and varied an hour and one-half in the same length of time, the development of the watch has kept pace with the "mother clock" and followed closely to it in time-keeping qualities.

The larger watch or ship chronometer, with its escapement so delicately made and adjusted that it must always be kept in the same position, was greatly improved through the efforts of the British government in 1714 by offering rewards of ten, fifteen and twenty thousand pounds to any who should make chronometers that would run so accurately that the longitude of a ship at sea could be determined within fifty, forty and thirty miles, and Harrison, the inventor of the compensating pendulum and the compensating balance, which is now used in watches, succeeded in making a chronometer which, after being tested on a long voyage, was found to run so closely that the position of the ship was determined within eighteen miles, and he was therefore paid the full award of twenty thousand pounds. That historic chronometer, which marked a new era in navigation, is now numbered among the treasures of the Greenwich observatory. Modern ships are equipped with chronometers so accurate and so reliable, and with sextants of such precision that navigators can determine their position in latitude and longitude within a few miles.

The perfection attained in the measurement of time, which is of such great practical value in nearly every sphere of life, would not have been possible were it not for the even greater refinements that have characterized the methods and instruments used by the astronomer in determining the length of the day and of the year, which are the fundamental standards of time.

That the repulsive and even dangerous spider has plenty of enemies among the human family there can be no doubt, yet if the value of the contributions which it has made to the cause of science were generally known, it would surely have a greater number of friends than at present, and most certainly the astronomer will say naught against it, for after the experience of many years he has found that the spider furnishes the only thread which can be successfully used in the instruments for carrying on his work.

The spider lines mostly used are from one-fifth to one-seventh of a thousandth of an inch in diameter, and in addition to their strength and elasticity they have the peculiar property of withstanding great changes of temperature, and often when measuring the sun spots, although the heat is so intense as to crack the lenses of the micrometer eye-piece, yet the spider lines are not in the least injured.

The threads of the silkworm, although of great value as a commercial product, are so coarse and rough compared with the silk of the spider that they can not be used in such instruments.

Platinum wires are made sufficiently fine, and make most excellent cross wires for instruments where low magnifying powers are used, yet as the power increases they become rough and imperfect.

Spider lines, although of but a fraction of a thousandth of an inch in diameter, are made up of several thousands of microscopic streams of fluid, which unite and form a single line, and it is because of this that they remain true and round under the highest magnifying power.

An instance of the durability of the spider lines is found in the Alleghany Observatory, where the same set of lines in the micrometer of the transit instrument has been in use since 1859.

The placing of the spider lines in the micrometer is a work of great delicacy, and in some micrometers there are as many as thirty which form a reticule, with lines two one-thousandths of an inch apart, and parallel with each other under the highest magnifying power.

BOOKS RECEIVED.

Cyclopedia of Applied Electricity. Various authors. 5 Volumes. 2,200 pp. 2,000 illustrations, 9½ x 6½ in. Half Morocco, $30.00. [Introductory Price. $15.] American School of Correspondence, Chicago, Ill.

It is impossible, in the limited space available for a review of these extensive volumes, to give more than a brief outline of the wide range of topics treated therein, but a most hasty examination reveals at once the excellent and careful manner in which the seventeen different authors have presented the several subjects upon which they have written. In addition, twenty-seven eminent authorities have been consulted during the preparation of the matter, thus giving to the various sections a completeness and up-to-date character rarely to be found in a work of this kind. To the student of electricity, who must of necessity have a working knowledge of the commercial applications as well as theoretical principles of the subject, these volumes will be of the greatest value, as they supply in convenient form a store of knowledge to be obtained otherwise only by the purchase of numerous books at a cost far greater than the moderate sum at which these volumes are offered.

In Vol. I. are found the sections: Elements of Electricity, The Electric current, Electrical Measurements, Electric Wiring, The Electric Telegraph, Wireless Telegraph, The Telautograph, Insulators and Electric Welding.

In Vol. II.:—Theory of Dynamo-Electric Machinery, Direct Current Dynamos, Types of Dynamos, Electric Machinery, Direct Current Motors, Electric Motors in Machine Shop Service, and Storage Batteries.

In Vol. III.—Electric Lighting, Shop Lighting, Electric Machinery, Power Stations, Central Station Development, and Geographical Method of Recording Data for Boiler Trials.

In Vol. IV.:—The Alternator, Commercial Types of Alternators, Synchronous Motors, The Transformer, Rotary Converter, Induction Motor, Switchboard and Station Appliances, Power Transmission and Mercury Vapor Converter.

In Vol. V.:—Telephone Instruments, Telephone Lines, Telephone Exchanges, Common Battery Systems, Telephone Operation, Telephone Systems, Telephone Maintenance, Automatic Telephone, Wireless Telephone, and Index.

In the above it will be noted that the more recent developments of the art receive due attention, while the older and familiar phases are presented with the completeness and accuracy possible only to the present day writers. The progress in electrical invention has been so rapid and varied during the last decade that single text-books can no longer contain other than the briefest presentation of principles; and a work of the size and extent of that above mentioned is necessary to any one who would study with that thoroughness which would make his work of practical value. For that reason, as well as many others, this cyclepedia is warmly commended to the readers of this magazine.

Metal Working. Edited by Paul N. Hasluck. 760 pp. 9 x 6½ in. 2,200 Illustrations. $4.00. Cassell & Co., Ltd. New Yokr. Supplied by Amateur Work.

As indicated by the title, mental working in all its branches is quite fully covered within the limits of this rather massive volume. After holding it long enough to obtain a comprehensive idea of its contents, one is inclined to wish the publishers had seen fit to divide it into two or three parts, but this objection will be quickly forgotten in the interest which its contents will have to the mechanically inclined reader, be he amateur or professional. The chapter on foundry work includes the commonly used metals and alloys, the processes of melting and pouring and moulding the patterns for casting; smith's work includes sheet and bar metal work, as well as decorative iron work; forging and working sheet metal having additional chapters which treat these subjects quite exhaustively. Chipping, filing, polishing, annealing, hardening and tempering are fully dealt with, as as are drilling and boring. Taps, threads and dies are followed by soldering, brazing and rivetting. Repousse work, oriental decorative brass work, finishing, lacquering and coloring brass, gold and silver working, and wire work are also given special chapters.

Lathes and lathe work include both speed and screw cutting lathe work, the uses of hand tools and lathe attachments, as well as the uses of tools for measuring and testing metal work. A chapter on metal spinning is of special interest. The building of a lathe, skeleton clock, horizontal and vertical steam engines, boiler, gasoline motor, water motor, dynamo, microscope and telescope, supply varied applications of the information contained in previous chapters. A very complete index facilitates reference to the contents, which should be of interest to many readers of this magazine. As a book for public libraries it would have a special field of usefulness.

Elementary Course in Mechanical Drawing. Arthur W. Chase, B. S. Part I., 189 pp. 8½ x 6¾. 97 Illustrations. Cloth, $1.50.

That the author has pronounced ideas relative to the method of teaching mechanical drawing in a manual training high school, is evident from the general make-up of the contents. To prevent copying, which is objected to by the author, no plate showing a finished sheet of geometrical or projection problems has been included. Other departures from conventional methods are noted which, with the one above mentioned will be strongly questioned by teachers of experience, as well as by drafting room managers. The previous work done by the pupil, or absence of any previous instruction, will have an important bearing on the adaptability of this book. As a desk book for teachers it contains much of decided value, and is a very useful help in making up class work.

Electrical Engineering for Students. S. R. Bottone, 153 pp. 7¼ x 4¾. 49 Illustrations. Cloth, 80 cents. Gilbert Pitman, London. Supplied by Amateur Work.

The author is so well known as an able writer on electrical subjects that no words of commendation are needed to assure those interested in the subject that this book presents the elemental principles in a clear and attractive manner, together with considerable constructural work by means of which the instruction given can be more fully understood. An excellent work for beginners.

Ornamental Turning. J. H. Evans. Vol. I. 172 pp. 7½ x 5. 120 Illustrations. Cloth, $1.25. Gilbert Pitman, London. Supplied b Amateur Work.

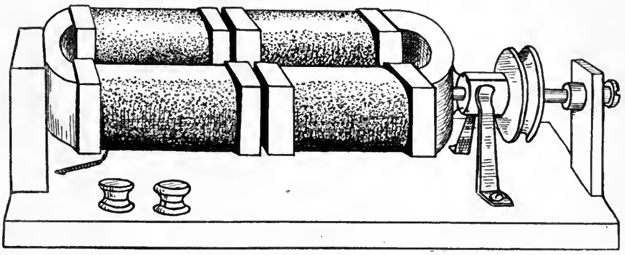
The author is a well-known authority and writer upon this subject, and this volume, the first of three, presents a well arranged and systematic course in ornamental turning. The text is fittingly supplemented by suitable illustrations, making the book invaluable to any one interested in posting up on this subject, as well as the best guide obtainable to one who would learn without a teacher.

A SIMPLE ELECTRIC MOTOR.

ALBERT G. WARREN.

The accompanying illustration shows a simple type of electro-motor suitable for driving small models, boats and cars or for rotating color discs. Under no circumstances must it be expected to do work requiring more power than that derived from the ordinary types sold for about a dollar, yet if well made it will run well on one cell of any kind of battery, and at a high speed when more cells are added.

The magnets may be cast in soft iron from a wooden pattern, or forged into shape from a strip of iron ⅛ in. thick and ¾ in. to 1 in. wide. Each magnet is 2½ in. long, and the space between poles is 1½ in. One of the magnets is to be fastened permanently to the wooden surport, and the other is fastened to a shaft of ⅛ in. steel. This shaft fits evenly into ⅛ holes drilled into



small machine screws which serve for bearings. One screw is shown in the illustration, and the second projects through the center of the fixed magnet. A two-part commutator, of a design so familiar to all amateurs that it need not be described here, is affixed to the shaft, as is also a small wooden pulley turned to any size convenient for the maker. The two magnets are wound each to have north and south poles like any horseshoe magnet. The wire should be about No. 22.

The rotating magnet is placed in position before the fixed magnet with just enough space between the poles so as not to interfere when in motion.

One of the ends of the wire coming from the fixed magnet goes to a battery binding post. The other is carried to one of the brushes. The other brush is connected the remaining battery terminal. Each of the revolvin magnet terminals is connected with a segment of the commutator. All bearings should be well oiled and the shaft adjusted so as to turn freely.

CORRESPONDENCE.

No. 85. So. Norwalk, Conn., Jan. 23, '05.

Will you kindly answer the following questions relative to the battery described in the July, '03, number of Amateur Work:

1. The diameter of the tin cans?

2. If cans were used 5 in. diameter and 10 in. high, what would be the correct dimensions for the wire gauze cylinder?

3. Can wire window screen netting be used in place of the 20-mesh gauze, as specified?

4. Can kerosene be used in place of the paraffine oil?

5. Should both the solution and oil be poured in the cylinder and on the filings?

6. What is the ampere hour capacity? F. B. H.

1. As mentioned in the description referred to, any tin can having lapped joints can be used; those with soldered joints will not answer, as the potash solution will attack the solder aud leaks will soon follow. Cans used for preserved tomatoes will answer and are easily obtainable.

2. The gauze cylinder could be made about 2 in. diameter and 9 in. high. The purpose of the gauze cylinder is simply to retain the filings in place and prevent them from coming in contact with the zinc.

3. If window screen netting is used any paint should first be burned off and the filings will have to be screened, and none used that pass through the screen. A larger quantity ot chips will be needed from which to get enough of the required size after screening.

4. Kerosene oil will not answer, and as paraffine oil is not expensive and is easily obtained of oil dealers, it should certainly be used.

5. The solution is poured into the cylinder before placing the zinc in position; it will fill any space around the filings and within the cylinder. The oil is then poured in and is used to prevent air from reaching the solution, potash having a great affinity for the moisture in the air as well as the oxygen.

6. Having had no personal experience with this cell would request any reader who has to give his experience in this matter.

No. 85 Clarkesville, Ga., Jan. 17, '05,

Will you please tell me of the process by which I can make a cell of dry battery stronger after it has become too weak to use? S. C. K.

An exhausted dry battery may be partially revived by sending a current of low voltage through same in reverse direction from the discharge, or by punching a few holes through the pitch used to seal it at the top, and putting in a solution of sal-amoniac and water or salt in water. Ordinarily, however, it is more satisfactory to get a new cell. Another way is to punch holes in the sides and put cell into an ordinary glass preserve jar and fill up with the sal-amoniac solution, thus converting it into a wet battery.

No. 87. Barre, Vt., Jan. 11, '05.

What is the voltage of the Edison-Laland battery, type V.? Can anyone cast the zinc himself? E. N.

The E. M. F. of the Edison primary battery, type V., is .75 volt. It is made in two sizes, one giving 150 and the other 300 ampere hours. The zincs can easily be cast in wooden molds or in sand, but the oxide of copper cakes can only be made with suitable machinery, as a very heavy pressure is required to form them.

No. 88. Cleveland, Ohio, Jan. 12, '05.

Will you please give directions in your valuable magazine for making an induction coil which will give a good 12-in spark on a 20-volt current through the primary winding? E. A. H.

We quite frequently receive requests for descriptions for making large coils, but find that when the writer learns the cost of materials and the amount of work involved in the making, the desire is satisfied with a coil of much smaller dimensions. As there is, however, a demand for a coil of fair size, to be used in X-ray experiments in connection with a high-frequency coil, we are having prepared a description of an induction coil to give an 8-in. spark, to be followed by a description of a high-frequency coil of a suitable size to work with it. The combination will be adequate to do excellent X-ray and other coil experimental work, and is recommended as being an excellent size for ambitious amateurs to attempt.

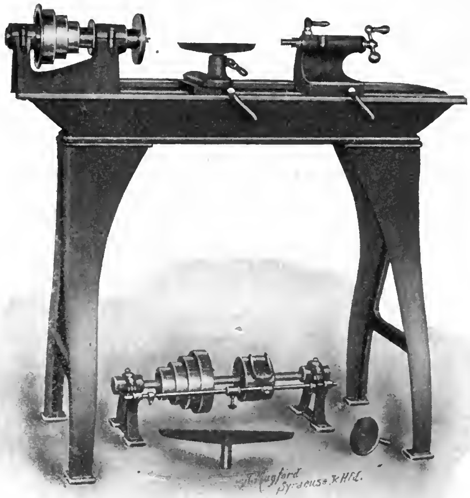
Dr. Haanel, Dominion Superintendent of Mines, who recently went to Europe to investigate methods of electrical treatment of ores, has received samples of gray, white and mottled pig iron, all having been reduced from the ore direct by the aid of an electrical furnace. Samples of castings made direct from the furnace are on exhibition, and are said to be of excellent quality. The gray pig is a superior quality of foundry iron, and can also be used for conversion into steel by the acid process.

An exhibit at the recent meeting of the Society of German Plumbers which attracted considerable attention was that showing an invention of Chemist Blau, of Augsburg, for the manufacture of fluid gas from the residuum of petroleum and heavy mineral oils. The inventor says this gas may be manufactured very cheaply where there is an abundance of petroleum, and that it may be transported from one place to another in cylinders as easily as carbonic acid gas. The gas may be used for lighting churches, halls and detached buildings, and small tanks may be used in lighting automobiles. The Blau gas makes a very brilliant light for street lighting, and is very difficult to explode.

TRADE NOTES.

The accompanying cut shows the 10 in. "Star" wood turning lathe of a new design which has just been placed on the market. This lathe is admirably suited for use in manual training schools, as it contains many desirable features for such work, and is also commended to wood turners in general. The rated swing of the lathe is 10 in., but it has an actual swing of 11 in. over ways, and 7 in. over hand rest.

The head stock is of the web pattern, strong and solid, has a hollow spindle (with 17-32 in. holes) made from a crucible steel forging, and runs in large phosphor bronze bearings which are dust-proof and self-oiling, and will run at a high speed for a very long time without attention. The spindle is ground true and the bearings hand scraped to an accurate fit. The cone pulley has four steps, is turned inside as well as outside, and is in perfect balance for high speeds.



The tail stock is the curved or cut-under pattern, has a long bearing on the ways, and is firmly locked to the bed by a convenient lever which is attached and always in place, no wrench required. The tail stock spindle is locked by an improved locking device. The hand rest has long and short T-rests. The rest socket and saddle are locked to the bed by a cam locking device, and the T-rest is held in socket by a friction clamp (doing away with the objectionable set screw commonly used; both are operated by levers attached and always in place. No wrenches are required, therefore, for either the tail stock or rest saddle and socket.

The bed is broad and deep, and being thoroughly braced by cross webs is very stiff and rigid, and at present is made in two lengths, four and five feet long. The front way is flat and the back way is V-shaped (same as inside ways of the "Star" screw-cutting engine lathe). A convenient shelf is secured to the back of bed for reception of tools, etc. The countershaft has self-oiling and self-aligning shaft bearings, four step cone, and tight and loose pulleys; the loose pulley has a self-closing oil cup. Face plate, screw chuck, cup and spur centers are furnished with each lathe and, when desired, a slide rest for metal turning will be furnished at an additional price.

This lathe is manufactured by the Senaca Falls M'fg. Company, 103 Water Street, Senaca Falls, N. Y., U. S. A., makers of the well known "Star" screw-cutting engine lathes for foot or power, and the company will be pleased to send on request catalogue describing their complete line.

A new battery switch is now being placed on the market by the Atwater Kent M'fg. Works, Philadelphia. This switch is intended to be convenient and durable, and is designed after larger electrical apparatus. The handle end of the lever is provided with notches to keep the lever in the position in which it is intended to stay, and the handle is substantial and

can be manipulated easily when the hand is covered by a heavy glove. The locking device has been omitted on this switch, as such devices are known to be ineffective, and the owner is often annoyed by mislaying or losing the removable part.

Another convenient feature is that all connections are made after the switch has been mounted on the dash, and then the whole is covered by a name plate. This avoids bending the wires after the connections are made, in order to screw the switch into place, and the possibility of a poor connection. Whenever necessary to examine the connections the name plate may be easily and quickly removed for that purpose. It is of excellent design and substantially made; all of the brass parts are made of heavy metal, and the only holes that are tapped in the insulating part are bushed with brass. The list price is $2.00 each. For sale by leading dealers in automobile supplies, or forwarded upon receipt of price by the manufacturers.

The fountain ruling pen here illustrated has been designed to overcome the drawbacks peculiar to such pens hitherto constructed, and from personal experience we can say it has proved to be a perfect success. Its outer appearance is that of an ordinary ruling pen; the hollow German silver handle, milled on the outside, serves as a reservoir for the ink; screwed to one of its ends is a fine capillary feeding tube, which extends be-

tween the blades of the pen proper. The latter is of finest quality and made of the best English steel. A German silver piston-rod acting screw-like from the other end of the handle effects a drawing in and expelling of the ink into or from the reservoir handle.

As the ink is drawn up in the reservoir handle, held there and expelled from it by pneumatic force it is impossible to "drop" ink while the pen is in use or when it is carried in the pocket, and the feeder is not liable to become clogged easily.

To fill the pen, the pen proper is pulled off the handle, thereby exposing the capillary feeding tube; the latter is immersed in the ink and by turning the milled head of the piston-rod to the left, the ink is drawn up in the reservoir handle. After replacing the pen on the latter, it is charged with ink by slowly rotating the piston-rod to the right. The pen is then ready for use. Should any ink be left in the pen proper after use, the same can be drawn back into the reservoir by turning piston-rod to the left. If the feeding tube should become clogged with ink, a steel pricker, furnished with each pen, serves to clean it. It can be obtained from Kolesch & Co., 138 Fulton Street, New York.

The "Echophone" is the name given to a new telephone here illustrated, which is manufactured by The Ericsson Telephone C o., 2{6 Broadway, New York City It is specially adapted to private line use, and possesses several novel features which will be found to add greatly to its value. One of these is the adaptability with which any electric bell circuit can be changed to a telephone circuit by simply replacing the push button with a new one having terminals for connecting in the telephone. This method of connection enables a single telephone to be used at several stations, and enlarges the amount of service which can be secured with two or more instruments. The expense of equipping a residence, factory or store with these instruments is less than would be the case with stationary instruments. Full directions for installing are furnished with each set of instruments, and anyone without experience would have no difficulty in securing satisfactory service. The workmanship is of the well-known excellence of this company, the wonder being how such excellent work and finish can be given at the price at which these instruments are sold. A descriptive circular will be mailed upon request to the company.

The Fitchburg File Works have lately removed to a new and much larger establishment located at South Fitchburg. A visit to the new quarters shows a most excellently arranged and appointed building, with every facility for the manufacturing, packing and shipping of a wide variety of work. A spur track gives direct access to to the factory, so that material can be received and goods shipped without teaming, which in this industry is a most important feature. The additional facilities now at hand will undoubtdly result in a further increase in the rapidly growing business of this firm, and which the excellent quality of their files and hack saws most certainly entitles them.

The rapid acting vise manufactured by Abernathy Vise & Tool Co., Chicago, Ill., is just the vise for amateurs, as well as being specially adapted to the needs of manual training schools. It has a very quick yet positive action, is simple and strong in construction, has ample capacity, with no parts liable to break or wear out and, what is of equal importance, is sold at a price placing it within the reach of all.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

Vol. IV. No. 5. BOSTON, MARCH, 1905. One Dollar a Year.

THE AMATEUR RUNABOUT.

FREDERICK A. DRAPER.

I. General Design.

The design of the runabout to be described in this series of articles is as simple in construction as a servicable vehicle will permit, and the work will nct be found difficult by anyone having reasonable skill in the use of a screw-cutting lathe. With the exception tion of the balance wheel on the engine, all the machine work can be done on a 9-inch lathe, this being a size in common use among amateur mechanics. It is quite probable that, of those making a car from this description, some will prefer to buy complete parts, such as the engine, in preference to making them. therefore the several chapters will be progressively arranged with this in view, the frame and running gear being first described, the engine being taken up last.

As will be noted from the illustrations, an air-cooled gasoline engine, *E*, is the motive power, one with a 3½ in. cylinder at 1200 to 1500 rev. per min., providing sufficient power for all except a very hilly country. If greater speed and power is thought desirable, a slightly larger engine can be used; it may also be water-cooled if the maker prefers that type, as there is plenty of room in the hood for radiator tubes, gasoline tank and a tool box of ample capacity.

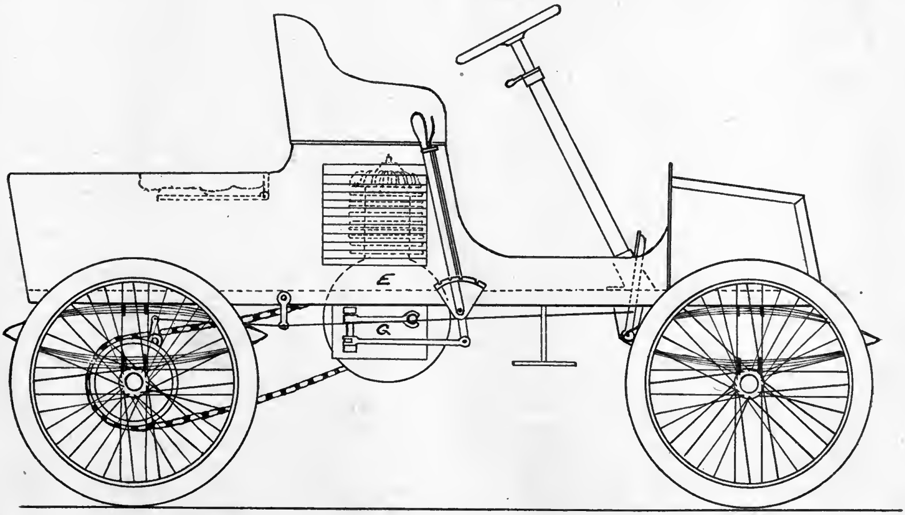


FIGURE 1. SIDE VIEW.

As one of the requirements of this car is as low a cost as possible, wire-spoked wheels with wood rims are used, although cost was not the sole reason for adopting this kind of wheel. It can, in case of an accident, be easily repaired at about any bicycle repair shop, and at small cost ; whereas a wooden wheel, when out of order, requires a skilled wheelwright to repair it. The rims are cresent shape.

The tire question is of decided importance, and, after considering all the advantages of the various types, the single tube, 28 x $2\frac{1}{2}$ in., was selected as being most suitable. A 2 in. tire can be used, but the saving in first cost would soon be offset by renewals, the smaller tire having comparatively thin walls, and not heavy enough for continuous work. In addition, the difference in first cost between the two sizes is not very great, and the larger size is enough more durable to warrant the extra expense.

price. The expansion clutch is of the metal-to-metal type, very similar to one described in a recent issue of this magazine.

The front axle is of the usual type with forged steering knuckles for ball bearing hubs. The pivots should also be forgings. The rear axle is of the "live" type, with differential and sprocket enclosed in a muff, to which is attached the axle casing. The hubs of the rear wheels are keyed in.

The frame for the body is of angle iron with cross ties of the same, which gives a rigid yet light construction. The springs shown, four leaf, 32 x $1\frac{1}{4}$ in., are the double eliptic, but $\frac{3}{4}$ eliptic springs with suitable hangers can be used if preferred, but are more expensive. It will be noted that the engine, the heaviest single

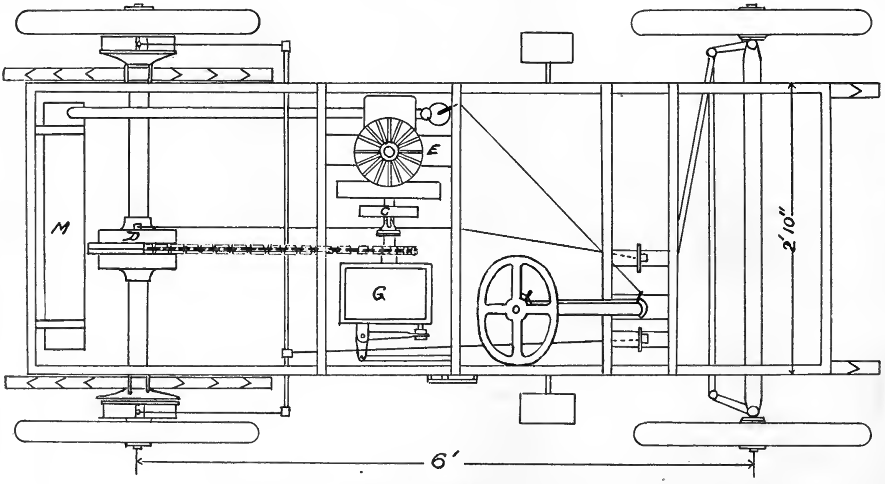


FIGURE 2. PLAN OF AMATEUR RUNABOUT.

In addition to the brake on the differential, drum brakes are shown on the rear wheels. The latter are necessary only in the event of the car being used in a rather hilly country, and plenty of power desired for holding on steep grades.

A wheel steering device is shown, but a lever may be substituted, and is quite sufficient for such a light car. Whichever form is used, the driver should at all times keep it in the control of the hand ; carelessness in this regard being responsible for many avoidable accidents.

The change-speed case *G*, expansion clutch *C*, and a few other parts, have been designed especially for this car. Two speeds forward, 6 and 24 miles, and a reverse, are quite sufficient for a car of this size, and by omitting one forward change (three changes being the usual number) a much lighter and more easily made gear-case is obtained. On the high speed no gears are in mesh, the drive being direct. Ample lubrication is also provided. Castings for the special parts are being prepared, and can be purchased at very reasonable

part of the car, is placed on the side opposite the driver, thus serving to balance the car when carrying only one, who is generally the heavier when two are riding. It will also be noted that provision is made for having the top of the rear part of the body hinged to fold back on itself, and fitted with a seat and light frame back support, thus allowing children to be carried, which can be done on level roads. When not so used, ample space is provided for luggage needed on a long trip.

The body can easily be constructed, or if the feature just mentioned is not needed, can be purchased "in the white" of a dealer, the size being right for stock bodies to be found in catalogs of several supply houses. An important point to be kept in mind is that all parts, though well protected from the elements, dust or mud, should be easily accessible.

The muffler *M* is of ample capacity to allow of a nearly noiseless exhaust, and also avoid back-pressure. The carburettor should be purchased, as very few mechanics have the tools, skill and experience necessary to make one that will give anything like satisfactory results ; generally the reverse. The best that can be purchased will be found the most economical in the end, and the increased efficiency of motor make the purchase desirable.

As the various parts are presented in the several chapters, detail drawings and directions will be given, with partial assembly drawings when needed. The wheels will be described in the following chapter, and those proposing to build the car can profitably look up, in the interim, the nearest supply house carrying hubs, knuckles, spokes, rims, etc. The diameter of axles is ⅞ in.

NOTES ON WIRELESS TELEGRAPHY.

L. T. KNIGHT.

V. Peculiarities of Coherer Action.

A question frequently propounded by beginners in wireless experiment work is that of how far wireless signals may be transmitted by a given spark. It is to be presumed that the writer contemplates purchasing an induction coil of one or more inches spark length, and wishes to use it for communication with a station several miles distant, but foreseeing numerous expenditures for appartus, seeks advice as to the advisability of proceeding with such a limited source of energy. In attempting to answer the above question it is well to state that there seems to be a very general misunderstanding regarding the principles of wireless signaling, especially in regard to the receiving apparatus, and the functions performed by the latter.

In order to follow intelligently the advances of wireless telegraphy it is necessary to have a general idea of the modern scientist's view regarding the nature of electrical phenomena.

All space must be regarded as something styled the "luminiferous ether." Not only does this ether permeate all space, but it also permeates all solids. Further, its nature is such that the movement of solids is not restrained by such permeation, the closest analogy being that of a wire sieve, representing the solid, being moved about in the water, which represents the ether.

This ether is the sea, not only of all electrical phenomena, but also of all the phenomena of heat and light. Heat, light and electricity are but the result of vibrations or waves in the ether, the apparent differences being due to the differences in length and frequency, just as one musical note differs from another in the same particulars, only that sound waves are air waves, not ether waves.

It is claimed that in wireless telegraphy that currents are vibrations of the ether along the path of the wire. That is, the wire acts merely as a guide for the ether waves.

In wireless telegraphy ether vibrations are also set up at the transmitting end, but these waves have no conducting guide, and so radiate in all directions through space. and a small percentage of them arrive at the receiving end where they are caught on the aerial wire and caused to record themselves upon a coherer or similar device.

The first receiving device studied by the amateur is the coherer, the earliest successful collector of Hertzian waves. The coherer is an insulated container, usually a tube of glass. Sealed between two metal plugs in this tube may be found fillings of iron. antimony, silver or nickel, in quantitities and proportions calculated by the designer to give the most satisfactory results under certain conditions or distance. Each coher of a collection has some especial qualification, determined by tests after manufacture ; some are suited for long distance and some for short, all vary in sensitivity after repeated use.

When inserted in the relay circuit a coherer must be susceptible to waves entering on the aerial wire, and cohere or, rather, the filings inclosed in the tube must cohere or "stick" electrically more closely together, causing a sudden fall in resistance to a point where the battery in the relay circuit may pass through both coherer and relay, and thus operate a sounder and other recording devices.

Often the first of a chain of waves will somewhat lessen the coherer resistence, but not sufficiently to operate the relay. In this case more waves must perform their duty upon the coherer before the first dot or dash can be recorded. While waves come to the coherer at a rapid rate, this delay in cohering counts considerably, both in accuracy and in the time it takes to send a given message. Hence the necessity of having the coherer as sensitive as possible.

Connected in one branch of the receiving circuit is the decoherer, a device operated electrically like a vi brating door bell, which taps the coherer near the fi ings chamber with the purpose of restoring or deco hering the filings to that state of inactivity where no current can pass through the relay until one or more waves have again reached the aerial wire. Oft times the tapper, instead of completely performing its function, simply partially decoheres thefilings, causing er rors in recording. Frequently the tapping throws the filings into a state of higher resistance than formerly, and makes readjustment of the relay circuit necessary, for it must be remembered that in setting up the relay and battery circuit a variable resistance was included, by which the current was kept at a point where it would not force through the coherer normally but would press through instantly when the resistance of the coherer was lowered by incoming waves. Such is the theory of the coherer, and to date no amount of tinkering with vacuum or filings, or distance between electrodes will greatly alter the situation. Atmospheric disturbances will store electrical charges upon aerial wires, and the coherer operates at random moments.

The writer recalls, while visiting quite recently a coherer receiving station, the illegible records made on the tapes by the impulses that followed along with and after the regular message. These marks were explained by the operator to be atmospheric disturbances which were caught because the coherer and relay circuit were adjusted to a most sensitive degree, owing to the extreme distance between stations.

To the coherer must be given the credit, however, of opening up the field of investigation more effectively, because of these very short comings. Many wireless experts dropped the coherer principle after a few trials and took up the study of electrolytic, thermostatic and magnetic detectors, many of which, like the coherer, at times have their failings.

The problem of recording, by means of a relay and recording device, waves which decrease in direct proportson to the distance between stations, is a task calcuated to cause many a clever man much loss of sleep. How to take an accurate, decipherable record of an impulse transmitted from a point a thousand miles away, possessing less than one thousandth of the energy it had when wafted from its sending aerial, is a problem, the final solution of which should mean a comfortable fortune for the inventor, and a wide development of wireless telegraphy.

A GASOLINE TOURING CAR.

R. G. GRISWOLD.

IV. Two Cylinder Air Cooled Engine.

In machining the piston a special arbor is made to mount it on, as the truest and best work can be done in this way only. Grip the piston in a chuck or strap it to a face plate and bore out the hole in the head. Turn up an arbor two inches longer than the piston, one end of which is slightly tapered so as to drive into the bored hole. The opposite end is then provided with four tapped holes, 90° apart, to receive ¼ or 5-16 in. screw pins.

The tapered end of the mandril is then driven into the hole and the pins screwed out against the inside of the shell, centering the open end. The piston may now be turned in the lathe, and a very true cylinder obtained. The ring grooves must be cut very smooth and true, and the sides may be finished best by using a keen hand tool and scraping off a very light cut as the piston revolves. Do not allow chattering to take place, as much of the tightness of the piston against leakage depends upon the fit of the rings in these grooves. Three " water grooves " are turned in the end of the piston, which serve to carry oil to all parts of the cylinder. The head is also squared before removing from the lathe.

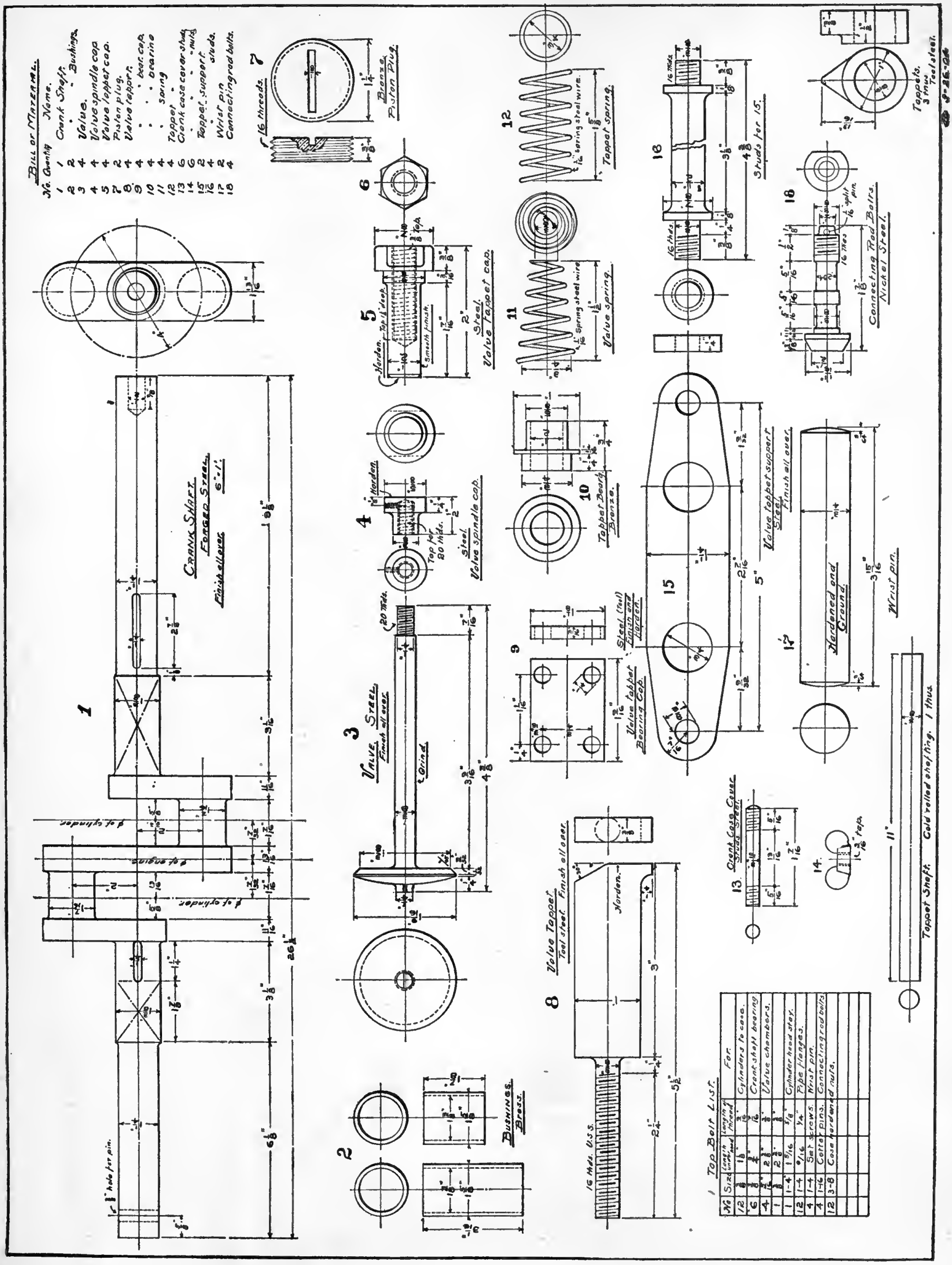
For boring the cross-head pin hole, make two very shallow V blocks, not over ¼ in. thick at the bottom of the V. Strap the piston against the face plate, using these V blocks to rest it on. Lay off the centers of the inside bosses on the outside and use this point for centering. Then drill completely through, either with a ¾ in. drill or a smaller one, finishing the hole by boring with a tool. Drilling and tapping the holes for the set screws and screwing the plug in the hole (threaded in the chuck), finishes the piston.

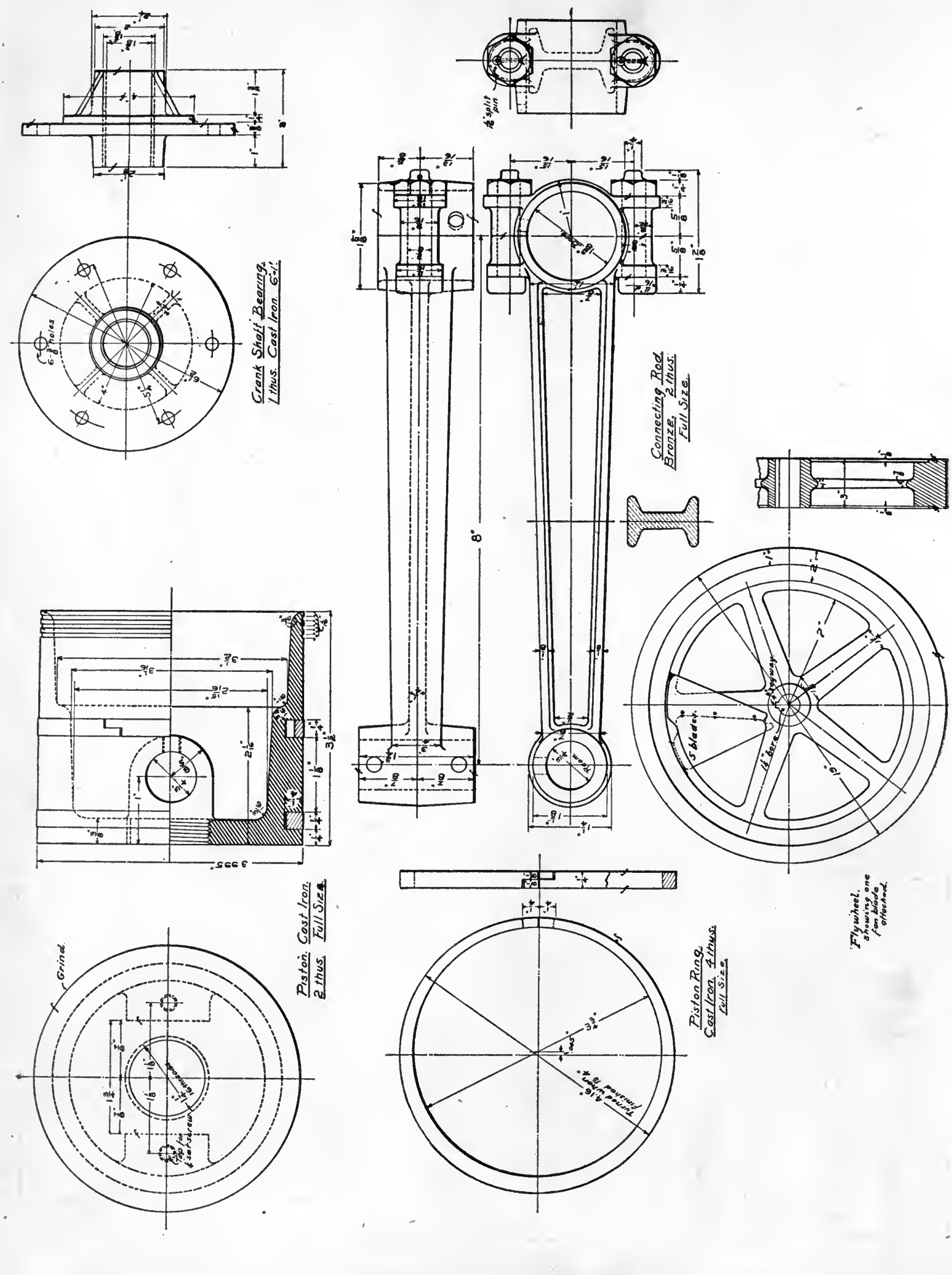
The rings need little description other than that they are sweated together after the bayonet joint is made and strapped to the face plate. The outside is then turned to exactly 4 in. in diameter. and after the joint is heated and springs apart, all solder is wiped off. The ring will be found to fit the cylinder perfectly. The sides are then filed perfectly smooth and true and the ring fitted in the slot. They should be a snug fit, but not so tight as to prevent any movement. Carefully spread the ends and sl p over the piston, sliding them down until they " snap " into the grooves.

The connecting rod may be bored by strapping it to a block fastened to the lathe carriage and using a boring bar. The crank pin end is first drilled and the bolts fitted. Then the split is made, the adjoining surface filed very smooth and the cap bolted on. The boring may then be proceeded with, exercising great care to keep the center line of the rod square with the axis of the boring bar.

The crank-shaft is centered on both ends, and the straight portions, and bearings and outsides of the crank webs finished. Two 4½ in. flanges are then turned up (or two pieces of iron, 4 x 2 x 1 in.) on a 1¼ in. arbor. A center is then drilled in each exactly 2 in. from the center of the hole. and a set screw provided for fastening the flanges to the shaft.

These flanges are then forced on the ends of the shaft with the two centers in line with the center of the crank pin to be turned, and securely fastened by the set screws. The shaft can now be put on the centers, and the pin turned. afterwards turning the flanges through 180° for the opposite pin. Wood sticks placed between the crank webs and flanges will prevent the


Bill of Material.
No. Quantity Name.
1 1 Crank Shaft.
2 2 " Bushings.
3 4 Valve.
4 4 Valve spindle cap.
5 4 Valve tappet cap.
7 2 Piston plug.
8 4 Valve tappet.
9 4 " " bear. cap.
10 4 " " bearing
11 4 " spring
12 4 Tappet "
13 6 Crank case cover studs
14 6 " " " nuts
15 2 Tappet support.
16 4 " " studs.
17 2 Wrist pin
18 4 Connecting rod bolts.
Crank Shaft. Forged Steel. Finish all over. 6"-1'.
Bushings. Brass.
Valve, Steel, Finish all over.
Grind
Steel. Valve spindle cap.
Steel. Valve tappet cap.
Bronze. Piston Plug.
16 threads.
Valve Tappet. Tool steel. Finish all over.
Harden.
16 thds. U.S.S.
Valve tappet Bearing Cap.
Steel (Tool) Finish and Harden.
Tappet Bearing Bronze.
Valve spring.
Tappet spring.
Spring steel wire.
Studs for 15.
Valve tappet support Steel. Finish all over.
Crank Case Cover Studs Steel.
Hardened and Ground.
Wrist pin.
Connecting Rod Bolts. Nickel Steel.
Tappets. 3 thus. Tool steel.
Tappet Shaft. Cold rolled shafting. 1 thus.
1 Tap Bolt List.
No. Size Length under head Length of thread For.
12 Cylinders to case.
6 Crank shaft bearing
4 Valve chambers.
1 1-4 1 5/16 5/8 Cylinder head stay.
12 1-4 9/16 1/4 Pipe flanges.
4 1-4 Set screws. Wrist pin.
4 1-16 Cotter pins. Connecting rod bolts.
12 3-8 Case hardened nuts.
9-26-04


Crank Shaft Bearing.
1 thus. Cast Iron. 6-1.
Connecting Rod.
Bronze. 2 thus.
Full Size.
Flywheel.
Showing one fan blade attached.
5 blades.
Keyway.
Piston. Cast Iron.
2 thus. Full Size.
Grind.
Piston Ring.
Cast Iron. 4 thus.
Full Size.

pressure of the center distorting the shaft. When finished, mount in the center rest and bore the hole in the end to take the journal of the clutch shaft. A ⅝ in. hole is drilled in the opposite end for a pin to engage with the starting lever jaw.

The smaller details need no description. While many of the parts are marked "tool steel," this is not absolutely necessary, as machine steel may be used and the wearing surfaces case hardened. In making fits always make them as good as you can, because the life and power of an engine depends greatly upon the quality of the workmanship.

The bearings of the crank shaft and crank-pins should be very carefully polished with fine emery powder and oil on a leather strap that can be tightly pressed against the revolving bearing.

A MUSIC CABINET.

JOHN F. ADAMS.

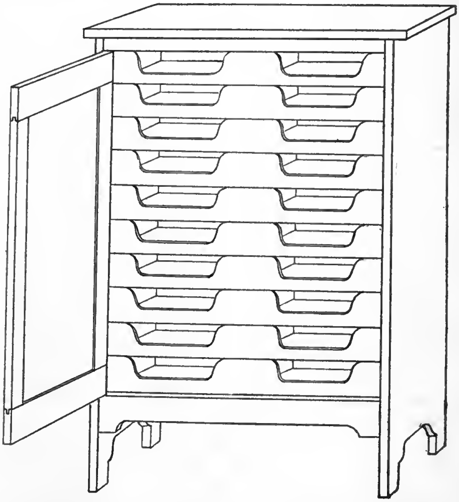
Many musicians, and especially teachers, accumulate a large stock of sheet music, for the proper storage of which no suitable piece of furniture can be found on sale by furniture dealers. The usual music cabinet has a few shelves, but to select any special piece requires that all on the shelf be taken out and looked over.

In the cabinet here illustrated and described, the arrangement is such that a selection may be quickly made and as readily returned to the proper place. This is accomplished by having ten shallow drawers with center division, giving twenty compartments in which the music is alphabetically arranged as in a letter file. If preferred, one half can be used for vocal music and the other for instrumental, in which case two or three letters are assigned to each division, and pieces of binders' board (or heavy cardboard cut from boxes) used to separate each letter in a division, the front of each being lettered. A suitable classification, to suit the particular needs of the user, will readily suggest itself. The wood and finish should be that which will harmonize with the instrument near which it will probably be placed.

The top, 27 x 18 x ¾ in., will have to be glued up from two pieces, care being used to get a good match of the grain. The two side pieces are 38 x 17 x ¾ in., and will also have to be glued up. The lower ends are cut out to an ornamental scroll, the space to the highest part being 5 in. A pattern should be made of cardboard and left with the order for the stock; the sawing out can then be done on a band-saw at small expense. The same should be done for the front piece under the drawers, which is 25 in. long, 3 in. wide at the ends and 2 in. at the narrower part, and ⅞ in. thick, which allows ½ in. at each end for tenons to fit into mortises cut in the side pieces.

Much labor can also be saved if the fronts of the drawers are sawed out at the mill. These measure 24 in. long, 3 in. wide and ½ in. thick. The center part is 15 in. long, the openings on each side are 6 in. long and 1¾ in. deep. The correct curves can easily be sketched out by making a full-size pattern of thick wrapping paper.

At the back and on a level with the cross-piece under the drawers, is placed a strip 25 in. long, 3 in wide and ¾ in. thick, the ends having ½ in. tenons fitting into the side pieces. The upper, outer edge of this piece, the inner, back edges of the side piece, and under back edge of the top should have ½ in. rabbets to receive the back sheathing, which is ½ in. matched sheathing. The top edge of the front cross piece under the drawers is 8 in. from the floor. A cross piece 25 in. long, 1½ in. wide and ¾ in. thick with ½ in. tenons is placed flush with the top of the sides. The top is then attached with screws cornered in, countersinking



for the heads. The runs for the drawers are 15 in. long and 1½ in. square, fastened to the sides by screws, the heads countersunk, and are spaced 3 in. apart, beginning at the bottom to mark off, the first one being flush with the upper side of the lower cross piece.

The drawers are so made that the front projects ½ in. below the sides, thus concealing the ends of the runs. The ends of the fronts are rabbeted for the side pieces, which are 15 in. long, 2½ in. wide, except those for the lower drawer, which are 3 in. wide, and are ⅝ in. thick.

The rear ends are rabbeted on the inner side for the back piece. A ¼ in. groove is cut ¼ in. above the lower edges of the ends and back, and ⅝ in. on the front, for receiving the board forming the bottom. Grooves are also cut in the centers of front and back piece to take the ends of the center dividing piece, which is 14⅝ in. long, 2 in. wide and ½ in. thick. By driving wire finish nails into the bottom and center division piece a rigid drawer is secured, which is needed, owing to the heavy weight of the contents. The edges of the openings are rounded off slightly and carefully smoothed with sandpaper to give a better finish and make the handling of them more satisfactory.

An ordinary panel door, 30 x 24 in. is made for the front, the rails being 24 in. long, 3 in. wide and ⅞ in. thick, allowing ½ in. tenons on the ends. A ¼ in. groove is cut at the center of the inner edges to receive the panel, which is 24¼ in. long, 19½ in. wide and ¼ in. thick. This will have to be glued up from two pieces, and a nice match made of the grain. This should surely be looked after, as a poor match would injure the appearance greatly. The door is hung with two brass hinges, fitted with lock, and a brass pull knob and key-hole plate on the outside.

A NEW GLOW LAMP.

It is credited to electric lighting, even by its worst enemies, that it has made the gas people wake up. The gas lamp has been much improved, and as the process has gone on there has been evidence of a reaction on the newer light. It will be remembered that in the beginning of electric lighting all the efforts of electric inventors were concentrated on the problem of producing a decent lamp. Then came a time when the carbon glow lamp was accepted as practically perfection, and the efforts of engineers were devoted to the cheapening of the production and distribution of electrical energy. Once again the pendulum has swung back, and the market is full of new lamps, and the tale of new lamps. The last example comes from Germany and threatens to be a formidable competitor of those established or seeking establishment. The Siemens & Halske Company has been for a long time engaged in an endeavor to improve the electric light at a place where there is the greatest room for improvement, viz., the hopelessly inefficient glow lamp; but the matter has been kept very quiet; indeed, the first publication was made at a meeting of the Berlin Elektrotechnischer Verein, on the 17th ult., when two papers were read by Mr. O. Feuerlein and Dr. von Bolton. The papers, and the communication of Mr. W. von Siemens are reproduced in the "Elektroteconische Zeitscrift" of January 26, with illustrations of the lamp and filament. There is, therefore, no longer any secrecy about the matter, and indeed one may expect to find the lamps upon the market almost immediately.

The new lamp has a metallic filament and, in fact, appears to constitute a solution of a problem to which Mr. Edison originally set himself without result. Undeterred by his failures the Siemens & Halske Company, some very considerable time ago, set Dr. von Bolton to work on the task of finding a substance capable of being drawn into a filament, and having a melting point so high that it would give a white light before failing. What Dr. von Bolton has done is to ransack the unused elements, and it seems that he has found what is wanted in tantalum. All that is known by most people of the properties of the so-called rare elements is the descriptions of them at the end of the chemistry books. These are mostly wrong for the simple reason that the things have been prepared once or twice by men who were not metallurgists, under circumstances of considerable difficulty, and without hope of any commercial gain which would justify the expenditure of time and money in purification. Of the two standard ways of getting anything which resists ordinary methods of reduction, the electric furnace invariably involves pollution with carbon. Electrolysis of the fused salt belongs rather to an element of a low melting point, and everyone knows the difficulty of getting a pure deposit. In fact, to draw any conclusions from the descriptions of the unused metals that appear in the books is very much the same as if one were to argue on the electrical possibilities of Fe from a small specimen of cast iron. Dr. von Bolton, in the course of his researches, tried vanadium, and found its melting point (as indeed he should have had fair warning, was much too low. The obvious course was then followed of trying the remaining elements of the same class—first niobium and then tantalum. The tantalum he has obtained is an entirely different substance to the tantalum of the books.

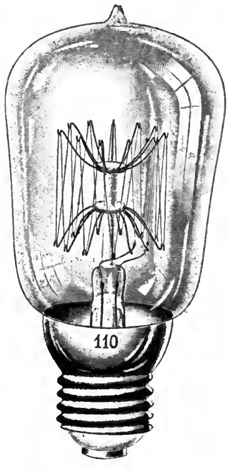
Pure metallic tantalum resists acids like platinum. It will burn in air, so that the lamp must be run in a vacuum; it absorbs hydrogen, nitrogen and carbon. Consequently, the tantalums that we have been put off with hitherto, though metallic in appearance, were really compounds or alloys. The tensile strengh of pure tantalum is 25 per cent. better than steel. It can be drawn into wire and it has the property which is so valuable in soft iron, viz., that it becomes malleable long before it actually melts.

Its electrical properties are even more convenient; the resistence of a meter wire of one square millimeter cross section is .16 ohms, but when run at its working temperature the resistance rises to .83 ohms, (say five times as much). Metallic tantalum has, in fact, as becomes a metal, a strong positive temperature coefficient. The ordinary carbon filament is, as is well known, deficient in this respect, though not (when at the temperature of incandescence) to such an extent as to make special treatment necessary, but the negative coefficients of the Nernst and of the arc constitute an effective nuisance.

The chemical difficulties of the manufacture of tantalum, which are not very serious, being removed, the mechanical problem remained of constructing a glow lamp that should have a filament two or three feet long, so as to run at a reasonable voltage, and this part of the work was out by Mr. Feuerlein. How the difficulty has been overcome will be seen from the illustration of the filament given herewith. The wire is looped round and round on a kind of frame. All metallic filaments are necessarily low resistance filaments, but it will be seen that, after all, there are compensations in working in metal instead of in carbon, or in a brittle paste of oxide. The type of lamp is already standardized for 110 volts 24 candles, and this lamp has a consumption of 1.6 watts per c. p. The filament is 25 inches long and has a diameter of .05 millimeter. As the weight of it is 22 milligrams, a pound of tantalum will make more than 20,000 lamps. The life of the lamp is about 500 hours, till at 1,000 hours it becomes a 2½ watt lamp. It is, therefore, quite possible that it may end as the 1,000 hour lamp that we are used to. It will be seen that the consumption renders the lamp an immediate competitor of the Nernst and the small enclosed arc. Its great point is that, like the osmium lamp of Dr. Auer von Welsbach, it contains no mechanism. The physical, as apart from the economic end of the lamp's life, appears to come when the wire becomes mis-shapen and brittle. Repeated expansion and contraction results in a shortening the length of the filament and a roughening. The new filament is quite tough, but old lamps should not be taken out or shaken (as with the gas mantle). Curiously enough, a broken lamp can frequently be mended by a simple process of tapping it until the loose ends touch together, when they weld themselves together. It then, of course, goes on as an over-run lamp. A similar habit was promised for the Nernst burner, but nothing came of it, and it seems unlikely that this auto-repairing faculty will come into practical use. The appearance of the filament has already been illustrated; it merely remains to add that it is inclosed in a vacuum bulb in every respect similar to that of the glow lamp of commerce. The limits of the voltage and size mentioned do not seem in any degree fixed. It is possible that they may be capable of considerable extension, but at present only 100 to 120 volt 24 c. p. lamp can be procured.

After the reading of the papers at Berlin some additional information was given by Mr. Wilhelm von Siemens; but except for the opening remarks of the chairman, Dr. Micke, there seems to have been no discussion. Beyond appreciation of the labors of Dr. von Bolton and Mr. Feuerlein, the important part of Mr. Siemen's speech was a declaration that the lamp was quite ready. The development has been done without any preliminary writing in the newspapers, and not a word has been said about it untll the company has not only got a lamp that will go, but is ready to go on turning them out for the market at the rate of 1,000 per day. Specimens of the present pattern have been running for a year.

There remains one point upon which the tantalum lamp is somewhat tantalizing; there is no information in the paper upon price. As regards the osmium lamp, with which one naturally compares it, when its producers have been asked whence they are going to get their osmium, they have replied in terms which, translated out of the language of politeness amount to



"That's our business; we have got it." At the same time, one naturally wants to know in what quantity. There is this about tantalum, that, although supposed to be a rare element, it exists in a quite sufficient quantity, even if no fresh discoveries are made, to provide the material of glow lamp filaments. That difficulty is no more likely to arise than in the case of finding sufficiency of the elements of the cerium group to make Welsbach mantles. And when manufactured in quantity there seems nothing in the process of production which should make it a matter of physical necessity that the new lamp should be excessively dear. It appears that the metal is reduced from the double fluoride of potassium and tantalum substantially after the manner to be found in the books. The impossible looking powder thus obtained when heated electrically under the air pump, parts with the gases it has obsorbed during the process of manufacture, and fuses into a workable metal—*Electrical Times, London.*

PHOTOGRAPHY.

GUM-BI-CHROMATE PRINTS.

JAMES E. MASTERS.

We hope this article will lead many of our readers to try their hands at gum-bichromate.

Gum-bichromate would seem in theory the simplest of printing processes, but in actual practice it will be found to be the most difficult. Prepared according to the method about to be described, it certainly has the advantage of cheapness. This latter quality is not one to be generally recommended, but in the case of the beginner in gum printing, who is almost certain to waste plenty of material during his early efforts, anything tending in the direction of economy is worthy of consideration. If the reader decides to prepare his own paper, his total outlay for the necessary equipment need not be more than sixpence. The materials required will be a brush for coating—a one inch flat hog hair brush will answer perfectly; an ounce of potassium bichromate, an ounce of gum arabic, and a sheet of cartridge paper.

The bicromate should be made up in a saturated solution, and the ounce of gum dissolved in 2½ ounces of water and then strained through fine muslin, in order to remove all impurities. The paper to be coated should be a little larger all round than the actual size required, and it will be found that the penny sheet of paper will be cut into nine pieces, each allowing ample margin for whole plate size.

Before coating, it will be well to place an old negative on the paper and run round the edges with lead pencil. This will ensure the requsite surface being covered, and will also be a guide as to whether the coating has been done properly.

The best pigment to start with is lamp-black, and instead of wasting money buying this, the writer scrapes a little as required from the inside of his dark room lantern. To coat the paper, mix equal portions (say ½ ounce) of the bichromate and gum solution in a measuring glass, take an old negative or a piece of opal, place a small portion of the lamp-black or soot in the center, and with a few drops of the gum-bichromate mixture, grind with an old palette knife or a worn out and flexible table knife. When the pigment is well ground up it should be removed by means of the knife to an old saucer, and thinned down to the proper consistency with some of the remaining bichromate and gum solution. I never weigh out any definite quantity of pigment, but after grinding add the gum and bichromate till I instinctively feel that the mixture is of the right consistency. The point at which the beginner nearly always goes wrong is in including too much pigment. This should be distinctly guarded against, and, instead of aiming at mixing an intense black liquid, the gum-bichromate solution should be added till the mixture is rather thin and easily workable with the brush. The right point will be reached when the pigment solution is of a slightly transparent greenish black color, which will allow the pencil marks on the paper to show through quite distinctly. After one or two trials, the beginner should experience no difficulty whatever with this part of the process.

For coating, the paper should be pinned down at the four corners to a board, and the sensitive pigmented solution applied by means of the brush. A good brushful should be sufficient to coat a whole-plate piece, the brush being worked backwards and forwards both ways of the paper till a thin and fairly even coating is obtained. By this time the paper will have expanded slightly, and the pins should be removed from the corners and the sheet again pinned down. The coating, when dry, should appear fairly even and of a greenish tint; should any slight streakiness be observed, it can be ignored, as it will not be evident in the print after development.

Printing takes about the same time as that required for carbon, and a soft and thin negative is best for the process. If an actinometer of some description is used no difficulty will be found, after one or two trials, as regards exposure.

Development is effected by floating the print face downwards in a dish of cold water. It will be best at first to immerse the print face upwards, and after seeing that no airbells have formed, the print can be floated face downwards on the surface of the water and left till development is complete. If exposure has been approximately correct, development will proceed automatically, and may occupy anything between twenty minutes and two or three hours. In the case of over-exposure, the use of warm water will help matters considerably.

Using lamp-black as I have recommended, the resulting print will be of a pleasing brownish black color suitable for most subjects ; but should the reader desire a greater variety, he can gratify his taste by procuring tubes of moist water-color of the requisite tints, and using them in place of the lamp-black.

The Photo-American.

PHOTOGRAPHY NOTES.

TO SENSITIZE PREPARED ARTIST'S CANVAS FOR SILVER PRINTING.

As a rule the surface of this is very greasy, and it is advisable to gently rub it over with a pad of cotton-wool dipped in weak solution of ammonia till it no longer appears greasy. The best method to sensitize is to use a gelatino-chloride emulsion, or the following is simpler:

Ammonia chloride	100 grs.	20 grs.
Gelatine	30 grs.	6 grs.
Water	10 ozs.	1,000 c. c.

Soak the gelatine for half an hour, then melt in a water bath and add the chloride. Keep at a temperature of about 100° F., and then with a varnish mop coat the canvas with an even and fairly thick coating. Keep the canvas level, and allow to set and dry. When dry use a broad, flat brush and paint fairly thickly with

Silver nitrate	50 grs.	100 g.
Water	1 oz.	1,000 c. c.

dissolve and add

Liquid ammonia fort .880

till the precipitate first formed is redissolved. Brush this evenly over the surface and dry, and it is ready for printing on; but when sensitized it will not keep more than 36 hours.—*Photo-American.*

WRITING ON BLUE PRINTS.

Those who occasionally print by the well-known ferro-prussiate process, as well as engineers who copy tracings by this means, may make a note of a rapid and easy method of writing details on such prints. A solution of carbonate of soda or caustic soda, frequently recommended for the purpose, is not nearly so good as one of potassium oxalate. The uniform strength of solution is important, though why a variation in the strength of such a neutral substance as potassium oxalate should make any difference I am unable to say. However, 75 grains dissolved in an ounce of water will remove the blue ground of the drawing in a few seconds, and can be applied with a pen or fine brush, the solution, if necessary, being thickened with gum. The paper should be well washed afterwards, for, if this is not done the blue color is very likely to reappear. Engineers who use this method on large tracings frequently content themselves with mopping off the surplus solution with blotting-paper and " washing " the treated part by applying wet blotting-paper once or twice. This imperfect method of removing the chemicals is, no doubt, responsible for the complaint made in many engineering shops that details written in this way gradually disappear from the drawing, the blue ground being gradually restored.—*Photo-American.*

THE OHM.

OSCAR F. DAME.

Electricians speak of a coil of wire measuring 3 ohms, or an electric incandescent lamp measuring 660 ohms, and the term is such a common one that many amateurs use the word without really comprehending its exact meaning. Mr. Ohm was an electrical experimenter whose researches in electrical matters, especially in relation to the laws of current flow, caused his name to be given to the unit of electrical resistance.

When a current of electricity is passed through a conductor, the conductor offers a resistence of obstruction to its passage, and the amount of current that passes in every instance will depend on the magnitude of this resistance. The resistance of a conductor varies directly as the length of the conductor ; inversely as the area of cross section, and also upon the kind of substance composing the conductor. Simplified, this means that a piece of wire of a given gauge, seven in. long, will have seven times the resistance of a piece only one in. long. The larger the conductor the less the resistance, is illustrated by noting that a foot of No. 16 gauge wire has much less resistance than a foot of No. 36 gauge. We also learn that some metals are not such good conductors as others, and consequently a given gauge of copper wire and iron wire will have different resistances. All kinds of metals, therefore, have a factor of resistance used in calculations. When we know the length of a copper wire in feet and its diameter in mills, we can multiply the standard coefficient of copper, 10.18, by length in feet and divide this by the diameter in mills, squared, and get the exact resistance. For example: No. 36 copper wire is 5 mills in diameter, and to find the resistance of a piece 1000 ft. long, we have 10.18 times 1000 divided by 5 squared equals 407.2 ohms.

Ohms law explains that a unit of resistence depends upon certain relations existing between current and electro-motive force. Ohm found that when a current was passed through a wire or other conductor, the relation which existed between resistance current and electro-motive force could be expressed:—

$$\text{Current, (Amperes)} = \frac{\text{E. M. F.}}{\text{Ohms}}$$

The correct difinition of an ohm, may therefore be as follows:

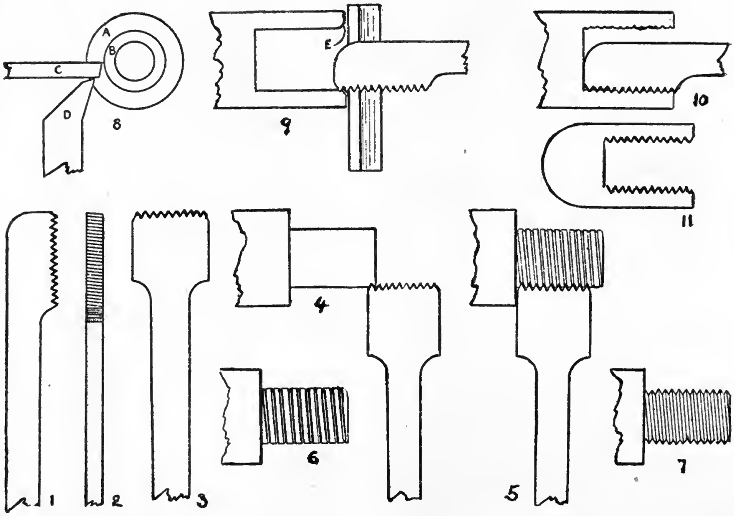
An ohm is that resistance through which a pressure of one volt will cause a current of one ampere to flow.

The catalogs of many manufacturers and electrical supply houses contain tables showing, among other things, the resistances of copper wires of all gauges by the pound and foot, also the diameter of these gauges in inches and mills and the number of feet in the pound.

SCREW CHASING IN WOOD.

HENRY JARVIS.

The chasing of inside and outside threads in the lathe is a task essayed by a great many amateurs, but their work is often attended with very poor results, the cause usually being either that they do not go the right way to work, or that they have not sufficient perseverance to survive the first failure. Now there is no reason whatever why one and all should not be successful in screw chasiug, the necessary appliance being few and cheap and the experience required being very little.



First as to tools required. These consist of one or more pairs of chasers (one for the inside and one for the outside screw thread) which must be of such a pitch as to suit the work in hand. A good size for a beginner is sixteen or eighteen teeth to the inch, which will cut a thread suitable for small boxes. It is well not to commence with either very fine or very coarse work.

The shape of the inside chaser is shown in Fig. 1, and a front view of the same in Fig. 2, while Fig. 3 shows the outside tool. The teeth of both the inside and outside tools are made at an angle, as in Fig. 2, to suit the pitch of the screw they will cut; they are also made at a slight angle with the side of the tools, so as to give the necessary clearance.

For the sake of illustration we will suppose that a small box has to be provided with a screw-on lid and that it is already turned up to the proper sizes, ready for chasing. This is commenced as in Fig. 4. The box must be held in the lathe in a chuck, or if too long for this, a mandril can be fitted into the opening, to enable it to be mounted between the centers. The outside chaser is held flat on the rest and fed up to the box, so that the first tooth will just catch in the wood; and if the lathe is turned very slowly, the beveled teeth of the chaser will draw themselves evenly and truly, until the side of the tool touches the shoulder of the box, as in Fig. 5.

If this has been done and no slipping has occurred, the wood will now be as in Fig. 6, the threads of the screw being represented by slight cuts only, scarcely more than scratches. The same process must be repeated, deepening the scratches slightly, as in Fig. 5, and gradually going over them again and again, until the finished result is as Fig. 7.

The tool will be found to work best if the cutting part is on an exact level with the lathe centers, as in Fig 8, where *A* represents the body of the box, *B* the reduced part on which the screw thread has to be chased, *C* the chasing tool and *D* the rest.

Now for the inside chasing, which will be found the most difficult to do. The box lid must be mounted truly in a chuck of some description, and the rest fixed close up to it, across the end as in Fig. 9. The opening should be chamfered slightly at *E* to enable the tool to start easily, and the tool is then placed so that it will just bite at the commencement, when it should draw itself along, making a slight thread only, but the same depth throughout, until it reaches the end of the opening, as in Fig. 10. The thread must be gradually deepened in the same way as before until it is cut to the full depth as in Fig. 11, or until the first part will easily screw into it. As it approaches the finish it is necessary to frequently try this, or the lid may be spoilt through making it too large.

All this looks very easy on paper, and it looks nearly as simple to watch an experienced person doing it, but for the novice there are many pitfalls which it will be well to describe so that they may be avoided. The first risk lies in taking too deep a cut, this having the same effect as in ordinary fine turning, tearing the work about and throwing it out of the center and causing a general upset. The remedy is obvious. Use the tool carefully. Another fault is running the lathe at too high speed; this causes all command over the tools to be lost, and when the shoulder is reached, so that the tool can go no further, it cuts off the threads already made. The remedy is to run the lathe as slowly as possible, even to dispense with the treadle and turn the mandril by hand; or to borrow the ser-services of an obliging friend to do so, at least during the first stages of experimenting with the tools.

Another very frequent fault with beginners is allowing the tool to draw itself in or out, after starting at the proper depth. This is caused through not holding the tools parallel or at right angles with the work at the commencement. It is easily rectified in the outside tool, but the fault is not apparent in the inside one until the mischief is done, hence care is required in this respect.

Another mistake often made, especially by novices, is to turn the two parts so that they fit one in the other before the threads are chased, so that when the latter is done the lid is of course too large for the other part. For threads of the size mentioned above, about an eighth of an inch should be allowed; it need not be done to any exact size, as it is easy to take an extra cut if the parts fit too tightly.

It is always best to chase the outside thread first, as this can then be fitted into the other as required, without disturbing the center. And it is as well to chase the inside thread while the wood is mounted on the original chuck, cutting the lid off and finishing after the thread is cut. When a very short screw is wanted, it should be cut off to the length after chasing, as it is much easier to make a screw of say an inch long, than it is one of three or four threads only; in fact, it is as well to always allow for cutting off a short length at the end of a thread, as it then makes a clean finish, or rather beginning, which is not always the case when the turning is finished to length before chasing.

When using either the inside or outside tool, it must be held quite straight with the work and also perfectly horizontal, as shown in the drawing (Fig. 8) the latter especially being very important. Do not attempt o chase screws on very soft wood; a close, hard-grained wood is the best, especially for trial.

If all the points here mentioned are attended to, there should be no difficulty in turning out good screws, but if any one is neglected, failure will certainly result.—*Hobbies, London.*

Some comparative tests between twist drills made of ordinary tool steel and of their ".0172" high-speed steel have recently been carried out at the works of Messrs. Cammell, Laird & Co., Coventry, Eng. Each drill was ⅞ in. in diameter, the ordinary steel costing 2s 7d net. The former was run at 32 ft. cutting speed per minute, and in 40 minutes drilled 36 holes through a high-carbon steel-plate 1¼ in. thick, and then required grinding. The operation was then repeated until 3600 holes in all had been drilled, when the tool was too short for further use. With the ".0172" steel drill the machine was speeded up to give a cutting speed of 60 ft. per minute, and on exactly similar material 150 holes were drilled in 80 minutes, when the tool was reground, although in better condition than the other when the latter had drilled 18 holes. After drilling 3600 holes the drill was still far from worn out, but, allowing the same life to each drill, the firm estimates the total cost of drilling 15,000 holes at $59 for the ordinary drills and $26 for their high-speed drills.

A short time ago Messrs. Witherington & Sons, millers, of Reading, England, made a comparison between the cost of carriage by steam motor and that by horse-drawn vehicles. In 1602 they had seven horses, and the expense of them for the year was $2,530.58. At the end of 1902 they sold the horses and purchased a steam machine, ran it 5272 miles, carried 3370 tons and burned 41½ tons of coal, at the total cost of $1,8849.27, including interest on the original car and also depreciation.

A German paper states that artificial rubies have been produced in France by reducing small natural rubies into a very fine powder, which is melted in an electric furnace, cooled rapidly and crystallized. The product obtained, from what was of little worth on account of minuteness, possesses a comparatively high value. The main difficulty encountered is to prevent cavities and fissures in the crystals. The new process can not be employed with emeralds and sapphires, as they become discolored by the action of the heat.

An indication of the immense business being done in the iron trade is the congestion of the tracks by cars loaded with the products of the mills in the vicinity of Homestead, Pa., and other manufacturing points. In one yard there were six miles of cars waiting movement one day in the early part of last month.

AMATEUR WORK.

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MARCH, 1905.

In this issue will be found the first chapter of the description of the Amateur runabout, which was announced in the previous number. The writer claims but little originality in the design and wishes to express his obligation to those who are so kindly assisting in supplying the necessary information. The principal objects in view are to supply a serviceable car at the lowest possible cost consistent with durable construction. The various sources of supply for parts are being investigated, and several fixtures are being made up special, that those building from this description may be able to get supplies of up-to-date design and yet at low cost. As many questions are likely to arise, special attention will be given to correspondence regarding same, by this means giving readers all the data necessary to intelligent progress with the work. Suggestions will also be gratefully received. We confidently believe this to be the first practical description of a motor car to be published in this country, and that it will be welcomed by a wide circle of readers.

The addition of a number of new and desirable premiums to our list has delayed the issue of same till the next issue. We hope to have it fully completed for that issue.

The reprint and binding of all the back numbers is about completed, and it is expected that all orders for bound volumes will be filled by the time this magazine is delivered.

Photography is one of the most valuable means of record, and its uses for this purpose is extending into all departments of engineering and mechanical work. A photograph tells its story at a glance, and when dated and supplemented with written notes a series of views makes the best possible record of progress. The cost of making photographs with a proper equipment is not a great expense, and any bright young man can learn to make exposures, develop the negatives and make the prints in a few days. To insure accuracy as to the dating it is a practice to set up a small blackboard in the foreground with the date chalked in large letters thereon. Whenever a special job is done a picture should be taken of the set-up of the machine and of the successive steps taken in the operation. It will often be of material assistance afterward to be able to show just how a certain job was done and what tools were used. In a case of accident or breakdown a record may be of great value, and cases are known where a good picture has been the principal and deciding evidence in a damage suit. With a high-grade lens tracings can be photographed in greatly reduced scale without distortion, and prints made from the negatives may be used in the shop much more conveniently than the large, cumbersome blueprints. Lines and dimensions, although of microscopic size, will stand forth with great distinctness even though the tracing is photographed to a scale, say, one-sixth or less of the original size. In fact the usefulness of the camera in the average shop is only limited by the enterprise of those responsible for its application.

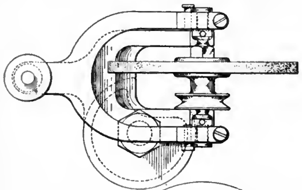
In looking up with criticism or adimration at a modern office building probably the last question which would suggest itself to the observer is "how much does it weigh?" The mind can hardly realize the significance of figures in this connection, and yet it is not uninteresting to read of a close estimate of the exact weight of an up-to-date metropolitan steel structure, including the entire contents. The aggregate weight of one just built for the New York *Times* has been declared as 81,913,000 pounds. Of course the actual weight of a large part of everything used in its construction is known to the contractors who handle and bill it, as for example, the structural iron, which weighed 7,021,000 pounds.

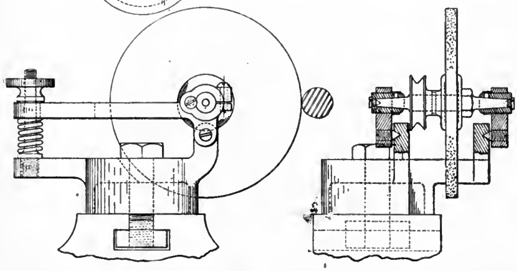
TOOL MAKING FOR AMATEURS.

ROBERT GIBSON GRISWOLD.

VII. A Grinder Head for a Lathe.

To the amateur, fond of doing fine mechanical work, there is nothing that appeals so strongly as a finely finished piece of work or an absolutely accurate fit. But such accurate work demands very accurate tools. The ordinary lathe tools are not capable of doing very close work, especially when the finish is made with a file: but if work is finished to within .003 of an inch with a tool and then brought to size by grinding, a very accurate piece of work may be obtained.





In fact, there is scarcely any limit to the nicety with which a definite size may be obtained on cylindrical forms, and one may, with a little practice, come within .0001 or .0002 in. of a given size, while an absolute diameter, as measured with a micrometer, is quite as readily obtained,

Most of the grinding done in commercial lines is accomplished by means of special machines, the truth and accuracy of which is almost beyond criticism. But if the ways of a lathe are in good condition a very fair class of work may be done, and far ahead of any hand finish that can possibly be given. The thought generally arises in the mind that grinding is a slow and tedious process, but in all probability this is due to the fact that the wheel apparently removes little material at a time. But such thoughts are fallacies. A perfectly true-to-size piece may be secured in far less time by grinding than by any other method, and that with absolute certainty as to its being straight.

Most of the appliances used in lathe grinding are more or less crude, especially what is known as the "tool-post" grinder. This is through no fault of the no fault of the machine, but due to an accumulation of possible errors. In the first place, the cross feed screw of any lathe is not fine enough to secure cuts varying from .0001 in. to .0005 in., and unless this is possible little can be done towards really accurate work. Then again, the wheel is generally overhung on parallel bearings, seldom adjustable. In grinding to a shoulder, parallelism of the wheel with the plane of the shoulder is dependent only on the accuracy of the tool-post seat and bottom of the grinder stock. Too often the grinder is made interchangeable with an inside grinder; this should never be, for the simple reason that the requirements of the two are so entirely different and the speeds so varying, that of an inside grinder being fully five to ten times that of an outside grinder. The bearings required by the two shifts are very different.

Another feature that is absolutely essential in any good grinder is rigidity, and that can hardly be possessed by a greatly overhung wheel supported by a simple fork, as generally used in the tool-post style.

The desire to make a grinder head for a lathe that would overcome these bad features has led to the design shown in Fig. 1. Every part has been given sufficient rigidity and weight to overcome vibration, which would result in chattering and a rippled surface on the work. The adjustment of the wheel feed is so sensitive that .0001 in. or less may be very easily secured, while the coarse feed may be had by the carriage screw. The head is also adjustable to any angle, so that surface grinding may be done on the face plate. The wheel is supported on a hardened steel shaft running in hardened steel bushings, thus giving the minimum amount of wear. The bearings are adjustable and carry the tapered journals of the wheel shaft. This adjustment is absolute and the very best that can be secured for such high-speed, and at the same time, light work.

The base is provided with a body that can be trued on an arbor so that it will bear evenly on the tool-post seat. A ball passes through the center into a nut in the "T" slot, a slight turn on which securely fastens the grinder in any desired position. A lug extends from one side carrying the adjustable screw, and a very heavy, substantial fork carries the wheel yoke. The adjusting screw should be provided with very fine threads, say 40 the inch, and the thumb nut should have a spherical seat washer under it to accommodate every motion of the arm, although small. The spring should be of No. 14 piano wire and very stiff. Drill the cups for the pointed trunion screws very accurately in the lathe. Best done by laying off carefully and then drilling between centers with a very short, stiff drill held in a chuck. Grind the drill to the same angle as the screws, about 60°.

The yoke carrying the wheel spindle is given a form best adapting it to resist the spreading strain of the trunion screws, but as these should be just brought to firm bearing, no great strain need be imposed, as the weight to be carried is comparatively small and the wheel strain very slight. The positions of the various screws are laid off and accurately drilled between centers, as described above. Mount the yoke on its trunions and clamp to the lathe carriage, the base of the head having been so machined as to bring the center of the wheel spindle directly in line with the lathe centers. Then sharpen a ⅜ in. drill and mount in a drill chuck so that it runs perfectly true. Now feed the carriage along very slowly so that the drill will drill a smooth, true hole through each arm of the yoke. This insures the parallelism of the lathe centers and wheel spindle, since the holes have been drilled in place. If a ⅜ in. reamer is at hand, use a drill about 1-64 in. under size and ream the holes true. The adjusting arm should be clamped down tightly on a small block cut to the proper length to hold the arm in its middle position while drilling. The spring might not be sufficiently stiff to keep the drill from "walking". The bearing is now split on one side with a fine saw, and this serves to clamp the bushing firmly in place.

The bushings are turned out of a piece of ⅜ in Stubbs' steel drill rod. The spindle may also be turned from the same, but it would be better, if a very fine job is desired, to make two spindles, mounting the wheels on one finished as nicely as possible by hand and then grinding the other, after hardening, to a true cylinder and the journals perfectly in line. These journals have a taper of ½ in. per foot. The bearings can be made by reaming out the hole with a reamer turned to the taper of the journal. To make this reamer, turn a piece of tool steel to the proper taper and then file away one side until the flat surface coincides with the center line. This leaves a cutting edge on either side, and it will ream a very smooth hole. Harden and grind on the flat side only.

Harden the bushings and lap the hole out with a piece of copper (held in the chuck) turned to the proper taper and charged with flour of emery and oil. This will give a beautiful surface and the bearing will be truly conical.

The spindle is slightly longer than the distance between the arms of the yoke, owing to the desire te get the supports as near the wheel as possible and this necessitates canting the spindle and putting in first one end and then the other, afterwards inserting the bushings. But as the head is seldom taken apart except for the removal of a broken or worn out wheel, this does not mean much in the matter of time, and it does allow a solid support for the bushing, which is a point greatly to be desired. The head of the adjusting screw bears on one edge of the bushing, and a fine adjustment is secured by screwing these in as wear takes place.

Oil holes are drilled in the top of the bushings and covered with a small ring of brass to exclude dust and small particles of abrasure. A small washer of felt should be inserted in the hole at the end of the bushing, acting as a plug and oil reservoir.

The pulley and clamping flanges need no description excepting that they are secured to the spindle by a spur, the hole for which is drilled in the spindle before hardening. The emery wheel should be about 3 in. diameter and not over 3-16 in. or ¼ in. thick, and what is known as "Grade No. 60 or 70." The speed at which a 3 in. wheel should run is about 6500 revolutions per minute, but on foot power lathes this may be difficult without an overhead shaft and light driving wheel, which will be described in the next chapter.

At that time there will be described an inside grinder and the overhead hangers and shafting necessary for driving the wheels, to be followed by chapter on grinding, selection of wheels, speeds, etc.

"There is no place in the modern world for the unskilled; no one can hope for any genuine success who fails to give himself the most complete special education. Good intentions go for nothing, and industry is thrown away if one cannot infuse a high degree of skill into his work. The man of medium skill depends upon fortunate conditions for success; he cannot command it, nor can he keep it. The trained man has all the advantages on his side; the untrained man invites all the tragic possibilities of failure."—*Hamilton W. Mabie.*

When tightening down a cylinder head or flange after putting in a new gasket, take great pains to screw down the nuts evenly all around. If one side is screwed down too hard there will be a weak spot on the opposite side, or the head or flange may even be sprung. Give each nut a fraction of a turn and keep going around until all are firmly down. Do not, however, make the mistake of putting on too much force and and breaking the threads — not at all difficult to do with a small bolt and long wrench.

Forest Leaves notes that in the making of charcoal the condensible gases from one cord of wood amounts to 224 gallons of liquor. This liquor is known as green liquor or pyroligneous acid. It is largely made up of water but contains also, alcohol, tar, ammonia compounds, acteone (alyl-alcohol, ethers, aldehydes and acetic acid. Alcohol, acetic acid and formaldehyde are the substances usually separated out of the liquor.

HOW TO BUILD A POWER LAUNCH.

CARL H. CLARK.

IV. Framing for Deck.

If the moulds have not been already removed it may now be done, and any nail holes where fastenings have been put in, should be carefully plugged, using a small wooden plug, if necessary.

The tops of the frames, except three at each end, are now cut off even with the upper edge of the top streak. The clamps are 3½ in. wide by 2 in. deep, of hard pine, and are laid with their 2 in, side on the frames, as shown in the cross section. In order that they may bend more easily they may be tapered off towards each end to 2½ in.; if this ½ in. is taken off the outside edge it will aid in giving the clamp a small amount of original curvature. The whole outer edge should also be beveled so that when the clamp is in place it will have a slight slope, so as to match the crown of the deck at the ends. As will be noted, the main clamp extends only the length of the cabin trunk, and at the ends other additional short clamps are fitted. The main clamps extend from the third frame from the bow to the second frame from the stern, as shown in the general drawing. It may even, to good advantage, extend to the second frame, as this will allow the fastening of the end. The clamps may be bent into place when cold, as the curvature is slight, but before bending them in, a double turn of rope with a stick to twist it up should be passed over the tops of the frames at the ends of the clamps to prevent the bulging of the sides of the boat at these joints, owing to the pressure when clamp is bent into place, and at any signs of bulging it may be brought back to shape by revolving the stick, thus twisting the rope and drawing the ends together.

When the clamp is in place it is fastened with rivets driven through the tops of the frames and the top streak. Before fastening, care must be taken that the clamp bears evenly on all the frames, and any which are thicker than the others should be trimmed down; this is necessary, as the clamp, being heavier than the side of the boat will draw the latter to it, and if the frames did not all bear evenly some would be drawn in more than others and the side of the deck would be irregular. The short clamps at the ends are also of hard pine, 1¼ in. thick and 3½ in. wide, tapering to 3 in. at the extreme ends. They are bent around flatwise 2 in. below the top of the top streak and, as will be seen, they will just pass under the main clamp, which they should be allowed to do, and extend at least a frame space beyond the end of the main clamp. This avoids a break in the structure of the boat and preserves the strength.

These short clamps are fastened in the same manner as the main clamps, and at the extreme ends, where there are no frames, pieces of board of the same thickness as the frames are placed under the clamps and fastened through. At the bow a knee, or a triangular piece of board, should be fitted between the clamps and well fastened. After the clamps are all fastened the ropes may be removed and the tops of the remaining frames cut off. A few braces should, however, be fastened across the boat to prevent any change of form, as there may be a tendency to spread amidships, and it must not be allowed.

In each bilge a stringer is to be fitted. It is of hard pine, 1 in. thick and 4 in. wide amidships, tapering to 3 in. at the ends. These stringers are bent around in such a manner as to lie flat on the frames and are held in place by shores to the beam above. They are held by fastening to the frames with nails or screws, and should be fastened at each edge to every frame.

Before going farther, the hole for the rudder post tube would best be bored, as it is more accessible now than after the deck is fitted. This tube is a piece of 1 in. standard iron pipe, galvanized and threaded for a length of about 8 inches. The hole is bored of the size of the bottom of the thread, and care must be used that it is exactly plumb and fair with the stern-post. No harm will be done if the hole passes through the stern knee, as shown. If the hole, as first bored, does not come exactly fair and in line with the stern-post, it may be trimmed out somewhat with a gouge. In any case, when the rudder post is in place it must be in line with the stern-post when viewed from aft. The tube may now be smeared with white lead and screwed down into place with a pipe wrench. It should be turned down until it projects below the fantail an inch or more.

The deck beams are preferably of oak and sawed to shape out of a 1½ in plank—they are 2 deep and are cut to such a curvature that the longest beams have a camber of about 3 in. in their length. They should, of course, be planed all over, and their upper edges especially should be an even fair curve, so that the deck plank will lie evenly. The beams are fitted on the top of the clamps and just aft of the frames, and are fastened to both clamps and frames with screws or rivets. Care must be taken to see that the upper faces of the frames are in the same line so that the deck plank will lie fair and even.

In order that the coamings of cabin and standing-room may fit neatly, curved pieces are worked into the corners between the clamps and the beams, as shown in the deck plan; they are of oak and are fastened to both clamps and beams. The next step will be to lay the deck. A covering board of oak is first to be bent around the outer edge of the deck to add strength and form a finish. It is ⅞ in. thick, 3 in. wide amidships, and 2½ in. wide at the ends. The projecting top of the stern is trimmed up square, and the end of the covering board neatly fitted to it. The clamp, beams and upper edge of the top streak are to be joined and smoothed down to an even surface so that the covering board will lie evenly.

In bending the covering board into place it may, perhaps, be well to steam the forward end where the curvature is greatest. When bent around it should be held in place with clamps until fastened. Just aft of the stem head a short beam should be fitted on top of the beam already fitted, as otherwise there will be nothing to support the ends of the deck plank. The covering board is held in place by nails driven into the edge of the top streak, the beams and the main clamps. Especial care must be taken with the joint between the covering board and the top streak, as this joint is very plainly in view and must be tight.

At the after end the covering boards are cut with a mitre joint, and a piece of similar size is fitted across the stern, joining both covering boards. To support this cross piece, short pieces are nailed to the inside of the stern board. A board about 4 in. wide is also fastened to the under side of the boat and projecting 1 in. beyond the edge of the after covering board; this latter is to support the ends of the deck plank.

The deck plank should be preferably of white pine, as this wood makes a very fine deck, but almost any other kind may be used if the above is not obtainable Whatever stock is used should be clean and straight grained, and if possible the two lengths which are laid alongside the cabin and standing room should be in a single length. The stock should be ⅞ in. thick and in about 2 in. widths, so as to bend easily. In laying, the several planks are bent around inside the covering board, one after the other. An oak board 5 in. wide should be fitted lengthwise in the middle of the forward deck, running from the forward end of the cabin trunk to the stem and being fitted nicely to the stem and covering boards. It is fastened to the deck beams with counterbored fastenings. A similar board 4½ in. wide is fastened in the middle of the after deck and neatly fitted to the after covering board. As will be seen, there are only two plank, one on each side, which run the whole length, the remainder being short. The forward end of these plank are fitted to bear against the middle plank, and are bent around inside of the covering board and the after end fitted to the after covering board; they are fastened to beams and clamps with counterbored fastenings. The upper corners of each plank should be slightly beveled before being laid, so that the seam will be slightly open to admit the insertion of the calking. The single deck plank should be found to have its inner edge just even with the inner edge of the main clamp. If for any reason this does not occur, another plank may be laid the whole length and trimmed out to come even with the clamp. The remaining planks are all short lengths and are fitted very quickly; the ends are all fitted against the middle plank.

It may be found necessary to fasten some short pieces to the under side of the middle plank between the beams, and projecting over beyond the line of the cabin and standing room and the ends trimmed off later to the correct curve. All fastenings in the deck must, of course, be counterbored for and the holes filled with bungs, in the same manner as before described. If necessary, the deck should be smoothed somewhat at this time, leaving the final smoothing, however, until the last. The deck must also be calked with cotton and the seams either filled with putty or marine glue; the latter is preferred as it is elastic and perfectly water proof. It is poured into the seams in a melted condition, but full directions can be obtained where the glue is purchased so will not be given here. If one is less particular as to the appearance and finish of the boat, the covering boards, instead of being carried to the stem may be allowed to run off straight after being bent to the curvature of the house sides, and the whole of the decks between them filled with a few wide boards; this is strong enough, but is not really to be recommended, as the time saved is not worth the difference in appearance. The ends of the deck plank are now to be trimmed out to the curve of the trunk and standing room ends.

The cabin trunk is next to be bent into place. For this purpose a ⅞ in. oak plank 15 in. wide and about 17 feet long will be required. Before bending it to shape the outline of the lower edge must be gotten; to do this a thin board 8 or 10 in. wide is used, being bent around in the position which the covering will occupy. A line is scribed on the board even with the deck, the board is then removed and trimmed down to this line, and when laid on the oak plank will give the outline of the lower edge of the coaming. The latter is then cut to fit the pattern. The coaming will require very thorough steaming in order to render it sufficiently limber; the stock also should not be too dry, as in this case it is likely to break during bending. It is better to use a rather green piece of stock and allow it to season in place. The plank is well steamed and carefully bent around into place, using clamps to draw it into the sharp bends. It must be held firmly by plenty of clamps, and fastened in place by heavy screws before it is thoroughly cold. A brace should be fastened across the after end to prevent the sides from springing out. When properly fitted it should slope slightly inwards all around. It must be allowed to thoroughly dry before being disturbed further.

The coaming should now be cut off about 1 ft. back from the position of the bulkhead. The top of the coaming also, is trimmed down to the correct outline and should stand about 2 in. above the deck at the center forward.

The standing-room coaming will probably need to be in three pieces with the joints about on number 6 mould. The oak plank for this coaming will need to be 9 or 10 in. wide and ⅞ in. thick. The after curved piece is first bent into shape, as described, for the r unk. The projecting ends of the trunk coaming are trimmed on the inside down to the thickness of the coaming ; this allows the standing-room coaming to be joined to it and make an even thickness. The two side pieces of the coaming are next to be fitted ; they are butted against the after piece and joined by a butt block about 10 in. long on the outside, fastened with screws. They are joined to the trunk coaming by halving each and fastening with rivets. After it is all fitted it is to be trimmed down to a height of 3 in. above deck, and at the forward end the curve is worked as shown at the after end of the trunk. The top edge of the coaming is rounded off neatly all around.

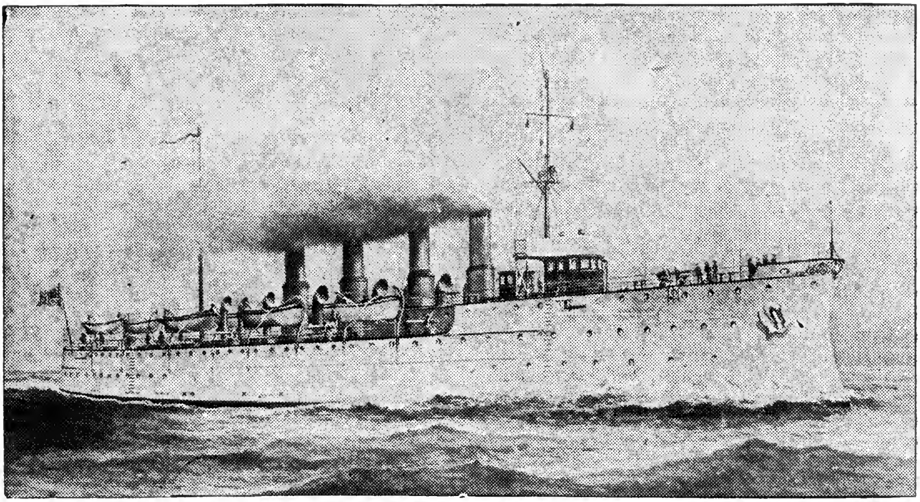
The beams of the cabin trunk are of oak ⅞ in. thick by 1½ in. wide, and are cut to a crown of about 5 in. in the length of 5 ft. They should be smoothly planed and the lower edges beaded. Starting with the inside of the after bulkhead, the beams are spaced 9 in. apart, center to center ; they are dovetailed into the trunk, care being taken that the dovetail does not cut through to the outside of the trunk. The beams are then inserted from above and the top edge of the trunk beveled to the proper angle of the beams. The top of the house is of ⅞ in. tongued and grooved pine and is laid with the beaded side below. It is laid fore and aft, starting at the middle and working towards the edges nailing to the frames and trunk sides. It is trimmed off around the outer edge of the coaming but across the after edge it is left long and trimmed off later.

The after bulkhead is next to be fitted on the after side of the last roof beam. This bulkhead is of ⅞ in. stock, matched. It has been figured that the lower edge of this bulkhead would come so that it can be nailed directly to frame, but if this can not be done cleats can be fastened to the inside of the plank. The bulkhead runs to the side of the boat and should be made as strong as possible, as it is a valuable brace to the boat. A door 2 feet or so in width is left in the center. The after edge of the house top may now be trimmed off even with the face of the bulkhead.

TRIAL TRIP OF A BATTLE-SHIP.

ALBERT GRAHAM.

To a few only is given the pleasure of witnessing a full power, speed and endurance trial of a large ship, such as our battleships and cruisers. I will try to describe to the readers of this magazine a trial trip of a sea-going war ship, and endeavor to show, in a very meagre way some of the life and action that is going on in the dark depths below decks.



U. S. SCOUT CRUISERS CHESTER, BIRMINGHAM AND SALEM.

On the night before the trial, and, in fact, for several days before, the massive machinery has been thoroughly inspected and made ready for the run. All depends upon the high efficiency of the power plant, and great care is exercised to see that there is no possible chance for an accident. Very early in the morning, long before the sun has even tinted the eastern horizon with the first signs of dawn, begins the vibration of auxiliary machinery throughout the ship, and a dull hum arises from the depths of the hold as the men are getting everything in readiness.

Dressed in an old suit of clothes and making a hasty toilet, we make our way along a narrow passageway to the brass-railed ladders leading to the engine rooms below. As we pass through the hatch in the protective deck, a gust of hot steam-and-oil laden atmosphere envelopes us, and far below in a misty light, forms are hurrying to and fro attending to duties too numerous to mention.

But down we go through a forest of pipes of all sizes, some hot, some cold, some as large as our body and others not larger than our middle finger, all apparently hopelessly jumbled into an inextricable mass with numberless hand wheels peeping out here and there. As we pass the middle landing our gaze falls for the first time upon the massive reciprocating parts of the main engines, all brightly polished and standing out boldly against the more puny columns, handling gear and pipes.

Upon reaching the lower landing, or engine room floor, a man rushes past with two buckets of oil, while all around us are busily engaged men, each performing some particular duty previously assigned. Passing forward through the power-closing, water-tight doors into the passage that leads to the fire-rooms, then through the air-lock doors, we are ushered into the first fire room.

Here all is life, bustle and activity. Great yawning incandescent mouths are devouring shovelful after shovelful of coal as the firemen toss it to the further end of the furnace with apparently little effort. And you ask, " Why, is that little pile of coal all that they carry? " as you see perhaps a couple of tons piled along the middle of the floor, from which each fireman takes, but no sooner has the sentence left your lips than there issues from a small door in the side of the room, which is really the coal bunker bulkhead, a black, grimy form bearing, or helping bring through a large bucket of coal, which is dumped alongside of the other. And thus it goes, with the exception that while on the run all the coal used is brought out in bags and each bag is supposed to contain an exact amount. One of the official observers counts these bags and thus determines the exact amount of coal burned during the run.

As we look up at the massive boilers we see a man whose duty it is to simply tend the water and see that it never falls below a certain point in the gauge glasses. Upon looking through a door in the center-line bulkhead we see another fire room just like the one we are in; and, walking forward, we pass through two more.

We now go above and take a walk on deck where everything is quiet. Overhead floats a cloud of dense black smoke from the funnels forward. The sea is smooth and the stars are dimly twinkling a farewell as they retire before the rising orb, now just climbing over the edge of the sea, turning the intervening stretch into a lane of fire and liquid gold. We have not long to wait before we see in the distance a tug approaching, brim full of saucy importance and bearing the official observers, reporters, photographers and guests. As she nears the side we, for the first time, realize how massive our leviathan really is, as our rail towers way above the tall stack of the tug. One by one her passengers climb up the ladder on the side and gradually disappear below, while the tug backs away to await the visitors' return.

By this time everything has been made ready and we return to the engine rooms. On the bulkhead behind us are fastened gauges, clocks and various indicators, while below stands a large dial and gong, a mechanical telegraph connecting with the bridge from where the movements of the ship are directed. We are suddenly startled by the clang of the huge gong, and the pointer moves around to " Ahead, slow. " The engineer opens the throttle slightly and the huge arms begin to move up and down as the shaft revolves. There is hardly a sound, so perfectly does the engine run, and as the gong clangs again with the indicator pointing to " Ahead, Half, " we realize that our ship has headed for the course.

Everthing seems to run like clockwork. All the auxiliary machinery is running steadily, and the large engines are turning over about sixty revolutions per minute. Our steam gauge has long since reached the 230 pound mark and our engineer signals that everything is in readiness.

Again the gong clangs out "' Full speed ahead " and a few turns of the throttle gives our engines 130 revolutions per minute. This speed, for a large engine, cannot be realized unless seen, for it means tons of rapidly revolving metal.

Before long the atmosphere begins to be filled with vapor and flying oil. The huge cranks are splashing it everywhere, while oilers with large syringes squirt pints of oil on the piston rods and guides. But oil does not count. The main question is to " keep her going cool." The floor soon " swims in oil " and lumps of white grease are spattered over everything within reach. As we pass into the shaft alley, the thrust collars and shoes are a mass of foam, and perhaps here and there a stream of water may be playing on a bearing to keep it cool. The damage a hot bearing may cause is, indeed, great, and no end of pains is spared to prevent it. You remark upon the coolness of the room. Yes, it is cool for an engine room. The temperature seldom goes above 85° or 90° in the winter, but somewhat higher in the summer and in southern climes.

Again we go into the fire rooms, but this time we are almost swept from our feet by the blast as the air-lock doors are opened. The fire-rooms are now closed and are under forced draft. Large fans are driving the air into the rooms under pressure, so that the fires may burn hotly and generate sufficient steam. You can see what force it has as the finer particles of coal are carried from the shovel into the furnace before reaching the open door.

You also notice how each furnace is fired in regular order. No adjoining furnaces are fired consecutively, but perhaps in this order: If there are eight furnaces in the fire room, 1 and 8, 3 and 6, 4 and 5, 2 and 7. This prevents too much unburnt coal being put into one furnace, which would chill it, and, besides, there is less cold air let into the furnace at one place. But upon our return to the engine-room, behold our finely polished engines completely covered with a coating of white grease; the floors are slimy and slippery with oil; the men are soaked from head to foot with oil.

But as we are nearing the end of the course we go up on deck in time to see the last stake boat loom into sight, and we feverishly await the passing, for we are told that probably we shall make more than twenty-four knots per hour if we can pass her in twenty-three minutes. From the bows we are sending spray in every direction, and a churning mass of foam glides past us as we lean over the rail. Walking to the stern we see a turbulent churning wake stretching as far as eye can see.

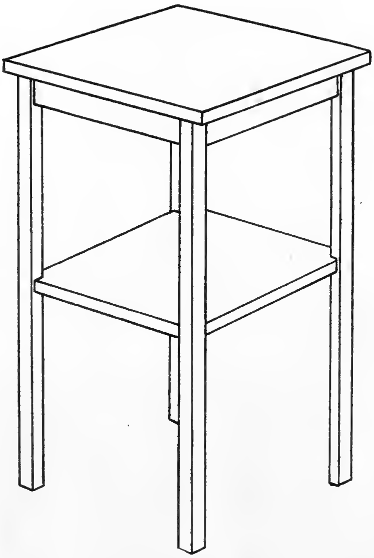
Directly beneath us we see the silver-white blades cleaving the pale green water, and can almost trace the very thread that is being cut in the waves.

We are now passing the stake boat, and soon begin to make the turn for the return run. Our first run has been against the tide and our return will be, for the greater part, with it. But not for a moment has the throbbing pulse below ceased, and neither will it until the finish, for she must prove herself capable under the severest strain.

AN OCCASIONAL TABLE.

JOHN F. ADAMS.

Small tables are always in demand for various uses, and the one here described will be found very serviceable in hall, library or chamber. The wood used for constructing it should be finished to correspond with the other furniture in the room where it is to be placed.



The top is 15 in. square and ⅞ in. thick, of one piece, if possible. It should be of well seasoned stock to avoid subsequent warping, and planed smooth and level. The legs are 1½ in. square, and 29 in. long. Mortises ⅜ in. wide, ¾ in. deep and 2 in. long are cut at the top ends to receive tenons on cross-pieces under the top, which are 11¼ in. long, 2 in. wide and ⅜ in. thick, allowing ¾ in. on each end for tenons. The fitting of these cross-pieces should be very accurately done, otherwise the table will not be firm. The joints are glued and pinned with 3-16 in. dowels. In boring the holes for the dowels be careful not to split the wood.

The top is attached to the cross-pieces by screws put through from the under side. First bore ½ in. holes, two in each cross-piece, to a depth of about 1½ in., then following with a gimlet bit, a trifle larger than the screw. By placing the top of the table on the floor, with the under side up, and then placing the frame on top, first having marked lines to show the proper position, the holes in the top can be bored and the screws then put in so they will hold very securely.

The under shelf is 12½ in. square and ¾ in. thick, 1 in. square being cut out of each corner to fit around the legs. It is well to wait until the frame is made, however, before cutting out the corners, so that any little inaccuracies of fitting may be allowed for. The The under shelf is attached to the legs by screws cornered in from the under side, countersinking for the heads and using a long screw of not very large gauge.

Multiply the number of volts of a storage battery by the amperes, and you will have the number of watts. Divide the watts by 746 and you have the horsepower. From 20 to 40 per cent of the energy developed by the battery will be lost in converting it into power in a motor, the remainder being available for use in the form of power.

WEATHER INDICATIONS

AFFORDED BY ANIMALS, BIRDS AND PLANTS.

Observations of the habits and conditions of animals and birds, and the appearance of plants, have a recognized value in determining the character of past weather and, to a limited extent, the weather for a few hours in the future. In a state of nature the condition of animals and plants is an indication of the character of past weather, so far as it has affected their physical condition in the one case and their growth and preservation in the other. The appreciation of animals and plants for future weather must necessarily be limited to the effect or influence upon their organizations of present atmospheric conditions, and in the case of animals the sensations that are produced by certain conditions or variations of atmospheric moisture, pressure, temperature, etc., are instinctively associated with the kind of weather that usually follows the kind of sensations experienced. Neither animals nor plants can possibly be affected by the weather of a future month or season.

Undomesticated or wild animals, fowl, and birds are usually used as an observation basis for long-range forecasts. Animals, such as the ground hog, or woodchuck and the bear, that make winter a season of hibernation, are supposed, by the character of their preparations and the time of their retirement, to indicate the length and strength of the cold of the approaching winter, and towards winter's close they again become prominent factors in this scheme of forecasting. For, according to weather folklore:

If, on Candlemas day the weather is bright and clear, the ground hog will stay in or return to his den, thus indicating that more snow and cold are to come (and there he stays for a period that varies in length in the different sayings that relate to this act from two to six weeks) but if it snows or rains he will creep out, as the winter is ended. The bear comes out on the 2d of February, Candlemas day, and if he sees his shadow he returns for six weeks.

If the sayiing regarding the coming out of the ground hog and the bear on Candlemas day possess any merit it rests upon the fact that fine and clear days in the early part of February are usually cold days, and that cloudy weather at that season is likely to prevail during warm days. The animals in question, therefore, consult their own comfort in cases where they make a premature exit from winter quarters. If it is cold they return; if it is not cold they remain out until the inevitable return of cold weather, which at that season will not be delayed many days.

The thickness of the fur of fur-bearing animals is also used as evidence of the character of approaching winter, when, as a matter of fact, this depends absolutely upon "the physical condition of the animal, and his physical condition depends upen the weather of the past and the extent to which it has affected his food supply and general health, rather than upon the weather of the future."

The accumulation of food by squirrels, beavers, and other animals during the autumn months is also taken as a guide to the character of the coming winter. It is assumed that the gathering of a large supply of food indicates a long, hard winter. Careful observations of the habits of animals show that the autumn habits referred to or their omission bear no relation to the character of the following winter. The quantity of nuts stored by squirrels is governed by the supply of nuts at their disposal. In seasons when the crop is abundant the busy little animals will gather a large quantity, and when nuts are scarce his accumulation will be correspondingly small. The supply of nuts is governed by past and not future weather.

Birds of passage migrate to the south with the first breath of winter, or when their food supply is affected by inclement weather that is peculiar to approaching cold weather, and return north when spring sets in in the south. That their flights are influenced by present rather than a knowledge of future weather conditions is evident to all observers. Their judgment is on a par with that exhibited by some men in doffing or donning winter clothing; their actions are dictated by a sense of personal comfort, and they are often compelled by actions to admit their error.

The thickness of plumage on wild and domestic fowls is also a result of feeding and past conditions of weather, rather than an indication of the character of future weather. And the goose-bone theory is one on which no two geese agree.

Moss, bark on trees, and the thickness of nut shells, pumpkin rinds, etc., furnish another basis for long-range weather speculations that also confuse and misinterpret conditions that are due to past conditions and have no bearing on future weather. There is one feature of tree weather forecasting, however, that possesses merit in so far as it presents as a basis a record of the general character of the weather for many years, and may thus show or indicate recurring seasons of certain kinds of weather. Trees of great age and large growth, like the sequoias, indicate by their rings years that have been favorable and unfavorable for their growth, or, in other words, wet and dry years in the region in which they are located, and thus establish a record of the seasons that may be useful in calculations for the future.

In passing, it will be noted that prominent advocates of this branch of long-range weather forecasting have long since disappeared from public view, which fact may be taken as indicating that dishonest practices can be profitably conducted only by the possession, or an assumed possession, of superior knowledge, or under a cloak of mysticism, and not in connection with matters concerning which ordinary observation will reveal the truth.

THE SCHOOL OF THE APPRENTICE.

FREDERICK A. DRAPER.

Not every young man has the fortune (or, shall I say, misfortune) to be born with a silver spoon, and has the means wherewith to obtain his education at a technical college. And to those upon whom Fortune has not thus smiled, and yet who desire to advance in the paths of learning, the picture of the student, surrounded by willing instructors and expensive equipment, is an alluring one, well calculated to make the unthinking have envious thoughts and bemoan the fate that forced him to hours of labor rather than study. It is but natural that one wishes for what he has not, and fails to realize the value of that which he has.

And so with the young man who begins his apprenticeship as a mechanic ; he thinks of the greater progress he might make if he could but graduate at a technical school, forgetting that at hand and without cost, he has what no student can get, the instruction of that greater school of "experience" as developed by the stern necessities of industrial progress.

It is well, therefore, for the one whom ambition urges forward, and who, unaided by fortune, must make the fight solely by his own exertions, to consider the nature and extent of the handicap under which he labors, and to determine the ways by which he can overcome the obstacles in his path and eventually reach the place in the affairs of life which he pictures in such glowing colors at the start.

And is the position of the student so greatly superior to that of apprentice? Four years of theory, with hardly enough practice to assimilate more than a small part of the instruction. The real start is made when, leaving college doors behind, the student becomes a worker in competition with other workers ; the stored knowledge must then be drawn upon and used intelligently to keep up in the race. Now, natural ability begins to tell, and when seconded by strong determination and persistent striving for advancement, the years of study return many fold their cost in time and money.

If the student has to travel such a rugged path, how much more difficult is it for the apprentice to succeed. Not so. The latter has many advantages which offset in considerable measure the loss in an educational way. He sees around him operations conducted on a large scale, with varied and perfected machinery designed to produce work of the utmost accuracy at a minimum cost. Results are what count in the shop, and new and better machines replace those that cannot meet requirements of output or quality. The apprentice learns processes, therefore, from simple observation.

He requires no time for instruction in what is fully demonstrated before him. The great lessons of economy (of time) and accuracy are learned without effort, become a second nature to him, and his reasoning, as he advances in skill, conforms to the necessities of these two fundamental laws of production. It is here, also, that the apprentice meets and masters (or fails) that which the student possesses in abundance, theory. It is quite as necessary for the apprentice to study the theory of his work, the laws of mechanics, as it is for the student to acquire practice, and neither will reach any advancement worth mentioning until this has been done.

The supplementing a day of manual labor with an evening of mental work, will not seem attractive to the young man of social disposition. The theatre, social gatherings and numerous ways present alluring inducements to leave dry text-books behind. And text-books are dry if the mind is elsewhere, but not if an earnest disposition to know them is accompanied by regular hours of study.

As soon as the routine has become fixed, the work will take on a new interest, and in a surprisingly short time the regret will be that more time is not available for reading and study. In addition, the shop work will be found of increased interest, new work will be taken up with intelligence, and soon recognition will be given by superintendent or foreman. The practical value of theory will then be self evident, and the shop-educated workman will be found shoulder to shoulder with the college graduate because both are equally competent, although educated in different ways.

"But how can the apprentice study theory, with no one to direct his study, correct his errors and give needed instruction ?" This is a problem which each one must work out for himself. It must be a very small town in which there is not some one to be found by diligent inquiry, who would quite gladly assist in settling the larger problems ; the smaller ones can nearly always be solved from books to be found in the public library, or purchased for a moderate sum. The accumulation of a select list of technical reference books and treatises will follow as a matter of course.

For self instruction the correspondence school is the nearest to resident instruction which it is possible to obtain, and the courses offered by the larger and better ones are very complete and extensive enough to carry one far on the road to a good technical education. They have an added value, inasmuch as the beginner is more inclined to persist in his studies until regular habits have been formed and possible reluctance been replaced by eagerness and quickened ambition. A good start is everything, and for that reason advantage should be taken of every help which will tend to make first work easier and more inteligible. As the text-books and instruction papers of correspondence schools are written especially for use in home study, they possess advantages over many general treatises, and also have test questions and frequent examinations to determine the thoroughness with which the work is being followed. To one who seeks instruction for its own sake, these correspondence courses are invaluable.

In conclusion, the comparative advantages of the two ways of acquiring a technical education may be summed up as follows:

The student in the technical college acquires an immense stock of theoretical and some practical knowledge, which makes the acquiring of more knowledge easy and rapid.

The apprentice in the shop learns the practical side and sees about him the application of the theoretical principles underlying mechanical operations, which he recognizes when such principles have been learned. To succeed, therefore, the apprentice must learn theory, and when this is done, the application to practical operations will be easy.

The value of such effort on the part of the apprentice should be self evident. The demand for the skilled workman was never greater than it is today. The apprentice is soon the workman, the foreman, the superintendent, the engineer. The reward is assuredly great and easily within the reach of him who will persistently and industriously seek it.

FINISH FOR NATURAL WOODS.

Suggestions regarding the finish for natural woods in interior work are always interesting, and our readers are likely to obtain a hint or two regarding this matter from the reply presented in a recent issue of the *Painter's Magazine* to a correspondent of that journal, who stated that he desired to give a dull finish to the wood work of three rooms, one of which was to be in birch, another in oak and the third in Georgia pine. He wanted to know the best method of producing the desired result, stating that he had had poor success in filling oak, and raised the question if he should apply two coats of paste filler. In conclusion he inquired what was best for rubbing, pumice stone and water or pumice stone and oil?

In reply to these questions the journal named offered the following: Birch belongs to the close grained woods and does not necessarily require filling, yet where it has been stained, many finishers are of the opinion that paste filler colored to suit the stain brings out some pretty effects not otherwise obtained. Whether filled or not, at least one coat of white shellac should be applied before the rubbing varnish is put on, and the latter need not be extra pale for this wood. Two coats of interior or cabinet rubbing varnish at least are required for a good finish, and three coats are none too many. Each coat of varnish should be permitted to stand 48 hours, and then be lightly rubbed with steel wool or curled hair before applying the next coat. The final coat should be allowed to stand at least three days, and then be rubbed to a dull finish with pumice stone and water. The work must be cleaned up well, and if the finish is too dull, go over it with a little rotten stone and rubbing oil. The pumice stone must be free from grit in order to avoid scratches.

White oak, as well as dark oak, belongs to the coarse, open grained variety of woods, and is difficult to fill properly. However, we do not believe in two applications of paste filler, and if one application is insufficient the fault is with the quality of the filler, though it may be in a measure due to inferiority of the wood.

Color the paste filler, if necessary, to suit the wood, apply one full coat, allow to set from 15 to 30 minutes, remove the surplus with waste or excelsior shavings, and after 24 hours sandpaper lightly and dust off. Then apply a thin coat of white shellac varnish, and when dry, again sandpaper lightly and you will find the wood well filled. Now apply the interior rubbing varnish, treating each coat as described for birch. Georgia pine is a sappy, close grained wood and requires no paste filler, but it is best to give a thin coat of white shellac varnish, which, when dry should be sandpapered lightly. Over this coat of shellac as many coats of interior rubbing varnish as your contract will permit should be applied, each coat to be rubbed as above. A light colored varnish is recommended, because varnish of dark color does not make a good appearance over this wood.

An ingenious suggestion was made recently by Major G. O. Squier, of the signal corps of the United States army, which, if it proves practicable, will be of great service to the signal corps. Major Squier says that as a living organism may form a part of an electrical circuit, it is possible to utilize a tree as the aerial of a wireless telegraph system. Connections should be made near the ground and where the branches begin to spread, by the simple method of driving in two iron nails to which the receiving device is attached. If the plan works well in practice there will always be suitable aerials for army use, except in a very barren country. Probably a tree is not as efficient as a metallic wire properly suspended, but as the distances to be covered in army signalling will never be great, this is a small matter. A more important point is the deduction that if a tree can be used in this way with good results, it would seem to follow that an intervening forest adds to the difficulty of transmitting messages over land. It may, in some cases, make the operation of a wireless system, under such conditions, practically impossible.—*Elec. Review.*

The city of Paris now has street sweepers, fire engines, post-office vans, and dust carts propelled by motors.

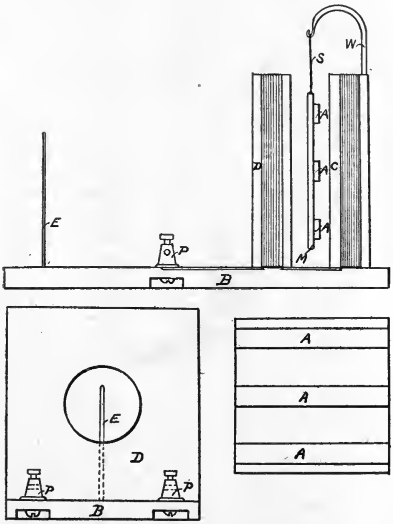
JUNIOR DEPARTMENT.

A SIMPLE GALVANOMETER.

PHILIP C. HOLDEN.

Any of the younger readers of this magazine who may desire to construct a galvanometer, will find the one here described quite easy to make and sensitive in action with the small currents to which its use is restricted.

The baseboard, *B*, should be made of oak or maple and is 5 x 2½ x ½ in. Two other pieces, *C* and *D*, upon which to wind the coils, are 2½ x 2½ x ½ in. Around the edges of these two pieces cut flat grooves, ¼ in. wide and ⅛ in. deep. In the center of the piece *D* bore a hole 1 in. in diameter. The grooves are then filled with cotton covered magnet wire, No. 18 gauge, wound in even layers, the coils being each wound in the same direction and the ends joined as though both were but one coil. They are then fastened to the base board with brass nails, boring holes with an awl, or they may be glued, holding them down with clamps until the glue is quite hard.



Two binding posts are mounted on the base board to which the remaining ends of the coil are fastened. At the top and at the back of coil *C* a piece of brass wire is inserted in a hole, previously bored, the free end being bent to a curve, as shown in the illustration, an eye having first been formed by filing the end of the wire flat and then bending.

A piece of mirror, *M*, made on thin glass 2 in. square, is then suspended by a silk fibre, *S*, drawn from a piece of discarded bass string of a violin. The silk is attached to the center of the top edge of mirror with sealing wax. Before doing this attach to the back of the mirror three pieces of thin spring steel, *A*, 2 in. long, ¼ in. wide, spaced ½ in apart. To do this coat one side with shellac, place against the mirror and hold in position until the shellac sets, which takes but a few moments. These pieces of steel should be previously magnetized, care being taken to mark the N pole on each and to have the same poles on the same side of the mirror.

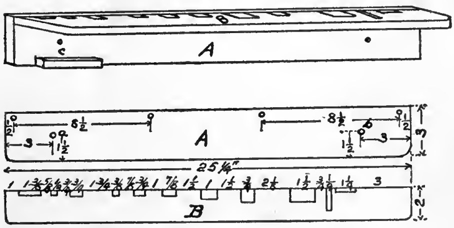
One half inch from the other end of base board, bore a small hole and place therein a polished steel wire 1¾ in. long, above the surface, (a piece of a knitting needle will serve.)

In using the instrument place in such a position as regards the polarity of the earth that the mirror will be exactly parallel with the coils. This can be ascertained by sighting from the needle through the hole in *D* and observing when the reflection of the needle is exactly connecting the current to be tested, the mirror will turn because of the influence of the coils on the magnets.

SMALL TOOL RACK.

GEO. E. GREGORY.

How many times may one enter an amateur's workshop and see the various tools scattered about on the benches. And what a contrast with the shop where the tools were well arranged in racks. To help readers of this magazine to be in the latter class, the very handy tool shown in the illustration, is here described.



Most any kind of wood will do, but ash, whitewood or gum wood are suggested as being the best. If looks are to be taken into consideration the latter is probably most suitable. Two pieces of wood are required, one of which, *A*, must be 25¼ in.

long, 3 in. wide and $\frac{5}{8}$ in. thick, and the other, *B*, $25\frac{1}{4}$ in. long, 2 in. wide and $\frac{3}{4}$ in. thick.

After sawing and planing this piece to the size given and rounding off the corners as shown in the figure, holes are drilled and countersunk in the positions indicated. The two holes *a* and *b*, should be countersunk on the front of the board, as they are to be used in holding the rack in place against the wall. The other four holes shown are countersunk on the back side of the board. Screws are to be passed through these holes to hold the smaller board, *B*, in position, using $1\frac{1}{4}$ in. No. 10 screws in all places. The board, *B*, is sawed and planed to size given, and a series of notches for holding the tools are cut on the rear edge.

This particular arrangement of notches is good, but the maker can adopt such an arrangement as would be best suited to the tools he will place therein. In this rack the tool arrangement provided, beginning at the left side, for rule, pencil, knife, $\frac{1}{4}$ in. flat chisel, $\frac{5}{8}$ in. flat chisel, $\frac{3}{4}$ in. flat chisel, spoke shave, scratch gauge, hammer, and next the claw, and lastly the blade of the try square. These notches are made by sawing inside lines previously made, in laying out, and then the remainder of the stock taken out with a chisel.

In order that the pencil and ruler shall stay in place a small piece of wood, *C*, $2\frac{1}{2}$ in. long, $\frac{1}{2}$ in. wide and $\frac{3}{8}$ in. thick, should be screwed onto the back board with $\frac{1}{2}$ in. screws in a position directly under the slots for pencil and rule.

To finish, the parts of the rack should be given a coat of shellac and then allowed to dry for an hour before giving it the second coat. The parts are then assembled, and the amateur has a piece of furniture which will prove well worth the short time required to make it.

SCIENCE AND INDUSTRY.

One of the favorite methods of forming accumulator plates quickly is that due to Lucas, in which sodium perchlorate plays an important part. In general it may be assumed that the best substances for assisting in quick formation are those bodies which either do not change during electrolysis or the changes of which are easily controlled. Hence one may expect that inorganic bodies will be more favorable for producing quick formation than organic bodies. Another important feature of the substance used for quick formation is its purity. Bearing these facts in mind, it seemed to Dr. Schmidt Altwegg that potassium chlorate might be very effective in hastening the formation of lead plates. Experiments were conducted to determine whether this was so. The plates were formed in an electrolyte of 0.06 specific gravity, which consisted of chemically pure sulphuric acid mixed with distilled water, and containing one per cent of potassium chlorate. The current density was 0.613 ampere per cubic decimetre of exposed surface. The charge lasted uninterruptedly for twenty-four hours, after which the plates were charged in the opposite direction at the same rate for an equal length of time. The plates were then carefully washed and set up as positive plates in a cell. They were finally charged for sixty hours at the rate of 0.413 ampere per square decimetre of surface. Following this charge they were discharged at the rate of 0.226 ampere per square decimetre of positive plate. It required twenty minutes to discharge them. Upon reformation the voltage upon discharge fell to the same point after fifty minutes, and after a third charging, two hours were required to the point. The voltage at the end of the discharge in each case was 1.83.—*Electrical Review.*

A new system of road locomotives has been brought out by the Siemens-Schuckert Company. It is now in use very successfully on a line running through the valley of the Veischeide as far as Belstein. Current is taken from a double overhead line by a pole and a form of sliding trolley which is adapted to the purpose. The locomotives are equipped with two Siemens-Schuckert motors of twenty-five kilowatts each, and weigh 6.5 tons. They can carry a load of two tons. The locomotive draws a train of three trailers, each of which can carry a net load of 5.5 tons. The present system is controlled by the Schiemann Company, which is specially engaged in operating this form of train. One feature to be noticed is that all cars are connected to the locomotive or with each other by a coupling device somewhat resembling that which is used on the Renard auto train in Paris. Part of the motive power is transmitted through the coupling to the wheels of each car so that it becomes self-propelled to a certain extent. This gives it the advantage of passing around curves in the same path with the locomotive, and it does not obstruct the track. On the other hand, the dead weight of the locomotive can be made smaller.

There are a good many rooms where the radiator is either too small or the steam pressure too low to maintain a comfortable temperature in severe weather. If the tenant is enjoying the many advantages afforded by central station electric lighting service, the matter can easily be remedied. Take the fan that kept you cool all summer and set it where it can blow against a large part of the radiator's surface. Turn it on at low speed, or at high, if necessary, and your cold room will soon be thoroughly warmed. The philosophy of the thing is that steam at a low pressure carries much less latent heat than steam at a high pressure, and therefore warms the radiator so poorly that only a slight draft of air rises around the pipes, and condensation is slow. With the fan in operation there is a forced draft against the radiator that conducts a great deal more heat away from the iron, cooling it so much more condensation of steam occurs inside it. The heat thus snatched from the reluctant radiator is held in the circulating atmosphere of the room, which is soon changed from cold to warm at a trifling cost for electric energy.—*Electricity.*

Great interest has been excited among motorists by the report of the trial on the Seine in France of a new kind of motor boat, which is propelled by a 14 h. p. De Dion-Bouton motor. The peculiarity of this boat is that the principle of the aeroplane is applied to it, and that it practically glides on the surface of the water instead of through it. The boat in question is about 20 feet long and about half that in width. On the bottom are fixed inclined planes or fins, the angles of which increase as they near the stern. When the boat is at rest it floats, more or less immersed, as an ordinary raft would do; but when under power the bow lifts out of the water and the boat glides along on the inclined planes. It is reported that at the trial the speed over a measured course was at the rate of nearly 20 miles an hour, which is about double the pace that could be got out of an ordinary launch with that power of engine. The boat is fitted with two rudders, between which the propeller works.

A beautiful dead black ebony stain, largely used by camera makers for blacking the insides of camera woodwork, carriers, &c., is made by first coating the wood with a strong decoction of ground logwood, or logwood chips, in hot water and then, when nearly dry, applying a solution made by putting 6 oz. or 8 oz. of iron filings into a 20-oz. bottle, shaking occasionally for a few days before using. This will impart a fine and even black to mahogany, or any sort of wood—a black that will neither chip, powder nor rub off, and with a perfect, non-reflective surface. For external parts of apparatus, a more finished appearance will be imparted by rubbing over with boiled linseed oil.

Sir John Primrose, at a recent banquent at Glasgow, made reference to a new process for obtaining a complete combustion of coal. He has experimented in his factories with many previous inventions of this kind in order to abate the smoke nuisance. Recently he tried a new furnace, which seems not only to prevent smoke, but permits a much greater efficiency of the coal used.

The speaker said of the invention that the burning of the coal takes place in a chamber surrounded by a water jacket, separated from the boiler, and that only the gaseous products of combustion are used for heating the boiler.

According to this new process a steamer would require less than one-half of the room now used for the boilers in order to generate the same amount of power, and the weight of the heating apparatus would also be diminished more than one-half. Air and fuel gas are conducted simultaneously to the boiler, and no unburned gases can escape into the air, so that no smoke and no carbonic acid escapes through the smokestacks. For steam purposes it would also be of importance, as it is said that the process permits of the use of inferior fuel.

An experiment for the purpose of testing the durability of liquid air has been made between Berlin and Geneva. The manufacture of liquid air for scientific and technical purposes has assumed considerable proportions in Germany. For the further growth of this industry the question of how far liquid air can be transported without serious loss by evaporation is a vital one. The experiment referred to was made for this purpose.

One morning two quarts of liquid air were delivered to the railroad at Berlin, packed in a manner specially adapted for this purpose, for transportation to Geneva. The shipment arrived in Geneva in five days, and after an additional delay of half a day it was delivered to the chemical laboratory of the University of Geneva. The glass vessel in which the liquid air was sent still contained one-fourth of a quart thereof, which was at once experimented with.

It is stated that this was the longest distance over which this curious liquid has been transported, and the result is encouraging to make larger shipments, where the loss would be relatively less.

Americans will be surprised to learn that it should take five days for such an article to reach Berlin; the same distance in the same distance in the United States would not exceed thirty-six hours.

Under date of November 7, 1904, United States Consul E. Theophilus Liefield, of Freiburg, Germany, reports that a German patent has been taken out for an electrical apparatus whereby the presence and extent of shoals of fish can be ascertained. A microphone, enclosed in a water tight case connected with an electric battery and telephone, is lowered into the water. So long as the telephone hangs free no sound is heard, but on its coming into contact with a shoal of fish, the constant tapping of the fish against the microphone case produces a series of sounds which at once betrays their presence. The rope attached to the microphone is marked so that the exact depth of the shoal is at once ascertained.

It is a good thing to put in the supply line for a gasoline engine near the tank valve which has in it a wire gauze, which will strain the gasoline as it goes toward the engine, preventing any chips, dirt or sediment from reaching the engine and causing trouble, perhaps, by preventing the valves from seating. It is surprising what a quantity of dirt and chips from barrels will some will sometimes get into the gasoline, and many an operator has spent hours trying to find out what was the matter with his engine, eventually to learn that it was from dirt in the gasoline which had prevented the check valves from seating, or some other like trouble.

Education in the true sense is not mere instruction in Latin, English, French or history. It is the unfolding of the whole human nature. It is growing up in all things to our highest possibility.—*J. N. Clarke.*

The New Mexico College of Agriculture has been making exhaustive tests to determine the relative value of crude petroleum, kerosene and gasoline for use in internal combustion engines. Results as given in *Farm and Stock* are that, with a crude oil or kerosene consuming attachment to the ordinary gasoline engine, either was as efficient as gasoline. The tests were made by an engine pumping water for irrigation, but the relative cost of each would be the same in any kind of work. With gasoline, 1,096 gallons of water a minute were pumped, and the fuel cost for 24 hours was $15.95. With kerosene, 1082 gallons a minute were pumped at a 24-hour cost of $25.76. With crude oil, 1,088 gallons a minute were pumped, at a 24-hour cost of $7.07.—*Engineer*.

It has been announced that an effort will be made to keep in communication with Lieut. R. E. Peary in his proposed search for the North Pole by means of wireless telegraphy. Lieut Peary will erect stations at proper points to keep in touch with the coast of Labrader, from which place he hopes to be able to communicate with New York.

A stiff toothbrush and a little gasoline will soon remove soot from spark plugs under ordinary circumstances. If the deposit is hard it may be scraped off with a knife.

TRADE NOTES.

North Brothers Mfg. Company of Philadelphia, Pa., are sending out a neat little pamphlet of a size convenient to carry in the pocket and illustrating and describing Yankee tools. The latter have been named Yankee because they are the invention of a Maine Yankee and because they embody that "ingenuity and slickness in the doing of work for which they are intended which has made Yankee inventions famous the world over." They are simple in construction, strong and durable, do not get out of order, work smoothly and quickly and wear well. The Yankee tools were first offered the trade in 1898, and each year since there has been a notable increase in the sales. The lines include ratchet screw drivers, spiral ratchet screw drivers, chucks, automatic drills, reciprocating drills and pocket magazine screw drivers. In response to frequent demands for the Yankee screw drivers put up in substantial boxes to be used by mechanics who desire to keep the tools in fine order, and by gentlemen or amateur mechanics who especially appreciate tools put up in handsome sets, the manufacturers are offering what is known as the Yankee tool set No. 100. The box contains the styles of Yankee tools most in demand, and the combination in the set covers all the usual requirements in tools for driving in and turning out screws.

In considering the purchase of new equipment during the coming year, the directors of manual training schools in which wood working is taught, should not overlook the band and circular saws, both foot and power, manufacturod by J. M. Marston & Co., 241 Ruggles Street, Boston, Mass. These machines are well designed and well made, and yet sold at very low prices, considering their capacity. For carpenters and cabinet-makers shops they are especially adapted.

The amateur or professional mechanic or worker who visits New York City should not fail to call at the new and spacious store occupied by Hammacher, Schlemmer & Co., Fourth Avenue, corner 13th Street. Here is to be found a large assortment of modern tools displayed so that examination is convenient and selections can therefore be made with the greatest facility.

The attention of readers is called to the advertisement of the Griswold Co., Quincy, Mass., which makes a specialty of supplying castings and parts with which to make up various machines and hand tools. The grinders mentioned in this issue will be found of special value by those making up machine work on which a fine finish or close fit is necessary. The small gas engine is just the thing for power for a small shop, or for a dynamo for house lighting plant. The lathe and hand turning tools are made from the best of stock by workmen of exceptional experienee and may be purchased with entire confidence.

The large and varied line of wood-working machines manufactured by the American Wood Working Machinery Co., New York, will be found to meet the most exacting demands of high grade wood working. These machines are so well known throughout the country that special mention would be almost needless. Their catalogue should be in the possession of every teacher or director of manual training.

The spark coils manufactured by the New England Coil Winding Co., Atlantic, Mass., will be found specially adapted for electrical experimental work and wireless telgraphy for distances within their capacity. There are few electrical instruments which can be adapted to as great a variety of demonstration work as can the Ruhmkorf Coil. For that reason, every one interested in the study of electricity should obtain one at the earliest opportunity.

The new tools recently placed on the market by The L. S. Starret Co., Athol, Mass., and described in the supplement of their catalogue, will be welcomed by the mechanic who endeavors to keep a suitable assortment of tools required by his work. Both catalogue and supplement are sent upon request.

The Manhattan Electric Supply Co., 32 Courtlandt Street, New York, is well known to all electricians as being the headquarters for all kinds of electrical supplies. Special attention is given to orders by mail, and shipments are made with exceptional promptness.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

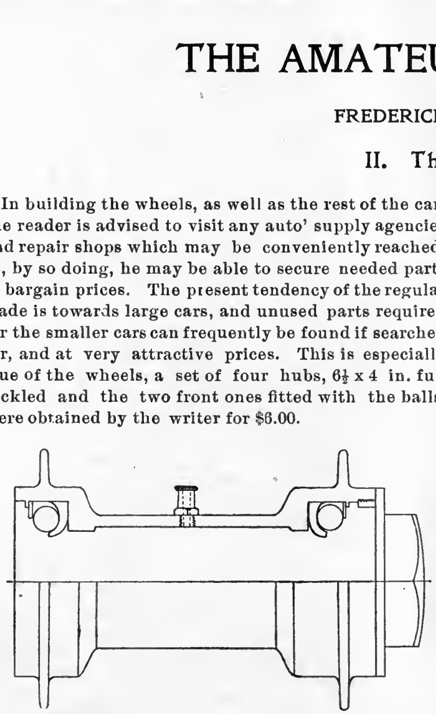
Vol. IV. No. 6. BOSTON, APRIL, 1905. One Dollar a Year.

THE AMATEUR RUNABOUT.

FREDERICK A. DRAPER.

II. The Wheels.

In building the wheels, as well as the rest of the car, the reader is advised to visit any auto' supply agencies and repair shops which may be conveniently reached, as, by so doing, he may be able to secure needed parts at bargain prices. The present tendency of the regular trade is towards large cars, and unused parts required for the smaller cars can frequently be found if searched for, and at very attractive prices. This is especially true of the wheels, a set of four hubs, 6½ x 4 in. full nickled and the two front ones fitted with the balls, were obtained by the writer for $6.00.



As quite a supply of these hubs are available to builders of this car, no extended description will be given. The diameter of the cups, fitted to front knuckles, is 1¾ in. from center to center of the balls, and the cups are spaced 4½ in. apart. These dimensions will enable any one to secure knuckles of the correct size. The balls, 15 in number, are ⅜ in. diameter.

The question of rim is not so easily determined, as the kind of tire to be used must first be selected and the rim be one upon which the tire can be used. The prevailing practice is now almost exclusively a double tube tire, of which there are several excellent makes available. The single tube tire has the great disadvantage of being very difficult to repair in case of a puncture, but the first cost is less than for the double tube. The total cost for several seasons' use will, however, undoubtedly be in favor of the double tube tire, and the greater ease of repair of the latter, especially when far away from a repair shop, as one is quite likely to be when trouble happens, makes the difference in first cost a matter of minor importance. It is also well to call attention to the fact that several new and recent improvements in the manner of attaching the tire to the rim, require that the builder familiarize himself with the leading styles, which can be quickly done by visiting several storage and sales rooms and examining the new cars, those of last year, and previous, not having the latest and best devices. The solid tire, owing to the high cost of crude rubber, costs so much that it has been given no consideration.

The kind of tire being selected, the rims for same should be secured. They should have 40 holes for the spokes, the hub having the same number, 20 on each end. The holes in the hub are all countersunk for the heads of the spokes, one-half have the heads on the inside of the flange, and the other half on the outside. The wiring of a wheel may, at first glance, seem complicated, but a little study of the illustration will show how the spokes are arranged.

The hub should first be suspended so that it may revolve freely and yet be held in place. A frame can be made from boards for this, or a round piece of wood or the axle can be secured in a vise, upon which the hub can be suspended. It is necessary to have the hub revolve, so that when the spokes are finally tightened the rim can be trued up, and this can only be ascertained by turning it on the axle.

The illustration shows the spokes of only one end of the hub, the arrangement for the other end being exactly the same, with the exception that the outer ends are one hole to the right or left, as may be found best for the particular rims and spokes used. The spokes for a 28 in. wheel are 12 in. long of 6-8 gauge, both ends being of greater diameter than the main part of the spoke. At the outer ends, nipples, with washers un-

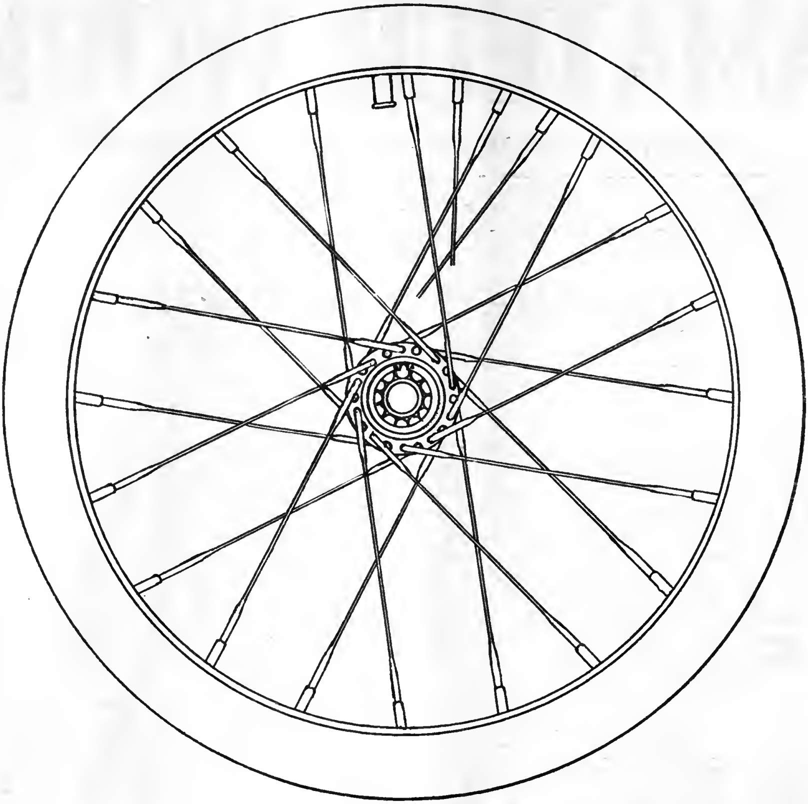


FIGURE 4. WIRING DIAGRAM.

der the heads, unless the rim is thick enough so that they are not needed, keep the spokes at the proper tension, being threaded; the nipples having a slot in the head for turning up with a screw driver, and also flats on the sides to take a wrench so that the spokes may be tightened when necessary after the tire is on.

To set up a wheel proceed as follows:—Put in the spoke shown at the top of the illustration to the right of the inflation valve. It will be seen that the head of this spoke is on the inside of the flange and placed in the fourth hole to the right of the one at the top center. Three holes to the left of the top center hole place a spoke with the head on the outside and the outer end in the hole in the rim the second to the right of the first spoke. The rim hole between these two contains the spoke from the other end of the hub corresponding to the first spoke, and shown in part in the illustration. Two holes to the right is the spoke from the same end of the hub and corresponding to the second spoke mentioned. Continuing again with the spokes on the end first mentioned, put a spoke through the second hole below the one containing the first spoke, carrying the outer end to the fourth hole in the rim to the right of the first spoke. The arrangement of the rest of the spokes is so clearly shown in the illustration that no difficulty should be experienced in setting them.

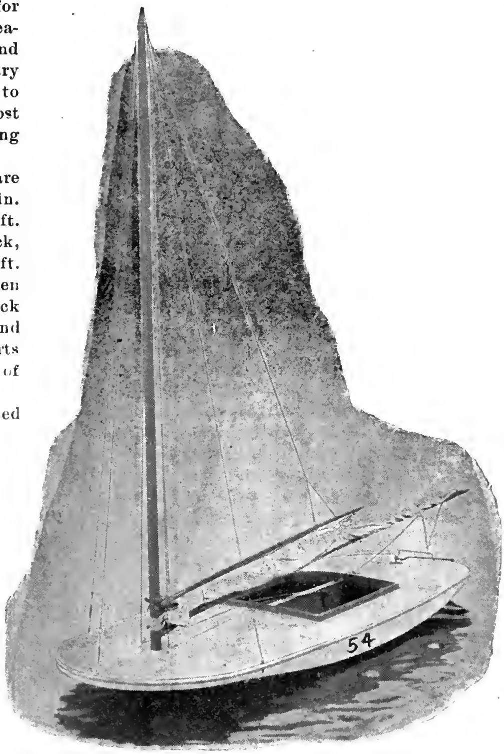
The nipples are given only a few turns at first, the final adjustment and truing up being done when all the spokes are in place. As already stated, washers should be placed under the heads of the rims for double tube tires, rims of thin steel are used, and rims for double tub tires are of this description, and washers should therefore be used on them. When the final truing up is done, revolve the wheel frequently, holding the end of a stick or other indicator on a steady rest, so that any uneven places will be noticed and worked out by adjusting the tension of spokes.

The complete car will weigh about 600 pounds, varying from this if lighter or heavier parts are used.

A RACING SAILBOAT.

C. C. BROOKS.

Full size patterns for this boat may be obtained of the Brooks Bout Mfg. Ba., Grand Rapids, Mich.



The boat here described is a very popular design for inland ponds and lakes and sheltered bays on the sea-coast. It is very stiff in a squall, easily handled, and such a boat can be constructed by anyone of ordinary skill with woodworking tools. To those unused to sailing boats and wishing to make a start in this most pleasant sport, this design is recommended as being one of the best and safest which can be made.

Those parts requiring white oak, rock elm or fir are as follows: One piece 16 ft. long, 3 in. wide, $1\frac{1}{8}$ in. thick, for the two bent end pieces. One piece 6 ft. long, 12 in. wide, $1\frac{1}{8}$ thick, for the skeg, butt block, head ledge, stern post and spar step. One piece 12 ft. long, 6 in. wide, $\frac{3}{4}$ in. thick, for center-board. Fifteen pieces 12 ft. long, $\frac{7}{8}$ in. square, for ribs and deck beams, twenty-eight running feet of $\frac{3}{4}$ in. half-round for fender wale. (NOTE.—Fir may be used for all parts excepting the two bent pieces that form the ends of of the boat.)

Of pine, cypress, cedar, fir or spruce, there is needed two pieces 14 ft. long, 17 in. wide, and one piece 12 ft. long and 15 in. wide, all $\frac{7}{8}$ in. thick, for back-bone. (NOTE.—If you can get two pieces 18 ft. long and 17 in. wide, you can make the back-bone without splicing it. There will be enough waste lumber left from the backbone to make the cheek pieces. Two pieces 14 ft. long, 8 in. wide and $\frac{7}{8}$ in. thick for sides. Two hundred and twenty-five surface feet $\frac{5}{8}$ in. thick for planking, decking and coaming. Get this in 12, 14 or 16 ft. lengths and 12 in. or more wide. To make this $\frac{5}{8}$ stock you can have 180 ft. (board measure) of $1\frac{1}{2}$ in. lumber resawed and dressed. One piece 16 ft. long, 3 in. square, for spar. One piece 18 ft. long, $2\frac{1}{2}$ in. squarefor boom. One piece 10 ft. long, 2 in. square, for gaff. (NOTE—Spruce makes the best timber for the spars.)

For hardware, obtain four pounds $1\frac{3}{8}$ in. clout nails for planking and decking. Two pounds 2 in. common wire nails for fastening plank to back-bone, ends and sides. One pound 8-penny casing nails for fastening ribs and deck-beams. Eight 4-in. wire spikes for fastening skeg. One package of two ounce tacks. Two and one-half dozen $1\frac{1}{2}$ in. No. 12 screws for cheek-pieces, back-bone and end pieces. Two dozen $1\frac{1}{4}$ in. No. 12 screws for fastening butt blocks to end pieces. Two dozen $\frac{1}{4}$ in. carriage bolts, 3 in. long, for back-bone. One $\frac{1}{2}$-in. carriage bolt, $4\frac{3}{4}$ in. long, for king-bolt for center-board. One pound spun calking cotton. Sand-paper, putty and paint.

To make the sail and rigging, get 33 yards of 6 or 7-ounce duck, 30 in. wide, for sail. If roped in hem, 61 ft. of cotton rope. If roped outside, 40 ft. of $\frac{1}{2}$ in. Russian bolt rope. (See instructions for making sail.) Forty feet of $\frac{1}{4}$ in. wire rope rigging for stays. Three $\frac{1}{4}$ in. pipe turnbuckles, 8 in. long, with eye and shackle for stays. Six 4-in. mast hoops. One sheet traveler of $\frac{3}{8}$-in. rod, 18 in. long. Five single $\frac{3}{8}$-in. blocks, without beckets. Three single $\frac{3}{8}$-in. blocks with beckets. Three 4-in. deck cleats. Two $\frac{1}{4}$-in. eye bolts, 3 in long. Two $\frac{1}{4}$-in. eye bolts, 3 in. long. Two wire staples, $2\frac{1}{2}$ in. long. One hundred and sixty-five feet of $\frac{3}{8}$-in. manila rope for halyards and sheet. Thirty-five feet of $\frac{1}{4}$-in. cotton rope for lacing on sail. Twenty feet of marlin.

For the frame we recommend white oak, this being the best timber known for this purpose. If, however, suitable oak is not easily procurable, we would advise fir or rock elm as a very satisfactory frame timber. When purchasing the lumber it is not necessary to

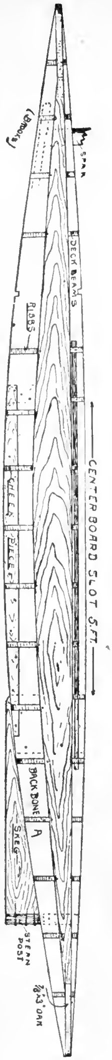


FIGURE 2. BACKBONE.

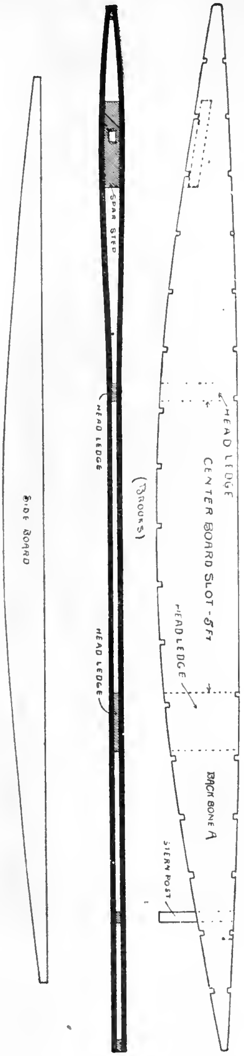


FIGURE 3. CROSS SECTION OF FRAME.

adhere to the dimensions given, but good judgment should be used in not making any of the parts too light.

The lumber in bill of material should be well seasoned. The oak for the end pieces should be straight grained and not kiln dried, as this injures its bending qualities. The lumber for planking should be of good, sound quality. A few sound, small knots may be used, and thereby make a material saving in the cost of the lnmber. In the bill we have given the dimensions to which you should have the lumber dressed. The bill of material gives the thickness of the lumber for each piece, the patterns give the shape. The bill also gives the size of the nails, screws or bolts used for the different fastenings. In building the boat, take up each step in the same order as given in the instructions.

We assume that you are an amateur, and therefore give details that will appear unnecessaty to practical mechanics. One important point to the amateur is, keep your tools sharp and in good condition. One of the great faults of the novice is that he will attempt to use dull tools, resulting in rough work, which he attributes to his inexperience, while, in fact, a skilled mechanic could do no better under the same conditions. The amateur should not expect to understand every detail from simply reading the instructions. The points that now appear hazy will be plain when you are working on the actual construction.

A light, warm shop makes boat building pleasant. On one side have a work bench with plank top about 2 ft. 8 in. high and not less than 16 ft. long. Have a carpenter's vise at the left hand end. You will need a claw hammer, clinch iron, rip saw, cutting-off saw, smooth plane, block plane, screw driver, draw shave, ratchet bitstock, ¼ in. bit for carriage bolts, a No. 6 German bit for the No 12 screws, a No. 2 German bit for the nails of planking, a brad awl for the decks, etc., a counter-sink and screw driver for bitstock, four iron clamp screws of five inch openings, a two-foot rule, plumb bob and line, and a one-half inch chisel.

Before driving a nail or screw, always first bore with a bit slightly smaller than the nail or screw, and countersink for the head of the screw. For No. 12 screws use No. 6 German bit. Before putting in a bolt always first bore with a bit same size as bolt. All bolts are driven from the outside in; that is their heads are always on outside of boat. A washer is always put under all bolt nuts. A clinch iron (flat iron will do) is always held opposite or against all nails when they are driven or set.

The following instructions are given for those using prepared paper patterns:

When the patterns do not intersect you may cut them apart for convenience. Lay the pattern on the material, place it so it will cut to the greatest advantage and not waste lumber, fasten patterns securely with a few tacks, and then prick through with an awl on lines of patterns. When the lines curve, make the prick marks close; follow outside of the line which gives you room to dress with plane after the piece is cut out; take pattern off and drive some nails in the marks made by awl. Now take a thin strip or batten and bend it up to the nails, then mark in the line. This will reproduce the same lines on the lumber that are on the pattern. This method saves the pattern from being destroyed. Another way is to use a tracing wheel, the same as used n dressmaking, and by rolling it over the pattern the points will prick through and leave a mark so that the battens will be unneces-

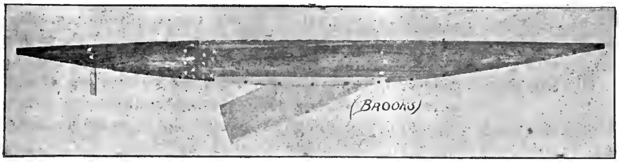
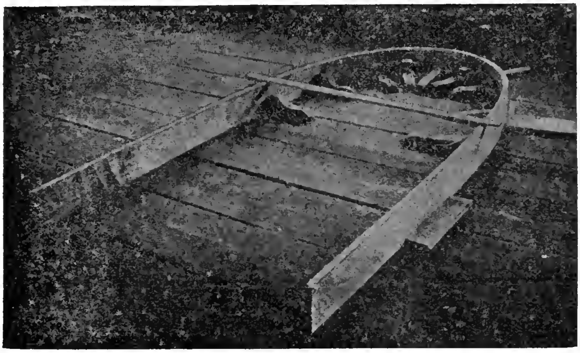


Fig. 4.



g. 5.

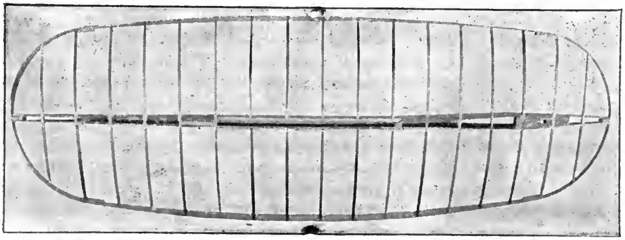


Fig. 6.

sary. A handy way to mark out the plank is to cut the patterns apart, lay them on the material and drive some small nails through the patterns on the lines, then bend battens up to nails, and by using the sharp point of a knife the patterns will be cut to shape and the material marked at the same time.

Make two ordinary saw horses, such as carpenters use. Make these about 20 in. high and 6 ft. 6 in. long.

THE BACKBONE.

The first step is the making of the backbone. This forms the truss that gives strength to the boat and takes the place of keel and center-board box in ordinary sail boats. The backbone extends the length of the boat, and reaches from top to bottom edge, holding the ribs and its top edge, the deck-beams.

The backbone is made double for the full length and consists of two boards bolted together with the mast-step, head-ledge, butt-block, stern-post and after butt block fastened between them. With the pattern of the backbone is given a pattern showing an edge view of the backbone with these pieces in place between the two boards that f· m the sides of the backbone.

This is also plainly shown in illustration 2.

First get out the two sides of the backbone and shape both of these from the one pattern (marked backbone.)

Note.—If you have been able to get these boards in 18-ft. lengths, each side will be made in one piece; however, this is seldom possible. The usual way is to make each side of the two pieces, letting them end on the butt-block that forms the after head-ledge of the center-board box. For this reason an extra wide piece is used for this butt-block, which allows of two rows of bolts, as shown in illustration 4. This makes it just as strong as though the sides were in one piece.

Now, get out the head-ledge, butt-block and stern-post, and place these pieces at their stations between the sides, as shown on the patterns, and clamp the whole together, fastening with ½-in. carriage bolts 3 in. long. For these three pieces use about 22 bolts, as shown in illustration 4.

Shape the mast-step from the pattern (marked step.) The mast-step should be about 2¼ in. thick, and as your material for this is 1⅛ in. thick, get out two pieces and nail them together to give proper thickness. You need mortise the hole that receives the end of the spar in the top piece only. Put the step in place and then bring the two ends of the side together at the forward end, holding with clamps, and fasten with a dozen nails through sides into edge of step, and with two or three 1½-in. No. 12 screws at the end of sides to hold them in place.

The after end of the backbone is not brought together, as is the forward end, but has a block 1⅛ in. thick between the side pieces, as shown on patterns. This is also shown in illustration 2. This end block is fastened in place with a couple of ½ x3 in. carriage bolts.

Get out the two cheek pieces and cut the mortises to receive the ribs in their lower edge, as shown on patterns. Fasten the cheek pieces on each side of the backbone with twelve 1½-in. screws to each cheek-piece, then cut the rest of the mortises in the backbone. These are to receive the ribs and deck-beams, which pieces extend clear across from side to side of boat, excepting at the center-board, and at this place the ribs end in mortises of the cheek-pieces, as shown in illustration No. 6. Cut the mortises a scant ⅞ in. square so that the ribs and deck-beams will fit tight.

CENTER-BOARD.

Make this of three pieces doweled together with ½ in. drift bolts. Cut the dowels from ½ in. round rods and have them about 9 in. long. Put the three parts that form the center board together and bore through the edge of the two outside ones into the edge of the middle one, then drive in the drift-bolts. The board may then be trimmed to shape of pattern. Another way to fasten the center-board together would be to let in three iron straps on each side so that they would be flush. These straps should be ⅛ of an inch thick and one inch wide. Have them drilled and countersunk every three inches for ¼-in. rivets, the same rivet fastening the strap on both sides. After riveting on the straps, file down the heads so that they will be flush with the sides of the board to prevent binding. Or, a third and perhaps the simplest way would be to have the center-board cut from a plate of sheet iron ⅛ of an inch thick. (Note.—If iron center-board is used reduce the thickness of the head-ledge and buttock to ⅝ of an inch.)

The after end of the board is connected by a clevis to a chain for raising and lowering it, and the forward end is fastened in place by the king-bolt. This is a ½-in. carriage bolt, 4¾ in. long that is put through the cheek-pieces, back-bone and center-board, at the point marked with a small circle on the patterns.

TO SET UP BOAT.

Get out the two side boards. These are both shaped from the pattern marked "side". Next, cut out and shape the two end pieces. These are straight pieces about 7½ ft. long and 3 in. wide, and are bent to a circle, shown on patterns.

Illustration 5 shows the manner in which the end pieces are bent. The illustration, however, shows a larger piece than the end piece is. To bend the end pieces, nail up some blocks on the floor to give the same circle as is shown by the pattern; then steam the pieces well and bend them on while hot, after which they may be secured by nailing on a stay, as shown in illustration 5.

Place the two saw horses about 13½ ft. apart and parallel to each other; place the back-bone in the middle of these horses, letting an equal amount extend beyond each horse; place the back-bone on edge with its bottom edge up. Nail four pieces, 1¼ in. thick, on top of horses, one piece on each side of the back-bone on each horse. Each one of these pieces should be about two feet long and be placed at the outer ends of the horses.

The object of these pieces is to properly raise the side. Place the two side boards on edge, upside down, so that they will be parallel to the back-bone and about three feet from it. Have the ends of the side pieces extend an equal distance beyond the horses. These side pieces will, of course, rest on the 1¼ blocks that have been nailed to the top of the horses. Now cut a couple of pieces 2 ft. 9½ in. long and about 6 in. wide. These pieces are for spreaders, to hold the side pieces in proper distance from the back-bone. Place a spreader at each side of the back-bone at its center, and let one end of the spreader end against the back-bone, and the other against the inside of side piece. These pieces may be held temporarily by toe-nailing them to place.

After the spreaders are in, the ends of the sides are each drawn in until the two sides are five feet apart at the ends, measuring from their outer edges. The sides may be held in place by blocks nailed on the horses,

Try both end pieces up to place and round off the back-bone to fit the curve of the end pieces. When fastened in place, the end pieces connect the ends of the two sides and the back-bone. These end pieces are purposely made a little long so that you may saw them off to exact length after they are in place. First, fasten the center of the end pieces to the ends of the back-bone with a couple of 1½ in. No. 12 screws and two or three casing nails. Have the top edge of the end piece flush with the top edge of the back-bone. Saw off the ends of the end pieces so that they will butt against the ends of the side pieces (that is the two pieces will come end to end). This joint, or butt, is fastened by putting a butt-block, covering the joint on the inside, as shown in illustration 6. This butt-block is of 1⅛ in. oak about 8 in. long. The end pieces are fastened to the block with three or four 1¼ in. No. 12 screws in each piece. Where these butt blocks come on the end pieces, they should be made to fit the curve.

RIBS.

Make a bending form by shaping the edge of a board to conform to the pattern (bending form). This form is used to shape the ribs, and it is given with more bend than is required, for the reason that the ribs will straighten some when they are taken off the form. It will be convenient to make the bending form from two boards with short pieces nailed across them so as to make it wide enough to allow of a number of ribs being bent at the same time. If made in this way the form would resemble the truss which masons use to construct an arch over doors and windows in brick walls.

Either steam or soak the ribs in hot water and bend them on the form, tying their ends down with cord. Let them stand until cold, then remove them one at a time and fasten directly to place. The ribs go straight across and are fastened to each side of the back-bone with one eight-penny casing nail, their outer ends being mortised one-half inch into the lower edge of the side piece; that is, the ribs are mortised in with their bottoms flush with the bottom of the sides, but these mortises do not go though to the outside of the side pieces. See illustration 6. The outer ends of the ribs are fastened to the side pieces with one eight-penny casing nail in each end.

[CONCLUDED IN MAY NUMBER.]

HOW TO BUILD A POWER LAUNCH.

CARL H. CLARK.

V. The Floors, Transoms and Seats.

Across the top of the opening which has been left for entrance to the cabin, a piece about 2 in. wide is to be fastened longitudinally on each side of the beam, to fill it out to the level of the sheathing already in place. The top of the house is to be covered with about 8 oz. duck, laid in paint ; it is tightly stretched and brought down over the edge and tacked at close intervals with small copper tacks.

If it is desired, an opening may be left in the roof over the entrance, and a shade fitted over it, but with the height which there is between the floor and roof in this case, it is not considered necessary. A half round moulding of oak or mahogany, about 1 in. wide, is bent around the edge of the house and across, being mitered at the after corner, where the two lengths meet. The canvas should be painted with a priming coat.

The engine bed should be fitted as early as possible, before the floor is laid. In order to do this all the base measurements of the engine must be known. The shaft-hole being already bored, will locate the center-line. A small line or wire is drawn through the hole and fastened so that it lies exactly in the center, thus locating the shaft center : the forward end of this line should be fastened to a cleat nailed across the door of the cabin. The bed logs must, of course, be far enough apart to admit the base of the engine, and at the correct height so that the center line of the engine shaft will agree with the line already in position. A templet, or pattern, of thin board should be made of the inside surface of the bed.

The outline of the lower edge, which fits the side of the boat, may be obtained as follows: A carpenter's level is laid on the stretched cord, taking care not to sag it, the distance to the inside of the bed is measured out on the level, from the cord and the vertical distance it is from the last point down to the skin is measured. These measurements are taken on every frame throughout the bed, and are then laid off from the curvature. The bed logs should run well forward and aft of the engine to distribute the weight and should be tapered down at the ends. Each bed log is 4 in. thick. The pattern, after being fitted, is laid on and the log cut to shape, leaving the lower edge square. The bevel of the lower edge is obtained by trial and should fit neatly in place on the inside of the frames. It is now notched out to fit over the frames on to the plank, and when correctly fitted should lie fairly on the plank all over and stand vertical. The upper edge may now be laid off by the aid of the level, making it the same distance below the cord as the flanges of the engine are below the shaft center. It will be well, however, to leave a small amount for the final fitting.

The beds are secured in place by nails or screws driven up through the plank. Between the beds a cross piece about 3 in. thick is fitted and fastened to hold them vertical, and on the outside two or three knees should be fitted between the beds and frames. Beds fitted in this way are very strong and distribute the vibration of the engine.

The floor of the standing room and cabin is supported on beams fastened across from frame to frame; these beams may be made of common stock $\frac{7}{8}$ in. thick and 2 in. deep. The cabin floor should be as low as is possible and still avoid trouble with bilge water; that of the standing room should, however, be rather high, or otherwise it will be difficult to see over the cabin and the backs of the seats will be so high as to be uncomfortable. It should be about 11 in. above the rabbet on mould No. 4, and 4 in. above mould No. 7.

The floor beams are tapered off at the ends and fastened on top of the frames, care being taken to have them all in line. It will hardly be necessary to place them closer than every other frame. Beams which fall next to the engine bed will be cut and fastened to cleats on the side of the bed.

Flooring is of $\frac{7}{8}$ in. stock and is laid out and fitted to the side of the boat in both standing room and cabin; the middle boards in the standing room cannot be fitted until the engine is installed.

The inside of the cabin may be either ceiled or left plain, as desired. For ceiling, $\frac{1}{2}$ in. pine stock is used.

A space of $\frac{1}{2}$ in. should be left between the clamps and the upper edge of the ceiling. The several strakes of ceiling are bent around and shaped in the same manner as the outside planking, the edges being beaded. It is fastened in with small nails or brass screws. The ceiling should extend down to the floor, making a fairly tight joint.

Light ports must now be cut in the trunk about 12 in. long and 4 in. wide, elliptical in shape. A compass saw is used to cut them, being started through a $\frac{3}{8}$ in. hole. The inside edge is neatly rounded and on the outside a rabbet is cut about $\frac{1}{2}$ in. wide and $\frac{1}{2}$ in. deep to take the glass. Glass for this purpose should be at least double thick, cut to shape and set in putty.

The tank should be made and fastened in place next; the capacity should be about 20 gallons. A cylindrical, galvanized iron tank can be bought quite cheaply, and is very good for the purpose. It does, however, take up more room than one shaped to the boat. In the latter case, either copper or galvanized iron may be used, but in either case the metal should be heavy and the joints riveted and soldered. The tank is supported upon brackets and is strongly fastened in place so as not to be disturbed by the motion of the boat. The filling pipe should be carried up through the deck in one piece and have a screw cap, while the feed should have a cock with a union beyond it.

The bulkheads at the forward end of the cabin and the after end of the standing room are of ⅝ in. matched pine or cypress. The boards are fastened to the beams above, and to cleats nailed on the floor. A removable panel should be left in each and fitted with catches or hinges to hold it in place.

Cabin transoms are to be built above the floor, leaving a clear floor space between of about 2 ft. at the after end tapering forward. The transoms should run across the forward end of the cabin—and a board in the top should be made removable, to allow access to the locker space underneath. The front of the transoms should be sheathed up and a ledge formed around the top to hold the cushions in place. The cabin opening should have a jamb fitted around it and be provided with two doors opening outwards. Such lockers and shelves may be fitted in the cabin as may be desired.

Seats in the standing room are to be fitted about 16 in. above the floor ; they are supported on small beams which are fastened to the frames at the back and supported at the front by small turned posts. The seats should be at least 13 in. wide outside of wash rail, and preferably 15 in.

The make of engine to be installed will also make some difference in the arrangement of the seats, some makes of engines being so wide that it will be necessary to cut away the seat on one side abreast of the engine to give a sufficiently wide passage ; the opposite seat, however, should be left intact, as it is convenient for locker space, also to cover the piping. If a large amount of locker room is desired the space under the seats may be enclosed by sheathing up from the floor to the seat, leaving openings either in the sheathing or the seats for access to them.

The rudder may be either a ⅛ in. iron plate or of 1 in. oak. It is 22 in. square, with the corners rounded off as shown in the general plan. The stock is placed 4½ in. from the forward edge.

If made of an iron plate the stock should be split and the blade inserted and riveted through. If made of wood the stock should be oak, put together with 5-16 in. galvanized iron rods. The piece forward of the stock, and a similar piece aft of it, are fastened first, the rods being riveted over washers; the remaining pieces necessary to complete this size are then fastened to the after piece. The corners are rounded and the edge beveled off fairly sharp. The lower end should preferably be turned down to ½ in. to allow the insertion of a split pin below the skeg. The top is squared for the tiller with a ½ in. hole above the latter. The tiller should be about 15 in. long with an eye in the outer end to take the wheel ropes. It may be forged and drilled by a blacksmith and the hole filed out square by hand.

The skeg is of ½ in. x 2 in. flat galvanized iron, with the end turned over as shown in general plan ; the space between the bend and the straight part being 1 in. A hole is drilled in the bend to take the lower end of the rudder stock. It is fastened to the bottom of the keel by three ½ in. lug screws.

A piece of ⅝ in. half round galvaninized iron is fastened on the face of the stem, running well down on to the keel.

All the varnished work should be treated to a coat of shellac, sandpapered, and given two coats of best spar varnish. Only the best varnish should be used, as a poor quality will allow the weather to get into the wood and stain it. The painted parts should have two coats after the priming, all the seams in both bottom and top sides being carefully puttied.

The bottom is painted with some kind of non-fouling paint, and it is advised that the water line be struck an inch or two higher than shown in the plans, so that the topside paint may not come near enough to the water to be fouled.

The arrangement of the boat as outlined, is, of course, for general guidance, and any changes may be made to suit any particular requirements of the individual builder.

The directions already given should enable the builder to complete the hull and the directions for installing the motor will be given in the next chapter.

SUITABLE CLOTHING FOR BOYS.

A head master of one of the oldest schools in Surrey, the Kingston Grammar School, upon assuming charge recently, addressed a letter to the parents of his pupils urging the adoption of a more rational dress for boys, and the letter has been given to the press. This schoolmaster asserts that the vest, or waistcoat, is no protection to the most vulnerable part of the body, the back, because the hinder part of the waistcoat is not of wool or a heavy material, while the tightly buttoned vest prevents the fullest increase of chest growth. He advises parents to dispense with the waistcoat and to clothe their boys in sweaters and flannels; in his opinion a flannel shirt and and flannel collar with a tie would be smart and pleasing. While acting as master at Lorretto school, at which the boys dressed as suggested and were enabled to take active exercise at any time without running the risk of taking a chill, he observed that the average school boy became "larger limbed, broader chested, and on the whole more physically fit than the average boy at any other public school." Bicycle rides to school and the various physical exercises and outdoor sports result in much perspiration, and if a linen or cotton shirt or cotton shirt waist is worn there is constant liability to colds.

BOOK-BINDING FOR AMATEURS.

WINTHROP C. PEABODY.

IV. Arranging the Signatures.

In most families are to be found numerous magazines which are not valued to the extent of going to the expense of having them bound up at a bindery, but are, nevertheless, well worth the time and slight cost necessary to binding them at home. In many instances, book binding begun in this casual way has been found of so much interest, and the worker has acquired such skill, that bindings of most artistic and mechanical skill have been executed, and a library of choice bindings eventually acquired.

It will be the purpose of these articles to direct the reader along the first stages of this artistic occupation, but sufficient information will be given so that continued progress can be followed intelligently, and with a proper understanding of the lines along which to study.

A start will be made, therefore, by describing the processes to be followed in binding a set of magazines, and that the illustration may be familiar to us, we will take the numbers of AMATEUR WORK for one year, and comprising a volume. Other magazines will vary but little from this one, and no difficulty will be found in working them if these directions are followed. It is assumed that before commencing the work of binding the reader will have provided himself with the necessary tools, which may be purchased of dealers in bookbinders' supplies, or that he will have made them, as described in previous numbers of this magazine. The sewing frame, described in the September, 1902 ; the press, December, 1902, and cutting press and plow in the February, 1903, issues, are all necessary tools ; the cutting press and plow can be dispensed with if a printer friend with paper cutter can be prevailed upon to do the trimming, but as work of this class works havoc with the knives, a refusal may be expected at the second visit.

The first work is to look over each magazine carefully, smoothing out folds or wrinkles, mending torn places with gummed paper specially prepared for this use and obtained at the public libraries if the stationer does not keep it. Also observe if plate illustrations are correctly placed, that no pages are missing, and that colored illustrations are protected by thin, strong sheets of tissue. Further directions for handling colored plates will be given later.

An examination of the method of binding or stitching each magazine is next in order. AMATEUR WORK being wire stitched in two places, the several sheets making up one magazine being assembled one within another; "saddled" as it is termed, the whole making up what in the book will be termed a "signature". Other magazines will be found bound with wire staples driven through the sheets from top to bottom, near the edge, and others are stitched with thread in several different ways. The two latter classes of magazines generally have several signatures to each magazine, each signature being handled separately when being stitched for binding into a book.

The wire staples, or threads, as the case may be, must be carefully removed, using care not to tear the folds of the leaves. If glue has been used for attaching a cover, the application of hot water is necessary, or the glued surface can be held in the steam from the nose of a teakettle, but should be protected by strips of wood along the edges, held by clamps, to prevent the moisture from working back onto the page and damaging it. After wetting or steaming, the edges should be allowed to dry thoroughly before further work is attempted as, while moist, the sheets will tear very easily. The glue, when moistened as directed, should be scraped off with a dull knife, followed by a moist sponge. The signatures are then separated and laid upon a flat surface to dry, being collected again in the original order when dry.

Again examining the several magazines which are to make up one volume, it will frequently be found that the margins are not uniform at top or bottom. When this is the case, it is necessary to so arrange them that the margins will be alike, so that the book will "register". First find the magazine or signature having the least margin at the top, measure the distance from the headline to the top edge of the page, then mark on the back of each signature a guide line giving the same top margin. When assembled for sawing cuts for the stitching, these marks should be in line, giving to the book an even register.

The handling which has thus far been given the sheets will have the effect of making them lie loosely together, and be more or less wrinkled. To compress them and smooth out the pages, the signatures comprising a book are jogged up evenly at the back and put in the press, where they should remain over night under heavy pressure. Colored illustrations, especially if of recent print, would become attached to the pages facing them if not suitably protected while in the press. In binderies, sheets of tin (not tinned iron) are placed over colored plates, but for the occasional use of amateurs, the oiled paper used for wet copying of correspondence and obtainable at most stationery stores, will serve the purpose as well. As they are so handily obtained, their purchase can be deferred until the necessity for the r use arrives.

As the reader who engages in book binding will, in all probablity, have several books in process at a time, to assemble them in the press it is necessary to have a supply of pressing boards, varying in size for the different sizes of books to be bound. They are smooth, rectangular pieces of maple, or birch or other fine-grained, hard wood, from ½ to ⅝ in. thick, and about 1 in. larger on all sides than the books they are used with. They should be very smooth and even. The top block nearest the screw should be about 2 in. thick. The books to be pressed are piled one upon the other in the center of the press, separated by the pressing boards, as illustrated in the description of the press. Care must be used to get the pile as near the center as possible, so that the pressure of the screw will be applied evenly. If a book be thrown out of shape in the press by being placed to one side, it will be quite difficult to again get it to remain even.

To the reader who has but few books to bind, and who is not desirous of fitting up a press as described, a book or two can be pressed by means of wooden hand clamps, such as are used by cabinet-makers for gluing up work, and pressing boards rather thicker than as above specified. An enterprising friend of the writer made use of a bench vise with thick boards each side of the book, and binding only one book at a time.

TOOL MAKING FOR AMATEURS.

ROBERT GIBSON GRISWOLD.

VIII. Inside Grinder Head for a Lathe.

If you have ever tried to make an accurate fit in the case of a plug entering a hole, you have doubtless met with considerable difficulty. There are many methods used in machine work for making true, circular holes, but none approaching the inside grinder in results attained. A well sharpened reamer will do a beautiful piece of work when properly used, but after a reamer has once entered a hole and performed its work, it is very likely no longer to size, although the wear may be imperceptible. But continued use of this tool will soon place it in a position where it will be impossible to do a good job with it at all. And then, again, the reamer has its limitations. Unless the hole has a considerable depth, it is very difficult to make the reamer follow true; it has a tendency to cut on one side or the other, depending upon how nearly vertical it is held, and if it is being driven by hand. This does not happen so frequently, however, when the reamer is used in a lathe and resting against the tail center.

But when it is necessary to make a ground fit, a fit that will allow of perfect freedom of movement and still allow no shake, then it is necessary to resort to a more accurate means of finishing the hole. This is the duty of the inside grinder, and it is indeed wonderful to see some of the classes of work that are done daily on this little tool. And then, again, the time saved is a very important factor, for by no other method can an equally good job be accomplished.

The inside grinder runs at a very high speed, far greater than that necessary for the outside grinder. This is due to the fact that the cutting speed of a wheel depends upon the velocity with which the surface of the work and the particles of emery pass each other. The higher the speed, naturally, the faster will the small particles cut into the comparatively soft steel or other metal. In the case of the outside grinder we have a wheel varying from two to three inches in diameter, while the wheel on the inside grinder is about ½ in. or less in diameter. The circumferences of any two circles are directly proportional to their respective diameters, and if we have an outside wheel that is 3 in. in diameter and running at 3,000 revolutions per minute its peripheral speed will be

$$3 \times 3.1416 \div 12 = 2356 \text{ feet per minute,}$$

while for the half-inch wheel to attain the same peripheral velocity will require a speed of

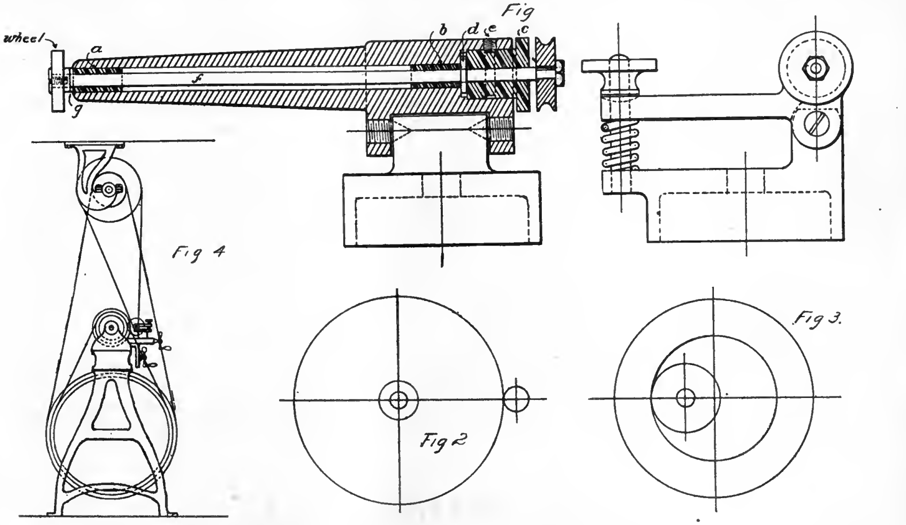
$$12 \times 2356 \div .5 \times 3.1416 = 18{,}000 \text{ revolutions per minute,}$$

or the revolutions vary inversely as the respective diameters of the wheels. It is seldom possible for the amateur to run his grinder at any such speed, and it is not necessary, as we will learn later.

Let us first look into the construction of the inside grinder. In Fig. 1 is shown a very simple but highly efficient inside grinder head complete with a micrometer adjustment. The base and micrometer arms are similar to those described in the last chapter. It may be well to state at this point why a combination tool grinder is not good for this class of work.

First and foremost, no tool carriage has a feed screw sufficiently fine to take cuts .0005 in., as the movement of the handle would be almost imperceptible to the touch. Then again, such a tool would at times be used for outside grinding and the bearing bushings would soon become worn (this is with reference to that type wherein the spindle may be worked to and fro with the hand) so that a clearance of .0004 in. or .0005 in. would exist, caused by fine particles of abrasive being carried in on the spindle and then grinding out the bushings. Now, when one attempted to use this on a very fine piece of work, either inside or out, he might be surprised to find out how much 2 × .0004 in. really means in close work.

It also requires more pressure to make an inside cutting wheel take hold of the work than an outside wheel. This is for the following reason: In Fig. 2 is shown the action between a piece of work and the outside wheel. The points of contact form a very narrow line, and it takes very little pressure to make the grains cut keenly. But now look at the case shown in Fig. 3. Here we have a half-inch wheel cutting inside of a one-inch hole. Notice how large the arc of contact now becomes. It takes considerably more pressure to make all these grains bite into the metal than in the case of Fig. 2.



Now, if we were to place this little wheel on the end of a rapidly revolving spindle that overhung its bearing by say, three inches, and presented it to the work, we would find that the pressure that we were required to place on the spindle would bend it slightly, and as the wheel gradually took a deeper cut under the spring of the spindle, the hole would soon be ground with anything but a straight side or of a uniform diameter.

This leads us up to the design adopted in Fig. 1. Here the bearing is carried in an arm that extends close up to the wheel, thus taking all the bending strains, and, since it is necessary to have it only a little smaller than the diameter of the wheel, it can be made strong enough to be quite stiff against such strains. This arm carries a hardened steel bushing, *a*, at the end, and another at the center of the stock. These form the principal bearings for the spindle, which is made of tool steel, hardened and ground so that it runs with absolute truth. A soft steel or composition sleeve nut enters the stock at *c*, and bears against the shoulder *d*, preventing end play in the wheel. A small set screw, *e*, prevents the nut from backing out. This sleeve may be lined with a steel bushing, but the bearing is so long that it is hardly necessary, and the pull of the belt cannot be transmitted to the spindle and wheel, owing to the intermediate bearing, *b*. When the head is assembled, a quantity of thin oil is placed in the annular space, *f*, which keeps the bearing *a* and *b* well lubricated. It is an excellent scheme to keep a small felt washer, *g*, between the wheel and bearing *a*, to prevent the very fine particles of abrasive reaching the bearing.

As the spindle heats, as they always do under such high speed, the expansion is taken care of by the collar *d*, which allows the spindle to lengthen in either direction, but at the same time prevents end play. A very light belt is used to drive this grinder, and for this reason a twisted rawhide belt is far better than any other, owing to the grip that it takes on the pulley. Otherwise, the design is similar to that shown in the last chapter.

These grinders require an overhead drum or pulley, as shown in Fig. 4. This is simply a drum supported by two hangers and driven by a belt from the driving wheel of the lathe. The back gears of the lathe are thrown in, and the work is driven at a very slow speed, while the small wheels must be driven as fast as it is possible with foot power.

The drum may be made of a series of wood strips glued together to form the drum and afterwards turned in the lathe. As these strips are laid together the ends are nailed to the two flanges at the ends, and after all the strips are in place a cord is wrapped tightly around the whole, binding them all closely together until the glue is dry. It is then swung in the lathe and a small tool fitted to the tool post, having a very keen edge. A fine feed may then be used and the piece driven at a good rate of speed which will make a very nicely finished drum, especially after sandpaper has been applied. The drum need not be over six or seven inches in diameter.

The lead of the belting is shown in Fig. 4. If the drum is over three feet above the lathe, the increase and decrease of tension in the grinder belt will not matter much, but under that the strain will become greater as you feed away from the center. This can be accommodated by unhooking the two ends, untwisting slightly, and again joining together.

Now let us consider for a few minutes the question of the selection of the wheel. Perhaps in no other department of machine shop practice is there such a widely varying result gained from the use of two similar tools as that obtained by the use of different grades of emery wheels. Emery wheels are graded in two ways; first, as to their degree of fineness, running from No. 8 to 120, the former being very coarse and the latter very fine, and second, as to their relative hardness. This degree of hardness is denoted by the letters of the alphabet, A denoting the softest grade.

The hardness of a wheel depends largely upon the amount and character of material used in making up the wheel. Generally speaking, a wheel composed of fine emery is more compact and harder than one made of coarser emery. Softness is the most important characteristic in a wheel, as a soft wheel will be less likely to affect the temperature of the work or to glaze, and is best for grinding hardened steel, cast iron, brass, copper and rubber. For soft steel and iron, use a harder and more compact wheel. It might be said that the harder the work the softer the wheel required to give a certain finish.

The thickness of the wheel or width of the surface presented to the work also controls the degree of hardness to a certain extent. The narrower the wheel the harder should be the grade.

Below is given a table of the numbers representing the various grades of emery, and the degree of smoothness of surface they leave may be compared to that left by flat files as follows:

8 and 10	represents the cut of a wood rasp.
16 and 20	" " " " a coarse rough file.
24 and 30	" " " " " an ordinary rough file.
36 and 40	" " " " " a bastard file.
46 and 60	" " " " " a second-cut file.
70 and 80	" " " " " a smooth file.
90 and 100	" " " " " a superfine file.
120F and FF	" " " " " a dead-smooth file.

The following table gives the average speeds for emery wheels as taken from the lists of various manufacturers:

Diam. of wheel	Rev. per min.
1 in.	15,000
1½ "	12,500
2 "	10,000
2½ "	8,000
3 "	7,000
4 "	5,000
5 "	4,000
6 "	3,600
7 "	3,000

As a general rule, the peripheral speed of a wheel should be about 5500 feet per minute.

THE OSMIUM LAMP.

The following is an abridged translation of a paper on the osmium lamp read by Herr Fritz Blau before the Elektrotechnischer Verein, of Berlin, on January 24:

The total energy radiated by a heated body is proportional to the fourth power of the absolute temperature of the body. As the temperature increases, the percentage of the short waves emitted, as compared with those of long length radiated, increases also very rapidly ; but the absolute value of this percentage varies for different bodies, being smallest in so-called "black" bodies, but comparatively high in bodies with a metallic lustre and a smooth surface. Only these short waves, it need hardly be said, are observed as light. An efficient light-giving body must, therefore, withstand very high temperatures; its radiating surface, at a given efficiency, should be as large as possible; the substance of the filament should be transparent or white to minimize the effects of blackening; the surface of the filament should not become blacker or rough with use, and its resistance should increase with increasing temperature.

Osmium, generally in the form of osmium-iridium, is found in platinum ores and also in gold and silver. It is at present usually obtained by alloying the residue which remains when platinum is dissolved in aqua regia, with metals, such as zinc, lead or tin. The osmium-iridium passes thereby into a finely divided state, and if it is now heated in a current of oxygen it will split up into osmium tetroxide and iridium. Osmium may then be obtained by treating the osmium tetroxide with any reducing agent.

When Herr Auer von Welsbach invented the osmium lamp some six years ago, he found it impossible to draw osmium in form of wire, and he first tried the expedient of coating platinum wire with osmium and evaporating subsequently the greater part of the platinum. It was observed, however, that a platinum osmium alloy was formed which—when containing more than four per cent of platinum—began to melt when the platinum was being evaporated. In order to keep percentage of platinum below this figure, the finished filament had to be made about five times thicker than its platinum core. As uniform platinum wire was not obtainable in thickness less than 0.02 millimetre, it will readily be seen that the osmium filaments could not advantageously be made in diameters below 0.1 millimetre. Such filaments, however, are not suitable for lamps consuming less than one ampere.

The next and final step was to mix most finely divided osmium with certain organic binding substances to a thick, tenacious paste. The paste is forced under high pressure through a diamond or sapphire die on to a card which is moved about in such a manner that the filament is deposited in loops. After drying, the organic binding substance is carbonized by heating the filament in vacuo. This porous filament, rich in carbon, is gradually heated to an intense incandescence by an electric current in an atmosphere containing much steam and a certain quantity of reducing gases. The carbon of the raw filament changes into carbon oxide and carbon dioxide, and after a relatively short time the filament consists of pure, or very nearly pure, osmium only, the percentage of carbon being insignificant. Although the density of the filament has greatly increased during this process, the filament is still porous and its surface is far from smooth. After trying unsuccessfully several means of connecting the filament to the platinum leads, it was found that a very satisfactory method was to fuse them together by the electric arc. Osmium is brittle when cold, but soft when heated, and for this reason the lamps as made at present, are required to burn in a definite position.

When the manufacture of this lamp was taken up by the Deutche Gasgluhlicht Actiengesellschaft, the highest voltage that the lamp could stand was twenty-seven volts. After the lamps had been perfected to burn at thirty-seven volts they were put on the open market. The lamp voltage was soon after brought up to forty-four volts, and during the last few months a considerable number of fifty-five and seventy-three-lamps have been sold. Quite recently 110-volt lamps have appeared.

The filament of an osmium lamp for thirty-seven volts, twenty-five candle-power (Hefner units) consuming one and one-half watts per candle-power, has a diameter of 0.087 millimetre and a length of 280 millimetres. The radiating surface is from three square millimetres to 3.2 square millimetres per candle-power. If an ordinary glow lamp be run at one and one-half watts per candle-power, its radiating surface per candle power is only 1.6 square millimetres. The carbon filament, therefore, must be both hotter and "blacker" than the osmium filament. With an increase of voltage of ten per cent the current increases 6.5 in the case of the osmium lamp and twelve per cent in the carbon filament lamp. The corresponding increase in illuminating power is forty per cent and eighty per cent, respectively.

It is not possible to state definitely the life of the osmium lamp, but 5000 hours have been repeatedly exceeded. Blackening of the bulb is very rare; (observed in ten per cent only of the lamps investigated so far. The surface of the lamp filament is at first somewhat rough, but it gradually becomes smoother, and this is the reason why the candle-power increases durins the first 250 hours or so. Before the lamp is ready for sale it is burned in the factory for several hours in order to bring the lamp up to an approximately steady state.

If the lamp is run at less than one and one half watts per candle-power, the structural changes in the filament occur too rapidly for practical purposes. Nevertheless, lamps consuming one watt per per candle-power only have been observed to burn for several hundreds of hours without decrease in light. When exposed to hard shocks, the osmium lamp filament is somewhat more liable to break than the carbon filament, but if properly packed the loss through breakages in transit is small, being only about one and one-half per cent. These lamps stand the shocks of railway carriages and omnibuses very well. The osmium lamp is efficient also for very low voltages, and a large number of two-volt lamps for mines are in use in connection with portable accumulators. For a long time it was not possible to make thin filaments, but recently it has become feasible to reduce the diameter down to 0.03 milimetre—*Electrician.*

NEW OZONE GENERATOR.

A new ozone generator has been recently brought out in London and is described in the *Electrical Review*, of that city, for November 11. The apparatus consists of a mahogany box about 16 x 28 in., lined with asbestos board. At one end is a small electric fan producing the necessary circulation of air. Several baffle plates are placed within the box, on which the ozonizing girds are fixed. The box also contains a small step-up transformer for producing the necessary high potential.

The baffle plates consist of thin sheets of highly insulating material, such as micanite, on each side of which sheets of copper gauze having forty meshes to the inch are fixed. These sheets are connected alternately to the two poles of the step-up transformer, which gives a potential difference of 4,500 volts, this having been found by experiment to be the best pressure for the purpose. The ozonizing surfaces have an area of about four square feet. As at each corner of each mesh of the gauze the wire is necessarily bent so as to form an elevation, which may be regarded as a round-point, there are 230,400 such points to a square foot of the ozonizing surface, giving a total of over 900,000 points in the apparatus from each of which a discharge takes place. Owing to this extreme subdivision of the discharge there is said to be no sparking and no formation of nitrous compounds. It is said that this apparatus is capable of ozoning 30,000 cubic feet of air per hour, with an expenditure of sixty watts, including all the losses.

AMATEUR WORK.

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APRIL, 1905.

The relation of the school system of a country to the welfare of the public is intimate. Indeed, it is of vital importance that proper educational facilities be provided, that all may find it easily possible to acquire that education which will enable their natural abilities to be developed to the utmost. It is a fact, unfortunately, that school life is commonly looked upon as something more or less apart from the practical, productive work which begins when the former ends. Not only is this idea wrong, but the very fact that it is more or less prevalent is, in itself, harmful, as it acts to prevent many who would be greatly benefited by educational work from becoming interested in it, and so utilizing present facilities, and also discouraging the undertaking of addional ones.

This condition is undoubtedly due, in large measure, to the chaotic state in which industrial educational methods now are, and the additional fact that comparatively little intelligent effort is at present, put forth to better matters. This, in turn, is undoubtedly because of the rapid and transforming changes which have recently taken place in the industrial world, and the inabilty of of educational methods to become readjusted to the new requirements. As the industrial changes are still in progress, it is also rather difficult for those who have not given special study to the subject to determine exactly what are the lines on which educational work shall be developed, and as the number who have realized the urgent necessity of comprehensive industrial educational facilities is not yet large, and the discussion of the subject but recently become in any way general, no systematic effort has yet crystalized to the extent of formulating plans for such work.

That we are on the eve of a general awakening to the importance of the subject seems evident; that it may be speedy and fruitful of results is earnestly to be desired. For in no other way can the youth of the country be brought to that condition of skill and experience which will fit them for the higher and more profitable vocations open to them if given the facilities by which they may become competent. It is the earnest duty of all, therefore, to encourage the expansion of our educational system, especially along industrial lines, so that opportunities for advancement dependent upon educational progress may not be confined to the rich, but rather that merit be given an even chance in the race, which can only be when industrial education is comprehensive and within the reach of all.

We have but to look to the magnificent industrial educational work of Germany to realize how great are our own necessities, and the need of immediate action.

The Vienna *Workingman's Journal* reports that at the general meeting of the Mineralogical Society of Vienna, January 9, 1905, Dr. Morosiewicz, professor of of mineralogy at the University of Krakau, announced that he had discovered a new mineral, to which he had given the name Beckolith, in honor of the Vienna mineralogist, Prof. Friedrich Beck. He asserted that it does not correspond to any of the mineral combinations so far known, but resembles mostly combinations of garnet, having similar regular crystals, and contains many rare earths, which form 75 per cent of its volume. The chief components are cero, lanthano and didymo oxides, and it may be of use for the manufacture of chemical products, especially for the light industry. The discovery was made during a scientific exploration which Prof. Morosiewicz made in southern Russia, and the government district of Rekaterinoslaw is probably the chief locality where the mineral may be found. The rock in which it was discovered is called marinpolith.

A REFRIGERATOR.

JOHN F. ADAMS.

Winter has but just left us, yet it becomes necessary to think of summer and the ice man. This leads up to the subject of a refrigerator, the one here described being a size and design suitable for family use. The reader need have no hesitation about using this style of construction, as one like it has been in constant use for over four years and is still in excellent shape for use at least as much longer. The cost for lumber will vary from $6 to $8, and the zinc, shellac and fittings will cost about $2 more; the finished refrigerator being quite equal to any $25 article which can be purchased, and much superior to many.

The chopped cork, used for the packing, is readily obtained for the asking of any fruit dealer handling Malaga grapes, but it would be well to obtain it at once, as the grape season is about over, and as the cork is thrown away it cannot be obtained readily very much longer. About a grape keg full will be required. It is much the best thing which can be used for packing, keeping dry and odorless even after many years of use.

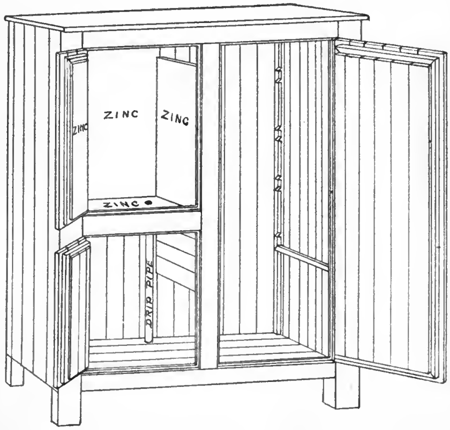
The lumber bill includes the following:

40 sq. ft. spruce sheathing, ½ or ¾ in. thick.
40 " " gum-wood " " " " "
36 ft. 2 x 3 in. spruce, planed all over.
1 piece gum-wood, 36 x 24 x ⅞, glued up.
1 piece oak, 20 x 12 x ¾ in.
2 " " 19 x 10 x ¾ in.

Gum-wood for the outside sheathing gives a fine appearance, but costs more than spruce, which may be substituted if desired. In addition will be needed 3 pieces of zinc or galvanized iron 19 x 24 in. Also three pairs brass hinges and three refrigerator door fasteners, the latter being found on sale at large hardware stores.

With these materials at hand, first make two frames of the 2 x 3 spruce, which after being planed will measure about 1¾ x 2¼ in. Cut four pieces 33 in. long, and four pieces 22 in. long; make halved joints at the ends and nail firmly, the larger dimensions of the stock being vertical. One of these will be for the top and the other for the bottom of the refrigerator. With the spruce sheathing cover the under side of the top frame and top side of the bottom frame, the sheathing being brought flush to the sides of the frame, except on the front, where it covers only 1 in. of the frame, with places cut out for the posts next to be mentioned. The front strips of sheathing are not nailed in place, therefore, until after putting in these posts.

Cut three pieces of the 2 x 3 in. spruce, 36½ in. long, one for each corner and one for the center, as shown in the illustration. Also cut a piece 24 in. long, for the cross piece between the ice and lower chamber on the left. The lower edge of this cross piece should be 24 in. above the lower frame, and the ends are halved into the uprights. Before fastening in place cut a groove ⅞ in. wide, ½ in. deep and 12 in. long in the center of the inner surface, beginning at the center post, to receive the end of the oak pieces forming the floor of the



ice chamber. The joints should be glued, drying in clamps.

Prepare strips of ¾ in. stock 1½ in. wide, and firmly screw same to the sheathing at the ends and back of both upper and lower frames. The ends of the inside sheathing are nailed to these strips.

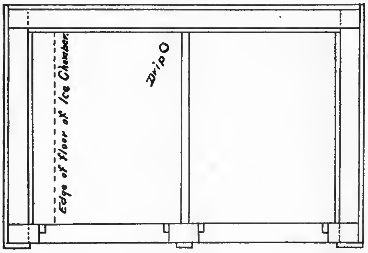
The erecting can now begin by nailing the three posts onto the lower frames, the cross-piece above mentioned being in place; the upper frame is then put on, temporarily holding same at the back by nailing strips to both lower and upper frames.

The inside sheathing is then nailed in place, using wire finish nails and blind nailing as much as possible.

The corners are made as tight as possible. If the joints are glued when matching, less moisture will work into the wood, which is an advantage.

The floor of the ice chamber is next put in place. This is made of an oak board about 19 in. long and 12 wide, the right edge being brought flush against the center partition, leaving a space about 2 in. wide at the left, through which the cold air falls to the chamber below. A slight slant must be given this floor piece towards the inner, center corner, where is located the drip pipe. A hole 1 in. diameter is bored in this corner, centering 2 in. from the right edge and 1 in. from the rear end. This hole should be bored before fastening the board in place, which is done by nailing through the sheathing and the first cross piece. The center partition is then put in. It is of ⅞ in. sheathing, and begins 4 in. from the under side of the top, and continues down to about 6 in. from the bottom, leaving these spaces for the circulation of the air.

Directly under the hole in the ice chamber for the drip pipe in the floor of the lower chamber is bored a 1 in. hole for the drip pipe. In a piece of the 2 x 3 in. spruce about 4 in long, bore a 1 in. hole and nail the piece to the under side of the sheathing, boring a hole to meet same in the sheathing put on under the lower frame. See that the holes in sheathing and block are in line and straight, making a firm, tight fit for the pipe. The sheathing on the under side of the lower frame is then put on. To do this, lay the whole frame on the back and begin at the back edge, the first strip of



sheathing being put flush with the lower edge. Before fitting on the last two strips begin the packing with the chopped cork. Put in enough to fill the space to a depth of about 6 in., tamp it down with a stick, not too hard, or it will force out the sheathing, but firm enough to prevent spaces being formed by subsequent moving about of the refrigerator. Keep adding the cork and tamping with a stick until all the space is filled, putting on the last strip of sheathing and covering the narrow space then remaining after filling as full as possible with the cork chips.

The two ends are then sheathed in the same way, beginning at the back and placing the first strip at each end so as to cover the edge of the sheathing on the back. The back sheathing is then put on, laying the work on one end to do this. Should the sheathing show a tendency to bulge out. put in a short piece of the 2 x 3 in. spruce and fasten with long screws of small gauge from both inside and out. The top, 24 x 36 in. is then put on, after firmly packing the space with cork, and securely nailing to frames and sheathing.

The front is then finished off by putting strips across the top and bottom, along each side, down the center and on the cross piece, these pieces being the proper width to allow the posts and cross piece to expose a margin of about ⅞ in., and forming a jamb to the doors, serving in part to make them air tight. Strips ⅞ x ½ in. are also nicely fitted around the inner edges of the door making a second jamb, and giving tight doors.

Under each corner, legs 4 in. high are screwed. These can be made from pieces of the 2 x 3 in. spruce.

The ice chamber is then lined with zinc or galvanized iron, after nailing to the left edge of the floor a strip of oak ½ in. square, which acts as a stop to the water from the melting ice. If the reader is not used to such work a plumber should be employed, who can do all the work in a couple of hours if the pieces have been cut and fitted ready for him. The drip pipe fits over the end of a short piece soldered to the lining of the ice chamber, and can be formed up from a piece of the zinc or galvanized iron. At the lower end, which projects below the under side, a V shaped cone is made having three upright strips soldered to it, which enter the drip pipe and hold the cone in position. This fills with water and acts as a seal to prevent cold air from escaping from the ice chamber.

The doors are made as follows: Frames are made of stock 1 in. thick and 2 in. wide, the corners being mitered and then sheathed front and back, the latter being put on last and the space filled with cork as before described. The front sheathing laps over about ⅞ in. all around, and the back sheathing is short ½ in. on all sides. All joints should be well made, and the doors a good fit, without being so tight as to bind as they may swell a little from moisture.

In each corner of the large chamber, strips of spruce ⅞ x ½ are firmly nailed; the edges of these strips have slots cut in them at suitable places in which rest the ends of the cross pieces holding the shelves. The shelves, if made of wood, should not be much over one-half the depth of the chamber in width, and when in use should have a small air space at the back to give proper circulation. If the whole capacity of the food chambers are needed, then shelves of wire netting or perforated zinc, should be made by fitting the wire or zinc to a frame made of rod iron, painted with alluminum paint to avoid rusting.

The inside is then given two or three coats of spirit shellac, using only the best grade and allowing each coat to dry thoroughly before applying the next; work the shellac into all joints aud cracks so that there will be no places for moisture to work into the wood. An additional coat of shellac will be needed after the first season's use.

The hinges and fastenings are then fitted. For catches, get the kind with drop handles that work on a cam, which will bind the door tight when closed. Ball bearing castors on the legs make moving about an easy matter, the completed refrigerator being quite heavy. The outside is finished with a natural filler and then shellacked and varnished.

Wood is now seasoned by the use of electric current, the sap being drawn out and borax resin drawn into the pores of the wood in its place by electrolysis.

Renew your subscription before you forget it.

PHOTOGRAPHY.

PORTRATURE BY DAYLIGHT
IN AND OUT OF DOORS.

Only the merest rudiments of this very interesting occupation can be touched upon.

But within the space at our disposal we can, firstly, put the reader on his guard against the special dangers of indoor portraiture—dangers which do not readily occur to those who for the first time set up their cameras in the house ; and, secondly, give him some hints on the quite opposite difficulties of portraiture out of doors.

INDOORS.

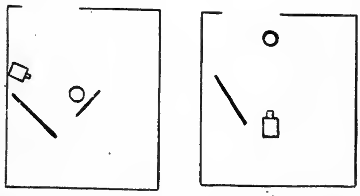
Indoors.—For purposes of practical work do not let us limit "indoors" to sitting-rooms, drawing-rooms or other apartments of the home. The opportunities for portraiture occur in many other places than these—in the shop of carpenter or cobbler, or in the schoolroom or in the inn parlor. The ruder and rougher the building, the better for our photographic purpose ; the array of glittering knick-knacks in the drawing-room, as it is furnished by the young matron, being one of the minor obstacles in the path of the indoor photographer.

Lighting.—One window being usually the only source of light, it is soon discovered that the lighting of the sitter can easily be wrong. The most common mistake is to place the sitter sideways with the window and fairly close to it, with the result that one side is in strong light and the other in deep shadow, with little gradation between these two extremes. The effect is a hard or "chalky" portrait, not calculated to display to advantage the features of any but the most rugged Irving or Martin Harver type of countenance. On the other hand, if the sitter's face is fronting the window the light is the same all over the face, and the result is a corpse-like flatness, perhaps the worst sin of indoor lighting that can be committed.

The chief secrets of obtaining a pleasing modelling on the face are:—(1) A position for the sitter not near to the window, say 5 or 6 ft. from it ; (2) a reflector on the shadow side of the face ; and (3) softening the strong light coming through the upper part of the window. This latter casts heavy shadows under the eyes, nose, lips and chin. We can get rid of this top light altogether by going far enough back into the room, but then we lose the relief which it gives. With the sitter in a position nearer to the window the top-light is screened by pinning tissue paper over the window frame or using a screen (say of muslin stretched on a child's hoop) above the sitter.

Figure *a* shows how camera, sitter and reflector may be placed, and is offered as the roughest hint as to arranging matters in an ordinary room.

The Background.—The wall or interior of a room is almost always the worst of backgrounds, unless stripped of ornaments and prominent objects, which, by hook or crook, manage to show up somewhere behind the sitter's head most prominently, causing us much work before they can be removed from the negative. Smooth brown paper damped and mounted on a clotheshorse or a framework made for the purpose, forms a good background. For a lighter one a blanket will answer well—a white sheet is too light—or a light-colored traveling rug. One little dodge about backgrounds may be mentioned here, and that is on using some rug or drapery of prominent pattern when a a plain background is wanted. It is really very simple. Get some one to gently move the background a little up and down and side to side during the exposure.



a. b

The reflector is a big piece of white cardboard or a white sheet stretched on a frame. It is all the better to have the reflector pivoted so that it can swing from its center like a bedroom looking-glass. The movement is convenient in tilting it towards or away from the sitter.

The Lens and Camera.—The largest aperture the lens can be opened to may safely be used for portraiture indoors, that is to say *f* / 8 : or *f*/ 6 is none too rapid.

The danger of indoor work is under-exposure, and as the exposure must not be long—to avoid movement of the sitter—there is need of a large aperture and a fairly rapid plate. In this as in all portraiture, it is well to use a lens of the longest focal length permitted by the distance between sitter and camera. In many rooms this is not greater than the orthodox $5\frac{1}{2}$ in. for quarter-plate, but it is better to have longer if circumstances allow.

Exposure.—In winter work—indoors or out—use a meter. Useful in summer, a meter is indispensable in winter, when the light falls off after noon with much greater speed than in summer. For indoor work it is convenient to work the meter at the quarter tint, otherwise the time taken by the paper to darken is too great.

In portraiture the beginner must learn to recognize the effects of under and over-exposure : The former accentuating the features of the face, burying dark parts in one inky blackness, and the latter by the loss of contrast on the face, general flatness, and a lack of difference between tones which were different.

On development there is little to be said beyond the caution to aim at a thin, delicate negative, for which amidol, metol or rodinal is a very suitable developer.

Against the Light.—With proper precautions some most charming effects can be obtained by placing the sitter close to the window, the chief light coming towards the camera and thus putting the side of the face, as seen in a photograph ,in shadow. The beauty of this form of lighting depends on preserving the roundness of the face and figure of the sitter, and to do this the reflector must be used to relieve the heavy shadow on the near side; but not too much reflector, or the effect of the straight lighting is lost. A beautiful profile is *the* subject for lighting of this kind, by which also transparent draperies, muslins, chiffons and lace appear with good effect. The arrangement of camera, etc., will be somewhat as in Fig. *b*. Plates should be backed and a liberal exposure be given, so that everything you want in the negative develops easily in about five minutes. In this way halation will be avoided as much as possible.

The fine piece of portraiture of this kind by Mr. M'-Lean may be taken as an incentive and a standard by those commencing indoor work.

Sunshine is susceptible of many strong and beautiful effects, but it wants more skill in management than diffused lighting, and particularly so in small rooms. The wisest suggestion that can be made to those anxious to use it for portraiture is to commence in semi-outdoors, such as a veranda, gateway, or even doorway.

OUTDOOR PORTRAITS.

Indoors the lighting is too strong in one direction—from the window on to the sitter. Out of doors the lighting suffers from an exactly opposite defect—it is too even all round. To obtain relief and contrast we must cut it off on one side or the other. One of the simplest ways of doing this is to place the sitter in the angle of a building where light from behind and from one side is quite cut off by high walls. Then there is probably too much top light, and a light screen of muslin stretched a few feet above the sitter will greatly improve matters. With a second screen at the side we practically reconstruct a regular studio, and some very effective portraiture can be done with such an arrangement ; or better, with the portable studios constructed on the same principle by Tylar of Birmingham and others.

Those who want to study portraiture as it can be done without a studio should fix up a couple of stout parallel copper wires at about 8 feet from the ground and about 6 feet apart. On these can be hung screens of muslin or opaque cloth, with which can be obtained almost any sort of lighting.

Arranging Sitter and Background.—It is worth while to try heads, or half-lengths (head and hands, in a sitting posture), and to make them a good size on the plate instead of confining oneself to full-length figures in small size amidst a great mass of surroundings, as is usual. Choose your background and arrange the camera before asking your sitter to be seated, for until you have gained experience you will be slow, and apt to tire a nervous sitter. Let the background be natural for choice ; and remember that the nearer your main object is to the camera the nearer will be the point beyond which objects are out of focus. As you will probably have to use a large aperture for the portrait exposure, the background must not be a very distant scene, if you want it very sharp. On the other hand, a distant object entirely out of focus will often make a very pleasant soft background of indefinite light and shade.

Artificial Background reflectors.—A white sheet, a plain blanket and plain rugs obtainable in every household, give backgrounds of various tones, so that one can be chosen to suit any subject. Even an apron, or a focusing cloth, if held by an assistant close behind the sitter, may answer as a background. It is best to pin it to a broom handle or walking stick, so that it hangs flat. In some cases, especially in direct sunshine, there are heavy shadows under the eyes, nose and lower lip. These may be considerably lighted up by laying a few newspapers on the floor around the sitter.

Lighting the Sitter.—The lighting must be chosen before the sitter is posed, or even the background selected. It is not well to place the sitter in sunshine, unless you have had much experience of this work (see later paragraph, however). With a generally diffused light, as from a lightly clouded or a grey sky, good portraits can be made almost anywhere, but even in these cases it is well to have something to give a little variety of light and shade to the face, and any building will do this. Suppose you want a full face portrait, with considerable contrast between the lighter and the darker sides of the face, place the sitter within two or three feet of the side of a house and with her shoulder toward the house. The house (of brick or stone) reflects very little light ; and the actinic difference will be more than the visual difference between the two sides of the face. Every foot that the sitter moves away from the house will make the shadow side lighter. For diffused front lighting, place the sitter with her back to the house and facing toward the most open part of the view. Remember that the more nearly you can see the horizon, the more diffused will be your light. The nearer you come to houses or trees, the stronger (proportionally) are your top-light and your top-light shadows. Note what was said in previous paragraph *re* reflectors.

In many cases a soft lighting of the face may be obtained even where the top-light is hard and concentrated, by simply letting the sitter wear a wide-brimmed hat, which takes off the harsh top-lighting and smooths out the wrinkles and shadows as if by magic. A white straw hat often lets through the brim and reflects from its under side just enough light to make a pleasant play.

Again, if your difficulty is that the contrast in lighting between the two sides of the face is too great, this may be overcome by hanging a white sheet (on a clothes-horse or from a broom handle laid on top of a pair of steps) or pinning a few newspapers to reflect light on to the shadow side of the face.

Sunlight portraits may be made very attractive if thoroughly well done, but they require much more careful handling than diffused light pictures. Few faces can stand the photographic effect of absolute sunlight, so that the best results will be secured if the hat, or convenient branch of tree or bush, is used to shade part, at any rate, of the face. The wide brimmed hat, thin white hat suggested in the last paragraph, is very convenient for sunshine work, and will give a shadow that makes a fresh bright face very interesting. With sunlight portraits the background needs careful consideration. It should not be too dark, to contrast harshly with the figure, and should not be too hard and spotty. For sunshine portraits it is well to use a backed plate, which should be very rapid but of considerable latitude (preferably double coated); and the exposure must be ample.

Photogram.

DANGERS FROM ILLUMINATING GAS.

The illuminating gas hazard to life and property is explained in clear and intelligent shape by Fire Marshal Davis of Ohio, as follows:

"The swinging gas jet with more than one movable joint is safe in a building only when the gas is shut off at the curb, and one with a single joint should have a stop on each side to prevent its being turned against goods or the wall, unless it is furnished with a glass globe or wire hood. The fixture which causes the most earnest criticism from fire marshals while making inspections, is the swinging jet used alternately to light the coal bin and the furnace door in city dwellings. They usually find spots of char made by it at some part of the woodwork. A gas jet will first char wood which is too close to it and afterward will fire the charcoal it has formed. One having in mind the fact that charcoal is necessary to the explosion in gunpowder or its liability to spontaneous combustion cannot view its formation over a gas jet or under a gas stove without apprehension. A jet should not be within 2½ feet of the ceiling. The greatest distance at which a gas jet is reported as having set fire to a ceiling is 28½ inches.

Gas does not freeze; neither do gas pipes. What may freeze is the vapor of water carried by all gas in larger or smaller percentages. This watery vapor is condensed as frost on the inside of a cold pipe and may build up enough to close it. A very few degrees of heat will reconvert it into water, and when such conversion takes place, a pipe which may have been temporarily closed is open again and permits gas to pass through. This happens frequently in dwellings and explains why a gas light turned low will sometimes go out and gas be subsequently found flowing through the burner. There are many safe lights for the bedroom, and gas is so unsafe that its use for that purpose can only be attributed to ignorance of the danger it involves at all seasons, but especially in winter. The number of fatalities from the leakage of illuminating gas is not only large but increasing. An investigating committee in Boston found that a moderate increase in pressure caused leakage in 89 per cent of all homes examined. One part of gas with six of air makes an explosive compound.

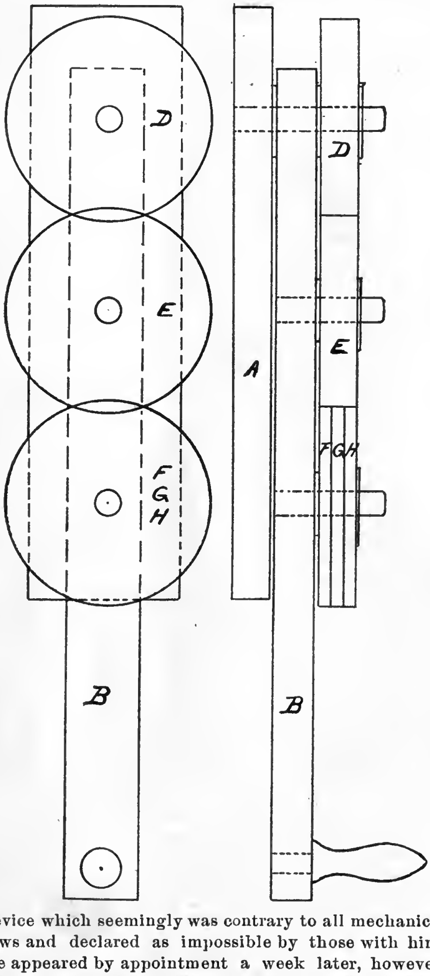
Necessary to the appreciation of the different degrees of danger, from having one of the several kinds of gas in a dwelling, is a knowledge of the constituents of each. When coal is roasted in a retort, coke, tar, ammonia liquor and illuminating gases are produced. These gases are passed from the retort through an iron pipe to the bottom of a large horizontal pipe half filled with water, in which most of the tar and ammonia settle. The gases then pass through a series of tall iron pipes, which cools them; up through a tower filled with coke, down which the water trickles (the 'scrubber'), which dissolves out the ammonia and other soluble gases: then through the purifiers, in which lime and hydrated oxide of iron absorb most of the carbon, dioxide of iron and sulphur compounds; then into the large gas holders.

This product, ready to be pressed into the mains is, speaking broadly, hydrogen one-half, natural gas one-third, with 6 to 11 per cent. carbon monoxide which slays its thousands each year, and 3 to 11 per cent. of heavy hydrocarbon (olefiants). The first three in burning produce heat, but practically no light without the hydrocarbons, which contains ethylene. The fine particles separated from the ethylene by becoming white hot give off light, and, not being entirely consumed, unless the gas is mixed with 15 times its volume of air, part of them float away as pure carbon (soot).

Within a few years the practice of mixing water gas with coal gas, or using it separately in the interest of economy, has become general. This at least quadruples its dangers, as shown by chemical analysis and by the alarming increase in the number of gas asphyxiations. Water gas is made by forcing steam through charcoal which is at a white heat. The atoms of oxygen in the water, which is in the form of steam, unite with atoms of carbon from the charcoal to form carbon monoxide, liberating the atoms of hydrogen. When piped into homes it is 44 per cent carbon monoxide. So 2 per cent of water gas in the air will kill an adult, because .65 per cent of carbon mon-oxide destroys life."

FERGUSON'S MECHANICAL PARADOX.

The remarkable history of James Ferguson, a self-educated man who achieved a prominent place in astronomical circles during the middle of the last century, affords an incident which will be of interest to many readers of this magazine. While engaged one evening in a religious controversy, and to prove his contention, he volunteered to construct a mechanical device which seemingly was contrary to all mechanical laws and declared as impossible by those with him. He appeared by appointment a week later, however, with the arrangement of gears given in the following description, which greatly mystified his associates, who were unable to solve the reason why the gears moved contrary to recognized laws. The original model made by Ferguson was of wood, and similar ones can easily be made if the directions are carefully followed, which will be a good puzzle for the unitiated to study over and show the extent of their knowledge of gears.



We will first have a description of the device, which the illustration shows to be a train of gears mounted on a frame and which may be turned in either direction by the handle. The gear *D* is a fixed gear, the others turn on their shafts. If the frame be revolved, any number of times, the several gears will presumably be found to mesh at the same places when the frame is brought to the same vertical position, but this is just what does *not* take place.

Of the three gears, *F*, *G* and *H*, one will remain in the same place, another will be found several teeth to the right, and the other several teeth to the left of the position from which it started. This will be made evident if, before the frame is turned a chalk mark is drawn on the top of these three gears, the location of the chalk marks after several turns of the frame showing the movement of two of the gears mentioned above.

The solution of the mystery lies in the fact that the gear *G* has one tooth less, and the gear *H* one tooth more than the others, the teeth on *G* being thickened slightly and on *H* thinned, to run on *E* without binding. That the difference in pitch be as inconspicuous as possible, the gears should have quite a number of teeth. Gears 4 in. in diameter make a good size, and 100 teeth are easily laid out on this size.

To make a wooden model, a supporting board, *A*, is first prepared. This may be 12 in. long. 3 in. wide and $\frac{3}{4}$ in. thick. The piece *B* is 14 in. long, $1\frac{1}{2}$ in. wide and $\frac{3}{4}$ in. thick. To avoid excessive wear, the shafts can best be made of brass rod $\frac{3}{8}$ in. diameter; that for gear being 3 in. long, and for the others 2 in. long. The shaft for *D* is driven with a tight fit into a hole bored $2\frac{1}{4}$ in. from the top of and in the center of the board, *A*. A hole is bored in *B*, the center of which is 1 in. from the upper end and is an easy fit for the shaft, so that *B* may freely turn on it. The gear *D* is a tight fit on this shaft and does not turn. A small piece of wood $\frac{1}{2}$ in. thick is placed on the shaft *A* and *B*, to keep the latter away from the former. The shaft for *E* is driven with a tight fit into a hole bored in *E* and centering about $3\frac{7}{8}$ in. from the hole for *D*. The locating of the holes for the shafts should be done after the gears are made, that they may be so spaced as to prevent binding or looseness. The shaft for the three gears, F, *G* and *H*, is also spaced about $3\frac{7}{8}$ in. from that for *E*, and tightly driven in a hole in *B*.

The gear, *D*, should be about $\frac{1}{2}$ in. thick, and the three gears, *F*, *G* and *H*, each ½ in. thick. They should be made of well seasoned maple or birch of even grain, which should run parallel with the shafts. They should also be well soaked in oil, after the teeth are cut, to avoid splitting or change of shape. The gears, *D*, *E* and *F*, have 100 teeth, *G* has 99 teeth, and *H* 101 It will also be necessary to make the teeth on *E* rather thinner than that pitch would ordinarily allow. The shaft for the three lower gears should have a small hole drilled near the outer end, into which a stay pin can be placed, holding the gears in position when turning, yet allowing of their easy removal to adjust so that there will be a straight row of teeth at the top of these gears before commencing to turn and upon which a chalk mark can be made, when showing the device to visitors.

The handle is attached to the lower end of *B*. It is evident that, if the frame be turned, the gear *G*, having one tooth less than *F*, will turn on its axis faster than *F* and in the direction it moves on its axis, while *H*, having one tooth more than *F*, will turn slower than *F* and in the opposite direction from which it turns on its axis.

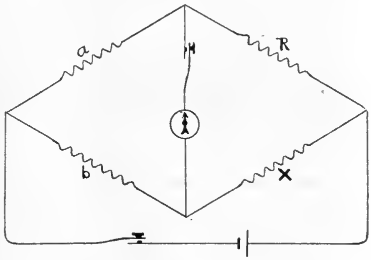
This device offers an excellent study in wood working, as well as an interesting example of the action of a train of gears and will prove of much interest to anyone making it, as well as to visiting friends interested in mechanical novelties.

MEASUREMENTS OF RESISTANCE.

OSCAR N. DAME.

Measurements of resistance are made by comparing the unknown resistance to be measured with certain standards of known resistance, there being several different methods in general use. The standard resistance coils are made of German silver or platinum alloy, as these metals have high resistance, which varies less than other metals, with change of temperature. Resistance boxes are constructed with a large number of coils of varying resistances, so that by means of plugs about any desired resistance can be obtained.

One of the most commonly used methods is that of



THE WHEATSTONE BRIDGE.

X = unknown Resistance.

a and b are fixed resistances in proportion to one another; for instance, as 1 to 100 or 1 to 1,000.

R= an adjustable resistance which should be adjusted until there is no galvanometer deflection with both keys depressed.

Then this ratio exists:

A : b :: R : x or ax= bR,

that is, the products of opposite sides of the bridge are always equal to each other.

Should a and b be equal, then x=R.

Should a : b = 1 : 100, then x = 100 times R.

Often further accuracy is required. For example: Let a=10 and b =1,000; x = between 5.11 and 5.12

Notice the galvanometer deflection to left and right and less resistances in "R" and calculate by proportion the excess of the true resistance over the lesser.

R=5.11=for instance, 6 deflection to left=d_1.

R=5.12= for instance, 12 deflection to right=d_2.

Then $(d_1+d_2) : 1 :: d_1 : y$

that is $(6+12) : 1 :: 6 : y$

that is (18 : 1 :: 6 : y = about .3

hence x = 5.113.

SUBSTITUTION METHOD.

We know from Ohms law that with the increase of resistance in a circuit, there is a decrease of current. This gives a simple method of approximately determining resistance, but it is not as accurate as the preceding method.

The battery of known E. M. E., the unknown resistance and a galvanometer are connected in series; the current passing will be indicated by the latter. The unknown resistance is then replaced with known resistance until the deflection of the needle is the same as with the unknown resistance.

Galvanometer resistance=say 100.

Battery resistance = say 0.

X=unknown resistance and R=known resistance.

A resistance of 320 w=deflection of 20 divisions or points.

An unknown resistance gave 30 points.

$x=\frac{d_1}{d}(R+G)-G$, or by arithmetic, $x=\frac{20}{30}(320+100)-100=180$ ohms.

that is, X= known points divided by unknown points multiplied by the sum of the (known resistance and resistance of galvanometer) and then the resistance of the galvanometer subtracted from that.

$x=\frac{d_1}{d}(R+G)-G$, *i. e.* x = unknown points.

EASY ELECTRICAL EXPERIMENTS.

ARTHUR H. BELL.

The possessor of an induction coil giving an inch spark or over, may construct, at small expense, a number of interesting accessories with which to amuse himself and friends.

The first device, Fig. 1, is constructed of wire and a pivot turned or drilled and filed out of brass rod. Because of the direction given to the wire and points, the electric discharge at the gap causes the device to revolve in a remarkable manner, as long as the coil is in operation.

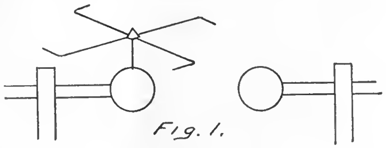


FIG. 1.

Another device, which is simply made and can be developed into a fascinating display for store windows or other exhibition purposes, is the tempest display, illustrated in Fig. 2. The houses, church, flag pole and trees may be designed in any shape desired, but must be whittled out of soft wood and painted in natural colors. All of these houses rest permanently on a metal plate, which may be covered with sand to more closely resemble the earth. All of the objects, whether houses or trees, must have the uppermost portions connected with the metal base by a fine concealed iron or copper wire, which plays a very important part in the successful operation of the device. Above the houses and trees is suspended, by fine wires, a sheet of metal screening, such as fly screening. This screen is connected to the positive terminal of a spark coil and the metal plate to the other terminal. When the coil is set in operation, sparks play about the trees and church spires just as they often do in summer tempests. Though described in crude form, this scheme is worthy of development, and bright amateurs possessing coils will readily perceive the ways of perfecting a regular landscape, with sky, storm clouds and artificial downpour. The writer built such a device a few years ago, and had the pleasure of seeing it in constant use for several weeks in a prominent store window, and realizing therefrom a considerable revenue for the rental of what every one declared to be the successful window display of the year.

It is also possible to construct an attractive display by using pith, taken from corn or cane stocks. Pith is an article of commerce and may be readily purchased of apparatus dealers, and often of druggists. Little balls of pith when inserted loosely between plates such as were described for Fig. 2, will jump and bob about in an animated manner, and if puppets of pith are constructed to resemble persons, dogs and other animal life, their remarkable antics will cause much speculation and amusement for the uninitiated.

The writer once purchased quite a large ball of pith and decorated it with colored inks. This ball was fastened to a stout straw and counterbalanced by a shoe button at the other end. The see-saw-like affair was suspended from the upper plate, half way down, by a fine silk fiber, and as the fittings of the device, including the sheets of metal were all painted a dull black, it was impossible for any outsider to tell the cause of the wonderful see-saw motion.

Another simple device is to write a name on a strip of black cardboard and punch out the lines with a stout needle or awl. This card is placed close to and in front of the spark gap of the Rhumkorff coil, and in the dark the illumination of the letter is very fascinating.

The writer also remembers a mouse trap altered to cause instant death to the mouse, when the trigger was released. Most readers are accustomed to the round red mouse traps which have five or more holes into which the hungry creature thrusts his head, only to be gripped by a noose of iron wire actuated by quite a powerful spring. One of these mouse traps was placed on a metal plate, and the trigger and spring so arranged for a wipe contact that when the cheese bait was moved inside the primary of the induction coil was set in operation and a current of high voltage sped through the mouse's body, bringing instant death. The secondary of the coil was connected to the metal plate and to another little plate just inside the hole, not actually in direct contact with plate number one. There are many other simple ways that a small coil can be utilized, and of these the writer may treat in succeeding numbers, with the hope that his amateur friends will try all the experiments and endeavor to devise new and original ones.

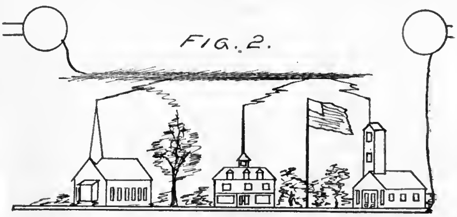


FIG. 2.

POINTERS ON THE USE OF DRILLS.

The removal of the stub of a stud or bolt broken off short in the hole, leaving nothing to get hold of, is not such a hopeles job as it looks. Put a center-punch mark or "center-pop" exactly in the center of the broken bolt and drill a hole clear through it with a drill $\frac{1}{8}$ to $\frac{1}{4}$ in. smaller in diameter than the bolt, according to the size of the bolt, and drill straight, leaving a thin shell of the broken stud. The heat and vibration of the drilling frequently has the effect of loosening the stud, which is, of course, an advantage in the final operation. Then take a piece of square steel measuring diagonally, from corner to corner, one-sixteenth inch larger than the driled hole. Taper it slightly so that the small end will just enter the hole, taking care that the corners are straight and sharp. Drive it lightly into the shell of the broken stud, just enough to make it grip, and with a wrench unscrew the shell. If it is found that the steel drift revolves without turning the stud, drive it a trifle harder; but remember that if driven too hard it will simply expand the shell and make it more difficult to remove.

A good way to loosen a stud that promises to be difficult to start is heat to a bright red a piece of iron that will just enter the hole drilled and leave it there until it cools to almost black. Then, with a squirt-can or in any other convenient way, apply cold water to the shell and immediately drive in your drift and apply the wrench. The purpose is to loosen up the rust by the alternate and unequal expansion and contraction of the stud and surrounding metal.

If all such efforts to dislonge the stump prove ineffectual, there is a last resort which seldom fails, but which should not be attempted except in case of necessity. With a narrow cape chisel or triangular file, cut a groove the full length of the hole drilled in the stub, cutting the groove just to the bottom of the thread. This will cut the shell so that the cape chisel, applied at the top near the groove, will close it into the hole, loosening it so that it will easily come out.

To place a hole with extreme accuracy, make the center-pop with a sharp-pointed punch, called a "prick-punch," and describe a circle with your dividers just a trifle larger in diameter than the hole is to be. If the hole is to be small a plainly marked circle will be sufficient, but if the hole is over $\frac{1}{4}$ in. make four center-pops with the prick-punch exactly on the circle at approximately equal distances apart. Start the drill, and before it has cut in far enough to bury the beveled part, stop drilling, and examine the work. If the edge of the started hole is exactly concentric with the circle, or equi-distant from each of the center-pops made on the circle, the hole is started true. If, however, the preliminary cut is off center, make a center-pop in the hole a trifle further from the exact center of the drill point than the distance by which the hole is out of true. Make the center-pop quite deep, so that the point of the drill will be drawn out of its original course enough to true the hole. Drill a trifle deeper and examine the cut, if necessary, repeating the operation. A little preliminary experimenting will make this quite clear. The process is called "drawing" a hole. When large drills are used, say from $\frac{5}{8}$ in. up, instead of making a center-pop, a groove is cut down the side of the cut with a round-nosed chisel, as a center-pop would not be sufficient to draw so large a drill.

When drilling steel or wrought iron, the drill should be kept well oiled or it will soon overheat and lose its temper and, besides, will cut less freely. Cast iron and brass, however, must be drilled dry, and for the latter the speed of the drill should be as high as possible for small holes.

Grind twist and fluted drills so that the cutting edge is left projecting a little. If this is not done the drill will simply glide around on a beveled end, taking at most only a very slight scrape instead of a full cut. If a drill seems sharp but refuses to cut it will generally be found that the troubie is lack of "backing off," as it is called. When grinding be careful to keep the point exactly in the center of the drill, for any little variation in its position will cause the hole drilled to be larger than the diameter of the drill. In fact, it is a common practice, where a hole of slightly larger size than the drill is wanted, to grind the tool a little off of center. This is a makeshift, of course, and is to be recommended only when there is no other way out of the difficulty.

A drill for enlarging a hole already drilled should have a small flat ground on the lip just behind the cutting edge. For ordinary drilling this would reduce the depth of cut and make the drill work very slowly and heat up quickly; but in enlarging a hole the drill has not the steadying influence of the point to guide it, and, as ordinarily ground would, as soon as it touched the metal, dig in viciously and stick. If the driving power were greater than the resisting force, something would, of course, give way, and the something is likely to be the drill. Fluted drills are better adapted to enlarging holes than twist drills, the latter having more tendency to draw in than the former. Never trust to a drill for enlarging if you want the hole to be smooth and true, for the drill, having no support from the center, will "wabble" and make the hole irregular. A little caliper work on any enlarged hole will show this very readily. If there is no reamer at hand to ream a hole to the desired size, the hole can be plugged, the plug center-popped and a new hole of the correct diameter drilled through the plug.

To drill a hole in any metal that is too hard to be touched by a drill of ordinary hardness, try hardening in mercury or strong brine. Drilling very hard metal with a glasslike tool is, however, a very unsatisfactory business, and should be avoided, if possible. The proper hardening of tools is an important matter, and though long experience is necessary for the production of the best results, ordinary tempering may be done by the amateur with a little practice. Take a flat drill, for instance. Heat the drill to a bright red for about half an inch from the point and dip it vertically into the water, point first, completely submerging it. Do this quickly and then bring it up so that only the cutting edge and a little more of the drill remainin water, and hold it there for a few seconds. Take it out of the water, and, as quickly as possible, polish off one side of the point, brush your finger quickly over t and watch the colors appear on the clean place. If you want the drill very hard, wait until the cutting edge assumes a light straw color, and plunge it entirely under water, holding it there until it is comparatively cool. A dark blue color will give a cutting edge too soft for ordinary work, and between these two colors can be found any desired temper. This method will leave the shank of the drill soft, so that it will not snap under strain, as it would if it were made as hard as the edge. Another way to bring the drill to the correct temper is to harden it outright at once, and reheat until the proper colors appear; but this is not usually as satisfactory as the first method, which is the one generally used in shop practice. The point is hardened outright and the shank left soft and so hot that it transmits enough heat to the point to reduce the hardness to the proper degree. If the shank is too hot the colors will flash along the point so quickly that the proper one cannot be caught and the line between the hard and the soft part is apt to be too sharply defined. If too cold, there is not heat enough to do the work, and the drill will have to be re-heated to temper it.

COMMERCIAL SUCCESS.

It has been remarked, and with truth, that one of the secrets, perhaps it may be termed the chief secret, of commercial success is enthusiasm, wisely directed, of course. The business man who strives to invest his duties, day by day, with the spirit of enthusiasm, may be said to give his day's task a good "set off," as it were, while he is likely to get through his work with less expenditure of nerve force, and with a greater degree of pleasure to himself than if he started in an indifferent or dull frame of mind, as many business men are, unfortunately, so often accustomed to do.

The foregoing observations may truthfully be said to apply to every branch of business, including that of engineering. This is a "point" which the young engineer should take careful note of. He should remember that our great engineers and inventors did not achieve distinction merely by dogged application to the task on hand, but likewise by the enthusiastic way in which they, as a rule, went about their respective work.

Some of our eminent living engineers, electricians and inventors (whose names might easily be adduced), are noted for the jubilant spirit with which they invariably invest their labors. They appear to find a perennial pleasure in their work; and that is exactly what everyone, the academically-trained professional, commercial men, and artisans alike, ought ever to strive to do. They will thereby be able to find pleasure—nay, even delight—in the performance of their work, whatever it may be. We are quite well aware of the fact (and it is an ugly fact, too) that many men are today pursuing a calling for which they have no particular liking. Such unhappy souls are frequently heard to say "that they do not care for the work, but it is the only kind of business that they are qualiffed for." Such individuals, and we fear they are somewhat numerous, are assuredly to be pitied.

It is a pity for any man to have to follow a trade or profession which does not lie near to his heart. He is not likely to attain distinction, nor even ordinary success in his own sphere of labor. There would be fewer of this type of worker in our midst at this present hour if parents studied the "bent" of their children's minds ere apprenticing them to a trade. The natural taste of a child should always be allowed due weight when determining upon their future life calling. Indeed, we do not know but that it should rank as a primary element in the matter, that is, assuming that the youth or girl is physically and mentally qualified to pursue the particular line of business towards which his or her native bent of mind points.—*Engineering and Iron Trades Advertiser, Glasgow.*

The inspector-general of the Paris, Lyons & Meditteranean Railroad Company, Lyons, France, says that his road uses large quantities of coal briquettes, about 10 per cent of its fuel consisting of them. Thus the road is enabled to utilize all the slack and coal dust from the mines. The engineers can get up steam more quickly with briquettes than with any other kind of coal without them. They form no slag or clinkers and tend to prevent the formation of clinkers when used with other coal. The company manufactures its own briquettes. About 95 per cent of its fuel consists of fine coal or slack. Coal briquetes are in very general use in France, hardly a household being without them during cold weather. They are more easily handled and more readily ignited, and they throw out more heat than coal and make no dirt at all. They are preferred to any kind of coal.

If a man empties his purse into his head, no man can take take it away from him. An investment in knowledge always pays the best interest.—*Franklin.*

SCIENCE AND INDUSTRY.

U. S. Consul Halstead, Birmingham, England, re reports: The Nonex is a device which, according to public tests recently made in London, renders all receptacles containing inflammable liquids comparatively secure from explosion. The device is an application of the Davy lamp, supplemented by a fusible cap or plug.

If a vessel of ordinary type, containing an explosive liquid, be subjected to sufficient outside heat, or if the contents be lighted at the orifice, the walls of the tank will burst by the force of the expansion. At an exhibition given by the owners of the patent, a 20-gallon tank was partly filled with gasoline and placed upon a lighted bonfire. The fusible screw cap, made in two parts which were simply soldered together, soon blew out, the solder having melted, and the ascending vapor caught fire immediately; but no explosion followed because the orifice of the tank formed the upper end of a tube which projected down inside the vessel to its bottom, where it was closed. To allow the oil or gas to percolate from the interior of the tank each of the metal layers of which this tube was composed had been perforated, and, while the perforations would permit the spirit to be poured out, they prevented the passage of the burning gas to the interior by absorbing its heat as the wire gauze does in the Davy lamp. While the gasoline contained in the tube burned the flame did not extend to the liquid or accumulated vapor in the half-full tank and, consequently, there was not sufficient expansive force generated to burst the tank. The flame was easily extinguished with a bundle of rags and then lighted and put out several times. The gasoline would, I judge, percolate constantly through the perforated layers of metal to the inside of the tube and there keep up a continuous burning; but according to the accounts of tests which I have read, the flame does not appear to have been allowed to burn any length of time to see how long the metal layers of the tube could absorb the heat without becoming so hot that they would heat and dangerously expand the gasoline in the tank. A motor car tank to which the device was affixed, was lighted with a match and extinguished at will. A gasoline can without the device exploded almost instantaneously when lighted.

The device applied to small gasoline cans, kerosene drums and other petroleum containers, would undoubtedly serve a desirable purpose.

U. S. Consul Hamm, Hull, England, reports: The need of a standard screw in the more delicate branches of engineering has long been acknowledged by the profession. This lack has been especially evident in optics and gunnery; but the difficulties in the way of obtaining such a standard have been just as evident. The British war office seems to have overcome most if not all these difficulties, and to have succeeded in constructing one which it is claimed will stand every test.

Recognizing the importance of having a standard screw in gun fittings and mountings, the war office was led four years ago to appoint a committee of experts to investigate the subject and devise means for the production of the article wanted. The result of the labors of this committee can now be seen in the new standard screw-cutting lathe just set up at the National Physical Laboratory at Bushy House, London.

It became clear at an early stage of the investigation that to secure interchangeability in screws it was necessary to supply accurate standard leading screws from which the screws could be cut and to construct a special lathe on which these leading screws could be adjusted and measured. The standard screw now in Bushy House is made of compressed steel and is some 6 ft. in length. The lathe to which it is attached exceeds 20 ft. in length, and as it works to so fine a degree of accuracy as to correct an error of one ten-thousandth part of an inch, every precaution has been taken to protect it from the vagaries of temperature by housing it in a special building heated to a constant temperature of 60°. The lathe differs in construction very greatly from ordinary lathes. The leading screw and the screw to be cut are coaxial. No gear wheels are employed, and there are means for automatically correcting even the most trifling errors of the leading screw.

A British trade journal states that the Elektricitats-Aktien-Gesellschaft, of Frankfort, has recently introduced a convenient machine for testing the lubricating qualities of oils. The essential part is a short shaft working in a bearing and loaded appropriately. About half a pint of the oil under examination is poured onto the bearing, and the shaft is set revolving at a definite speed. The time that elapses before the shaft comes to rest is noted; the greater the time the better is the lubricating quality of the oil. After the test the bearing is cleaned by pouring over it a liquid in which the oil is soluble and then removing the liquid by a blast of air; this method of cleaning is found to be quite effective and is economical of time. The machine may be driven by an electric motor or other mechanical means or by hand, and there is an arrangement of resistance coils by which the bearing can be heated up to any required temperature. Both the bearing pressure and the speed may be conveniently arranged.

One characteristic feature of Australian hard wood trees, of which there exists an almost endless variety, says *Carpenter and Builder*, is the great size of the beams which may be obtained from them, as well as the extreme toughness and durability of their wood, the gray ironbark having a resistance to breaking equal to 17,900 pounds per square inch, as compared with a mean of 11,800 pounds for English oak and 15,-500 for teak. None of the other timbers has so high a resistance to breaking as this description of ironbark, but nearly all the varieties have a greater strength than oak. The quality of the wood is materially influenced by the soil on which the trees grow, while the absence of branches for the greater portion of the height, enables the timber to be obtained to the best advantage; and as full grown trees of most varieties are rarely less than 100 feet high, with corresponding girth, the quantity of timber obtainable from the virgin forests is very great.

German papers state that pure and clear water can contain disease germs for a long time in a living and poisonous state. It has been presumed that disease-causing bacteria could not increase in pure water, and therefore, soon died, due to the effect of light, low temperature, current of the water, other harmless germs, and lack of suitable nutrition. It has been demonstrated that the typhus baccillus requires at least 67 milligrams of nitrogenous matter in one quart of water, and the sewer germ over 400 milligrams. The typhus baccillus is said to be able to live only seven days in common waterworks water, and the cholera baccillus only three days. It would appear that these researches were made somewhat superficially, as, according to Mr. Konradi, water is suited to many disease germs which in time overcome harmless bacteria instead of succumbing to them. The experiments of Konradi with the baccillus Milzbrand, which causes inflamation of the spleen, and the typhus baccillus, have demonstrated that the harmless bacteria in the water increased largely for some time, but died subsequently, so that, finally, the water kept in ordinary room temperatures contained only the disease bacteria in full malignancy. The "spleen" bacillus remained alive from 264 to 816 days, and displaced the other bacteria within three to four weeks. The pus baccillus overcame the other baccilli after three months and lived 508 days, while the typhus baccillus become dominant only after more than fonr months, but lived 499 days. The "spleen" baccilli thrive even in sterilized water.

According to M. P. S. Guedras, in *Comptes Rendus*, a new method of blasting has been tried. Calcium carbide is introduced into a metallic cartridge, separated by a diaphragm from the necessary water for its decomposition; the cartridge also contains an air space and a cavity having a detonater. The cartridge is introduced into a bore-hole, which is tamped with a wooden plug, and by striking a projecting-rod the diaphragm is pierced. After five minutes the cartridge is exploded by firing the detonater. The rock is shattered, but not projected, and can be easily hewn with a pick. The charge of carbide is fifty grammes.

The forests of the United States have become so reduced that they can last but a few decades at most. Those of the South will be gone by 1925, and of the Pacific before 1950. The seaports of the South Atlantic and Gulf of Mexico are exporting rapidly to South Africa and to many European marts, besides supplying ties and timbers for a large portion of this country in which the wood has become exhausted.

There are no forests being propagated throughout the South. Annual fires, a vicious practice to give fresh grazing for a few animals, keeps the young pine from growing, while baby saplings are having their life-blood drawn for the turpentine stills.

With the general indifference of the public there is no hope for a future timber growth of value. Where trees remain they are of inferior quality, and undergrowths, where they exist, are of little prospective importance.

New England has not enough timber for her own factories; eight inch trees are being sawed into box lumber. The four Middle States are dependent upon the South, having no timber left. The prairies remain treeless, except as a few groves are being planted, insufficient to be seriously considered. Four States may furnish lumber for a little while: Oregon, Washington, Northern California and Idaho.

With calls for timber from Asia, Africa, much of Europe and all of the United States, what prospect is there for a permanent contribution to all these fields without a greater effort to protect the young growth and to economize in that of mature age?—*Arboriculture.*

In a recent article in the *American Machinist*, W. Osborne calls attention to one source of difficulty in starting a gas engine which is worth noting. When the engine stops without turning the fuel off, the cylinder will be left full of gas, and unless this gas is worked out by turning the engine over several times, there will be little air mixed with the fuel when an attempt is made to start the engine and ignition cannot take place. Letting the engine stand with the exhaust valve open or working it back and forth to drive the gas from the cylinder allows easy starting.

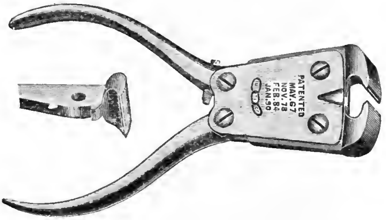
Experiments have been made recently at the Allston shops of the New York Central Railroad, with an electrical horseshoe magnet attached to a set of locomotive driving wheels to determine the degree of magnetic resistance it was possible to exert. It was found that with the attachment employed the adhesion was increased fully 35 per cent. The Central will have 30 of its locomotives fitted with the device, so as to do away with the use of sand.

Several experiments have recently been made at Camogli, near Genoa, Italy, with a new submarine boat. The craft is intended to recover objects from the bed of the sea, and for this purpose is provided with powerful hooked arms worked by electricity. So far the greatest depth reached is 58 fathoms, and at this the men were able to breathe and work freely.

Ether and chloroform, so useful in sending men to sleep, have the very opposite effect on plants, which are stimulated to the greatest possible activity by these drugs. In Denmark and Germany, advantage has been taken of this fact to force flowers in rooms and glass houses and to make them bloom out of season. The results are said to be marvelous.

TRADE NOTES.

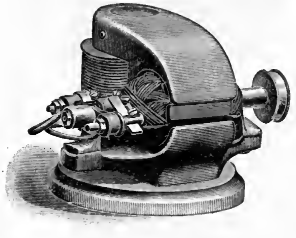
The need of an improved compound nipper with parts perfectly interchangeable has long been felt. Hall's compound and cutting nipper, manufactured by the Utica Drop Forge & Tool Co., Utica, N. Y., has been remodelled and the parts are in every respect interchangeable. The advantage of such a tool is that it lasts indefinitely; when a part becomes worn it can be replaced at a slight cost.



The nipper is simplicity itself and will not get out of order; the parts are so constructed that with the aid of a screw-driver a new part can be inserted quickly and easily. Its construction throughout is of the best quality of tool steel, carefully hardened and tempered; the jaws and handles are drop forgings and not castings. All parts are guaranteed.

The extreme leverage makes it the easiest cutting nipper on the market. It can be had in three different finishes; black with polished jaws and plates, full polished or nickel plated, in the following six sizes: 4, 5, 6, 7, 8 and 11 in. If specially ordered it can be furnished for cutting music wire. New York office, No. 296 Broadway.

This well-known machine has been on the market since 1894, and the manufacturers, The Elbridge Electrical Mfg. Co. of Elbridge, N. Y., take great pride in the fact that the machine actually represents the fin-



est possible construction throughout, and that its present first-class design and high efficiency are not the result of guess work or imitation, but rather brought about through more than ten years of gradual development and improvement, step by step.

"The Midget" is one of the smallest dynamos on the market, but unlike many others, it has almost every detail of large commercial machines and is, therefore, suitable for teaching and experimental purposes; in fact, the machine with hand power, is to be found in many of the schools and colleges in the world. Every facility has been provided by the manufacturers for the production of these machines at the smallest possibie cost, consequently they are able to offer a better quality of goods at lower prices than would be possible without their facilities.

Weight of the Midget without hand power, 4 pounds; weight with hand power, 12 pounds; height of hand power, 11 in.; length of outfit with hand power, 20 in. Pulley $\frac{7}{8}$ in. diameter for 3-16 in. round belt.

The Midget has a short magnetic circuit with wrought iron magnet core and pole pieces accurately bored so that the armature clearance is only 1-32 in. Brass bearings are held in place by a single screw in each, and shoulders are provided for end chase. Brush holders are strong and easily adjusted, field coil is shunt wound in even layers throughout; it has heavy fibre bands. The armature is a perfect model in every way, has a lathe turned shaft, laminated core with perforations for the winding and waterproof insulation. The commutator is of copper, of good size and is well insulated.

The makers rate the Midget as having an output of 10 watts, that is, the load the machine will carry continuously, but it is able to deliver, for short periods, as much as 40 or even 60 watts. Every machine is also tested to operate as a motor, and made to run without load on a total expenditure of $\frac{1}{4}$ of a watt of electrical energy.

With each machine is sent a little booklet of instructions for the care of machine, and for conducting 35 of the most important electrical experiments, including experiments in magnetism, gold, silver, nickel and copper plating, exploding powder, electric, lighting, etc.

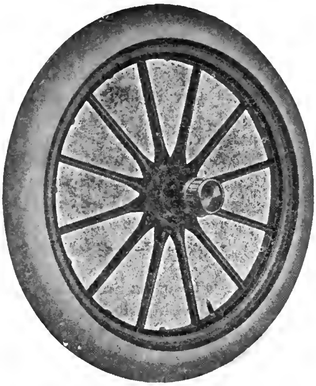
The machine can be furnished with or without power, and is often supplied for special purposes to order. The Elbridge Company will be glad to correspond with all interested parties. No charge is made for experimental work necessary to perfectly adapt the Midget to special requirements.

The new catalogue recently issued by Carlisle & Finch, 228 E. Clifton Ave., Cincinnati, Ohio, decribes a number of new things which are of interest to readers of this magazine. A gasoline engine of 1-6 h. p. 2-cycle type, is of simple construction and just the thing for running small dynamos for charging storage batteries, or model lighting plants. It is of solid construction for the size and will undoubtedly give excellent service.

A 500-watt dynamo, or $\frac{3}{4}$ h. h. motor of excellent dedesign, a 150-watt alternating dynamo, a 150-watt multipolar dynamos, igniting dynamo of several types, water-motor and several new model railway outfits are other equally interesting things, making the catalogue one which every amateur interested in mechanics should possess.

Upon the advent of the automobile no wheel was found adapted to it. The wire wheel was tried and it did not look right; then the wood wheel was tried and it did not work right. The one is not adapted to a carriage; the other is not intended for an engine. A wheel that would meet both of these requirements was needed; one that would look like a wood wheel and work like a steel one. The wheel of an automobile has to do something more than carry weight; it must transmit the power of the motor.

In a horse drawn vehicle it is evident that there is no twist or torque on the hub of the wheel, for the power is applied through an axle that does not turn; the wheel is revolved by the friction of the road, and the only resistance to this motion is the frictional reresistance of the bearing, which in the case of a good one is very slight.



The wheel of an automobile must transmit the whole power of the motor which is applied to it (usually) at the hub. This work it must do in addition to carrying the weight of the car and taking the sidewise thrusting strains whenever a car departs from a straight line. It must do all that an ordinary carriage wheel does, as well as all that the motor may call upon it to do, and no wheel is more illy adapted to take this torque or hub strain than one with a metal hub and a wooden spoke, nor is there any better abapted to such service than one that is made all in one piece.

A wood wheel depends upon the rim to hold it together. If the wood shrinks the rim must be shortened in order to bind the parts together; this can be done in the case of a carriage wheel but it is impossible in an automobile, because the size of the rim is fixed, and any alteration in it will destroy its usefulness as a seat for the tire.

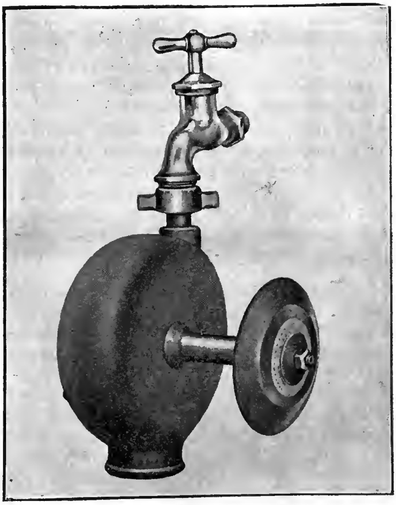
This has made the wooden automobile wheel unreliable and short lived when the climatic conditions are unfavorable, for it is impossible to season wood so that it will not be affected by the varying conditions of climate.

The Midgley Pressed Steel wheel, as illustrated above, and manufactured by The Midgley Manufacturing Co. of Columbus, Ohio, is made wholly of sheet steel: nothing else enters its construction, and it will be found to fully meet the requirements of the most exacting service.

We herein illustrate a new and very useful article offered by the Smith & Hemenway Company of 296 Broadway, publishers of the "Green Book" of hardware specialties.

It is a water motor which actually develops ⅛ brake horse power on 80 pounds pressure from a city main, using a No. 50 nozzle, or about ⅛ in. stream; 80 pounds being the ordinary pressure from a city main. Motors are furnished this way unless specially ordered.

The little motor develops a speed on pressure mentioned above of 4500 r. p. m. with an ordinary 5 in. emery wheel or a 9 in. buffiing wheel for polishing. The emery wheel is suitable for grinding knives, scissors, razors, axes, hatchets, hammers, or in fact, any edged tool. The buffing wheel is suitable for polishing, cleaning and buffing any metal surface.



This will be found a valuable addition to any boarding house, restaurant, dentist, butcher or private house where any grinding is to be done. It also has sufficient power for running sewing machines, small lathes, scroll saws, dynamos, etc.

The illustration above shows the motor attached to an ordinary screw sink faucet in a private residence and can be adjusted to either the right or the left hand side.

The total weight complete, put up in a box, with polishing wheel or buffing wheel, emery wheel, stick polish, is 6½ pounds. Printed matter and prices will be sent upon application.

AMATEUR WORK

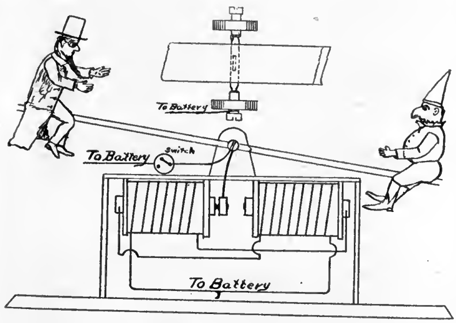
A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

Vol. IV. No. 7. BOSTON, MAY, 1905. One Dollar a Year.

ELECTRICAL WINDOW DISPLAY.

OSCAR N. DAME.

A novel electrical display, something out of the ordinary, will attract more attention than any other device. The following illustration shows an attraction which is easily made and well worth the short time required for its construction. The principle of this device is the see-saw, in which a suspended pendulum of iron acts as an armature and an electrical conductor as well. The horizontal beam must be considerably longer than the pendulum, even longer in proportion than shown in the illustration, so that a good tilting movement may be secured with a minimum of pendulum swing, for it will be seen that the play of the armature between the magnet poles is less than one quarter of an inch.



The beam is constructed of a strip of wood ⅛ in. thick and ⅜ in. wide and is evenly balanced on the support as shown in Fig. 1, by means of a small pin-brad, soldered to it. If obtainable, the staff of the balance wheel of an old alarm clock and the two bearings for same make just the thing for this part, as it permits of close adjustment. The pendulum, made from a piece of watch spring, is also soldered to the staff or brad, and bears at its lower end a disc or washer of iron of sufficient weight to counterbalance the tilt-bar. This disc acts as the armature to the magnets.

It will be seen by the illustration that each side of the armature has a contact point of silver or platinum wire, and the attracting pole of each magnet is also tipped with a contact point of the same material.

The wiring diagram of this device must be closely studied to avoid mistakes. Each electro-magnet consists of a ½ in. core of iron 2 in. long, wound with 16 layers of No. 20 s. c. magnet wire. The ends of the cores project out from the winding ¼ in. The battery used is two cells of dry for occasional use, or three cells of gravity for window display. It will be seen by the diagram that one side of the battery is connected to the pendulum support. Then one end of one magnet winding is connected to the iron core of the other magnet. This occurs on both magnets. The other free ends of the magnet windings are connected together and to the other side of the battery.

All of this apparatus and wiring is intended to be covered from view by a box of wood, such as a cigar box, so that only the tilt bar and its support and the upper part of the pendulum are visible to the observer. One puppet should be a clown and the second a Rube. One puppet should also be a trifle heavier than the other, so that the tilt will not balance horizontally, in which case it would not make contact below on the armature. A switch should be placed in the battery circuit.

When the battery is thrown on, the circuit is completed through the pendulum, one core to the opposite magnet winding, back to the battery again. This puts the pendulum armature against the opposite magnet by magnetic attraction, and in contact electrically with the core of that magnet, thereby completing another circuit through core to the winding of the opposite magnet and back to the battery again.

In building this device, remember to reduce the pendulum length as much as posiible. Make the puppets of light wood or paper. Make the tilt arm long in proportion to the length of pendulum, and have the play of the armature between the magnet poles only sufficient to give a correct tilt to the tilt arm or bar. Paint everything in bright colors. A change of puppets will give additional interest.

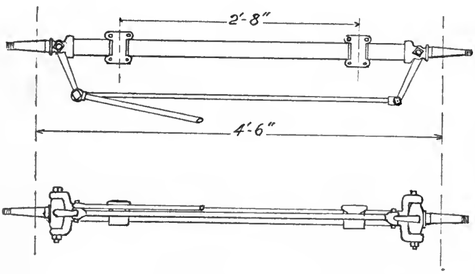
THE AMATEUR RUNABOUT.

FREDERICK A. DRAPER.

III. The Front Axle.

We have now reached a part of the work where the reader must rely upon his own diligence to a certain extent, provided he desires to keep the cost down to the lowest point. By this is meant that the exercise of a little "shopping" may be productive of important results in the way of securing finished parts all ready to be assembled at little or no greater cost than the wrought forgings would cost.

If the reader lives in the vicinity of any automobile manufactury or repair shop, a visit should be made to such places to learn what may be obtained there in finished state, and the writer's own experience is that such investigations will save much work. The body, springs, axles, hubs, spokes and other parts, were obtained in this way at a most satisfactory price to the buyer. Of course one has to take the parts as they are and adapt the vehicle he is making to the dimensions of such parts, but a little study will usually bring this out all right.



Those who have to make up the front axle will require two knuckles to fit hubs, as described in the last chapter, yokes for same, a piece of iron pipe about 1½ in. (iron pipe size), and two spring seats. The size of piping will depend upon the yokes, or a solid axle may be used, in which case a piece of square bar steel is welded to the yokes.

About the only dimensions that can be given, therefore, are those for the tread, 4 ft. 6 in. from center to center of the wheels. This is a trifle less than standard, but is suitable for a light car. The spring seats are also to be located to suit the body, and those with bolts for fastening are recommended, as the location can be changed if found necessary, which cannot be done if brazed on.

The ends of the knuckles are joined with a rod, ½ in. round steel being large enough. Yokes for the ends of these rods are to be had of dealers for a small sum, and can be easily forged to the rods. One knuckle, also, is connected to the end of the rod leading to the steering gear. A plain rack and pinion gear is ample for a car of this size and will be described later. It is mentioned here, as readers may feel inclined to get the more complicated and expensive kind, which is unnecessary.

As the rear axle will be taken up in the following chapter, readers should look up equalizing gears, as the shaft and gear casing will depend on the style of gear used. The general design of rear axle of the "Franklin" car is recommended as being simple of construction, strong and not likely to get out of order.

J. L. Haycock, Canadian inspector of binder twine, gives the following simple rule for determining the length of twine in a ball: "Take a sample ball, press the strands close together, and note the number required lying side by side to make an inch. Every strand within the inch will represent 50 feet in the pound. If ten strands lying side by side makes 1 in., then a pound will contain 500 feet; if eleven strands, 550 feet; if twelve strands, 600 feet, and so on. Having this rule in mind, anyone can test his twine for length, and need not be duped by short measure."

The Dominion Iron and Steel Company has, it is understood, decided to adopt at its works at Sydney, Nova Scotia, a new and inexpensive process for the manufacture of pig iron, utilizing waste iron ore, which costs from 60 to 75 cents a ton. Iron ore in this condition can be used only when it is solidified. For a great many years chemists endeavored to solve this problem, but it was only a few years ago that W. Owen, consulting engineer and foreign representative of Bruck, Kretschel & Co., steel manufacturers, of Osnabruck, Germany, made the discovery. Since then the process has been adopted by seven German and two or three English steel companies, with eminent satisfaction. The waste is solidified, usually in bricks, and in this condition is placed in blast furnaces, when pig is produced. The plant which the Sydney Steel Company proposes to install will cost about $8000, and will have a daily output of about 75 tons. It will be the first of the kind erected on the continent, and the company will have exclusive use for the Dominion of Canada.

A RACING SAILBOAT.

C. C. BROOKS.

Concluded from the April Number.

PLANKING.

As both sides are alike, patterns are given for one side only, and as some of the planks are over 16 ft. long, the patterns of these are given in two pieces, as they will have to be put on in two pieces unless you have some 18 ft. lumber. Commence with the No. 1, or middle plank, and get it out from shape of pattern. It is best not to cut the center-board slot in this plank until after it has been fastened in place. Try the plank to place, clamping it down at the ends. You will now see that the lower edge of the end pieces must be beveled off to allow the ends of the plank to come into place. This beveling you will do by trimming off the edge of the end piece until the plank lays fair upon it.

Although the pattern shows the shape of the ends of the plank, it is advisable not to cut the ends of the the planking to shape of patterns, but to leave all the plank a little long so that they will extend beyond the ends of the boat a few inches; then after it has all been fastened to place, it may be cut off flush with the ends of the boat. Put on in this way, it is less apt to split at the ends when nailing.

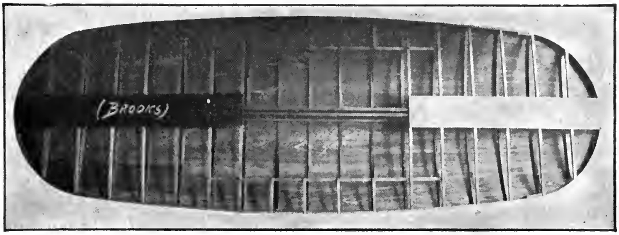


FIG. 7.

You must, however, be careful to have the edges of the plank fit tightly together. The seams should be tight on the inside and a little open, say 1-16 in. on the outside, for calking. When putting on each plank, bevel the edge with a plane until it fits. Fasten the plank to the back-bone with 12-in. wire nails. Around the centerboard slot, nail close—say one nail every inch. Slightly stagger or zig-zag these nails to prevent their splitting. Fasten all planks to the ribs with 1 7/8 in. clout nails, three or four to each plank, at each rib. The ends of the plank are fastened to the end pieces with 2 in. wire nails. The outside edge of the outside plank is fastened to the side with 2-in. wire nails.

The bottom edge of the side pieces must be beveled, so that the planks lay flat on them. The outside plank is closely nailed to the side the same as with the plank around center-board slot. When driving all nails, hold a clinch-iron (flat-iron will do) on the inside. After all plank are on, set in all nails about 1/8 in., with a nail set, holding on clinch-iron when setting nails. The joint or butt of those plank that have to be put on in two pieces may come on a rib or half way between two ribs, in which latter case butt blocks of 7/8 in. oak may be put on the inside, with the ends of the planks nailed to them. (Note instructions for canvas covered planking.)

Nail two or three stays or braces across the top of the boat, from side to side, to prevent its spreading; then turn the boat over, right side up, and put in the deck beams. These are the same size as the ribs and are put in and fastened in the same manner. The deck-beams, however, will not require steaming as they will bend easily to place when cold. You will note in Fig. 7 that those beams that come alongside the cock-pit do not extend clear across, but end on a fore and aft piece. This piece is the same size as the deck-beams. After putting in the long deck beams, put in the two fore and aft pieces that support the short deck beams. These pieces are put under the deck beams and fastened to two of the long beams at each end. They are fastened with one 1½ in. No. 12 screw at each beam. The inner ends of the short neck beams are fastened to the top of these pieces with one 1½ in. screw in each.

The deck frame when in will show an opening for cockpit 5 ft. long and 4 ft. wide. Lay the decking on the deck frame in the same manner as the planking.

As the neck is made simply of straight pieces, no patterns are necessary. After the deck is on, trim it off to shape of outer edge of boat and the cockpit. The deck may be either calked or covered with canvas. We recommend the latter method. If deck is calked, the nails should be set the same as was planking. If deck is canvas covered it should first be planed and sandpapered smooth and all cracks filled with putty.

To canvas the deck will require 5 yds. of 6-oz. duck. The canvas or duck may be sewed or tacked together in the seams. The seams of the canvas may be run crosswise of boat. First, give he deck a coat of paste and lay the canvas on while t is wet, working out all the wrinkles. Fold the canvas over the edge and tack it. If the canvas has not been sewn together it must be lapped about ½ in. at the seams and tacked closely.

COAMING.

The coaming is simply four straight pieces that go around and finish the edge of the cockpit. Get the coaming out of the waste lumber left from planking. It will take two pieces 5 ft. and two pieces 4 ft. long. Have it about 5 or 6 in. wide, so that it will extend at least 4 in. above the deck. Fasten the coaming to the deck beams with 4⅝ in. clout nails or 1 in. screws could be used. A piece of ½ in. quarter-round may be bent around coaming, next to the desk to give a finish, as shown in Fig. 8.

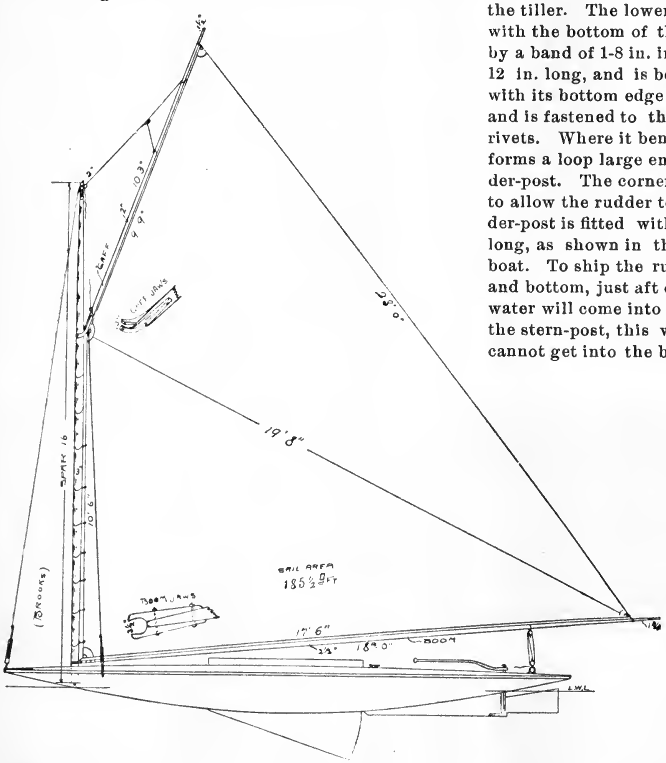


FIG. 10.

FENDER-WALE.

This is a piece of ¾ in. half-round which is bent around the outside edge of boat flush with the top of the deck. This piece covers the edge of the canvas. The parts that are bent around the end will have to be steamed or soaked in hot water. The fender-wale is fastened in place with 8-penny casing nails. Before putting on fender-wale, see instructions for putting on chain-plates, as these are best put on under the fender wale.

SKEG.

Cut out the skeg from the pattern and fasten it in place on the outside of the planking, forward of the stern-post, B, putting three or four 4 in. wire spikes through the stern-post into the skeg, ahd three or four through the skeg and planking into the butt block.

RUDDER.

Make the rudder of iron 1-8 in. thick and rivet it to a 1 in. round iron rudder-post. The rudder-post extends up through the deck its upper end about 3 in. above the deck. This end is forged square to receive the tiller. The lower end of the rudder-post ends flush with the bottom of the skeg, where it is held in place by a band of 1-8 in. iron 1 in. wide. This band is about 12 in. long, and is bent around the end of the skeg, with its bottom edge flush with the bottom of the skeg and is fastened to the sides of the skeg with bolts or rivets. Where it bends around the end of the skeg it forms a loop large enough to take the end of the rudder-post. The corner of the rudder-plate is cut away to allow the rudder to be shipped. The top of the rudder-post is fitted with an iron tiller about three feet long, as shown in the illustration of the completed boat. To ship the rudder, a hole is bored in the deck and bottom, just aft of the stern-post. Although the water will come into the space in the backbone aft of the stern-post, this will do no harm whatever, as it cannot get into the boat.

CALKING.

Use a small calking iron and mallet. To calk the lark will require a 1 pound roll of calking cotton. When calking, start at the end of a seam and calk in the end of the thread. Let the thread hang down from the seam, then gather up an inch or so of the thread and drive it in, slightly advancing along the seam; this will show a fullness or loop of cotton that has not been driven in. This is so you can regulate the amount of cotton to the condition and opening of the seam by making the fullness of the loop as close as desired. After calking a few feet, go back

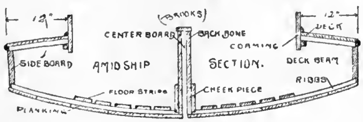


FIG. 8.

over it again and drive it home Do not use too heavy a mallet or drive the cotton too hard; it is only necessary that it is firmly in place. As the plank are light, care will have to be taken not to get in too much cotton because after the boat is in the water, both the cotton and plank will swell. A little judgment will tell you how big a thread of cotton to use, and a little practice will show you. Fill the seams about two-thirds full of cotton.

When calking a seam that is tight on the outside, first, drive the iron along the seam to slightly open it before trying to calk in the cotton. First calk the butts between the ends of such streaks of planking as have been put on in two pieces, then calk the seams between the plank, calking the tightest seams first and leaving those that show the most opening to be calked last. The seam between the sides, ends and bottom is not calked. After boat is calked, smooth it down with sand paper and give outside a priming of white lead and oil, working it well into seams with a narrow seam brush. When dry, putty seams, butts and nail heads, and then give outside two more coats of paint. A good white paint is made by using equal parts of boiled oil and turpentine mixed with equal parts of white lead and zinc. The bottom of the boat may then be given a coat of copper paint, which will act as a preservative in hot water and also prevent the fouling of the hull by moss in fresh water. The coaming, fender-wales and deck, if not canvassed, should be finished in natural wood. First scrape smooth and sandpaper, putty all brad heads, then give three coats of spar varnish. When painting or varnishing let each coat dry well before putting on the next.

The bottom of the cock-pit may be fitted with a tight floor of half-inch stuff or with open slats as shown in Fig. 8.

CENTER-BOARD BOX CAP.

In the instructions for making the center-board, we told you to connect its after top edge with a chain. For this boat a chain is better than a rod for the reason that when the board is only half way down, the rod will be in the way of the boom swinging.

For the chain use a dog chain or any small chain that will allow of the spike being put through the links to hold the board in place.

Fit a cap on the top of the center-board box, letting it extend from the forward end back to within a couple of inches of the after end. (See Fig. 8.)

The dimensions of the spar, boom, gaff, sail, etc., are given in Fig. 10. To make the spar, take a square piece and dress down the corners until it is eight squared, that is, has eight instead of four equal surfaces. Then repeat the operation so as to give sixteen sides to the piece after which it may be easily planed and sandpapered perfectly round. Leave the spar the full size to within three feet of its top, the top three feet being tapered to half size. Make the boom and gaff in the same way. The jaws of the boom and gaff are made of oak and shaped as shown in Fig. 10. Bolt in place with ¼ in. carriage bolts. Bore one ⅜ in. hole near the after end of the boom and gaff, and two holes hrough the jaws of each, close to the end of boom and gaff. These holes are to take the lacings that hold the sail at the corners.

Fasten the upper or peak halyard block to the spar with a ¼ in. eye-bolt, locating this bolt six inches below the top of the spar. Fasten the lower or throat halyard block in the same way, one foot below the peak halyard block. Bore the holes for these eye-bolts so that the blocks will come on the after side of the spar. For mast stays, cut three pieces (legs) of ¼ in. wire rope rigging 15 ft. long, and splice an eye in one end of each just large enough to go over the top of the spar. These eyes will slip down and rest on the eye-bolt that hold the peak halyard block.

CHAIN PLATES.

The chain-plates are made from ¼ in. band iron 1 in. wide, are fastened to the sides and end and hold the turn buckles as shown in Fig. 11. The chain plates should be 3 in. long with an eye at top to take bolt of turnbuckle. Drill and countersink four holes in each and fasten them in place with 1 1-8 in. No. 12 screws. The forward chain-plate is located at the center of the bow and the side chain plates are located at a point eight inches aft of the center of the spar.

Now, cut the hole in the deck for the spar. This hole is directly over the mast step so that the spar will stand plumb. A collar of oak may be put around the hole and screwed to the deck to reinforce it.

Set the spar in place and pass the three lower ends of the wire rigging through the top of the turnbuckles and seize the ends back to the standing part. By seizing is meant to wind a piece of string or marline about both parts.

Set up the turnbuckles so as to take out the slack, and bring the rigging down to place, after which it may be loosened and the lower ends spliced to place.

SAIL.

When possible, it is always best to have the sail made by an experienced sail maker. However, some amateurs have turned out very creditable sails. The sail is stitched on a sewing machine with coarse linen thread. The sail for the lark should be single bighted, that is, a fold is taken in the middle of each breadth so as to form a hem or seam one inch wide. This seam is stitched on both edges. A small hem is stitched around the outer edge of the sail through which is run a ¼ in. piece of cotton rope. This rope ends with a knot at the after end of the boom so that the slack in it may, from time to time, be taken up. If sail is roped on the outside no hem is used, the rope being sewed directly to the edge of sail with palm and needle. When roped in this way use ½ in. bolt rope, and starting one foot from the bottom on the after edge, work round to a point one foot from the top of the after edge. This will leave the most of the leach or after edge without bolt rope. This edge is simply hemmed between the ends of the bolt rope. One set of reef points is worked in 3½ ft. above the bottom edge. These points are pieces of ¼ in. cotton rope. One reef point is put in each seam, excepting the outer edges.

For the reef points, work a hole (same as button hole) and, cutting off the cotton in four foot lengths, seize the ends with twine and sew the middle in the hole worked in seams. The sail is reinforced at the four corners with a patch, as shown in Fig 10.

Work holes in each corner of the sail, also along the lower edge, every six inches, to lace it to the gaff holes along the forward edge (throat) every eighteen inches, to tie it to the mast hoops.

TO BEND ON THE SAIL.

Fasten the four corners of the sail to the boom and gaff, by splicing one end of a piece of the cotton rope into the corner holes of the sail and then lacing it with a couple of turns through the holes on boom and gaff. The corners at the forward end, or throat, are laced down tight to the jaws of the boom and gaff. Do not stretch the sail, as the slack had best be taken up after the sail has been used. Lace the sail to the boom and gaff by simply running a piece of the cotton line around and around these pieces, the lacing being put through one of the holes in the sail, at each turn.

RUNNING GEAR.

Staple a single block on each side of the spar, as shown in Fig. 11. Fasten a single block with a short bridle of manila line to the gaff for the peak halyard. Fasten a single block directly to the jaws of the gaff with a short piece of marline. Hook a single block with becket to each of the eye-bolts in the spar. Splice the end of the peak halyard into the becket of the upper block on the spar and then reeve it through the block that is bridled to the gaff, then reeve back through the upper block on spar and on down through the block on deck, from which it leads aft through a hole in the forward side of coaming to a cleat that is fastened to the after end of the center-board box. Splice the end of the throat halyard into the becket of the lower block on the spar, then reeve it through the block at the jaws of the gaff back through the block to which it is spliced, and down to the deck block on opposite side from peak halyard, thence back through hole in coaming to a cleat on after end of the center-board box.

SHEET.

The in-board block of the sheet is fastened to a ring on a traveler which is fastened to the deck, half way between the rudderpost and the stern, as shown in Fig. 10. The traveler is 18 in. long and is made of ⅜ in. iron and may be fitted with plates to screw to the deck or bolt through the deck, as shown in Fig. 12. Hook a block with becket to traveler ring and seize a block to the boom at a point that will be just over the traveler when the boom is amidships. Splice the end of the sheet into a becket of the block on the traveler from which it will lead forward to a cleat on deck just aft of the coaming. The ends of all lines should be whipped to prevent their unlaying. To whip a loose end, wind it with twine, sewing the twine through and around the windings with a coarse needle. When sailing, you will need a short stick to push the center-board down. No seats are used in a Lark. Instead, a cushion is used on the floor of the cockpit. All the blocks should be moused to prevent their unhooking. Mousing means to tie a turn of marline from the top to the shank of the hook.

CANVAS COVERED PLANKING.

Built in this way, no calking is necessary and, instead of using ⅝ in. planking, ¼ or ⅜ in. is used. We advise the ¼ in. It will take the same number of surface feet and the plank is put on in the same way, excepting that 1⅛ in. clout nails would be used for a ¼ in. plank and 1¼ in. clout nails for a ⅜ in. plank. To cover the plank with canvas will require 8 yds. of 14½ oz. duck 30 inches wide, and 6 pounds of marine glue. After being planked the bottom is sand papered smooth, the nails heads being only set flush. Fill any crevices with putty and then apply the glue. The marine glue, when cold, is hard, having about the consistency of molasses candy. To apply it, it must be heated and put on hot, and even then it will be found too stiff to spread nicely and will simply have to be daubed on as evenly as possible. An ordinary whisk broom, cut off short so as to be stiff, makes a good brush with which to apply it. After the glue is on it will immediately harden. Then spread over the canvas, putting this on one breadth at a time and having it run crosswise at right angles to back-bone. Secure each breadth in place with a few tacks and, commencing in the middle of the breadth, iron it out with a hot flat iron, keeping the iron just hot enough not to burn the canvas. This will cause the glue to melt and join firmly to the canvas. Let the edges of each breadth lap the adjoining one for ½ in. and let the canvas come over the edge of the boat and lap 1 in. on to the sides and ends. This edge is closely tacked with 2 oz. tacks, as is also the edge around the center-board slot. A double row of tacks is put in the lap at each seam.

The Canadian "Gazette" says the Postmaster-General has had under consideration the liability of articles of celluloid to explode or catch fire under certain conditions, cases having occurred that strongly pointed to mails being injured from this cause. It has been decided that such articles may in future be mailed only if packed in tin boxes with closely fitting lids. Notice is therefore given that celluloid is regarded by the postal authorities as an explosive, and the mailing of such articles, except as prescribed, is prohibited and renders the sender liable to prosecution under section P of the post-office act relating to the sending of explosives, matches, etc., in the mails.

The hand that sets out a shade tree confers a blessing upon present and future generations, and immediate reward will be had from increased value to property. The coming spring will be the right time to begin.

INTERFERENCE IN WIRELESS TELEGRAPHY.

JOHN STONE STONE.

Of the various problems which have been presented in the course of the development of the new art of wireless telegraphy, none is of greater interest to the engineer, and none is of more far-reaching importance from the industrial and commercial standpoint than that of rendering the receiving instruments of wireless telegraph stations immune from interference.

There are two principal kinds of interference.

I. Interference which arises from electrical charges which accumulate upon the vertical oscillator under various conditions of weather, provided the vertical oscillator has no adequate electrical connection to the earth.

2. Interference which arises from such stray electromagnetic waves as are produced by lighting, by magnetic storms, by sparks in neighboring circuits, such for instance at occur in trolley circuits, and also from wireless telegraph stations other than that with which communication is desired.

INTERFERENCE DUE TO STATIC CHARGES.

The interference which results from the first of those two sources is readily overcome since the oscillator of a wireless receiving station may always be given a metallic connection to the earth sufficient to maintain it clear of statistical charges without in any appreciable degree interfering with its operation as a receiving oscillator.

Thus, for instance, if the vertical oscillator includes a condenser insulating a portion of the vertical oscillator from the earth, the condenser may be shunted by a coil of inductance so large that for the high frequencies employed in wireless telegraphy it shall operate practically as an open circuit, while affording a ready path to earth for the electrical charges which would accumulate upon the vertical oscillator and produce disruptive discharges to earth.

Again, if a highly sensitive detector or receiving device be included directly in the vertical receiving oscillator, such an inductance coil may be placed in shunt to the receiver without appreciably affecting its apparent sensitiveness. The coil will then serve as a by-path for the currents due to the passage of the charges of the vertical oscillator to the earth.

Another device which may serve to still further protect the receiver under these conditions is that illustrated in Fig. 1, in which V and V are portions of the vertical oscillator system, L is a coil of large inductance, R is the receiving device, and C is a condenser of capacity so large as not to impede appreciably the passage of the high-frequency oscillations of wireless telegraphy while acting practically as an open circuit for the more slowly varying currents by which the vertical oscillator is maintained free of static charges.

The greatest security from this form of interference is, however, obtained by providing the vertical receiving oscillator with an adequate conductive connection to earth and by placing the receiving device in a local circuit made resonant by a coil and a condenser to the frequency of the electrical oscillations to which the receiver is intended to respond.

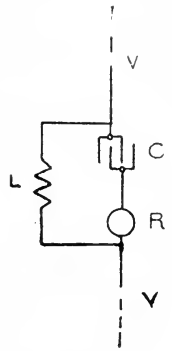


FIG. 1.

An example of such an arrangement is shown in Fig. 2, in which VI_2 is the vertical receiving oscillator I_1 I_2 are the two coils of a high-frequency transformer, R is the receiver, C_2 is a condenser and L_2 is an inductance coil.

The manner in which the local circuit containing the receiver is made resonant to the frequency of the oscillations which it is intended to respond will be considered later in this paper. It is sufficiently high that the local circuit being resonant for the purposes of wireless telegraphy will not be appreciably affected by the more slowly varying currents in the vertical oscillator by which the latter is maintained free from static charges.

INTERFERENCE DUE TO ELECTROMAGNETIC WAVES.

Coming now to the prevention of interference by electromagnetic waves such as emanate from other wireless stations than that with which it is desired to hold communication, and to the prevention of interference by stray electromagnet waves, we find the solution of the problem depends upon the character of the message-bearing waves, the energy of which it is desired to convey to the receiving device, and also upon the character of the disturbing waves, the energy of which it is desired to exclude or divert from the receiving device.

We can control the character of the waves whose energy we wish to receive, by suitably designing the apparatus to be used at the transmitting station, but we have no control over the character of the disturbing waves, except in so far as these arise from wireless stations within operative range of the receiving station.

The simplest solution of this problem is to cause each transmitter to send out its signals by means of persistent trains of simple harmonic waves of a frequency materially different from that employed by any other transmitter within operative range of the receiving station with which communication is to be maintained and to make each receiver responsive only to persistent trains of simple harmonic waves of the frequency employed by the transmitter with which it is in communication.

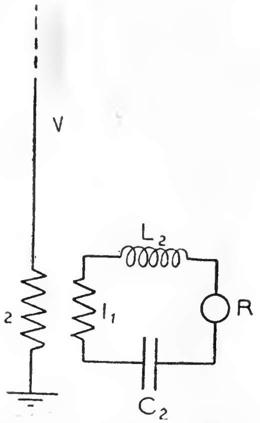


FIG. 2.

By this means the system is rendered selective and becomes a multiple system of telegraphy, permitting he operator at each station to select the station with which he wishes to hold communication to the exclusion of all other stations, and by which a number of messages may be transmitted simultaneously in a given region without interfering with one another.

Since the stray electromagnetic waves arising from lightning, etc., are not persistent trains of simple harmonic waves, but partake more of the character of isolated impulses, the receiver in such a system does not respond to such stray electromagnetic waves and it is therefore freed from interference which would otherwise arise from such sources.

The manner in which a transmitting station is made to develop persistent trains of simple harmonic electromagnetic waves of one frequency to the exclusion of other frequencies, though simple in itself, in practice requires the strictest attention to certain details, and these may be best understood by the consideration of a concrete case, this being the manner in which such problems are usually presented to the engineer if not to the inventor.

TRANSMITTER.

In modern wireless telegraphy the messages are transmitted by electromagnetic waves which are horizontally polarized at the earth's surface, and which are developed by electrical oscillations whose axis is normal to the surface of the earth and which is connected to the earth at its lowest extremity.

The reason for employing waves of this type and so developed, is that such waves have, at the earth's surface, no component of electric force parallel to the surface and no component of the magnetic force normal to or cutting that surface, except in the immediate neighborhood of the base of the transmitting oscillator. As a result they do not tend to induce currents in the surface of the earth as they travel away from the transmitter except where the surface of the earth deviates from the plane of polarization of the waves at that surface. The energy which would otherwise be rapidly dissipated through the production of induced currents in the earth is therefore conserved in the waves. Moreover, when a deviation occurs between the plane of the earth's surface and the plane of polarization of the waves at the earth's surface, the currents induced in the surface of the earth are such as to bend the wave front into a position normal to the surface with the result that the waves travel over and around mountains and in fact follow the earth's surface whatever be its contour, instead of tending to travel in straight lines

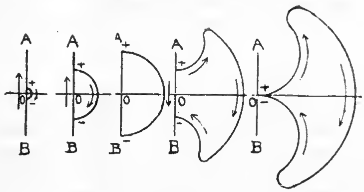


FIG. 3.

like ordinary light waves and as would be the case with vertically polarized electromagnetic waves.

There is not space in this paper to discuss in detail the development of the waves described above, but their genesis and mode of propagation are clearly suggested by Figs. 3 to 8. Fig. 3 and Fig. 4 illustrate the development of a wave by free electrical oscillations in a straight wire AoB, the curve lines indicating a line of electric force in its various phases from $t=0$ to $t=\frac{5}{8}T$, where T is the time of a complete free electrical oscillation in the wire. In Figs. 5 and 6 the genesis of a wave from a vertical linear oscillator, AO, earthed at its lower extremity, is illustrated, and in Figs. 7 and 8 the effect of an elevation and depression in the surface of the earth upon the wave fronts at that surface is indicated.

We may next consider the earth connection of the transmitting oscillator and the nature of the supports for the oscillator.

Although, by the use of such waves as are described above, normally the current density in the surface of the earth at a distance from the transmitting oscillator is rendered excessively small, nevertheless at and in the immediate neighborhood of the base of the vertical oscillator, the current density is in general very great. Moreover, since the current is of high frequency, it tends to flow only on the surface of the earth. For this reason the usual specifications for obtaining a good earth connection which involve burying a conductor of large area so deep in the ground that it shall be in permanently moist earth are no longer advantageous, and in a properly constructed wireless telegraph station the conductivity of the surface of the earth in the immediate neighborhood of the base of oscillator is artificially increased by a superficial ground-plate composed of sheet metal, or of wire netting, extending radially from the base of the oscillator aud covering as large an area about the base of the ossillator as is available for the purpose and consistent with reasonable economy.

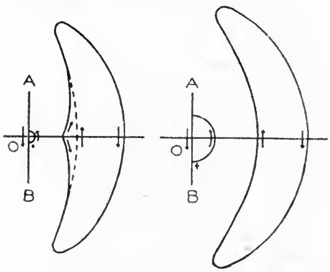


Fig. 4.

Since the waves are horizonally polarized, the supports for the vertical oscillator, such as masts or guy ropes, should either be of insulating material or, if of metal, they should be divided by insulation into sections short compared to one-half the wave length of any of the waves to be employed. The reason for this is that the fundamental free period of vibration of a linear conductor is such as to respond most energetically to waves of twice its own length. For such wavelengths, therefore, the linear conductor would absorb an undue amount of the energy of the waves and moreover because of the rise of potential which occurs at the ends of the conductor for waves of such length it would be difficult to insulate the conductor from the earth or adjacent portions of the support of the vertical oscillator.

We come now to the vertical oscillator itself. This in general consists of two parts, the elevated conductor *per re* and the devices through which it is connected with the earth.

We shall here consider the relative simple case in which the elevated conductor is a straight, cylindrical copper wire of length a aud radius p.

Both theory and practice show that the electrical vibrations in such a wire connected directly to the earth at its lower extremity correspond very closely to the transverse vibrations of a heavily damped stretched string.

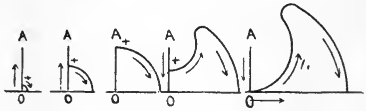


Fig. 5.

If such a wire be charged to a high potential and be then permitted to discharge to earth, the electrical oscillations developed in it, and therefore also the electromagnetic waves radiated by it, will not be simple harmonic type and will not be persistent. These waves will not, therefore, correspond to the sound waves given out by a tuning-fork, but will be of the character of those given out by a heavily damped violin string plucked at its center.

The fundamental of the waves given out by such an oscillator has a wave-length which very closely approximates four times the length of the wire, and this is accompanied by all the odd harmonics. The oscillations are so much damped by the energy drawn off by the energy drawn off from the oscillator by radiation as to make the resulting waves more nearly an equivalent of an impulse than of a sustained or persistent train of waves.

If, however, the elevated conductor be not directly connected to the earth, but be connected to it through an inductance coil, both theory and practice show that its electrical vibrations correspond to the transverse vibrations of a heavily damped stretched string with a mass attached to its center.

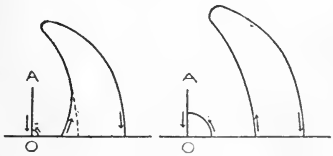


Fig. 6.

The effect of the load at the center of the stretched string and of the inductance at the base of the vertical wire is to increase the persistency of the vibrations, to minimize the importance of the harmonics and to lower the frequency of the fundamental.

It might, therefore, seem that in order to cause the vertical oscillator in question to radiate a persistent train of simple harmonic waves of a predetermined frequency, it would be sufficient to charge the vertical wire to a high potential and permit it to discharge to earth through an inductance coil of suitable dimensions.

This, indeed, was the plan adopted in the first crude attempts to produce a selective system of wireless telegraphy. This method necessitates the use of waves of much lower frequency than that normally produced by natural vibrations of the vertical wire *per se*.

The degree of persistency of oscillations so obtained, however, is not as great as is required in practice. Such persistency as is obtained is gained at the expense of the amplitude of the current oscillator, the latter being *caetiris paribus* less for low than for high frequencies. Moreover, the spark in the vertical oscillator which normally dissipates an undue amount of the energy of the oscillations, has its resistance enhanced by the reduction of the amplitude of the current oscillations due to the presence of the inductance coil.

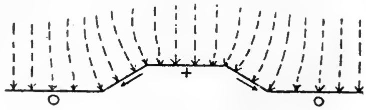


FIG. 7.

The latter difficulty may in a measure be overcome at the expense of any increase of the energy supplied to the oscillator, by shunting the spark gap by a condenser of large capacity. The discharge of the condenser across the spark gap increases the current through the spark and thereby reduces its resistance and damping effect upon the oscillations. The damping effect of the radiation still remains and the persistency is still too much limited for practical purposes.

So far we have considered only the natural oscillations of the vertical oscillator which are produced by charging the elevated conductor to a high potential and then permitting it to discharge to earth. When, however, a high degree of persistency, a pure sine wave and a great amplitude of oscillation are desired, the spark gap is removed from the vertical oscillating circuit and a simple harmonic electro-motive force is impressed upon the vertical oscillator in its place. The resulting vibrations in the vertical oscillator are then forced simple harmonic vibrations. In order that they may be of great amplitude, the frequency of the impressed force is made to correspond to the fundamental of the vertical oscillator or to one of its harmonics, in which cases the reactance of the vertical oscillator is nil.

A simple arrangement for producing forced, simple harmonic vibrations in the vertical oscillator is shown in Fig. 9 in which G is an alternating-current generator, K is a key, P shows the connection to the terminals of the primary of a spark coil, C is a condenser, L is an inductance, I and I_2 are the primary and secondary coils of a high-frequency transformer, V is the vertical wire and E is the earth.

There is a variety of ways in which substantially the same results may be accomplished, but there is not space in this article to consider more than one arrangement. * * * * * * * * * * *

Concerning the arrangement illustrated in Fig. 9, there is much of detail which requires attention in order that the apparatus shall satisfactorily fulfil the requirements of radiating a persistent train of simple harmonic waves. For instance, if a dialetric having considerablo electrostatic hysteresis be employed in the condenser, a surprisingly large amount of energy will be dissipated in this dialetric. The magnitude of this loss is due to the fact that the energy dissipated increases both the potential difference employed at the terminals of the condenser and also with the frequency. Since the potential difference employed at the terminals of the condenser amounting to 50,000 volts and oscillations having frequencies of 5,000,000 are not unusual in wireless telegraphy, it is easy to see that the losses in the dialetric of condensers employed in the usual power or lighting circuits.

Moreover, the specific inductive capacity of most dieletrics is a function of the density of the displacement current in the dieletric, and when such dieletrics are employed in the condenser in an oscillating circuit, the resulting oscillations are not simple harmonic in form and are not isochronous throughout the train.

Air condensers should therefore be used in wireless telegraphy to the exclusion of any other type pending the publication of the results of certain investigations which are being conducted with the view of supplying a dieletric of high dieletric strength and constant specific capacity.

The coils used in wireless telegraphy should not have iron cores except the iron be very finely comminuted and imbedded in a non-hygroscopio dieletric matrix. It has even been found by the author that coils wound on a wooden cylinder do not operate satisfactorily when used in the oscillating circuits of wireless telegraphy. The coils for this purpose are

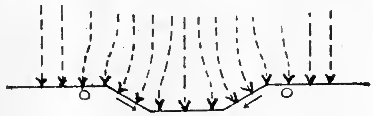


FIG. 8.

best constructed by winding a few turns of bare copper wire in a single layer on a skeleton frame made of ebonite, care being taken to separate the turns by such an amount that the sum of the air spaces between the wires of the turns is equal to or slightly greater than the sparking distance in air corresponding to the greatest potential difference liable to occur at the terminals of the coil when the apparatus is in operation.

An isolated circuit of the type shown in Fig. 9, may be made to give extremely persistent simple harmonic oscillations, but if it be given a large coefficient of muinductance with another oscillator of relatively low persistency, such as the vertical oscillator VI_2E of the arrangement shown in Fig. 9, two things happen. In the first place the two oscillations of the circuit are in general no longer simple harmonic, but are broken up into two simple harmonic oscillations of different frequencies, and in the second place the persistency is greatly reduced.

To overcome this difficulty it is necessary either to make the magnetic leakage of the high frequency transformer, connecting the local oscillating circuit with the vertical oscillator, unusually large, or else to the local oscillating circuit an inductance coil M, with sufficient inductance to swamp by its effect the reaction from the secondary circuit.

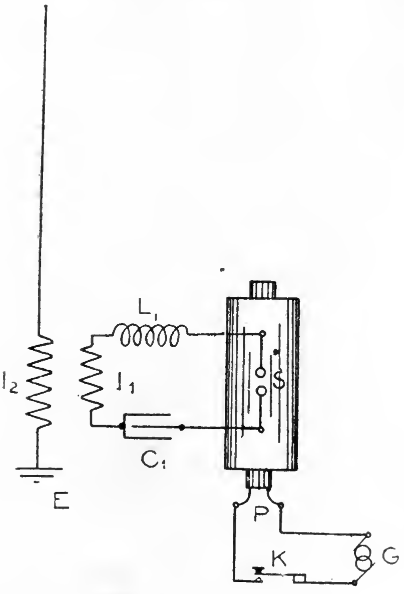


FIG. 9.

When intense radiation is desired, it is necessary to make the capacity S of the condenser C_1 in the local oscillating circuit large compared to S_1, the apparent capacity of the elevated conductor *per se.* for the frequency employed.

RECEIVER.

Since the electromagnetic waves to be received at a wireless receiving station are horizontally polarized at the earth's surface, an electrical oscillator whose axis is normal to the earth's surface is employed at the receiving station. This oscillator may either be connected to earth at its lower extremity or it may be connected to a device having reactance equal for all frequencies to the reactance of the vertical oscillator. It is to be remembered in this regard that at the receiving station we are not concerned with what becomes of the energy which is dissipated by the reradiation of the energy from the receiving vertical oscillator.

We shall consider again a simple concrete case, and shall assume the elevated conductor to be a cylindrical copper wire of length a and radius p as in the case of the transmitter, though it must by no means be assumed that the elevated conductor at the receiving station must necessarily be similar to that at the transmitting station, or, in fact, that it must bear any resemblance to that at the transmitting station except in so far as its axis is preferably normal in the surface of the earth.

As in the case of the transmitting station, only one simple arrangement of the apparatus sufficient to give the desired result will here be considered. By this ararrangement messages transmitted by means of persistent trains of simple harmonic electromagnetic waves of a predetermined frequency may be received to the exclusion of similar waves of materially different frequencies and without interference by impulsive waves. Such an arrangement of the circuits and apparatus is shown in the diagram, Fig. 11. In this arrangement the receiving device which is indicated at R is placed in a local circuit $C_3I_3L_3R_3$ which is made resonant to the frequency of the waves to which the station is intended to respond, and a second resonant circuit C_2I_1 L_2I_2 resonant to the same frequency and called a "weeding-out circuit," is interposed between the first mentioned circuit and the vertical oscillator.

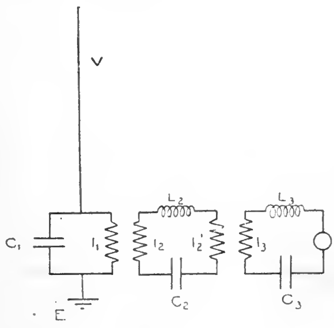


FIG. 11.

The branch circuit, consisting of the coil I_1 and the condenser C_1, is not, when taken by itself, resonant to the same frequency as the other local circuits, but so proportioned that when connected as a branch circuit, forming a part of the vertical oscillator system, the latter shall respond most energetically to persistent trains of waves of that frequency falling upon the vertical wire.

The way in which this is accomplished is perhaps more easily seen by a graphical demonstration than by the use of the analytical solution, though the latter is by no means difficult.

The curves in Fig. 12 illustrate the point in question. Curve 1 represents the reactance of the vertical wire measured at the point of its attachment to the loop circuit, for varying periodicities of the impressed force. It will be seen that the periodicity of the fundamental of the vertical wire at the point n_1'', where the reluctance first vanishes. The first even harmonic is at n_2'', and the periodicity of its first odd harmonic is at n_3'', where the reactance again vanishes. Normally, therefore, curve 3, which is the current curve for varying

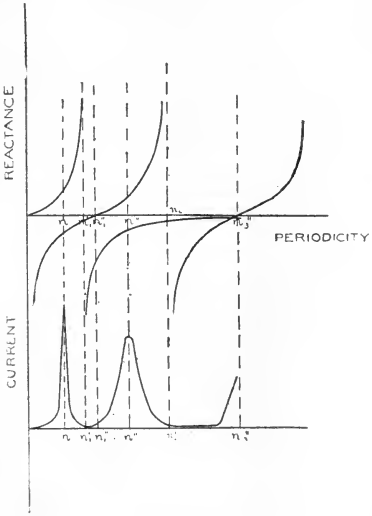


FIG. 12.

periodicities of the impressed force on the vertical wire would show maxima at n_1'' and at n_3''. The reactance of the loop circuit for varying periodicities of the impressed force, measured across the points of its attachment to the vertical wire and earth connection is shown in curve 2. The total reactance of the vertical oscillator measured at the earthed terminal is the algebraic sum of two reactances shown in curves 1 and 2, and as a result the current curve 3 shows maxima, not at n_1'' and n_3'', but at periodicities n, n'' and at a periodicity slightly higher than n_3''.

These are the points at which the reactance of the loop circuit is equal, but opposite in sign, to that of the vertical wire.

The periodicity of the local loop circuit *per see* is n_1', and for this periodicity the current in the vertical wire is practically nil.

The "weeding-out circuit" and the circuit containing the receiver are both resonant to the periodicity n, so that for persistent trains of waves of that periodicty the energy of the oscillations set up in the vertical oscillator is transmitted directly to the receiver, but persistent trains of waves of other frequencies, either produce but slight response in the vertical oscillator or else produce oscillations of the periodicity n'', or of a periodicity slightly higher than n_3''. To such periodicty the "weeding-out circuit" and the circuit containing the receiver are extremely irresponsive so that the receiving device receives but an inappreciable amount of the energy of the waves.

In the case of impulsive waves the vertical wire tends to respond only to its own natural rates of vibration as affected by the loop circuit, that is to say, it tends to oscillate at periodicity n'' and to upper harmonics. Such waves acting on the vertical wire, have little tendency to develop oscillations of the natural period of the loop circuit as affected by its connection with the vertical wire, namely n, and the receiver is, therefore, also protected from the effects of such impulsive waves.

All that has been said regarding the effects of elecstatic and magnetic hysteresis in the description of the transmitting station applies with added force to the apparatus at the receiving station. It is, in fact, much more important to exclude the effects of hysteresis from the receiving circuits than from the transmitting circuits, and it may be laid down as an important rule that under no circumstances shall solid or liquid dielectrics be used in the receiving circuits.

Moreover, the injunction in regard to making the mutual inductance small between oscillators at the transmitting station applies in the case of the resonant circuits at the receiving station, since if the mutual energies of the related resonant circuits be not small compared to their self energies, the resonant circuits will modify one another's natural periods and each circuit will respond to more than one periodicity.

So great is the selectivity of resonant circuits constructed of air condensers and properly designed coils that there is no difficulty in adjusting such circuits to resonance for a given frequency with an error of less than one part in 3000.

The importance of the "weeding-out circuit" at the receiving station becomes apparent when we observe that the selectivity of the vertical oscillator is greatly diminished by the dissipation of energy, which results from the reradiation of energy by that oscillator and that the selectivity of the resonant circuit containing the receiver may be greatly diminished by the energy absorbed by the receiver and utilized in its operation—
—"Electrical Review."

A writer in a current issue of a contemporary, states that the ordinary acid solutions should not be used as a flux in soldering electrical connections. The acid solutions will attack the insulation if they come in contact with it. A non-corrosive flux can be made by dissolving rosin in alcohol.

A SIMPLE "WIRELESS" OUTFIT.

CHARLES D. HORTON.

There is something mysterious about wireless telegraphy. It appears to the uninitiated as a magical art; a science unfathomable except to a few whose researches have given them understanding not shared by the average student.

Amateurs in years past have found in the telegraph and the telephone an unlimited amount of pleasure. The construction of transmitter and receivers, the building of the line from house to house, and the subsequent operation of the outfit is bright in the memory of hundreds who now hold responsible positions in the electrical business world.

Not long ago a prominent electrical contractor, becoming reminiscent of his amateur days, said to me, " In my boyhood days we cherished the hope of becoming high in the ranks. We wrote E. E. after our names in the school text-books, and printed letter heads on small hand presses, upon which to correspond with each other. We constructed telephones, both acoustic and electric, and strung telegraph lines across nearly every street in town. But as I think over the past, I realize the immense amount of fun we youngsters lost because wireless telegraphy had not come into existence.

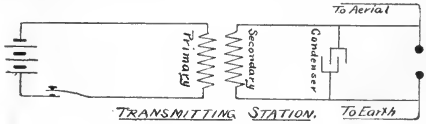
I believe every young man should study the subject and make all the experiments his means will allow. For the young man who takes the study seriously there is a bright future. There is no questiou but what it is the coming thing, and how soon it will be established universally depends upon the energies of the young men of today."

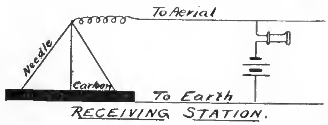
An amateur outfit of wireless telegraphy in the country or city, should prove a source of much pleasure and profit during the coming months. It is not as expensive as wire telegraphy, which requires relays, sounders and other apparatus, together with wire, which is a leading and heavy expense if a line of any length is constructed.

For a distance of a mile or two no elaborate apparatus is needed, as the sending end comprises a simple key, a few dry cells and a small spark coil, giving about a half-inch spark. The receiving end requires only the purchase of a telephone receiver and a few incidentals, such as a stock of carbon and a few steel needles, etc.

Amateurs may find a detailed description of small coils suitable for wireless sending in back numbers of AMATEUR WORK, and bearing in mind that for short distances of a mile or so a large spark is not a requirement, the expense of construction may be cut down to a very small amount. A spark of one half-inch will serve admirably if care is taken in constructing the receiving end.

In recent experiments I have made over short distances, I have not noted any marked degree of superiority where aerial wires have been carried to extreme heights. I found that a small length of magnet wire, supported on porcelain knobs, from peak of house to the first floor, sufficed for the aerial wire, and for a ground plate I drove several long iron rods into the moist earth and connected same together at the tops. I purchased my key of a telegraph supply house for 30 cents, it being listed as a " strap key." I made a small coil which would give a $\frac{1}{2}$-in. to $\frac{3}{4}$-in. spark, according





to battery power. For Leyden jars I followed instructions found in a back number of AMATEUR WORK, using two glass tumblers instead of one larger jar. When the coil key and wiring were connected and one side of the spark gap connected to the aerial and the other to the earth, I was able to radiate enough energy into the air and earth to send distinct messages from one end of the village to the other. Fig. 1 shows a diagram of transmitter connections.

Fig. 2 illustrates the receiving end. The receiver consists of a tripod of three needles with a coil of finest copper wire connected to the top and connected to the aerial binding post. This tripod rests on a small slab or block of carbon, selected for its smooth surface, and this carbon block is connected to the earth. A weak cell of dry battery and the telephone receiver are connected to bridge the tripod and carbon. A choke coil, consisting of a small bundle of iron wires, covered with a hundred turns of fine covered magnet wire was connected between the battery and the telephone receiver. This device greatly improves the signals.

The messages came in long and short distinct buzzes according to the length of time the sending key is depressed. Any code may be used, preferably the American Morse. This outfit seldom gets out of order, and will operate regardless of temperature and other weather conditions, if constructed in a neat manner. It requires no relay, sounders, decoherers and other expensive devices. Improvements, as they suggest themselves, may readily be applied at small cost.

AMATEUR WORK.

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MAY, 1905.

Those of our readers who have not a complete file of this magazine, should order at an early date as the snpply of back numbers of volumes I and II is being rapidly exhausted. The present supply is all that can be obtained of these volumes, as the heavy expense of reprinting does not permit of having it done for a whole volume.

When making inquiries through the Correspondence department, be sure and enclose stamp.

BOOKS RECEIVED.

Alternating Current Machinery. William Esty, 412 pp., 9½ x 6½. Half seal leather. Price, $3.50. American School of Correspondence, Chicago, Ill. Supplied by Amateur Work.

This book has been prepared with the special object of giving the beginner, as well as the practical electrician, a working knowledge of alternating current apparatus, so that he may know how to install and operate it intelligently. It seems to be a very common opinion that to acquire such knowledge requires an extensive mathematical training, but that such an idea is erroneous, is evident from a perusal of this book, which is clearly and interestingly written and very completely covers the field for which it is intended. It contains no mathematics beyond the simplest trigonometry, and but little of that.

It assumes that the reader has some acquaintance with the simpler laws of electricity and magnetism, the opening chapters presenting the essential features of the source of alternating currents and the alternator, and progressively takes up and explains the various phases of this interesting and important department of electrical work.

Maxwell's Theory and Wireless Telegraphy. Part I. Maxwell's Theory and Hertzian Oscillations, N. Poincare; translated by Frederick K. Vreeland. Part II. The Principles of Wireless Telegraphy. Frederick K. Vreeland. 250 pp., 8¼ x 5¾; Cloth. Price $2.00. McGraw Publishing Co., New York. Supplied by Amateur Work.

The object of this book is to give a physical treatment of theory and its application to some modern electrical problems, to set forth the fundamental principles which underlie all electrical phenomena, according to Maxwell and his school, to show how these principles explain the ordinary facts of electricity and optics, and to derive from them a practical understanding of the essentials of wireless telegraphy.

Mathematics and abstruse reasoning are avoided, making a book which the busy man or student may peruse with interest and profit. While it does not describe all the numerous forms of apparatus now in use, it does present those features necessary to a practical knowledge of the subject, and in such a clear and interesting way as to make the book of the utmost value to those desirous of studying the underlying principles of this important field of electrical research.

Practical Electricity. W. E. Ayrton. 642 pp. 7 x 5 in. Cloth. Price $2.00. Cassell & Co., Ltd. London and New York. Supplied by Amateur Work.

It is not necessary to mention this book to any electrical engineer; it is a constant reference book to all, and is so complete and contains so much of value to every day work that it cannot be too highly recommended. No student of electricity can invest in a book which will be of more practical value than this; we cannot speak too highly of it. Its special field is that of experimental and testing work with instruments, which is treated with great fullness. It is just the book for amateurs who have progressed beyond first principles.

Manual of Mechanical Drawing. Philip D. Johnston, 150 pp., including 69 plates, 9½ x 7½. Cloth. Price $2.00. David Williams Co., New York. Supplied by Amateur Work.

This book meets to the fullest extent what, in our judgment, should be included in a text book upon this subject, and should be cordially welcomed by instructors. The exercises are in accord with modern drawing-room practice, the part devoted to geometry and projection is complete without being tiresome, and the studies in machines include a vertical steam engine with detail of parts. A student who would faithfully pursue this course of instruction would be able to do work which would meet the approval of a pretty exacting head of the drafting room.

Renew your subscription before you forget it.

THE METAL WORKING LATHE AND ITS USES.

ROBERT GIBSON GRISWOLD.

I. Description of the Lathe.

Without exception, the screw-cutting lathe is the most universal machine tool that we have. Especially is this so when fitted out with various attachments for performing many operations usually assigned to the milling machine. This universality is not alone inherent with the design of the lathe, but it comes largely from the methods of design used in machine construction. It is far easier to turn a shaft to a cylindrical form than to make it square, or of other geometrical section, although a shaft of such a shape would answer the purpose quite as well in many cases. Of course, in such cases as that in which a shaft is provided with a journal turning in a bearing, it is imperative that the section be circular.

Nor does the limit of work end with the turning of pieces between the centers. The face plate aids in the performance of numberless jobs which, for the sake of speed, are assigned to either the shaper, planer or milling machine. But their work is no more accurate than what can be done on the face plate in facing the sides of a piece to absolute parallelism. Provided the face plate is true and the slide rest is absolutely parallel with it, delicate operations may be performed in this manner with ease and speed.

A great many lathes, especially the smaller sizes adapted for the use of amateurs, are fitted with milling attachments which widens the scope of the lathe still more. Gears, both of the spur and bevel variety may

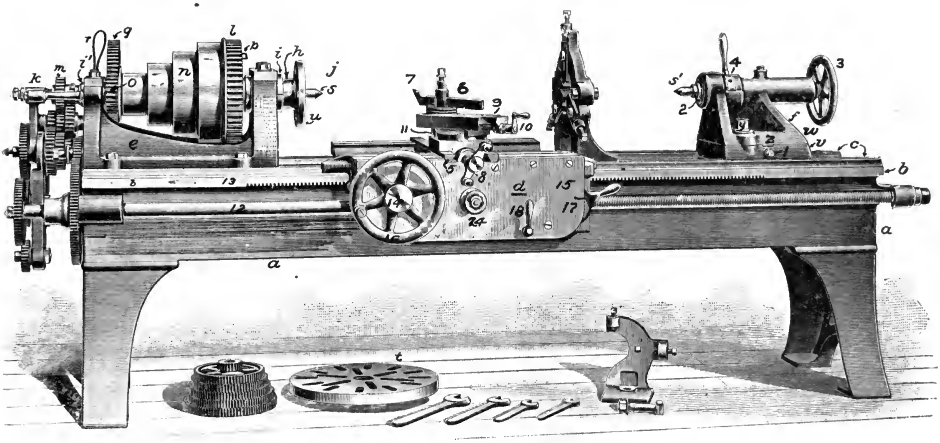


FIGURE 1. METAL WORKING LATHE.

The vast field of thread cutting is easily covered by the modern screw-cutting lathes, and threads of every conceivable section are readily cut. Nor is it uncommon to see the formation of a spiral groove, which in reality forms a thread, cut across the face of a piece of work. Threads may be readily formed on the conical surface of a piece, and in a great many cases threads are cut on worms for the transmission of power when the contour of the worm is far from a straight line.

By the aid of special forming cams attached either to the cross feed screw or elsewhere, certain predetermined shapes may be formed from solid blank material, and in repetition, with the assurance that each will be an exact duplicate of every other.

be readily cut, while cutters, reamers, and other special forms may be made.

The tool carriage may be easily fitted with a saddle upon which cylinders may be strapped and by the aid of a boring bar swung between the centers, bored to a true cylindrical surface, the feed of the carriage moving the work to the cutter. In this respect it occupies the place of the horizontal boring mill, while the shaper milling machine and drill press are each divisted of certain lines of work usually assigned to them as belonging to their particular field.

It is the intention to treat in these articles the various operations that may be performed on the lathe, as well as the other machine tools in common use in the shop. The various parts of the lathe, its construction and method of operation will first be considered.

As it will be impossible to cover in the space available, every type of American lathes, a representative will be taken that lies midway between the very large and the small machines, and one that is not provided with all the new change gear features of convenience will be described at some future time. Fig. 1 shows very clearly such a lathe, and the letters of reference indicate the various parts to be spoken of in detail.

The bed of the lathe, a, is one of the most important features. While it does not appear at first sight to require any very great skill to make a metal form that will support and guide the carriage, a more intimate study of its construction will show many points where cheap lathes "fall down" when the test of heavy work is applied. The heavier the bed the greater solidity given to the machine, but not necessarily stiffness, which is purely a point of design. When a piece is supported between centers and revolved rapidly, as is usually the case in finishing the surface with emery and oil, any irregularity of form will cause a serious pull from from one side to the other, due to the centrifugal force. This pull will soon set up a vibration in the machine if it is light, that is annoying and apt to throw the parts out of alignment.

The strength of the bed is alone a feature of design. They are usually made of the box-girder form, similar to that shown in Fig. 1, the two sides being tied together at frequent intervals by the struts cast integrally with them. There is a flange at the top and bottom of each side which gives lateral stiffness, and upon the top flange the carriage usually moves. Great care is necessary in the casting of these beds to see that during the cooling of the metal, no unnecessary shrinkage strains are set up, which, after the "skin" is planed off, will cause a distortion that may in time grow worse.

The upper side of the top flange, b, is usually made with one or two, (two in the best forms) inverted V ridges, which form the ways, c, upon which the carriage, d, moves, and the headstock, e, and the tailstock, f, rest. These ways are planed perfectly straight and true, and they form the guide for the tool, and, unless they are in perfect truth, the work will not be straight. In some forms of lathes there are no ways on the rear top flange, the carriage resting on the flat surface. One point of argument in support of this method is that the expansion of the struts has no tendency to lift the carriage and cause it to run on one side only of the the two Vs.

The greatest wear on these ways naturally takes place near the headstock, while that portion towards the tailstock end may not be worn in the least. Of course the majority of the work is short and the movements of the carriage are greatest at this point. The best makes of lathes provides an extra long bearing for the carriage, which obviates this difficulty to a great extent. There is now on the market a new tool-steel way that may be attached to a lathe bed. This may be renewed when worn and, since it can be hardened, greatly lengthens the life of the lathe within accurate limits, although there are few lathes that will outwear the ordinary cast iron ways. By the time they have served their period of usefulness, every bearing and gear has become badly worn.

It should be cited that two sets of ways are frequently provided for this reason; the head and tail stocks are mounted on one set, which are never worn to any extent and therefore always remain in line and true, while the carriage travels on the other set, in which the wear is evident, but, since it is in a vertical direction to a great extent, the point of the tool does not travel very far from a straight line parallel with the centers.

The headstock, e, is bolted firmly to the bed, generally resting on one of two sets of Vs. This stock carries the spindle, h, which runs in the bearings, i and i. The spindle is usually hollow to admit of rod stock being run through it to a chuck. The end at j is provided with threads and a shoulder against which the various pieces may jamb when screwed into place. The thrust of the work and tool against the spindle is taken up either by a thrust bearing surrounding the spindle at the back end, or by a yoke and thrust screw, as shown at k. This screw is also provided with an axial hole through which rod stock may be passed. This form, however, is rapidly being supplanted, especially in the smaller forms, and it is rarely seen except in some very large lathes. It has many points of advantage, however, and leaves the bearings of the spindle free of all thrust loads.

The spindle should be as heavy as convenient, and should be supported in large bearings, especially at the head. This bearing, i, takes all the inducing chatter. Then, again, this bearing is largely responsible for the alignment of the lathe and any wear that takes place here will soon throw the entire machine out of commission for accurate work. It is very seldom, except in cases where the belt pulls down, that any great wear occurs in the bottom half of the bearing. The belt generally pulls upwards and the tool thrusts the work upwards so that the top half of the bearing receives most of the wear. The bearing at the opposite end of the spindle is not subject to such great strains and, therefore, does not wear rapidly. The spindle, m, carries two gears in most cases, a large one, l, at the head end, and a small one, m, at the opposite end. The gear, l, is invariably keyed securely to the spindle, as the latter is driven by it at all times.

Mounted upon this spindle is the cone-pulley, n, to the small end of which is keyed a small pinion, o. This cone is free to revolve upon the spindle, and can be rigidly connected to the spindle only by means of a sliding bolt at p. This sliding bolt takes different forms; in some instances it is made to push in or pull out, and is then very convenient. With the ordinary bolt a wrench is necessary, and by sliding it in or out of a notch in the inner periphery of the cone, a positive driving connection is made.

Owing to the fact that the countershaft turns at a constant speed, it becomes necessary to have some device whereby the speed of the spindle may be altered at will. As the diameter of the work increases, the speed will have to be reduced to maintain the cutting speed found best for that material. In order that this end may be readily accomplished, two opposed cone pulleys are used and so arranged that the largest step of one drives onto the smallest step of the other. By this method, the mere shifting of the belt from one step to another will give quite a variation of speed. Many of the light lathes and most all speed lathes are fitted with this cone only, but in lathes intended for heavy service and a greater range of work, it becomes necessary to provide more changes in speed, and to this end another spindle carrying a large and small gear is supported directly behind the main spindle. The large gear, q, meshes with the small pinion, o, and the smaller pinion on the "back-gear" shaf t meshes with the gear, I. These gears may be thrown in or out of mesh by means of a small eccentric journal on the end of a shaft, and this shaft is turned by means of a small handle, r.

The ratio of these back-gears is such that the same arithmetical proportion is preserved throughout the entire series of belt positions and, as in the case of the lathe shown, there would be four speeds with the cone connected directly to the gear, l, and four slower speeds with the back gears thrown in. Of course the bolt, p, must be withdrawn from its slot when the back gears are thrown into mesh.

The end, h, is shown in Fig. 1, carrying a small driver plate, which is provided with one or more slots into which the tail of a "carrier" or "dog" enters, so that the motion of the spindle may be transmitted to the work, being turned on the centers, s and s′. A large face-plate, t, is also provided, which screws onto the spindle, in place of the small carrier plate, u. Chucks and other fixtures may be fitted to this threaded end.

At this point it may be well to give a few words of caution regarding the use and abuse of this thread. Too many lathe hands are careless in this respect, and it is a vital point in any lathe. In the first place, before screwing any fixture onto the spindle, see that the threads are perfectly clean; wipe them out with a little oil on a piece of waste, using a small stick of wood instead of any metal to force the waste into the groove. Then be equally sure that the thread in the face-plate, chuck or carrier is equally clean; also that the seat against which these parts rest are clean, as a small chip may throw any one of them out of alignment. When any one of them is put away, be sure to fill the threaded hole full of cotton waste which will keep out all dirt. If the pieces are to be hung up, use a wooden peg rather than one of metal, as the latter mars the threads. Thus, with careful use, the fit of these attachments to the lathe spindle should remain accurate for years.

The tail-stock, f, is usually made in two pieces; a v, and the head, w. The base v is fitted to the inner set Vs in a manner similar to that used in the head-stock, except that it is free to move from one end of the lathe to the other. It is clamped in any particular position by means of the bolt, y, which passes into a clamping yoke beneath the upper flanges.

The head, w, is fitted to the base by means of a tongue-and-groove joint, z, which insures perfect parallelism, no matter what positions the two parts assume. A small screw, l, serves to move the parts from one side to the other. This lateral movement is provided in order that tapers may be turned. The tail-stock is set to one side of the center line, and since the tool moves in a straight line, it will gradually approach nearer to one center than the other, thus making a gradual reduction in the diameter of the piece being turned. In many of the modern lathes this is rendered unnecessary by a taper attatchment fixed to the back of the lathe. It is simply a grooved piece so supported that it may be set at any angle, within small limits, with the centerline of the lathe. In this groove slides a block to which is attached the tool-post block. The tool is therefore constrained to move in a line at a definite angle with the axis of the work which forms the taper. This attachment is far superior to the method of setting over the tail-center, as the work revolves upon a perfectly fitted cone, and not on one side of it. As a general rule, a more abrupt taper may be turned with this attachment, and it is especially handy when the taper occurs in the middle of a long piece, as it then becomes very difficult to set the tail-stock over far enough.

This stock also carries a spindle, called the "tail-spindle" the end of which is shown at 2. This spindle is free to move in a longitudinal direction, but a key in the stock barrel prevents its rotation. A taper socket is provided which accommodates the center s′ or another attachment that may be desired. A hand-wheel, serves to move the spindle in or out, and it is clamped in position by some such device as the cam, 4, or a clamping screw. As there is little movement in this spindle, it does not wear to any great extent. It should be very solid, however, as lack of rigidity at this point will quickly induce chattering.

The tool carriage next claims our attention. The carriage proper rests upon the outer set of Vs, and is provided with very long bearings so that the wear may be reduced to a minimum. The bridge connecting the two bearings is provided with Vs, 5, upon which the tool block, 6, is mounted. This block, which carries the tool, 7, is moved by the screw, 8, of which only the handle is visible. A modification that is often made made of the plain rest is that shown in Fig. 1 and known as the compound rest. It is simply another slide mounted on the tool block, the slide, 9, being moved by the screw, 10. This slide may be set at any angle and the tool thus fed to the work along any line at any angle to the plane of the face-plate or center-line of the lathe. It is almost indispensable in a general line of work, as tapered holes may be bored with it and very short tapers turned. The base, 11, is generally provided with a graduated arc by means of which the exact angle being turned may be determined.

The carriage is fed along the ways by means of a feed screw, 12. This screw is driven by gearing in this case, but usually a belt is used, as breakage is often prevented under an overload by the belt slipping. The thread of the screw is seldom, and should never, be used for ordinary feeding, as its purpose is that of thread cutting, and the greater the wear therein the less accurate will be the thread cut. A key-way or "spline" is usually cut throughout the entire length of this screw, into which fits a key in a sleeve surrounding screw 12. The rotation of 12 then turns this sleeve, the periphery of which is provided with a worm thread. This in turn drives a gear that meshes with the rack, 13, and any motiou of the gear will cause the carriage to move along the bed. This gear may be thrown in or out at will by the thumb-nut, 14, which controls a friction clutch behind the apron, 15. For ordinary feeding by hand, and rapid movement of the carriage, the hand-wheel, 16, which is connected with the rack-gear by means of an intermediate pinion, is used.

In order that the screw, 12, may be used for thread cutting, a means for attaching the carriage thereto must be provided, and this is accomplished with a spit that closes over the screw by means of the handle , 17. Another set of gears, behind the apron, are thrown into gear by the friction clutch nut, 24, and feed the tool across the carriage, giving what is known as automatic cross feed. A lever, 18, is provided on many lathes for reversing the direction of feed at the apron, and is very convenient. Still others incorporate this attachment as a part of the head-stock mechanism.

The matter of the change gear, compound gearing, thread cutting and the use of special attachments will be taken up in later chapters.

HOW TO BUILD A POWER LAUNCH.

CARL H. CLARK.

VI. Installing the Engine.

In choosing the engine, as good a machine should be purchased as the means at hand will allow. Although the four-cycle type is rather more reliable and economical of fuel, almost any of the two-cycle types will be found to give good satisfaction when well installed, and are much simpler and cheaper. An engine of medium weight should be chosen, as being less of a burden, and also, as having a higher rate of revolutions, the vibration will be less—the extremely light type should not, however, be used as the weight of metal is usually not sufficient to stand continued use. As to size, a three h. p. engine will probably do fairly well, but to obtain the best results a 3½ or even 4 h. p. may be made.

It is hardly necessary, in a boat of this size, to use any kind of reversing apparatus, although a reversible propeller is sometimes useful and is quite desirable if a good type be obtained. If the question of cost enters into the matter, the reversing apparatus may easily be dispensed with and a plain shaft and wheel fitted. The fact that most two-cycle engines will run in either direction and may, with sufficient skill, even be reversed will help to decide the question.

The construction of the engine bed has already been described and the engine must now be fitted into place.

A fine wire is passed through the shaft hole, stretched tight, and fastened so that it is in the exact center; this locates the center of the shaft. The engine is now measured to find the exact relation of the bed flanges to the shaft center; they will usually be either in the line of the center or slightly below it. The bed is now trimmed down until it bears the same relation to the wire that the flanges do to the shaft center. The engine is now lifted in place and the propeller shaft passed through and secured in place to the engine coupling. When the engine is correctly set the shaft will be exactly in the center of the hole; it is then fastened into place with lag screws.

The stern bearing should be shipped on to the end of the shaft and fitted to the back side of the sternpost. The latter is trimmed until the bearing bears evenly against it without cramping the shaft. It should be borne in mind that the joint between the bearing and the sternpost must be water tight to prevent leakage into the boat through the shaft hole. The bearing is fastened into place with lag screws, after smearing with white lead. In some makes of engines the stem-bearing is fitted on the inner end of the shaft log, and a plain bearing on the other end; this is the preferable method, as then the gland may be tightened more readily.

The shaft will usually be sent several inches length to spare. One end will be already fitted to the propeller. Careful measurements should be taken and the shaft cut to such a length that there will be sufficient length between the propeller and the bearing, that the cap may be removed and the gland packed without trouble. The propeller is securely fastened to the shaft by the means provided, the shaft is put into place and the set screws in the coupling set up tight. After this is done the engine should turn freely if everything is properly in line. When the engine is properly set the remaining pieces of floor may be fitted and laid, a suitable opening being left in front of the engine to allow starting with the handle.

The piping may be arranged all on one side of the engine, leaving the other side open for the passage, or if it is desired to have both sides of the engine clear, all pipes may lead directly down from the engine to the floor, and a light guard or slip be fitted over them.

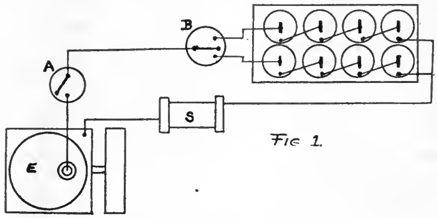
The exhaust piping should be fitted first, as it is the largest and hardest to handle. The muffler should be placed athwartships under the after seat. The openings for pipes on the different makes of engines vary to such a degree that exact directions cannot be given. The exhaust should be piped from the engine to the space under the seat, ending in an ell; from this ell a straight pipe runs aft under the seat and is connected to the muffler with an ell. The exhaust from the muffler passes out through an ell, up and aft and out through the sternboard. A locknut is fitted on the exhaust pipes inside and outside of the stern board to secure tightness. The exhaust pipe should be kept clear of all wood work as far as possible, and whenever this cannot be done the woodwork should be covered with asbestos.

The inlet for the cooling water should be well below the water line. A perfectly tight joint should be secured with lockers and washers inside and outside. It is the common practice to fit a short piece of pipe to the plank and make the remainder of the connection to the engine with a rubber hose; in which case the jar of the engine will not tend to loosen the pipe in the plank and cause a leak. The outlet from the engine should lead out through the side of the boat above the water. The inlet should be covered with a strainer to prevent the sucking in of sand or other material. The joints in the water piping should be made up with red lead to assure tightness.

The pipe from the gasoline tank is best of lead securely soldered to unions at each end. A stop-cock should be fitted on the tank and another at the vaporizer; this will allow the pipe to be disconnected if necessary, without emptying the tank. Great care is necessary to have all the piping connected with the the gasoline absolutely tight. The filling pipe for the tank should extend up through the deck in one piece, leaving no open space through which the gasoline would have to pass, allowing it to generate vapor. The lead gasline pipe should be led in such a manner that it is in no danger of damage, as it is quite soft and easily jammed. Joints in the gasoline pipe should be made up with shellac or soap, as red lead will be eaten out by the gasoline and leaks caused.

If pipe dies are not at hand, the pipe may be taken to a pipe fitter together with careful measurements, and pipe cut by him. The pipe for the exhaust may be of galvanized iron and that for the cooling water of brass.

For ignition two sets of batteries should be used of six each, they should be arranged in a box of requisite size, as shown in Fig. 1. The rows are connected up separately, the zinc of one cell to the carbon of the next, and so on. On one end of the box is fitted the three-pole switch, B, which allows either set to be used as desired, the wires from the carbons of the end cells being connected to the poles of the switch. The zincs of the cells at the other end are connected to one



Wiring Diagram for Engine.

wire, which leads to one terminal of the spark coil, S. From the other terminal of the coil a wire is led to some part of the engine or piping and a good electritrical connection made. From the third point of the battery switch a wire is led to one point of the two-point switch, A, and from the other point of this switch to the insulated electrode of the engine. The switch, A, is placed near the engine and allows the current to be cut off when the engine is not in use. The battery box should be placed in some dry location, together with the coil, which may be fastened to the box if desired. The wiring should be very carefully done, as a large part of gasoline engine troubles are caused by defective electrical outfit. The connections for a jump spark ignition will be much the same, differing principally in the connections at the engine.

When purchasing the engine, the buyer should obtain all the information possible in regard to its installation and operation, as in this way much time and labor may sometimes be saved.

When all the work has been done the final coat of paint should be given and all seams filled with rather soft putty, which will be easily squeezed out when the planks swell. The boat should then be launched.

If the builder is not familiar with gasoline engines it will be well to obtain the services of an experienced person for the trial trip, and the amateur is advised to obtain one of the several good books on this subject and make a study of it so as to familiarize himself with the theory and principles of operation.

During the first few weeks of running, plenty of lubricating oil should be used until the various bearings become smoothed down to a good wearing surface, and care should be taken that no grit or other material finds its way into them to cut them out.

With proper care both engine and boat should last for several years with only minor repairs.

The hull should be smoothed up after two or three months and another coat of paint applied. All varnished work should also be kept well covered during the first year to avoid cracks and checks while the wood is setting into place. It is hoped that with these instructions the amateur will be able to construct an able and satisfactory boat, and one which will give pleasure to himself and his friends for many years.

SECONDARY TECHNICAL EDUCATION.

Secondary technical education has come to mean that instruction in technical schools which stand midway between the engineering college course and the trade school course. It consists of study and practical work combined, with the object of giving a thorough grounding in the principles and main facts of engineering, and to supplement this with application of these facts and principles to actual work.

Technical education in this country has, so far, been largely confined to the development of purely engineering courses, fitting the student for design and supervision of installation of railroad, power plant machine shop or what not, and incidentally giving some idea of the actual work required in carrying out these designs and installations.

Considered from an economic standpoint, time and energy spent in completing an engineering course by the man whose natural ability and instinct fit him for a position in charge of actual construction work is out of proportion to the necessities of the case. To complete an engineering course in a good college requires, before entrance, the completion of at least a full high school course, and four years in the college. To the student of ordinary mental ability, this means that his ctua life work cannot be commenced much under the age of 23 years. While this may not be a burdensome matter for many of those who contemplate engineering as a life work it, nevertheless, bars from a technical school education many young men who have in them the making of first-rate foremen and superintendents.

In a recent address delivered before the Schoolmasters' Club of Denver, Victor C. Alderson, president of the Colorado School of Mines, called attention to the industrial strength which has been achieved by Switzerland in spite of unfavorable conditions by the system of detail instruction in industries. This system extends from the Polytechnic School at Zurich, which is one of the finest in the world, through all grades of instruction down to a traveling school for shoemakers which goes from place to place instructing the peasants in the art. In all the courses of all of these schools, science, art, literature and language are studied, but simply as a means to the industrial end.

In treating all subjects on this basis, it is not necessary that they should lose their value as mental training, or their influence to broaden the student. All that is needful is that studies should be so chosen and related to each other that the utilitarian value of each shall be brought out to the greatest possible degree. In France, the National Institute of Art and Trade stands at the head of the system of technical education which includes instruction in commerce—by both high school and college courses; in foremanship, by a system of four schools giving secondary technical instruction; special schools in wood and iron industries, in watch making, in weaving, modeling, cabinet making, machine shop practice and gun making. Besides the national system, many cities have special schools of their own for teaching trades and arts.

English cities and philanthropists are establishing technical schools for day, and especially for evening students, largely of secondary technical grade, but no national sysiem is organized.

German industrial schools are models to be envied and followed. From the primary schools all students pass to trade schools of all industries for both boys and girls, and to secondary schools of technics and commerce. Above these are the higher engineering schools standing beside the great universities which are devoted to literature and pure science. As a consequence, Germany has developed an industrial system which has turned the empire into a vast workshop and placed it in the front rank of manufacturing nations in spite of unfavorable conditions and the somewhat phlegmatic temperament of the people.

As a nation, we are industrially successful, but are we as successful as we might be, if our workmen, our foremen, our superintendents, were all trained to utilize their abilities to the best advantage? Engineering colleges are doing a splendid work, but from observation of the occupations of technical graduates, it would appear that these colleges are at present turning out as large a supply of designing engineers as the industries of the country can use. On the other hand, the only source from which men can at present be drawn for intermediate positions in manufarturing systems—which has a course not intended to train for such work—or the rank and file of the workmen.—"The Engineer."

The temperature attained by the burning gases in the combustion chamber of a gasoline motor cylinder, at the moment of explosion, is in the neighborhood of 3000° Fahr., while the temperature of the exhaust is from 700 to 900°.

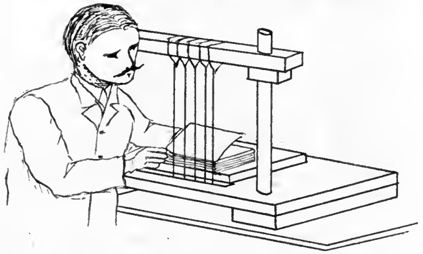
BOOK-BINDING FOR AMATEURS.

WINTHROP C. PEABODY.

V. Stitching the Book.

The books having been arranged and placed as described in the previous chapter, they are then ready for the important operation of sawing and sewing. The book or books are evenly "jogged" on the back to bring that surface perfectly flat, using care that, in doing this, the top register is not broken. Press boards are then placed outside, with the edges at the back about ½ in. from the back of the book. The book and containing boards are then placed in the laying press or, in the absence of this tool, in a vise or between cabinet makers' clamps tightly screwed up to prevent movement during the sawing of the sewing kerfs or slots on the back.

Before sawing the kerfs they should be spaced off and plainly marked with a pencil, using an ordinary carpenter's square so that they may be accurate. For



POSITION FOR SEWING.

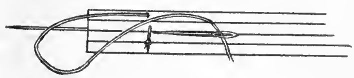
all except the largest books, five cords will answer. Begin by marking with a pencil the place for the cut at the head or top of the book, which should be about ¾ in. from the top edge when trimmed. The one at the tail, or bottom of the book, should be about 1 in. from the edge; then cuts about ¾ in. inside of each of these two; then another at the center between the two already made, and one each central between the center one and those at the ends, making seven in all. The two cuts nearest the ends are for the "kettle" stitches and do not have cords, so are made only deep enough to enable the sewing needle to be put through without difficulty. Kerfs are then sawed with a back-saw at the places marked, to a depth of about 1-16 in., varying slightly with the size of cord used in the sewing frame. With large, heavy books it may be necessary to enlarge the kerfs by canting the saw first to one side and then to the other, in this way getting a wider cut than would be made by the saw in a vertical position.

The next operation is that of sewing. A sewing frame of the kind described in the September, 1902 issue of AMATEUR WORK, is threaded with cord, one for each kerf. These cords should be of the best quality hemp, and obtainable of dealers in cord and twine. At the same time get the sewing twine, which should be an unbleached linen twine, smooth and strong. The size will largely depend on the thickness of the signatures comprising the book being sewed; if the signatures are thick, as would be the case with AMATEUR WORK, a strong, rather large twine should be used, but for thin signatures of eight to twelve pages, a smaller one is best. A little experience and the examination of a well bound volume of a size similar to those in hand, will show the correct size to use.

STITCHING WITH FIVE CORDS.

The cords in the sewing frame are first tied at the lower ends to short, flat pieces of wood which span the opening through which the cords are brought up to the cross bar at the top. The upper ends are carried twice around the bar and tied with a slip knot, using care to have all of an even tension.

The back of the book is then placed against those cords, which are moved along until they are in the right place to fit into the kerfs. The cords are then tightened by turning the nuts under the cross bar, until the cords are sufficiently tight to prevent being moved from the proper places during stitching. It is desirable to place the cords as far to the right



TYING AT THE ENDS.

of the frame as possible to give room for the arms in sewing. A strip of wood should also be placed in the opening in the table to prevent the cords from moving forward under the pressure of the book as the sewing proceeds. A pressing board is then laid upon the table with one edge flush against the cords.

The book is then laid upon the bench to the left of and near the sewing frame, with the fore edge to the front and title page at the top. The first signature is then lifted, turned over to face downward, and partly opened at the center by placing the first two fingers therein and pressing with the thumb to keep the leaves from slipping apart, and placed against the cords where the kerfs have been cut.

A needle, single threaded, with about a yard of the sewing twine is then put through the kerf at the left, taken by the left hand and put through the nearest kerf containing a cord and to the nearest side of the latter, and drawn out until only about three inches of twine extends from the first kerf. The needle is then returned through the same or second kerf, but on the other side of the cord, carried to the next kerf, out and around the cord there, and so on to the kerf containing the last cord. After being carried around this last cord it is brought out through the remaining kerf, drawn taut but not too tight, and another signature is then placed in position. The sewing is then repeated, but in the reverse direction, and upon reaching the (first) end kerf, is knotted to the projecting end just underneath. Another signature is then added, the sewing proceeds as with the first one; another signature brings the sewing back to the starting kerf again. On reaching the end kerf of every signature after the second, the needle is passed between the two signatures immediately under it, knotted with a slip knot drawn tightly into place. This is done at each end. As sewing proceeds it will probably be necessary with all except very thin books, to occasionally press the signatures down with an ivory, so that the subsequent "backing" will not disclose loose stitching. A strong double knot is made with the end of the last signature and the end cut off, leaving enough to prevent untying. When one needleful has been used, an other length of twine is tied on, making the sewing twine practically one continuous length. When the sewing is completed the cords are cut off, leaving about two inches on either side.

PHOTOGRAPHY.

WHY? – SOME BEGINNERS QUESTIONS ANTICIPATED AND ANSWERED.

T. THORNE BAKER.

If for the term "why and wherefore", we had substituted the word "chemistry," the beginner would very likely have passed over this article, thinking it altogether beyond his ken. It is not, then, to be chemistry at all, but merely a simple chapter on the reasons for doing as we do in development, and, in order to make it quite seasonable, it shall deal exclusively with the development of lantern plates and bromide and slow contact, or "gaslight papers.

It would be quite possible to lay down a vast series of laws, of what to do in development, what to avoid doing, and what steps to take in various cases, so that an amateur photographer who could bear them all in mind and put them into use would be capable of dealing with any emergency. But if, right from the start of photographic work, the amateur would ask the question, what is he doing, and why, and thus understand a reason for every action, the time would very rapidly come when his own knowledge of the "Why and Wherefore" would enable him to cope with all difficulties without troubling a friend, textbook or all-patient Editor for information.

Development, when considered seriously, is a remarkable thing, and must arouse curiosity in the mind of every photographer at some time or other. It requires little thought, however, to see that the developing solution turns the film of a plate or piece of bromide paper black wherever the light has acted upon it, *i. e.*, wherever it has "seen" the light.

A piece of P. O. P., if put into some developer, will turn black almost immediately, whether it has "seen" the light or not, and this behavior is characteristic of every brand of printing-out paper which requires the continued action of daylight to print it to sufficient depth.

A lantern plate is a piece of glass, coated on one side with a mixture of gelatine and a cream colored substance called silver bromide; the same mixture is used for bromide papers. In some makes other substances are, of course, used as well, but silver bromide will be sufficient for our purpose here. During the exposure of a lantern plate behind a negative, a physical change quite invisible to the eye takes place in every portion of the film where the light is able to reach it; thus the black portions of the negatives or "high lights," do not allow light to reach the lantern plate film, while the light can pass freely through the clear portions or "shadows" of the negative, and thereby produce the physical change already referred to. The nature of this change is too complex to be discussed here, and hence only its consequences need interest us.

Suppose that now we place an exposed lantern plate in some developing solution and watch the progress of development. First of all, the developer consists of, let us say, hydroquinone and soda, originally in two solutions, A and B. A consisted of the hydroquinone in water, together with some preservative, such as sodium sulphite, and B of caustic soda in water; in the mixed developer, therefore, we have all these things, and always a little bromide as well.

The change that took place during exposure has made the following difference in the film: Wherever the light got through a clear portion of the negative exposure and reached the plate, the film will begin to turn black, whilst the protected parts will not be in any way altered. If no caustic soda or alkali were present, the development would proceed very slowly; the soda, however, neutralizes, or "kills" this acid, and the more we put in the developer the quicker does it act, and the result is that the dark parts of the image become sufficiently developed before the half tones or delicate portions are of sufficient depth or density. Thus it is necessary to adjust the proportion of soda to hydro-quinone, or carbonate to metol or whatever it may be (in general "alkali" to "reducer"), with precision; hence the necessity for a reliable formula.

A lantern plate or bromide paper developer must contain the following parts: the developer itself, such as hydroquinone; the preservative, such as sodium sulphite; the alkali, such as sodium carbonate; the solvent, water; and, finally, what we may discreetly term the safety-valve, potassium bromide. Our bottle of ten per cent bromide solution is an all-powerful lever; it ensures purity in the whites, it regulates contrast, and is in every way a necessary thing.

Bromide is such an important thing, in fact, that we had better just see how and why it works. A sheet of gaslight paper, unexposed to light, should be left in a metol-hydroquinone developer, and another, sheet in a similar developer, only to which several drops of ten per cent. bromide solution have been added, for the same time—say one minute. On then examining them, it will be found that the piece developed in the presence of the extra bromide is infinitely cleaner or "whiter" than the other. This experiment alone teaches us two things: First, that the paper will fog, or turn discolored, even if it has no exposure, on prolonged development; second, that the fog produced by the developer is prevented by bromide, at any rate, to some extent. We are thus taught the following:

1. Never leave a lantern plate or piece of development paper in the developer longer than is necessary.
2. If the whites do not seem pure, add an extra drop or two of bromide solution to the developer.

It also follows from what we have said that too much bromide in the developer will destroy the softest gradation, and give us very clean but very harsh pictures.

That the amount of carbonate or caustic in a developer must be accurately arranged, has already been pointed out, and this is not only because a developer such as hydroquinone requires a specific quantity. but also, since the amount varies very considerably with different developing agents. Amidol, for instance, does not require any alkali at all, and the best formula is made up thus:

Sulphite of soda	10 parts.
Water	100 "
Amidol	1 "

Here, again, the amount of amidol may be varied; more amidol gives greater density, less gives less, just as if an alkali were present; the bromide, too, must be present, in order to ensure cleanliness.

When development is finished, we have a black image consisting of decomposed bromide of silver resting on, and in, the original creamy white film. It is obvious that this unused substance must be removed, and we therefore put the plate or paper into a "fixing" bath which dissolves away any silver bromide not affected by light during the exposure. Remember that the ordinary light should never be turned on in the darkroom, nor the plate removed from the red light until thorough fixing of a lantern plate or rapid bromide paper is accomplished.

As hypo dissolves the white silver salts, it is at once evident how careful we must be not to allow any fixing solution to drop into the developer. The more we know of the action of our various chemicals, the greater need we shall see of cleanliness.—"Amateur Photographer."

PHOTOGRAPHIC NOTES.

Twenty years ago, said Dr. Hollingsworth, it was a common practice to over expose, whereas, nowadays, with beginners, at least, it seems to be nothing but hand cameras and under exposure, and it seems unfortunate that the most difficult process of exposure should come first.

With a negative that is technically good we can do almost anything, but if we get a defective one it is only by dodging, and experience at that, we can overcome its defects. Under and over exposure teaches us that there are limitations within which exposure lies, and that it takes time for the light to impress the image upon the plate.

In taking photographs we have to deal with or consider, a number of factors. Some of these take the form of atmosphere, wind, fogs, varying conditions of lighting, the summer or winter, and the difference in the actinic value of the light brought about by the changes of the seasons, and, finally, with the important matter of the subject itself.

Then, again, many beginners do not find out for a long time the value of the stops, though this has a great deal to do with the length of the exposure and the results obtained. It should be understood that each one, as we work down, practically doubles the exposure. In focussing at open aperture (which is the correct method) it is best to aim at sharpening up any object about a third of the distance away, and then to stop only sufficient to bring the whole field of view into equal focus.

There is also the question of fast plates and slow one. The tyro generally uses the former, although the latter are the most easy to control. The fast makes are more easily damaged by fog in the dark room, owing to the unnecessary and continuous practice of frequently looking through the plate to see how development is going on.

There is a golden rule—expose for shadows, and the rest will take care of themselves, which each must always bear in mind if he wants to make the negative a successful one.

The use of an actinometer was strongly recommended, so that some guide may be followed. It will save its cost over and over during a busy season.

Metol seemed to have the faculty of bringing out detail before it piles up density. With it one has to take the plate further than seems to be necessary, as it looses a good deal of density during fixation.

It is most important, if one wants to do good work to stick to one developer and master it before one makes any change. The same rule applies equally to the plate. We should thoroughly understand one particular kind, exhaust its possibilities, instead of flirting about from one to another. If this is followed out, the more experience one gets the more will he find that one make is perhaps as good as another and capable of producing good negatives if the exposure and development are correct.

A French photographer, M. G. A. Liebert, has recently devised an apparatus which will enable him to take instantaneous photographs in his studio. This device is described in *Le Revue Patrique de l'Electricite* for December 5. The object of using electric lights is to give the photographer entire control of the quality and amount of illumination and to render him independent of daylight. Moreover, to obtain the best portraits it is very desirable that they should be taken instantaneously and at the moment when the subject is in the best pose.

The device consists of a large parabolic reflector of aluminum, having placed on its inner edge a series of incandescent lamps shaded with ground glass screens. The object of these is merely to light up the subject, permitting the photographer to secure the best pose and to determine when the real exposure should be made. At the center of this reflector is an arc lamp with three carbons. One of these is fixed and the other two are moveable. When a photograph is to be taken, the subject is arranged and the sensitive plate is exposed. The photographer then waits until a desirable pose has been secured, when he presses a rubber bulb, which draws the two movable arc light carbons across the fixed one, thus forming a brilliant arc; but the moment the current passes through the lamp the movable carbons are drawn away from the fixed one by means of an electromagnet, and the arc is thus extinguished. It lasts about one-fiftieth of a second, but this gives sufficient time for an exposure.

WIRE GAUGE TABLE.

By Courtesy of Brown & Sharpe Mfg. Co.

DIFFERENT STANDARDS FOR WIRE GAUGE IN USE IN THE UNITED STATES.

Dimensions of Sizes in Decimal Parts of an Inch.

Number of Wire Gauge.	American or Brown & Sharpe.	Birmingham, or Stubs' Wire.	Washburn & Moen Mfg. Co. Worcester, Ms.	Imperial Wire Gauge.	Stubs' Steel Wire.	U. S. Stand. for Plate.	Number of Wire Gauge.
000000	....	......	....	.464	......	.46875	000000
00000	....	......	....	.432	......	.4375	00000
0000	.46	.454	.3938	.400	......	.40625	0000
000	.40964	.425	.3625	.372	......	.375	000
00	.3648	.38	.3310	.348	......	.34375	00
0	.32486	.34	.3065	.324	......	.3125	0
1	.2893	.3	.2830	.300	.227	.28125	1
2	.25763	.284	.2625	.276	.219	.265625	2
3	.22942	.259	.2437	.252	.212	.25	3
4	.20431	.238	.2253	.232	.207	.234375	4
5	.18194	.22	.2070	.212	.204	.21875	5
6	.16202	.203	.1920	.192	.201	.203125	6
7	.14428	.18	.1770	.176	.199	.1875	7
8	.12849	.165	.1620	.160	.197	.171875	8
9	.11443	.148	.1483	.144	.194	.15625	9
10	.10189	.134	.1350	.128	.191	.140625	10
11	.090742	.12	.1205	.116	.188	.125	11
12	.080808	.109	.1055	.104	.185	.109375	12
13	.071961	.095	.0915	.092	.182	.09375	13
14	.064084	.083	.0800	.080	.180	.078125	14
15	.057068	.072	.0720	.072	.178	.0703125	15
16	.05082	.065	.0625	.064	.175	.0625	16
17	.045257	.058	.0540	.056	.172	.05625	17
18	.040303	.049	.0475	.048	.168	.05	18
19	.03589	.042	.0410	.040	.164	.04375	19
20	.031961	.035	.0348	.036	.161	.0375	20
21	.028462	.032	.03175	.032	.157	.034375	21
22	.025347	.028	.0286	.028	.155	.03125	22
23	.022571	.025	.0258	.024	.153	.028125	23
24	.0201	.022	.0230	.022	.151	.025	24
25	.0179	.02	.0204	.020	.148	.021875	25
26	.01594	.018	.0181	.018	.146	.01875	26
27	.014195	.016	.0173	.0164	.143	.0171875	27
28	.012641	.014	.0162	.0149	.139	.015625	28
29	.011257	.013	.0150	.0136	.134	.0140625	29
30	.010025	.012	.0140	.0124	.127	.0125	30
31	.008928	.01	.0132	.0116	.120	.0109375	31
32	.00795	.009	.0128	.0108	.115	.01015625	32
33	.00708	.008	.0118	.0100	.112	.009375	33
34	.006304	.007	.0104	.0092	.110	.00859375	34
35	.005614	.005	.0095	.0084	.108	.0078125	35
36	.005	.004	.0090	.0076	.106	.00703125	36
37	.004453	......	....	.0068	.103	.006640625	37
38	.003965	......	....	.0060	.101	.00625	38
39	.003531	......	....	.0052	.099	....	39
40	.003144	......	....	.0048	.097	....	40

A new and simple method for testing eggs is published in German papers. It is based upon the fact that the air chamber in the flat end of the egg increases with age. If the egg is placed in a saturated solution of common salt it will show an increasing inclination to float with the long axis vertical. A scale is attached to the vessel containing the salt solution so that the inclination of the floating egg toward the horizontal can be measured. In this way the age of the egg can be determined almost to a day. A fresh egg lies in a horizontal position at the bottom of the vessel; an egg from 4 to 5 days old shows an elevation of the flat end, so that its long axis forms an angle of 20 degrees. With an egg 8 days old the angle increases to 45 degrees; with an egg 14 days old to 60 degrees, and with one 3 weeks old to 65 degrees, while an egg a month old floats vertically upon the pointed end.

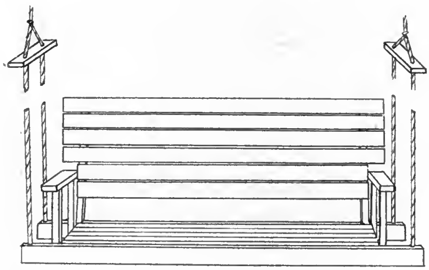
SWING SEAT FOR PIAZZA.

JOHN F. ADAMS.

Swing seats for the piazza are becoming very popular, and the near advent of warm weather leads one to think of fittings which will add comfort during the season when out-door rest is desirable. The seat here described is easy to make and will be found very useful. About any kind of wood may be used except the softest, like pine. It should be stained a dark green or brown to present the best appearance. The lumber required is as follows:

12	pieces	4 ft.	long	3 in. wide,	¾ in. thick.
2	"	5 "	"	and 2 x 3 in.	
3	"	20 "	"	" "	"
4	"	13 "	"	1½ x 2	"
3	"	20 "	"	1½ x 1	"

The two long pieces and three short pieces of 2 x 3 in. stock are used to make the seat frame, the three cross pieces being blind mortised into the long ones, the mortises for the ends being cut to bring the outer edges of the cross pieces 6 in. from the ends, the other being midway between these two. Good, firm joints should be made, as the strain is considerable. One inch from each end of the long pieces bore holes for the suspension ropes which should be at least ½ in. diameter.



The arm posts are made from the 1½ x 2 in. stock, the lower ends being firmly screwed to the corners of the frame just made, on the outside of the cross pieces. The arms are 20 in. long, projecting 3½ beyond the posts. They are attached to the posts by stout screws, the heads being countersunk, and covered with putty or wood buttons before staining.

The back is inclined at a regular chair angle and supported by two end pieces of 1½ x 1 in. stock, and a center piece, the two former being firmly screwed to the rear arm posts and the seat frame. The center piece is attached by screws to the slats only.

The slats for both seat and back are spaced equally and fastened with 1 in. wood screws, the heads countersunk.

Two spacing bars hold the ropes apart above the seat, making it more easily managed, as without such bars it is rather easy to get a spill if care is not used in keeping one's balance. These bars should be located as high as space will permit, and held in place by putting wire nails through both bars and ropes. The ropes are brought together above the bars, and it will be found convenient to have two loops to enable the height from the the floor to be changed, as short people will not find it convenient to use unless they can rest their feet on the floor.

The best way to fit the suspension ropes is to make the loops and splice at the top, to fit the spacing bars and fasten to the seat by tying strong knots underneath after the correct height has been found by test. It should be a little high at first if new rope is used, as the latter will stretch. This can be taken up by untying the knots and retying higher up.

The user must also observe care not to swing endwise with the fingers on the arms where the suspension ropes will pinch them. Cushions and sofa pillows add much to the appearance of the seat and comfort of the user.

Piassava is a fiber made from the bamboo tree and is used in Europe to make brooms, brushes, and the like. In Liberia the bamboo is taken from the tree and placed in water until the outer covering decays. It is then beaten in a forked stick, erected for the purpose, until there remains only the fiber, which is weighed and bound in bundles much like American wheat, except that it is bound at both ends. This is the best method of obtaining the bamboo fiber. The other method, beating the bamboo dry, breaks many of the strands and produces an inferior fiber.

Two well-known Chester, Nova Scotia, men, A. M. Church and Mr. Cleveland, the latter a blacksmith, are satisfied that they have succeeded in hardening copper, and E. B. Church has a piece of metal treated by the process which appears to be very hard. He also has a razor made of their hardened copper, with which one can shave. Having been made in a blacksmith shop the razor is necessarily crude, but the blade is hard and carries a sufficiently sharp edge to remove superfluous hair. The elder Mr. Church writes that by the process the metal can be hardened to any degree.

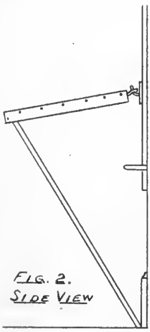
HANDY HINTS FOR AMATEURS.

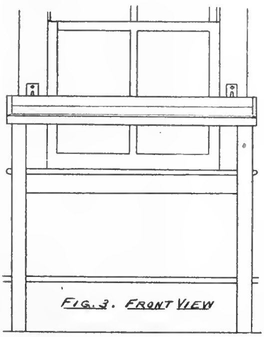
Contributions are solicited for this department, and for each accepted article the sender will be given the choice of any one-subscription premium from our premium offers.

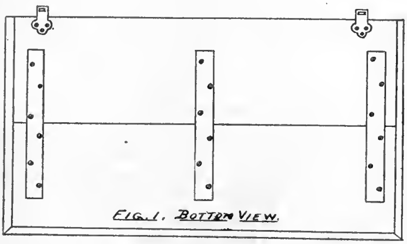
A SIMPLE DRAWING TABLE.

C. D. SHRECK.

This table is intended for the amateur who desires to construct his own table at a small cost, and have when completed one that will answer all requirements and be satisfactory in every respect. It is intended to be set up in front of a window, the casing of the window, in fact, acting as the front supports. It may be set in front of any window, but a north window would be preferable, owing to the fact that the sun hardly ever reaches it and the light would be more nearly uniform.







Procure at a lumber yard a smooth, dry, soft, white pine board, 8 feet long, 12 in. wide and ⅞ in. thick; also two strips of the same material, each 10 feet long, 2 in. wide and 1 in. thick. This material will cost you about 50 cents. By sawing the board crosswise through the middle you will get two boards, each four feet long. Lay these face downward, side by side, and fasten them together by the means of three cleats cut from one of the strips. Each cleat should be one foot, three in. long and located as in Fig. 1. Then on three edges of the table fasten, by the means of wire finishing nails or round-headed screws, strips cut from the 2 x 1 material. These strips serve to keep the table from warping, hold the back supports in position and add greatly to the general appearance of the table. These strips should be mitred at the ends where they meet each other so as to form a neat joint.

The table should be suspended to the window casing by the means of hangers, such as are employed in hanging window screens. You can procure them from any hardware dealer and the pair will probably cost fifteen cents, screws included. The hangers should be mounted on table and casing, as shown in drawing. The parts of the hangers that go on the casing should be located 46½ in. from the floor and at a distance apart so that the window curtain, in being pulled down, will clear them.

All that remains to complete your table are a pair of supports, each 4 ft. long, cut from the 2 x 1 material. To suspend the table to the casing, slip the hangers together, raise the lower end and place the supports in position, the lower ends resting on the quarter round and floor and the upper ends on the under side side of the table in the corners, between the cleats and strips.

Owing to existing conditions it may be convenient or even necessary to deviate from the instructions here given as, for instance, if you cannot obtain the hangers described, you may substitute hooks and screw-eyes and get practically the same results. But if the general scheme is followed the results will be satisfactory.

ANGLE PLATE FOR LATHE.

FRANK H. JACKSON.

The angle-plate is one of the handiest attachments to a lathe a workman can have, and is one of the easiest to make.

If the tool of tools (the lathe) is used to its fullest capabilities, it can be made to answer for many other machines. Milling, shaping, planing, etc., can be very efficiently done on a lathe with the aid of various attachments, one of which is here described.

In making my angle I used a casting as shown in the sketches, it being, when finished, 4½ in. long and the shelf part about $2\frac{1}{4}$ in. wide, which is suitable for a lathe from 7 to 9 in. swing. A pattern for the casting is easily made. I also planed up a piece of hard maple perfectly square $2 \times 2\frac{1}{2} \times 4\frac{3}{4}$ in. long, and fastened it to the face plate, A, as shown at B, Fig. 1. C is a trysquare testing the upper face of wood which must be exactly at a right angle to the faceplate. Fig. 2 at D, represents the angle-plate casting bolted on the wood block preparatory to turning off one of the faces. The casting must, of course, have some holes drilled to take the necessary bolts to hold it on the face plate; these holes should be put in the proper places so they can be filed into slots, as shown in Fig. 3, which shows the finished angle-plate.

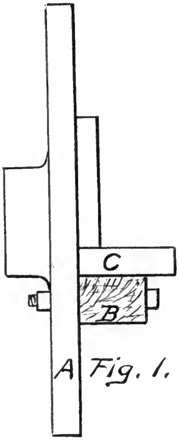


Fig. 1.

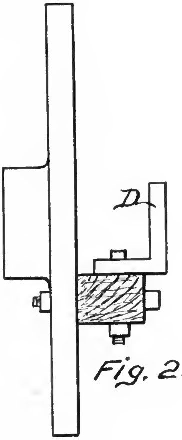


Fig. 2.

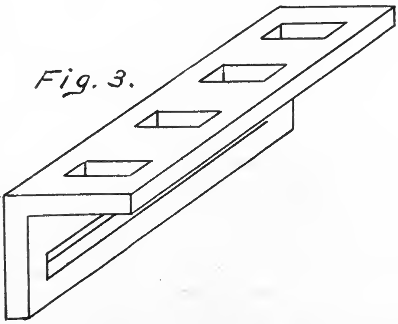


Fig. 3.

After one face has been properly turned off, as shown in Fig. 2. remove it and again bolt it, the turned face down, on the block, being careful to locate it so the cut will cover the entire surface. When this side is properly turned the various slots can be drilled and filed out, the edges trued up, and, if care has been taken, you will have an angle-plate that will answer the purpose as well as one costing a considerable amount.

If a suitable casting cannot be obtained a piece of wrought iron rolled angle plate will answer the purpose. Look over scrap piles; they often contain pieces that can be used to good advantage.

The amateur mechanic should make all the tools and lathe fittings he can, rather than buy them, as by so doing he gains valuable experience, and when he comes to make an engine, or some other larger machine, he can go at it with confidence that he can build it.

SCIENCE AND INDUSTRY.

A grammaphone which, it is said, can be heard at a distance of three miles is the latest invention of the Hon. C. A. Parsons, of turbine fame. The instrument, which was exhibited privately at Metzler's Hall on Monday, is named the auxetophone, and is worked by means of compressed air. This is pumped in by a small engine at a pressure which can be adjusted up to over 3 pounds, through a small valve, which takes the place of the ordinary diaphragm, into the trumpet. The valve consists of a number of small slots, covered with a fine comb, not unlike the mouth organ, and the vibration of this comb produces the sound. On a calm, windless day, it is estimated that, with a high pressure, the record could be distinctly heard three miles away.

Various metals which are themselves non-magnetic, may form alloys which display magnetic qualities; some of these have been produced in recent experiments. Aluminum, copper and manganese are all non-magnetic, but when combined in certain proportions, an alloy of considerable magnetism is produced. As no alloy of copper and aluminum alone is magnetic, this effect must be ascribed to the manganese, and yet this metal alone, as well as copper and aluminum, remained non-magnetic when cooled to the temperature of liquid air. An alloy of manganese with iron is practically non-magnetic, but with the same manganese a magnetic copper alloy can be made.—"Engineering Review."

In some experiments carried out at the Iowa State College by Messrs. H. T. Borsheim and L. C. Moody on the efficiency of steam-pipe coverings, it was noted that with a steam pressure of 20 pounds per square inch in the pipe the loss in a bare pipe amounted to 2,405 B. T. U. per hour per square foot per degree of difference of temperature. With 40 pounds of steam the corresponding figure was 2,589, with 60 pounds of steam 2,686, with 80 pounds of steam, 2,752, and with 100 pounds of pressure, 2,897 B. T. U. per hour per square foot and per degree of temperature difference.

The electrical resistance of the human body as a whole is also beginning to receive attention, with some unexpected results. Herr E. K. Muller, in a paper contributed by him to a Swiss technical journal, tells us, as the outcome of some careful experiments made by him, that it is by no means uniform with all individuals, although it is for the most part somewhere near to 3,000 ohms. So wide are the variations that he is led to believe that every person has a normal resistance peculiar to himself or herself. But apart from this, it varies from moment to moment in response to every emotion from within, and nearly every sensation coming from the outside world. By carefully insulating his subjects, Herr Muller found that the entrance of a stranger into the room where the experiments were conducted caused an instant variation, as did the exertion of speaking, the falling of a ray of light upon the eye, the attempt to listen, or the perception of a powerful smell. He thinks that this hitherto unsuspected sensitiveness of the body accounts in great part for the images seen in dreams. He finds, too, that the resistance is very low with whole classes, such as persons accounted "nervous" and smokers and drinkers. With the hypnotized there is a wonderful tranquility, or invariability of the resistance, so long as the patient is undisturbed, coupled with an increased sensitiveness to external sights and sounds.

The largest double-throw crankshaft in the world was recently forged under the 4,000 ton hydraulic press of the Bethlehem Steel Company, South Bethlehem, Pa. The shaft is one of three ordered by the International Steam Pump Company. It will be, when finished, 27 ft. long. The largest pin diameter is 37 in. The webs in extreme dimensions will be 64 in. by 49 in. and 16⅝ in. thick. The weight of the ingot was 240,000 pounds.

TRADE NOTES.

"Some interesting Facts" is the title of a well gotten up booklet issued by E. Atkins & Co., Inc., Indianapolis, Ind., which presents the points of merit of the goods manufactured by this company. Every woodworker should send for it, as it contains several pages of items of general interest.

G. & H. Barnett Co., The Black Diamond File Works, Philadelphia, Pa., are mailing a new edition of their illustrated catalogue of files and rasps. Every user of files, and especially instructors of manual training should have this catalogue included in their list, and give a trial order of this excellent make when opportunity presents.

Parsell & Weed, 131 W. 31st Street, New York City, are mailing a bulletin of dynamo castings, and complete experimental outfits of quite a substantial type, the output of the dynamos ranging from one tenth to three-quarters kilowatt, according to speed at which it is driven and construction of fields. It is just the thing for lighting a small residence and should prove of much interest to those who are desirous of fitting up such private plants. About 1 h. p. is required to drive it to the fullest capacity.

The exceptional facilities offered by Hammacher, Schlemmer & Co., 4th avenue, New York City, for promptly filling orders for a wide range of tools, should be of value to those interested in the purchase of equipment for the Manual Training Schools. By placing the order with this company, about everything required could be obtained on one bill, thus avoiding duplication of checking up and auditing, etc., to which school orders are subject.

The amateur boat builder who is desirous of building a boat and has as his only guide drawings of a relatively small scale is, under the circumstances, obliged to lay out the lines on a large, smooth floor surface, which is, in many cases, not available. It is important that this be done, as it is the only way in which patterns may be secured which will fair up, one part with another, and no beat, except the very simplest of skiffs, should be attempted without such laying out. Where this is not possible or, because of inexperience, lack of time, or other reasons, the builder does not wish to do this part of the work, the patterns to be had of the Brooks Boat Manf'g Co., 4205 Ship Street, Bay City, Mich., are of exceptional value, as their use ensures a good boat with a minimum of work in fairing up. Boats can be built much quicker with such full size patterns than without them, and our readers interested in boat building should write for particulars.

Are you a sportsman? Well, if you are, you ought to know that the first salmon in the famous Bangor Pool was landed twenty minutes after the law went off April 1st. Yes, the disciples of Isaac Walton were fishing in Bangor Pool at 12.01, A. M., April 1st; but did you know that the fishing season is now on in earnest? Why, the lakes and ponds of Maine are all opened up now, and "they're" hauling out the big ones! Sebago is sending away some choice samples of the Ounaniche or land-locked salmon; the Rangeleys are gathering the experts; the trout streams are being whipped; Moosehead is welcoming her visitors; the Dead River region is as popular as ever with the salmon and trout fishermen, and in the upper Kennebec Country, such fishing grounds as Carry Pond, Lily Pond, Embden Pond, Otter Pond, Moose Pond, Lake Austin, Pleasant Pond and Pierce Pond are all ready for the sport. In New Hampshire at Winnipesaukee, Sunapee and Newfound Lakes, and in Vermont at Memphremagog, Willoughby and Champlain they have been filling their creels for several weeks. A two cent stamp, sent to the General Passenger Department, Boston & Maine Railroad, Boston, will bring you a beautiful illustrated booklet, "Fishing and Hunting," also a booklet giving the fish and game laws of Northern New England. Be sure and send for one; you can't afford to go away without these requisites.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

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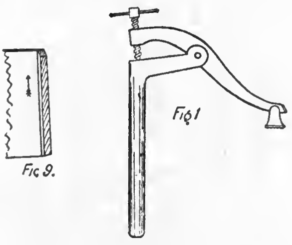
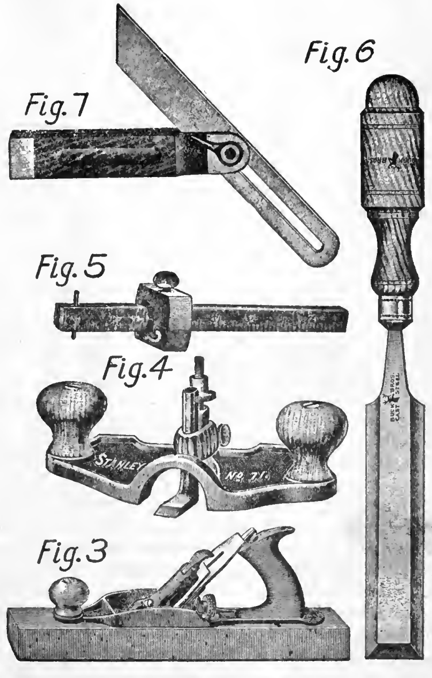
SIMPLE LESSONS IN WOOD INLAYING.

A. C. HORTH.

Inlaying is a craft that allows of no scamping, and should be attempted by no one who expects to get good results with little work. Its difficulties, however, are more apparent than actual, and are overcome without much trouble if the worker is content to start from the beginning. The expense for tools and materials is slight. The following tools will suffice at first: A strong bench, provided with a vise and holes for a holdfast, Fig. 1, a trying plane either of wood, Fig. 2, or iron; assorted firmer chisels, Fig. 3, 1 in., ¾ in., ½ in., ¼ in. and 1-8 in.; a router, Fig 4, tenon saw, gauge, Fig. 5, smoothing plane, shuting board, Fig. 6, bevel, Fig. 7, square rule, and mallet.



A first attempt may be made on a simple teapot stand, such as is illustrated herewith. Plane up the surface of a piece of ¾ in. wood quite smooth and the edges square on the board, being very careful when planing across the end grain to cut off the far corner, to the line, as shown in Fig. 9. When this is ready, set the gauge to 1 in. and gauge a line from each side. Next, set to 1½ in. and run a set of lines inside these lines, and then with the square and a penknife cut in these lines as well as a 1½ in. square in the center. Now take a chisel and pare out the waste wood from between these lines to a depth of 1-8 in., finishing with the router, the iron of which should project exactly 1-8 from the sole. This plane will clean up the bottom of the grooves, and ensure them all being at the same depth.



The wood to be inlaid should now be planed up to size on the shuting board. It should be slightly wider than the space it is to fit in, and of course a little thicker. Having planed up the pieces, fit in the center, but do not drive it home. Next fit the border, very carefully making the joint at the corners, called a "mitre." When the fitting is complete, run some thin glue into the grooves and on to the pieces and drive them in with the mallet. The work should be cleaned up with the smoothing plane when the glue is quite set, on no account before, and then the edges chamfered to complete the stand.

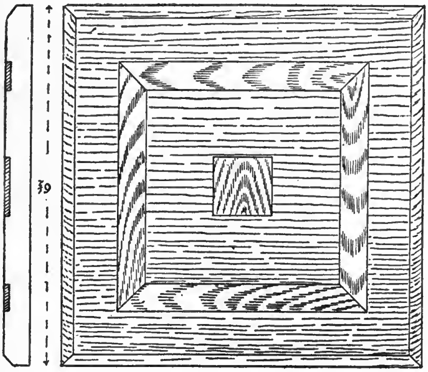


FIG. 8. SIMPLE PATTERN FOR FIRST ATTEMPT.

In cases where it is impossible to get the wood quite smooth, a scraper should be used. A piece of broken glass makes an excellent scraper, and, if carefully used, will clean up the whole surface. Finish it off with glass paper polishing.

pieces are planed up exactly true and an extra one is added. These pieces are then glued together, and when the glue is perfectly set strips are sawn off and placed together, after being planed up on the shuting board and moved along in alternate strips to get the chequered effect. They are then glued up on a piece of stiff paper. In making similar patterns to these, it is of the utmost importance that the planing be true, and each strip exactly the same width.

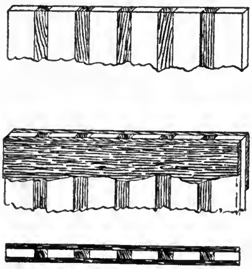


Fig 15.

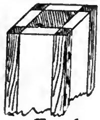


Fig 16.

Fig 17.

Bandings for inlaying borders are made by sawing narrow strips of the piece just described, as illustrated in Fig. 14. A more elaborate yet very simple piece of banding is shown in Fig. 15. To make it, first of all get out a series of strips and glue them up; next glue on each side, after cleaning off the glue and scraping over both surfaces with the saw edge, a thin piece of board, and put under pressure until dry. The banding

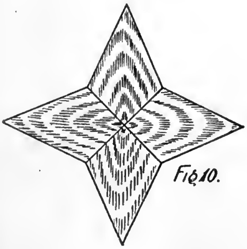


Fig 10.

Fig 11.

Fig 12.

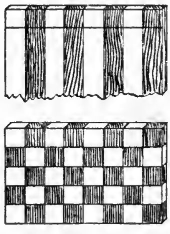


Fig 13.

Fig 14.

To continue the work a stage further, an inlay of some simple ornament, such as the star shown in Fig. 10, may be used instead of the square in the center. It should be made of two contrasting woods, such as sycamore or holly and walnut or rosewood, and cut from a strip of wood in the way shown in Figs. 11 and 12. The latter method, although economical, is not always the most suitable, for the grain should always be studied.

Fig. 13 illustrates how a chequers pattern is produced. The operation is simple. When the size of the square is determined, the requisite number of

is made of strips sawn off the end and planed up smooth.

Corner pieces are also easily made; two of simple patterns are shown at Figs. 16 and 17. The former, the more difficult of the two, is composed of a square piece of wood, with a piece of square section in each corner. Fig. 17 is much the easier; four strips for inlaying are sawn off the end the required thickness.

For those workers in inlay who wish for a piece of work to advance their skill and utilize some of the above pieces of work, the design for an inlaid chessboard is given to enable the worker to utilize his practice. The pattern, which consists of 1¼ inch square, should be made and then inlaid. A banding, made up in a similar manner to that shown at Fig. 25, should be let in as a border, with corners to match built up

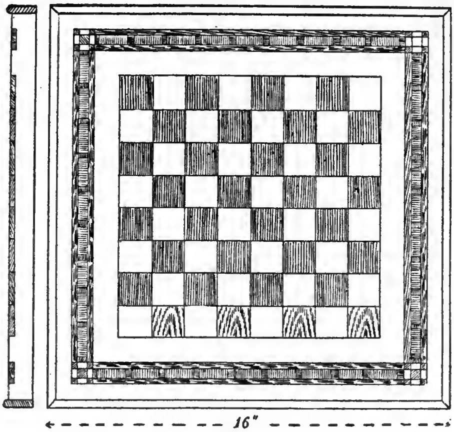


FIG. 18. SIMPLE INLAID CHESS-BOARD.

like Fig. 16. A half-round rim should be screwed on to give a finish to the work. The same idea might easily be carried out in the form of a table, which should afterwards be French polished.—"Arts and Crafts."

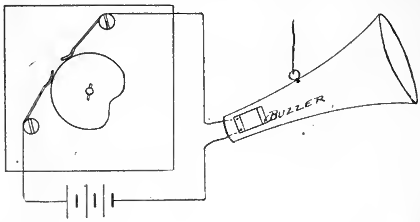
OUTWITTING THE ROBINS.

CARL B. FAUME.

Last year our cherry trees suffered from the depredations of robins, and we lost many baskets of luscious "white hearts" in consequence. This year our trees have blossomed so luxuriantly that I have devised a simple device to scare away the marauders, and, believing that many readers of AMATEUR WORK have a need for the same device, I herewith give a brief description of it.

I first procured a Lungen buzzer at an electrical supply house, also two coils of dry battery and some cheap No. 16 wire. Procuring a piece of sheet tinned iron, I constructed a horn shaped affair, about 12 in. long, 4 in. in diameter at the larger end and 2 in. at the smaller end. Two pieces of insulated wire were fastened to the buzzer binding posts and the buzzer then fastened securely into the horn, at the small end.

It is not desirable to have the buzzer constantly in operation in the cherry tree, as the birds will become familiar with the sound and soon have no fear of it. I therefore arranged the mechanism of an old clock so as to obtain a contact for three-fourths of a revolution of one the cog wheels, by constructing a simple interrupter and two brushes as shown in the diagram. The interruption takes place when the wipe between the brushes and metal disc is broken. In this way the buzzes are irregularly intermittent and, with two or three cells of battery in the circuit, very vigorous. It is advisable to suspend the horn by a wire in the middle



branches, where the wind may cause it to swing as it buzzes. The batteries may be placed in a rain-proof box near the tree, or in the house if you have wire enough to run the line, sufficient allowance being made for loss of battery owing to the resistance of additional wiring. This device is also suitable for suspension over a strawberry bed.

The Westminster Bridge to Tooting tramway will be constructed by the London County Council on the conduit system, at an estimated cost of £251,900. The adoption of the trolley system would have meant a decrease in the capital expenditure corresponding to a reduction of £1,900 in the annual cost of upkeep. The advantage obtained in return for the extra cost has been the absence of any disfigurement of the streets.

The fire risk with incandescent lamps is commonly supposed by the ordinary user to be *nil*, but "Cassier's Magazine" publishes a reminder that while the view is fairly warranted, it is not altogether accurate. For example, in three months of last year at least five fires were caused by the ignition of inflammable materials due to heat generated by electric incandescent lamps. Systematic tests have been made to determine the heating effects of and the extent of the danger of fire from these lamps when in proximity to inflammable materials, and it was found that a 16-candle-power incandescent lamp, immersed in ½ pint of water, caused the water to boil within an hour. A similar lamp, encased in two thicknesses of muslin, caused it to smoke in three minutes, and in six minutes, when fresh air was admitted to the interior, the muslin burst into flame. A newspaper against which the lamp pressed, ignited in three quarters of an hour, and an article of celluloid ignited in three minutes under the same conditions. There is, however, no comparison between security from fires due to the use of the incandescent lamp and that of oil lamps; the published statistics show that accidents and explosions due to the use of oil lamps number many thousands every year.

A CHEAP NINE-INCH REFLECTOR.

M. A. AINSLEY.

I. Tools and Materials Needed.

The telescope I propose to describe was made some two years back, and since it was finished several improvements and alterations have occurred to me—these I will indicate as I proceed. I will devote this letter to a brief summary of the methods I used and the materials required.

The speculum (and this applies to the second 9 in. mirror also) was worked by hand on a glass tool of the same size, the latter being supported on a stout box which was fixed to the top of a cask. The speculum was cemented with pitch to a wooden handle until the fine-grinding was completed, when it was held in a tight wooden triangle, just tight enough to hold it without undue pressure or freedom. The mirror was figured on a graduated polisher (to be described later) and tested by the Wassell method, though my apparatus was considerably simpler than Mr. Wassell's. Having nothing in the way of a workshop (in fact, a good deal was done out of doors), and only a few hand tools, I was largely dependent on the local carpenter and blacksmith, so that anyone with a small workshop and some skill as a carpenter would make a material reduction in the cost.

As to the materials, the glass will be the first thing to get. I was advised to have my 9 in. mirror 1½ in. thick; but I found a good deal of difficulty in procuring glass of this thickness, and had to be content with 1 in. This has proved ample in practice—with care in supporting the mirror, to avoid flexure—but as Dr. Common said in a letter to me: "If your 9 in. were 1½ thick it would not suffer from flexure, however supported." So I should advise 1½ in., or about one-sixth of the diameter of the mirror. I expect 1½ in. would be thick enough for any size up to 10½ in. or even 12 in. They should be roughly ground circular, and the sharp edges removed. Fine grinding of the edges is unnecessary.

THE BENCH OR SUPPORT FOR TOOL.

An old paraffine cask was what I used; but it was not high enough for me, as I stand 6 ft. 2 in., so I raised it another 6 in. or so by means of a stout box, which should be as flat as possible, to keep the tool in place. I found this quite steady, though I think it would be better still to fill both box and cask with stones, earth or something heavy enough. The surface of the tool was high enough to be about 5 in. below the point of my elbow when standing upright. This gave command of the work and avoided stooping, while I could put sufficient pressure on the mirror during grinding to make the emery do its work. I did not find it necessary to fix the tool down (with pitch or otherwise), and if there was any flexure of the tool during the work, it has no perceptible effect on the figure of the completed mirror. The same tool was used to grind both mirrors; the second mirror, however, seemed to be quite rigid enough to impart a good spherical figure to the mirror.

THE GRINDING MATERIAL.

Throughout the grinding operations I used ordinary emery. I understand that "carborundum" is a much more effective grinding material, and I am told it cuts far more rapidly; but it is much more expensive, and as yet I have not tried it; but if I do any more work of this description I shall certainly do so.

For the rough grinding, emery of the grade known as "1½" was used. Sand is a good material for the purpose. In fact, it is recommended by Dr. Common; but I had no supply on hand, and I have found from past experience that the use of it lengthens the rough grinding considerably. It cuts well when quite fresh, but very soon seems to wear down and so has to be very frequently renewed. I tried rough-grinding with coarser emeries, even as coarse as No. 4½, but the edges of both tool and mirror were badly chipped; and it appears also that if the rough-grinding material is too coarse, the mirror, after "roughing out", is not spherical, but has considerably more curvature in the center. If a finer grade of emery than "1½" is used, the rough-grinding is much prolonged.

About 10 pounds of the "1½" emery will be required for the "roughing-out" of the mirror. The amount required, of course, depends on the diameter and focus of the mirror, and it is not to be expected that the process should be as rapid as in the case of a mirror of smaller size. The depth of the center of my first 9 in. mirror is about 1-12 in., the focus being 63 in., and it is obvious that as the depth of the mirror in the center varies as the square of the aperture, the focus being constant, the time being taken to dig out a mirror of large diameter is much greater than that required for one of smaller size. For the fine-grinding, emery of No. 46 grade was used first; when the curve became nearly spherical, emery of No. 150 grade was employed, then washed flour emery; after which I prepared the finer emeries by processes to be described later. The amount required for the 9 in. mirror was as follows: No. 1½, about 10 lb.; No. 46 about 2 lb.; Nos. 120 or 180, or anything of about that fineness, about 2 lb.; washed flour emery about 6 lb., though more may be required if the later stages of fine-grinding have to be repeated.

The exact grade of emery required for each stage is not very important. For example, an equally good result could be obtained with emery of say, 1½, 80, 180 as with 1½, 46, 180, the main point being to insure a steady diminution in the size of the grain. There is no necessity to use many different grades; in fact, Dr. Common used sand 150, and worked flour in succession. I quote from a letter received from him about two years ago.)

I will defer any consideration of polishing material till later. Meanwhile I would impress upon the would-be beginners in the art the necessity for patience in each stage of the proceedings. I can speak from experience that more trouble is caused by hurry and impatience in going from one grade to the next than by anything else. "The greatest thing in mirror-grinding is to get a good surface before polishing." (Dr. Common.) And I have found much reason to believe in the truth of the statement. Every stage of the work must be thoroughly done, and 'More haste less speed" is never truer than in this delicate and fascinating art.

ROUGH GRINDING.

In order to hold the mirror comfortably and to avoid touching it with the fingers during fine-grinding, I obtained a disc of hard wood 6 in. in diameter and ½ in. thick with a handle 1½ in. thick and 3½ in. long fixed in the center. The glass disc was smeared with turpentine, and a pool of melted pitch nearly as large as the wooden disc was poured on, the glass having been previously roughly levelled. I strongly advise the would-be speculum worker never to omit the precaution of first smearing the glass with turpentine. I omitted it once, with the result that when the rough-grinding was nearly complete and I was lifting the mirror off the tool, I had the mortification of seeing it drop on a brick floor from a height of some four feet and, of course, on the "buttered side ". Result, a chip 2 in. square out of the face and a new disc required. If, however, the glass is smeared with turpentine, there is little fear of such a catastrophe.

Here a word concerning pitch—which will be a good friend or a bad enemy, according as we use it well or ill. The pitch was Sweedish pitch, in 2 lb. cylindrical boxes. To get the pitch out, do not attempt to chip it, but cut clean through box and all with a chisel. The wood, which is very thin, will come away from the pitch easily and leave a block. I cut mine into cakes 1 in. thick and melted them in an iron ladle over the kitchen range. There should be no solder in the vessel used, and a long handle and spout are convenient; but, before all things, do not melt the pitch over an open fire, or in any place where it or its vapor can possibly come in contact with the flame. This warning has been often given before, but it is most important if danger of fire is to be avoided. Having got a pool of pitch about 5 or 6 in. in diameter, place the wooden disc on it without pressure and move it about until the wooden and glass discs are concentric; then press down firmly and leave to cool. It is important that the handle should be accurately centered; this can be tested by rolling the disc of glass along a table and seeing whether the handle rises and falls or is apparently stationary. This adjustment is of some importance, as it ensures correct centering of the concavity.

Provide a flat, broad-bladed knife (a putty-knife, for instance), a old sponge, and a basin or bucket of water, (warm for choice).

Wet both tool and mirror thoroughly and sprinkle the tool evenly and closely with the coarse emery. A few drops more water from the sponge will about give the amount of moisture required. It is impossible to say on paper how much emery is required for each "wet" or how much water. This is a matter for experience. If too little water is used the grinding is stiff and unsatisfactory. Too much water or too little emery will cause most of the grinding material to be driven off the tool. Too much emery will give rise to a thick mud, which will slow down the grinding.

Having placed the mirror (or what will be the mirror) on the tool, grasp the handle with both hands, the fingers lying across the disc of wood and reaching to its further edge. Work the mirror to and fro with long, straight strokes, no side motion being given; keep the mirror revolving to the right, or left, as may be convenient, by working the fingers along the edge of the wooden disc, and at the same time walk around the cask, in either direction, so as to get around about once in 20 or 25 strokes. The exact speed is immaterial, but the motion should be continuous. All this will become quite mechanical after a few minutes' work. It will probably be found that a great deal of emery will be driven off the tool; but it can all be collected with the knife and used again, so there is not much waste. The noise made, if the emery is doing its work properly, should be considerable, and it will gradually reduce as the emery wears down. When the mirror glides over the tool nearly silently it is time to put on a fresh " wet ". The mirror is slid off the tool—a band being kept under it to avoid accident—and sponged over, a fresh lot of emery is evenly sprinkled over the tool, a few drops of water added from the sponge, and the work proceeds as before. As a rough guide to the quantity of emery required for each wet, I may say that for a 6 in. mirror I used about as much as would go on a crown piece, heaped up; but this is only a rough idea of the quantity. After every five or six wets the speculum and tool should be thoroughly washed with the sponge.

Before this has been going on long a straight-edge placed across the mirror will begin to show "daylight" in the center, and we must begin to think of some way of testing the depth of the curve. A plan often recommended is to make templets in glass or zinc by means of a bar cut to the radius of curvatures required and used as a long beam compass, the glass or zinc being ground smooth after cutting. A plan I got from a back number of "Ours" and which proved very accurate and simple, is as follows: Find out by measurement how thick a pile of, say, 100 sheets of writing paper is

(I used glazed paper which proved to be exactly 200 to to the inch). Dividing by 100, or whatever the number is, we get the thickness of one sheet; in my case, .005 in. Prepare a series of strips of this about ½ in. wide; then if a straight edge of steel is placed across the center of the mirror and strips of paper placed under its center until it just turns about the center rather than about one end, the depth can be easily arrived at by counting the number of strips required. The depth required, the diameter of the mirror being D and the focus aimed at F, is given by the formula $\frac{D^2}{16F}$

Thus, for a 9 in. mirror of 63 in. focus we have the depth in the center $= \frac{81}{16 \times 63} = .08$ nearly, for a 6 in. mirror of 60 in focus $\frac{36}{16 \times 60} = .0375$, and so on.

It is worth noticing that if the focal length of the mirror is made eight times its aperture, the depth required in the center becomes $\frac{D^2}{16.8D}$ or $\frac{D}{128}$; and if the focal length of the mirror is made ten times the aperature, it is $\frac{D}{160}$. Thus a 9 in. mirror of 6 ft. focus would have a depth of 9-128 or 1-14 nearly. I am assuming that the reader has not got the chance of copying an already-worked mirror. If he has the following will be found very simple. Provide a piece of wood (hard for choice) 6 x 1½ x ⅝ in. Drive two 1½ in. wire nails through one end, side by side, and one through the other end, or use screws, it is quite immaterial, so as to form a long isosceles triangle. Through the center pass a screw about 2 in. long. This will form a rough sperometer, which, if not much use for measuring the depth of a curve, is capable of testing with very considerable accuracy when a certain curve is obtained. Place it so that the points of the end screws rest on the center screw until the whole just turns about its center rather than one end. When the rough sperometer is transferred to the mirror being made, the curve thereof is known to be correct when it just turns about its center as before.

When the rough-grinding is carried so far that the depth of the mirror in the center is as required, it will probably be found on testing with the spherometer that the center is somewhat more curved than the parts nearer the edge; this will disappear in the fine-grinding, but if a definite focal length is required, it is advisable to go on rough-grinding a little more, as the effect of the fine-grinding, in my hands, at least, is to slightly lengthen the focus.

The stroke in rough grinding may be as long as can be given without the center of the mirror going beyond the edge of the tool. If the mirror lifts, in consequence of a tool long stroke, chipping is to be feared. A certain amount of pressure with the hands is permissable but if too much is applied, the emery is liable to be driven off the tool.

THE USES OF HIGH SPEED STEEL.

The writer has taken a good deal of interest in the method of using, treating and grinding high-speed steels. The first thing is to make up one's mind as to the quality or kind of steel to use, which means to be satisfied with the steel which has been found to work best in one's own shop. This has been a difficult matter for superintendents and foremen to decide, because it is so hard to discover the best way to determine which steel will do the most work, and experience has taught most of us that any of our high-speed steels, when properly treated, will do considerably more work than the machine is capable of.

I do not think it advisable to have too many different kinds of stock in the works; results depend entirely upon the way of forging and treating the tool. If the tool maker is familiar with one or two grades of the best high-speed steel, and the quality is found satisfactory and bringing about the best results that the machines can stand up to, these are the steels that should be adopted. Each of these steels must be treated differently, and if the tool maker succeeds in treating one grade properly and understanding it thoroughly, it means much time saved and better results in the shop.

In introducing the use of high-speed steel in a shop, like everything else that is to be a success, one must start right. That is, the work should be undertaken by some responsible person—superintendent, foreman or speed boss; in other words, the man who is responsible for the work turned out in the machine shop. All tools, of course, have some particular way of treating, which should be understood by the person in char ge Now, it is "up to the forger". The person in charge should see that the tool has its proper treatment. When the tool is finished and the superintendent or foreman is satisfied that it has been properly treated in accordance with directions, it is ready for grinding and for making a test. It should be ground on a wet emery wheel, and care taken to heat the tool just so it can be touched with the fingers.

The tool once ground and ready to do the work, the question arises: "What lathe, planer or machine are we going to put it into?" In most cases when a new tool is tried it is put in a lathe to do turning. So, naturally, the superintendent or forman would pick out the best lathe that was in the shop—i. e., the lathe that was considered to have the most power. Being now ready to make the test, it is generally tried on steel; that is considered by most superintendents and foremen to be the severest test to make. Take a piece of steel of almost any diameter and of the quality most used in the shop, and prepare to take the cut. It seems to puzzle most every foreman to know just what to do and where to start. I speak now of what I have seen, and of the men who are sometimes sent by the steel makers to demonstrate the use of their steels. I think the proper way is to get at least one dozen shafts of a standard size that are used in the regular line of product, and to first look up the exact time it took to finish or rough off the previous lot; then to determine about what percentage of time would be considered a fair gain to warrant adopting the steel, based on the price per pound of the steel being used. Let it be based at 25 per cent, which I find in most shops can be accomplished, and the lathe be speeded up faster than when the last lot was turned, starting with the same feed, and about the same cut, which almost any lathe will stand. The superintendent finds, after he has roughed off about two or three pieces, that the tool seems to stand up all right. The next step is to find out about the speeds and feeds. The first thing is to increase the feed with the same speed the machine is running at. In most cases which I have seen, after the tool had traveled a certain distance, the cutting edge would break or crumble, and the foreman would say: "Just as I expected. All this high-speed steel will do the same thing!" forgetting he had just been doing over 25 per cent. more work than ever before, without the least bit of trouble.

Now the tool is taken out and looked over, it is found that a portion of its cutting-edge has been broken off. Here is where most foremen make a mistake; they take the tool back to the forger or tool dresser to have it redressed and treated over. If it is only broken off slightly and can be ground, even if it takes ten or fifteen minutes to grind, it should be done by all means. My experience has taught me that it will prove a better tool than before; but care must be taken not to overheat in grinding.

The tool is now put back in the lathe, which is started again; and generally, to one's astonisment, it will be found that the tool will stand up all right. One should not be too anxious to break the tool again (!) but should turn up two or three more pieces with an increase of feed, keeping a record of the time it takes to turn up each piece. Once convinced that the tool will stay up all right with the increase of feed, the foreman can increase the speed one step on the cone. About the time this is done it is found either that the belt slips, the lathe is stalled, or the countershaft will not drive. (It is my opinion that in most all machines which have been built up to a year or so the countershafts are not strong enough in comparison with the machine tools.) Now, no doubt if these things had not occurred the tool would have done better; but in this case reduce the speed and finish the twelve shafts which it will probably be found can be done without grinding the the tool. When the shafts are all roughed off and finished, the foreman will find, to his great astonishment, that by actual time the lathe has produced over 25 to 40 per cent more work than ever before. I allude to the lathe using most all ordinary tool steels.

At this point it in up to the superintendent to see just where he is at, and he finds in looking around his shop that there is hardly a machine that he can't speed up; but he also finds that the speeds on the countershafts are all too slow. This means that he has either got to increase his speed by increasing the main line, or buy new pulleys to increase his countershafts. In most instances it is advisable to increase the speed of the countershaft; but by doing this he generally finds that the countershaft will not stand the speed. If the machines are not too badly worn out, and he is satisfied that he can get at least 25 per cent. more work out of the tool by increasing the counterspeed, by all means let him get a new countershaft and treat each machine this way.

No doubt the readers of this article will know the results that some of us have arrived at in the last two years. In regard to cutting speeds and feeds there has been and always will be difference of opinion, and it is almost impossible to determine the right feeds and speeds, whether it is for steel or cast iron, and for the operations of planing, turning or milling. The work varies so in different shops; that is, regarding the construction of different pieces, the amount of metal there is to remove from each piece, and how accurately the work has to be done.

There is no doubt in my mind that the makers of high-speed steel have awakened the management of different shops, and it is surprising the amount of work which can be accomplished even with the old machines, with very little redesigning. There is no question but that the machine shops which do very heavy work have not the necessary power for the use of high-speed steels, as the power should be used if the machines are old ones. Referring again to the question of grinding, I wish to state that this is a very important factor in the use of high-speed steels. I have seen much damage to the tools, in many instances making it necessary to treat them over, and as we all know, this takes much time. My recommendation for grinding is to let one man grind all the tools and be responsible for them. When a lathe tool or a machine hand wants his tool ground, he simply gives it to the man who is responsible, and gets another the same size and shape, these being always kept ground and ready for service. In this way the tools are kept uniform and ground alike.

In reference to the amount of work that can be accomplished on different machine tools, the writer finds that the feeds have been altogether too fine on most makes of machines up to the time that they were redesigned for high-speed work. Now it has been demonstrated that high-speed steel has come to stay, and we all know that it works better on roughing work than it does on finishing. If most of the product of the machine department is to be turned, it has come to the point where the majority of work must be ground; and this is the only way to get good and accurate work, especially where the strains of the cut spring the work. Moreover, as it is not necessary to straighten the work to any great extent, it certainly means a great saving, as many of our readers know. The writer is not a builder of grinders, but merely speaks of the saving it has been on his own work.

Below is a fair average of the speeds that most any good make of lathe, planer, drill press or radial, ought to stand when using high-speed steel. Every lathe has a face-plate about the diameter of the swing, or very near that. Take the periphery speed of same by feet minute; the use of a Warner cut-meter will give you speeds instantly. This is one of the handiest little tools that can be obtained, and no machine-shop is complete without it. The speed must be taken with the belt on the largest step of the cone, with the back gears in. The speed of the following sizes of lathes, taken from a large faceplate with the slowest speed, I find to work very well, and considerable saving has been effected on old lathes. Of course, the feeds will have to be determined by the amount of power available:

LATHES.

14 in.	swing;	slowest	speed	with	back	gears	in,	100	ft.
16 "	"	"	"	"	"	"	"	90	"
18 "	"	"	"	"	"	"	"	85	"
20 "	"	"	"	"	"	"	"	75	"
24 "	"	"	"	"	"	"	"	65	"
30 "	"	"	"	"	"	"	"	60	"
36 "	"	"	"	"	"	"	"	50	"
42 "	"	"	"	"	"	"	"	30	"

Larger lathes in proportion.

PLANERS.

20 by 20	travel of	cut	40 ft.
24 by 24	"	"	38 "
36 by 36	"	"	35 "
48 by 43	"	"	30 "

Larger ones in same proportion.

If you have the power in your planers the speeds ought to work on soft steel as well as cast iron.

High speed twist drills, drilling cast iron, ought to drill the following, if you have the power and feeds:

½ in.	diam.,	speed	500	r. p. m.,	3¼ in	deep in	one min.
⅝ in.	"	"	400	"	2¾ in.	"	"
¾ in.	"	"	335	"	2½ in.	"	"
⅞ in.	"	"	290	"	2¼ in.	"	"
1 in.	"	"	250	"	2¼ in.	"	"
1⅛ in.	"	"	220	"	2⅛ in.	"	"
1¼ in.	"	"	200	"	2 in.	"	"
1⅜ in.	"	"	185	"	1⅛ in.	"	"
1½ in.	"	"	175	"	1¾ in.	"	"

Larger ones in proportion.

These speeds are all based on a periphery speed of 65 ft. per minute. High-speed drills have done somewhat better than this, however; but, taking into consideration the time of grinding, I find that this speed is a good average during a day's work.—"Machinery."

A classification of electric motors shows them to be divided into groups according to their winding and the character of the current employed to operate them. The direct current is used for motors wound as follows: Constant current series-wound motors, constant potential shunt-wound motors, constant potential differentially wound motors. Each of these types is distinct as far as its winding is concerned, although the last is a combination of the first two—that is, shunt and series winding. Series-wound motors are employed on direct current circuits which supply a constant potential; they are used in high tension arc light constant current systems and in street railway 500-volt constant potential systems. The shunt-wound motor is used for stationary work, such as the running of machine tools, printing presses, etc.

Experiments in long-distance overland space telegraphy were made last year, says "Cassier's Magazine," and in the United States signals were transmitted a distance of about 300 miles between Chicago and St. Louis. There appears to be no crying demand, however, for a wireless telegraph service for public use between large cities, even if the entire practicability of the sytem for long distances overland had been satisfactorily demonstrated; but the employment of this beautiful system, which has not yet ceased to be wonderful, between ships at sea and ships and the mainland, and between points divided by sea or lake, where the use of cables is not economically practicable, is steadily and rapidly increasing. Among the more recent important instances of this nature are the five Marconi stations on the river and Gulf of St. Lawrence, which cover a territory of nearly 1000 miles, and the De Forest Stations at Bocas det Terro, Panama, and Port Limon, Costa Rica, seventy miles apart.

A recent improvement in microscopy utilizes an entirely new principle of radiance. When ordinary sunlight is analyzed by a prism, the observer sees all the colors of the rainbow, there being at one end of the series a violet band and at the other a red one. The rays emanating from the former are shorter than the others. Out beyond the visible violet rays are others having a still shorter wave length, but ordinarily unseen. Glass obstructs them, but a prism of quartz transmits them. These "ultra violet" rays have a high photographic value. The astronomer is thus enabled to obtain records of lines in the solar spectrum which he cannot see. Some of the Jena experts have proposed to substitute quartz for glass in the train of lenses interposed between the arc light and the specimen, and also in the objective used for examination. Thus the visible light is reinforced by invisible light, the latter being particularly useful for obtaining a photograph of a specimen. The plan has the additional merit that the staining of a specimen before examining it would be unnecessary.

A READING STAND.

JOHN F. ADAMS.

Many readers of AMATEUR WORK are undoubtedly studious and given to reading, and when such reading is from a large and heavy book, fervently wish for some kind of supporting device wherewith to make easier the holding of the book. This is especially true when, tired from an arduous day's work, one desires to lie on a couch and rest, and at the same time to read. While visiting a friend recently, whose ingenious mind is always planning, and skillful hands making, some labor saving fixture, the stand here described was exhibited and pronounced by the owner to be most satisfactory furniture he had added to a somewhat large collection of homemade work. The illustration clearly shows its general makeup. It can be made of whitewood, gumwood, oak or any except very soft wood.

The lumber bill is as follows:

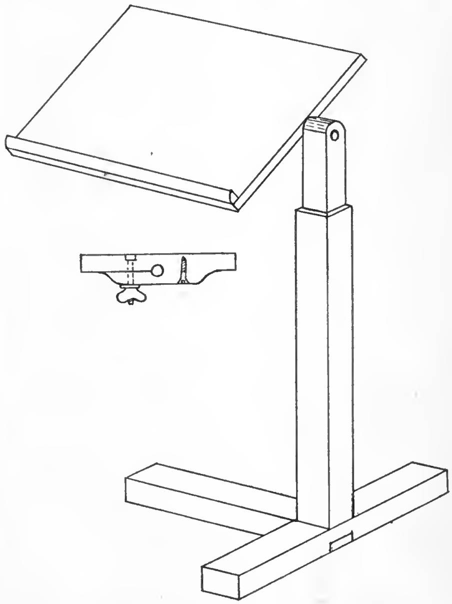
1	piece 4 ft. long and 1¾ in. wide, ½ in. thick.
1	" 7 " " " " " " 1¾ x 2¾ in. "
1	" 4 " " 2¾ " " " 1½ in. "
1	" 18 in. " 15 in. " " ¾ in.
1	" 18 in. " " 1¼ in. round curtain rod.
1	" ½ in. moulding.

The T frame at the base is made of the 1¾ x 2¾ in. stock, the top of the T being 18 in. long and the extending piece, 16 in. long, with halved joint. A mortise 1½ in. square is made through the center of the joint to receive the tenon on a piece of the same stock, 6 in. long and 1¾ in. square. The tenon made on this latter piece is very firmly wedged into the mortise, and also glued for additional strength.

The barrel, 24 in. long, is made of the ½ in. stock, measuring inside 1¾ in. The joints should be glued and nailed, planing off, when the glue is dry, to secure a good, smooth surface. When finished it is firmly nailed at the bottom to the short piece projecting from the T base.

The post should have a snug fit inside the barrel, and yet slide therein without binding. It is 24 in. long and 1¾ in. square, which is secured by sawing off one edge of the 1¾ x 2¾ in. stock. The top end is rounded off, as shown. A hole is bored not quite through the top, and centering 2 in. from the top, for the end of the piece of 1¼ in. curtain pole. If this size cannot be obtained, use 1 in. pole.

The table is a plain board 18 x 15¾ in., with two supports, screwed and glued to the under side of the shape of the supports, as shown in the illustration. They are cut out of the 1¾ x 2¾ in. stock, and are 12 in. long. Holes are bored at the center to give an easy fit to the rod. Slots are also cut from one end to the center of the holes, and bolts with butterfly nuts fitted, so that by screwing up the nuts, the supports will bind on the rod and hold the table in any desired position. It is also well to put screws through the ends opposite the slots to prevent their splitting at that place. Washers should also be placed under the nuts. It will be noted that to adapt the stand to either side of a couch or bed, it is only necessary to take off the table, turn it around and replace upon the rod.



To adjust the height of the post, 1 in. holes 3 in. apart are bored in both barrel and post on the side from which the table extends, but not through the outer side of the barrel. The lower hole is 12 in. above the base. A wooden pin is then made to fit the holes, with the inner end pointed for easy insertion.

In addition to the uses first mentioned, this stand is very handy as a medicine or food table beside a bed for case of sickness.

"Acid metal" or "lead bronze" is a durable alloy which can withstand the corrosive action of mine water. It is, therefore, suitable for machinery employed underground. Its ingredients are: 75 per cent. copper, 15 per cent. lead, 99 percent tin, and 0.10 per cent. phosphorus.

MARINE GASOLINE MOTORS.

THEIR DESIGN AND OPERATION.

By Courtesy of the Brooks Boat Mfg, Co.

Most manufacturers of these motors claim that theirs is the best, most reliable motor on the market, and in support of this claim give a detailed description of the different parts and manner of construction; explain the principle upon which the motor operates; show illustrations of the different parts, etc.

All this would be perfectly proper and of value to those seeking information were it not inferred that each point and principle described was a special feature of their particular motor and of no other. To those unfamiliar with them, this result is a confused idea that there are numerous kinds of these motors involving entirely different principles of construction and operation. It is with a view to correct this erroneous impression and at the same time give a true understanding of the principle and operation of all gasoline motors that the following explanation is given. The subject is therefore taken up only in a general sense and does not apply to motors of one make any more than it does to those of another.

PROPERTIES OF GASOLINE.

Gasoline alone will ignite but not explode. The mixture of vapor formed by gasoline and air will ignite and explode. When this vapor is compressed it will ignite easier and give more power to the explosion. The power of all gasoline motors is derived from the impulse given by the explosion of the compressed vapor.

MOTOR CONSTRUCTION.

Marine gasoline motors consist of one or more water jacketed cylinders with an immovable head at the top end, and a movable piston inside that is connected by a rod to the crank shaft. This is the foundation of all motors.

The conditions are that in operation the combustion of the vapor produces heat; that the cylinder must be kept cool for proper lubrication; that a proper mixture of vapor must be supplied to the cylinder; that this vapor must be compressed by the piston; that the compressed vapor must be ignited; that proper lubrication to all parts must be had, an that all of these must be automatic, positive and under control.

IN OPERATION

The cylinder is kept cool by water circulating through the water-jacket of the cylinder. The water is circulated by a pump attached to the shaft. The vapor is supplied by the carburetor or vaporizer, devices that properly mix the gasoline and air. The vapor is drawn into the cylinder by the piston, which in this connection acts as a pump. The charge is compressed by the return stroke of the piston, and when so compressed is fired by an electric spark. The explosion of the compressed charge imparts an impulse to the down stroke of the piston, a portion of the energy being stored in the momentum of the flywheel. This stored energy completes the revolution and compresses the next charge. The pistons and connections are lubricated by sight feed and compression oil cups, using for the gas-engine cylinder oil.

TWO AND FOUR CYCLE MOTORS.

The gasoline motors in general use operate as stated, on the one principle. They vary only in the application of the same principle. There are two important variations. First, in the number of revolutions made to each impulse. Second, in the igniting device. With reference to the first, a motor that makes one complete revolution of the shaft to each impulse is called a two cycle. (The piston makes two motions—up and down.) A motor that makes two complete revolutions of the shaft to each impulse is called a four-cycle. (The piston makes four motions—up, down; up, down). There are arguments in favor of and against both types, which we will state and comment on.

THE TWO CYCLE MCTOR.

The two cycle motor having an impulse to each revolution will have twice as many impulses as a four cycle. This results in a more even distribution of the power, hence less vibration. To state this in another way—a four cycle, to develop the same power on the same number of revolutions, would require twice as strong an impulse, as it would have but half the number of them.

The two cycle has this objection—that the compressed charge is not as pure, and that a slight portion of it is wasted. Theoretically the impulse given by the explosion takes effect when the piston is at the top of the cylinder, driving it down. Near the bottom of these is the exhaust outlet, and the other is the inlet for the new charge. As both of these are practically open at the same time, a slight amount of the new charge may pass through without being compressed, and as the new charge is taken in at the same time that the old one is exhausted, a part of the latter may not escape. Hence, theoretically the two cycle has not as pure a mixture as the four cycle. This objection is partly remedied by the deflector, which is a plate on top of the piston that deflects the new or entering charge up and away from the exhaust port.

FOUR CYCLE MOTORS.

The four cycle cylinder has both the intake and exhaust openings at the top of the cylinder, and they are operated automatically by valves instead of by the piston as in the two cycle. To explain, we will follow the operation. Commencing with the piston at the top of the cylinder, the down stroke of the piston draws in a charge, the inlet valve being open and the exhaust closed. At the end of the down stroke of the piston the inlet valve closes and the up stroke of the piston compresses the charge, which is exploded driving the piston down. At the end of this down stroke of the piston the exhaust valve opens and the up stroke forces the exhausted charge out. At the end of this up stroke the exhaust valve closes and the inlet valve opens, ready to repeat the operation.

The argument in favor of the four cycle is that the cylinder is better cleared of the exploded charge before the fresh charge enters. This is not entirely true for the reason that the piston does not travel clear to the top of the cylinder, therefore the compression or firing chamber may still retain a portion of the exploded charge.

This is the most important factor in the operation of the motor. There are several forms of ignition in use. First, the hot tube method, a device but little used by manufacturers in this country except for stationary motors using natural gas, so we will not trouble to describe it.

All electrical sparking devices are supplied with electricity, either from the cells of a battery or a small dynamo. As the latter will not generate the current until in motion it is always necessary to have the battery to start the motor. After the motor is in motion the bttery is switched off and the current supplied by the dynamo only. This results in saving the battery and is in all ways most satisfactory. This is particularly true in reference to the larger motors.

The electrical sparking devices may be divided into two classes. The first class consists of the the jump spark. The second class may be classified under three heads, the make and break, the wipe spark and the hammer break.

The jump spark is becoming the most popular method and is fast superseding all the others for two cycle motors. The jump spark mechanism consists of three or four dry cells, an induction coil with a primary and secondary winding fitted with a vibrator (commercially known as a spark coil), a spark plug and a suitable device attached to the shaft for making the circuit. The spark plug screws directly into the firing chamber and contains the points or terminals. These are properly insulated and at their end are not more than 1-16 inch apart. Without technical explanation it may be stated that when the circuit is formed the excitement of the coil causes a strong spark to jump between the terminals of the spark plug within the firing chamber.

The points in favor of the jump spark are less moving parts, positive ignition, simplicity of mechanism and no moving parts within the firing chamber.

The objection to the jump spark is that the space between the terminals is liable to become fouled by soot ifthe vapor is too rich in gasoline or by oil if too much lubrication is given the cylinder. However, the objectional conditions seldom occur after one becomes familiar with the requirements of the motor, and when the points do become fouled the spark plug may be instantly removed and cleaned.

The second class, the make and break, wipe spark and hammer break all operate on the same principle with numerous different mechanical methods of operation. Therefore, we will not attempt any definite description other than to state that they consist of two electrodes or terminals within the firing chamber. One of these is stationary and one movable. The spark is given by the separation of the terminals. When the points lap by and wipe together it is called a wipe spark; when separated by a spring it is called a make and break, and when separated by a blow from a projecting arm it is called a hammer break. Of the three, the make and break is most in favor. The objection to all of these is the mechanism required and its liability to get out of order; that the firing chamber is twice punctured by the electrodes; that it is difficult to keep the joint tight where the moving electrode enters the firing chamber; that it is hard to lubricate—this for for the reason that the pressure within tends to force back the oil; that the points of the terminals wear out and are apt to become fouled or gummed with oil and soot.

Although our experience is in favor of the jump spark, especially with the smaller types of motors, we must, in justice say that some of the make and break devices give splendid satisfaction, particularly when used on the larger multiple cylinder motors.

VAPORIZING THE FUEL.

There are in general use two devices for mixing the gasoline and air to form the vapor. These are the vaporizer and the carburetor. The vaporizer is a device that mixes the gasoline and air by the operation of the motor, that is, the up stroke of the piston acts as a pump and draws in the supply of air. This mixes with a jet of gasoline and passes into the base. The down stroke of the piston compresses this vapor so that when the port opens it passes into the firing chamber above the piston.

The gasoline feed of the vaporizer is regulated by a needle valve, and the air supply is usually taken through a cheek valve. The vaporizer mixes sufficient vapor at each cycle for the charge only.

The carburetor produces the vapor by bringing a quantity of air and gasoline into contact, either by drawing the air through a reservoir of gasoline or over its surface. The carburetor has a supply of vapor in reserve. Both the vaporizer and carburetor operate better in warm than in cold weather, as the expansion of the gasoline greatly reduces the temperature. This is overcome by heating the air supply. A simple heating device is to place a perforated collar over the exhaust pipe, thus making a hot air chamber and connecting this with suitable piping to the intake air valve.

CONTROL.

As the marine motors are all comparatively high speed, the piston travel is very quick, and in order that the thrust may be given to the piston the ignition must take place at such a point as gives the best results. Regarding this we must consider two points—the speed of the piston and the time required to expand the charge after it has been ignited. We will make this point clear, as it is of importance to the amateur operator. In the first place, the sparking device on all motors is or should be regulated by a lever under the operator's control so that by manipulation of this lever the spark (time of ignition) may be advanced so as to cause early ignition, or retarded so as to cause late ignition at will. Now supposing the motor is turning very slowly (as when cranking it) the lever should be set so as to fire the charge just when the piston is starting on the down stroke. But as the speed of the motor increases the travel of the piston becomes so fast that it does not receive the impulse, that is, the charge has not had time to fully expand while the piston is on the downward stroke, therefore the time of ignition must be advanced to that point which will give the greatest force of the expansion to the down stroke of the piston. This results in the ignition taking place while the piston is on the up stroke; that is, while it is still compressing the charge.

The regulation of this is a very simple matter and is, of course, dependent upon the speed or number of revolutions the motor is making. The operator merely manipulates the controling lever.

By advancing it he will increase the speed up to the maximum point. By retarding it he will decrease the speed or check down the motor.

It is by this manipulation of the spark that the motors may be made to run either way. After one becomes thoroughly familiar with some of the smaller two cycle motors, they can be slowed down and reversed without stopping, through a proper manipulation of the spark control.

When the motor is to be run under check for any length of time, the supply of vapor must also be reduced.

CONCLUDED IN THE JULY NUMBER.

THUNDER STORM INDICATOR.

OSCAR F. DAME.

Every student of wireless telegraphy is familiar with the story of the first coherer, with which electrical disturbances in the air were noted by the operation of a relay and the ringing of a bell.

This same coherer principle enters into the receiving apparatus of many wireless systems. While the scheme is an old one, there is still an excellent opportunity for experiments in this line, and apparatus built according to the accompanying specifications should be a fairly accurate recorder of the excess of electrical impulses in the air which usually precede a thunder storm.

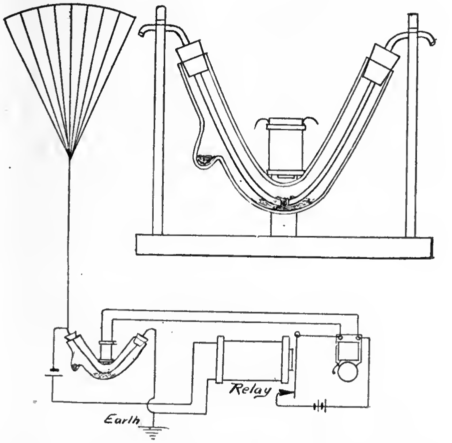


Fig. 1 represents a coherer designed especially for receiving high voltage disturbances, and immune from arc light and trolley spark waves. The glass tube may be purchased at any drug store for a few cents. The diameter of the tube is about ¼ in. The tube is heated over an alcohol or gas flame and bent to a V form. A sack is also drawn out on one side near the top to hold extra filings. The two electrodes are of polished heavy copper wire.

This coherer is not exhausted, and the amount of filings at the electrodes may be regulated by drawing from the supply at the sack. The filings are of clean cast iron, as fine as can be made. Any relay suitable for wireless telegraphy, many of which have been described in back numbers of AMATEUR WORK, will operate with this receiver. The electro-magnet is about the size of one coil in an electric door bell, but should be wound with finer wire, No. 24 being a good size. The purpose of this magnet is to serve as a decoherer when the relay operates. The coherer should be supported by two wooden pillars mounted on a base-board. These can be made from meat skewers. A 2½ in. door bell serves for a signal in place of a sounder. The aerial wire and ground wire should be constructed the same as those of a simple wireless circuit.

To test the purity of turpentine, drop a small quantity on a piece of white paper and expose to the air. No trace will be left if the turpentine is pine; but if it contains oil or other foreign matter, the paper will be greasy.

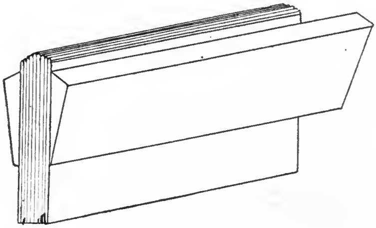
BOOK=BINDING FOR AMATEURS.

WINTHROP C. PEABODY.

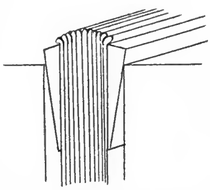
VI. Rounding the Back.

The sewing completed, an examination should be made to ascertain that all sheets, plates, etc., have been securely fastened. The next operation is the addition of the end papers, or what are commonly termed "fly leaves". These are the blank pages to be found at the front and back ends of all bound books. In the finer binding a white paper similar to that of the book, but slightly thicker, may be used, or a tinted paper, if desired.

When folded once in the middle the size should be that of the book. The fold should be pressed down with an ivory, thin glue spread along the edge of the fold and then placed evenly on the book, a board and weights being placed over it until dry. But little glue should be used, just enough to firmly fasten in place along the whole edge.



READY FOR LAYING PRESS.



AFTER BACKING.

It will be necessary at this point to distinguish between grades of work, as much labor can be saved on books which are bound largely for the sake of keeping them in permanent shape, and without special desire to secure a fine appearance. With books of this class we can at once proceed to have them trimmed on the paper cutter of some printer friend, first having "jogged" the back perfectly flat, and marked in pencil on the top page, lines showing where the knife is to cut.

With books of more value and finer bindings, this trimming is done "in boards," or after the boards have been attached and other work done, and this method will be described later.

After trimming, the backs are "rounded up," which also has the effect of giving the front a concave form, making a better appearance than when flat, and also easier to turn the leaves when reading. This operation is one requiring some experience and skill before it can be done quickly, but with the exercise of patience and care, no great difficulty will be met with. The experienced binder will partly work up the back with a few turns of the hand, but the beginner can do nearly as well if he will provide himself with some strips of wood, the upper surface of which has been rounded to the arc of a circle with diameter of about twice the thickness of of the book. Holding the book at the ends with both hands, jog the back on a flat, solid surface until it is even, turn the book over and jog the front edge on the rounded surface of the rounded strips. This will give the back the desired curvature, using care that the curve is even throughout.

Holding the book, with the back rounded, in the left hand, a backing board is placed on one side, with the edge of the board about ⅛ in. lower than the back. Another backing board is then placed on the other side of the book, and book and boards placed in the laying press or vise, which is screwed up tight, as shown in the illustration. Backing boards can be made from cyyress clapboards of even grain, the thin edge being cut off and the thick edge beveled.

The back of the book is then covered with thin glue, applied with a brush, working the glue into the back sufficiently to hold it securely and yet not enough to run down into the leaves and make the back unduly stiff. The glue is then allowed to dry until it is almost hard, or until all "tackiness" has disappeared and will not stick to the hammer. With a flat-headed hammer, much like those used by shoemakers; the edges are then hammered outward a little at a time and working all along the edges until they are bent to the extent of the thickness of the boards used for the cover. The motion given the hammer is much like that used in heading over a rivet, but care must be used not to strike with the edge or the paper will be cut. It must also be done gradually, or creases and breaks will result. A little practice will soon show what is needed.

The backing being completed, apply another very thin coating of glue, then put on a strip of thin, tough paper, of a size to just cover the back, except about ¼ in. at each end. If unable to obtain the special paper used for this purpose, a thin, strong manila paper will serve. Again apply thin glue to this covering of paper and put on the strip of backing cloth, the size being such as to come within ¼ in. of the ends of the book and projecting to either side from 1 to 1½ in. according to the size of the book. When the glue is quite dry, remove from the press, for further work, which will be described in the next chapter. The process here given is that suitable for binding of magazines, or where only plain, rapid work will answer. The backing of books of a more valuable and attractive character is done in a slightly different way, to be taken up in a subsequent chapter.

AMATEUR WORK.

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New advertisments, or changes, intended for a particular issue, must be received at this office on or before the 10th. of the previous month.

Entered at the Post Office, Boston, as second class mail matter, Jan. 14, 1902.

JUNE, 1905.

The demand for sets of bound volumes has been so large as greatly to reduce the supply of Volume I. Those desiring a complete file of the magazine will be obliged to send their order at an early date to ensure obtaining all the volumes. It is very doubtful if any more of Volume I. will be bound, as several numbers are out of print, and the expense of reprinting is too heavy to warrant this being done to the extent necessary to make up a complete volume.

The vacation season is at hand. To those of our readers who are fortunate in having two or three months which can be utilized as desire dictates, a word of suggestion is offered. Instead of the usual period of idleness or sport, why not lay out a course of study in some useful and practical line, such as visiting the electrical power houses, machine shops, or other large industrial plants in which one may be interested, in this way acquiring a fund of useful knowledge which the future may show to be of direct personal profit.

In addition, a course of reading along lines in which one is interested will serve to fill in many an idle hour and result in greatly increased knowledge of something of practical value. Constructive work of an electrical or mechanical nature is also to be recommended, and those attempting it will find, at the close of the vacation, that they are fully as well physically, and much improved mentally, as though sport or idlenes had been the sole consideration.

An inspector who has just returned from a tour of the buoys on the coast of Nova Scotia reports that the sub-marine bells which have been placed in position, one off Sambro and the other off Egg Island, are working admirably. The bells can be heard at a distance of five miles, as tested by the steamer Laurier, which is equipped with a receiving instrument on which the sound is heard. Submarine telephone signals will be established at several other points on the Nova Scotia coast in the Bay of Fundy and on the Cape Breton seaboard. The department of marine has contracted for a large number of these well-tried and successful aids to navigation and they will be installed as rapidly as possible. It is expected that all steamers running to Canadian ports will soon be supplied with the receiving apparatus which will enable approach to the coast with safety in all kinds of weather. Mr. Prefontaine, minister of marine, made a personal test of the submarine telephones on the Metropolitan Line steamers running between Boston and New York, and he is confident that these bells will be of the utmost value to Canadian shipping.

Fires caused by steam pipes are often very difficult to trace to their source. A large house in New York was not long since burned, and it was found that the fire was caused by a steam drum in contact with wood, with which it was encased. The manner in which a heat of less than scorching intensity sets fire to woodwork is not generally known. The conditions to produce this are, first a degree of heat not less than 212° F.; second, the presence of wood in close proximity to the iron steam pipes; third, the existence of scale or rust on the iron; fourth, varying temperature. The heat drives the oxygen from the iron rust, which then becomes what is known as reduced iron, a finely divided metallic powder of the natural color of iron. The heat necessary to ignite the wood, which is in a tinder-like condition, from its proximity to the hot pipe, is generated in the rapid oxidation of the iron. It absorbs oxygen so rapidly under certain atmospheric conditions of humidity and temperature as to glow for a few seconds, long enough to set the adjoining wood on fire. The greatest caution should be exercised in installing heating systems to allow ample space between steam heating pipes and adjacent woodwork.

THE METAL WORKING LATHE AND ITS USES.

ROBERT GIBSON GRISWOLD.

II. Screw Cutting—What Gears to Use.

Perhaps the one feature above all others that makes the engine lathe so valuable and the "king of machine tools," is its power of screw cutting. By means of the lead screw which is shown running along the front of the bed in the illustration given in Chapter I, the carriage, carrying the threading tool, may be moved along the ways at a predetermined rate, and the groove cut by the point of the tool will have a definite pitch per unit of length.

The lead screw is caused to revolve by a series of gears placed on adjustable studs at the left hand of the lathe-bed. These gears, shown piled one above the other on the floor, are called the "change gears," and bear such a relation to one another that certain standard threads may be cut by their aid, and, by compounding them, many fine and fractional threads may be produced.

The formula for calculating the correct gears to use for cutting a certain thread is interesting, of value, and well worth the time in becoming acquainted with it. All lead screws are cut with a certain number of threads per inch; in small lathes it may be 10, while in larger types the pitch may be 5, 4, or even two threads per inch. Owing to the fact that a split nut has been provided in the apron of the tool carriage whereby the carriage may be moved along the ways when it is closed around the lead screw, this rate of movement may be modified by controlling ratio between the revolutions of the spindle and lead screw.

Suppose that the lead screw has ten threads per inch; one revo ution of the screw would move the carriage 1-10 in.; two revolutions 2-10, a half revolution would move it 1-20, and so on. If we have a piece between the centers upon which we wish to cut a thread of ten pitch, and the lead screw is provided with ten threads per inch, it is evident that if the spindle and screw revolve in unison the tool will be moved along the surface of the piece at the rate of 1-10 in. But perhaps we wish to cut fifteen threads per inch. In this case the lead screw must not advance the carriage so rapidly, but while the spindle is making fifteen revolutions, the lead screw must make only ten, so that the carriage will be moved just 1 in. The ratio of the revolutions, therefore, is 15 : 10 or 3 : 2. Now, if we placed a gear having 20 teeth on the spindle, and another having 30 teeth on the lead screw, the spindle would revolve three times while the lead screw was revolving twice, since $3 \times 20 = 2 \times 30$.

We are now in a position to derive our formula which may be applied to any lathe, and the amateur may make up his thread table for any number of threads within the capacity of the change gears. As we learned above, the number of threads cut depends upon the ratio existing between the revolutions of the spindle and those of the lead screw, and its pitch of thread. When the pitch to be cut is the same as that of the lead screw, the number of teeth in the spindle gear and those in the lead-screw gear mnst be the same. An idler gear placed between these two gears in no way affects their ratios of revolutions, but simply alters the direction of revolution. Therefore, the Pitch to be cut : Pitch of lead screw : : No. teeth in lead-screw gear : No. teeth in the spindle gear.

The ratios between the two pitches and the teeth of the two gears are inversely proportional. Then

Let p=pitch to be cut.

Lp=pitch of the lead screw.

Gl=number of teeth in the lead-screw gear.

Gs=number of teeth in the spindle gear.

Then $\frac{p}{Lp} = \frac{G1}{Gs}$, and $G1 = \frac{Gs \times p}{Lp}$

In this formula, three of the quantities maybe either determined or assumed, and by simple proportion the the fourth may be readily found. First determine the pitch of the lead-screw by counting the number of threads per inch; then make a list of every gear that comes with the lathe. By simply substituting the different numbers of teeth in the formula, a table may be readily formed for every possible thread that can be cut by this simple train of gears. This is what is known as simple gearing, and the rule may be expressed as follows:

"Where the spindle gear is either driven on the spindle direct, or on a separate stud that revolves in unison with the spindle, to cut a given number of threads per inch, select a certain gear for this stud; multiply the number of its teeth by the pitch to be cut, and divide this product by the pitch of the lead screw; the quotient will be the number of teeth necessary in the lead-screw gear." Should this number be fractional, which would give a fractional number of teeth and is impossible, select some other gear for the spindle gear and repeat the operation until some gear is found that will give an even number of teeth for the lead-screw gear and one that is contained in the set.

You may readily reverse this process by selecting the gear for the lead-screw, multiply the number of teeth by the pitch of the lead screw, and divide this product by the number of theads per inch which you wish to cut. The quotient will be the number of teeth required in the spindle gear.

If the number of teeth in the gears supplied with the lathe increase by a constant number, that is, if the smallest gear has 20 teeth, the next largest 24, the next 28, 32, 36, etc., it is readily seen that the constant number by which they vary is 4; multiply 4, or any multiple of 4, by the number of threads per inch in the lead-screw. The product thus found will be the number of teeth in the spindle gear. Then multiply the same constant by the number of threads that you wish to cut, and this product will be the required number of teeth in the lead-screw gear.

It sometimes happens that the various makers of lathes adopt different methods of driving the first or spindle gear. Some place it directly on the tail of the spindle, others place it directly below, driving through a pair of spur gears, while others use a train of gears and alter the ratio of these gears from 1 : 1 to 1 : 2 or 2 : 3, thus making the spindle-gear stud revolve more slowly than the spindle.

This will alter the formula given above to this extent. The apparent pitch of the lead-screw will be in-increased, and before calculating its gear, multiply the number of threads per inch by 2 if the stud revolves one-half as fast as the spindle, by 3 if the ratio is 1 : 3, or by 1.5 if the ratio is 3 : 2. Then use the apparent pitch of the lead-screw for Lp.

There is one fractional thread that is very often cut, and that is the thread used in pipe work, 11½ threads per inch. It may be interesting to use this example as an illustration in assisting the amateur to understand the foregoing directions. Let us assume that the lead screw has 6 threads per inch and that the number of threads to be cut is 11½ per inch. The gear on the spindle is driven direct and at the same speed as the spindle, and the constant number between the gears is 4. We wish to find the gears for the spindle and lead-screw.

The pitch of the lead-screw is 1-6, and the pitch of the thread to be cut is 1-11½, or 2-23. Reducing these two fractions to a common denominator, we have 12-138 and 23-138, respectively. These two screws, therefore, will be in the proportion of 12 to 23, the denominators of the fractions, and we can assume that the threads to be cut are 23 per inch and that the lead-screw has 12 threads per inch. Multiplying each by the constant 4, we have $4 \times 12 = 48$, the number of teeth in the spindle gear, and $4 \times 23 = 92$, the number of teeth for the lead-screw. These two gears, therefore, cut 11½ threads per inch, or, since this is the ratio that is to be preserved and not the number of teeth, two gears of 24 and 46 teeth would accomplish the same result, as would 12 and 23 teeth. Should it happen that the stud travels one-half as fast as the spindle, multiply 12 by 2, and this product by 4, which would give 96 as the number of teeth required in the gear on the stud, the gear on the lead-screw remaining the same.

But in a train of simple gearing, such as has been described above, the number of threads possible with a limited number of gears is small. We have, however, recourse to another method which greatly enlarges the number of possible threads and renders it possible to cut threads of an almost infinite number of pitches with a comparatively small set of gears, because the limit to the number is only reached after every possible combination with each gear has been made. This method consists of interposing between the gear on the stud and that on the lead-screw, two other gears mounted on a stud carried by an adjustable spider, the combination of which may either reduce or increase the ratio existing between the numbers of teeth on the spindle and lead-screw gears. This is known as compound gearing, and consists of the substitution of two gears that run together on a sleeve, for the immediate idle gear. One of these two gears is driven by the gear on the stud, while the other drives the gear on the lead-screw.

The ratios given in the formula above no longer hold when compound gearing is used. Suppose that we placed on this intermediate stud two gears whose ratios were as 1 : 2, driving the large gear from the spindle and allowing the smaller gear to drive the lead-screw. We would then have multiplied the number of threads to be cut by 2, because the lead-screw will revolve just one-half as fast. Thus, if we use two gears with this particular ratio on the idler stud, we could multiply the number of threads on the lead-screw by 2 and proceed as in simple gearing; just so if the ratio was 1 : 3, multiply by 3 and proceed.

But another rule is often given. The spindle gear is a driving gear, as is also the smaller gear that drives the lead-screw gear; the larger gear of the pair revolving on the same sleeve (to which they are immovably fixed by a key) is a driven gear, and so is the gear on the lead-screw. Therefore, to cut a given number of threads when the lathe is compounded, select the three gears except the one for the lead-screw, at random. Place them in position and multiply together the number of teeth in the driving gears and the number of threads to be cut. Then multiply together the number of threads in the lead-screw and the number of teeth in the driven gear on the sleeve; divide the first product by this product and the quotient will be the number of teeth required in the lead-screw gear, which is the remaining driven gear. Where a ratio other than 1 : 1 exists between two revolutions of the spindle and the first stud, proceed exactly as in simple gearing, multiplying the threads of the lead-screw by the ratio, and using this figure in the calculations.

Signifying the two intermediate gears used in compounding in the following manner, the gear meshing with and being driven by the gear on the spindle of stud being known as Cd and the other gear mounted beside it on the sleeve and driving the lead-screw gear as Ca, we have the formula:

No. of threads to be cut × number of teeth in spindle gear × No. of teeth in Ca = No. teeth in Cd × threads per inch in lead screw gear, or $L_g = \frac{P \times Sg \times Ca}{Cd \times Lp}$

Using this formula, a table may be computed, showing all the possible threads, fractional and whole, that may be cut with the set of change gears accompanying the lathe.

Owing to the fact that the metric system is used in several works in this country, this article would fall short of its purpose if the cutting of metric threads was not described. In the metric system, screw threads are usually expressed in threads per centimeter, and by proper compounding any lathe may be made to cut metric threads. A centimeter is equal to 50-127 or 50 divided by 127 equals .3937.

Let it be required to cut a screw having 8 threads per centimeter, look in the thread table for the simple gears to cut 8 threads per inch and put them in position. Then fill the intermediate space by two gears mounted immovably on a sleeve which may revove on a stud, having 50 and 127 teeth respectively, the gear with 127 teeth meshing with the gear on the spindle, while the gear with 500 teeth drives the lead-screw gear. The threads cut will be 8 per centimeter, and furthermore, the thread table accompanying the lathe may be used for cutting any other number of threads in the metric system, because the number of threads per inch and per centimeter remain the same throughout.

The usual forms of thread used in this country are the sharp V thread, the United States Standard thread or the Sellers system, the square thread and the acme thread. Each type has its particular advantage or disadvantage. The sharp V thread, owing to the bottom of the thread terminating in a very acute angle, weakens to a great extent the strength of the piece upon which it is cut. There seems to be a tendency for the sharp point of the tool to injure the metal beyond, perhaps starting an incipient crack which reduces the effective cross-sectional area of the piece. It is a difficult thread to cut owing to the fact that the fine point of the tool enters the metal first and at all times takes the heaviest load; being unsupported by the metal at the sides, a hard spot may crack off the point entirely. Then the sharp edge of the threads is very easily injured by coming in contact with other objects, and, after once being battered out of shape, it is almost impossible to get a close-fitting nut to go on. It is also very easily ruined if a small portion of the edge happens to become torn away and rolls up inside the nut.

The other threads will be taken up in the next chapter, together with the tools required to cut them; multiple pitch will also be spoken of in connection with screw cutting.

The underground railway system of London is operated only in part by electricity, steam locomotives still being employed on a number of the lines. When the electrification of all the subways is completed, as planned, one will be able to travel sixty miles underground without running twice over the same track.

WIRELESS TELEGRAPHY AT NIGHT.

Wireless telegraphy by night has a notable phenomenon attached to it. "Technics" points out that there is conclusive proof that wireless telegraph signals can be transmitted to a greater distance by night than by day, the ratio of the distances being as 5 is to two. At first sight this appears to be very extraordinary, but recent investigations afford a very simple explanation of it. In wireless telegraphy, electric "tubes of force" are projected into space from the sparking apparatus at the transmitting station: if they reach the receiving station they affect the coherer or other receiving apparatus. Now, it has been proved that a heated body emits negatively charging particles, or electrons, each possessing about one-thousandth part of the mass of a hydrogen atom. The sun, being at a high temperature, must emit these particles; some of these, when they reach the earth, strike against the gas molecules comprised in the atmosphere, and break these up into their constituent charged atoms. A single electron may dissociate a large nnmber of gas molecules. Hence in daylight the atmosphere contains numerous charged particles. If an electric field is established in the air during the daytime, the charged particles will travel along the "tubes of force". Now, the electric "tubes of force" projected from a wireless telegraph transmitting station, as they pass through the atmosphere, will set the charged particles in motion; since the charged particles possess inertia, energy must be absorbed when they are set in motion, and hence the "tubes of force" must lose energy and finally disappear. At night time the charged particles emitted by the sun are falling on the opposite side of the earth, since they travel in straight lines, like light rays; hence at night the atmosphere is practically free from charged particles, and is no longer rendered conducting. About two minutes after sunrise the atmosphere has become saturated with charged particles, and the absorption of the electric "tubes of force" has reached its maximum value. Since light consists of moving "tubes of force" similar to those utilized in wireless telegraphy, it might appear strange that light is not absorbed by the atmosphere; but in this case, owing to the very short length of the light waves, the field acting on a charged particle changes its direction about 4×10^{15} times a second; therefore the particle is not set in motion, just as no deflection is produced in a galvanometer by a quickly alternating current. In wireless telegraphy the wave lengths utilized average about 300 ft., or 9,000 ems, and the field at any point in the line of transmission, is reversed about 0.5×10^6 times per second.

The talent of success is nothing more than doing what you can do well, and doing well whatever you do, without a thought of fame.—Longfellow.

PHOTOGRAPHY.

CHANGING AND DEVELOPING BOX.

E. MASON.

The piece of apparatus described and illustrated below is one, the use of which by many photographers, means dispensing with the dark room altogether. A dark room, to most, is necessary only for the changing of slides and cameras with light sensitive plates or films, for negative and positive development, and a few supplementary operations rarely required. All these operations can be conducted with greater ease and comfort by the use of the changing and developing box.

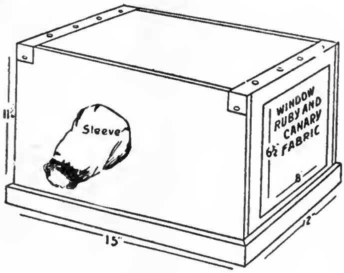


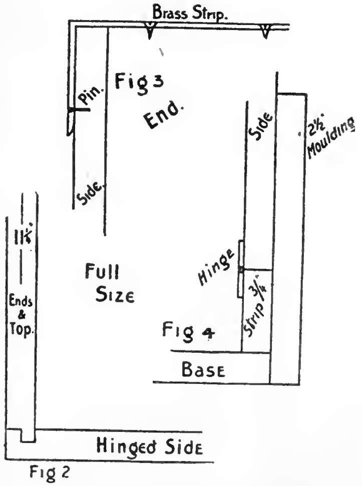
Fig. 1.

The dimensions of the box when folded are 15 x 12 x 2½ in.; erected for use its outside dimensions are 15 x 12 x 11½ in. The wood may be ¼ in. mahogany, walnut, or gum wood. The following pieces are required: Base, 14½ x 11½ in.; two sides, each 14½ x 11 in.; two ends, 11½ x 11 in.; top, 14 x 11¼ in.; two mouldings, 15 x 2½ in.; two mouldings, 12 x 2½ in. There will also be wanted two brass strips, 13½ in x ⅝ in. wide, as shown in Fig. 1. One inch at each end of these there is turned at right angles and has a hole drilled a quarter of an inch from the end, which engages with a slightly projecting pin on one side of the case. The brass strips act in two ways—they preclude any possibility of light entering at the junction of the top and ends, and when the ends are pushed home lock all the parts together.

The sides have a ⅛ in. groove across each end and top, and cut ⅛ in. from the edge, the top and ends having an ⅛ in. tongue to slide in, the same as shown in Fig. 2. One side piece is hinged directly to the base. A strip, 14½ x ⅝ in., is cut off the other side, and this is glued along the base inside and close to the moulding (see Fig 4). The object is to raise the side so that it will fold flat on top of the other side piece and sleeve.

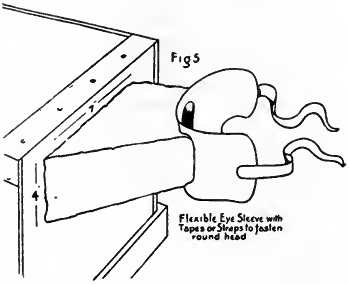
The sleeve apartures are each 6 in. in diameter for sleeves 7 x 4 in. The sleeves are made of one thickness of "Ruby Christia," between two of black silesia. A rubber band is sewn in to grip round the arms. The flexible band to go across the eyes is made of moderately thick chamois (wash) leather. The window is made of one thickness each of ruby and canary fabric.

The outside of the case may be polished, but the inside must be finished dead black. In the size given I can develop whole plates.



Raising the sides, the top and window end are slipped in their respeective grooves. After pouring out the developer required, the measure containing it is placed inside against the window with any other solution that may be required alongside. Then follows a half-plate porcelain dish containing the fixing bath, covered with a light-tight lid; on the top of this stands the xylynite developing dish, also with a light-tight cover. After inserting the dark slide with the exposed plates, the remaining side is pushed home, making the whole case as solid as a block of wood. The eye sleeve is adjusted and the hands inserted so that the sleeves go up under the wearer's coat sleeves. As I use the time system I also place my watch in one corner of the case where it can be easily seen, and then if development is likely to be long, after placing on the cover, I withdraw my hands, remove the eye-shade, and simply rock the case slightly until development is complete. When finished the negative is placed in the fixing bath, covered with the lid, the end slipped up, and the dishes, etc., washed. A duplicate fixing bath may then be inserted, and the whole procedure gone through with the next plate. Two fixing baths I find sufficient, using them alternately.

Development with such a piece of apparatus may be conducted anywhere, at any time. When not in use it occupies little space, and, being light, may be carried on tour, making the owner independent of doubtful "dark rooms." A great consideration is that the mouth and nostrils are outside, so that one does not



have to go on breathing contaminated air.

My recommendation, in conclusion, is to use an exposure-meter, to develop with a standard developer by the time system, to abolish the dark room, and with it one-half of the photographic worry will have forever disappeared. As a photographer, the sole trouble should be to discover a suitable subject, the correct lighting, and the most suitable view point. When found, the rest is easy, or should be if modern methods are adopted.

The case can, of course, be made larger or smaller to suit the size of plates generally used.—"The Photo-American."

DIFFICULTIES IN DEVELOPMENT.

Beginners often wrap exposed, but not developed, plates in printed paper, with the result that, in development, the letters appear on the negative, often to such an extent as to spoil the plate completely. It is impossible to remove these marks, but there is no reason why any such failure should occur, as plates, if packed face to face, with nothing whatever between them, and merely wrapped up in the brown paper as used by the manufacturers, will suffer no harm and will remain in perfect condition for a considerable time. To pass on now to the development, perhaps the commonest failure of the beginner is his inability to produce a negative clean and "fog"-less. Now, it is useless for him to blame the plates for this, as the plates of the present day are remarkably free from "fog," provided that they receive reasonably correct and careful treatment. The causes which may contribute to this "fog" are over-exposure to white light before or during development, an unsafe dark-room light, excess of alkali in the developer, and overheating of the dark room. The dark-room light should be tested by placing a plate, half of which is covered by an opaque card, at the spot usually occupied by the developing-dish for ten minutes or so; if, on development, any difference can be seen between the two halves of the plate the light is not safe, and must be screened by an extra thickness of non-actinic medium. Again, alkali is often added in large quantities to the developer for the purpose of forcing out detail on an under-exposed plate, and this is a frequent cause of fog. The developers recommended in the makers' instructions are usually rather too concentrated and include rather too much alkali than is advisable for general use by a beginner; most of these formulæ would be improved by the use of twice as much water and half as much alkali as is advised in the directions. When caustic soda is the accelerator employed, the addition of water and reduction of accelerator is particularly necessary, in order to avoid a harsh negative or a ruinous amount of fog. Overheating of the dark room is most likely to occur when development is carried out in a badly ventilated room, with an ill-kept oil lamp or a powerful gas jet. With regard to density, it is an open question whether more negatives are spoiled by being thin and ghostly or by being harsh and over-contrasty. The chief causes of thin negatives are over-exposure, under-development, too weak a developer, or slight excess of alkali, while harsh negatives are generally the result of the exact opposite of these faults. Our aim must be, when we have found out in which direction we are erring, to strike the happy medium, and to do this we shall do well to use the same brand of plate and the same developer time after time, blaming ourselves, and not our materials, for our want of success, and striving to master the peculiarities of one plate and one developer before turning to others which are probably no better and about which we know absolutely nothing.

The system of time-development introduced by Mr. Watkins has much to recommend it, and its adoption by beginners would lead to regularity and absence of that uncertainty which is, unfortunately, so characteristic of their work. Another common fault is the disfigurement of negatives by markings or patches, generally caused by uneven flowing of the developer over the plate, sometimes by the use of an insufficient quantity of developer to cover it fully. The best way to pour on the developer is to hold the dish, with the plate in it, in the left hand, and the measure of developer in the right, and then to pour the liquid gently but quickly along one edge of the dish, starting from the farthest right-hand corner, tilting the dish so that the developer flows over the plate in one sweep.

Air-bells, too, are very annoying, since, where they form, the plate is not acted on by the developer, and, when fixed, shows transparent holes, which print out out as black spots; they can be avoided by passing a broad camel-hair brush lightly across the plate as soon as the developer is turned on. Wetting the plate before pouring on the developer is almost certain to give rise to air-bells. These are but a few of the errors which can be made by the inexperienced; but if these points are attended to much waste of plates, time and trouble will be avoided.

"The Photo American."

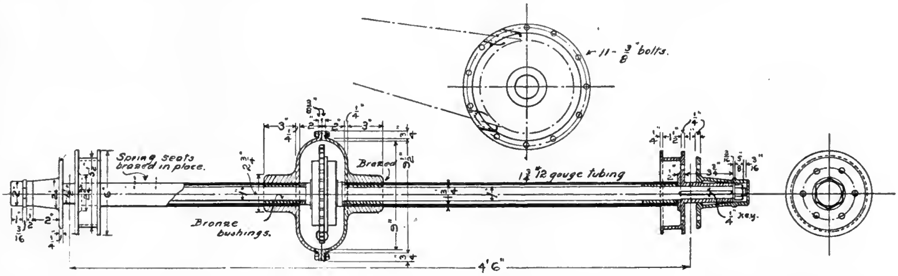
THE AMATEUR RUNABOUT.

FREDERICK A. DRAPER.

IV. The Rear Axle.

The rear axle of an auto requires quite as careful work as any other part. It is not only subjected to bending strains due to vertical load, but it must also resist the pull of the chain. Then, when the hub-brake is used a severe torsional strain is imposed and the combination of the three subjects this part to the most severe twisting and bending strains.

The spring-seats are brazed to the tubing before assembling, and their position can best be determined after the exact spring position is determined. The spring seats should have lugs to receive the ends of the radius rods, or these may be attached to separate castings brazed on to the tubing.



The cut shows a sectional elevation of the axle with the hubs and muff enclosing the differential. The outside shell is made of 1⅜ in No. 12 gauge seamless drawn steel tubing. The lengths are cut to suit the work, depending on the width of tread, and are brazed into the separate halves of the muff. Two bronze bushings are forced into the ends of each half and secured by a pin. These bushings can be made of brass tubing, which can be obtained in any large city.

The sides of the muff are turned on an arbor and finished with a male and female joint. This insures a perfect alignment of the bearings. The tubing is brazed into its sockets, which makes a very strong job. The muff is provided with two openings through which the chain passes. The flanges are provided with holes for 11 ⅜ in. bolts.

The shafts are of 1 in. cold rolled steel shafting fitted to the hubs and provided with a key. A nut on the ends of the shaft keeps the hub in place.

Each inside hub-flange is provided with a drum for the brake band. These are turned true and smooth. Where the shafts pass into the differential case they are provided with collars pinned in place, each half of the shaft is keyed to one of the differential gears, as will be described and detailed in the next chapter.

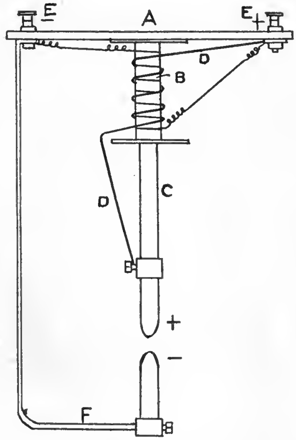
Speaking at the Royal Institute, London, recently, on "Fungi," Prof. Ward said that the mould on wall paper was rather on the paste than on the paper. With cheese, it was the water in it that gave rise to mouldiness, while that on boots was an outcome of the blacking, not of the leather. Ninety to ninety-five per cent of the fungi was water, and this was so in the case of mushrooms. There was a popular mistaken notion that these fungi were nutritious, but there was very little nutriment even in a hundredweight. The other 5 per cent. or 10 per cent. was made up of nitrogen and oxygen. Jellies, in particular, were the choice food of moulds. Some fungi were so luminous that photographs had been taken of them by their own light. These fungi were very destructive. They simply ate up whatever they fastened on, mostly wood. There was also a mould which the professor called "lurking fungi". This generally attacked grain, and in a way went to sleep between the seed and its husk. They were poisonous and had caused epidemics in the past. It was his belief that beri-beri was caused solely by a "lurking fungi" in the rice. This was a very serious thing to Eastern nations, especially to an army in the field, like that of the Japanese.

PRINCIPLES OF ARC LAMP CONSTRUCTION.

Electricity may be defined as matter in motion along definite lines through material capable of having its particles moved by this force. When the particles yield readily to the force brought to bear upon them, their temperature is very slightly altered; but when they resist electric force, their temperature rises rapidly. When many lines of force are brought to bear on a small number of particles, the great strain on them causes their temperature to rise considerably and, in some cases, entirely overcomes their bonds of cohesion. This is the case when a large number of lines are forced through a thin carbon rod. The particles of carbon resist electric force and get warm, then hot, then red-hot, then white-hot, then incandescent, and finally break away under the great strain. When two such rods are placed end to end to form a conductor of electric current, their particles at the ends are imperfectly connected, and their consequent resistance is higher; they therefore soon become white-hot and break away from the solid mass, but at the same time they heat the air around them, and this hot air also conducts the current Small particles of carbon, glowing at a white heat, are carried by this current of heated air from one carbon rod to the other, and others are turned into incandescent vapor in the space between them, to form an arched bridge of light known as the electric arc light.

To produce this arc the electric current must have volume sufficient to make the carbon particles white-hot, and sufficient electro-motive force to carry them over the space between the tips of two carbon rods. The volume of current required to incandesce carbon rods at their tips in an arc lamp may be put down as 5 amperes for each ½ in. in diameter, while the E. M. F. is a constant of from 45 to 50 volts for all ordinary arcs these being formed when the carbon rods are 1-12 in. apart. The light given by an electric arc lamp may be put down as 500 candle power for a 5-ampere lamp. If, therefore, two carbon rods, each ½ in. in diameter, are so placed together that their two ends firmly touch each other, and an electric current of 5 amperes and 50 volts is made to pass through the carbons, the point of contact will first get red-hot, then white-hot, then glow with much brilliance, while the carbon particles burn away, until the gap between the ends of the carbon becomes 1-12 in. wide. A bridge of burning carbon in the form of an arc will then emit a brilliant light for a few moments, while the arc lengthens to ⅛ in. and then expires, unless the carbon rods are moved towards each other and the arc gap maintained.

An arc lamp, therefore, is a small machine made to hold the carbons and move them towards each other as they burn away, so as to maintain the right space between them to form the arc. But it must do more than this. It must be so constructed as to separate the carbon rods when they are hot enough to give the necessary light, and thus "strike the arc". Numerous devices have been invented to attain this end, and some wonderful pieces of clockwork mechanism, combined with electro-magnetic apparatus, have been sold as arc lamps. One of the most simple forms, embracing the leading principles of construction in the lamps, is shown in the accompanying illustration, where, fixed



by its upper part to a platform *a* of wood or of sheet-ebonite, is a hollow brass bobbin, *b*. A soft iron rod,*c*, nearly fills the hollow space in this bobbin, and is made to slide in it freely. The lower part of the rod is enlarged to form a socket to hold the upper carbon rod, also a small milled terminal screw for attachment to the flexible conductor shown in the sketch. The bobbin is wound with two coils of wire. A thick wire coil, *d* capable of carrying the full current consumed in the lamp is connected in series with the carbon-holder (this coil makes only a few turns round the bobbin), and a thin wire coil of several ohms resistance is wound over this, as shown by the thin line. This coil is connected in shunt with the main circuit to the two terminals, *e*, on the platform. The lower carbon is held in a suitable socket attached to the bracket, *f*, the upper part of which is connected to one of the terminals above.

When this lamp is unconnected with an electric current, the two carbons rest upon each other and are kept in close contact by the weight of the iron rod. But when a sufficiently strong electric current is connected to the two terminals, *e*, it traverses the thick coil, *d*, and converts the air space within the bobbin, *b*, into an electro-magnet, called a solenoid (which has the property of sucking the iron core, *c*, into itself); the carbon-holder is therefore drawn up, the carbons are separated, and the arc is struck.

If the current is too strong, the upward pull of the solenoid will jerk the carbons violently apart, and, as this will break the circuit, they will as suddenly fall together again, with a resulting pumping action and unsteady, flashing light. To counteract this fault, the bobbin is also wound with many turns of a long, thin wire in the opposite direction, and this wire is connected in shunt across the terminals. A part of the current therefore traverses the fine coil, and induces a contrary magnetism in the solenoid, which serves as a brake on the otherwise violent upward pull of the main current. When the turns of the wire in the main coil are properly proportioned to the turns of wire in the fine coil, the two coils so balance each other as to maintain the gap between the ends of the carbons at its proper length to produce a steady arc light. In an arc lamp of this design, the magnetic solenoid acts against gravity to pull the top carbon up from contact with the bottom one. As it does this the arc is first formed, then lengthened, and with the lengthening a higher resistance to the current is created, with the result that less current passes through the main coil and the magnetism of the solenoid is weakened. The carbon therefore drops a little, and the arc is shortened; but as the resistance of the main circuit increases, more current goes through the fine coil and checks the downward course, as it checked the upward course, and thus the balance is restored when the normal arc is formed.

In a good lamp, well designed and adjusted and kept clean, these intervals of up and down movement are so short as to make the feeding of the carbons appear continuous. The proportionate resistance of the two coils is usually 1 to 100; that is, the series coil as 1 ohm, and the shunt coil 100 ohms. The gauge of copper wire employed in the series must be large enough to safely carry the current required to maintain the arc light. The flexible wire cord connecting this coil to the upper carbon must have the same capacity. If the current to be carried by the series coil is 5 amperes, the wire in this coil should be No. 14 s. w. g. copper, cotton-covered and parafined; and the flexible wire cord should be 100-36 silk braided.

The illustration given is only intended to show the principles of construction in one of the most simple designs of arc lamps. An arc lamp embodying these principles can be constructed and designed by almost anyone following the hints here given. First decide upon the candle-power of the lamp, and choose a suitable pair of carbon rods. The sizes given by makers run from 8 mm. to 30 mm. and vary in price from 1½c to 12c per foot-length. The smaller diameters are for lamps of low candle-power, taking a small current. The rods are made solid for the lower carbon, and cored for the upper carbon. On referring to the illustration, it will be seen that the lower carbon rod is pointed and is marked —, indicating that is the negative carbon and most be connected to the negative pole. It is a solid rod, and as it does not burn away so fast as the upper carbon, it may be made shorter. The upper carbon has a slightly hollowed end and is marked + to show that it is the positive and so must be connected to the positive pole. The current will therefore pass from the upper carbon to the lower, and frit off more particles from the upper rod than it does from the lower one. As it burns with a hollow center—called a crater—it is made with a soft core. These facts must be noted when buying the carbon rods, the length of which must be determined by the number of hours they are required to burn, the approximate consumption being from 1¾ to 3 in. per hour for the two rods; the proportion for each rod being 2 to 1, that is, 2 in 3 for the positive, and 1 in 3 for the negative carbon.

When the size and length of the carbon rods have been determined, all the dimensions of the other parts of the lamp can be adapted to them. The diameter of the carbon holders must be adapted to that of the carbon rods. The length of the upper carbon holder with its iron core must also be adapted to the carbon, and the bobbin to the solenoid coil to the iron core working in it. After this, the dimensions of the frame and platform can easily be determined. If it is desired to enclose the upper part of the lamp in a brass case, this can be added, together with any other conveniences, after the lamp is made. Connection is secured between the lamp and the source of current by means of flexible wire cables.

The foregoing principles of construction have a modified application in some of the best lamps. In the Brockie-Pell lamp, two solenoids, side by side, regulate the arc by means of a lever and brake action. In the Brush lamp there are two sets of carbons, worked with two solenoids side by side, and regulated by a triangular clutch between them. In the Angold lamps, two solenoids actuate a lever and ratchet device, and a brake to regulate one set of carbons.

To avoid the shortening of machine belts, one firm cuts them too short, when they are first applied to the machine, by a length of 1 ft. or several inches. When the belt grows slack this piece is removed, and a shorter piece is inserted instead. A variety of widths and lengths is kept for this purpose, and when a machine operator wishes to shorten a belt, he determines about how much slack needs taking up, and gets a piece that much shorter than the one already in the belt. The piece is returned to be used again as occasion requires. This system prevents the actual belt from being wasted and obviates the necessity of squaring ends and punching new holes each time the belt is shortened.

Oil for cylinder lubrication cannot be too good. A new cylinder costs more than a great deal of good oil.

RELAYS FOR WIRELESS TELEGRAPHY.

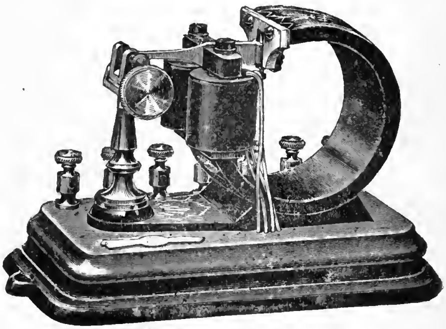
ARTHUR H. BELL.

Amateurs interested in Wireless Telegraphy are often puzzled as to the best relay to use in connection with their receiving apparatus, and as a sensitive relay is very essential, I will briefly describe the different kinds of relays that are on the market or which may be constructed at home, and give the reasons why one type is superior to another.

Nearly every amateur is familiar with the telegraph relay, so common to wireless telegraphy. This type of relay is a neutral or simple electro-magnetic relay, designed with magnets exactly like the magnets of a vibrating door bell, only finer wire is used in the coils. In this type of relay it matters not as to the direction of the current in its course to the relay, the only requisite being that there be enough "juice" passing into the relay to magnetize the cores and attract the armature, and in the ordinary 150 ohm telegraph relay, by careful adjustments, one can make the armature throw over with the current from one cell of dry battery. But anything less than 1½ volts will not do this every time. So, for service in a coherer circuit where, under normal conditions there is not sufficient current passing into the relay to cause it to operate, and where the current increases considerably when the coherer is affected by the Hertzian waves, the telegraph relay is a good instrument for short distances only, say for one to four miles at the most.

There is a relay, however, used universally in telegraphy which one does not find in every small office, but which plays a very important part in rapid commercial business where one telegraph circuit is handling two or more messages simultaneously.

This apparatus is the polarized relay, unquestionably the most sensitive instrument to be obtained at a moderate price. By examining the illustration the reader will note that there is a permanent magnet of horse-shoe type, having at one pole a pair of wound electro-magnets exactly like the magnets on the ordinary relay. As these magnets have soft iron cores, it should be understood that the magnetism of the steel permanent magnet saturates them and makes both of them of the same polarity as the tip of the steel magnet to which they are fastened; that is to say, if the bottom pole of the permanent magnet is south these poles of the electro-magnet are south. To the other pole of the permanent magnet is pivoted, sensitively, a soft iron bar which takes, of course, the same polarity as the pole to which it is affixed. So we have a movable north pole playing between the two poles of the electro-magnets, and bear in mind this point, this condition of affairs occurs only when the current of electricity passing through the coils from the battery, is not of right direction of flow to change the polarity of the coils and cause the armature to swing over because of this change. So we note that the operation of a polarized relay does not depend on attraction; that is, sufficient generation of lines of force to pull a soft iron armature towards the poles of an electro magnet, as with the first type of relay, but depends absoutely on changes in direction of current.



In wireless work there is sufficient tension put on the pivoted armature to cause it to hug the pole opposite the contact point, and the battery is poled right by testing, so that when applied directly to the windings, the armature swings over instantaneously and makes contact. With this relay and a dry cell in circuit with the filings coherer and a small set of adjustable resistance cut into the circuit, by close adjustment the permanent magnetic effect of the relay can be opposed with just enough poled energy, when the coherer operates, to make a very delicate and rapid contact.

Any amateur who wishes to experiment with a polarized relay will find the 600 ohm bell used by telephone companies a very satisfactory instrument and very easily constructed for wireless work.

The "gold from sea water" craze appears to be having a lively run in England at the present time, and it is asserted that no less a person that Sir William Ramsey has endorsed a process for extracting the gold. Unless such approval appears over the signature of this eminent scientist, the statement should be viewed with suspicion. Many investors in a similar enterprise in this country would have little faith in it, if all the scientists in the world gave approval.

PHOTOGRAPHIC NOTES.

A good photograph of a lightning flash is reproduced in a recent issue of "Photography". The photograph was taken in July last at Weston-super Mare by T. G. Goodman, A. C. P., F. R. G. S., who states that it was taken on an Ilford chromatic plate, and has not been touched up in any way. The camera was focussed in a perfectly dark room on a light in a room some distance off. The plate was then inserted, the cap removed, and within a few seconds a brilliant flash came in that part of the sky to which the camera pointed, immediately after the cap was put on. The stop used was $\frac{1}{8}$; date, July 21, 1904; time, eight minutes to ten. "Photography" says that it is not often a single flash single, that is, in point of time—makes so fine a show as it does in Mr. Goodman's print, which is altogether remarkable in this respect. Those who would seek to get similar results would do well to note his procedure. It is a convenience to have a mark on the baseboard of every camera, showing exactly how far to extend the camera with any given lens to secure a sharp image of anything at "infinity". This is most conveniently done in day time by focussing on some object two or three hundred yards away, since, when a storm does come there is not always a light at a suitable distance on which to focus. Then when a thunderstorm happens at night, all that has to be done is to extend the camera to the mark, put a plate in, point the camera in the direction in which most flashes are to be seen, and uncap the lens. As soon as a flash has been seen, in that direction, the plate should be changed, and as it often happens the flashes that are very visible to the eye do not appear on the plate at all for one reason or another, it is always advisable to make as many exposures as the storm will admit; some are then sure to be found on the plate.

A French photographer, M. G. A. Liebert, has recently devised an apporatus which will enable him to take instantaneous photographs in his studio. This device is described in *La Bevue de l'Electricite*. The object of using electric lights is to give the photographer entire control of the quality and amount of illumination and to render him independent of daylight. Moreover, to obtain the best portraits it is very desirable that they should be taken instantaneously and at the moment when the subject is in the best pose.

The device consists of a large parabolic reflector of aluminum, having placed on its inner edge a series of incandescent lamps shaded with ground-glass screens. The object of these is merely to light up the subject, permitting the photographer to secure the best pose and to determine when the real exposure should be made. At the center of this reflector is an arc lamp with three carbons. One of these is fixed, and the other two are movable. When a photograph is to be taken, the subject is arranged and the sensitive plate is exposed. The photographer then waits until a desirable pose has been secured, when he presses a rubber bulb, which draws the two movable arc light carbons across the fixed one, thus forming a brilliant arc; but the moment the current passes through the lamp the movable carbons are drawn away from the fixed ones by means of an electromagnet, and the arc is thus extinguished. It lasts about one-fiftieth of a second, but this gives sufficient time for an exposure.

ONE SESSION FOR SCHOOLS.

Dr. Otto Dornblueth, of Frankfort, a specialist in nervous diseases, writes against the practice of holding afternoon sessions in the public schools. In support of his position he points to the investigations instituted among 16,000 school children by the distinguished expert in school hygiene, Dr. Schmidt-Monnard of Halle, who found that the number of sick among the children attending morning and afternoon sessions was by one-half greater than among children who attended sessions in the forenoon only. The investigations by Prof. Koppman of Leipzig, led to the same conclusion.

Dr. Dornblueth favors a morning session of five hours, giving a resting pause of fifteen minutes at the end of each hour. He says that the afternoon sessions exhaust the vitality of the children, disturb their digestive organs, and tire their brains. From a medical standpoint afternoon sessions should be abolished. The afternoon hours should be given to play, outdoor exercise and physical training. The selfish motives of many parents in not wishing the children at home because they are bothersome and require supervision should not avail against a reform which is necessary and beneficial for the little ones. The doctor suggests the establishment of public retreats where the children who cannot be supervised at home may spend the afternoon hours in the care of one or more suitable adults. He suggests that these retreats be provided with implements and material and that children desiring instruction in light handicrafts may be accommodated. This may give the initiative for training clever women and good mechanics.

Under the present system of instruction the pupils of the upper school classes attend forty-two and some forty-four hours per week.

A method of distingushing iron from steel is to wash the piece of metal to be tested and then plunge it into a solution of bichromate of potash, with the addition of a considerable quantity of sulphuric acid. In from thirty to sixty seconds the metal can be taken out, washed and wiped. Soft steels and cast-iron will have assumed a regular ash-gray tint; tempered steels will have become almost black, without any metallic reflection; puddled and refined irons will remain nearly white with metallic reflections on the part of their surface previously filed, the remainder of the surface presenting irregular blackish spots.

BOOKS RECEIVED.

AMERICAN TELEPHONE PRACTICE. Kempston B. Miller. Fourth edition. Enlarged and Entirely Rewritten. 904 pp., 6½ x 10 in. 643 Illustrations. Cloth. Price. $4.00. McGraw Pub. Co. New York. Supplied by AMATEUR WORK.

It is not an easy task to give, in the space available, a comprehensive idea of this magnificent volume. The preceding editions have made it well known as an authority to all telephone engineers, and the completeness with which the new edition brings it up to date, will undoubtedly make it the leading book upon the subject for a long time to come. A copy should be in the hands of everyone engaged in telephone engineering work. As the publishers have issued an illustrated prospectus containing table of contents, etc., which will be mailed to any one sending for it, we would recommend those interested in this subject to secure same, or better yet, order a copy at once, as it will repay the cost to the owner.

GAS ENGINE DESIGN. Chas. Edward Lucke, Ph. D. 254 pp. 6 x 9 in. 154 illustrations. Cloth. Price $3.00. D. Van Nostrand Co., New York City. Supplied by AMATEUR WORK.

The purpose of this book is to present in compact form those principles which underlie the design of gas engines, together with such data on the subject as seems reliable for the use of those engaged in building this kind of machinery, and who are familiar with its characteristics. The book is concerned entirely with the quantative side of design, and treats solely of the forces in, and the energy-transforming power of the exploding gas-engine.

The work is divided into three parts. The first, treating of the power, efficiency and economy, gives the material necessary for deciding on the necessary piston displacement for any kind of gas, and enables the designer to approximately predict economy. The second part contains the data and method for determining the stresses in the parts and the number and arrangement of cylinder necessary for balance or turning effort to meet the specifications. The last part is entirely concerned with the dimensions of the parts to meet the stresses, showing between what limits every principal dimension should lie. It is a book of great value to those engaged in designing and building gas-engines.

ELECTRICAL INSTRUMENTS AND TESTING. N. H. Schneider. 200 pp., 5 x 7½ in. 104 Illustrations. Cloth. Price $1.00. Spon & Chamberlain, New York. Supplied by AMATEUR WORK.

This book is intended for practical use, and also as an introduction to the larger works on the subject. The apparatus described is of the most modern type, such as will be found in universal use. The tests are such as occur daily in the work of the engine room, power house or technical school. Beginners in the study of electricity will find it of great value.

ELEMENTS OF MECHANICS. Mansfield Merriman. 172 pp., 4¾ x 7½ in. Cloth. Price $1.00. John Wiley & Son, New York City. Supplied by AMATEUR WORK.

This book is intended for manual training schools, freshman classes in engineering colleges, or for students who have the preparation above indicated. It is an attempt to apply the best methods of applied mechanics to the fundamental principles and methods of rational mechanics. To this end constant appeals are made to experience, through numerous numerical illustrations, many queries and problems are stated as exercises for the student, and a system of units is employed with which every boy is acquainted. It should prove an excellent text-book in the special fields for which it is intended.

PRACTICAL WOOD CARVING. Charles J. Woodsend. 86 pp. 6 x 9 in. 108 Illustrations. Cloth. Price $1.00. David Williams Co., New York City. Supplied by AMATEUR WORK.

This book has been written for the special purpose of meeting the requirements of the young mechanic or student who is desirous of acquainting himself with the rudiments of the art, and an examination shows it to be especially adapted to fulfilling its purpose. The reader who will follow the directions given and repeatedly practice the examples, cannot fail to possess a good knowledge of the principles of wood carving.

PRACTICAL METHODS OF DEVELOPMENT, No. 66; PRACTICAL ORTHOCHROMATIC PHOTOGRAPHY, No. 67; PHOTO-MINIATURE. 48 pp. Paper, 25 cents each. Tennant & Ward, New York.

No one who is doing regular work in photography now tries to get along without each and every one of this valuable series of photographic studies. They are all well worth the having.

Some interesting notes on diamonds, recently published, contain reference to the fact that apophyllite, a silicate of lime and potash with 16 per cent of water and easily fusible at the ordinary temperatures obtained with a blowpipe, has been found inside a diamond. This is considered to disfavor the idea that diamonds had an igneous origin. A leaf of gold has also been reported in the center of a crystalized Brazilian stone. These facts are considered incompatible with the formation of stones at high temperatures, and additional argument is derived from the great size of the stones, which seems to favor the idea of a slow gowth analagous to that of ordinary crystals.

"Let a man do a thing incomparably well and the world will make a beaten path to his door."—*Emerson.*

CORRESPONDENCE.

No. 89. PORT ORCHARD, WASH., May 3, 1905.

Having been a subscriber for and purchaser of of every copy of AMATEUR WORK which has been issued, I presume to seek the following advice: Between my office and home the distance is four miles, unobstructed salt water. Is it possible for me, an amateur, to operate a wireless telegraph between the two points with any degree of success? If so, what would be the probable cost of the necessary equipment, and would it be better to attempt to make, or buy the apparatus? If to buy, where can I purchase the most successful instruments, within the reach of the pocketbook of one who does not desire to spend any more money than is absolutely necessary to have a satisfactory working system, and not one that is more trouble than it is worth—if any such exist—which I wish you would tell me honestly. J. G. B.

Replying to your letter of May 3. The location of your home and office, as you describe it, offers an exceptional opportunity for wireless communication. Success in wireless telegraphy depends as much on the amateur's understanding of the principles as upon the selection of instruments, for the best of apparatus on the market has its shortcomings, which can only be remedied by careful harmonizing of working conditions.

You will need a pole at each end, either a few feet high from the house top, or rising 40 to 50 feet from the ground. Each station will require a spark coil giving about 4-in. spark, and operated by 10 or more cells of dry battery. A smaller spark might suffice, but it is advisable to have reserve power over the requisite amount. Coils, in fact the entire sending end, may be constructed at home, if the maker has the time and materials.

It is difficult to express an opinion by letter as to the advisability of constructing all the "receiving" instruments at home. Amateurs have accomplished this at very moderate expense, but there are rules which can not be laid down specifically, each man's experience differing from that of every one else.

A coherer is difficult to make. A good one can be bought for $4. You can construct a sensitive relay for about $5 and a sounder for $1, or you can buy the coherer, decoherer, relay and sounder in the form of a set, of apparatus concerns, for from $25 to $35, according to accuracy and finish.

If we were in your place, we would commence a set of experiments, constructing the spark coil, pole wiring and other appurtenances of one sending end, as carefully as possible. Then purchase a coherer, and a 25-ohm relay of the regular telegraph type, and make experiments in the arrangement of apparatus until every depression of the sending key operates the receiving end. Having accomplished this construct a decoherer, descriptions of which have appeared in AMATEUR WORK, and connect it in the relay circuit. Then experiment until the receiver receives each impulse and decoheres as it should. You may now purchase the sounder and complete the first receiving set. By experimenting as you build, you will be likely to save considerable money on the second set, which will be a duplicate of the first.

We have gone into all these details, not to discourage, but rather to interest you in what will prove most entertaining and instructive work. Even if you bought the most elaborate sets on the market at a cost of hundreds of dollars, there would be times when you would have to exercise all your ingenuity to make everything work. We have subscribers who have done as we advise you, and their results have been highly satisfactory, over much longer distances than required by you.

No. 90. ROCHESTER, N. Y., May 9, 1905.

Will you kindly answer the following questions through your valuable magazine? (1). How can a watch be demagnetized? (2). What rated spark would be necessary for wireless telegraph stations at a distance of three miles? What would be the cost of the material providing I have purchased the coil? L.W. O.

(1). To properly demagnetize a watch, especially one of any value, is a rather delicate operation requiring considerable experience and a suitable outfit, and we would not recommend any one unacquainted with the work attempting to do it.

(2). A wireless telegraph outfit to operate over a distance of three miles on land would undoubtedly require a coil giving a 4 in. spark, but much depends upon the construction of the receiving end and local conditions. The cost would all depend upon how much of the apparatus was made by the owners, the coherers should be purchased, although it is recommended that some of the types described in the magazine be made for the purpose of becoming familiar with their operation.

No. 91. TOLEDO, OHIO, May 26, 1605.

Will a rheostat of the type described in AMATEUR WORK, January, 1903, work well on a lighting circuit of 110 volts, 19 amperes? I have not had success with it, as it did not cut the current down to the desired extent; in fact, not to any noticeable extent. Is carbon resistance suitable for controlling the motor or continuous work of any kind? Will it last as well as German silver wire? G. H. D.

The rheostat mentioned is not suitable, either in size or type, for the work mentioned. It is of much too small a capacity for the current, and it is fortunate that no harmful effects resulted from its use. It would have little appreciable effect in regulating a current of the volume named. We hope to publish, at an early date, a description of a rheostat suitable for regular lighting circuits. If only a small current is needed a lamp could be used to take most of the current, the balance being used as required.

No. 92. East Aurora, N. Y., May 9, 1905.

Can you tell me how to make a Tesla oscillator; also a small telescope? E. L. F.

A description of a Tesla oscillator of a size suitable to work with a Rhumkorff coil giving a 4-in. spark, is in preparation. The first chapter of a description of a reflector telescope appears in this issue. This instrument, while not large or difficult for the amateur of fair skill, is of a size which will permit of very interesting and valuable astronomical work.

No. 93. New Haven, Conn., May 4, 1905.

I have a lathe built on the plan given in the Amateur Work for July, August and September, 1903. The way I have of driving it at present is not satisfactory, so I would like particulars of a motor strong enough to drive it. Where can I get a motor or the castings for one? What fraction of a horse power is necessary? What voltage would be required? What type of battery would be best? H. S. P.

The power required to drive a turning lathe, even of such a small size as the one you have, is greater than might be thought until actual experience has shown this to be so. A quarter horse power motor would be necessary to give the power and speed on heavy work, and sufficient power should always be provided to take care of the heaviest work a machine is given. For light work or light cuts on heavy work, less power might answer, say one-eighth horse power, but to run an electric motor of even the smaller power by battery current, would call for an expensive battery outfit as well as heavy expense of maintenance. A storage battery would not be expensive to maintain, if one had the charging facilities.

The most suitable driving device for the lathe is a drive wheel operated by treadle. A stand can be made of wood, the drive wheel keyed to a shaft, on each end of which are lugs and bolts to connect with treadle rods to the treadle. This gives ample power, is inexpensive to fit up and costs nothing to run.

No. 95. Jacksonville, Ill., May 14, 1905.

Will you kindly answer the following questions relative to wireless telegraph apparatus described in the November and December, 1904, numbers:

1. What should be the resistance of the variable inductance coil described in the November number?

2. What capacity should the Leyden jars be for the battery described in the same number and how many jars should be used?

3. Using a coil giving a one-inch spark, how far is it possible to transmit and receive signals, with the apparatus described in the November and December numbers? C. B. V.

The resistance of the variable inductance should be as low as possible, using as heavy as No. 12 gauge copper wire, or even larger. The capacity of the Leyden jars should be .0005 M. F. each for coils up to 2 in. spark. With a 50-ft. aerial wire at each end and very sensitive coherers, relays, etc., it is possible to send, with a coil giving a 1-in. spark, for a distance of one mile over land, or even further, but local conditions have considerable bearing on the results attained, no fixed rule being possible.

SCIENCE AND INDUSTRY.

The size of the Atlantic waves has been carefully measured for the Washington Hydrographic Bureau. In height the waves usually average about 30 ft., but in rough weather they attain from 40 to 48 ft. In storms they are often 500 to 600 ft. long, and last 10 or 11 seconds, while the longest yet known measured half a mile, and did not spend itself for 23 seconds.

An interesting correspondence, says the London "Electrical Review," has been proceeding for some time in the "Chemiker Zeitung" on the cause of the occasional explosions of vapors which have taken place at different chemical works. A very inflammable volatile liquid, carbon bisulphide, more particularly, has been run through metallic pipes, or through a metallic funnel, into a metallic or non-metallic drum, replacing the air formerly in that vessel. Part of the liquid has evaporated, forming a mixture of vapor and air, which, in the total absence of fire or artificial light, has exploded and done more or less damage. It has been so difficult to find the proper explanation for this curious phenomenon, that certain writers have suggested that the friction of the passing liquid upon the edges of the funnel or the mouth of the pipe must have generated sufficient electricity to produce a spark, which has immediately fired the explosive mixture.

A more probable and entirely chemical explanation of the explosions has now been put forward, which appears to meet all the requirements of the case. According to this view, when a volatile organic liquid of the kind now under consideration, which contains sulphur either as a part of its nature, or as an impurity, is brought into contact with iron or steel, sulphide of iron is formed. In presence of air this body oxidizes, generating so much heat in the process as to raise the mixture of vapor and air above its inflaming point, when, if it takes fire in a confined situation, it produces the symptoms of a gas explosion.

Stone sawing by wire is done successfully in France, according to a paper by Mr. E. Bourdon in the "Bulletin" of the Society for Encouragement of National Industry. A complete plant comprises an endless wire passing around a series of pulleys, one of which is a driving-pulley. The necessary tension is obtained by a straining trolley working on an inclined plane, and between the driving shaft and this trolley is situated the saw frame, which carries the guide pulleys for the wire saw. This wire, which is driven at a given speed, is caused to press lightly on the stone, and the cutting is done by sand mixed with water, which is conveyed into the saw cut as the work proceeds. Though the mode of operation appears simple, it entails various difficulties in practical application. Three twisted steel wires are used, each wire having a diameter of 0.098 in. The strands must be twisted fairly tight, and should make one turn in 1.18 in. The wire may be driven in the workshop at a speed of 23 ft. per second, but in quarries, drifts and mine tunnels the speed should not exceed 13 ft. per second. The force exerted by the wire to produce the cut must be uniform and must be capable of being readily varied. Moreover, it must be proportionate to the length of the cut.

Carbon and metal brushes for dynamos have their advantages summed up in "Technics," according to which a most important departure in dynamo design was made when carbon brushes were introduced. With metal brushes sparking can only be avoided by altering their lead, with every variation of load. When carbon brushes are used, and the dynamo has been suitably designed, absolutely sparkless running may be secured for all loads with fixed brushes. It is, perhaps, not too much to say that the present success in the design and construction of large traction generators is due to the use of carbon brushes. Their superiority to metal brushes is due to several causes. In the first place, metal brushes, when greatly heated, are liable to fuse at the tips, with the result that the commutator becomes pitted. In addition, metallic vapor is sometimes produced, and this gives rise to an arc between the brush and tip and the commutator segment which has just left it. Both these sources of trouble are removed when carbon brushes are used. In addition, there is a definite contact resistance between a carbon brush and the commutator segment on which it rests, and this resistance increases as the commutator segment is withdrawn from under the brush. The effect of this is that the current in the armature coil, short-circuited by the brush, is first reduced to zero, and then reversed, without any help from a reversing field. The method of commutation with movable brushes may be compared with the method of stopping a locomotive by reversing the engine, while the use of fixed carbon brushes for commutation may be compared with the use of a brake.

The waste of gold in a manufacturing jeweller's premises is likely to be so considerable that the most stringent measures have to be taken to avoid loss by reason of the gold dust falling to the floor, getting caught in the workers' clothes, getting washed off his hands, and so passed to the drains, and in many other ways. An American jewellery trade paper says that some time ago a gold and silver manufacturing firm had occasion to put in a new floor in its work room, and the man who made the change simply took the old floor in payment of his work, and was well paid. In the process of manufacture it is impossible to avoid small particles of the precious metal flying upon the floor, where they are trodden into the crevices until the floor is saturated with them. The floor in a manufacturing jeweller's workshop, which has become so worn that it must be replaced, contains fully sufficient gold to pay for a new one. The shop sweepings are sent to the refiners' for the gold to be extracted. The process of extracting the gold from these sweepings is very simple. They are burnt, and the ashes are carefully collected; the buyer selects samples here and there, taking a portion from every part of the heap. These he weighs, puts through a grinder and sieve, then thoroughly mixes the product, takes a sample of it, weighs it, refines it and calculates how much gold there is in the whole quantity of ashes. From this he forms an estimate of the value and pays accordingly. Even the water in which the gold is washed when a ring or other article of jewelry is to be cleaned is preserved until there is sufficient quantity to make it worth while to separate the gold from it.

M. Positano, of Rome, has recently succeeded in making a modification of the well-known Daniell cell, increasing the electromotive force and intensity of the battery, without diminishing its constancy. M. Positano substitutes for the ordinary exciting element (water containing a certain percentage of sulphuric acid) a solution of chloride of ammonia of 25 per cent. strength; also, to increase the intensity, he replaces the hollow cylinder of copper by a spiral formed of several turns of strip copper. The pile, as modified, gives a current relatively intense, and the cell will find a new use in galvanic applications, and for electric clock service, as well as in telegraphic and other work where a constant current of small intensity is required.

"Pearl solder" is the misleading name applied to a very fusible solder employed for repairing articles containing pearls and other gems, when it is inconvenient to remove these. The color of pearls is easily destroyed by the heat essential to hard soldering, and so a special solder of low fusibility is necessary. Such a solder may be prepared as follows: Bismuth, 1 pwt. (.050 part); lead, 15 gr. (.031 part); tin, 9 gr. (019 part). This solder melts at about the boiling point of water, and is useful for many intricate little jobs. The flux used is venice turpentine, which does not leave a stain on the finished work if the heating is done with care.

Aluminum silver or silver metal is an alloy of copper, 57 parts; nickel, 20 parts; zinc, 20 parts, and aluminum, 3 parts; and it is coming into use for typewriter spacing levers. It is nickel-plated when the machine is new, but as the nickel wears off the metal still remains of a silver white color, which will not tarnish or rust. This metal is conceded to be better than brass, steel or iron for this special purpose; it is stiff and strong, does not cost more than brass, and is sufficiently hard to take a high polish.

It is said that radium has the property of completely neutralizing the poison of the viper, on fifty to sixty hours exposure.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

Vol. IV. No. 9. BOSTON, JULY, 1905. One Dollar a Year.

ALBO-METAL RELEIF.

Under the name of "Albo-Metal Relief," we have a new kind of *repousse'* work that will commend itself to amateurs on account of its simplicity, cleanliness, and the freedom from noise connected with its execution. In enumerating these advantages, we have said nothing of the good effect that is one of its chief merits. In its natural condition it resembles handsomely embossed silver or highly polished pewter. It is guaranteed not to tarnish and is very durable.

Beautiful results are to be obtained by tinting certain parts of the design by the aid of Cinque-cento laquers. These are easily applied and are to be had in blue, red, green, orange, yellow, maroon, purple, olive and brown.

Fig. 1.—The Double-Ended Tracer.

Fig. 2.—The Double-Ended Ball Modeller

Fig. 3.—The Steel Leveller.

Fig. 4. — The Matting Punch.

The tools required are of a simple nature, and are not unlike those employed for leather work and other arts. A tracer is needed for making out the design upon the metal. This is pointed at one end and rounded at the other end, Fig. 1, and is made of boxwood which, while firm enough to do its work well does not pierce the metal. The ball modeller, Fig. 2, also made of wood, is employed for rounding the design, and it often calls for the co-operation of the tracer. Fig. 3 shows the steel leveller for smoothing out the background previously to punching it with a matting punch in Fig. 3 to produce a pitted effect. A firm wooden table should be procured for working upon, or an ordinary drawing board. There is no messiness connected with this work with average care, so no special corner of the family sitting-room need be set apart for it, as is the case with wood-carving, fretwork, and some other arts. Upon the table or drawing-board should be stretched some thick cloth or felt. In all probability the household ironing blanket will be available and can be well borrowed. We are supposing that the design has already been chosen, and that it

Fig. 5.—Photograph Frame with Albo-Metal Decoration.

has been drawn distinctly upon a sheet of moderately thick paper. The sheet of metal should be spread, face upwards, upon one fold of the blanket; over it must be laid the design, the two materials being held together with stamp paper round the edges. Take the double-ended tracer, Fig. 1, and follow all the outlines with it. It is not necessary to do more at this stage than to mark out the design, so that it is plainly visible upon the metal. Remove the cloth and work over the outline again; this is the final tracing, so any little mperfections there may be can now be improved, and the outline in general made more distinct. Any veins of leaves, markings of flowers and other touches that there may be inside the outline must be put in.

Turn the metal over—that is, wrong side upward—and place it again upon the blanket, this time using two or three layers. Take the ball modeller, Fig. 2, or the tracer, Fig. 1, as may happen to be most convenient for the detail upon which the work is to be done, and press the design out from the back. Do this pressing evenly and, as it were, gradually, so that the metal becomes stretched and rounded, not pushed out with anything like an angular result. Take away the flannel and again turn the metal right side uppermost. Rub down the ground thoroughly with the leveller, Fig. 3. Press this carefully into all the angles between the design and round all the curves. This will throw the pattern up into still higher relief.

The next thing to do is to punch the ground all over to produce the pitted effect already mentioned. The metal should be laid on a slab of slate, marble, stone, or some similar hard and smooth material, and the punch should be held fully upright over the work and tapped with a light hammer.

The *repousse'* has next to be filled up at the back to prevent it from becoming dented in course of use. There are several substances that may be employed for this purpose, but the Relievo filling that is sold for gesso modelling is particularly clean and pleasant to use. It simply needs to be rubbed down with water till it is of the consistency of cream.

The composition must only be placed in the hollows of the *repousse'* work. None of it can be allowed to spread over the ground of the design, but if this should happen it can be easily taken off with a brush while wet, or with a penknife when dry. It is possible also that the filling may sink while drying, and if this is the case it must be raised by the adding of some more of the paste put on with a brush till it is exactly the level of the background. Leave the work till dry, then paste a sheet of paper over the whole of the background, using photographic mountenant or some other adhesive of a similar kind. When this is dry the decoration can be affixed with Tenasitine to any wooden, leather, or other kind of article for which it is destined. In this way, also, it is possible to utilize even the smallest scraps of the metal. They may have effective devices embossed upon them, and those may be cut round the edges and glued down to the corners of blotters, boxes and the like. The metal is thin and soft enough to be easily cut with scissors or a sharp penknife. In all probability it would lend itself well to fretwork, but of this method of employing it we have as yet had no personal experience. Certain it is that many of our wood-carving designs would work out well in this relief metal work.

Before parting with our subject altogether it is advisable to remind inexperienced workers that, when the paper has been pasted over the metal this must be laid, face downwards, on a soft pad of blanket or flannel, a board placed on the top, and upon this a heavy weight of books. This is to ensure that the paper will keep smoothly in its place, and the work should be left thus under pressure until it is dry. The same set of tools and the Relievo filling may be employed also for copper modelling. Thin copper costs rather less than the Albo-metal, but it does not keep its color nearly so well, and does not, in consequenee, offer so much attraction to an amateur.—"Hobbies, London."

EGG SKINS FOR WOUNDS.

At a recent session of the Therapeutical Association of Paris, Dr. Amat lectured on the use of the membrane of eggs in the treatment of wounds. He has observed for some time the good results of placing these membranes upon the surface of wounds, and reports two new cases, that of a young girl suffering from a burn on her foot, and a man, 40 year old, with a large ulcer on his leg. Both wounds were in process of healing and were covered with healthy granulations. The surgeon overspread them with six or eight pieces of the membrane of eggs which was covered with tin foil and fastened with dry antiseptic bandages. After four days the membrane of the egg had partly grown into the tissues and had caused the growing of a good skin. That the egg membrane had contributed much to the healing process was demonstrated in the further course of treatment. It seems, however, that the membrane does not always adhere. The process of cicatrization is not only hastened but the wound heals exceptionally well and leaves but few perceptible traces. As these membranes are procurable everywhere, their use should attract more attention.

An English paper reports that a Norwegian has invented a telephone by which the noise made by fish in the depths of the sea can be heard. The instrument consists of a microphone in a hermatically sealed steel box. It is connected with a telephone on shipboard by electric wires, each sound in the water being intensified by the microphone. The inventor asserts that with its aid the presence of fish, and approximately their number and kind, can be recognized. When herrings or smaller fish are encountered in large numbers they make a whistling noise, and the sound made by codfish is more like howling. If they come near the submarine telephone their motion can be distinguished. The flow of water through the gills produces a noise similar to the labored breathing of a quadruped, and the motion of the fins produce a dull rolling sound.

THE LIGHTNING ROD.

It is interesting to observe the grogress of the lightning rod in the favor of men competent to judge of its merits. Years ago it was the bane of the land, and the lightning-rod agent was as little favored as the hobo of today. Very likely there was a good reason for this, for he certainly was the Baron Munchausen of applied electricity, yet it is apparent that some of the things that he did without other reason than to sell plenty of his twisted rods are now looked upon with favor by those who have studied the protection of structures from lightning. The disfavor of the lightning rod is certainly diminishing, and recently the National Fire Protection Association in this country and the Lightning Research Committee in Great Britain have been paying much attention to the subject.

Fortunately, it is now possible to understand why destruction formerly occurred in structures well equipped with rods properly installed. These cases, which were largely the cause of the lack of confidence shown in such protection, we now know to be due to an unusual form of lightning, and on account of the general growth of interest in the subject, it is timely mention the new theory of these discharges. Some years ago it was pointed out by Sir Oliver Lodge and others, that lightning was of two classes, which that physicist named the A and B flashes, respectively. The A flash, as explained in the recent report of the Lightning Research Committee, is of the simple type that arises when an electrically-charged cloud approaches the surface of the earth without an intermediate cloud intervening. Under these conditions the ordinary type of lightning conductor acts in two ways ; first, by silent discharge, and second, by absorbing the energy of a disruptive discharge. In the second class, B, where another cloud intervenes between the cloud carrying the primary charge and the earth, the two clouds practically form a condenser. When a discharge from the first takes place into the second, the free charge on the earth side of the lower cloud is suddenly relieved, and the disruptive discharge from the latter to the earth takes such an erratic course that no series of lightning conductors of the hitherto recognized type suffice to protect the building.

The reason for this latter statement can be best explained by pointing out the change in the opinions held concerning the character of lightning discharges. Formerly, as Dr. Lodge recently pointed out, electricity was treated as if it had no inertia and all that was necessary was to get it from the clouds to earth as quickly and easily as possible by the shortest path. It is now recognized, however, that it is not so much the quantity of electricity that has to be attended to as the electrical energy. The problem is to dissipate as quietly as possible this electrical energy stored between the clouds and the earth in dangerous amounts. A sudden dissipation of energy is always violent, and nobody in his senses tries to stop a heavy flywheel or a railway train suddenly. It is exactly the same with the store of energy beneath an electrified cloud or between one cloud and another. A perfect conductor, if struck, would deal with the energy in such a rapid manner that the result would be equivalent to an explosion. Hence the conductors must be of moderately high resistance. In any case, however, the rush is likely to be rather violent, and, like an avalanche, it will not take the easiest path provided for it. No one path artificially provided can be said to protect others, and the only safe protection is the impracticable one of encasing the building wholly in metal.

This statement explains why the points of conductors are sometimes inoperative in protecting a structure. When the energy is stored between cloud and cloud, instead of between cloud and earth, and the initial discharge is from one cloud to another, the lower cloud is liable to overflow suddenly to the earth through a region where there has been no previous preparation, and where any number of points or a rainshower or any other means for a gentle leak would be quite inoperative. A violent discharge can then occur at the sharpest point, and in this connection it should be observed that a column of heated air like that rising in a chimney is even preferred by the lightning to an ordinary conductor. These considerations have led the British committee to make the following practical suggestions concerning protection against lightning: Two main lightning rods, one on each side, should be provided, extending from the top of each tower, spire or high chimney by the most direct course to earth. Horizontal conductors should connect all the vertical rods (a) along the ridge or any other suitable position on the roof, and (b) at or near the ground line. The upper horizontal conductor should be fitted with aigrettes or points at intervals of 26 or 30 feet. Short vertical rods should be erected along minor pinnacles and connected with the upper horizontal conductors. All roof metals, such as finals, ridging, rainwater and ventilating pipes, metal cowls, lead flashing, gutters and the like, should be connected to the horizontal conductors. All large masses of metal in the building should be connected to earth either directly or indirectly by means of the lower horizontal conductor. Where roofs are partially or wholly metal-lined, they should be connected to earth by means of vertical rods at several points. Gas pipes should be kept as far away as possible from the positions occupied by lightning conductors, and as an addittonal protection the service mains to the gas meter should have a metallic connection with house service leading from the meter.

These suggestions are much less minute in their details than those recently made by the committee of the National Fire Protecilon Association, but it is not unlikely that they are about as useful in actual practice. They omit one suggestion that is strongly urged in this country by several investigators of lightning phenomena, and that is the provision of points and conductors on large trees in the vicinity of buildings. This provision, which seems to have originated in a suggestion made by Prof. Elihu Thompson, is a very good one for some cases. The most important feature of the work being done on both sides of the Atlantic is, however, the careful investsgation of cases of damage by lightning and the examination by men of high standing among electrical engineers of the data thus acquired. This work will eventually result in lifting the ban imposed by the public on the lightning rod, and will add somewhat to the safety of buildings and high chimneys against a class of accidents which are commonly classed as unpreventable.—"The Engineering Record."

THE INTERRUPTION OF PRIMARY CURRENTS IN RUHMKORFF COILS.

OSCAR N. DAME.

In connection with the operation of induction or spark coils, we find the interrupter he easiest part to manufacture, but the most difficult to design to meet the condition of the coil with which it is to be used. With small coils, using a battery of from four to ten dry cells, an apparently trifling change in the length of a vibrator, the weight of the head, the position of the platinum contacts or the back tension or throw causes a wide variance in spark results, and quite often from lack of understanding the cause of some trouble, a coil is condemned because the designer or manufacturer used a "stock" vibrator, instead of building one adjustacle to the primary and secondary conditions.

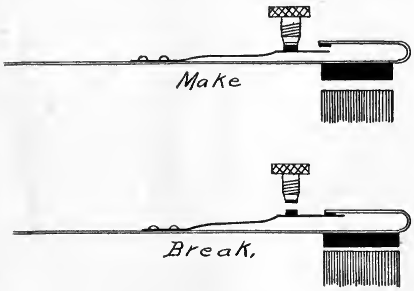


Fig. 1.

As in the designing of motor and dynamo armatures, special attention is given to permeability, etc.; so is it with primary cores, and the best material for a primary core is the finest grade of annealed iron wire, bundled into proper cylindrical form and dipped in shellac. No. 24 or 26 Swedish iron gives superior results.

The purpose of the primary winding is to furnish the proper number of conducting turns to energize the core and make a powerful magnet of it, and usually the best results are obtained with not over four layers. In planning the number of layers one must consider the space occupied by the secondary windings, for sufficient lines of force must be generated to reach the maximum number of turns in the secondary, so that the full value of the spark may result, yet on the other hand, the more turns on the primary the greater the resistance, the inductance, and in general the more sluggish the coil action. We find that the more turns we have on the primary, the greater the spark at the platinum points of the vibrating interrupter, and to care for this spark which, of course, is a result of intense primary saturation, we of necessity must place a larger condenser capacity in micro-farads across these points.

The higher the resistance of the primary, the less amperage available from the battery supply, and also the less likelihood of quick exhaustion of these batteries.

For a standard one-inch spark coil, operated by four dry cells, the vibrator is usually two inches in length, where the primary windings are not over three layers, which gives sufficient time for the "make" to allow the current to make a strong electro-magnet of the core. While electricity in itself is treated generally as instantaneous in its performances, in spark coil operation we find time an important factor. For example, a vibrator only two inches in length if connected to a six-inch coil, would not give satisfactory results because, owing to the very high speed of vibration of such a short piece of spring metal there is not sufficient time on the "make" and before the "break" to permit the primary to become properly saturated, and with the "break" of the circuit there is not sufficient time for demagnetization before the make occurs again. On the other hand, if we were to use a four inch vibrator on a one-inch spark coil, the result would be a splitting, lifeless spark, making the inch spark at times, but valueless for practical uses.

In all sizes of induction coils, the spark value is determined by the instantaneous break at the proper time, often styled the long make and the quick break. All good vibrators are devised to make sudden break of contact at the proper moment, and this is usually accomplished by attachments connected to the vibrating part itself, which "kick" off the spark just as the vibrator is moving at its highest rate of speed. Figure 1 illustrates the principle of this "kick," different manufacturers applying different methods to accomplish the same result.

It will be noted that the lip is bent over from the head and does not strike the piece bearing the platinum contact until the vibrator is well down to the core, and by proper adjustment this kick will happen when the speed is the greatest.

On coils larger than three inches, core actuated interrupters are seldom used, because separately actuated magnetic interrupters give better saturation and a more instantaneous break. Figure 2 shows a vibrator frequently seen on moderately sized battery coils, and the spark results are far better than could be obtained with a vibrator actuated by the coil core. Cores on large coils possess sufficient instantaneous magnetism to act on the hammer head of a core-actuated vibrator as soon as the current enters the primary. Consequently the length of beat, which is commonly governed by the length of the vibrating metal, is not her ea factor. With a separate vibrator coil, wound with a few turns of suitable wire, the electro magnetic value of this coil does not reach a maximum as promptly as

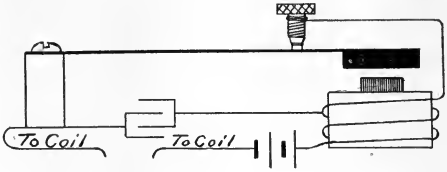


FIG 2.

in the coil primary, so the hammer head is not attracted until the coil itself is in readiness for the break. And because of the low resistance winding of this vibrator coil, and the few number of turns, neither resistance can affect the amperage of the primary to any extent, nor retard the reversals at the interruption and re-contact.

BOOK=BINDING FOR AMATEURS.

WINTHROP C. PEABODY.

VII. Putting on the Covers.

A previously mentioned, preference is given in these articles to the styles of binding likely to be most used by those who care only to bind magazines and books with inexpensive but durable bindings. In accordance with this idea, the covers to be first described will be those known as "cloth."

This brings us to one of the difficulties likely to be experienced by the amateur who buys his materials in small quantities, thus depriving him of the opportunity of buying of the wholesale houses who sell only the quantity comprised in original packages. An exception is sometimes made in cloth, leather and twines, but the mill-board packages are not broken. The latter must be obtained elsewhere, and the small jobbing bindery will be found the best place to make purchases, as at such places the remainder of lots used for other work can usually be had at a small advance in price over that charged by the wholesaler.

Mill-board is obtainable in two regular sizes, 22 x 26 in. and 20 x 30 in. It is designated by numbers which refer to the number of sheets in 100 lbs. of board, as 12, 16, 18, 20, 25, 30, etc., up to 100 sheets per 100 lbs. weight, the latter being but little thicker than a heavy paper. The mill board used in the bound volumes of AMATEUR WORK are known as "30," which means that 30 sheets would weigh 100 lbs.

Binders' cloth comes in rolls and is 38 in. wide. This can be purchased by the yard, the price varying from 12 to 20 cents per yard for the cheaper grades, and from 20 to 40 cents for the better. A yard of cloth will cover several books, so this item of expense is not a heavy one.

To prepare the "covers," as cloth bindings are termed before being put on, the mill-board is cut to the required size. The margins to allow can be determined by an examination of other books of about the same size. It will be noted that the back edge does not meet the "backing" of the book, the space left being sufficient to form the hinge, so that the cover may be opened wide, yet not enough to cause looseness with continued use.

In cutting the cloth, an easy way for the beginner to get correct size and spacing is to draw a diagram which is dimensioned by measurements of the book to be covered. Note the space to be left between the two boards, and the amount to be turned over on the inside, also allowing for the thickness of the boards. The way to trim and turn in at the corners can readily be learned from books already at hand.

With boards and cloth cut and in readiness, the next process is gluing together. Regular binders have glue-pots contained in a hot water can, which serves te keep the glue fluid while using. If the reader lacks this and is binding but few books at one time, a bottle of liquid glue will serve, but it will be necessary to thin it until it will drop freely from the brush, much as would paint.

The cloth is then spread flat upon a smooth board or upon a sheet of clean wrapping paper, coated with a thin, even layer of glue, which should be applied as quickly as possible, brushing out any spots where too much glue has been applied. The boards are then placed in their proper places, the edges of the cloth turned over, after cutting out at the corners, smoothing over with an ivory folder. Care must be used, however, when using cloth with a grained pattern, not to press too hard, or the pattern will be rubbed out, leaving smooth spots which will greatly mar the appearance of the work. All that is necessary is that the cloth shall be firmly in contact with the boards at all places, so that when the glue is dry no "blisters" will appear.

On the inside of the cover between the boards a strip of strong paper, manila of moderate thickness will answer, is placed. It should be a trifle short of reaching the outer edges of the boards. The lap of the cloth is then turned over upon itself, the edges just meeting the ends of the paper. If the covers are not attached to the book at once they should dry between boards, the press boards serving for this purpose, which will prevent them from curling out of shape.

To put on the covers, coat the loose parts of the backing cloth with glue, place the book back downward in the proper place in the open covers, firmly press the cloth with the ivory, open the end papers, which have previously been covered with a strong paste, press the end papers smooth, using care not to stretch them, close the book and run the edge of the ivory along the back edge of each cover between the board and rounded backing, and the book is complete.

Nothing has been said about lettering or tool work of any kind; this will be taken up in a subsequent chapter.

A beautiful dead-black ebony stain, largely used by camera-makers for blacking the insides of camera woodwork, carriers, etc., is made by first coating the wood with a strong decoction of ground logwood, or wood chips, in hot water and then, when nearly dry, applying a solution made by putting 6 or 8 oz. of iron filings into the bottle, shaking occasionally for a few days before use. This will impart a fine and even black to mahogany, or any sort of wood—a black that will neither chip, powder nor rub off, and with a perfect non reflective surface. For external parts of apparatus, a more finished appearance will be imparted by rubbing over with boiled linseed oil.

Many useful tools can be obtained by securing new subscriptions for AMATEUR WORK.

DESTROYING PLANT LICE.

The Practical Counsellor for Fruit and Garden Culture, of Frankfort, Germany, recently offered a prize for the best method of destroying plant lice, for which 58 persons competed. The prize was awarded to the author of the following preparation: Qnassia wood 2½ pounds, to be soaked overnight in 10 quarts of water and well boiled, then strained through a cloth, and placed, with 100 quarts of water in a petroleum barrel with 5 pounds of soft soap. The mixture is then ready for sprinkling on plants infested with lice. Leaves, even those of peach trees, will not be injured in the least by the solution, which can be kept covered in the barrel from spring to fall without deterioration. As soon as the lice appear the leaves should be sprinkled with the solution. If this is repeated several times, the pests will disappear.

A DEATH TEST.

Although physicians assert that the possibility of being buried alive can only occur where a medical examination has not been made, German papers state that a stronger, absolutely reliable guaranty for discerning actual death is still demanded. The discovery of a new modium for ascertaining death with perfect certainty will, therefore, attract attention. It consists in injecting a solution of fluorescine deep into the tissues. If circulation exists the skin and mucous membranes become very yellow and the eyes assume the color of emeralds; if the circulation has ceased, none of these results occur. The discoverer, Dr. Icard, proposes that at least two hours before bodies are placed in coffins such an injection with fluorescine be made. If life is not yet extinct the injection does no harm and the coloring disappears.

On the principal railways of France the traveller finds his train keeping to the left set of rails. This is what he is used to in England; but when he emerges from the station and takes a tram car or cab he finds his vehicle and all others inclining to the right. When he comes into Germany he finds trains rigidly keeping to the right like road vehicles. Why is the difference, asks an English traveller. In France the railroad was not developed from the colliery tramway as this had been from the plank road, but was imported from England, and with it the left hand direction. Once settled the railways have stayed so—with a flavor of the exoctic about them still.

German locomotive engineers receive a gold medal and $500 for every 10 years of service without accident.

A CHEAP NINE=INCH REFLECTOR.

M. A. AINSLEY.

II. Medium and Fine Grinding.

MEDIUM GRINDING.

We will suppose now that the mirror is roughened out, and that the depth of the concavity in the center is judged sufficient. It is hard to say how long this should take. My own mirror took well over ten hours to rough out, but with carborundum and a smaller mirror the work would be far quicker. However, my first mirror was of rather short focus—only 7 diameters —and I certainly should not recommend less than 8½ or 9 diameters for focal length.

The first thing is to get rid of every trace of the rough emery. The tool, mirror, handle, bench, etc., must be thoroughly rinsed and filled up with fresh water. The utmost attention to this is absolutely necessary every time the grade of emery is changed; otherwise the final surface is sure to show scratches which, if not appreciably affecting the performance of the mirror, are unsightly and unworkmanlike.

Having everything clean and free from grit, we "carry on" with No. 46, or No. 80, or something of the sort. It is not necessary to use so much at a "wet," and at this point we may shorten the stroke and introduce side motion. In fact, I have obtained the best results as regards freedom from sticking and regularity of curve by keeping the stroke quite irregular, sometimes circular, then straight for a bit, then elliptical, then spinning the mirror on its center for a second or two, and then perhaps returning to a short, quick, straight stroke with a little (1 in. or so) side motion. This is a matter on which there may be several opinions; but I can only say that in working my second 9 in. mirror I never had the semblance of a "stick" from beginning to end of the fine-grinding, and the spherical surface produced left nothing to be desired, both as tested optically and by the spherometer. The grinding is continued with No. 40 until the surface made by the coarse "roughing-out" emery is replaced by a uniform surface due to the 46, all coarse pittings having disappeared. This will not take long; but it is absolutely necessary to get rid of every trace of the rough surface. I have found it a good plan to have a series of plate-glass discs ground with the different emeries used, one ground with "1½," one with "46," one with "180," and one with "washed flour." The surface of the mirror can be compared with these as the work proceeds, and with the help of a pocket lens it is easy to see if the surface is a true "46" or "180" surface, and so on, or if any trace of the previous surface remains.

When the "46" surface is perfect all over, we may wet the mirror and test its focal length, either, preferably, by direct measurement in the sunshine, or by observing the reflection of a candle flame. If the mirror is made thoroughly wet and kept so, as Mr. Ellison recommends, and the image of the sun received on a visiting card, the position of the card where the image is smallest will give an approximate focus, and the focal length can be measured by means of a tape or a piece of string. If not short enough we must continue the rough-grinding a bit further; if too short, the position of tool and mirror should be reversed for a bit; but if care is taken, this should not be necessary, and it may be repeated that the focal length does not matter so long as it is less than seven or eight times the diameter of the mirror. I will leave the mirror at this stage for the present. My next will deal with the fine grinding.

FINE GRINDING.

We have now got rid of the surface produced by the coarse emery, and the figure of the speculum is beginning to approximate to a sphere. The object of the fine-grinding is to perfect the spherical figure as far as possible, and to render the surface so fine that it can be readily polished. The fine-grinding is commenced with No. 120, 150 or 180—it does not much matter which—and continued in the same manner as before until all trace of the "49" surface is gone. It will be found a great convenience to apply the emery to the tool by means of a flat, soft brush. The brush is dipped in water, then into the emery, and the small quantity it takes up is painted evenly over the tool. There is little fear of sticking at this stage; but if it occurs it is a sign that the emery is not spread over the tool sufficiently even. The stroke is kept irregular, as already indicated. It should not take long to get rid of the 46 surface, and, as I said in my last, it is important to do so completely. Any impatience at this stage of the work will render the final surface difficult to polish. After the 130, washed flour emery is used in the same way and with a similar stroke.

The use of the brush to apply the emery is even more to be recommended with the washed flour. If care is taken to have the emery quite evenly distributed, so that actual contact of the glass surfaces does not take place, sticking can be completely avoided. A little saliva, or a small quantity of soap in the water, will help to this end.

The "washed flour" produces a very fine surface, but not nearly sufficiently fine to polish; so it is necessary for the worker to prepare his finer emeries himself. My way was as follows:

Take 2 lbs. or so of washed flour emery and stir it up in a jug with half a gallon of water, then leave it to stand for one minute. The coarse emery will sink to the bottom, leaving the finer sorts in suspension; after the minute has elapsed, the water, holding in suspension the emery required, is poured or siphoned off into a basin, where it is allowed to settle for several hours. The water is then poured off and the emery may be dried and collected. The process is repeated, except that five minutes are allowed to elapse before pouring; then 15 or 20 minutes, then 40 minutes. It is possible to go even further, but I found that little was gained. We thus abtain a series of washed emeries of increasing fineness, the quantity obtained, of course, decreasing as the length of time during which the emery is allowed to remain in suspension increases. Very little of the finer grades is, however, required, and 4 lbs of washed flour should prove ample for a 9 in. Of course the "one minute" and "five minute" not required can be returned to the washing jug. Care must, of course, be taken that none of the sediment in the washing jug comes over with the liquid. A siphon of india-rubber tubing is distinctly useful.

In practice it is not necessary to dry these emeries, the superfluous water having been drained off; they can be applied to the tool with a soft, flat, camel's-hair brush, and will contain just about the right amount of water required.

It will be seen that I used 1, 5, 20 and 40-minute emeries. There is no virtue in these figures, all that is required being to secure a steady diminution in the size of the grains.

After each grade is finished with, it is a good plan to add water to the emery left on the tool, and grind for a few minutes with the small quantity of emery left. This tends to fineness of surface.

Here a word of warning may not be out of place. The motion of mirror over tool with the fine emeries is exquisitely smooth and frictionless, and the mirror should never be left to itself on the tool without a hand to hold it, otherwise it is very liable to slip off with disastrous consequences.

Some workers recommend that the tool should be divided into squares, by grooves either ground or filed out. This is said to prevent sticking, and in large work is, I believe, essential. But I did not find it necessary for my 9 in., and in any case it would be a tedious job to cut the grooves. The fine-grinding is is not the least fascinating part of the work, the surface produced being so exquisitely fine it has been compared to the side of a tumbler in which milk has just been, and should be semi-transparent, so that a candle flame can be seen at a distance of 10 ft. or more. In my case, after the fine-grinding was complete, large type could be read through the speculum placed on its back, although the glass is 1½ in. thick.

The importance of obtaining a really fine surface before polishing cannot be over-estimated. It is impossible to get a really good polish unless the surface is properly prepared, and each grade should be used until it fails to produce any further effect. Moreover, if care is taken over the fine-grinding, the surface produced will be almost perfectly spherical.

On the completion of the fine-grinding the wooden disc and handles should be removed. This is easily done by standing the mirror on its edge, holding it firmly, and striking the edge of the wooden disc with a mallet. Any pitch left on the back of the mirror can be scraped off and finally washed off with turpentine.—"English Mechanic."

PAPAYA JUICE.

Papaya juice is extracted from the fruit of the papaw tree, which grows rapidly, attaining its full bearing capacity in a year. It produces from 40 to 50 papaws of a dark green color, ripening to a deep yellow, resembling in shape a squash. A very light superficial incision is made in the fruit, from which exudes a clear water-like juice which, on exposure to the air, becomes opaque. As it drips from the fruit it is received in a porcelain-lined receptacle. As it is very corrosive, metal receptacles would injure its appearance and qualities. It possesses great digestive virtues, and the refined article is considered superior to all animal pepsins.

After the desired quantity has been collected the juice is placed in shallow porcelain or glass lined pans and allowed to evaporate. While this is not a very delicate or difficult operation, it requires considerable attention so that the juice will dry uniformly and the product be white and well granulated. In its granulated state it is shipped to the united States, undergoes a refining process, and is sold as the papaw of commerce for medicinal purposes.

The ripe papaw is palatable, and an excellent aid to digestion. Meat wrapped in papaw leaves for a short time becomes quite tender without any impairment in appearance or taste.

In extracting the juice the hands should be protected by rubber gloves, as in its crude state it attacks the tissues. An average tree will produce about one-fourth of the granulated juice. It sells in the United States for from $4 to $6 per pound in the crude state.

German papers report that a new anæshetic juice has recently been discovered in Japan, the product of a plant growing in that Empire. This anæsthetic has been called scopolamine, and is said to be superior in its effects to all other articles of this kind. It is administered hyperdermically and produces a deep sleep lasting from eight to nine hours. If the assertion concerning scopolamine are confirmed, it will certainly be used in surgical operations, as it is claimed that it does not produce the slightest ill after-effects, which are always to be feared with the anæsthetics hitherto used.

PHOTOGRAPHY.

THE CARBON PROCESS.

CHESTER F. STILES.

The name "carbon process" is a misnomer, as in this most beautiful of photo devices, we are not held down to a rigid set of tones, but may, by varying our coloring materials, produce any tone at will. "Pigment process" would more accurately describe it.

In the carbon process our work is more of a mechanical nature than chemical, and therefore our control over printing is almost unlimited. We simply dissolve away by warm water the parts of the picture not affected by light, and by varying the temperature of the developing bath in this operation, we can retard or accelerate at will. We are not, however, as was formerly the case, obliged to prepare these tissues ourselves, for several varieties, and all necessary colors are available at photo supply stores. This tissue, however, must be sensitized at home, as it does not keep well after sensitizing.

Before going into specific details we must briefly sketch the process in a general way. The "tissue," which is the technical name for a piece of carbon paper, consists of a film of gelatine, into which pigments of the desired colors are incorporated. These pigments are minutely ground and are selected with the same care as artists' fine colors. The tissues are sensitized by the operator in a weak solution of bichromate of potash in warm water, after which they are dried for use. They are now sensitive to light and must be handled with more care than the ordinary printing-out papers.

Unlike the papers of the last-mentioned type, the carbon tissue does not show a visible image. The action of light is simply to render the gelatine insoluble wherever the light strikes—the eye can see no difference. In order to time the printing we have recourse to an "actinometer," which we will later describe in detail. When the actinometer shows that the printing is complete, we remove the tissue in a semi-dark room, and develop the image by means of hot water.

A little thought here will show that the surface of the gelatine must be all insoluble because some light has been received by all portions of it. We are therefore obliged to work in from the back, and to do so must transfer the tissue temporarily to a support for development. This, of course, reverses rights and lefts, so when the development is complete another transfer may be necessary. In such an event we may, however, apply the tissue to a variety of supports—glass, paper, porcelain, wood, etc., making it the most versatile of all printing processes.

We would recommend that the novice in carbon content himself with the single transfer process. By selecting a negative which will bear right for left reversing ,such as a landscape, we may use the temporary support as a permanent one. We require the three dishes, one for cold water, one for hot water and another for a saturated solution of alum. Use dishes large enough to afford plenty of room and do not use rubber or composition trays for the hot water, for very obvious reasons.

The other materials necessary are some black varnish and a brush, a quantity of powdered alum, a few pieces of opal glass a little larger than the tissue used, a squeegee, and a board to operate on. For the varnish and brush may be substituted a ten-cent package of lantern binders to be used for making the "safe edge" on the negative, of which more further on. Opal glass is porcelain glass like the white opaque lamp shades. It is obtainable of glaziers and photo supply stores.

The sensitizing solution for carbon tissue is made by dissolving one ounce of bichromate of potash in 20 of water. This is an average formula, for in winter it is wise to make it somewhat stronger, and in summer, weaker. The bichromate is an orange salt which dissolves rapidly in water. Use hot water and filter while hot, so as to filter rapidly. Alcohol is added by some to the sensitizing bath to produce a quick drying tissue.

Use a deep zinc or porcelain tray and sensitize by immersion. Keep the pigment side up and watch for air bubbles on the surface. Authorities vary as to the length of time necessary in the sensitizer, but one to two minutes will usually be sufficient. Of great importance, however, is the temperature. Have this uniformly at a temperature between 50° and 65°.

After sensitizing, hang in a warm room where the tissue will dry quickly. The room should not be less than 70°, for tissue dried too slowly becomes insoluble in developing.

By means of the varnish we paint a border of black completely around the negative on the film side, or accomplish this same object by pasting on the lantern binders. After this the printing frame is made ready as usual, the operations being performed in very subdued daylight or by full lamplight. The pigment side is placed in contact with the negative, and another negative of as nearly the same density as possible is made ready with ordinary Solio paper in a separate printing frame.

The two negatives are placed in the sun together. When the silver paper begins to show detail in the dense parts, the carbon prints should be about finished. The tissue is then placed in the dish of cold water, care being taken to break all air bubbles which otherwise make spots. When the weather is dry the tissues will be dry and stiff; when damp they are much more limp. In case the tissue is dry, the cold water will end to roll it up. We must take care to keep the tissue under the water till it begins to flatten. The damper tissues do not need as much care and soaking.

The opal for the support being handy, we place the tissue upon it quickly, and squeeze out all superfluous moisture and air. When this is done, the opal, with print upon it, is placed between blotters under pressure. In about five minutes it is ready for development.

The water for development should be at about 10° Fahr. The pigment commences to ooze out after a few seconds from between the opal glass and the paper of the tissue. When the proper time arrives the paper will strip easily from the tissue itself, but do not hurry this operation, for the tissue is delicate and will not stand forcing. In all this manipulation it is essential to keep the opal plate completely immersed in the developing water, so as to prevent tearing.

When the paper comes off, wash the print gently with the warm water. The pigment not acted on by light will gradually loosen and fall away from the tissue, and the image will begin to appear. Now, if the printing is correctly done, the development will be at a normal speed and well under control; but if an over-exposure was made, somewhat hotter water will be required to dissolve away the gelatine pigment. Conversely, if an under-exposure is indicated by a wholesale falling away of detail, we must quickly arrest development by cold water, and modify the developing temperature to suit. Extreme latitude is thus secured. Skillful carbon printers lose few sheets of tissue by errors.

When development is complete we stop it by immersion in cold water. It should be rinsed till the drippings are quite clear. After this, a bath of alum serves to move the bicarbonate and to harden the gelatine film.

It is here necessary to explain the "safe edge." We wish to prevent the light from acting clear to the edge of the tissue, for in this case the paper back would cling to the tissue and tear away pieces of the image. By putting on the safe edge we preserve a soluble border of gelatine around the printed image, and the paper back detaches easily.

The "actinometer" makes a better printing guide than the plan above suggested. It may be constructed in a few minutes spare time. Get a small printing frame about 4x5, with a glass to fit. Cut a strip of tracing cloth, or onion skin paper, about 4 inches long, and an inch wide. Next cut a similar strip of 4¾, 4½, 4¼ in., etc., of the same width as the first. Lay the set over one another on the glass so that the longest is on the bottom, and we will then have a series of steps and cover the rest of the clear glass on the plate with black paper. Number with opaque ink the various steps from one upwards.

The actinometer is used in place of the trial negative mentioned before. One negative may need printing till the actinometer shows light action under the number 8, for instance; another may need but 5, and so on. Once the correct number is found it is marked on the negative. It should be possible to make perfect and uniform prints from a negative from here on, as the actinometer is an accurate measure of light.

As stated before, the single transfer process is only applicable to a few subjects. A portrait is allowable in single transfer, and landscapes in an artistic sense. There is, however, a curious difference between the two sides of a face in an ordinary person, and while always recognizable, a single transfer print sometimes gives queer expressions to familiar faces. Similarly a landscape reversed from right to left will sometimes be unrecognized by people who know the locality well. A picture including a sign of any kind would, of course, be ridiculous, as the printing of the sign would run backward.

The description of the carbon process, like many another of the photo operations, is much more complicated than the operation itself. Thus, in the soaking of the tissue before the first transfer, a little judgment must be used. Too long an immersion in water spoils the sticking property of the tissue. When the tissue is hard and brittle it curls inward in the water and must be soaked till it starts to flatten out and become limp. But as soon as the flattening commences it indicates the time for squeegeeing to the temporary support. If the tissue be left in the water till it curls outward, the chances are much against its adhering at all.

The double transfer process is quite easy after a little experience with the simple single process. We need now, in addition to our outfit, some temporary supports. These may be of ground opal, or the more convenient "flexible temporary support" may be obtained at the dealers. Note that the temporary support must be waxed thoroughly else the print would stick to it permanently and could not be transferred.

The waxing solution is made as below:

No. 1. Benzol, 1 oz., brown wax, 3 gr.

No. 2. Spirits turpentine, 1 oz., resin, 12 gr.

Dissolve separately and mix. Pour a little on a cloth and rub over the temporary support, polishing with a second cloth.

The flexible temporary support is covered with insoluble gelatine and shellac. The waxing prevents the tissue from sticking fast at the last transfer.

The exposed print is carried through the preliminary processes just as for single transfer. We are now ready to make the last transfer, and while the developing operations are going on, a piece of commercial "double transfer paper" should be soaking in warm water. When the transfer paper becomes shiny we may then proceed to the final transfer.

The developed print on the temporary support is fixed from bichromate by the bath of alum. It is then thoroughly rinsed and put away to dry. The transfer should be made as soon as the drying is complete. We bring the shiny transfer paper of the preceding paragraph into immediate contact by squeegeeing. This serves to remove air bubbles and superfluous moisture.

We next dry the tissue, double transfer paper and attached temporary support in a warm current of air, after which the temporary support may be removed. The tissue will adhere to the final support if all the operations are correctly performed, and the image now shows in the correct position.

Failure to leave the temporary support shows incomplete waxing; failure to stick to the permanent support shows this support to have been incompletely sealed. If ground opal has been used for a temporary support the print takes on a matt surface, but remains smooth if the commercial support is used.

We come now to a most curious property of the carbon process which is used by experienced carbon printers with great success. We refer to the continuing action of light, which is the property of exposed carbon tissues to gain detail without further action of light when not developed immediately after printing. If we have a batch of carbons which do not develop fully, we may set them aside a day or so, and the remainder of the lot will develop perfectly well. A carbon printer of long experience uses this property to save time in printing when rushed. He prints several actinometer tints short of the correct time, then lets the tissue rest and gain density over night.

The keeping quality of sensitive tissue is fair. It is wiser to make for immediate needs, however. Tissue kept too long becomes insoluble and won't develop. The same defect is caused by dampness. The correction of these defects is quite obvious.

Another cause of insolubility comes from acid bichromate of potash or from impurities in the chemical. Slow drying also produces bad effects. The drying, however, in sensitizing or in the ordinary processes should never be greatly forced. A natural drying is preferable in every branch of photo work.

Before squeegeeing the tissue to temporary supports we should blot off the excess of moisture, otherwise spots may develop on the finished prints. Drying between blotters is recommended to remove the moisture.

Tissue which has just been sensitized does not work well; after two or three days the results are more even and satisfactory. The newly sensitized tissue is lacking in details in the high lights, which defect may also come from underprinting or too hot developing bath.

An operation called "sunning" is recommended by many professionals. This a few seconds exposure of the blank sensitized tissue to sun before placing in the printing frame. It has the effect of tinting over the high lights and making the surface of the tissue entirely insoluble. It, therefore, adheres perfectly to the supports. Sunning is almost a necessity for prints with extreme contrasts.

To retouch or spot out defects, use some of the first drippings in the development. Obviously the color matching will be perfect.

Carbons may be transferred to other supports than paper. If wood, canvas, stone, etc., are used, it is first necessary to prepare the surface with gelatine made insoluble. This may be done by means of chrome-alum, or some of the gelatine may be treated with bichromate and a vigorous sunning given to the prepared surface.

IODINE CURE FOR TUBERCULOSIS.

United States Consul Harlan W. Brush, of Milan, Italy, transmits information regarding the reported discovery, by Prof. Joseph Levi, of Milan, of a cure of tuberculosis by the use of a specially prepared iodine. Prof. Levi, who for many years has been connected with the Veterinary School of Milan, has practiced the use of iodine on horses for the last twenty years, and now announces that by his new method consumption can not only be arrested, but be completely cured. He says:

It is a well known fact that iodine can immediately convert itself into vaccine and become a virus of the most active and deadly kind. It follows from this that a person affected with tuberculosis becomes capable of making by himself and in himself, his own curative serum, ready for healing purposes when this iodine can circulate intelligently in the blood. And it is precisely this which I have obtained by my new method.

Prof. d'Auria, of Naples, made many encouraging experiments with iodine in cases of tuberculosis, as also Durante before him, but from what is alleged, Prof. Levi has now brought former theories and experiments to a definite solution.

A short time ago several new locomotives of German manufacture but of what is here styled the American "Atlantic" type, were put in service on the fast express line between Cologne, Berlin, and Aix la Chapelle. The boilers are considerably larger than in the usual German engines, in consequence of which the smokestack is very low, being of the same height as the dome. The diameter of the driving wheels has been considerably increased and they are driven by four cylinders. There are two distinct furnaces fitted with smoke consuming apparatus, which seems to produce good results. These locomotives have attracted much attention by their massive and powerful appearance, and have proved to be more powerful and speedy than the ordinary German engines, so there is every prospect of their number being increased. The tender is likewise built after the American pattern and is so constructed as to carry an extra large supply of water in addition to fuel.

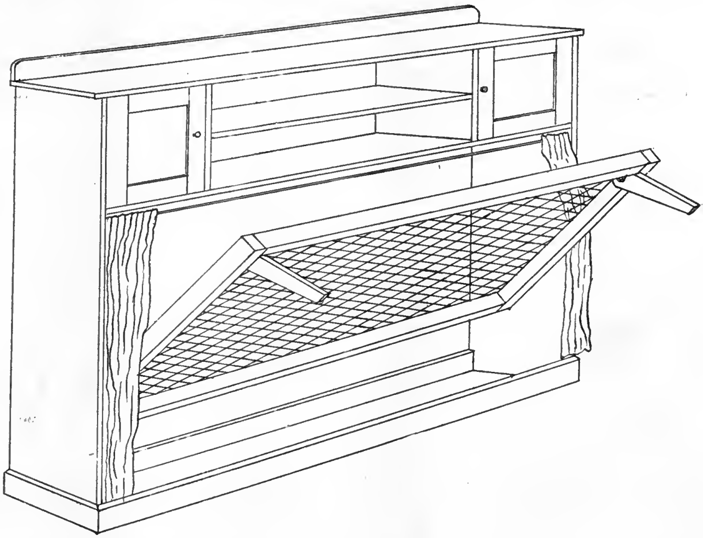
A STUDENT'S FOLDING BED.

JOHN F. ADAMS.

The usual student's room is one in which surplus space is not abundant, and where the furniture has been selected to fit the available places. When visitors are numerous, as they frequently are, the host is then cramped for room in his efforts to accommodate, and the writer has more than once had bed, bureau, tables, etc., utilized as seats, with a small drafting-board on the waste basket for himself. At such times a folding bed, similar to the one here described would have made it possible to have seated three more (with borrowed chairs) at these by-gone deliberations.

springs. This should be done in either case, as different makes vary slightly in size.

The end boards should be about 10 in. wide, the top board 11 in. wide, and the back board at the top 3 in. in. wide; the latter may be omitted if desired. The strips around the bottom are 3½ in. wide with upper edge planed to a slight bevel. The strip across the back is sunk in, by cutting out the corners of the end boards, so that the rear side will be flush with the rear edge of the ends, thus allowing the bed to stand firm against the base board of the room.



This bed consists of an ordinary wire spring with wooden frame, to be found on sale at all furniture dealers. It is attached to the casing with a ½-in. bolt at each end, as will be hereafter described. When not in use it is lifted to a vertical position, the curtains are drawn, and it then resembles a bookcase with curtained front. The illustration shows a top with two cupboards at the ends, and shelves; but a more simple design would have just the top shelf and backboard, as shown. In the latter case the springs can well be full size, 4 ft. 6 in. wide; with the cupboards and shelves the single width, 3 ft. 6 in. would be best.

The latter, only, will be described, as the other can be easily made without dimensions by first making a sketch and adding dimensions after purchasing the

The shelves and top board are fastened to ends with 2 in. screws, the heads being deeply countersunk to allow for puttying.

Between the ends of the spring frame and the end boards are fastened blocks of wood about 1½ in. thick, to provide room at the ends for the curtains. The holes in the spring frame for the bolts are bored large enough to receive, with a loose fit, a bushing of brass or drawn steel tubing, the length of which is a trifle greater than the thickness of the frame. With washers under the head of the bolts and also between the frame and the block above mentioned, the nuts can be screwed up tight without binding on the frame which turns on the bushing instead of on the bolts.

The legs at the front of the springs are attached with

½ in. lag screws, and placed so that when in position the outer edges will rest firmly against the frame, with the lower ends about 3 in. further out, thus avoiding any tendency to close up under the weight of the occupant, or when getting in or out of the bed. The upper ends are rounded on the inner corners to allow of folding back when not in use. Wooden buttons are mounted on blocks and fastened to the inner sides of the ends near the lower shelf to hold the springs when folded back. Stop blocks are also placed at the back.

Pieces of webbing with the free ends oversewed are tacked to the springs about one foot from each end, those at the back having buckles, which are used to hold the mattress and bed clothing in place when folded back. This allows the bed to be made up at any time, and it is then ready for use when taken down by simply removing the bands.

The backs of the cupboards are filled in with boards nailed through the ends and shelves. The curtain can be hung on large picture wire, or a small curtain rod, and the curtain should be of rather light material to slide into small space at the ends. Small angle irons are fastened to the back inner edges of the ends, projecting at the back the right distance to fasten to the walls of the room.

A headboard consisting of two strips 1½ x ⅞ in. and a cross piece 5 x ½ in., can be attached by ½ in. lag screws to the spring frame. There should be an open space under the cross piece of about 6 in. to permit the headboard to be folded. The headboard rests against the end when open, or stop blocks can be put at the lower ends of the strips. The headboard should have a slight outward incline. The wood for the frame should be any light wood; oak is too heavy.

INSTANTANEOUS X-RAY PHOTOS.

X-ray photography has labored under the disadvantage of demanding long exposure, while, for practical purposes, instantaneous pictures were required. Professer Rieder and Dr. Joseph Rosenthal, of Munich, have attained the desired end, reports Richard Guenther, U. S. Consul at Frankfort, Germany. After laborious experiments they have succeeded in obtaining in less than a second, X-ray photographs of the human chest, the patient ceasing to breathe meanwhile. Strong electric currents, especially good X-ray tubes, very sensitive photographic films and intensifying screens were used.

They have worked on unremittingly after their first success, and have now published in the "Medical Week" of Munich. a report concerning their further experiments. They find that high-priced and easily perishable films can be dispensed with, as less sensitive photographic plates will produce as good a picture in not more than a few seconds. It is, however, of the greatest importance that the time of exposure be shortened as much as possible for certain X-ray photographs, for instance, when it is desired to show the structure of the lungs.

While they formerly had taken a photograph during one intermission of breathing, they tried to reduce the time of exposure to the time between the beatings of the heart, as the heart beats impair the exactness of the picture. It was evident that for X-ray pictures of the heart such an accomplishment would be of great value. The first difficulty was to get a precise and reliable measurement of the length or time necessary to apply the rays for photographic purposes. This they accomplshed by a contrivance consisting principally of a wooden disk covered with lead, the diameter of which is about 39 inches. From this disk a sector was cut, amounting to about one-seventh of its total surface. The object to be photographed and the sensitive plate were placed behind the disk and the X-ray apparatus in front. The X-rays were passed through the opening in the disk while it revolved on its center once in a second, the exposure of the plate to the ray thus lasting one-seventh of a second. By changing the speed of the revolution of the disk the time of utilizing the X-rays could of course be either increased or decreased. The X-ray apparatus was supplied with a tube of very thin glass. In addition, the most sensitive films and especially strong X-rays were used. Good X-ray photographs were secured in one-tenth of a second. The outlines of the heart and of large portions of the lungs can be photographed with much greater success than was possible heretofore.

NEW WHITE PAINT.

British trade journals describe a new white paint, patented in Germany, which is claimed to far excel lead and other similar products, in fineness and smoothness of surface, covering power, permanence and cheapness. It is said to be obtained by saturating burnt lime containing magnesia with a hydrocarbon, and firing until all the carbon is burned. The material is then ground fine and colored ready for treatment with linseed or other saponifiable oils; with mineral oil, also, partial saponification takes place, resulting in a good workable paint. A dolomitic limestone, containing from 20 to 50 per cent of magnesia, is said to be best for the purpose, although a limestone having less than 20 per cent may be enriched by adding the desired quantity of magnesia, but with not such good results as are produced by the dolomite. Other pigments can be mixed with the material to produce paints of any required shades. The advantages claimed for the paint are that it dries quickly without driers, is unaffected by light, and not changed by ammonia, sulphurated hydrogen, or sulphurous acid; that the coating hardens like enamel after some months, possesses a dull gloss, does not blister in the sun, and is washable, yet retains its original smoothness. The paint is suitable for walls and woodwork of all descriptions.

AMATEUR WORK.

DRAPER PUBLISHING CO., Publishers,

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A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month for the benefit and instruction of the amateur worker.

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Single copies of back numbers, 10 cents each.

TO ADVERTISERS.

New advertisments, or changes, intended for a particular issue, must be received at this office on or before the 10th. of the previous month.

Entered at the Post Office, Boston, as second class mail matter, Jan. 14, 1902.

JULY, 1905.

Of late many inquiries have been received which have been of such a character as to necessitate a few limitations in the "Correspondence" Department. We cannot give advice as to the merits and commercial possibilities of inventions and patents, or the sale of same, nor can we furnish designs of dynamos, steam engines, or flying machines upon requests written upon postal cards. It is also necessary that inquirers sign their names, as we are not mind readers and cannot reply if we do not know who makes the inquiries. Also, many of the inquiries are of such a nature as to require correspondence on our part, and it frequently takes some little time to procure the desired information. It is our intention, however, to make prompt reply by direct letter when a stamp is enclosed for postage.

A few inquiries regarding the reliability of some of our advertisers leads us to state that no advertisements are inserted in this magazine which we do not believe to be quite trustworthy. We accept no advertisements of doubtful character; in fact, have been accused of being over scrupulous, and feel confident that our readers will have no cause for complaint in any dealings which result from any advertisement appearing in the magazine.

We expect to be able to announce in the next issue a premium offer which we feel confident will be welcomed by a large number of our readers :— A servicable, efficient telephone for *Two New Subscribers*. The talking efficiency of these telephones will be fully equal to those of much higher price. They will have ringing bell, watch case receiver, switch hook, etc, and be *well* made in every particular. They will be just the thing for connecting the homes of two friends, from house to stable, or similar uses. We know they will be fully satisfactory, and advise our subscribers who would like them to secure the necessary subscriptions from their friends, which can be sent in advance and the premium sent when ready.

Do not delay ordering a set of the bound volumes; they are going fast, and the supply of Vol. I. will soon be exhausted. The large amount of interesting and valuable information contained in these volume, makes their acquisition desirable while it is possible to secure them.

The steamship engineer carries great responsibility, and so much depends on him that any device that will facilitate his movements about the ship or aid him in his work is well worth installing. The "American Shipbuilder" suggests the need of elevators for the personal convenience of engineers in descending or ascending the 30 or 40 feet to and from the engine-room. The means of descent is ordinarily a slippery iron staircase where a firm grip, steady nerves and a sure foot are required to make it in safety. The elevator would cost little, as there is always plenty of steam or electricity at hand and plenty of room to spare.

Fir will grow at as great an altitude as 6700 feet above sea level, yellow pine at 6200 feet, ash at 4800 feet, and oak at 3350 feet. The vine ceases to grow at 2300 feet.

THE RUHMKORFF COIL.

JOHN E. ATKINS.

The amateur interested in electricity should make himself familiar with the various parts of a spark coil; it is proposed, therefore, while avoiding as far as possible electrical technicalities, to explain understandingly the principal features and functions of the coil.

The first step is to acquire a supply of electrical energy to produce the required current. Assume that one of the many forms of primary battery is selected—preferably new, dry cells. The next question is how the electrical energy, with which the amateur has supplied himself, is to be made to produce a spark by means of an induction coil.

The construction of the induction coil is based upon certain principles of electricity discovered years ago.

The first principle is:—With two entirely separate and distinct circuits placed near to each other, but not in contact, by exciting an electric current in one of them, there will be instantly induced, or in other words, produced by induction, an electrical current in the opposite direction in the other circuit. The original current is called the primary current, and the induced current is called the secondary current, and the circuit in which it is induced is called the secondary circuit. Similarly, if the current in the primary circuit is suddenly interrupted, a secondary current will be momentarily induced in the secondary circuit, but this time in the same direction as the primary current. It follows that, if you alternately open and close the primary circuit with great rapidity, thus alternately exciting and interrupting its current, there will be induced in the secondary circuit a current which is continually changing in direction; in other words, what is called an alternating current.

The second principle is:—That the rapid movement of a magnet in proximity to a conductor, or of a conductor in proximity to a magnet, will excite an electrical current in such conductor.

The third principle is:—That an ordinary bar of soft iron, which is for practical purposes non-magnetic, may be turned into a very powerful magnet—termed an electro magnet—by being placed in the neighborhood of an electric current, and that the magnetism so produced will last so long as the current continues.

Now, in the center of the Ruhmkorff coil is a core of soft iron wire around which the primary wire is wound, the effect of which is that directly an electric current is excited in this circuit the iron core becomes magnetized. The core is, in fact, instantly converted into an electro-magnet emitting lines of magnetic influence, and the immediate sphere through which these lines of magnetic influence pass is called the magnetic field.

The secondary coil, consisting of many thousands of yards of very fine insulated copper wire, is wound round the core and primary circuit in such a manner that it is continually passing through the magnetic field.

Fig. 1, while by no means showing the detailed construction, will serve to illustrate the principle upon which the primary and secondary circuits are respectively wound. The iron core is represented by *a a*. The thick line, marked *b b*, represents the primary circuit, the positive, +, and negative, —, terminals of which *A A* would be connected to the corresponding terminals of the battery. It will be seen that this primary circuit, *b b*, is wound round the core, *a a*, so that immediately the current is turned on the core will be magnetized.

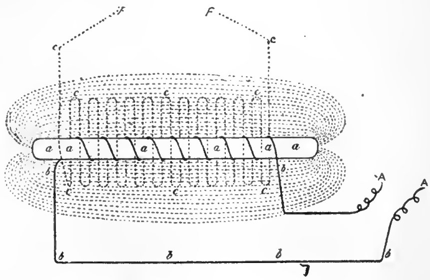


FIG. 1.

Owing to the proximity of this secondary circuit *e e* to the primary circuit *b b* the instant the primary current is excited in *b b*, a secondary current in the opposite direction is induced in *c c*, while the instant the primary circuit *b b* is broken or opened, a secondary current in the same direction is induced in the secondary circuit, *c c*.

In order to make the diagram plain, the secondary circuit is shown as passing only twelve times round the primary circuit and core, but in actual practice this secondary circuit is several miles in length, and is wound many thousands of time round both, in the form of a bobbin.

The horizontal lines in Fig. 1 represent the invisible lines of magnetic force caused by the magnetization of the core *a a*, and it will be noticed that by the ar-arrangement above described, the secondary circuit, *c c*, is enveloped in this magnetic field; in other words, the secondary current is continually passing through the lines of magnetic force.

The foregoing is a mere outline of the principle of the construction of an induction coil, and the beginner will naturally ask how this apparatus operates to intensify the force of the current supplied by the batteries.

The actual E. M. F. of the primary circuit remains in all probability unaltered, but the E. M. F. of the resulting secondary current is vastly increased from several causes. One cause is the great length of the secondary circuit, necessitating an enormous number of turns or coils. The greater the number of coils, the more frequently does the secondary current have to pass through the lines of magnetic influence, and the more often it passes through this magnetic field the more intense becomes the voltage.

Another cause is a contrivance by which the primary circuit is opened and closed, and the primary current consequently interrupted with great frequency and rapidity, thus constantly magnetizing and demagnetizing the core. We have already explained that the rapid movement of a magnet in proximity to a conductor will excite a current in such conductor. In the Ruhmkorff coil you are, by repeatedly interrupting the primary circuit, constantly magnetizing and demagnetizing the core; in other words, constantly producing a magnet in proximity to the secondary circuit, and immediately taking it away, an operation practically equivalent to the rapid movement of a magnet in proximity to the secondary circuit, the result being to excite a current in the secondary circuit.

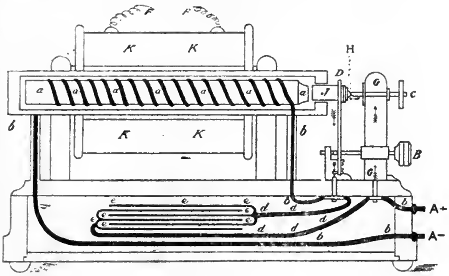


Fig. 2.

It will thus be seen that the secondary current is not only intensified by its constant passage through the lines of magnetic force, but also by the rapid magnetization and demagnetization of the iron core. It must also be remembered that the continual making and breaking of the primary current causes the secondary current to be constantly changing its direction, so that it is further intensified by being converted into an alternating current.

The device by which the primary current is thus interrupted is shown at Fig. 2. In Fig. 2, the primary circuit is closed. The current passes from the positive terminal, +, up the metal pillar, *G*, by way of the platinum points, *H*, to the hammer or contact breaker, *J*, down the spring of the hammer, *D*, and thence by way of the primary circuit *b b*, round the core *a a*, and back to the negative terminal, —.

A loop, *d d*, is shown which goes off to the condenser, *e e*, but if this is followed it will be perceived that the two parts of the condenser are not in contact, so that the current cannot circulate through this loop, the functions of which are described later.

Now, the moment the current is turned on, the core, *a a*, is magnetized, and, as a natural consequence, the hammer or contact-breaker, *J*, is drawn by magnetic attraction towards it. The immediate effect of this is to break the contact, or open the circuit at the platinum points, *H*. The result of thus breaking or opening the primary circuit is to demagnetize the core, *a a*, so that the hammer, *J*, ceases to be attracted, and is caused by the spring, *D*, to fly back to its original position, when the process is automatically repeated; the primary current being thus interrupted and the circuit opened and closed with wonderful rapidity.

It now remains to draw attention to the loop, *d d*, leading to the condenser. The reader will observe that this loop is not strictly a portion of the primary circuit proper, but a kind of extension of the circuit from the contact breaker. The condenser itself, *e e*, to which this loop leads, consists of several thin layers of tinfoil placed in the base or stand under the coil. Each layer is connected to the next layer but one, but is carefully insulated from its next-door neighbor. One set of connected layers is attached to the positive conductor of the loop, while the other set is attached to the negative. It will be seen from Fig. 2 that by this arrangement this loop does not form a complete circuit, there being no actual contact between the positive and negative layers; whereas, if they were connected, the primary circuit would not be opened or broken when the interruptions at *H*, which we have already described, take place, because the current could pass from *G* to *D* by way of *d d* and *e e*.

We have already explained that the making and breaking of the primary circuit induces alternate currents in the secondary circuit, and it is also a fact that the breaking of the primary circuit will momentarily produce by induction a current in the same direction in itself—a phenomenon which is called self-induction.

Now, the function of the condenser is to absorb this self-induced current which is formed in the primary circuit at the moment when such circuit is broken at *H*. When this break occurs, the current seeking a passage rushes to the condenser by way of the loop, *d d*, only to find that there is no contact between the positive and negative sheets of tinfoil which compose the condenser. The electricity thus accumulated by the condenser is discharged a moment later through the primary coil, thus creating a current in the opposite direction to the battery current, and consequently demagnetizing the core.

As the induced current is due to the change in the magnetization of the core, this demagnetizing current greatly adds to the efficiency of the coil.

Further, by thus absorbing the current, the condenser reduces the liability of the current to "arc" or spark across the space between the platinum points at H when the contact is broken.

The important part which this condenser plays in intensifying the secondary current will be appreciated when we inform the reader that a 1 in. spark coil, without a condenser, will barely give a spark of ⅛ of an inch in length.

To such an extent is the intensity of the secondary current increased by the devices which we have described, that if the secondary circuit is left open between the terminals F F, the current will be forced across the intervening space, and a continuous stream of sparks, like miniature forked lightning, will pass from one terminal to the other.

TECHNICAL EDUCATION.

The following are abstracts from an address, entitled "Commerce and Culture," delivered by Sir Swire Smith, a leading English authority on industrial art and technical education, on the occasion of the distribution of prizes Dec. 19, 1904, at the Central Municipal Technical School of Liverpool, England. The report was transmitted by United States Consul Boyle, of Liverpool:

The best spent money is that which is spent in cultivating the brains of future rate payers. You seem to have shown a determination in your educational agencies to give equality of opportunity to rich and poor alike, so that talent, wherever it may be found, may be available for the enrichment of the community. The object of education has been defined as the fitting of the people for their work in life and for their duties as citizens.

All realize that in the future the greatest success in the world's commerce will be achieved by that nation which can make the most effective use of education, science, machinery and available advantages, and thus can place upon the shop counters of the world the commodities that the world wants. I have had, in my experience, exceptional opportunities of comparing, face to face with the facts, the resources and the aids which count for success in manufacturing industries in the leading countries of the world. I am fully acquainted with the many difficulties with which British manufacturers have had to contend in their competition with foreign rivals. I know something of the effect of the lower wages and longer hours of competing operatives in other countries, and of other factors that have influenced the competition.

In the world's race for commerce we are meeting competitors equally armed with weapons of precision. Our position will depend on our national supply of "brains and brawn," and how we can best utilize them for the public service. The more I see of the progress of other countries the more do I realize that education is the main factor in the competition that lies before us; in proportion as we can raise the individual efficiency of our people, in that proportion shall we hold our own. Some of our industries may be harassed by what we call unfair competition, but we must take consolation from the fact that those nations do not permanently hurt us that compel us to put forth our best. New markets are ever opening up, new wants are arising.

We can no more compel our customers to buy what we wish to sell than the angler can compel the trout in the stream to take the fly he casts. More than ever our manufacturers will have to cater for two important classes of customers—the million who must have cheapness, and the tasteful and wealthy who demand excellence—you find the characteristic productions of our industries represented by the labor of quantity and the labor of quality, in both of which we are destined to stand or fall against the world. In the labor of quantity, in supplying the goods for the millions, in which we have so long been supreme, we must be first in the adoption of all machinery and methods that will insure economy of production. Young men will have to enter the world with open minds, ready to learn all that can from all sources, and to apply what they learn. In spite of all obstacles there is still, especially in the neutral markets, an immense field open for the trade in common goods for the million, which offers success and fortune to those who enter it with knowledge and with a determination to suit the convenience and taste of the buyers. As for the labor of quality, represented by excellence in the manufacture of superior goods and luxuries, every market in the world is open. It can only be secured by the greatest taste in designing, by the finest knowledge in applying science to industry, and by the most highly trained skill and workmanship. Success in this field means the capture of many prizes now held by our rivals, and the development of industries of enormous value to our home market, as well as to all the wealthy markets of the world.

For more than thirty years I have been intimately associated with the education of my own town, and more particularly with its technical school, through which several thousands of students have passed. Living among them, I have watched the career of many, and can testify to the soundness of their education; yet I confess that some of the most brilliant students and prize winners have not fulfilled the promise of their youth. They have been lacking in grit and energy, some of them looking upon education not as a means to an end, but as an end in itself. I have also known others who, by perseverance and character have turned a little learning to good account in many ways and have become leaders of men. I have seen youths and maidens come to the evening classes in science and other subjects, with a slender equipment of scholastic knowledge, who have soon learned how to learn, and have had implanted in their minds a genuine love of knowledge. And I wish to say in defense of this so-called "bread and butter education," that whatever may be the ultimate object in view of the student, all true education leads to culture. I have known scores of students from the humblest ranks who passed from the half-time factory schools to evening classes who obtained scholarships to the highest colleges and universities, and are now worthily recognized as men of culture.

I have found among the apprentices from machine shops and factories many whose first idea in attending an evening class was to obtain knowledge that they could turn to practical account in the daytime, but who, after receiving advanced instruction in science were lured to the Elysian fields of literature beyond. Many a student whose habits of study have been formed under the stimulus of bettering his material condition, has been led to seek the solace and pleasure that he could get from books that elevated his moral character and contributed to the refinement of his nature. And when we consider the influence of such young men among their associates in the workshops and in mellowing their hearts while they are strengthening their faculties as men of affairs. Thus it is that in considering the broad question of education to the millions who start out in life with no inherited capital but that in their brains and sinews, I am strongly of opinion that the education imparted in such a school as this is not only most fitting in itself for their industrial training, but in most instances it forms the best foundation for the extension of culture, and often acts as a stimulus toward its attainment. My advice, therefore, to the students who are before me is this: "Seek ye first the necessaries of education, and the luxuries will be added unto you."

You will have noted that a controversy has been going on for some time as to the importance of the teaching of Greek in our old universities of Oxford and Cambridge. I do not think that you and I need to be seriously concerned about this question. I am reminded of the mischievous schoolboy at Eton who wrote on the door of the classical professor, "This road leads to nowhere." When the professor saw the inscription, he wrote underneath it, "Nevertheless, a good road on which to take exercise"—surely a terse and witty answer. But the answer reminds me of another story of a wealthy manufacturer, and one of the pioneers of the wool industry of Bradford. He had contracted some ailment, and he called in his medical man, who prescribed that he should get some dumb-bells and take vigorous gymnastic exercises. "But," asked the patient, "would not exercise in my factory do as well for me?" "Quite as well," replied the doctor. And this rich manufacturer could be seen perspiring among his workmen, packing the bales of pieces and loading them on to the wagons. He said he "didn't believe in doing work that didn't bring something in." Your technical instruction, like Greek, will give you good exercise, and yet, unlike Greek, will bring something in.

I have no fears that this country will suffer in its higher interests from too much attention being paid to the utilities of life. It is not so much what a young man learns as the spirit in which he enters upon his studies that determines the formation of his tastes, and culture is the bourn toward which the searcher for knowledge is ever tending, no matter in what field that knowledge may lie. I heartily accept Mr. Ruskin's definition as upholding the line which I have presumed to take on this question. He says, "Education briefly is the leading of human souls to what is best, and making what is best out of them; and these two objects are always attainable together, and by the same means; the training which makes men the happiest in themselves also makes them most serviceable to others. I believe that what is most honorable to know it is also most profitable to learn, and that the science which it is the highest power to possess it is also the best exercise to acquire." Emerson taught that the acquisition of some manual skill, and the practice of some form of manual labor, were essential elements of culture, and this idea has been more and more accepted in the systematic education of youth."

PRACTICAL EDUCATION AND LITERARY CULTURE.

As to the bearing of practical side of education on literary culture, Mr. Henry Smith Williams, in an article on the Literature of Science, shows by remarkable examples that some of the greatest masters of literary style have been men of scientific training. I select the following among many:

"Buffon, famed a century ago for his mastery of literary style, was by profession a naturalist. Dante was learned in every phase of the known science of his time. Keats, 'one of the few writers of his time whom critics have ventured to mention in the same breath as Shakespeare,' was trained in the profession of medicine. Goldsmith was a practicing physician; so also was Schiller, the second poet of Germany. Goethe, 'whose genius raised the German language to a new plane as a medium of literary expression,' would be remembered as a discoverer in science had he never penned a page that can be called literature. Darwin's Origin of Species owed much to the form of its presentation, but much more to the greater artist. Huxley, in Man's Place in Nature, and in a score of other essays, brought all the resources of a marvelously flexible literary style to the aid of the equally revolutionary doctrines that Darwin had inaugurated. It is well to remember also among the teachings of history that material prosperity in the true development of civilization must go hand in hand with intellectual culture, and none have more ardently desired the spread of the latter than those who were in their day the great economic pioneers of the former."

Earl Stanhope said that:

"In Athens the study of the arts and the acquirements of literature were united and made to flourish by the pursuits of commerce. For while these great speculations in philosophy were being pursued in the grooves of the Acadamy, and while Phidias was raising the masterpieces of his art—at that very time ships from every clime then known were crowding the wealthy ports of the Piræus."

Your own illustrious townsman, William Roscoe, so long ago as 1817, at the opening of the Liverpool Royal Institution, in an eloquent discourse, remarked:

"We find that in every nation where commerce has been cultivated upon great and enlightened principles a considerable proficiency has been made in liberal studies and pursuits. * * * Under the influence of commerce the barren islands of Venice, and the unhealthy swamps of Holland, became not only the seats of opulence and splendor but the abodes of literature, of science and the fine arts, and vied with each other not less in the number and celebrity of eminent men and distinguished scholars than in the extent of their mercantile concerns."

Lord Beaconsfield, in an address to the students of the Atheneum at Manchester, sixty years ago, declared:

"It is knowledge that equalizes the social condition of man, that gives to all, whatever may be their political position, passions which are in common and enjoyments which are universal."

Here is the testimony of the great Lancashire man, who was described by Mr. Gladstone as the "inspired bagman." In 1844 Er. Richard Cobden said:

"There will be one test for the future greatness of Manchester, and that will be a mental test and not a material test—that our destiny will be decided, not by the expanse of bricks and mortar, not by the muliplication of steam engines, nor by the accumulation of wealth, but just in proportion as mental development goes forward, and in proportion to the development of wealth and mental resources, just in the same proportion will our destiny be exalted or the very reverse."

At Manchester also, in 1847, the second great apostle of the "Manchester School," Mr. John Bright, spoke in a similar strain. After enumerating some of the examples of the commercial progress of the country, he asked:

"With these increased comforts and advantages that we enjoy, shall we neglect that which is most noble because it is the indestructable portion of our being? Shall we be victors in the material world only and gain no laurels in the intellectual? Or shall we dive to the deepest depths and soar to the loftiest heights; growing in mental stature and adding to all those outward blessings that surround us—yet neglect those which are purer and more lasting and which spring up as a rich harvest from the culture of the mind?"

Here we have the loftiest and most eloquent tributes to culture from the most eminent promoters of trade and commerce that this country has produced. I could give many others, but I will content myself with a brief appreciation of this same culture by the greatest industrial leader and the most generous friend of technical education of our time—nay, of all time—Mr. Andrew Carnegie. In his rectorial address to the students of St. Andrews he said:

"Of what value is material compared with moral and intellectual supremacy—supremacy not in things of the body, but in those of the spirit? What the barbarous triumphs of the sword compared with those of the pen? What the action of the thews and sinews against that of godlike reason, the murdering savage armies of brutal force against the peaceful armies of literature, poetry, art, science, law, government, medicine, and all the agencies which refine and civilize man, and help him onward and upward?"

An so, to sum up, I rejoice in the assurance that the technical and scientific training which this great school is imparting to you is not only providing each of you with working capital that can be utilized in the development of the industries of Liverpool, but is "leading your human souls to what is best" in the cultivation of your higher intellectual faculties. We sometimes speak of Britain as the "old country," as if it had seen its best days and was entering upon its period of decay. It is venerable in years, and perhaps it clings rather tenaciously to some of its old-fashioned customs and ways; but it retains its vigorous strength, its love of freedom, its unbounded energy, its doggedness of purpose, and there has been no falling away in the breed and stamina of its people. It is when we see the young men and maidens of our country gathered together as they are here tonight that, as Burns says, "Hope springs eternal on triumphant wings," and we feel assured of the enduring qualities of our race and of the perpetual youth of our country.

Where it is impracticable to thoroughly drain the swamp regions, says "Aboriculture," an improvement may be effected by planting willows and other growths which emit roots readily from cuttings, and many of these are of greater valve than existing swamp trees. Willows reduce the malarial gases and thereby improve health conditions. They evaporate vast quantities of water through their leaves and absorb carbonic acid gas from the atmosphere, thus drying up the moisture and purifying the air. Some of the willows are valuable for a number of uses. Charcoal for powder is best made from willow. Salicylic acid is a product of willow bark and is very largely used in pharmacy. Artificial limbs are preferably made from willow, which combines great strength with lightness.

Renew your subscription before you forget it.

MARINE GASOLINE MOTORS.

THEIR DESIGN AND OPERATION.

By Courtesy of the Brooks Boat Mfg. Co.

LUBRICATION.

A gasoline motor requires ordinary intelligent care. It should be kept clean internally and externally. Grease and dirt form conductors, injure the insulation. See that no foreign substance enters the fuel tank, as a small particle will obstruct the needle valve. It is a good plan to have a gauze strainer in the funnel used to fill the tank. Never use ice for cooling parts that have become heated—cool gradually. Use a high grade gas engine oil for cylinder. This is a high fire test mineral oil—animal oils will not do.

A good grade of machine oil is suitable for shaft bearings and other working parts, or still better, use compression grease cups on all the main bearings.

If the motor lubricates the connecting rod by the splash system, the crank chamber should be supplied with "crank case oil." All parts must be oiled sufficient for lubrication. Beyond this, an excess of oil is a detriment, resulting in an accumulation of grease about the motor besides forming a gum that clogs the openings to the cylinder, the rings of the piston and the spark points.

HINTS TO THE AMATEUR OPERATOR.

There are four important points that the operator must attend to. First, the ignition; second, the mixture; third, the lubrication, and fourth, the water circulation.

To start the motor you will first see that there is a supply of fuel in the tank, then open the valve next to tank and also give a vent to the tank. Open the gasoline valve next to vaporizer and the needle valve of the mixing device. Open the relief cock of the cylinder and give the fly-wheel a couple of turns in the direction motor runs, adjust the ignition to take place at the top of the stroke, close the relief cock, throw in the switch and give a quick turn to the fly-wheel. The motor will then start. You must now advance the spark and if dynamo is used, switch current from battery to it. See that pump is working and adjust oil cups to give proper supply.

It will be found that to start the motor when it is cold will require an extra amount of gasoline, but as the cylinder becomes warm the supply can be reduced to the proper point. Less gasoline is required in warm than in cold weather. Keep watch of the sight feed oil cups until they become warm, as the oil will then run more freely. Adjust the cylinder cups to feed from 6 to 7 drops per minute. To check down the motor, shift the lever so as to retard the spark. If the slow speed is to be continued any length of time, reduce the supply of gasoline accordingly.

To stop the motor—throw off the switch, turn off the supply of gasoline at the stop-cock and needle valve, shut off the oil cups, and when leaving the boat shut off the gasoline at the tank and close the vent.

LOCATING TROUBLE.

If, after a proper trial the motor fails to run, first examine the spark. If make and break is used, test by turning the fly-wheel until the points or electrodes within the cylinder are brought in contact, then detach the wire from the stationary electrode and pass the end of the wire across its post and see if there is a spark. If the spark shows all right, turn the flywheel until the electrodes are separated and try again in the same way. This time there should not be any spark. If jump spark is used, disconnect the wire and take out the spark plug, reconnect the wire and lay the spark plug on top of the cylinder in such a position as to ground the metal part with the cylinder, then turn the flywheel until the circuit is formed, when a spark should show between the points of the spark plug.

If no spark occurs with the make and break, look over the insulation of the wires and all connections. See that no wire is broken under the insulation and that connections are firmly made. Ascertain if the battery is weak.

WEAK BATTERY.

When a motor stops or refuses to start, nine times out of ten the trouble will be found with the spark. When a battery alone is used to furnish the spark, it will in time become weak and useless. A weak battery will recuperate and show a good spark, but this will not last. A few sparks will exhaust it and then a rest of a few minutes will again recuperate it sufficient for a few more sparks.

This often puzzles the amateur, as he will try the spark and apparently it will be all right, and at the same time the motor will stop after three or four revolutions. Therefore, when testing the spark for weakness, try it by repeatedly sparking it for at least a minute to ascertain that the spark holds its strength. Never add new cells to an old set of batteries to strengthen them, as one old, weak cell will bring down the new ones to its strength or voltage.

In all except small cylinder motors a dynamo should be used to give the current, the batteries only being used to start with.

If no spark occurs with the jump spark, look over the insulation wires and spark coil, and see that the vibrator is adjusted properly, see that the insulation or porcelain of the plug is not cracked, and that the points are clean and not over 1-16 of an inch apart. If the spark is not at fault, then look at the mixture. This may be either too rich or too poor in gasoline or the compression of the charge may not be perfect. A mixture that is too rich will cause a smoky exhaust, resulting in fouling the cylinder electrodes and valves. A mixture too poor will not ignite regularly and is apt to be slow firing, which is one of the causes of back firing. After the valves of the mixing device have been once adjusted to give the proper mixture, they should be marked in this position.

COMPRESSION.

If the cylinder leaks or loses its compression through a leak, it will result in a loss of power or may cause the motor to stop. A two cycle motor may leak past the piston if the rings become fouled or worn, or it may leak at the spark plug. A four cycle motor leaks compression at the intake or exhaust valves. These are liable to leak through becoming corroded, and when found in this condition they should be removed and ground to their seats with emery flour.

WATER CIRCULATION.

Should the pump stop working and the cylinder become hot, stop the motor and let it cool gradually. Never put water in while the cylinder is overheated. If you have been using dirty, muddy water, the sediment is liable to clog the water, to clog the water jacket and cause trouble unless removed. In freezing weather draw off the water from the cylinder, pipes and pump—otherwise they will be broken.

SOME POINTERS.

Do not fill the gasoline tank near an open lamp.

Strain the gasoline before using it.

Remember to give vent to tank.

Do not permit any joints or valves to leak.

If motor is two cycle and compresses in the base, see that the base is tight.

If make and break sparker is used and causes trouble see that the spring is not cracked or broken, or that the moving electrode is not bound by becoming overheated or from a lack of lubrication.

Use kerosene oil to clean out a fouled or gummed cylinder—gasoline will not do.

If jump spark is used, see that the porcelain is not cracked, or that the points are not fouled.

Use 76° test gasoline—never lower that 74° test.

Do not feed too much gasoline—Do not feed too much cylinder oil.

Do not forget to drain cylinder, pump and pipes in freezing weather.

Remember that a leak of any kind at any place is detrimental.

FOUNDATION.

Some of the smaller makes of motors require only two foundation timbers which are placed athwartships (right angle to keel), and the bed plate is bolted directly to these timbers. Most motors, however, are fastened to two fore and aft timbers that are placed on top of the athwartship timbers. The athwartship timbers are notched over the keel and shaped to fit the inside of the planking. These timbers are bolted to the keel and the planking is nailed to the timbers from the outside. The top of the foundations is trimmed to conform with the line of shaft. A very simple way to line up a small motor is to first put in the outboard shaft and stern bearing, and then so shape the top of the foundation as to bring the crank shaft in line with the outboard shaft.

FUEL TANK.

This should be of copper or galvanized iron. The latter is commonly used and is perfectly satisfactory. Be sure the tank does not leak. If it is of over ten gallons capacity, it should be made with two or three compartments or partitions placed fore and aft with a small opening in the bottom of each. This prevents the contents shifting with every list of the boat. The fuel tank should be placed on a shelf close up under the forward deck, and be provided with a suitable opening on deck for filling. This opening should have a pin hole vent. The tank should be connected with the motor with either block tin or lead pipe and a shut-off valve be placed both next to the tank and next to the motor. An ordinary glass water gauge may be connected so as to show at a glance the amount of fuel in tank. Brass fittings should be used to connect up gasoline piping and the unions of such fittings have ground joints that need no gasket. If, however, you should use iron unions, make all gaskets of leather, as ordinary rubber or composition packing will not stand. Use shellac or common soap on the threads when putting gasoline piping together. To figure the capacity of fuel tank, allow one gallon of gasoline per h. p. of motor for ten hours running.

MUFFLER.

The muffler is an expansion chamber attached to the exhaust, used to deaden the sound. It is usual to place this under the after deck. In small boats it is sometimes placed next to the motor with the exhaust outlet directly through side of boat. The water from the motor may be piped into the exhaust pipe so as to flow through the muffler and overboard. The advantage of this is to keep the exhaust piping cool. It, however, has this objection, that the water partly turns to steam, which makes the exhaust always visible. When the water is piped into the exhaust, the exhaust pipe must slant down from the motor to the point of discharge—otherwise the water would flow back into the cylinder when the motor stopped. The exhaust pipe and muffler should be covered with asbestos covering. This covering may be finished with brass bands and painted with aluminum paint.

If jump spark ignition is used, the batteries and spark coil must be placed in a locker so that they may be kept dry. The jump spark requires a high tension current that must be carried to the spark plug with a special insulated wire. This, however, is furnished by all motor manufacturers.

BOOKS RECEIVED.

Spangenberg's Steam and Electrical Engineeing. In Questions and Answers. E. Spangenberg, M. E.; Albert Uhl, A. I. E. E., and E. W. Pratt. 672 pp. 8½ x 5½; 643 Illustrations. George A. Zeller, St. Louis, Mo. Price, $3.50. Supplied by Amateur Work.

As indicated above, the method of presenting the various topics included in this book is by means of over one thousand carefully prepared questions and answers, but in addition are to be found extended sections treating many important subjects in a more complete way than by simple answers. The authors are experts in their several lines, with the additional ability of being able to impart their knowledge in a very interesting and readable way. An additional section of 83 pages treats of the locomotive; compressed air, gas and gasoline engines, mechanical refrigeration, hydraulic elevators and repair work have separate sections, making the book a valuable one to those interested in these subjects.

Spangefberg's Practical Arithmetic, Self Taught. E. S. Spangenberg, C. E. 228 pp. 5⅝ x 4. George A. Zeller, St. Louis, Mo. Price, 50 cents. Supplied by Amateur Work.

This book differs materially from the ordinary arithmetic, and to its decided advantage in view of the fact that it is written especially for self instruction. Special attention has been given to practical methods of calculation, familiar to all who make frequent use of mathematical processes, but rarely taught efficiently in the grammar schools. Any one requiring a book for review or for first instruction will find this one of great value; the size making it convenient for the pocket.

Modern Electrical Construction. Henry C. Horstmann and Victor H. Tousley. 243 pp. 6½ x 4½. 138 Illustrations. Flexible leatner. Price, $1.20. Frederick J. Drake & Co., Chicago, Ill. For sale by Amateur Work.

It is intended in this book to provide the beginner in electrical construction work with a practical guide; one that will tell him exactly how to install his work in accordance with the latest approved methods. In accordance with this idea the rules of the "National Electrical Code" of the National Board of Fire Underwriters have been used as a text in connection with which there is interspersed in the proper places a complete explanation of the work by which the rules apply, remembering in this the method by which many successful, practical workmen have learned the trade. An excellent book for all electrical workers.

Decorative Photography. No. 68, Photo Miniature, Tennant & Ward, New York.

Gives detail directions and excellent illustrations of decorative work in photography. Of particular interest in illustrating, menu and program decoration, advertising, etc.

ELECTRIC PURIFICATION OF DRINKING WATER.

The Frankfort "News" states that it is probable that electric purification of drinking water will soon be introduced into the home. This method, already used by a number of municipal waterworks, is based upon the germ-killing effects of ozone, which is cheaply engendered by electricity. If an electric discharge takes place between two glass tubes, one inside the other, whose surfaces facing each other are coated with metal, ozone is developed in the space between the tubes.

Electricians have tried in recent years to simplify the means of electric ozone for purifying water. The ideal apparatus would be one which every housekeeper could put up in the kitchen, and by utilizing the electric current of the common electric-light wires purify every glass of drinking water. According to the "Frankfurtnr Umschau," such an apparatus seems to have been successfully made by a French engineer, Mr. Otto.

The apparatus is of very simple construction and takes up little space. It consists principally of a small closed box, the metal cover of which is made conductory with the bottom. In the box is an ozone developer, an interrupter and a tin tube. Through the latter the ozone, which first has to pass through a cotton stopper to free it from dust and germs contained in the air, is conducted into the water and mixed therewith. If much ozone has become absorbed, the water becomes phosphorescent in the dark. The most important part of the apparatus is the "mixer," action of which can be interrupted at will. The apparatus is capable of purifying about 60 gallons of water an hour and the cost is about the same as that of an ordinary electric incandescent light.

Some years ago the Furness Railway in Great Britain unfortunately had a mail train blown from the track by the fury of a winter gale. The train was thrown over the Levens viaduct and nearly fell into the sea. With the idea of preventing the recurrence of a similar disaster, the railway company installed an instrument which automatically warns the signal men stationed at Clark and at Plumpton when the wind pressure on the viaduct reaches the danger point.

The apparatus has been plaeed on the western side of the structure, and is a wind pressure gauge with suitable recording apparatus. Not only is the wind pressure constantly recorded, but the device has the further function of warning the signal man when the wind is too strong for the safe passage of trains. The warning it given by the automatic ringing of bells in in the signal towers. The bell rings steadily as long as the dangerous velocity of the wind keeps up, and all traffic over the viaduct is absolutely stopped. When the bells cease ringing it indicates that the fury of the wind has subsided and that traffic may be resumed with safety.

THE METAL WORKING LATHE AND ITS USES.

ROBERT GIBSON GRISWOLD.

III. Screw Cutting—Kinds of Threads.

The two threads in principal use in this country are the sharp " V " thread and the Sellers or U. S. Standard thread. The former, shown in Fig. 1, is the one most readily cut. It has many disadvantages, however, chief among them being its liability to injury owing to the very sharp points. When these are battered it becomes very difficult to run the nut on and stripping may result from forcing.

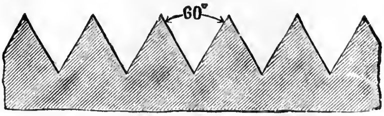


Fig. 1.

In cutting the " V " thread in the lathe, the work is first swung on the centers. The thread tool is then ground so that the two sides of the point form an angle of 60°. This is generally tested and determined by using a thread gauge, as shown in Fig. 2.

In many lathes it is necessary to reverse the lathe to return the tool to the beginning of the thread, but some of the later models are being provided with an attachment operated by a reversing lever placed in the apron. This renders unnecessary the reversal of the lathe and the tool will catch the thread at any position. In the ordinary lathe this is almost impossible since, if the tool is removed from the cut and returned to the start by hand after releasing the nut, the exact position on the lead screw for closing the nut may or may not be readily found. And besides it is almost as quick to reverse the lathe and let the lead-screw carry the tool back.

A very important caution is to always back the tool out from its cut so that it will not drag on the return. If this is not done the point will invariably be broken off, as it has no support on the top side. While the tool is being returned the gauge is set so that the next cut will be slightly deeper. Never attempt a very heavy cut with this tool as the point is not strong

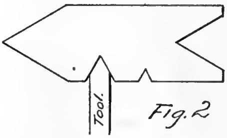


Fig. 2

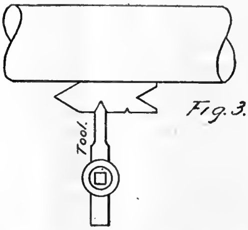


Fig. 3.

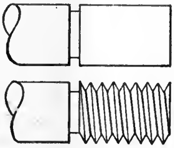


Fig. 4.

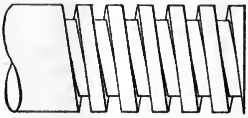


Fig. 8.

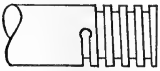


Fig. 5.

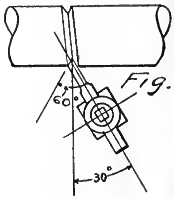


Fig. 6.

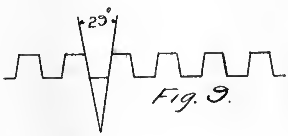


Fig. 9.

When properly ground and the edge properly stoned for smooth cutting, the tool is set in the tool-post by aid of the thread-gauge, as shown in Fig. 3. One edge is placed in contact with the work, and the tool is then adjusted so that the point exactly fits the " V " which insures the proper angle between the sides of the thread and the axis of the work.

The point of the tool is now brought into contact with the surface to be cut and the thread-stop on the cross-slide set. A light cut is then run along for the proper length of thread, and the number of threads per inch counted to determine if the gears have been properly set.

enough. As it is, the most delicate portion of the tool is exposed to the hardest work.

The proper depth of cut may be readily determined, as the tops of the threads will become perfectly sharp, but it is better to try a nut on the thread and thus ascertain the fit. At the root, diameter may be measured with a pair of calipers made for the purpose.

A beginner may experience some difficulty in withdrawing the tool at the end of the cut without snapping off the point. If possible, it is much better to cut a groove in the piece at the end of the threaded portion into which the tool runs at the end of its cut. This is shown in Fig. 4. This in no way weakens the piece, as the root diameter of the thread and the groove are the same.

In very large threads, and especially with square and acme threads, the thread groove often terminates in a hole drilled in the piece as in Fig. 5, which gives the tool an excellent chance to finish a good thread and back out.

There are several lubricants used in screw cutting, but lard oil is quite as good as any. Solutions of soda and soap are often used with good effect, and are cheap.

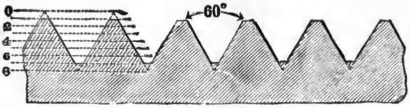


FIG. 7.

A thread tool is seldom allowed much top rake, owing to difficulties in setting, and its cut is thus necessarily of a scraping nature. A keen edge is necessary at all times to prevent making a rough thread. Sometimes a tool, such as shown in Fig. 9, is used where a compound rest is fitted. The point is ground to a 65° angle, and the slide is set so as to feed the tool to the work at an angle of 30°. All the cutting is thus done with one side, similar to a cutting-off tool. With care a very good thread may be made, but one side is likely to show the path of the tool point and must be cut smooth with a final chip.

The U. S. Standard thread or Sellers thread is a modification of the sharp "V" and is shown in Fig. 7.

The fact that the outer point of the sharp "V" thread had little strength, was liable to injury, and also that the sharp corners at the root of the thread had a tendency to weaken the bolt, led to the adoption by the U. S. Government of the Sellers system, sometimes spoken of as the Franklin Institute standard. As shown in Fig. 7, the top of the thread is flattened and the bottom of the groove is filled in parallel to the axis by an amount equal to one-eighth of the pitch of the thread, or the slant side of the original "V". The advantages of this thread are at once obvious. It is less liable to injury and the bolt is much stronger since the cross-sectional area is greater than that provided by the sharp "V" thread. The bearing area of the thread is lessened somewhat, but that is seldom a matter of importance in this thread.

The tool for cutting this thread is set in exactly the same manner as that used for the "V" thread, but in grinding it the point is flattened by the correct amount. Every different thread requires a special tool, owing to the varying widths of flats. In the case of sharp "V" thread one tool would cut any one of the many sizes.

The Whitworth thread, shown in Fig. 10, is the English standard and seldom seen the United States. The included angle is 55° and the top of the thread is rounded. The bottom of the groove is also rounded, and in this respect it resembles the U. S. thread.

With all threads made with angular sides there is a tendency to split the nut when a strain is put upon the bolt and to obviate this the trapezoidal thread is used in many instances where great loads are to be sustained. The breech blocks of the modern United States Navy guns are mostly fitted with this thread. It is shown in sections in Fig. 8, and is merely a V-thread turned a little to one side so that the load will be taken on the flat side of the thread. It has this advantage over "V" and square threads. There is no tendency to split the nut under load in the former case, and the resistance to stripping at the base of the thread is about twice that of the square thread. Its principal drawback lies in its inadaptability to resisting strains in both directions, owing to the great bursting pressure that would be placed upon the nut.

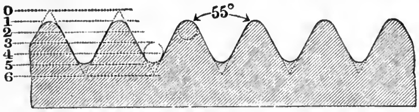


FIG. 10.

The square thread, shown in Fig. 8 is principally used for such purposes as lifting screws in jacks and machines and almost universally for the lead screws of lathes. It presents a flat wearing surface in either direction of resistance, but as stated above, has only half the strength of a "V" thread in shearing resistance. In cutting a square thread in the lathe. the tool must be of such angular shape as to follow in the groove cut. It frequently occurs that more than one thread will be cut on the screws, in which case we have double, triple and even quadruple threads. The pitches of the threads in these cases are just two, three or four times the single pitch, and one thread is cut between the turns of the others. These multiple pitches are mostly used where a considerable movement of the nut is required per revolution of the screw. The chief drawback to the square thread is its cost. Aside from the care required in its cutting, it necessitates very careful fitting, which is a tedious operation.

The Acme thread, shown in Fig. 9, has been designed to overcome some of the objections to the square thread and incorporate some of the good features of the "V" thread. The included angle between the sides is 29°, and the threads partake somewhat of the general cross section of the U. S. standard thread. The nut bursting tendency is not so great as the 60° "V" thread, and the shearing area at the base of the thread is greater than that of a square thread of like pitch. Owing to the taper of the thread it is less difficult to make a good fit.

In cutting threads on pieces of comparatively small diameter and considerable length, a back rest must be used to prevent the thrust of the tool springing the work and making the root diameter of the thread larger in the middle than at the ends.

PATTERN VARNISH.

C. C. BOSWORTH.

Every pattern-maker with any regard for his reputation loves to see the object of his skill leave his hands with a luster and without a scratch or blemish, and what is his consternation to see the molder, when he receives the same piece of work, take sandpaper, and that not always the finest grade, and go over this artistic piece of work to his own satisfaction.

We learn from this that those who use the patterns look upon the finish from another point of view, viz., that of utility instead or appearance, which is, after all the right view. Yet, at the same time, I do not wish to discourage any one in his efforts to produce a nice looking pattern. I wish only to show that it is a matter of secondary importance, the first being that of a hard, smooth, impervious coating which will leave the sand with little resistance and wear well. The ordinary orange or yellow shellac, which is best flake shellac dissolved in either grain or wood alcohol (but never in a mixture of the two), seems to be generally accepted as the most satisfactory varnish for a pattern, filling, as it does, the requirements named.

The ready-made shellac varnish varies in quality. The writer has known it to be of such a nature as to be apparently dry, and at the same time when put in the sand, the latter would adhere to the pattern to the extent of making it impossible to use, and no length of time in drying seemed to help the cause, and hence this varnish had all to be scraped off. Then again in making colored varnishes one must be careful in the selection of the coloring powders; for instance, in making black varnish, which is simply the yellow made black by the addition of lampblack, some grades of which when rubbed between the fingers are smooth and velvety to the touch, while other grades are gritty, and this latter will give a very unsatisfactory surface, with the best of care, and has but little gloss. Varnish, as its name implies, is a resinous liquid, laid on work to give it a gloss, but this gloss to a great extent is dependent upon the under coating and then upon the body and composition of the liquid. The under surface must be hard and smooth. We are all acquainted with the fact that the first coat of shellac laid upon the pattern gives it no luster at all, and this is even true of the second coat if the varnish used is very thin; it is absorbed by the grain of the wood which swells and raises its fiber, giving a rough dull surface, but after the pores of the wood become filled by the successive coats, each coat being rubbed lightly to a smooth finish with worn and fine sand paper, we notice that the succeeding coats become more glossy. When his varnish is thinned out too much it is possible to get but little gloss, as there is not enough of the resinous composition left on the surface, after the alcohol has evaporated, to give it a sufficient new body.

And again, if varnish is too thick there is not enough of the alcohol to float the resinous component, hence it cannot spread itself out evenly on the surface, hence it will appear mottled and when dry will even feel uneven, though glossy. When in this condition it is hard even to rub it to a smooth finish, in fact, it is worse to use varnish too thick than too thin. When a pattern is varnished often with shellac which is too thick it will crack and come off in flakes, bringing off all the successive coatings down to the wood, which makes the pattern hard to draw, and it has to be scraped; therefore, if the pattern maker would be careful in the selection of his materials, obtain a good surface and a medium body to his varnish, he will have all the gloss he desires after the third or fourth coat.

Now, in obtaining a good hard surface, I have known patterns that were to have constant use to be given a first coat or two of lead and oil for a filler; this gives a surface as hard and smooth as stone.

I have also known copal varnish, the outside kind, sometimes known as spar varnish, to be used where a specially glossy finish was wanted. Of course it must be applied to a good, dry, hard surface, and it takes several days for each coat of copal varnish to dry, but it wears well.

Oxalic acid is sometimes used to clear varnish. A teaspoonful will clear a quart of muddy varnish and give it a good clear color, but I do not like to use it as it is very poisonous. The writer once saw a man who nearly lost his arm by its use. He had a cut on his hand and got some acid treated varnish on it, the result being blood poisoning, much pain, and nearly the loss of his arm.

In fact, any shellac varnish should not be used on a cut, as is often done, as it is well known that wood alcohol is a poison of itself.

To keep varnish clear, I prefer keeping it in a porcelain cup or crock, well covered. Do not keep shellac varnish of any color, even black, in a galvanized can; it ruins the varnish.

As to pigment for red varnish, I find that indian red answers the purpose well, though of course it is not quite so brilliant as vermilion.—" The Patternmaker."

Investigation of fuels by the United States Geological Survey has shown that a ton of bituminous coal is capable of producing two and a half times as many heat units when producer gas is made from the coal as when it is burned in the usual way in the fire box of a boiler.

CORRESPONDENCE.

No. 96. EAST ORANGE, N. J., June, 2, 1905.

I have a small 1 in. induction coil which I recently purchased, and wish to know if same is good for wireless communication over water for two miles? If not, how far?

What do coherers sell for generally at the stores?

J. F. S.

A good 2 in. spark is sufficient for the distance you mention, provided you have a sensitive receiver and aerial wire at least 25-feet high; also a good ground connection at each station.

Coherers are catalogued generally at from $3.50 to $6.00, according to sensitivity and reliability. Address any of our electrical advertisers for price lists.

No. 97. FORT COLLINS, COL., June 9, 1905.

Are dry batteries better than wet batteries for small spark coils?

What insulating material is recommended for saturating a primary core and winding for a 6 in. coil?

What voltage is supposed to be given by the discharge of a 2-in. induction coil? G. R. N.

Dry batteries, because of portability, commend themselves for spark coil operation in wireless telegraphy. Fuller or Edison batteries give excellent results.

An excellent and cheap way to insulate a primary is to wrap one layer of thin cloth between each layer of wire on the primary. After winding is completed, wrap 3 layers of cotton cloth over the winding and tie tightly with thread or twine. Then heat to boiling ½ lb. of paraffine wax and two ounces of resin, and immerse the core and winding for twenty minutes. Then fashion from pasteboard a tube like a mailing tube, ½ in. larger in diameter than the primary and 1 in. longer. Insert the primary in the tube, stand on end and pour the following mixture into the tube, permitting same to thoroughly harden before removing the pasteboard form. For the mixture, add 2 ounces of resin to the remaining portion of the paraffine mixture previously mentioned, and stir thorougbly. The addition of an ounce of hard South American wax is recommended by many coil makers.

A 2-in. spark is commonly called 25,000 volts. Until recently there has been a wide difference of opinion as to the voltage for any given length, owing to lack of instruments for measuring high potentials. Some of the text books of ten years ago speak of 50,000 volts to the inch, but recent investigations show these measurements to be excessive. Even today, experts disagree as to the best way of calculating the pressures at spark gaps of various lengths. The figures we give seem to be reasonably accurate.

The coal production of the United States is now about 1,000,000 tons per day, and the railroads consume about 40 per cent of it.

DEFORESTATION AND CLIMATE.

During the May session of the German Meteorological Society at Berlin, a lecture on "Deforestation and Climate" was delivered by Dr. Hennig from which United States Consul-General Guenther, Frankfort, Germany, takes the following extracts:

The interest in deforestation and forestry may be called general and public. Whether forests exercise a perceptible influence upon the climate is a very old question, and even today it is not definitely settled. In many countries a drying up of climate has occurred, which is shown perhaps most strikingly in almost the whole of Africa. That deforesting has assumed constantly growing proportions in almost every part of the world is still most apparent. The climate of Greece, where today only 16 per cent of the area is covered with forests, has deteriorated. An increase of temperature and decrease of rain are noted, compared with ancient times, especially in Attica, which was thickly covered with forests about three thousand years ago, and where hardly any rain now falls, while the heat in the open air attains a degree which would make the "Olympian games" almost an impossibility. A similar condition exists in the peninsula of Sinai, where thousands of years ago the people of Israel lived in a luxuriant and fertile country and where today only forestless deserts abound. Palmyra, also once a flourishing oasis in the Syrian desert, presents today only a desolate waste of stones and ruins. In Mexico, where the Spaniards cut down the forests in the mountains, droughths, changing to devastating floods are now noticeable, especially in the vicinity of the City of Mexico. In upper Egypt, where only one hundred years ago rain was abundant, drought now usually prevails. In Algeria, where, since the middle of the last century the forests have been cut down on a large scale, dry weather has increased, and in Venezuela the level of Lake Tacarigua, to which Alexander von Humboldt drew attnntion, has been lowered in consequence of deforestation.

If these and other facts are kept in mind the sentence "Man traverses the earth and a desert results is understood. It must not be forgotten, however, that this applies mainly to the influence of civilization upon appearances and is not always due to climatic changes produced by deforesting.

Some authorities even deny the influence of forests on the weather and climate. It cannot be denied, however, that dense forests favor moisture and prevent the drying out of the soil to a considerable degree. At any rate, deforesting, which, in modern times assumes constantly growing proportions for industrial and agricultural purposes, is of universal importance.

Germany, with a forest area of about 26 per cent, realizes annually nearly $60,000,000 worth of timber therefrom, while the wood importations are about of the same value. The consumption of wood increases from year to year, and systematic forestry has not succeeded in keeping up the forest area of Germany. If it is furthermore borne in mind that Canada, which formerly possessed more than 300,000,000 acres of forests, has today only a forest area of about 225,000,000, it becomes evident that the question of deforestation assumes great importance. If civilization continues to change the face of the earth the problem of its wood supply will present itself like that of coal, and force the finding of a suitable substitute.

SCIENCE AND INDUSTRY.

The televue, or seeing telephone, as it is called, is the invention of J. B. Fowler, of Portland, Ore. Mr. Fowler is not a scientist, but a humble workmen, who has been classed as an inventor from the days of his boyhood. His latest production in that line consists of a device used in connection with an ordinary telephone by means of which one may distinctly see the features of the person with whom he is carrying on a conversation. While it is admitted that the televue is still in a crude state, it is said by those who have seen it, to be not more so than was the telephone when on exhibiton at the Centennial Exposition in Philadelphia.

For a cement for sticking leather fillet on brass patterns, melt together eight parts of beeswax and two of rosin; cut into strips when cold and apply with a sticking tool of the proper radius. A steel ball of the right size stuck on a wire and heated in a bunsen burner is the best. The pattern should be slightly warmed. Superfluous cement may be removed, when all is cold, with a bit of waste dipped in turpentine.

A new industry is being formed on the boader lines of Barren, Edmondson and Hart counties, Ky., for the development of large deposits of onyx which have been found in several caves of the State. In one cave is said to exist the largest deposit of oxyx in the world, it being 200 feet in circumference and 75 feet high. The onxy is white and said to be of the finest quality. In other places the deposits are red, yellow, black and varied-colored onyx.

Electricity is not a form of energy, any more than water is a form of enery, says Sir Oliver Lodge. Water may be a vehicle of energy, when at a high level or in motion; so may electricity. Electricity cannot be manufactured, as heat can; it can only be moved from place to place, like water, and its energy must be in the form of motion or of strain. Electricity under strain constitutes a current and magnetism; electricity in vibration constitutes light.

The power obtainable by a given stream of water is, within a small factor due to friction, directly as the head, but the water is not always applied to the greatest advantage.

To make a gas engine noiseless, the following simple device can be introduced by any one at a small expense, says an English journal. A pipe split for a distance of about 80 inches is attached to the end of the exhaust with the split end upward. Beginning at the lower end of the cut, which may be best made by a saw, dividing the pipe into two halves, the slotted opening is widened out toward the top until it has a width equal to the diameter of the pipe. The puff of the exhaust spreads out like a fan, and the discharge into the open air takes place gradually. The effect produced is said to be remarkable, but it depends somewhat on the fiber of the tube.

A new method of denaturing alcohol so as to render it unfit for drinking purposes is to charge it with acetylene gas. This gas is commonly stored by dissolving it in acetone, an alcohol-like liquid which has a partial affinity for acetylene. All alcohol possesses this affinity to some extent, and ordinary grain alcohol, which is by many regarded as the future fuel for internal combustion engines, will absorb considerable quantities of the gas. Alcohol thus denatured is rendered totally unfit for drinking, while at the same time its heating power, or calorific value is increased instead of diminished, as is the case of practically all other denaturing agents. Grain alcohol now sells for 16 cents a gallon in Holland, where there is no tax upon its use for industrial purposes, and denatured with a small amount of acetylene—too little to increase its cost materially—its power value is said to be much above that of gasoline.

Tantalium as material for tools may have a wonderful future. This substance is the metal employed by Siemens and Halske for their new incandescent lamp filaments. There is a report that laboratory experiments have shown it to possess a hardness comparable with that of the diamond, and great toughness also. When, after much work, a piece of the pure metal was for the first time produced, a sheet about 1 millimetre (.039 in.) thick was hammered from it. An attempt was made to drill this, and, other means failing, diamond drill was used. Constant work for three days and nights at the rate of 5000 revolutions per minute resulted in a depth of only ½ millimetre, and the drill was so badly worn that the experiment was discontintinued. Since tantalum is thoroughly unmagnetic, it would be of use where a metal as strong as steel is needed, but where the magnetic properties of the latter are objectionable. The fusing point lies at about 2300° C. (4172° F.) its specific gravity is from 14 to 17, and in color it resembles platinum. In the form of wire it sustains a load of 90 kg. per square millimetre, or 128,000 lbs. per square inch.

It is generally figured that 1 cubic inch of water, when evaporated under atmospheric pressure, will make 1 cubic foot of steam.

A column of water 2000 feet high, no matter what the length of the pipe line, will develop a static pressure of 866 pounds per square inch.

Two elaborate telephone systems are being installed on the steamer Dakota, now under construction for the Great Northern Company. This will be the first ship to be equipped with telephones.

The main use of metallic arsenic is in the manufacture of shot. When arsenic is added to lead and dropped from a height, the shot assumes a rounded shape which otherwise, with but the pure metallic lead, would assume a tailed form.

Concrete is not a new, nor even a modern substance. Important structures built by the old Romans before the commencement of the Christian era are today sound and solid—for example, the dome of the Pantheon in Rome, 142 feet in diameter.

To fasten paper labels, etc., on iron, use a cement made as folllows: Over a water bath dissolve 4 parts by weight of gelatine in 3 parts of water; while stirring add 1 part of acetic acid, 1 part alcohol and 1 part of pulverized alum. The metal must first be rubbed with a bit of fine emery paper.

A curious property of Portland cement, said an engineer, is that when a package of cement is opened and emptied it can be dusted out so that the bulk is increased quite one-third. I will defy anyone once havtng emptied a barrel of cement to replace the whole of it in the same barrel without considerable effort.

By short circuit is meant a direct connection by accident or design of the positive and negative leads of a supply circuit or dynamo by a conductor of low resistance. This allows an excessive current to flow, which, owing to the heat produced, will fuse the leads and possibly overload the generator supplying the current and thus destroy its insulation.

The first patent issued by the United States Patent office was on July 28, 1837. During that year a total of 106 patents was issued. During 1964 the number of patents issued was 30,267, a total to the first of January, 1905, of 748,567. This number has been since increased up to June 6, 1905, to a total of 791,991. At the present rate the number of patenls issued during the calendar year, 1905, will exceed 30,000.

While working upon a foolish theory that he could convert silver into gold, Nicholas Brandt, a German chemist, in the year 1732, made the discovery of phosphorous. Evidently he did not place much importance in his discovery, as he continued in his experiments to transmute silver into gold. Being thus engaged, other chemists made a study of phosphorous, and it is to the chemist Boyle that the world gives credit for the discovery.

The 353 foot-chimney of a smelting plant in Denver, Col., has been used to support the atennæ of a De Forest wirelees telegraph station.

Time in Manila, P. I., is 13 hours later than at Washngton, and 14 hours later than at Chicago.

Donaid Murray of England has devised a printing telegraph which will not only print telegrams at the receiving station but can be attached to a linotype machine and will set type without human aid. The inventor states, however, that the expense of the typesetting system is such that it is not likely to supersede the manual operation of linotype machines.

THERMIT.—WHAT IT IS AND DOES.

The Thermit heating and welding compound is coming to the front as a ready and practical method of effecting economy in various ways in shop practice.

One great saving brought about by its use is in the repairing of broken locomotive frames, which can be done without removing the wheels or other parts, as the welding is done with everything in place. The welded spot is as strong as the original piece itself, and in cases where the reinforcement or so-called "collar" can be left around the weld, it is really stronger than the original piece. The heat of the applied Thermit melts the broken ends, fusing them with itself; Thermit supplies the missing metal, the weld taking as large a reinforcement as the mold is made to permit.

Broken cog teeth can be recast on a wheel with Thermit steel; cracked driving wheels can be neatly mended in place, and an infinite number of useful and economical repairs made, that will keep down the scrap pile. Its use will give large resulant economy in time, patience and money.

Thermit itself is only a mixture of granulated aluminum and iron oxide, the combustion, or reaction being started by means of an ignition powder. Thermit mit itself can be thrown into the fire without igniting, as nothing less than the heat of liquid steel will cause it to burn.

As the combustion of the aluminum is supported entirely by the oxygen of the oxide, the reaction is entirely local, being coufined to the crucible, there being no explosion nor any gas resulting. The reaction is complete in a few seconds and the molten metal is instantly ready to run into the mold about the broken part; the iron, sepaıated out from the oxide, makes a very good mild steel with only 0.1 carbon.

Thermit is now being manufactured in this country under the Dr. Hans Goldschmidt patents. The apparatus necessary for operations with Thermit is simple and inexpensive, and the process can be employed by any practical mechanic.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

Vol. IV. No. 10. BOSTON, AUGUST, 1905. One Dollar a Year.

SENSITIVE "WIRELESS" RECEIVER.

ARTHUR H. BELL.

In wireless telegraphy one of the chief difficulties which operators have had to contend with is the securing of a sensitive and reliable receiver of the wave impulses from the transmitting station. This is especially true where the distances between stations have been at all great, the energy from large coils not being adequate to operate the coherer, which has been the form of wave detector usually adopted by amateurs.

The detector here described is of quite a different character; the principles involved in its operation will not here be considered. It is not difficult to construct if care be used in the handling of the delicate wire which forms the contact with the electrolyte. The materials, with possibly the exception of this fine wire, known as Wollaston wire, are easily obtainable in any large town or city. Wollaston wire is made by silver plating fine platinum wire, then drawing down through dies, thus greatly reducing the diameter of the core of platinum wire. The silver plating is then taken off by suitable acids leaving the minute platinum core exposed. As it is a rather difficult matter to handle this wire, the amateur is advised to first use No. 40 gauged platinum wire until sufficient skill in its use has been attained to use the other to good advantage.

To make the detector, obtain a block of solid brass about 4 in. square and 1/2 or 3/4 in. thick. This weight is needed to give solidity to the device and reduce vibration to a minimum. Also obtain a piece of brass rod 6 in. long, 3/8 in. thick and 1/2 in. wide. This is bent to the shape shown in the illustration by heating in a blast torch until ductile and easily bent. Holes are drilled and tapped in the feet for 1/4 in. brass screws, the feet being filed off to a good contact with the base; or this frame may be brazed to the base.

In the center of the top, drill and tap a hole for a 1/4 in. thumb screw with knurled head and fine pitch. Get as fine a thread as possible, as the adjustment is made with this screw, and a fine thread is desirable. In the lower end of this screw drill a hole for a No. 8 gauge brass wire, a short piece being fitted to this hole and the lower end slit by sawing with a fine fret saw. The burr made by slitting is removed with a fine file and one end of a short piece of the fine platinum wire is placed in this slit, which is then closed tight with nippers.

Obtain a piece of dynamo-brush about 1/2 in. square; round would be better but not so easily obtained. French arc-light carbon of a very fine grain will answer. Saw off a length of about 1/2 in. and coat the outside with several coats of shellac, using care not to get any on the top end. In the top drill a 1/8 in. hole about 3/8 in. deep. Mount this piece of carbon under the brass frame so that the platinum wire will be exactly in the center of the hole. This is done by coating the bottom of the cup with shellac, and before drying place it upon a piece of hard rubber which is attached to the brass block in the same way.

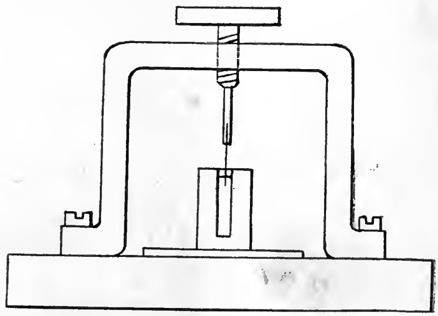


FIG. 1.

The leads are next attached, one to the carbon cup and one to the adjusting screw. Place a drop of soldering flux upon one edge of the top of the cup, also upon the end of a piece of double covered magnet wire, No. 18 gauge, then with a small soldering iron drop a bit of solder upon the wire which has been previously placed upon the cup. It is also advisable to make a coil in this lead of about a dozen turns around a pencil, about 3 in. from the cup.

The other lead is soldered to the top of the adjusting screw and should have a similar coil of about a dozen

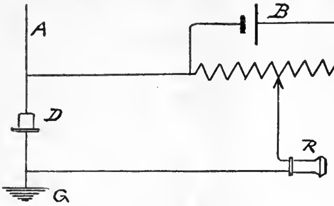


Fig. 2.

turns. These turns of wire are to ease any undue strain which might be brought upon the leads by the operator when handling.

The connections are shown in Fig. 2, in *D* which is the wave detector, *B* a local battery of one dry cell, *C* a variable resistance coil of about 50 ohms resistance, *R* a telephone receiver, *G* the ground and *A* the aerial. The construction of a resistance coil will be described in a subsequent article.

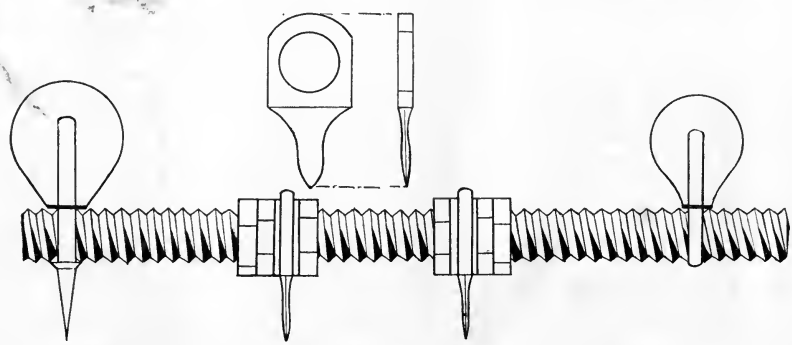
In making this detector, it will be advisable, to save breakage of the platinum wire, to put it in place after all the work is done and the detector in position for operating. A pair of long nose pliers of small size will be very servicable in handling the wire. When all adjustments are made the hole in the carbon cup is nearly filled with a solution of nitric acid and distilled or rain water; 1 part acid to 4 parts water. The platinum wire should enter the solution about ⅛ in.

A little experimenting will be necessary to determine the correct resistance of the coil *G*. Too much current will cause the platinum wire to be eaten away rapidly; too little will reduce the sensitiveness of the detector. The platinum wire should be removed from the electrolyte when through using.

WASHER CUTTER.

W. G. MILLER.

A tool to facilitate the cutting of discs and washers out of wood, fibre, rubber and soft, thin metal, is a necessity in most electrical and mechanical workshops. The writer recently, in a short space of time and at a very slight expense, constructed the tool here described, and found it a great labor-saver in shaping mica and fiber discs for insulating the sections of a high-frequency spark coil. The simplicity of construction and its adaptability to many purposes, commends it to all readers.



The rod is steel, 3 in. long; ½ or ⅛ in. in diameter. One-half inch from each end drill a 3-16 or ½ in. hole. Cut a close thread the entire length of the rod. Procure 6 hexagonal nuts which must fit the rod snugly; also some washers. Fashion from small pieces of soft tool steel the two "knife blade" cutters shown in the illustration. The holes must be the same diameter as the rod, and are not to be tapped with threads.

The cutters will be improved by hardening and tempering. From a piece of iron or steel rod make two pins, as illustrated. Drill them firmly into the end holes. The two handles are similar to awl handles, with holes drilled in the ends to fit on to the pins.

This simple tool can be set up and used in cutting discs or washers with considerable accuracy when care is taken to bind the "knife blades" securely between the nuts and washers intended to keep them in place.

A WALL TENT.

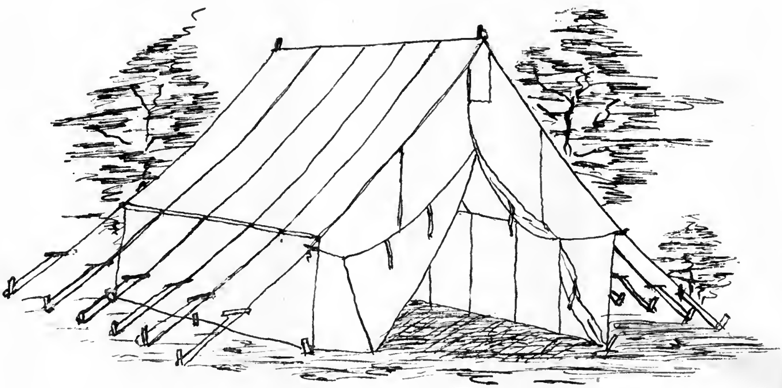
M. T. BROWNE.

The wall, or camping tent, possesses many advantages over the tent known as the A tent, inasmuch as the sides can be lifted in pleasant weather to allow a cross current of air through the tent, and yet can be quickly dropped and secured from the inside should storm arise. The size here described, 9 x 12 feet, will afford sleeping room for five persons, using single cot-beds.

The material used should not be lighter than 8-oz. duck; 12-oz. will be found best if extended camping is intended. Drilling is sometimes used, but the difference in the cost is not great enough to make it worth while to sacrifice the greater rain-resisting quality possessed by the duck, as well as the greater durability. If the tent is wanted only as a shelter for children, the lighter material will answer. The width of either duck or drilling is 29 or 30 in., the lap of the seams being varied from ½ in. to 1 in. depending on which width is used. About 60 yards will be needed.

There are five breadths in the sides and roof, each 8 yards long. These are cut and double stitched with a lap seam. For the ends cut four lengths 12 ft. 3 in. long. Sew two together with double stitched lap seams. Lay flat upon the floor and make a mark on one edge 3 ft. 1½ in. from the end; on the opposite edge 9 ft. 1½ in. from the same end, and with a straight edge or blue chalk line, connect the two points. A temporary chalk line can easily be made by chalking a piece of strong twine. Cut along this line, and by placing the long edges together one complete end is obtained. Repeating the operation will give the other end, the width being several inches greater than is required for the back.

The counter seam of the back is made the same as with the others, the extra width being cut off at the short edges leaving enough for a 1-in. lap seam with sides and top, which should also be double stitched. Before stitching the ends to the sides and top, however, measure the latter, and where the sides and roof meet the cloth is folded on itself, making what might be termed a pleat 2 in. wide and double stitched, with the stitching quite close together. This is done on each side, forming a lap in which are worked the holes for the guy-ropes. These holes are located one at each seam and the corners, but are not made until all stitching is completed.



The center seam of the front end is sewed at the top for only 1 ft. and allowing an inch on the outer edges for the seams there, the rest of the spare width is used for a lap for the entrance, so that when closed one side will close over the other from 6 to 8 in. Pieces of strong tape 9 in. long, are sewed to either side of the entrance on the inside, and used to tie them together. The front is then sewed to the sides and top, the lap of the latter being on the outside at both ends.

A hem is then made around the bottom about 1½ in. wide and strongly stitched. Holes for tie ropes are also worked in this hem at each corner, one in the center of each side; one in the center of the back, and one in each corner of the entrance breadths. The preferable way to work these holes is to use galvanized iron rings, which are made for this purpose, and which any hardware dealer can order from wholesale houses.

The cloth is cut out to fit over the inside of the ring and then with a small sail needle and strong cotton twine the ring is over-sewed in place. Made in this way the holes will never rip under any strain likely to be given them. They are frequently made without the rings and, if care is used to have close sewing, will be quite durable.

The poles are made after the tent is completed so that the lengths may be correct. Pole irons can be obtained of most hardware dealers and include two ferules with holes for the ridge pole, two rods for driving into the ends of the upright poles, and two ferules without holes for the latter. Spruce is the best wood to use for poles, being light and strong, but it may be necessary to round them by hand from square stock. They should be at least 2 in. in diameter and free from knots. Oak poles are stronger, but heavy, and weight is an object if long distances in the woods are to be attempted, The upright posts should be 9 ft. 4 in. long, or long enough to be sunk several inches into the ground without having the bottom of the tent more than just touch.

After the posts are made, the places where the iron rods in the upright posts pass through the ridge pole should be marked on the tent and pieces of cloth 6 in. square stitched on the inside. A hole is then cut and oversewed, to permit the rods to pass through, which they should for at least 1 in. No ring is used in these holes. The projecting rods are used to hold the ends of ropes, which in windy weather are sometimes needed to hold the tent from blowing over, especially when camping on sandy soil.

For a smaller tent 7 x 9½ ft. and 7t. high, with 3 ft. walls, about 34 yards of cloth would be needed. There would be four breadths in the sides 17 ft. long. and the ends would take three breadths at the back and two whole and two half breadths at the front.

SAFEGUARDS FOR WORKMEN.

The "Monitor" the official organ of the Belgian Government, has just published a decree prescribing the precautionary measures to be observed by owners of workshops to safeguard the health of the employes and to provide against aecidents to them.

In the ordinary workshop which the decree is intended to cover, each workman must have a free space of 10 cubic yards. The shop must have a height of 3 yards and must be ventilated in a thoroughly sanitary way. Certain prescribed appartus must be used to supply fresh and draw out vitiated air. This apparatus must have at least a capacity of 30 cubic yards an hour for each workman. In manufacturing establishments where the work is unhealthful, the capacity of the apparatus for renewing the air must be at least 60 cubic yards per hour for each workman. This apparatus must be arranged so that it will not in any way discommode or interfere with the workmen employed within the establishment.

Workshops or manufacturing establishments existing and in full operation before the issuance of this decree, the various rooms or departments of which could not be changed to comply with it without great expense or stoppage of work while the arrangements were being perfected, are allowed to continue on condition that (1) the working personnel of the establishlishment shall not be increased; (2) no toxic or other unhealthful materials shall be manufactured; (3) owners of such manufacturing establishments must indicate to the proper authorities the nature of the work, the location and the number of workmen employed, as well as the reasons for asking the indulgence. This declaration must be made within the year following the publication of the decree.

The owners of all establishments shall provide against the escape of gas or the existence of odors, vapors or dust that might in any way affect the health of the workmen. All shops shall be conveniently and systematically lighted, so that the workmen may be enabled to follow their employment without danger to their sight. All necessary precautions shall be taken to keep the air pure and to avoid the overheating of shops. During the winter the workshops must be conveniently and sufficiently heated, and in summer provision must be made against high temperature. The heating or lighting apparatus must be placed so as not to discommode or injure the workmen by reason of its proximity.

The waste, residue, sweepings and other accumulations shall be removed daily and destroyed. In establishments where the work is unhealthful the workmen must not enter or leave the workshop in the same clothing worn during employment. A cloakroom, with washstands and other necessary accommodations, must be established for the use of the employes. The heads of manufacturing enterprises must prohibit the carrying or eating of food within rooms where toxic materials are being manufactured. The water used, whether it be for drinking, spraying, or manufacturing purposes, must be pure.

The decree contains further provisions to guard the workmen against the influences of vapors or odors of any kind and against accidents from machinery, and to assure the solidity of the buildings and the absolute security of everything pertaining to the place where workmen are employed. Particular attention is drawn to the safety of ladders, wells, and staircases, and to precautions against fire. The introduction of alcoholic stimulants into the workshops or any part or place accessory to them is absolutely forbidden.

In a word, every precaution is demanded that will in any way protect the health of the Belgian workmen or lessen their liability to injury. The solicitude of the Belgian Government for its working classes is to be highly commended, and the fruit of such devotion is evident in the disposition of the workmen and their tendency to remain with the same employers throughout their lives.

PHOTOGRAPHY.

MASKING NEGATIVES.

WILLIAM A. INGRAM.

Beginners too often make prints from the whole of each negative, regardless of the fact that a portion would in many cases make a more satisfactory picture although, of course, less in size. Even when a stand camera with focussing screen is used, the resulting photograph can generally be improved by discretionary trimming.

The writer recently saw a full length photograph taken by an amateur on a 5 x 7 plate, the wrong way of the plate. Technically speaking, the photograph left little to be desired, but considered from an artistic or even common sense point of view, it was absurd. The figure occupied about one-sixth of the plate. A mass of trees on one side and a baseball grandstand on the other, dwarfed the *raison d'etre* of the photograph into insignificance.

Had the print been trimmed to about 3 x 5 it would have been passable, but as it was, it could boast of nothing except size. Circumstances might have made the use of a 5 x 7 plate, where a 4 x 5 would have served, admissable, but the mistake should not have been perpetuated by printing from the whole of the plate. Such photographs may be all right from a plate or printing paper maker's point of view, but the artistic, and in some cases, the economical side of the matter should be considered.

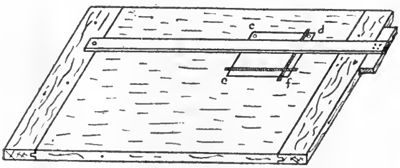


FIG. 1.

It is, therefore, desirable that some plan be adopted whereby the print may be reduced to the size most suitable for the display of its good qualities, and the diminution of its defects—if there are any.

This is best accomplished by masking, and the writer will, in the following lines, try to give the novice instructions and suggestions which will, as far as the practical part is concerned, enable him to make the best of his negative.

The artistic appearance of prints is improved in most cases by a narrow, plain margin between the photograph and mount. Furthermore, this margin permits the use of plain cards for mounting, thereby obviating the necessity of trimming prints to suit mounts.

This margin may be made in more than one way, and may be white or dark colored, or a combination of the two. The method of formation most generally applicable is that of masking, *i. e.*, covering with non-actinic paper, or some other opaque substance, parts of that the printing paper is not acted upon by the light in those parts.

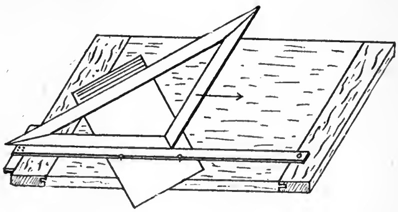


FIG. 2.

Masks for this purpose may be bought in a variety of sizes and shapes, but it is better to make one's own, for then the most suitable size can be obtained, which is impossible when one has only stock sizes on hand.

It is difficult to satisfactorily attach a loose cut-out mask with paste or any similar adhesive to the negative on account of the irregular expansion of the paper when moistened. For this reason cut-out masks have to be used loose. This is often a disadvantage because it means the finding of the mask each time a print is required, and there is always the probability of a loose mask moving during printing. So long as rectilinear sides are required the most satisfactory method is that of pasting strips of non-actinic paper along the sides of the negative. With a little practice this method of masking, as more fully described hereafter, takes less time than cutting the opening out of a piece of paper; and apart from the advantage of always having the negative ready for use, there is the fact that with glass negatives the strips act as a protection to the film.

Any kind of non-actinic paper may be used for the strips, so long as it is not too thick. The writer uses the black paper in which cyko and other kinds of printing paper is wrapped. Gummed passe partout binding is suitable if of dark color. This only needs moistening and it is ready for use.

METHOD OF PROCEDURE WITH FILM NEGATIVES.

Attach the film to the drawing board with two thumb tacks, using a tee square to insure the perpendicular lines on the negative being parallel to the sides of the board. To facilitate this adjustment a piece of white paper may be placed beneath the negative. If passe partout binding is used, cut two pieces from the roll, one the length and the other the breadth of the negative. Each of these strips may be divided down the middle. Moisten the four strips, take one, and with the tee square as a guide affix it in position on the negative. Go around the other three sides in the same manner, moving the thumb tacks if necessary. One thing to remember is that there should not be less than two tacks in the film at the same time, which will prevent displacement. This arrangement is shown at Fig. 1, in which *c d e f* is the negative, and the shaded portions two strips already affixed. When the strips are affixed on the four sides, remove the thumb tacks, lay the negative on a smooth surface, film side down, and with a piece of soft rag press the back side of the negative to insure perfect adhesion of the strip. Place the negative under pressure until dry, when it may be trimmed with scissors, if any part of the film extends beyond the masking strips, and is now ready for printing from.

The white margin on the print can be trimmed to the desired width.

If ordinary black paper be used instead of passe partout, it may be cut into strips in the following manner:

Take a piece of paper about one inch wider than the length of the negative. Fasten this to the drawing board with thumb tacks, at the same time fastening the tee square, as shown at Fig. 2. With a set square as a cutting guide cut the paper into strips about a

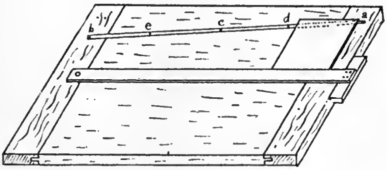


Fig. 3.

quarter of an inch wide. By moving the set square in the direction indicated by the arrow, the strips may be readily cut off. It is advantageous in cutting these strips not to sever them completely, except every four. They can then be pasted in batches of four, which takes less time than pasting them separately.

There are certain photographs on which a dark-colored border is more suitable than a white one. With film negatives this is very easily obtained. Trim the negative to the size required, and print with the printing paper extending one-quarter of an inch all around. The dark border so obtained can be trimmed to the desired width.

For those who like novelty a double border may be made on prints. The film is masked as described above and the mask and film trimmed, leaving only a narrow margin masked. A print from a negative so trimmed, with the paper so extending beyond the negative, will have a white margin next to the print, and outside of of that a dark one, which can be trimmed as desired.

MAKING GLASS NEGATIVES.

The procedure when masking glass negatives is not exactly the same as with films. Take a strip of passe partout binding about three inches longer than the sum of the four sides of the negative. Fasten one end of this strip with a thumb tack to a drawing board, gummed side upwards. Secure the other end in the same manner at such an angle that the strip will be parallel to the perpendicular lines on the image of the negative, when the latter is at the middle of the strip, and others at a distance apart as the sides of the negative require. The whole arrangement is shown at Fig. 3. Moisten the first division or the strip (*d a*) and with the tee square as a guide, which should be placed in position previous to moistening the strip, lay the negative on the moistened strip. When pressed into place cut off the portion of the strip without disturbing the position of the remainder, and follow the same procedure with the other three sides.

The negative is placed on the moistened strip—instead of the strip being placed on the negative—because it is much easier to handle the rigid negative than a piece of moistened paper.

When a black margin is required round a print from a glass negative, the easiest plan is to cut the printing paper about a quarter of an inch larger all around than the part of the negative to be printed. Cut a piece of non-actinic paper the size of the picture. Print from the negative first, and with a piece of paper on the print expose the margin behind a plate of glass in the printing frame.

It is not possible to make a double border on a print from a glass negative without cutting the latter with a diamond.

For temporary masking a glass negative four rubber bands may be used along the four sides. Care must, of course, be exercised on account of their flexibility. Rubber bands, cut like those used on fruit cans, only thinner, may be used when circular masks are required—"Photographic Times."

A detail of hardwood lumber production in the state of Michigan is the seasoning of a considerable portion of the clear white of the hard maple product so that the wood will be left white and not be in any way marred by sticker marks. This result is accomplished by drying the lumber on end under sheds. Maple lumber dried in this fashion commands a handsome premium over that seasoned in cross pile, as the sticker marks ordinarily showing on cross piled stock would be inimical to the production of the delicately hued maple furniture now so much in vogue.

PERSONAL RECOLLECTIONS OF THE ELECTRICAL INDUSTRY.

PROF. ELIHU THOMPSON.

Let us, in opening what will be but a brief outline of the development of the electrical industry in Lynn, look back to the conditions about 1876. In that year the Centennial Exposition was held in Philadelphia. This was the first large exposition in the United States and was in commemoration of the Declaration of Independence at that time, and of course can speak from a very intimate knowledge of things as they were. To give you some idea of the difference between that time and this, I have simply to mention that during that exposition no buildings were kept open at night; there were no means of lighting such buildings at night with any kind of ease or safety. All the power that distributed, nearly all the machinery the exposition was in one building—Machinery Hall—and the hall was traversed from the center in four directions by enormous shafts, with enormous belts and pulleys driving every piece of machinery in that hall. The engine,—a very large Corliss engine it was called—of 1400 horse power, was geared by great wooden cogs to a jack shaft below, and that jack shaft by bevel gear and belting, distributed power to the line shafting which ran the length of the building. This may give you some notion of the condition of power supply. There was a railway running through the grounds; of course it was a steam road; nothing else could have been thought of—nothing in the way of trolley cars; nothing in the way of electric railways.

Now, what did we find there in the way of electrical display? There were exhibits chiefly of telegraph instruments, and a small exhibit of telephones, but nobody believed that such an instrument was of any account, although it was used for the first time during the Centennial Exposition to transmit articulate speech over a line, and Lord Kelvin, who was then Sir William Thomsen, was one of the witnesses called to testify the fact that it did transmit speech. Even then it was two years before the telephone became recognized as a useful instrument of communication. Just try to imagine what the limitations were at a time when it was impossible to light any large building with any ease and without danger; perhaps with gas lights; perhaps with candles; perhaps with kerosene. I should say, however, that there were but two exhibits in that exposition which concerned electric lighting. One of these was the Gramme Electric Company's. The Gramme machine was made in Paris and was used to furnish current to a single arc light. A machine to work two lights, three, four or more lights, was unknown. There was a dynamo in the Gramme space (a little space, too), which drove as a motor another machine, and this motor worked a pump and ran a little water-fall. This was the first typical exhibit of the transmission of power by electricity in the United States, I think. It was the germ of a great industry. I was very naturally interested in all this—deeply interested. I had been building small dynamos, even before that time, and had experimented in a general way with electric lighting and so on, and I was much interested in seeing even these comparatively small exhibits.

The above article was originally delivered by Prof. Thomson as an address before the body of apprentices of the General Electric Company in Lincoln Hall, West Lynn, Mass. The lecture was prepared in compliance with a request by Mr. Magnus W. Alexander, who is in general charge of the apprentices. It was stenographically reported as delivered, and as now first given out in printed form, has been fully and carefully revised by Prof. Thomson and adapted to the wider audience reached by the pages of this magazine.

In 1878, at the Paris Exposition, one of the Streets of Paris—the Place de l'Opera and the Avenue de l'Opera—was for the first time lighted by a system called the Jablochkoff. In this system two carbon pieces were put up parallel to each other and the electric current passed across a white insulating material between. This was kaolin. This lighting created a very great sensation. Each of the large globes contained a number of the Jablochkoff candles, as these double carbon sticks were called, because these only lasted about an hour or an hour and a quarter, and when one was burned down the next had to be switched on, and so the last in the globe. But they made a splendid effect for those times and attracted universal attention.

I was naturally interested, and went to Paris partly to see this exhibit. I made the trip abroad at that time to get all the knowledge I could in relation to this new electric development, but came away believing the Jablochkoff candle was not the thing for lighting; that it was beautiful but expensive, and not in the direction in which it was proper to work. On getting back I set about producing what was finally called the Thomson-Houston system, joining energies with Prof. Houston, who was, like myself, teaching in the Philadelphia High School at that time. We produced a dynamo and lamps. My first machine, intended for running an actual electric light, was built in 1876, but was very moderate in size, and very small in the matter of light. I could, by the use of a foot lathe, get a small arc light out of it. By working very hard and perspiring a great deal I could keep the light going for about a minute or so.

In 1878, however, I built a machine which was capable of giving about 120 volts and 10 amperes. I made the patterns and put the machine together absolutely without any planing, having only a foot lathe at command. The armature was made up of cast-iron discs strung on a wooden hub or shaft, yet the machine certainly worked and was shown in operation at the Franklin Institute during the winter of 1878-79. It weighed about 350 pounds and was not a continuous-current dynamo but would give alternating currents. One could take from one end of the shaft continuous current, or direct current, and from the other end alternating current. More than that, one could get alternating current in two-phase relation. It was, in fact, a two-phase alternating-current machine, self-exciting, and the old machine has been preserved in the model collection at the Lynn works. This machine was in reality the beginning of our actual arc-lighting work on which was founded this industry.

In 1878 this machine was shown, as I have mentioned, at the Franklin Institute. It attracted the attention of Mr. Garrett, a typical Philadelphia Quaker, who was then the agent of the Brush Company, which was just beginning to put out some few arc lights. A few machines were in use, giving two to four arc lights to the machine. I must explain here that these machines worked in this way: whenever you wanted a light you ran a separate circuit out and back to the machine. They were what we may call single-arc multi-circuit machines. One set of armature coils fed to this line, another this, and so on, and for four lights you had to have four dynamos in one. The idea of putting lights one after the other in series was not developed at that time. Mr. Garrett asked if we could get up a four-light machine that would run these single-circuit lights, and he was told that we would try. "Well," he said, "if you want to try I will bear the expense and see how you come out." So I set to work at once. Evenings and whole nights were spent in getting information together and calculating out, as best I could, what that machine should be and how to build it in a small machine shop. I would not trust anybody to do the winding but myself. I personally wound the armature and the field, and did everything necessary of an electrical nature to ensure that nothing would go wrong.

It must be borne in mind that no armature winders were to be had in those days. It would have taken a great deal of superintendence to get any man to wind an armature correctly, or to do anything with insulated wire where the voltage was considerable. This machine was wound and run, and it gave four lights in four separate circuits. As the machine was being completed Mr. Garrett came in one day and said, "Can you not run those lights on one wire? I hear that the Brush Company is doing it." "Oh, yes," I said, "I can." We soon had them running on one wire, 20 amperes to each light. They were very large and beautiful arc lights, such as are not often seen nowadays. The lights ran all night in a bakery, and soon after a number were installed in a brewery, and so the business began. The bakery was fearfully hot in summer, and the temperature was about 140° in the room where the machine was running. We had to stay in it and so got baked as well as the bread and the arc machine. But somehow or other the machine stood up, and we stood up also.

Not long after the machine had been in operation another inquiry came from Mr. Garrett:—"Can you make that machine give half as much light per lamp and twice as many lamps, or can you put on more lamps and split the current up?" I said we could, for I had thought it all out before, believing it was coming; I did not wish to push him, but waited for him to push me in that respect, but the machine was all ready so that the circuit could be divided and made into what we called an eight-light 10-ampere series arc machine. For years after that the 10-ampere arc circuit was the standard, not only for ourselves, but for the other arc-light companies, with but one or two exceptions. The above conveys a general idea of how the Thomson-Houston arc system was started.

Mr. Garrett began to build machines after the first model and to sell them. One went into a brewery. An instance of something which happened there will show the way in which those new things were regarded at the time. We had established a seven-arc-light machine in this brewery, the proprietor, a good friend of ours, being willing to stake his lighting on our success. We were able to give him what he wanted, so put in the proper machinery and lighted this brewery. One night, for some reason or other, the hay in the loft above the stable which was part of the building took fire. It was thought somebody had been smoking there. The engineer at once shut down the lights, but the proprietor said, "No! No! Keep the lights on; I want to get the horses out." But when the firemen came, being unused to such lights, they played the hose on them and could not put them out. They were astonished to find that the globes could be full of water and that the light was still burning under water. Thus they learned that the electric light was different from other lights. There is no doubt in my mind that the fact that the electric light was kept going during the fire saved the building, because it enabled the firemen to work, and the only damage was in the upper story, in the malt room. The lights were run for a week or so afterwards with the wire lying across the burned portion of the building, so to speak. The circuit was passed through this burned portion and still ran the lights. I mention this as an incident of the early days, when the nature of electrie lighting was still little known.

It required, as you may well believe, a considerable amount of courage to start an enterprise of this kind; not knowing what market there might be for electrical apparatus. It required that we, as it were, should prejudge the future. But it seemed as if an era was opening in which electricity should have a great part—at least, so it seemed to me—and shortly afterwards a company was organized to begin operations in New Britain, Conn., and it was called the American Electric Company. It was formed for the exploitation of the system which we had been developing, and it carried on the work there for a year or two. The management was not very satisfactory at the start—was not pushing, not energetic—and the work dragged; but we kept at it and kept developing new things and perfecting our arrangements so that by the time the beginning of 1882 came there was a 25-light arc machine in existence and a number of appliances that made the system a very workable one—regulators, etc. In other words, we had, during this time of what one might call indifferent business management, got everything in good shape so that we could make a creditable effect with our arc-lighting system, when a better business outlook presented. I may say here that our arc-lighting system was the thing we began with, and that alone—simply a dynamo, regulators and arc lights. In 1882 our lights were shown in Boston for the first time.

Just at that time it happened that two or three gentlemen of Lynn, Mr. Henry A. Pevear, the first president of the Thomson-Houston Electric Company in Lynn, Mr. Silas A. Barton, the business manager, and a few others, were thinking of starting a little local electric-lighting company for supplying electric light to stores on Market street and thereabout. They happened to see our lights which had been put up in Boston, and which were being run by a company that was really only a stock-jobbing affair. This company was using one of our lighting machines as its own. But the promoters did not remove the nameplate from the machine, as it happened, and Mr. Pevear and Mr. Barton saw that the American Electric Company of New Britain Conn., were the makers, and took a train for New Britain to find out whether apparatus of that kind could be purchased. They appeared in New Britain one day in 1882. I was there, as was also Mr. E. W. Rice, now of Schenectady, and at present one of the vice-presidents of the General Electric Company, and we received them. We told them we did not know whether we could furnish them this apparatus or not. The majority of our stock had been bought out by the Brush Company of Cleveland, and we did not know whether or not they might try to shut us up. "Well," they said, "can't we buy what the Brush Company have bought?" "Possibly you may," we said. To make a long story short, negotiations were begun, and by the fall of the year 1882 the Lynn syndicate had purchased from the Brush Company such stock as was held by the Brush company. At once the Lynn management set to work with great vigor to make up for lost time. I must give all praise to the energy and push of the Lynn management at that time. It came into the matter with courage and determination to make the enterprise succeed. It ran the shop in New Britain for about a year while factory "A" was being built in Lynn. As soon as this was built we were to pick up everything and leave New Britain and come to Lynn, all of which occurred in the fall of 1883. So the first appearance of this electrical industry in Lynn was in the fall of 1883.

We then had only factory "A." The lower floor we had for the heavy work, such as dynamos, etc.; the upper floor was for lamps, and the middle floor for development work, pattern work and drafting. Everything was packed into factory "A," and Mr. Pevear thought—this is a story which he laughs about nowadays—that we should not need all of this building. He said: "Well, this business may not need the whole of factory 'A,' but anyhow the upper floor can be used for drying skins." It was but a few months before not only did we want all the floors there were in "A," but more room. "A" was loaded down from cellar to roof with all sorts of machines packed in closely everywhere, until it became doubtful whether the floors would withstand the weight, and I remember calling Mr. Baker's attention at one time to the floor weakening in "A" on account of overload. That was later on. But in these early days that was the condition—almost a serious risk from the weight there was in that building. This soon led, in 1886, to the building of factory "B," which gave considerable relief. Then we thought we had a great deal of room. It was not very long, however, before that building filled up, too. The top floor was the incandescent lamp factory, the middle floor the pattern shop, model room and office, and the lower floor was used for dynamo testing for some time. Factory "A" was given up to manufacturing parts almost entirely. Further on Factory "C" was built, and that was very soon filled; we kept on, as you know, and have now got pretty well along the alphabet to factory "R".

Now, this growth was of course not all the result of our original business of arc lights; it grew out of that business, but the Lynn management felt that we could not afford to tie ourselves down to any particular kind of application of electricity. We must take business of every kind that offered in the larger application of electricity. So, after the arc-lighting system was completed and in use, and so on, the next thing developed was incandescent lights, adapted to run on the arc-light circuits, to run in series with the arcs on the arc machine. Then came incandescent lights on continuous-potential circuits, as they are called. This was an entirely new business for us. It took some time to get under way—a great many things had to be done. And here I wish to say that while this was going on the Edison Company was devoting itself almost entirely to incandescent lights, and was building up a business at Schenectady—the Edison Machine Works. Later on, when the incandescent-lamp works had got well started, came alternating-current work, about 1886. Before that time everything had been direct current. Alternating current had very slight place—

and in speaking of alternating current I mean alternating currents sent over the line at high pressure with transformers to reduce the pressure for local lines. The beginning of the transformer work, which, as you know, forms a large portion of our work today, was in 1886.

But one of the greatest changes took place in 1887. This was the beginning of the railway work. Nearly all of the cars before that time throughout the country were drawn by horses. The Crescent Beach line, one of the first lines run by the Thomson-Houston Company, started in 1887. Very soon after that a line went over the Highlands through Lynn, the test being to see whether the trolley car could climb the heavy grade and make trips regularly without trouble. It was demonstrated to be feasible, and from that time the business of trolley-car introduction on electrical railways increased enormously.

Here I wish to speak of the spirit which existed in our organization. The management was always ready to recognize merit outside of the organization. There might be merit inside it, but the recognition of outside merit was just as ready as that of inside. It was found that Mr. Charles J. Van Depoele had been working on electrical apparatus in Chicago and had made considerable success in a way, without real financial return, and that Mr. Van Depoele was getting somewhat discouraged. We were quite ready to take Mr. Van Depoele under our wing and give him that encouragement which he needed. He had done considerable pioneer work which even at this day is found in electric railways. He was the originator of what is called "the under-running trolley"—that is, the little wheel on top of the wire—the over-running double trolley. I do not want to make these reminisences too tedious, but I wish to say that the railway business grew far more rapidly perhaps than almost any other business undertaken. Then came along meters and other devices in endless series. We know that we have continued the same proportion of growth and development right along, and of course we hope that we shall never see the end of the extension and development, and I do not think we shall.

Later came a large development in stationary motors and the use of cast steel for motors and dynamos. Previously, cast iron was the thing used in making all the frames of motors and dynamos. Cast steel could not be obtained. I remember distinctly writing to steel manufacturers around the country, asking if we could not get castings of such and such a shape of cast steel, and they said steel could not be cast that way. Finally, we had to put up our own steel foundries.

Now, in 1891, or about that time, came a great change. The Thomson-Houston Company here had achieved a great reputation and was a very active company, which had formerly been in the hands of the Brush Company, as I have told you, before the Lynn people became interested in it, had bought out the whole Brush Company—had turned the tables and bought out the Brush company and factory at Cleveland. Then shortly came the great consolidation which made the General Electric Company. "Why did such a consolidation appeal to the managers of the companies and others interested?" you may ask. Well, there was a large amount of money expended in competition with each other's business and in litigation, the outcome of which was uncertain, and so consolidation seemed the most natural thing in the world. One company was doing a large business in the same and different lines, and it was inevitable that they should severely compete, both in the market and in the courts. Business was impossible, in the best sense, when a great deal of money and talent which ought to go into dividends was being expended in legal combats or used in destructive warfare in the commercial market. Under these conditions the companies came together and the union of interests was perfected.

Mr. C. A. Coffin, now the president of the General Electric Company, had been active in the management from the start at Lynn, and was the head of the Thomson-Houston Company at the time of the consolidation. It is not too much to say that to his energy and resourcefulness much of the successful building up of the enterprise was due.

Now, what have we to look for in the future? Is this great growth that I have outlined—in the briefest way I must confess—going to go on? I think so. But what I wish to impress upon the young men in the electrical profession is that as you grow up you will find no really good result is ever obtained unless you are willing to exert yourself for it. In our early days we had lots of trouble, hard fights and plenty of difficulties to overcome obstacles or even prejudices against new things. Trolley lines were not adopted without such struggles. I recall being cross questioned in no very gentle way because I favored the introduction of the trolley line for Boston, as to whether people would not be killed or this disaster or that or the other calamity follow. I am happy to say that I was able to answer most of such inquiries and to satisfy those in control that there was not going to be any disaster following the introduction of the electric railway in the streets. In the early days, in 1882, as I have told you, we were bought out by the Brush Company. That was a time of discouragement. We did not know whether we were going to be shut up or go on with the business. But, fortunately, owing to the little accident of the Lynn people seeing what we were doing, the scale was turned and we began operations afresh with renewed courage, and of course with eventual success. It is indeed something to belong to, to be connected with an organization which has in so short a time grown to the magnitude and importance of our electrical industry.

THE INTERRUPTION OF PRIMARY CURRENTS IN RUHMKORFF COILS.

OSCAR N. DAME.

In the vibrating form of interrupter, whether core actuated or not, platinum is used for contact points because of its conductivity, hardness and freedom from smut or oxidization. The nearest approach to platinum for this purpose is coin silver, which is a slightly better conductor when oxidized than ordinarily, and much cheaper, but does not give lasting satisfaction, and is therefore used only on the simplest apparatus.

Iridium in combination with platinum makes an ideal contact metal. These points are extremely hard and are cast in " drops " of convenient size and ground flat when needed. For battery coils of the highest types, all vibrators are equipped with these points.

The amateur will readily understand that these points have to be flat at the point of contact so that the greatest amount of current may reach the primary of the core, for upon liberal saturation of the primary depends the generation of powerful lines of force cutting the secondary turns. Yet, on the other hand, on a vibrating spring only a few inches long there is a limit to the contact area of the pieces of platinum. Most interrupters have points of about No. 42 wire gauge.

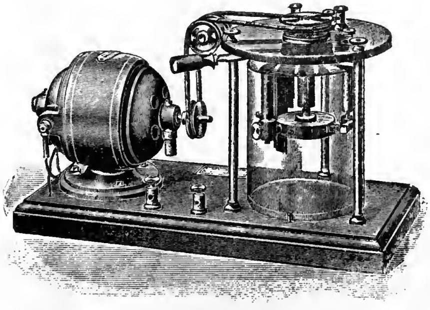


Fig. 1.

Condensers and their operation and construction have been so ably described in past issues of Amateur Work that I will pass this necessity in vibrator design with only a suggestion to amateurs about to construct one for home use. As is well known, a condenser to meet all conditions of coil operation must be varied in capacity to meet the conditions of the primary and battery used, also the frequency of vibration. It is advisable to make a number of small condensers which may be connected together in multiple, series or compound to give certain capacities needed. Amateurs will understand that the condenser is built up to the proper capacity to cut the contact spark to a minimum, and that the addition of more capacity will prove too much for the coil, thereby weakening and shortening the length of the secondary discharge. It will be seen, therefore, that there must be some sparking at the make or break points, or else the secondary discharge will fall short of maximum, and this condition of affairs furnishes plenty of opportunity for experimental condenser construction.

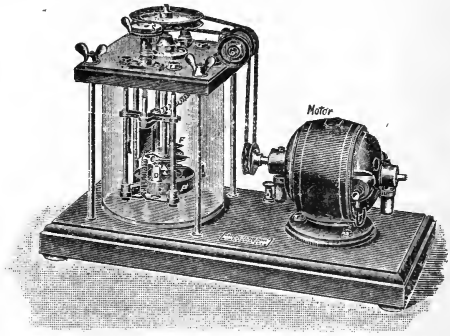


Fig 2.

Then, again, it will be observed that when the secondary spark balls are separated the maximum limit, the sparking at the contact points will be heavier than when the same coil is operated with the same primary battery and the spark balls closed to a fraction of an inch.

The vibrating interrupter admirably serves its purpose for small coil operation, and the cost of construction will not be great. But the amateur soon discovers that there are superior methods of interruption which bring out more of the spark value of the coil at but little additional expense.

First among other types of interrupters is the rotary, illustrated in Fig. 1. A large commutator is rotated between two carbon or copper flexible brushes, and as the insulated part of the commuter meets and passes the brushes, an interruption of the primary current takes place. Often times this commutator and brushes are immersed in alcohol or kerosene, which prevents sparking at the make and break. Condensers are used with this type, to absorb the extra self-induced primary current, as in styles previously mentioned.

Early experimenters in coil work found mercury a very appropriate medium for interrupting electric currents. Being liquid and an excellent conductor, an iron needle or rod could be immersed and removed up to 1000 times a minute by means of the simplest of mechanism, and with motor attachment to increase the speed, interruptions as high as 3500 were obtained. Alcohol or thin oil in the mercury jar, prevented undue spattering and confined the spark at the make and break.

Another type consisted of a disc of steel, rotated at high speed and the disc being cut away at one edge for a short distance made an interruption every revolution. Many interrupters of this type are in service today in England, where it was first introduced.

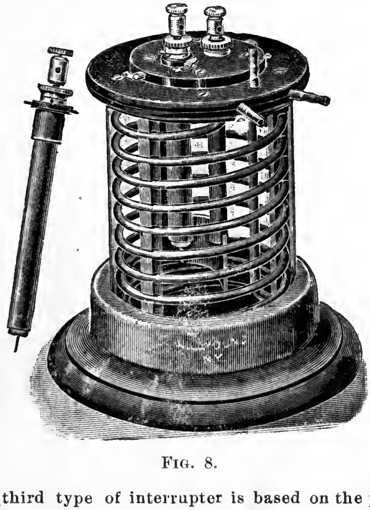


FIG. 8.

A third type of interrupter is based on the principles of the Archimedian screw. Turn to the pages in Deschanel's or Avery's Physics devoted to the Archimedian screw and note how readily this device may be installed for interrupter work. Rotation of the screw lifts the liquid from the bottom, up through the spiral turns to the top, where it falls to the trough again to be lifted. Mercury passes through the spiral as readily as water. It may cause the interruption by being dropped or forced upon a vane or blade of metal, or may complete a circuit by dashing its discharge against the mercury issuing from another pump. This seems to be the most feasible type of mercury interrupter in use today. In the X-ray laboratory, especially where tubes are being exhausted, it plays an important part. These mercury interrupters are used with all voltages up to 110 with little perceptible heating.

A great many operators now use the Wehnelt break with results which are extremely satisfactory. Owing to the large number of breaks (1000 or 10,000 or more per minute) the amount of energy delivered by the Secondary is greatly in excess of that possible with any other interrupter save the Caldwell form or a high speed mercury device; in making Skiagraphs, therefore, the time of exposure should be greatly diminished assuming that, other things being equal, the X-rays are proportional to the energy output per unit of time. That this is the case is proved by the results which have come to us. X-ray pictures through the body formerly requiring 15 to 36 minutes are now secured with exposures of from two to five minutes. Fluroroscopic images do not depend upon the energy output so much as upon the quality of the ray, and hence are not necessarily better with an Electrolytic than with an ordinary break except that absolute evenness and steadiness is secured with the former, whereas with the latter, unless the rate of interruption is high, there is flickering.

A Wehnelt interrupter consists essentially of a small surface (3 to 4 sq. millimeters) platinum anode and a large surface (200 or 300 sq. centimeters) lead kathode immersed in dilute H_2SO_4. If joined in series with the primary of an induction coil and sufficient E. M. F. exceedingly rapid breaks take place at the platinum surface. These breaks are probably due to the sudden formation of an envelope of nonconducting gas about the platinum surface; their frequency varies directly as the E. M. F. employed and inversely as the area of platinum. In practice at least 40 volts at the terminals of the interrupter must be used to obtain good results; as on large coils from one to four amperes will be required, this causes a heating loss of 40 to 160 watts so that the interrupter is theoretically not efficient. The rate of interruption is also seriously affected by the heating of the dilute acid; if heating goes too far, so that the fluid becomes actually warm to the touch the interruptions seem to lose their sharpness and will often fail altogether. This shows the necessity of keeping the fluid at a uniform and reasonably low temperature.

When using a Wehnelt interrupter no condenser is required; this reduces the cost of a coil somewhat.

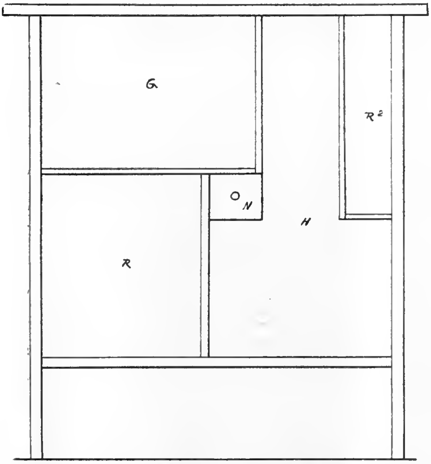
As the interruptions lose all sharpness when lead is made the anode and platinum the kathode this form of break permits the running of induction coils on alternating circuits, only positive impulses giving secondary discharges. There is, however, considerable corrosion of the platinum and its holder on the negative impulse thus making maintenance expensive, and it is, therefore, not advised for alternating use except when no other method of running is possible.

Phospher bronze is an alloy of phospher, tin and copper, containing usually 0.053 to 0.76 per cent phosphorus and four to ten per cent tin, balance copper. It is as tough as wrought iron, more ductile than copper and is capable of withstanding great wear.

A GRAMAPHONE CABINET.

JOHN F. ADAMS.

A gramaphone is a rather inconvenient instrument to handle, and without a suitable cabinet, is not convenient to put away when through using. The cabinet here described will contain all the parts, including horn, records, needles and the gramaphone. The compartment for the records is large enough to contain a pasteboard box with index holding 50 ten inch records and there is also an additional place for a few twelve-inch records. As the sizes of the different gramaphones vary a little, the dimensions of the compartment for storing it should be determined before cutting the pieces for the partitions so that the space will be of suitable size.



The top is 28 x 22 in. and 7/8 in. thick. The two sides are 29½ x 18 in. and ¾ in. thick and the lower surface is 5¾ in. above the floor. The partitions are all ½ in. thick. The board dividing the spaces *G* and R is 14 in. loug and 17 in. wide. That between *G* and *H* 10 in. long and 17 in. wide. Between *R* and *H* the board is 12 x 17 in. These three boards, as well as the top and sides, will have to be glued up from the narrower pieces. They are then nailed in position with 1½ in. wire nails of small gauge.

The board between B^2 and *H* is 13 x 17 in., and the lower board under B_2 is 17 in. long and 3½ in. wide, the grain of the board running from front to back. The drawer, *H*, is 3¼ x 2¾ in. and 12 in. long, outside dimensions, and made of stock ¼ in. thick, except the ends, which should be ½ in. thick. Pieces of ¼ in. stock, for the right and under side are cut out and nailed together at the edges joining and then nailed to the partitions. The front and end pieces of the drawer is made to project over these pieces and conceal them when the drawer is closed.

Two doors 23 x 11½ in. are made with panels, if the maker cares to put in the additional work required to make them, or may be of plain boards, with or without cleats at each end. Without cleats there is the liability of warping, unless the stock is thoroughly seasoned and all wind planed out.

The hinges can be of the usual kind, hung in the jamb, or ornamental brass hinges hung outside can be used to good effect if the wood is to be finished dark.

"WIRELESS" COMMUNICATION AMONG SAVAGES.

Many explorers have commented on the speed with which news travels among savage tribes. A curious observation as to a possible solution of the problem of their methods has been made by the Rev. A. Rideout. who, as a missionary among the Basutos, has noticed their method of sending messages from village to village by means of a signal drum or gourd. This gourd, covered with the dried and stretched skin of a kid gives out a sound which travels and can be heard at distances of from five to eight miles. The transmission and reception of messages on these drums is entrusted to special corps of signallers, some one of whom is always on duty, and who beat on the message in what is practically a Morse alphabet. "On hearing the message," says Mr. Rideout, "the signaller can always tell whether it is for his chief or for some distant village, and delivers it verbally or sends it on accordingly, and it is thus carried on with surprising rapidity from one village to another till it reaches its destination. King Lerothodi granted me the privilege of sending messages to our missionary workers by his great telegraph system, and never have I known a message sent by it to fail to reach the person for whom it was intended in its proper form. All that took place in the Boer war, victories and reverses in the transvaal and Orange Free State were known to us by gourd line message hours before the news ever reached us by field telegraph. The natives guarded the secret of their code carefully. To my knowledge, messages have been sent a thousand miles by means of it." This is probably one of the earliest forms of wireless telegraphy.

Kerosene came into general use about 1850. It was first called coal oil. It was also known as mineral oil and petroleum oil.

AMATEUR WORK.

DRAPER PUBLISHING CO., Publishers,

88 Broad St., Room 522, Boston, Mass.

A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month for the benefit and instruction of the amateur worker.

Subscription rates for the United States, Canada, Mexico, Cuba, Porto Rico, $1.00 per year.

Single copies of back numbers, 10 cents each.

TO ADVERTISERS.

New advertisments, or changes, intended for a particular ssue, must be received at this office on or before the 10th. of the previous month.

Entered at the Post Office, Boston, as second class mail matter, Jan. 14, 1902.

AUGUST, 1905.

To impress upon the youth and young man the necessity of utilizing to the utmost every opportunity for educational advancement is now, as it always has been and is likely to continue, a well nigh impossible task. Pleasure, rather than profit, is the leading desire at this period of life, the time when the mind is most receptive of new impressions and ideas and when proper cultivation would produce most beneficial results in both a practical and intellectual way.

Is it always to be thus? There are indications in various sections of the country that educators and also industrial leaders are awakening to the importance of changes in the present educational methods, whereby the youth will be given practical instruction along industrial lines, in this way overcoming the lack of incentive on the part of the youth himself. This will probably meet with opposition from labor unions, the leaders and members of which, with few exceptions, have yet to learn that fundamental principle of industrial economics:—That educated and skilled labor will always command a higher wage than will the unlikled and uneducated, and that the large problem is to remove the competition of the latter class by universal education.

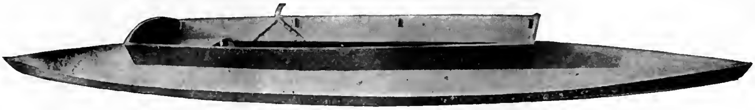
The magnificent results in this line now being realized in Germany, and the rapid progress of that country in industrial supremacy, affords ample evidence, if any be required, that youth should be given to industrial education. The relatively small proportion who have the means and the inclination for higher technical education, are amply provided for. It is those who now terminate their school life with the grammar or high school, totally lacking in the skill for any special work, that need consideration and it is encouraging to note that the subject is likely to be given the attention which its importance demands.

The "Model" telephone which we briefly announced in the previous number, is rapidly nearing completion, so that deliveries can be made at an early date. We can say without hesitation that this telephone will, so far as efficiency goes, be in every way satisfactory. It will operate over a line of at least 150 yards, and the number of inquiries already received leads us to believe that it will be one of our most popular premiums. Many of our readers have places about the house which could be connected with a pair of these instruments, thus saving many steps. It would take but little time to get the four new subscribers necessary to securing a pair. Try it.

Have you the complete set of bound volumes? If not, do not delay your order until it is too late.

The first five numbers of Vol. I, November, 1901 to March, 1902, are out of print, and no new orders can be received for same.

Most metals, when in a molten state, are capable of dissolving at least small proportions of carbon, which, in general, leads to a deterioration in metallicity, except in the case of iron, which, by the addition of a small percentage of carbon, gains in elasticity and tensile strength, with little loss of plasticity.



FIFTEEN-FOOT DUCK BOAT.

By Courtesy of the Brooks Boat Mfg. Co.

The following materials are required:

OAK, MAPLE OR ASH.

One piece 32 in. long, 5 in. wide, 1¾ in. thick for stems.

Eighteen running feet 1½ in. wide and ⅝ in. thick for floor timbers.

Fifty-five running feet ⅝ in. half-round for fender.

Two running feet 1 in. quarter-round for corners of coaming.

Sixteen running feet 3½ in. wide, 1 in. thick for knees.

HARDWARE, ETC.

One pound 6 penny wire nails; one pound 1¼ in. wire brads; one pound 1½ in. wire brads; one pound 1 in. wire nails.

Six doz. 1 in. No. 12 screws; six doz. 1¼ in. No. 12 screws. One ounce of 2 ounce tacks. Four yards of drilling.

The duck boat may be built anywhere and requires no preparation, but those who intend building a number of boats should have a suitable shop. A light, warm shop makes boat building pleasant. On one side have a workbench with a plank top about 2 ft. 8 in. high and 16 ft. long. Have a carpenter's vise at the left hand end.

The tools required to build the duck boat are a claw hammer, saw, draw shave, block plane, smooth plane, half inch chisel, brace, No. 4 German bit, countersink, screwdriver and brad awl.

INSTRUCTIONS.

When patterns do not intersect they may be cut apart for convenience.

Paper patterns for this boat are to be obtained of the Brooks Boat Mfg. Co., Bay City, Mich., and those not fa-

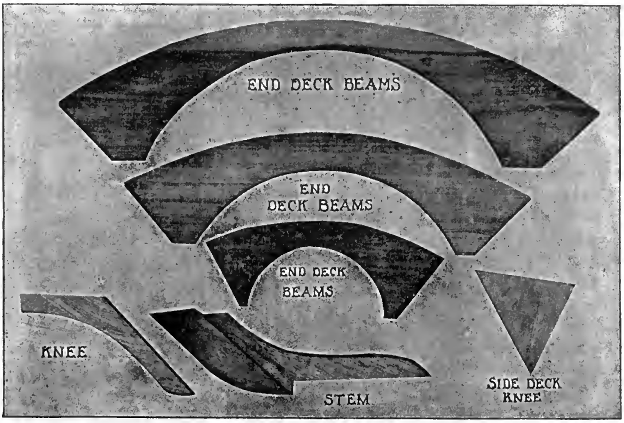


Fig. 1.

PINE, CEDAR OR CYPRESS.

Two pieces 15 feet long, 13½ in. wide, ⅝ in. thick for bottom or, if more convenient, get 3 pieces 9 in. wide.

Two pieces 16 feet long, 14 inches wide ⅝ in. thick for side plank, or four pieces 8 feet long, 9 in. wide may be spliced.

One piece 16 feet long, 14 in. wide, ⅝ in. thick for deck. This may be in 2 pieces 7 in. wide.

Two pieces 8 feet long, 6 in. wide, ⅝ in. thick for side coaming.

Two pieces 2 ft. long, 8 in. wide, ⅝ in. thick for end coaming, miliar with boat construction will find them a great convenience.

Lay the pattern on the material, place it so it will cut to the greatest advantage and not waste lumber, fasten pattern securely with a few tacks and then prick through with an awl on lines of patterns. When the lines curve make the prick marks close; follow outside of the line, which gives you room to dress with a plane after the piece is cut out; take pattern off and drive some small nails in marks made by awl. Now take a thin strip or batten and bend it up to nails, then mark in the line. This will reproduce the same lines on the lumber that are on the pattern. This out the deck beams, knees and stems and having them cut to shape. When this cannot be done cut the pieces to shape with a keyhole saw and a drawshave.

Before driving a nail, punch a hole with a bradawl through the outside piece only. Before putting in a screw, first bore with a No. 4 German bit, then slightly countersink for the head of the screw.

The pattern shows one side only. Use two or three boards ⅝ in. thick. In illustration No. 1 three boards are used, the line in center being the center line marked on the board. The boards may be put together with a square seam and calked, or with a rabbeted seam, which is the better way for the mechanic. Make

Fig. 2.

Fig. 3.

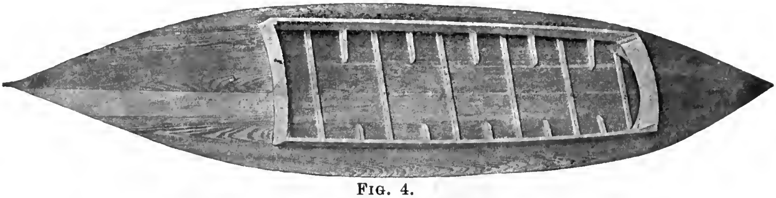


Fig. 4.

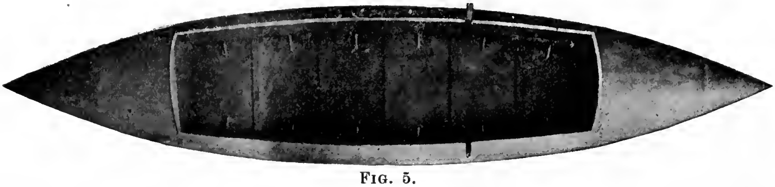


Fig. 5.

method saves the pattern from being destroyed. As the ends of this boat are exactly alike, patterns of the pieces of one only are given; therefore after making one piece, use it for a pattern to make a duplicate for opposite end or side. If the local mill has a band or jig saw, most of the work may be saved by marking the rabbet ⅝ in. wide, and one half the thickness of the plank. Put together with lead paint and fasten with ⅞ in. clout nails, holding the clinchiron against nails. Stagger the nails along the joint to prevent splitting. The first-mentioned method of square seams is the best for the amateur. See that the edges of the boards fit squarely together and are planed smooth. Cut the floor timbers into their proper lengths and fasten the bottom to them with 1 in. screws, putting the screws through the bottom first into floor timbers. The bottom is now square and twice the width of pattern. Mark a center line from end to end on outside of bottom; lay the center or dotted line of pattern to the line so marked and prick in the outside line. Now turn the pattern over and place to center line. Prick in the outside line by putting awl in the same holes. This gives entire bottom.

To make the stems, cut out of oak 1¾ in. thick. The rabbet line, as shown on patterns, is a line which is a furrow or trough cut in to receive the ends of the plank for the purpose of bringing them flush. This rabbet is cut in ⅜ of an in. deep and is beveled so as to receive the plank fair. Bevel in from rabbet line one way and from inner edge of stem, as shown in illustration. Bevel stem from rabbet to outer edge so as to leave edge ⅜ in. thick. Fasten stems to bottom with three 1½ in. screws and if necessary, draw tight with two or three six penny wire nails. Cut out the knees. There are sixteen, all shaped by one pattern. Fasten them at their places to bottom with two 1¼ in. screws. You will note in illustration No. 2, that knees are swung so as to be square with edge at spot where they are located. Cut deck beams out of ⅞ in. pine or cypress and fasten at their station with a 1¼ in. brad at each end through bottom.

The side pieces, plank, may be in one or two pieces, as shown in illustration No. 3. When two pieces are used the butt or joint comes in center and is reinforced with a six in. piece of the same material, covering butt on inside and fastened with six or eight ⅞ in. screws or ⅞ in. clout nails. It is better to make the side plank in one piece, if lumber wide enough can be obtained. Before fastening on sides place the bottom flat on the work bench, put a two inch block under each end and fasten the middle down to bench. This will give about the proper sheer to the bottom so that the sides will go on easily.

Fasten the side plank on. Commencing at one end, fasten to stem with three 1 in. wire nails and to knees with three 1 in. wire nails, and to deck beams with two 1¼ in. screws. Fasten lower edge of sides to bottom with six penny wire casing nails, 1½ in. apart. Cut out side deck knees 1, 2, 3. There will be four of Nos. 1 and 2 and two of No. 3. No. 3 goes in middle of boat, then 2 and 1 towards ends, as shown on pattern of side plank and in illustration No. 3. Fasten to deck beams with 1½ in. brads.

When deck is on, set nail and smooth off with coarse sandpaper and put on drilling. Stretch on smooth and tack to inner and outer edge of deck. Illustration No. 4 shows coaming in before deck is finished. The drilling should be put on before the coaming is fastened in. Cut coamings and fasten end pieces to deck beams with four 1½ in. screws. Fasten side pieces by putting a piece of 1 in. quarter-round at each corner and fastening both ways with three 1½ in. screws. Round off the outer corners of coaming. Fasten bottom of coaming to edge of deck with 1½ in. brads. Put a piece of ⅝ half-round for fender, from stem to stem. This will cover the seam between deck and sides and also cover the tack heads. Put a piece of ⅞ in. quarter round around outside of coaming on deck, fastening the quarter-round with 1¼ in. brads.

If the seams of the bottom have not been rabbeted, calk them with a light thread of calking cotton, using a small calking iron or a blunt putty knife will do. Be careful not to drive the cotton too hard as it swells when boat is in the water. Give the boat two good coats of lead paint. working well into all the seam joints. Should it be desired to rig boat for oars, a couple of iron outriggers similar to illustration may be fastened to coaming. For the benefit of the amateur we will repeat: Before driving a nail, punch a hole with a brad awl through the outside piece. Before putting in a screw, first bore with a No. 4 German bit, then countersink for screw head.

SLEEPING SICKNESS.

Col. David Bruce who, in Uganda and elsewhere has been inquiring into the cause, effect and distribution of "sleeping sickness," addressed a meeting at the Royal Institute of Public Health on the subject. Col. Bruce said that in certain parts of the country where the disease had broken out some time between 1896 and 1901 it had in a short time reduced a populous and richly cultivated country to a depopulated wilderness. Sleeping sickness was essentially a disturbance of the functions of the brain. A patient might go about doing his ordinary work for years without his friends noticing that there was anything the matter. But gradually a slight change in his demeanor became evident; he was less inclined to exert himself; he lay about more during the day; and at last his intimates saw that he had the first symptoms of that absolutely fatal disease. His investigations had led him to believe that probably the disease was introduced from the Congo; that it was caused by the entrance into the blood of a protozoal parasite, and that the infection was carried from the sick to the healthy by a species of fly. Where there was no fly there was no sleeping sickness. In other words, they were dealing with a human tsetse fly disease. Sleeping sickness was found to have a very peculiar distribution. It was restricted to the numerous islands that dot the northern part of the Victoria Nyanza and to a narrow belt of country a few miles wide skirting the shores of the lake, but only in localities where there was forest with high trees and dense undergrowth.

AMMONIA; THE PROCESS OF MANUFACTURE.

Abstract of a paper read at a meeting of the Cold Storage and Ice Association, London, Eng., by Mr. Charles Page.

You are, no doubt, all familiar with the form of a gas retort in which coal is distilled for the production of what, in spite of electricity, may still be described as our chief artificial illuminant. From this retort the crude gas and tar ascend by a pipe, which passes into the hydraulic main, a sealed trough containing water, where the tar is separated from the gas. The latter, still in the crude state, is led away by pipes, to go through the various processes of purification necessary to make it a good and innocuous illuminant. Of the impurities, ammonia forms an important part, and in order to remove it the gas is passed through a scrubber, of which the most common form is a series of towers containing coke, through which a constant flow of water is maintained. As water readily absorbs ammonia, this impurity of gas is given up during the passage of the crude gas through the scrubber.

The water of the last of the series of towers, where very little ammonia is present, is used over again in the rest of the series until it contains about two per cent of ammonia. This ammoniated water, termed commercially gas liquor, invariably contains other impurities of coal gas, including sulphur and a small percentage of tar, which will have passed over with the gas from the hydraulic main. This gas liquor, together with the tar and the water from the hydraulic main (which will also contain ammonia), is collected in suitable receivers, most commonly underground tanks, where the tar sinks to the bottom, and the two can be separated subsequently by suitably arranged pumps.

At this point it would be interesting to note some of the commercial aspects of the production of ammonia. You will have remarked that ammonia is a by-product of the manufacture of gas, and when I tell you that a ton of coal will yield only about four to five pounds of pure ammonia you will see at once that it could not be produced and sold at the current market price as a main product. Coals of different origin vary greatly in yield of gas and its by-products, but taking the average yield of the coal used for gas-making in this country, it may be stated roughly that one ton of coal distilled by the most modern process, will yield about 11,000 cubic feet of gas, 200 to 250 pounds of tar, four to five pounds of pure ammonia, twenty to twenty-two pounds of sulphur, and thirteen to fifteen hundred weight of coke.

The by-products, or residuals, as they are termed by gas engineers, form a very important part of the industry of gas-making, and naturally great attention is paid to them, both in the selection of coal and in the methods of distillation. So important a part do these residuals play, that in some places, where coal is cheap and the production of gas large—the town of Sheffield, for instance—the total cost of the coal is covered by the yield of the residuals. Those of you who are share-holders in gas undertakings will realize, therefore, what an effect the price of residuals, as the by-products are termed, will have upon your dividends.

And for all of us the point is an interesting one, as it exemplifies how one industry is dependent upon another in a way which by no means appears upon the surface. You would not think that the price you pay for the ammonia which you use for refrigeration has any sort of connection with the dress which your wife wears, which is dyed by a tar product possibly made from the same ton of coal as some of your ammonia, but it is an economic fact none the less.

I would mention here that ammonia is also produced in the processes of making coke for iron smelting and of distillation of shale for the manufacture of oil as carried on in Scotland.

These are important sources of ammonia, and the methods of obtaining it are much the same as those I have described. Water is the vehicle, and what may be termed the raw material, which is used by the manufacturers of ammonia, is gas liquor, containing only a small percentage of ammonia.

To return to the process of manufacture. I have shown you how gas liquor containing about 2 per cent of ammonia is obtained. This ammonia is partly free and partly fixed—that is, part of it will evaporate, and it is this portion which gives the strong odor to the liquor, while part of it is held in solution by the sulphur which also comes over with the other impurities of the crude gas. The relative portions of free and fixed ammonia vary according to the nature of the coal used and the condition of distillation. This gas liquor contains numerous impurities, which would go over with the ammonia if the latter were simply distilled, and it is the business of the manufacturers of anhydrous ammonia to get rid of these impurities, and so to produce an ammonia which will contain nothing which will have any injurious effect upon the most sensitive parts of a refrigerator plant, and which will be easy of compression and rapid of expansion. The surest method of accomplishing this is to make first a solution of this salt and drive the ammonia off again before drying and compressing it.

This brings us to the manufacture of sulphate of ammonia, a perfectly odorless salt, containing about 25 per cent of ammonia. In this process the gas liquor is passed into the top of a column, like a boiler placed on end, divided at intervals by plates which are perforated in the center and at alternate sides, and the perforations are so guarded that the gas liquor rests on each shelf to a certain regular depth before it can pass to the plate below. While the liquor thus descends from plate to plate through the tower, steam is admitted at the bottom and ascends through the center holes of the plate though the tower, (or, in some processes, in a separate tower to which the liquor is carried) milk of lime is introduced, and this sets free the fixed ammonia, which in like manner is carried up with the steam. The number of plates in the tower and the treatment by lime is governed by experience of the liquor being worked, and the outflow of water is tested from time to time to see that there be no waste of ammonia. The residue should not contain more than .002 per cent, or about one-thousandth part of ammonia which the gas liquor contained on entering the tower. The ammonia carried up by the steam is conducted by a pipe from the top of the tower to the saturator, a vessel containing sulphuric acid of the proper strength, which fixes the ammonia and forms sulphate of ammonia, precipitating it in the form of crystals, which are fished from the saturator and allowed to drain.

Having now imprisoned our very volatile gas in the form of sulphate of ammonia, it can be left exposed to the air for any period without detriment so long as the salt be kept fairly dry.

This, then, is the most convenient form in which ammonia can be transported, and it is in this form that several hundred thousand tons per annum are used for fertilizing purposes. But for our purpose we need the pure ammonia gas, and this is obtained by dissolving the sulphate of ammonia and adding milk of lime to it, which again sets the ammonia free. The solution is treated in much the same way as the gas liquor, but the resulting gas is naturally much more free from impurities than in the first process. In this process there is considerable loss of ammonia, for it is found that even when an excess of lime is used—by an excess I mean more than the quantity required chemically to combtne with the sulphuric acid and form sulphate of lime, which is the process by which the ammonia is set free—with an excess of acid and the employment of mechanical agitators it is impossible to recover all the ammonia. A yield of 90 per cent is in practical working considered a good yield.

This ammonia is now considered a very volatile gas, and throughout the remainder of the process great care has to be exercised to guard against loss by leaky joints, or accidents, or carelessness of workmen. It is first conducted to a condenser, where the gas is cooled, and then to purifiers and driers. In this stage of the process lime plays an important part, as it absorbs the moisture, while it has no affinity for ammonia. To ensure absolute dryness the ammonia gas is finally passed through a cooling tower which is itself refrigerated by means of anhydrous ammonia from the compressor, so that any remaining moisture is frozen out of the gas.

After the process of purifying and drying, the ammonia passes to the compressor, which works at a pressure of about 150 pounds, and from there it goes to a condenser, where it is contained until filled into cylinders for conveyance to the buyers.

A word about these cylinders, which form a very important and probably the most expensive part of the manufacturer's stock in trade, will not be without interest. They are made from tubes of toughened steel, and when new, after the valves are fitted, are subjected to a test by a hydraulic pressure of 1500 pounds to the square inch. They are thus absolutely safe even in the hottest climate when properly filled with anhydrous ammonia, but to insure this it is necessary that the quantity should not exceed five-eighths of the water capacity of the cylinder.—"National Engineer."

Some heroic work was recently accomplished in a burning coal mine at Edwardsville, Ill., when the miners concluded that their only salvation lay in cutting out the burning coal. This they did, sending the burning fuel to the surface in the mine cars. The mine workings were filled with gas, and the heat was almost unbearable, but the entire village depended for its existence on the operation of this one mine. With them it was a case of self-preservation, and they were found equal to the emergency, as they usually are when herculean tasks are to be performed in a mine, whether to save the lives of their fellow workers, or the property of their employers when it is in danger.

When melting babbitt metal care must be taken not to overheat it, or the more easily melted constituents partly evaporate, leaving the alloy in bad condition. Melt a small part first and gradually add to it until all is melted. Then skim off the top and the metal is ready to pour. Before pouring the metal wrap a sheet of smooth writing paper around the shaft or other journal to be babbitted, and secure it by winding a string spiral, in turns, half an inch apart. Then place in the bearing and pour the metal. The paper keeps the cold iron from too quickly chilling the babbitt and gives it a smooth surface, while the grooves made by the string make good oil conduits. It will be found, if this is properly done, the journals will fit the bearing nicely and will require no scraping.

The solid matter in ocean water is 2139 grains per gallon, and that in the Dead Sea about 19,700 grains per gallon. The amount of saline and other soluble material held in solution in salt lakes varies with the rainfall, some years it being greater than others. In stages of low water the quantity per gallon increases, and in stages of high water following heavy rains it becomes less.

A CHEAP NINE-INCH REFLECTOR.

M. A. AINSLEY.

III. Construction of the Polisher.

We have now arrived at the point where the worker will begin to appreciate the real difficulties of the work. Up to this point all has been fairly easy; but the beginner must not be discouraged if his early attempts at the construction of polishers are failures, and he must be prepared to exercise unlimited patience. The pleasure of seeing the wonders of the heavens through a telescope of his own construction will amply repay him for his time and trouble.

The pitch used, as before recommended, should be Swedish pitch, in 2 lb. boxes—about 2 lbs. will be required. Also we must obtain some rouge. I got mine in ½ lb. packets through a jeweller, who specially ordered it for me, and it is important to get the very best that can be got. If there is any difficulty about it, an optician would probably be able to supply it. It is somewhat expensive—$2.50 the pound, or so—but ½ lb. will be ample. An iron ladle to melt the pitch and an iron spoon to stir it are, of course, necessary, and an ample supply of turpentine.

There are two distinct methods that I have tried of making the polisher: One is to pour the pitch directly on the tool and stamp grooves in it to form the necessary facets. The other is to make the squares of pitch separately and mount them independently on the tool. I prefer the latter method, if only because a slight flaw in the polisher does not necessitate the renewal of the whole thing—local repairs being quite easy.

Now pitch is, as I have said, a good friend but a bad enemy. As I was told by an expert correspondent: "Stick to pitch—it will certainly stick to you," and "if it is a good friend, it does sometimes stick closer than a brother." But I am glad to say that there is one thing that pitch does not show any brotherly affection for, and that is blotting-paper. Provide, therefore, an ample supply of blotting-paper in sheets not less than 10 in. square, if possible. A large sheet of plate-glass or marble 14 in. square should be provided, and we shall require a stamper to form the square, and a frame of wood to retain the pitch till cool. The frame should be, for a 6 in. mirror, 40 in. square inside and 12 in. outside, the sides being therefore 1 in. broad, and it should be ⅜ in. deep. For a larger mirror it should, of course, be larger, the inside measurement being about 1 in. larger than the diameter of the mirror. This is to allow for a few extra squares in case any get broken. The stamper is made by screwing two flat pieces of wood, 12 in. x 1½ x ½ in. to the sides of a rod 1 in. square and about 18 in. long. The ends of the rod may be rounded off to form handles, and the flat side pieces should project about ½ in. as shown in the figure, and have V-shaped edges. I append a rough sketch of the instrument, which will explain what I mean.

The hardness of the pitch is a matter of some importance, and authorities differ to a large extent. I found in my own case, that if a shilling, standing on its edge, left five complete impressions of the "mill" in one minute, it was about right; the temperature makes a difference, the pitch being harder when cold, so that the test should be carried out at the same temperature as that of the room in which it is proposed to work. I do not recommend the beginner to have his pitch any softer than I have indicated; it may be even a little harder.

The pitch having been melted as before directed (in my second letter), its hardness should be tested by pouring a little on a piece of glass; and turpentine should be added slowly till it is about right, the pitch being thoroughly and constantly stirred while the turpentine is added. If too soft it should be kept at the melting point and allowed to evaporate, when it will harden. But I did not find this necessary, as the pitch is now poured out steadily on to the slab till it has a depth rather less than that of the frame, say 5-16 in. Any impurities must be kept back with the iron spoon.

After it has cooled down a bit, but before it hardens—and this may be tested by touching it it with a blunt wooden point covered with wet blotting-paper—the frame may be removed. This is quite easy if the blotting-paper is used, but not so easy if it is omitted—and a cake of pitch 10 in. square by 5-16, is left.

We now bring the stamper into action. A series of grooves are stamped out parallel with one side of the pitch cake. Each groove is stamped twice, the following edge of the stamper being placed in the groove just vacated by the leading edge. In this way the squares are all kept of the same size. A similar set of grooves at right angles to the first are stamped and the pitch cake is then divided in 1 in. squares separated by ¼ in. grooves. It is protected from dust without, of course, being touched, and left to get thoroughly cold. When cold it is slid to the edge of the glass slab and broken into squares very much as if it were toffee or chocolate. After a little practice this can be done without splintering the squares if care is taken; but as there are plenty of squares made, the loss of a few does not matter. The hands and pitch must be kept wet, to avoid the latter sticking to the fingers; and the pitch squares, when broken off, should be placed in a basin of cold water till required.

We have now to mount these squares of pitch on to the glass roof to make the polisher, and I may say at once that the position of the central square with regard to the center of the tool is a matter of the greatest importance. It might seem at first sight as though the most obvious way of securing uniformity of curve in the mirror would be to let the center of the tool coincide either with the center of a square or with the intersection of two grooves. This is not so. A glance at Fig. 2 will show that under these conditions a circle struck from the center of the tool would either fall almost entirely on the squares or between them. This would result in rings of unequal polish, and therefore

A slight difficulty arises with regard to the facets at the edge of the tool. I found it best to stick the square on without attempting to break them to shape, and cut them off afterwards. When the tool is completely covered with squares, the mirror should be covered with wet blotting-paper and placed on the polisher, the edges of the mirror and polisher coinciding accurately. A chisel, held vertically and lightly struck with a small mallet, is then used to cut off the portions projecting beyond the edge, and great care must be taken that the squares at the edge of the tool are properly stuck on.

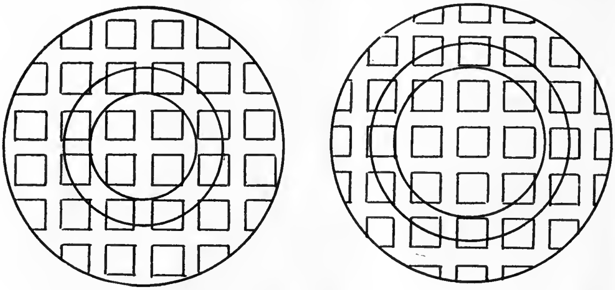


Fig. 2.

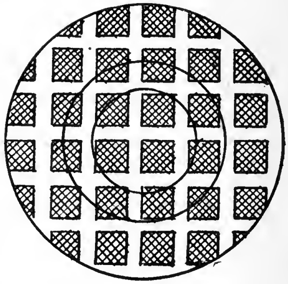


Fig. 3.

of unequal figure, being produced in the mirror, and such rings are very hard to get rid cf if once produced. They can be completely obviated, however, if care is taken to place the center of the tool in such a position with regard to the pitch that any circle struck from this center falls about equally on the squares and between them. For this purpose the center square of pitch is placed so that the center of the tool falls just within one corner of the square, as in Fig. 3.

The first thing, therefore, is to mark the center of the tool accurately. Lines may then be drawn in two series at right angles to guide in placing the pitch squares. This is not absolutely necessary, as they can be placed with sufficient accuracy by eye after a little practice.

The central squares may now be placed in position as above, and I found that the easiest method was to smear the tool with a little turpentine and hold each square just above the chimney of an ordinary paraffine lamp until the under surface was melted, when it was rapidly placed in the proper position on the tool, and pressed down for a few seconds. The squares should be dried on blotting-paper as they are taken from the water, and it is very necessary that no water should be allowed to be set between the squares and the tool. The back of the tool should be examined from time to time to insure that each square has made good contact as if any of the squares are not thoroughly stuck to the glass they are sure to come loose in the polishing. The squares may be placed about ¼ or ½ in. apart. This is to allow for a good deal of subsequent trimming. When the polisher is ready for work the intervals between the squares should be upwards of ½ in.

The polisher should now be warmed, either by holding it in front of a fire or by means of hot water, to soften the pitch. The mirror, still covered with wet blotting-paper, may be allowed to rest on it for a few seconds to mould the surface of the pitch to the curve of the glass, and the squares should be neatly and accurately trimmed off by means of a sharp knife or a chisel held vertically. If both chisel and pitch are kept thoroughly wet all the time (indeed, it is a good plan to do the trimming of the squares under water) there is little danger of splintering the pitch.

The polisher is alternately pressed and trimmed until all the squares have made good contact, and until they are all exactly the same size and have neat, sharp edges. Too much care and patience cannot be brought to bear on this, as a neatly and accurately made polisher is half the battle; any want of accuracy in the size of the squares is sure to cause trouble.

When the polisher is satisfactory, we may begin to think about the rouge. The rouge as sold is liable to contain a few coarse particles, and I found it essential to mix it with plenty of water and allow it to stand for a few moments to let these coarse particles settle. The rouge and water are then poured into another vessel and allowed to stand for several hours; the water being poured away. A mud or paste of rouge is left which is free from grit and which will not cause scratches.

The polisher may now be warmed up for the last time; and the mirror, painted evenly and densely with rouge and a flat camel's-hair brush, is placed on it, the blotting-paper being omitted. It is moved slowly to and fro, without pressure, and in a few minutes the pitch will have assumed the exact curve of the mirror, and be fit for use. If any square does not make good contact, the warming and pressing should be continued for a bit longer: but this should not be necessary. It is a good plan to scratch each square diagonally, as shown in the figure, after the polisher is moulded to the curve. This lessens the friction, and makes it easier to control the stroke in polishing.

In my practice I invariably apply the rouge to the speculum, and not to the polisher; it is easier to get it even, and renders the motion much easier and more regular. The speculum is held in a triangle of hard wood, with pieces screwed on at the corners to grip the glass. A cotton-reel screwed to the center of the triangle forms a convenient handle, and the glass should be held just tight, and not subjected to any pressure, which might distort the figure. It need hardly be said that every trace of emery must be thoroughly and completely got rid of; it is very easy to scratch the surface of the glass, and impossible to get the scratches out once they are there.

In the actual polishing I hold the handle at the back of the triangle in one hand and give a stroke of about half the diameter of the mirror. The mirror is allowed to rotate quite freely, the motion being always right-handed; the stroke given is elliptical, the ellipse havhaving a breadth of about 2 in.; also the center of the ellipse is kept moving from side to side to the extent of an inch or two. This prevents rings appearing on the surface and tends to uniformity of curve. At first the friction of polishing will be considerable, but it lessens as the polish on the glass improves, and if the polisher is neatly and accurately made the motion will be easy and regular. The stroke should always be made (round the ellipse) in the same direction—right-handed or "clockwise," in my case—as if it is attempted to move the mirror in the other direction over the polisher, the friction is enormously increased and sticking is the result. Why this should be I do not know, but it has been invariably the case in my experience.

The polish will ere long begin to appear on the glass with surprising rapidity—and as soon as it does testing should be commenced. This will form the subject of my next letter, when I shall endeavor to make the theory and practice of testing as plain as possible.

In cleaning the rouge off the mirror, to test or for any other purpose, I found it better to let the mirror get quite dry, and then to clean off the rouge with soft blotting-paper. This obviates staining the hands with rouge, and is more cleanly and satisfactory.

The polisher should, of course, be carefully protected from dust when not in use, and the mirror should never be allowed to remain at rest on the polisher. The quantity of water required is difficult to describe, but it should not be too much or sticking is the result.

CABINET MAKER'S CLAMPS.

The amateur who engages in woodworking has frequent need of clamps for gluing up stock to make wide widths such as table tops, etc. Clamps for such purposes can easily be made at small expense, as here described. To make three clamps, obtain three pieces of maple or birch 6 ft. long and 2 x 3 in., which will plane down to 1¾ x 2¾ in. From each saw off two pieces each 6 in. long. Also obtain a piece of maple 6 ft. long, 5½ in. wide and ¾ in. thick, which saw into twelve pieces 6 in. long. To each side of the short 2 x 3 pieces attach and bore the next hole, using the hole in the block as a guide for starting the hole in the bar. By boring the holes in this way they will all be in line, and the bolt will fit all holes. The next thing is boring the holes in the screw block for ½ in. lag screws 9 in. long, which can be purchased at any hardware store. The bit used for the holes should be a ⅜ in. After working the screws through once or twice to get the threads well cut, saw off the pointed ends of the lag screws with a hack-saw, and file the ends smooth.

one of the ¾ in. pieces, using four 1½ in. screws. These screws must be located on either side of the center line of the block with a clearance of a little over ½ in. so that when the holes for the screws are put in, the bit will not touch any of the screws.

To one end of each of the long pieces of 2 x 3 stock, attach with screws one of these pieces we have just made. Then mark out 6 in. spaces along the long piece, the first one about 15 in. from the inner end of the screw block. Bore with a ⅜ in. bit the first hole, then move the block along to the next space When using it is best to put a block of wood between the work and the ends of the screws.

The adjustable blocks are held with ⅜ in. bolts, 4 in. long, the heads of which are partly sunk in the side to prevent turning when screwing up the nuts. If the work is of a width which cannot be closely met by using the holes as bored, blocks of wood are used to space out with, as it is not advisable to bore more holes in the bar, thus weakening it. A set of these clamps will cost about 50 cents for material and will be found very serviceable.

THE METAL WORKING LATHE AND ITS USES.

ROBERT GIBSON GRISWOLD.

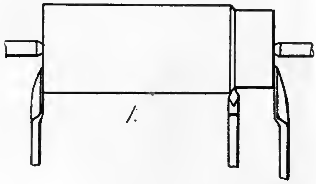
IV. Tools and Turning.

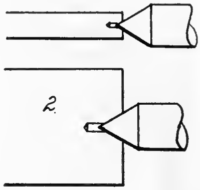
If a canvas was made throughout the various shops in this country, a great diversity of opinions would be found to exist as to just how a tool should be ground for certain work, what its shape should be and just how much feed should be given. Each lathe hand has experimented for himself and has found some particular shape and form of cutting edge that suits him best.

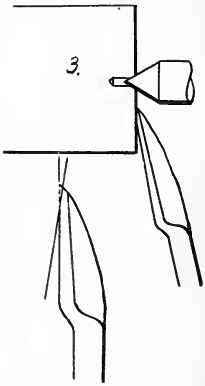
But the general principle upon which all lathe tools are formed is that of a wedge, and the keener the wedge the easier will be the cutting. For example, in woodworking we use tools possessing a very keen edge, obtained by grinding the tool edge on a long taper. Most every one is familiar with the smooth cutting properties of a well ground paring chisel and how very easily it will cut through the softer grained woods. But suppose we take a block of well seasoned oak and attempt to cut with the same chisel, especially by driving it with a mallet and hammer; if we are not very careful the edge will be broken off completely. Why? Simply because the edge has not sufficient strength to support the strain imposed by the heavier, harder wood.

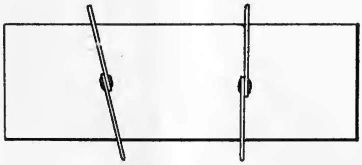
And this principle modifies or determines just how far we can go in grinding a tool for lathe use. We know from the action of a wedge that the sharper the edge the easier it may be driven into any substance. The cutting of a chip from any piece of metal depends upon the wedge-action of the tool-edge cutting or prying off the thin layer of metal lying on one side of the wedge. But the severing of this thin chip or layer requires considerable force, and if the edge of the tool is too keen it will be broken off. This cutting action was fully described in a former chapter under "Tool-making for Amateurs."

So it is merely a question of giving a tool as keen an edge as it will hold and still do the work. A light cut will allow of a keener edge than a heavy cut, while the softer metals will pull a tool with a keen edge into them, and, although it would seem that a keen edge would be the best for such work, practice shows that the best results are obtained with tools having very little rake—almost a scraper in their action. With cast iron and steel a greater rake is permissable.









Now let us take one or more examples that will show exactly how the several shapes of tools are used in turning a piece to size. Starting with a small cylinder, as shown in Fig. 1, we will suppose that the piece is in the rough and requires considerable turned off. The piece is first centered, drilled and countersunk for the lathe centers. A word of caution here may be of value. Never make your centers unnecessarily large. Suit the center to the work—a heavy piece requiring a large countersink, while a light piece requires a very small one. Heavy cuts cause a considerable strain on the centers. and if they do not enter into the piece by a sufficient depth may easily be broken off. Fig. 2 illustrates this, showing the greater support afforded as the center enters into the work deeper and deeper. The center should always be lubricated and a mixture of white lead and oil is probably the best as the lead affords a certain body which prevents the oil being squeezed out when the pressure of the cut is applied. A light oil will not wear well.

Another point—do not set the center up too tightly. It should have merely sufficient pressure to prevent the overhanging carrier-tail making it revolve as it passes center when the spindle is slowly revolved by hand. As the cuts continue the heat will gradually expand the piece, causing it to press more and more on the tail center, and if not relieved by slightly backing out, the tail-screw may generate sufficient heat to draw the temper of the center, when it will cut and wear very rapidly.

In taking the roughing cut, use a diamond-point tool, setting it almost at right angles to the work, as shown in Fig. 1. The clearance need not be great, probably eight or ten degrees will be enough and the top of the tool should have a rake of 8 to 15° and a side rake ranging from 15 to 20°, depending on the grade of the material being worked, machine steel allowing a 40° side rake, and sometimes even more. Side rake makes very fine cutting, especially if a lubricant is used.

The roughing cut is run across the piece until the carrier or dog interferes. The piece is then removed without backing away the tool, the carrier changed to the other end, the tool returned to the starting point and, after replacing the work the cut is finished. Since the tool position has not been altered, the cut will be continuous.

The roughing out, as its name implies, is merely used to remove the excess or superfluous stock and no pains need be taken, excepting that the cut, which should be as heavy as the lathe will carry to save time, should not spring the work. It sould, if possible, reduce the diameter of the piece to within .04 or .05 in. of size, the piece to be finished with the next two cuts.

The finishing cut may be made with the diamond point, provided it is rounded slightly with an oil stone. If the work is not very particular it may be brought to a smooth finish with a mill file and emery cloth, but grinding is the quickest and surest method of finishing a piece to size. The broad-nose finishing tool may also be used to good advantage, but a very light cut must be taken as the broad cutting surface readily induces chattering and this causes ripples over the entire surface.

In the matter of squaring the ends some prefer squaring first before the piece is turned, while others do it last. If done at first there is more metal to be removed by the side tool than if left until the last operation.

The stock should be cut almost to length, as the side tools are not able to remove much metal at a cut. If the diameter of the piece is very large, say four or five inches, the extreme point of the tool should be backed off slightly, as shown in Fig. 3 and then fed out across the end. This presents a small cutting surface and insures the end being square (provided the cross-slide ways are square with the center-line of the lathe). For small work it is quite sufficient to square the ends with the side of the tool. As work must always be turned end for end in squaring, the right side tool is the one most frequently used.

The sizes are measured with calipers. The sense of truth in calipering a piece may be developed to such a degree of sensitiveness that a difference of .001 or .002 may be easily detected. Never attempt to caliper a piece for finished size while in motion. Stop the work and carefully measure it throughout its length. The points of the calipers should just touch—no more, no less. Don't force them over and "guess" that you have it "within a hair." Get it just right. Hold the calipers truly perpendicular with the axis of the work, not canted as shown in Fig. 4.

When holding finished work in the carrier always place a strip of copper around the piece and a thick piece under the screw. This will prevent marring the work.

BOOKS RECEIVED.

Practical Wood Carving. Fred T. Hodgson. 284 pp. 8½ x 5 in. 185 Illustraitons. Cloth. Price $1.50. Frederick J. Drake & Co., Chicago, Ill. Supplied by Amateur Work.

The amateur who desires to learn wood carving without the direction and help of an instructor, will find this work of great help, and a careful following of the instructions given therein should result in the attainment of at least a fair measure of success.

An important feature is the extended treatment of the care and uses of tools peculiar to the different classes of wood carving, as well as those common to all.

The examples given to illustrate the several chapters are decidedly better than are to be found in most books upon this subject, which, together with the completeness with which the various operations are treated, make the book one which can be cordially recommended to the beginner.

Printing Out Papers. T. Thorne Baker. No. 69 Photo-Miniature. 25 cents. Tennant & Ward. New York.

Contains information of value and interest to every photographer who makes his own prints.

Sulphuric acid is said to have been discovered by Basil Valentine, a monk of Erfuri, in Saxony, in the fifteenth century. He obtained the acid by distilling coperas in a retort at red heat, the acid dropping from it in an oily liquid, whence the name of vitriol.

ALCHOHOL IN MANUFACTURES.

The importance of readjusting the internal revenue regulations and taxes on alcohol is clearly brought out by the United States Consul Halstead, Birmingham, England, who reports: The London, Manchester, Liverpool, Glasgow, and Birmingham chambers of commerce are taking part in the agitation to modify the restrictions placed by the inland revenue authorities upon the use of alcohol in manufacturing processes. I have reported that the chancellor of the exchequer had appointed a committee to look into the matter.

The Birmingham "Daily Post" claims that no district is so interested in the granting of the desired concessions as Birmingham, many of the principal industries in which alcohol is used being represented in or near the midland metropolis. There are a great many varnish manufacturers and lacquer makers with works in Birmingham or the immediate neighborhood. The "Post" says that "more lacquer is made in Birmingham than in all the rest of the world put together, and there can be no doubt that more of it is used than in any other place," for Birmingham is the center of the brass and other metal trades, and lacquer is used on practically every article of metal on which a high polish is desired. I quote the "Post" article in part, as follows:

It is contended that if lacquer could be made from pure, cheap spirit the metal workers would be able to turn out a better finished article at a lower price. Even in the manufacture of varnish the use of spirit that has been denatured by adding 10 per cent of wood naphtha has the effect of clouding the varnish. It is more expensive to use methylated spirit than to use pure spirit, because the cost of the methylating has to be added to the cost of the alcohol. The cost of methylated spirit is further increased by the fact that the process of methylating it is only practiced by a few firms in this country, and they are able to keep up the price. Consular returns show that during the present year, when English methylated spirit was being sold at 42 cents per gallon, alcohol of the best quality was being sold at Marseille in new, iron-bound barrels at 23 cents per gallon, less 6 per cent for cash; and the price of alcohol in Cuba was 10 cents per gallon.

The manufacturers contended that wood naphtha and turpentine are not the only effective denaturants, and that they should be allowed to mix the alcohol with denaturants that are not inimical to the process of manufacture. In the case of the lacquer manufacturers it is suggested that it is only necessary to mix the alcohol with shellac, which is impotable, and therefore would spoil the spirit for drinking purposes, but is an essential ingredient of lacquer and would improve the spirit for manufacturing purposes.

Chemists claim that the revenue authorities should be satified if they saw the alcohol mixed with one or other of the constituents of the particular drug that was in process of manufacture. Motorists would probably be content if the spirit was mixed with 10 per cent of petrol, which would render the liquid undrinkable and would improve it as a motor power. With regard to the manufacture of explosives, it is argued that if pure alcohol could be used a much cheaper and less dangerous process could be adopted. A leading firm of chemical manufacturers at Bristol states that practically the whole of the trade in drugs containing alcohol has got into the hands of the Germans because of the duty on alcohol.

On paper it seems that the Germans are not allowed to use absolutely pure alcohol duty free, but Mr. Barlow states that he has bought cheap alcohol in Germany which on analysis showed no signs of a denaturant except a small percentage of shellac, and there is documentary evidence to show that the restrictions in Germany are very much lighter than in this country. Instead of 10 per cent of wood naphtha Germans may mix with the alcohol 2 per cent of wood naphtha and 2 per cent of petroleum benzine or 0.5 per cent of turpentine. These quantities are so small that they do not appreciably affect the nature of the spirit, and there are many exceptions to these regulations. Under certain conditions the infinitesimal amount of .025 per cent animal oil may be used. The principle that the denaturant should be adapted to the commercial purpose for which the alcohol is to be used is largely carried out in Germany and also in France. For instance, in the manufacture of collodion, the alcohol may be mixed with 10 per cent of ether, which is a necessary ingredient of collodion.

In answer to the objection on the part of the inland revenue authorities that a relaxation of the existing restrictions would open the way to illicit dealing in spirits, Mr. Barlow contends that this could be obviated by granting the privilege only to those firms which are able to satisfy the revenue officers that the alcohol is duly mixed with the denaturant, and that it is actually used in the process of manufacture. He suggests that alcohol should be run direct into sealed tanks containing the shellac, petrol or ether, as the case may be.

The transmission of electrical energy by wires is nowhere more perfected than through the mining districts of the West. The increasing tendency to raise the line voltage in such transmissions has enormously increased the capacity of many lines, for we find today lines in successful operation with voltages running from 40,000 to 60,000, as compared with 4000 to 6000 volts of a few years ago.

ELECTRIC SHOCKS.

One of the new and not uncommon dangers of modern life is that of getting in the way of a powerful current of electricity and receiving the entire discharge through the body. The effects of such a discharge vary, of course, with the strength of the current. There may be simply a sharp muscular contraction accompanied by a familiar, disagreeable sensation of an electric shock; these contractions may be repeated several times after the current has ceased, constituting true convulsions, or there may be a persistent continued muscular contraction. There may be suspended respiration while the heart continues to beat; both heart and respiration may cease, in which case death will speedily follow unless instant medical relief is at hand or in other cases death may be instantaneous.

The first care is, of course, to free the person from contact with the live wire, and here great caution is necessary, or the giver of assistance may share the fate of the one he is trying to help. He must himself be insulated before touching the victim's body, if the latter is still within the path of the current, and this is especially important if the accident has happened out of doors on a wet day. Care should be taken also not to let any part of the body other than the hands, or rather one hand, touch the electrified person.

It may not be possible to pull the sufferer away from the source of electricity, and if not it will be necessary to make a short circuit by dropping a stiff wire or a metal tool of any kind over the live wire or cutting the wire.

Insulation is best obtained by rubber boots and gloves, but in the absence of these, standing on a folded coat or a woman's silk skirt and putting on thick wollen gloves or wrapping the hands in several folds of silk, woolen or cotton cloth, which of course must be dry. A dry board or several newspapers, or better still, both, may serve as an emergency insulating stool.

When the victim has been freed from the current he should be plaeed so that he can have plenty of fresh air. In severe cases artificial respiration will almost always be needed, just as it is in cases of drowning, and an early resort to it may save a life that would otherwise inevitably be lost.

HOW PINS ARE MADE.

The United States practically supplies the world with pins. In this country we use annually of common pins no less than ten billion, or ten thousand million. This is an average of not far from 136 pins for every inhabitant of the country. The total number of pins manufactured in the United States for 1900 was 68,889,260 gross. There were 43 pin factories which employed 2500 people. Pins are turned out automatically, and one machine is capable of producing several thousand gross of pins per hour. Coils of wire hung upon reels are passed into machines that cut the proper length of wire for the pins. They drop into a receptacle and mechanically arrange themselves in the line of a slot formed by two bars. When they reach the lower end of the bars they are seized and pressed between two discs, that forms the heads, and pass along into the grip of another steel instrument, which points them by pressure. Then they are dropped into a solution of sour beer, whirling as they go, to be cleaned and then into a hot solution of tin that is also kept revolving. Here they get their bright coat of tin, then are pushed along until sufficiently hardened, when dropped into a revolving barrel of bran and sawdust, which cools and polishes them at the same time. Through the oscillations of this barrel the pins work gradually down to the barrel's bottom, which is a metallic plate cut into slits just big enough for the body of the pins but not large enough for the head to pass through. Thus they are straightened out into rows again, and, like well drilled soldiers, pass along toward the edge of the bottom and slide down an inclined plane, still hanging by their heads, until they reach strips of paper into which they are inserted by a peculiar jerk of the machine. The consumption of iron in the manufacture of pins foots up in the neighborhood of 15,000 tons yearly.

ALUMINUM PLATING PROCESS.

Aluminum, on account of its great lightness and its toughness when alloyed with other metals, has, since its production, been so enormously cheapened, come into general use for a multiplicity of purposes. But one great drawback to its use is the rapidity with which its surface becomes dull and leaden in hue owing to rapid oxidation. This characteristic has hitherto prevented aluminum from being easily electroplated with gold or silver, as copper may be; but, according to an announcement in the Electro-Chemical Industry, this difficulty has been removed by the discovery of a method by which aluminum can be given a coating of any desired metal. The film of oxide which covers the surface of the aluminum is removed by adding to the plating bath a small quantity of soluble fluoride and the metal then receives a superficial coating of the zinc or copper, upon which silver or gold can be subsequently deposited. The new process will doubtless be highly valued by the makers of opera glasses, photographic lenses, telescopes and other instruments.

The Krupp Works, Germany, cover in area 1500 acres and daily output is 1877 tons. Alfred Krupp has built for his operatives 5500 dwellings and maintains a pension fund of $4 125,000 for their benefit.

SCIENCE AND INDUSTRY.

Two men employed in an Edinburgh rope factory have invented an apparatus for carrying off dust and bad air created by the machinery used in the flax industry. The principal sources of dust in a flax-preparing machine are the feed and delivery rollers. Over each of these parts is suspended a duct or flattened tube. An air-propelling fan, driven by belt and pulley, rotates in this horizontal tube. The tube may be made of such size and the fan of such power as to serve for ventilating a number of machines. To the lower part of the tube, ducts of flattened trumpet-mouth or rectangular shape are hinged at such an angle as to have their elongated narrow mouths over the rollers of one machine, or, it may be, two machines. Sliding doors, rotating grids or equivalent devices, are fitted in these ducts to regulate the draft of air. Cords or chains are secured to the lower ends of the ducts and carried on pulleys, so that the ducts can be drawn up to give room when the machine is being cleaned or repaired. The dust and bad air drawn away from the machine by the suction caused by the centrifugal fan are carried off by a duct attached to the fan duct, and are discharged in the atmosphere or in any receptacle where water may be employed. The estimated cost of making these machines is $50 each.

In a brief account in the "American Journal of Science" for June, of late mineral researches in Llano County, Tex., which have been made by him, Mr. William E. Hidden mentions a peculiar formation which he encountered. He found unusually long radial lines projecting in many directions from the bodies of ore richest in thorium, uranium and zirconium. He called these occurrences stars, and sought for them as positive pointers to ore. Finally, on removing a seventy-pound mass of zirconium-yttrium-uranium and thorium ore, which was a nucleus to one of the best marked of these stars, from its quartz matrix, his hands and face began to burn as if from the effect of strong sunlight, and after three days of this kind of mining a redness of skin and a burning sensation resulted which was followed by an actual soreness of the parts of his hands and face exposed to the direct emanations from the minerals. The author suggests that this burning be due to the work of a radioactive element of a peculiar if not unique kind.

U. S. Consul, T. W. Martin, of Nottingham, Eng., in a report says it is announced that a Lancaster mechanic, Dennis Flanagan, has invented what has long been needed but unsuccessfully attempted—a machine which will sew direct from two spools of thread, thus obviating the winding of spools and threading of the shuttles. Experts are quoted to the effect that if the invention is put on the market it will revolutionize the sewing machine trade of the world.

Flanagan has been experimenting since 1889, it is said, and that owing to the machine sewing direct from two spools of thread, there is an absence of complicated mechanism in consequence of which there is little chance of its getting out of order. A remarkable feature is the small number of parts required in in its construction and, as the cost of production will, comparatively speaking, be small, it is expected that the contrivance will be put on the market at a price far below that charged for most sewing machines.

The Chinese Government, according to German papers, has granted its first patent. It is for an electric lamp, the inventor of which is an inhabitant of Nankin, the old capital of China, who calls his lamp the "bright moonlight," and asserts that it is far superior to foreign glow lights that hitherto have been sold at Shanghai and other Chinese cities. The fact that China has entered upon the granting of letters patent is undoubtedly of more importance than the invention.

High speed trials of steam locomotives on the military railway between Marienfelde and Zossen, in Germany, have shown that the superheated steam locogives the best satisfaction. The trials have shown that this type of locomotive is more powerful than the usual express type, that it can cover greater distances without changing and is more economical of coal and water, but it is stated that it requires 32 per cent more lubricating oil.

Electric waves which were measured by Hertz and named after him were found to be 150 feet from the top of one wave to the top of the next. The waves used by Marconi in wireless telegraphy are said to be 600 feet or more in length and travel at the same speed as light, 184,000 miles a second. The light wave measures only a few millionths of an inch in length.

Development of the internal combustion engine for marine purposes means that, in the adoption of the now familiar motor boat, the same ranges of power and action as are obtained by the best reciprocating engines and boilers can be secured at one-sixth of the weight with the new motor. The British Admiralty are so convinced of the advantages of the combustion engine that they have carried out at sea a series of experiments, and there is some talk of utilizing this type of engine in the new torpedo boats which are about to be built.

Nitro-glycerine, or glyceryl nitrate, is a light yellow, oily liquid, which, under the action of a fulminating cap, explodes with great violence. It was found so dangerous that its use by itself was given up and the mixture of nitro-glycerine and infusorial earth (dynamite), has been used for some time past.

Markets belong to those who get them. The battle of trade today is to the strong, the swift, the alert and the intelligent. Trade plums do not drop into the mouths of those lying under the trees, but to those who shake the trees.

An excellent cement for splicing leather belting, recommended by a practical mechanic, is to thoroughly cook six ounces of the best white glue and then add two ounces of powdered white lead immediately after lifting from the fire, incorporating the two ingredients by thorough stirring, then pour into a shallow greased pan to cool and season for future use. Make the splice of the belt the same length as its width. Cut off a sufficiently large piece of the cement and dip it for a moment in scalding hot water and apply to the skived surfaces until they are completely covered, and neatly joint the two pieces together and hammer down smooth. The belt may be put into service within an hour.

It is possible to prevent the smoke from magnesium ribbon or powder spreading through the room by placing over it a large flat pad of damp wool lint. The lint should be tacked to a piece of flat board and supported on legs, just about the point where the ignition takes place—at such a height, of course, as not to interfere with the flash. The damp lint absorbs most of the products of combustion, and so prevents the usual cloud arising.

The conditions which insure a steady and abundant flow of water in mountain streams is not so much heavy rainfall as a heavy snowfall in the mountains, and for the best results it is the snow which falls in the early part of winter, and which becomes hard and compact during the winter season by successive rain and snowfalls until it is almost a mass of ice rather than snow. This melts slowly and maintains a summer supply.

Phosphorous, because of its tendency to ignite under the influence of frictional heat, is used in the making of matches. For this purpose it is usually combined with manganese dioxide, chalk and glue. Safety matches are made of a mixture of potassium chlorate, potassium bichromate and antimony trisulphide. This combination will not ignite readily by ordinary friction, but takes fire when drawn across a paper coated with antimony pentasulphide and red phosphorus.

The crank pin and cross head of an engine do not travel at the same rate throughout a revolution of the crank shaft. The crank pin travels at a constant speed, but the crosshead is constantly traveling at an accelerating or diminishing speed throughout the forward and backward stroke, coming to practically an absolute but only momentary standstill at either end, the duration of rest being so small that it is claimed by some that the crosshead does not actually stop at all.

CORRESPONDENCE.

No. 98. LOWELL, MASS., July 10, 1905.

I would very much like to correspond with any readers of AMATEUR WORK living in this sectton who are interested in wireless telegraphy. An interchange of ideas and the results of experimental work would undoubtedly prove profitable. Kindly address "Wireless" 54 Middle Street, Lowell, Mass.

Those at a greater distance than that mentioned above are invited to write their experiences for publication in this column that all readers may profit therefrom.

No. 99. FRANKLIN FALLS, N. H., July 12, '05.

Kindly advise if a glass plate condenser is as good as a Leyden jar for "Wireless" work. What will a thin glass tube 4 in. diameter and 8 in. long cost? Also of hard rubber of same dimensions? C. E. H.

There is no appreciable difference if equally well made and of the same capacity. The tube, either of glass or rubber, would probably have to be made to order, and cost about $4 for glass and $2.50 for rubber. The glass tube might be made from a glass bottle, to be found by searching among glassware dealers.

No. 100. SOMERVILLE, MASS., July 8, '05.

How can I gain admittance to the stations of the United States Government wireless telegraph stations? F. E. W.

Write a letter to the Chief Electrician of the station you desire to visit, stating your request, which may or may not secure the desired permission, this depending greatly on the conditions of business duties. On certain days visitors are generally allowed at Navy yards, and you might try on one of these days.

No. 101. MINNEAPOLIS, KAN., July 7, '05.

Would you advise amateurs to buy magnet wire and attempt to wind a small spark coil for a ¼ in. spark, and is it difficult to wind small coils? D. N. R.

Success in coil winding depends largely on the skill of the operator and care taken in the work. The small size you mention should be an easy matter, but it would hardly seem worth while to fit up for a coil of that size. With larger coils the preliminary work of making a winder, etc., is, of course, a necessity. The work has an educational and instructive value, which makes it necessary for each one to decide for himself whether making or buying a coil is advisable.

No. 102. PROVIDENCE, R. I., July 11, '05.

Please tell me the best kind of paper to use in a condenser for a 1-inch spark coil. I do not know the kind to use between the layers of tinfoil. D. C. W.

A strong waxed paper is placed between the different layers of tinfoil in a condenser. You may be able to find at a confectioner's or baker's paper which would be suitable, but each sheet must be carefully examined to see that it contains no pin holes. If unable to buy suitable waxed paper it may be made by dipping thin bond writing paper in melted paraffine, allowing same to become hard, and then pressing smooth with a flatiron slightly warmed. The latter paper will be best, being much stronger than any waxed paper you can ordinarily purchase.

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VACUUM TUBE WINDOW DISPLAY.

OSCAR N. DAME.

As many readers of this magazine are the possessors of spark coils giving from one to two inch sparks, they will be interested in learning how, during the winter holiday season, they can utilize their coils to profitable advantage by arranging and letting to enterprising merchants the window display here described, which is exceptionally attractive at all hours except bright daylight.

In addition to the coil batteries, etc., it will be necessary to have three or four vacuum tubes, "Geissler" tubes, as they are frequently called, a few shapes being shown in Fig. 1. The smaller sizes are sold for about 50 cents each, increasing in price to $1.50 for 12 in. compound tubes; the latter giving the most beautiful floresence when excited by a coil giving a 1 in. spark. These tubes are exhausted of air and then partially filled with gases which give characteristic colors when excited by the coil. With carbonic acid gas the color is whitish green; hydrogen, white and red; nitrogen, orange yellow. The compound tubes are composed of an inner tube with the usual twists and ornamental turns, and an outer, straight tube which serves to protect the inner one against breakage. This outer tube is also filled with various colored liquids which increase the luminous effect. As these tubes are almost entirely of foreign manufacture and imported by but few electrical supply houses, they will have to be ordered by mail by those not living in the largest cities.

The tubes are fitted at the ends with wire loops firmly set in the glass. They must be handled carefully, however, both to avoid breaking the glass and the outer ends of the loops. Simply mounted upon a frame with a black background, the appearance of the tubes is very fine, yet to get the best effects they should be rotated and a suitable device for doing this will now be described. Such an exhibit placed in a store window will attract much attention from passers, giving an excellent advertisement to the goods displayed in the window.

Referring to Fig. 2, the baseboard *B* is 12 in. square and ¾ in. thick. Holes for the supports, *s*, are cut 1½ in. from the front edge. These holes are 1½ x ¾ in. and are cut vertical, although the supports are inclined inward to be only 3 in. apart at the top. The supports, s, are 22 in. long, 2½ in. wide and ¾ in long, those at the bottom ¾ in. long. They should be carefully fitted and strongly secured by wedging and glue, as the revolutions of the wheel are liable to cause the frame to sway if poorly joined, the effects of which might be disastrous.

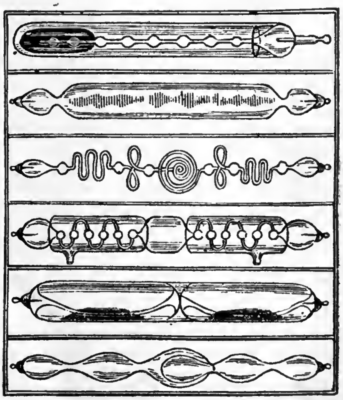


Fig. 1.

The piece *C* is 6 in. long, 2½ in. wide and 2 in. thick. Mortises for the supports are made 3 in. apart, and a hole bored through the center for the shaft *I*. This shaft is preferably made from a piece of ⅝ in. cold rolled steel, bushed with brass tubing, in which case the hole should be about 7-16 to ½ in., depending on the thickness of the tubing. Obtain the tubing before boring the hole, as it should be a drive fit. Care should also be used to see that the axis of the hole is exactly horizontal.

It will be necessary to have the outer end of the shaft threaded to receive nuts, one on each side of the revolving frame, which are screwed up hard and prevent the frame from turning on the shaft. Two collars are also needed. These can be made from the pieces of steel tubing, or $\frac{3}{4}$ in. rod, with a $\frac{3}{8}$ in. hole drilled in the center and set screws fitted to it. These are put, one on ea·h side of the block,§*C*. A pulley is mounted on the rear end of the shaft. A suitable pulley can be made of a pulley wheel used in awning pulleys and sold by large hardware dealers.

The revolving frame is made from two pieces, *F*, 36 x 2 x $\frac{3}{4}$, crossed with a halved joint. A hole for the shaft is bored at the center. At the back on each arm and 5 in. from the shaft *glue* blocks 2 x $\frac{3}{4}$ x $\frac{3}{4}$ in., and to these *glue* a wooden disk, *D*, 12 in. in diameter and about $\frac{3}{8}$ in. thick. The bottom of a peach basket will serve, or it can be cut out with a fret or keyhole saw from a board. In the center a hole is bored for the shaft, and around the rim a band of strip brass is attached with shellac, drilling a few holes for a few short brass brads with flat heads which should be filed flat so as not to project and wear out the brushes. This brass tire should be made up and the ends soldered before putting on.

The front of the frame is then covered with thick cardboard, the front surface being black. If black cardboard is not easily obtained, use any color and cover with black paper or velveteen.

The tube holders shown in Fig. 4 are made up after purchasing the tubes, so that the fit will be accurate. The piece, *H*, is of a length to bring the two ends pieces at the narrow necks between the end tubes. The end pieces are nailed to the bottom strip, and have the outer ends cut out to fit the tube and covered with black velvet glued on. The tubes are held in place with fine wire, the ends of which are put around small wire nails put into either side of the ends. The tube frame is attached to the revolving frame by a wood screw at the center. This permits of turning the tube holders on the frame to obtain different effects when rotating.

The tubes are wired up as follows: On the top of the block, *c*, a brush is made of a strip of spring brass, 4 in. long and $\frac{3}{8}$ in, wide. A quarter turn is made with pliers at the center and then bent at right angles. Holes are drilled or punched for two brass screws, by which one end is attached to the block so that the other end will bear firmly and securely on the shaft. A flexible wire is run from one of the screws to one end of the coil secondary.

Another brush is made from a strip 9 in. long with one end bent as previously mentioned, and the other end attached to one of the supports, *S*, as shown in Fig. 2. See that the turned end bears on the rim of the disk, *D*. This end is curved so that the frame may revolve in either direction. This bearing is connected to the other secondary terminal of the coil. The tubes are then connected with magnet wire, as per Fig. 3, the wire being run on the back of the frame and brought through to the front at the ends of the tubes. Use care to run the wire between the arms and the cardboard, so that the space between the wire and the rim of the disk is as great as possible. The high potential of the current will cause it to take the easiest circuit, and it is quite necessary that the distance between wires be at least double the sparking capacity of the current.

The frame is revolved by a suitable motor attached to the baseboard as shown in Fig. 2, and connected

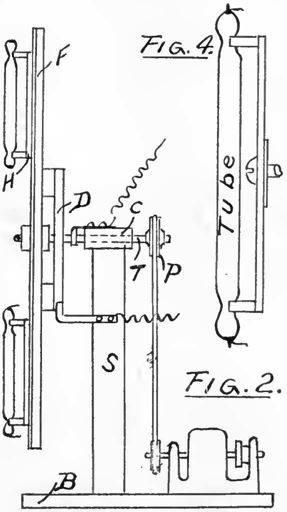


FIG. 4.

FIG. 2.

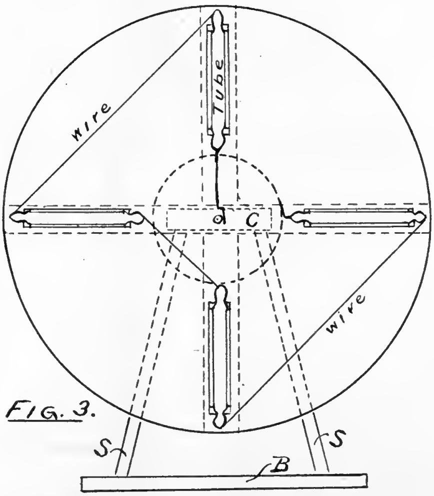


FIG. 3.

with a ¼ in. round belt to pulley on the shaft. Several cells of battery will be needed for current, and a switch should be placed on the baseboard to facilitate operations. The frame should be started by hand when switching on the motor, as the weight is considerable and much more power is required to start it than to keep it going.

The coil required to operate this device with four 12-in. tubes need be only about ½-in. spark capacity, as but little current is required to bring these tubes to full brilliancy. Coils of larger capacity can be used, the battery being cut down to reduce the sparking length. A little experimenting will undoubtedly be necessary to determine just the right battery power to use, being careful not to use too much and burn out the wire terminals of the tubes.

Care must also be used in wiring up and connecting to the metal tips of the tubes, as the construction is not always of the best and the tips easily break off, making connections difficult. If unused to blowpipe work and soft solder, breaks of this kind had best be repaired by a jeweller.

In addition to being an excellent window dislay, this devices makes a very interesting display for the home, and as the cost is not heavy for the whole outfit, providing the coil be home-made, those interested in coil work will find it woith the making.

CEMENT WALKS AND FLOORS.

Many farm houses have no walks about them. In too many cases only weedy paths lead to the front door and to side porches. We should plan to change these "farm houses" into farm homes. One of the best ways is to provide permanent walks—walks to the well and to the front gate; walks to the horse lot, as well as the garden. Gravel is thought to be the best material for this use, though sometimes crushed rock is available. Brick would be used more freely if less expensive. Neither of these materials makes a permanent walk.

The cheapest and best material for walks and certain floors is a concrete made of cement combined with gravel, or crushed rock, or crushed brick, and covered with cement and topping to give a durable finish. This same material may be used to great advantage as flooring for stalls in stables, dairies, graneries, etc. Such combinations, or concretes, are much cheaper than is commonly thought.

Take one part of cement to five parts of gravel or crushed brick, to form the foundation. This need be only three or four inches deep and laid flush with the ground surface or one inch above. Guide strips must be used to confine the walk to straight or regular lines. These strips of 1 x 4 or 1 x 6 laths should be laid down by careful measurement. When the foundation has begun to "set," put on one inch of topping made of two parts clean sand and one of cement. Rub the fresh surface repeatedly with a trowel to give a hard, smooth finish. When this surface has set, keep it moist for several days, laying wet sand on it to a depth of one inch.

These directions will enable any farmer or stockman to put down a permanent walk or floor if common sense be used in doing these simple things. The most durable results may be insured by repeatedly working over and mixing the cement with other ingredients, while all are dry, then wetting slowly while still working and applying in place quickly, before particles begin to set.

These concrete walks are commonly called "cement walks." After some unpleasant experience we can advise that a less expensive concrete can be made of flashed coal-tar and sand, which resembles asphalt very closely, but its application is troublesome and annoying because of its sticky preperties. In any case where large, flat surfaces are to be laid with concrete, parallel guides of 2 x 4 or 2 x 6 scantling should be placed every three feet, and the mixture placed in these by belts to insure proper levels and make the work uniform in all its parts. The scantling used must be straight to permit "striking off" to a plane surface. Floors that are expected to receive water frequently, or that require many washings, must be laid with a fall of 1½ or 2 inches to every ten feet.

The tools and equipment required for laying any ordinary job of concrete are: A wooden mortar box or a smooth platform, a packing maul for firming foundation, hoes and shovels, a plasterer's trowel, a spirit level and a straight edge for striking off smooth surfaces.

Babbitt metal is an alloy of copper, tin and antimony. It is soft and nearly white, and is used as an anti-friction metal. Isaac Babbitt, of Boston, patented the alloy in 1839, and the original alloy contained 24 parts tin, 4 parts copper and 8 antimony. The following gives a tougher metal: Tin 96 parts, copper 4 and antimony 8 parts. Lead is also added in some cases on account of its cheapness. In small amounts it is not objectionable, but the Babbitt metal that is sold in the market ready mixed usually contains a considerably larger proportion of lead than its price would indicate. The alloy is usually melted and run, while fluid, directly into the bearings, a space from an eighth to a half inch thick being left for it between the box and the shaft that is to be supported.

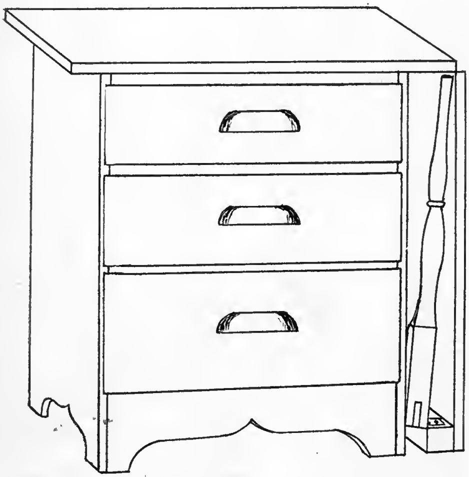
When the electrification of the railroads which run under ground in London is completed the traveller will be able to traverse 60 miles under ground by electric traction without running twice over the same piece of track.

A SEWING CABINET.

JOHN F. ADAMS.

The amateur cabinet maker should, whenever possible, lend his skill and labor to the making of furniture which will be serviceable to the gentler part of the family, thereby making easier and more agreeable the manifold duties incumbent upon them in most households. The sewing cabinet here described will be found of great convenience by those of our fair friends who have much sewing work to do, as it provides receptacles for the storage of the many articles needed in such work, as well as a large surface for marking and cutting out patterns.

The illustrations show the general construction of the cabinet. The folding end can be made without difficulty the legs being made from two stair banisters. The fronts of the drawers differ slightly from those described in previous articles, the edges of the front overlapping the frame and rounded off on the outer face.



For the top, including the part which drops down, there will be needed pieces which when glued up will measure 38½ x 19 x ¾ in. After gluing up, this is sawed into two pieces, the top being 25 in. long, and the drop 24½ in. The top projects 2 in. at the left and 3 in. at the right. The two sides are each 25 x 18¾ in. The bottom ends are sawed out on a band-saw to the scrolls shown. If a full size pattern be drawn and taken to the mill when the lumber is ordered, this sawing, as well as that on the piece at the bottom of the front, which is the same pattern, may be cut out at small expense, saving much time and labor.

The piece at the bottom of the front is 17½ x 5¾ in., the opening being 13½ in. long. This is attached to the sides by 1½ in. screws, countersinking the heads. A cross-piece 17½ x 3 in. is put across the back, attaching to side in the same way. Before putting in place, however, this latter piece should have a ¼ in. rabbet cut in the upper, outer edge to receive the backing, which is of ½ in. matched sheathing.

The runs for the lower drawer are strips 16½ x ¾ x ¾ in. After coating one surface liberally with glue, attach to the sides with three screws in each. Use care to see that the top edges are even with the tops of the division pieces between the drawers, which are 17¾ x 1 x ¾ in. These are nailed to the ends of the runs, and nails are also put through the sides. Use wire nails for this work. A similar piece is placed between the upper drawer and the top.

As previously mentioned, the fronts of the drawers lay the frame ½ in. all round. Much work may be saved in making them if the necessary rabbets are cut out at the mill when the lumber is obtained. The front of the lower drawer is 18 x 8, the middle one 18 x 5¼ and the upper one 18 x 14½. On the inner sides of the upper and lower edges of these fronts cut rabbets ½ in. deep and ¾ in. wide, allowing for the use of ½ in. stock for the sides of the drawers.

The sides of the drawers are 17 in. long and ½ in. less in width than the fronts. The front ends are placed in the rabbets at the ends of the front pieces, and securely nailed in place. The rear ends of the drawers are 19 in. long, and the same width as the sides. The bottoms of the drawers are fitted within the sides and securely nailed. The outer edges of the fronts are then quarter rounded with a plane smoothing off with sand paper.

A strip of wood ¾ x 1 in. is then nailed to the under side of the top, at the back, being set in ½ in. from the rear edges of the sides. To this strip, nail the top at the back, being set in ½ in. from the rear edges of the sides. To this strip, nail the top ends of the sheathing, which can now be put on.

The drop leaf can be greatly strengthened by means of cleats at the ends, which should be 1½ x ¾ in. First cut out rabbets on the under side of the board, and carefully fit the cleats, which should be both glued and screwed into place. At the lower, inner end a piece 17 x 1¼ in. is attached, to which the legs are hinged. This piece may be glued up from two piecs ¾ in. thick.

The legs are made from two stair banisters, which may be obtained of suitable pattern from any carpenter's shop. The top ends are cut off at the place most suitable to make the legs symetrical and 23 in. long.

In the square ends now remaining and forming the tops of the legs, cut mortises for a cross piece, which should be 17 x 2½ x ⅞ in. The tenons on this piece should be ½ in. thick leaving a ⅛ in. shoulder to give rigidity. Secure the joints with dowels and glue.

In attaching the legs to the piece at the bottom of the drop leaf, the joints of the hinges are placed ½ in. out from the piece, which serves to give the right height to the outer end of the leaf when raised. A hook and eye on the leg frame and cross piece will keep the legs in place when the leaf is up. The hinges at the upper end of the leaf are sunk into the wood the thickness of the hinges to prevent a wide crack when the leaf is down. The finish should be fairly dark, and if made of any light colored wood the stain should not be too thick, followed by a dark colored filler. This will give a uniform dark finish and yet bring out the grain. The coats of shellac varnish followed by a coat of varnish will give a durable wearing surface to which cloth will not stick after it is thoroughly dry.

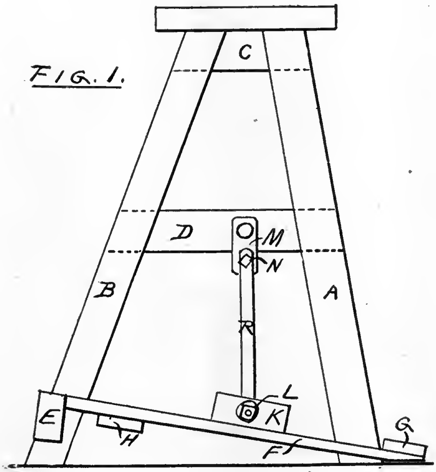
FOOT MOTION FOR BENCH LATHE.

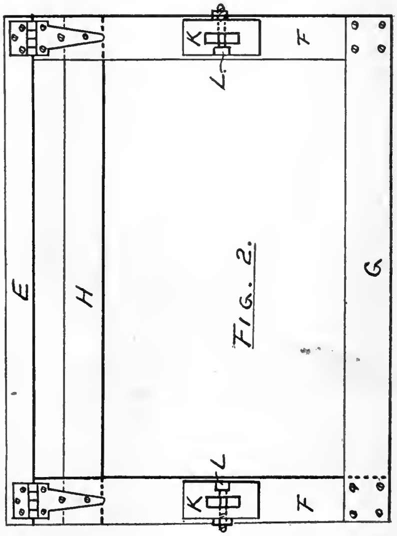
FREDERICK A. DRAPER.

The amateur who possesses a bench lathe does not always find it convenient to operate it by power and is obliged to either purchase or make a foot motion for driving it. Those who prefer to make one will find the design here described easily made with but little machine work, and this can be done by any blacksmith possessing a drill, or by a machinist, as it consists only of the drilling of a few holes and threading some of them. The dimensions are suitable for the Amateur Lathe.

the vertical line of the driving shape, at the top 4 in. and at the bottom 9 in. The two pieces, *B*, are 32 in. long, and distant from the shaft line, at the top 4 in. and the bottom 15 in. The object in throwing out the bottom of these pieces is to give a longer treadle arm, thus securing a shorter throw, in this case 8 inches.

The two pieces, *C*, at the top are 9½ in. long before cutting to the angles of the legs. They are mortised into the legs, care being used to get them to fit well, as poor fits will mean a wobbly frame. The pieces, *D*,





The wooden frame, shown in Fig. 1, is made of 2 x 3 in. spruce, and when planed on all sides will measure 1⅝ x 2⅝ in. The two pieces, *A*, are 30 in. long before the ends are cut to the angles to fit square on the floor, and to the top. The outer edges are distant from

are 16 in. long, also mortised to the legs with the upper edge 12½ in. from the top of *C*.

The legs, when framed up as above are 24½ in. apart, and as the piece, *E*, projects beyond them 3 in. at each end, this piece is 34 in. long. It is halved into the legs with the top edge 4¾ in. from the floor. Note that it is also at an angle with the pieces, *B*, which is to avoid cutting out more than is necessary to make a firm joint. This piece is attached to the legs, *B*, with large wood screws, countersinking the heads.

The treadle frame is shown in Fig. 2 and is made of selected spruce or oak, ⅞ in. thick. The former is the more desirable, making a lighter frame. The two pieces, *F*, are 24 in. long and 3 in. wide. The piece, *G* is 34 in. long and 3 in. wide. It should be firmly attached to the outer ends of the pieces, F, with several wood screws, countersinking the heads. The piece, *H*, is 34 x 2½ in. and fastened to the under sides of the pieces, *F*, with screws, the inner edge being spaced 1 in. from the ends of *F*.

Two pieces, *K*, of 2 x 3 spruce 5 in. long are fastened to the upper sides of the pieces, *F*, after cutting out holes for the treadle rods, *R*, Fig. 1. Long wood screws or bolts are used for fastening these pieces, as all the pull of the treadle comes upon them, and they should be well secured. Holes are bored through the centers of these pieces for the bolts, *L*, holding the treadle rod. These bolts are 3 x ½ in., square holes for the heads being cut on the inner sides of the blocks.

The treadle frame when finished is attached to the piece, *E*, by two heavy tee hinges, which should be carefully placed so they will work without binding. The top is a piece of spruce plank 12 in. wide and 36 in. long attached to the frame with strong screws.

The shaft is 31 in. long and 1 in. diameter. This can be obtained of any dealer in shafting and will need no machine work. At the ends are two arms, *M*, 4 in. long and 2 in. wide and ⅜ in. thick, made from bar iron or steel. A 1 in. hole is drilled at one end and a ⅜ in. hole at the other, the centers being 2 in. apart. The smaller hole is tapped for a 1 x ½ in. machine bolt, *N*. After fitting the arms to the shaft, drill ¼ in. holes and taper out with a taper reamer for a taper pin to key the arms to the shaft. Or a keyway may be cut with a cold chisel on the shaft, and a slot in the arm and a key fitted. Before finally fastening the arms in place, the drive wheel, *W*, is fitted to the shaft and also keyed in place.

The drive wheel is located just inside the left legs. Holes must also be bored in the cross pieces, *D*, to receive the shaft. These holes should be large enough to receive a bushing of brass or drawn steel tubing with a drive fit, the size of the hole depending on the thickness of tubing used. The drive wheel can be made of two thicknesses of 1 in. board, fastened together with glue and screws, and with the grain of each layer crossed, or can be of iron, if one can be purchased with the steps spaced correctly for the lathe.

The treadle rods, *R*, are made of bar iron or steel, and are 12½ in. long, 1¼ in. wide and ⅜ in. thick. Holes are bored at each end for the studs, *N*, and bolts, L, the centers being 11 in. apart. The holes should have easy fits. The top hole can also be made 1½ in. lon by drilling two more holes below the first one and filing out between. This will allow the treadle to lift should the foot be accidentally placed under it, and thus save being squeezed, as the treadle almost touches the floor. Anyone who has had a toe nipped with a treadle in this way will readily appreciate the value of having these slots. No mention has been made of oil holes as, if the lathe is used but little, oiling can be done from the sides of the bearings. It is advisable, however, to drill holes down through the pieces, *D*, and the bearings, so that the shaft can be oiled.

The reader is also cautioned to see that the drive wheel is fitted to the shaft with the steps the right way to receive the belt. As the weight of the treadle will cause the drive wheel to come to rest with the treadle down, a counter weight can be riveted to the wheel to balance the treadle and prevent this back motion, which on some work might prove bothersome.

DURABLE WHITEWASH.

The complete success is well known of the formula for whitewash adopted by the United States Government as a coating for lighthouses, and for its effectual prevention of any moisture striking through the walls. It is simply the mixing with fresh water, in the most thorough manner, of three parts Rosendale cement and one part of fine clean sand, thus giving a gray or granite color, dark or light according to the color of the cement; if a very light color is desired, lime is used with the cement and sand; if brick color is sought, enough Venetian red is added to the original mixture to insure that result. Care is exercised to have the various ingredients well mixed together—also, in applying the wash, to have the wall wet with clean, fresh water, followed immediately with the cement wash—this method preventing the bricks from absorbing the water from the wash too rapidly, and it also gives time for the cement to be properly set. The mixture is made as thick as can conveniently be applied with a whitewash brush in the usual manner, and the wash is well stirred during the process of its application. It is stated, however, that though this mixture is so admirably suited for the purpose in question, it cannot be used to advantage over paint or whitewash.—"Kuhlow's."

The rolling stone may gather no moss, but it knows a heap more than the stone that remains eternally in one place; a thought that occurs to the human traveller when he realizes the broadening, educating and uplifting influence of travel upon him. The best substitute for travel is the careful reading of well-selected books and periodicals; but both reading and travel are necessary to an intelligent understanding of the world and its people.

FACTS CONCERNING PATENTS.

A Paper read by Mr. F. W. Winter befo.e the Mechanical Section of the Engineers Society of Western Pennsylvania.

Engineers should have a general knowledge as to what rights they have in inventions made by themselves, or by those associated with them, the manner of securing and enforcing those rights and, in general, to be in possession of such information on the subject as to be able to act advisedly in regard thereto.

Basis of our patent system. The patent statutes of the United States are based upon Article 1, Section 8, of the Constitution, which provides that Congress shall have the power to promote the progress of science and useful arts by securing for limited times to inventors the exclusive right to their respective discoveries.

This constitutional provision gives the underlying principle of our patent statutes, and shows that the reward of the inventor is not the primary object aimed at. But it is a necessary incident. The framers of the Constitution perceived that the progress of science and the useful arts could best be promoted by furnishing an incentive to make improvements, and that the best incentive is some personal reward or advantage to the inventor. Accordingly an inventor for a certain period is given an exclusive right to his inventions and discoveries, that is, a monopoly. As a consideration he is required to describe and illustrate the invention in his patent specification and drawings so fully and clearly that a person skilled in the industry to which the invention relates can make and use the invention; to the end that after the monopoly has expired the public will be able to use and derive benefit therefrom.

Therefore an inventor applying for a patent must disclose his entire invention, the principle thereof, and the best manner of applying the same. He cannot withhold any part thereof; otherwise the patent will be void. If he wishes to keep the whole or any part of his invention secret, the patent statutes give him no aid. This statement is ventured because the writer has been asked to secure patents for inventions which the inventors did not care to disclose fully even to their attorney. Clearly all such efforts are futile.

What is patentable? The statutes provide for the grant of patents for new or useful arts, machines, manufactures, compositions of matter, improvements and designs.

The term "art" covers what are ordinarily known as methods or processes where the improvement consists in the manner or mode of accomplishing the result, as distinguished from the mechanical appliances necessary for this purpose.

The term "machine" is self-explanatory.

The term "composition of matter" covers all mixtures of several ingredients whether chemical combinations or mechanical mixtures. Soaps, powders, paints, etc., are examples of well-known compositions of matter.

A "manufacture," in the meaning of the patent statutes, is anything made by the hand of man and which is subject to manufacture and sale. This term is a broad and elastic one, and the interpretation given to it by the courts bring within it the inventions which cannot properly be classified under the other heads.

The term "improvement" in the statutes is largely superfluous, for in a sense every improved device is a new device; or, vice versa, most new devices are merely improvements over prior devices. In the history of our patent system there have been but few generically new devices or processes.

The inventor need not concern himself under which one of the statutory classes his invention belongs. Neither do the patent offices and the courts concern themselves with this question, it being sufficient that the invention is new, and that it marks an advance in science and the useful arts. The statutory classes of mechanical inventions will be stretched to cover it.

The term "design" in the patent statutes has a different meaning from what it has in engineering, where it is often used to mean a new plan or arrangement of mechanical parts for getting new or improved functions. For instance, a new design of motor is a new motor.

All such matters in the eye of the patent statutes are subjects for mechanical and not for design patents. The term "design" in the statutes is limited to matters of ornament or configuration appealing to the æsthetic sense, and not to utility; such as a new design for spoons, jewelry, vases and the like.

Utility. An improvement to be patentable must be useful. This does not mean that the device must be more efficient or economical than prior devices of the same kind. The degree of utility is not inquired into by the patent office.

If a device is incapable of producing any results whatsoever, it is inoperative and not patentable. So, too, if the device is injurious to the morals, health or good order of society, it is not useful within the meaning of the patent statutes. Upon this ground the patent office refuses to grant, and the courts refuse to sustain patents for deleterious compositions and compounds of food products and the like, and for devices which can be used only for immoral or unlawful purposes. The more completely such an invention could perform its functions the more objectionable it would be for want of utility.

If, however, a device is capable of a good result it is patentable, even though it may be used for some un-

unlawful or immoral purpose. The evil in such case is not inherent in the invention, but it is a fault of the user, for which the latter, and not the inventor, is punishable.

Subject to the exception in regard to the utility of an invention, it is a general rule that all changes or or improvements, whether mechanical electrical, chemical, structural, or otherwise, in a method or process, tool, machine, appliance, device, manufactured article or composition of matter, in all arts are patentable providing they are new and are the result of invention. The statutory classes of invention have been given a sufficiently broad and elastic interpretation to cover the whole range of human activities and industries.

Invention. As to what constitutes invention no general rule can be laid down. There are many improvements which are the natural result of the advancement of an industry and which are suggested by many persons whenever the occasion demands. There also are many changes which are merely the expected skill of an ordinary mechanic working in those lines. All such changes are not "inventions" within the meaning of the patent statutes and are not patentable.

In general, invention may be said to consist in bringing forth that which theretofore was hidden to persons skilled in that particular art. The amount of change necessary to constitute invention may be very small, or may be required to be quite radical, depending upon various factors, but principally upon the advantages and results following from the change. If the benefits are very great, and the public and manufacturers are anxious to adopt the improvement as soon as shown, it will be held to show that even a very slight change was the doing of something which before was hidden, and hence to be an invention. On the other hand, where there is no marked resulting advantage the courts require a greater degree of change in order to find the presence of invention.

Novelty. The question of the newness or novelty of an invention is purely one of fact and one upon which no opinion can be expressed without a detailed knowledge or examination of the art to which the invention relates. Under the statute, an invention is not new if it was:

1. Patented in this or any foreign country before the applicant's invention or discovery thereof, or more than two years prior to the application for patent.
2. Described in a printed publication in this or any foreign country prior to such invention or discovery, or more than two years prior to the application.
3. Known or used in this country prior to such ininvention or discovery, or
4. In public use or on sale in this country for more than two years prior to the discovery.

It follows that knowledge or use of an invention in a foreign country does not affect a patent granted in this country, unless such invention was either patented or described in some printed publication.

Novelty can be determined only by an examination of all prior patents, publications and uses in the same and analogous classes of inventions. This, to be thorough, covers a very wide range.

Term of patent. All mechanical patents are granted for the uniform term of 17 years. This is not now affected by the existence of any prior shorter term foreign patents for the same invention, the only requirement being that if a patent is first taken out in a foreign country the application in this country must be filed within 12 months after the filing of the foreign application. The term of 17 years can be extended only by a special act of Congress, and this has not been done in any case, and is not likely to be done.

In case there is a material error in the patent, or if it is inoperative or invalid by reason of a defective or insufficient specification or claim, it may be reissued, but such reissue patent will continue in force only for the unexpired term of the original patent.

Design patents are granted for terms of 3½, 7 or 14 years, at the option of the applicant. He must make his selection of the term at the time he files his application. It cannot be made thereafter.

The right granted by patent. All patents give an exclusive right during the term of the patent to (1) make, (2) use and (3) sell the invention covered thereby. Infringement, therefore, may occur either by making, or by using, or by selling the device. Where one party manufactures a patented device, another party sells it, and a third party uses it, they are each liable for the entire enfringement, and the patentee can choose which of the three he will use, thus being able to respond in damages.

Patent rights extend to all of the United States and territories, but not beyond the same. Vice versa, patents granted in foreign countries give no protection in this country. Therefore it is no aid to the protection in this country to also take out patents in foreign countries. The seller or user in this country of an article manufactured abroad will be liable for infringement of any United States patents covering said article.

A patent gives an exclusive right only for that which is distinctly claimed. If no sufficient claim is made, the courts will give no relief, even if the invention is exceedingly valuable. The utmost care should therefore be exercised in drawing the claims of a patent. It is possible to so restrict the claims for a very valuable invention that it will be easy for others to devise forms of apparatus which accomplish the same result but do not infringe the patent. The claims should cover all possible mechanical embodiments of the principle of the invention, so that others, even though they originate new mechanical constructions or combinations, cannot avoid infringement.

Patent claims usually are drawn to combinations of the various elements which constitute the new device. Infringement does not exist unless all elements of the claims are employed by the defendant. In other words, the combination of a claim must be used in its entirety or else infringement does not exist. It is therefore essential that the claim, or at least the broad claim, should contain no element of limitation which is not absolutely essential to the principle of the invention. Brevity in patent claims is desirable.

The monopoly does not begin until the patent has actually issued. While the application is still pending in the Patent Office, the inventor has no right to sue others for infringement.

CONCLUDED IN THE OCTOBER NUMBER.

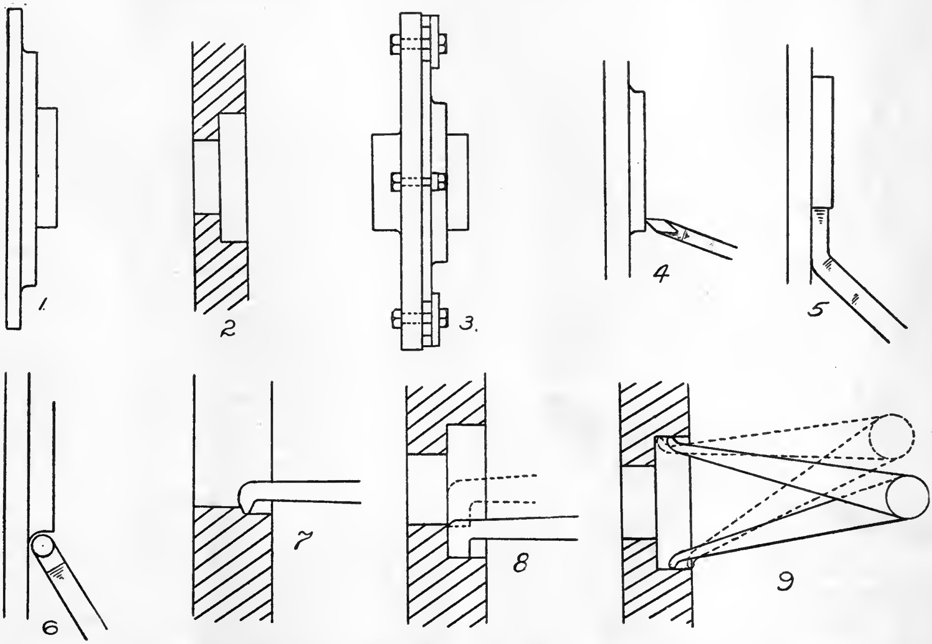
THE METAL WORKING LATHE AND ITS USES.

ROBERT GIBSON GRISWOLD.

V. Facing and Boring.

For truing up flat surfaces, the piece to be operated upon is strapped to the face plate either directly in contact therewith or, if it has one finished surface, it is laid on two parallel strips which insure this surface being exactly parallel with the surface of the face plate.

But before going further it is well to know whether the face plate is true; that is, whether it is a true plane, and whether the tool travels across the carriage in a line exactly at right angles with the center line of the lathe. If it does not it will be an extremely difficult operation to true up the face plate, or to make a good job of the work strapped to it. But assuming that the face plate is reasonably true, we will consider the steps in facing a bass on a rough, flat casting, like that shown in Fig. 1, and boring a hole through it' having a shoulder about half way through, as shown in section in Fig. 2.



The operation of strapping the the pieces to the face plate is more readily performed if the plate is removed from the spindle and laid on the bench. Strapping work to the plate while in the lathe is a laborious operation excepting when the piece can be held against it by the tail center.

After running a file over the back to make the surface reasonably flat and free from small projections, it is placed against the face plate with a piece of paper between. The object of this paper is to prevent the shifting of the piece when the tool takes a cut. It affords greater friction between the work and the plate. Three or four clamps are now set up against the piece, these clamps being simple straps of say ½ x 1¼ in. flat iron with a hole through them for the bolt, as shewn in Fig. 3. These bolts are first set up so as to clamp the piece firmly against the plate, but not so that it will not move when struck on the edge with a hammer. The piece is now ready to be centered.

When placing it on the plate it is centered as nearly as possible by eye, but the final adjustments are made in the lathe where the piece can be rapidly revolved. After screwing the face plate home the work is set in motion either by putting the belt on, running by power at a slow speed, and a piece of chalk is held in the hand and up against the edge of the work. The hand or arm rests against some solid part of the lathe, generally the tool part or carriage, and the chalk is just allowed to touch the high spots. When the work is stopped it will be found to bear chalk marks on the "high side" or on the side furthest from the center. It is quite obvious, therefore, that the piece should be moved slightly to the opposite side, and this is done by gently tapping it with a hammer. The chalking process is again repeated and the work moved until it is truly centered. Then the clamps are set down hard, care being exercised to see that the work is not moved during this operation.

The question as to whether the tool should be fed in towards or out from the center of the work is hard to decide, as this question, too, has its opponents. It is frequently decided by the character of the work itself, as the position of a shoulder on the face will determine in which direction the tool must be fed.

But in this case we will feed the tool in toward the center. A diamond point tool is the proper one to use first, setting it on an angle, as shown, and grinding the point so that it has a left-hand top rake. A point to be remembered in all work of this kind where castings are to be machined, is that the surface of a casting is very hard and that this "skin" or scale is very apt to take the edge off a tool even at a low cutting speed. Sometimes it seems almost impossible to make the tool penetrate below this skin, in which event it is well to score the edge about to be cut with a cold chisel. This breaks the surface and allows the tool to get under the scale.

When the roughing cuts have reduced the piece to within a few hundredths of an inch of finished dimensions, the side tool is put in and the finishing cuts are made with a sharp corner. A right-hand offset cornering tool must be used, as shown in Fig. 5. If a round fillet is required, a round-nose tool is used, as in Fig. 6.

Supposing the piece has now been finished in size, boring the hole next commands our attention. A centering tool is now placed in the post and a center bored in the face of the piece just deep enough to start the drill. A drill slightly smaller than the finished size of the hole is then set in the cup just bored, and the small center hole in the opposite tapered or stock end of the drill is placed on the drill to prevent its turning, the tail of the dog resting against the tool carriage.

When the hole has been drilled completely through (and right here is one reason for placing the work on parallel strips. If the hole to be bored is smaller than the topmost hole in the spindle, the drill and tool will not touch it, but if larger, the work must be mounted on strips that will allow the points of the drill and the tool passing completely through without touching the face plate) the drill is removed and the boring tool placed in the post. It is fed into the work with a small cut and fine feed, the tool being gradually fed out until the hole is finished exactly to size. The boring tool always cuts on the front edge and should be so ground as to present only a small cutting surface; the tool, owing to its shape, is not very stiff and if a broad cutting edge is used considerable chattering will surely occur.

But this hole is shown provided with a shoulder about half-way in. The first hole bored is the size of the smaller one. The tool is then fed out so as to enlarge the hole, and this cut is run in until until say 1-32 in. of finished depth and a few hundredths of an inch of finished diameter. Then the point of the tool, or better still, another tool kept especially for such work, is ground with a square corner and the finishing taken with this. Make the bottom cut by feeding the tool towards you rather than towards the face-plate, as the latter method presents a broad cutting surface, while the former takes only a small cut on the advancing edge of the tool.

This finishes this particular piece. In calipering the diameter of the hole, do not allow the calipers to drop below center, but measure the hole with the calipers standing as nearly perpendicular to the surface of the work as possible, as shown in full lines, Fig. 9, and not as shown in dotted lines.

From data recently published in connection with the present tendency in American colleges towards engineering as compared with arts it is found that, taking 18 of the leading institutions which offer courses in arts, sciences and engineering, the ratio of increase during the past four years has been but 15 per cent, even though these courses include practically all of the women students. As against this increase is set that for engineering, which is no less than 102 per cent. The figures include only regular students and seem to form one of the signs of the times.

GAS ENGINE ECONOMY.

The question of economy in the consumption of fuel is of great importance to the purchasers of gas or gasoline engines, and incidentally to the manufacturers of theso engines also. For, all things being equal, the firm that builds the most economical gas engine in the way of fuel consumption, or, in other words, that gives the best results for dollars expended, will get the largest amount of business, and as a corollary thereto, the greatest number of dollars. The question now arises, How shall we get the greatest amount of power out of a given sized engine with a given amount of fuel?

After having spent several years in studying this question and making experiments, and during that time having also built a large number of gas and gasoline engines, the writer of this article is firmly convinced that the position of the igniter in its relation to the charge of gas in the cylinder has far more to do with the economy of gas engines than is generally understood. It is a well-known fact that the charge of gas and air in the cylinder of an engine in operation is more or less stratified; that is, the air and gas are not thoroughly mixed, but portions of the charge are rich and others poor in gas. Someone might ask what difference this makes. When the explosion occurs the charge is entirely consumed and the piston receives its impulse from the expanding gases. The answer to this is: "All the difference between high and low economy in the consumption of fuel." If the charge is ignited at a point where it is rich in gas, the explosion is very sharp and strong and gives an injurious shock to the engine. The exhaust also is liable to be smoky, resulting in a loss of power. If the charge is ignited at a point where it is poor in gas, the explosion is too weak, resulting also in the loss of power, to overcome which the engine is fed more gas or gasoline with a consequent loss in economy. This argument is based on the assumption that the engine was at first fed the proper amount of gas and air to give the most efficient service. Now there are one or more parts of the indrawn charge where the air and gas are in exactly the right proportions. If the igniter can be brought in contact with the charge at this part, the result is the greatest economy and efficiency.

It has been said by a prominent writer on gas engines that in designing a gas engine we can never be sure beforehand what the results will be. He says that an engine of given dimensions should develop a certain horse power, but when the engine is built and put in operation the result may be very disappointing. In other words, the whole science of gas engine building, according to the writer, is a mere matter of guesswork. Now I contend that this is wrong,—the science of gas engine building should be as exact as is the science of steam engine building. Imagine a man of today experimenting on steam engines in order to find out what size is required to run a certain plant! It is not for one instant claimed that the builders of gas engines have not advanced scientifically and intelligently in the working of gas engines, nor do I claim that the placing of the igniter in the proper position on the cylinder would put this industry among the exact sciences, but I do claim that it would make a great advance toward that end.

When a change of gas and air enters the cylinder, it is more or less thoroughly mixed and position of the inlet valve and also by the shape of the cored passages so that the richest part of the charge will vary more or less in position in the same type of engine, giving more or less economy, unless the passages are machined of an exact size or very carefully molded. Competition is too keen nowadays for manufacturers to enter carelessly into these details. The chief trouble however, with most gas engine ignition does not lie in any inaccuracy in the inlet passages, but in the fact that the igniter is put in "any old place." As long as the charge ignites, some manufacturers—and their name is legion—think the engine is all right, not knowing that it is on the proper placing of the igniter that the engine mainly depends for its efficiency and economy. It is this false policy that has brought the gas engine rather into disrepute and lessened its sale. The writer is convinced that if this matter were properly attended to, and the scientific placing of the igniter more thoroughly understood, it would result in a greatly increased sale of gas engines. Some makers claim that the best point of ignition is right in the center of the charge, so as to ignite it in its entirety as rapidly as possible, but, as we said before, this depends upon the richness of the charge at that point. Moreover, the same principle should be applied to gas engines as is applied to guns. A small engine, like an army rifle, should have a sharper and more sudden explosion, a cannon, should have a slower explosion, corresponding to the slow-burning powder used in large guns. This makes them run smoothly and without shock.

The explosion of the cylinder is of an exceedingly high thermal efficiency, but it lasts only a short time and drops quickly to a very low point. In small engines of high speed a large amount of firing lead should be given, so as to take advantage of this high efficiency at the proper moment and not explosion and loss in heat units is also very sudden, and unless advantage is taken of these facts there is a great loss of power. As the engine increases in size the explosion and combustion of the charge must be slower, and the point of highest thermal efficiency must receive a sudden and severe shock that is very injurious to the working parts. If it is sought to overcome this by giving the engine less lead, the result will be loss of power. Now some manufacturers go ahead blindly and put the igniter in the same relative position on all their engines, irrespective of design or size, with the result that a few run over and a large number run under the expected horse power.

Let me here give an experience that came under my personal notice. A certain shop in Canada had been building gas engines designed by an expert. The igniter was directly on the top of the cylinder, since the gasoline vapor, being heavier than air, would not rise to the igniter. It was therefore decided to place the igniter as low down on the side of the cylinder as possible, which as can readily be seen, was an even worse position than the former, for I found by actual test that the consumption of gas was greatly increased. Several of these engines with the low igniter were built and sent out and shortly after returned to the shop because they used too much gas.

Although the igniter in its new position was far closer to the inlet valve, yet the charge passed by the igniter and became stratified in another part of the cylinder, leaving the part around the igniter very poor in gas. To overcome this, it was decided to place a hood inside the head, over the inlet valve, in order to deflect the charge against the igniter. What was the result? The charge at the igniter was so rich in gas that when the explosion occurred it was so early and severe that the shock in the engine could be heard quite a distance away, and would soon have made the engine fit only for the scrap pile. The only thing to do in this case was to give very little lead to the engine with a consequent loss of power. At my earnest solicitation the igniter was raised up a little and we had a test of the two styles. Both engines were of the 8-in. bore and 16-in. stroke. The engine with the low down igniter was running a chopper and all that could be got out of it was 15 bags of chop an hour with the engine loaded to its limit. We removed that cylinder and replaced it with one that had the igniter raised.

At the first test with the engine we chopped 34 bags of chop in one hour, and at a second test we chopped 32 bags in one hour. In this latter trial the engine was not loaded to its limit, so could have done even better, and this was accomplished with nearly 25 per cent less gas than the other style of cylinder required to chop 15 bags. I also took a brake test of the engine with the igniter raised, and it gave 24.4 h. p. Not a bad showing for an engine of that size.

If it were possible to build a four-cycle engine in which the charge could be thoroughly mixed before ignition, the question of the position of the igniter would not be of nearly so much importance. But engines are now built to run at two, three, or four hundred revolutions per minute, and competition being so keen, the question of cheapness of manufacture is of vital importance. Attempts more or less successful—generally less—have been made to overcome the difficulty, but most manufacturers and purchasers of gas engines want them as simple as can be made and with as few clap-traps as possible. This being the case, the writer is convinced that the only way to get the maximum amount of power with the minimum consumption of fuel is to place the igniter on the engine according to the size of the engine and the design of the inlet valve and passages, so that the charge that comes in contact with the igniter will be of the proper mixture for each particular size and design. When this is done a gasoline engine will run as smoothly and quietly as a steam engine, without the slightest shock and with the added advantage that there will be a considerable increase in power, and a greatly increased economy in the consumption of fuel over present makes of gasoline engines.—"Gas Power."

FROST ON SHOW WINDOWS.

During the winter months many shopkeepers experience more or less difficulty in keeping their windows free from the ice that in low temperature tends to defeat the object of the display. No doubt all of the devices for keeping glass clear of ice, published from time to time in the journals, have received a fair test with varying satisfaction. A writer in one of the foreign drug journals, apparently a druggist who has experienced the rigors of high latitudes, insists that none of the ordinary schemes are of much use, and that the only certain remedy for the opaque deposit of solid water is a double layer of glass with a sufficient air-space between. He states that the applications of glycerine, alcohol and other solutions are of no avail in extreme weather, and that, in any case, they must be so frequently renewed that they become extremely troublesome.

In the northern portions of Russia, where zero weather is sufficiently common, experience has taught the owners of show windows that the only effective protection is a three-inch air space between two panes of glass. The outer sash is rendered as nearly tight as possible by calking the chinks and pasting strips of paper over the crevices. The glass is then carefully cleaned and dried on a clear, mild day, and a second sash fitted with the same care to prevent all circulation of air, is inserted about 3 inches within the first. The double panes are said to obstruct the view very little. The physical cause of the deposit of moisture and ice upon windows is the difference in temperature between the surface of the glass and the air bearing a relatively high proportion of moisture, which comes in contact with it.—"Scientific American."

The famous Liberty Bell was cast in England and was brought from there in 1752. While being taken from the ship it was injured, spoiling its tone, and was recast in Philadelphia in 1753. It was broken in 1835 and has remained in that condition.

A TAILLESS OR MALAY KITE.

CHARLES B. GILMORE.

Kite flying has, within recent years, progressed beyond the field of affording amusement for boys and is now frequently used for both scientific and useful purposes. As a means of exploring the lower air currents, and for photographic purposes, the box kite has a well recognized place. The Malay, or tailesss kite is also a useful form, and is frequently used tandem for reaching high altitudes, for which purpose it is well adapted. To attain success in flying this kind of kite requires that it be accurately proportioned, well constructed, as well as designed for the particular strength of wind in which it is to be used.

here to good advantage. Shallow grooves are then cut in the ends of *AB* to receive strong, light cord (fish line is excellent) connecting the ends of both strips, and tied to prevent breaking away under wind pressure. This cord should not be very tightly stretched, as a slight bagginess in the covering along the cord is an advantage. Care should be taken to have each angle exactly like the one opposite to it.

A covering of strong, thin paper or silk is next put over the front or wind side of the frame, the edges being lapped over for about one inch and pasted or stitched, as the case may be. The kite is now tested by balancing on the point of the finger to find the center of gravity, which should lie at the point *F*, slightly over one-third the distance from *A* to *B*. If materially

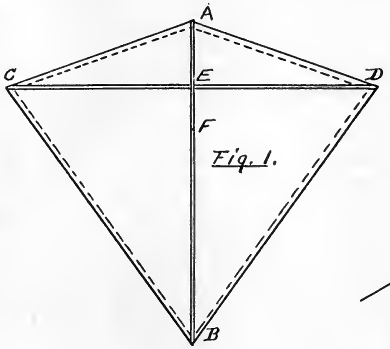


Fig. 1.

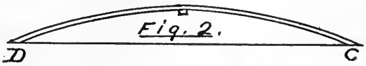


Fig. 2.

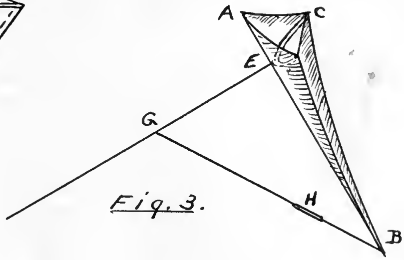


Fig. 3.

Dimensions will be given for two sizes, so that anyone caring to build one can select the size best adapted to his needs, but several trials may be necessary before satisfactory operations will be secured. Even then the kite may have a tendency to be erratic until high enough to reach steady winds; the lower currents ordinarily being rather gusty.

For a kite five feet high, the frame, as shown in Fig. 1, is as follows: The piece *AB* is 5 feet long and *CD* 5 ft 8 in. long, each made from spruce strips ½ x ⅝ in. See that these strips are perfectly straight grain and of uniform thickness. The piece *AB* is sometimes made of bamboo, which is both light and strong. If made of spruce, the strips may be planed down from the joining point *E* to a thickness of ¼ in. at the ends, which reduces the weight without loss of strength.

The piece *CD* must be worked until it will bend backwards with a uniform curve, as shown in Fig. 2, so that the curve will be about one-tenth of the length of the piece, or 6¾ in. A wire guitar or mandolin string can be used as a bowstring, considerable strength being required. Wire has the advantage over cord of not stretching should it rain while out and no shelter be at hand.

The bow being completed, it is lashed to the piece *A B* so that the space *AE* will be about 18 per cent of the length of *AB*, or 10¾ in. Piano wire can also be used

different from this point a new frame should be made.

The bridle is next to be added and some experimental flying may be necessary before this has been satisfactorily adjusted. The main flying string is attached to the joint of the cross-pieces and should, in flying, form a right angle with the piece, *AB*. The cord *GB*, Fig. 3, should be about 9-10th of the length of *AB*, but the knot may have to be moved towards or away from the kite an inch or two to work right. If the kite whirls around when rising, the knot is too near the kite and needs moving out a little.

Sidewise flying is corrected by adding a slight weight to the end of the strip *CD*, on the side opposite to that to which it flies. Tea lead from tea chests is excellent for this purpose, as but a very little weight is necessary to correct this trouble.

The strain of extra heavy gusts of wind may be thrown off if the cord GB has a strong rubber band inserted at the point *H*, Fig. 3. This will stretch a little, spilling the wind and easing the pressure. A parachute messenger device will be described in a future chapter.

The dimensions for a 3-foot kite are:—The piece *AB*, 3 ft.; *CD*, 3ft. 5 in.; the point *E* is 6½ in. from the top, and the bow has a bend of 4 in. The length of the cord *GB* is 3 ft. 1 in. The smaller size will be more difficult to fly than the larger one.

AMATEUR WORK.

DRAPER PUBLISHING CO., Publishers,

88 Broad St., Room 522, Boston, Mass.

A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month for the benefit and instruction of the amateur worker.

Subscription rates for the United States, Canada, Mexico, Cuba, Porto Rico, $1.00 per year.

Single copies of back numbers, 10 cents each.

TO ADVERTISERS.

New advertisments, or changes, intended for a particular ssue, must be received at this office on or before the 10th. of the previous month.

Entered at the Post Office, Boston, as second class mail matter, Jan. 14, 1902.

SEPTEMBER, 1905.

Mention has frequently been made in these columns of various phases of industrial education, with a view to emphasizing its importance to the individual worker as well as to the employer. It is now pretty generally admitted by those conversant with the subject that the apprentice system has seen its best days, and can no longer furnish a sufficient number of skilled mechanics to supply the demand.

And the causes operating to produce this result are not wholly or even in large measure due to the labor unions, nor yet are the large manufacturers at fault as a class. Some of the labor unions do have very oppressive regulations, which not only prevent large numbers of willing young men from obtaining a proper training at some trade, but a much larger number of manufacturers offer no opportunity for apprentices. In the latter case the reason will generally be found in the limited or special line of tools manufactured on special machinery which affords no facilities for the proper training of a mechanic.

What shall be done? For mechanics we must have, and those shops with apprentice systems are training no more than will meet their own requirements. A comprehensive system of trade schools would seem to be the answer. With such schools the pupil would make an early choice of the future vocation, and thereafter the whole course of training would be so designed as to produce graduates of sufficient skill and education so that they could, after a short term of shopwork, become efficient workmen.

It is too much to expect that such schools shall be conducted entirely by the State, and that instruction shall be free, as the cost of equipment would be quite beyond the means of most cities and towns. As any such scheme of instruction, to be adequate, must be general throughout the country, some plan of co-operation between manufacturers and educational authorities must be adopted, and herein lies a grand opportunity for the various associations of manufacturers to investigate and report upon the ways to be adopted to carry it out. Only in some such way can the means be provided for giving young men suitable academic instruction and at the same time a proper training in a craft or trade.

The addition of a number of new premiums to the premium list has made it advisable to delay its publication for another month. It will contain many useful tools which subscribers may easily obtain by a little work in making this magazine known to friends.

We are not much given to tooting our own trumpet, but we think we are fully warranted in stating that each volume contains information of value to even the general reader to make it worth much more than the moderate sum required for a year's subscription. A single suggestion may be of much practical value, and the means of securing large financial returns. No one interested in the subjects treated can afford to be without it.

A CHEAP NINE=INCH REFLECTOR.

M. A. AINSLEY.

IV. Figuring a Parabolic Speculum.

So much has been written on the subject of figuring a parabolic speculum, and so well has the matter been explained, that it may seem rather a waste of space for me to try and repeat what has been so often said before; but as I said in my first letter, I am writing for beginners, and I will ask the experts to bear with me if I tell them things they already know much better than I do.

Before beginning the practical figuring of a mirror, it is very necessary to have a clear idea of the effect of various curves upon the image formed by the mirror, and a little trouble taken in mastering the theory will render the practice much easier.

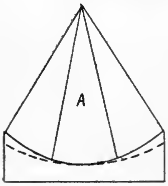


FIG. 1.

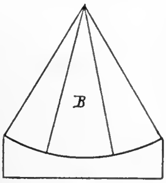


FIG. 2.

Speaking generally, the curve produced by polishing the fine-ground mirror (and I use the word "curve" as practically signifying the same thing as "surface" in this connection) falls into classes, which I shall call A, B, and C.

In class A, the curvature is greatest at the edge, and decreases regularly to the center of the mirror, where the curve is flattest. This is known as the "oblate spheroid", Fig. 1.

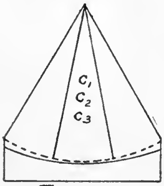


FIG. 3.

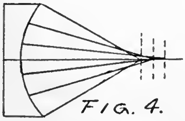


FIG. 4.

Class B consists of the sphere, in which, of course the curvature is the same all over, Fig. 2.

Class C contains the ellipse, parabola and hyperbola —in all of which the curvature is greatest at the center and least at the edge. I shall call these C_1, C_2, and C_3. Fig. 3.

Now let us consider the action of these curves upon a pencil of parallel rays, such as we get from a star.

The effect of classes A and B is to bring the rays falling upon the outside zone of the mirror to a focus of the central rays. This is also the case C_1, Fig 4.

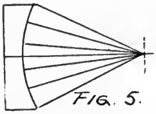


FIG. 5.

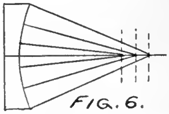


FIG. 6.

C_2 brings all the rays to the same focal point. This is what we want: Fig. 5. C_2 brings the outside rays to a focus further from the mirror than that of the inside rays, the effect being the exact opposite of that of A, B and C_1, Fig 6.

Now the only way, practically speaking, of obtaining a pencil of parallel rays is to utilize the rays from a star; and if we were confined to testing the mirror in the telescope on a star, a good deal of time would be lost waiting for a suitable occasion; so it is necessary to find some test which can always be applied. Before passing on, however, it is well to say something as to the appearance of the image of a star, in the telescope, as given by the various classes of surface.

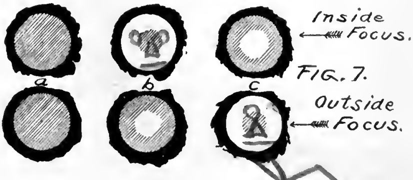


FIG. 7.

In the case of C_2 (the parabola), if the image is focussed as carefully as possible, and the eyepiece is then pushed in or pulled out, the image expands into a circular patch of light which is uniformly bright, and presents the same appearance inside and outside the focus, Fig. 7*a*.

In the case of A, B and C, the image inside the focus will have a dark center, while outside the center will be brighter than the rest of the circle, Fig. 7*b*. C_3, the hyperbola, gives exactly the opposite effect, the patch of light having a bright center inside the focus, and a dark center outside, Fig. 7*c*. It will thus be seen that it is possible to judge of the correctness of the curve of a mirror by actual testing a star in a telescope; but, as I said, the speculum worker does not, as a rule, care to wait a fortnight for the chance of getting a view of a star, as is sometimes necessary.

The practical method adopted is to make use of an artificial star, formed by a pinhole in a plate of metal, and placed at a curvature of the mirror. Being at the center of the curvature, the image of the pinhole will coincide with the pinhole itself; so it is necessary to move the pinhole a little to one side in order to view the image. This does not practically affect the results except with mirrors of abnormally short focal length.

The action of the various classes of curve, however, is somewhat different from the former case, where the star was at an infinite distance, and the incident rays of light consequently parallel. In the present case they are divergent from the center of curvature, and the difference between the condition of the two cases must be carefully noted.

Upon the new conditions, class A brings the outer rays to a focus nearer to the mirror than the inner, Fig. 4.

Class B brings all the rays to the same focus, Fig. 5.

Classes C_1, C_2, C_3, all bring the outer rays to a focus further from the mirror than the central rays, Fig. 6.

Again, if the image be examined with an eyepiece, as in a telescope, class A gives a bright center outside and a dark center inside the focus. Fig. 7*b*.

Class B, gives the same appearance inside and outside. Fig. 7*a*.

And class C_1, C^2, C^3, gives a dark center outside and a bright inside the focus, as in Fig. 7*c*.

It will thus be seen that, viewed with the eyepiece, C_1, C_2, C_3, gives the same appearance, differing only in degree, and it thus becomes necessary to have some means of determining with certainty when the parabola C_2 is obtained.

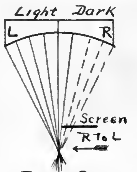


FIG. 8.

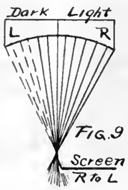


FIG. 9

If the eye be brought close up to the image of the pinhole so as to receive the whole pencil of rays reflected by the mirror, the whole mirror will be seen illuminated, and if a screen of metal be brought across the pencil of rays in the neighborhood of the image of the pinhole, it will cut off the light and apparently darken the surface of the mirrors seen by the eye. Its action, however, will be different, according as it is between the mirror and the image or beyond it.

Suppose the screen is always moved across from to left; then if it is within the focus, *i. e.*, nearer to the mirror than the image of the pinhole, it will be seen from Fig. 8 that it will darken the right-hand side of the mirror first; if it is exactly at the focus, the mirror being supposed spherical, the mirror will darken evenly all over, while if outside the focus, the shadow will appear to move from left to right, or in a direction opposite to the motion of the screen, Fig. 9. Thus, if the shadow moves the same way as the screen, the screen is known to be inside the focus; if the opposite way, the screen is outside the focus; while, if the screen is exactly at the focus, the mirror will darken uniformly and with very great rapidity as the screen is moved across.

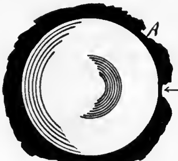


FIG. 10.

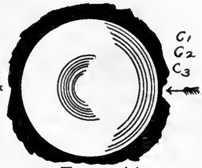


FIG. 11.

This gives us a very accurate means of placing the screen exactly at the focus of the mirror for rays diverging from the center of curvature; and what is true of the whole mirror is, of course, true of any part of it; so that, if the mirror is divided up into zones, and if all the mirror except the zone under examination is stopped out by means of a screen placed over the mirror, it is possible, by observing the point at which the zone darkens uniformly, to place the screen with very great accuracy at the focal point, for divergent rays, of any given zone. Thus the divergence in focus for different zones can be easily measured.

Before proceeding, however, to the actual measurement of the focal point for the different zones, it is as well to make an examination of the three classes, A, B, or C, it belongs to. As before said in the case of class A, the outside rays will come to a focus nearer to the mirror than the inside rays; consequently, if the screen is placed as near as possible to the image of the pinhole, so that the mirror darkens as uniformly as possible as the screen is brought across, the screen will be inside the focus for the central rays, and outside the focus for the marginal rays. Thus the shadow will advance across the mirror from left to right for the center, and from left to right for the margin, the screen being always carried across from right to left. The appearance of the mirror is shown in Fig. 10. In the case of the sphere class B, the darkening is uniform all over; while with class C, since the screen is now inside the focus for marginal rays and outside for central rays, the shadow will advance from left to right for the center, and from right to left for the outside, the appearance being exactly the opposite to that for class A, Fig 11. C_1, C_2, and C_3 all give the same appearance as regards this test, and it is absolutely necessary to submit the matter to exact measurement, as there is no other reliable way of deciding when C^2, the parabola, is exactly attained.

The method then, is to divide the surface of the mirror into zones by means of card screens placed against it, and to determine, by means of a screen brought across the image of a pinhole, what the exact position of the focus of any zone is.

In practice it is only necessary to measure the position of the screen for the central 2 in., and for the outside inch or so. An examination of the mirror as a whole will show whether the curve is regular, or whether there are any rings; though if the polisher is carefully made, as before explained, rings ought not to appear.

In my next chapter I hope to give the formula for determining when the parabola is attained and the practical details of the testing.

MINERAL POSSIBILITIES OF THE PACIFIC COAST.

The existence of wonderful mineral resources throughout the United States has been shown by governmental and private enterprise, the development of the useful metalliferous minerals is being pushed by miners all over the country, but the complete utilization of many of the most valuable minerals is, as yet in an embryonic stage. Germany, with its scientists, is pre-eminently the pioneer in this field, and as a consequence reaps a rich harvest from minerals obtained in the United States. While at present apparently of limited importance, yet this branch of mineral development is destined to take a leading place among the economic industries of the country.

Recent examples are found in the use of certain rare earths in the manufacture of incandescent mantles, the adoption of tantalum as a filament for the incandescent electric light, the demand for uranium minerals in the manufacture of radium, and the use of various metals and metallic oxides in the manufacture of high-grade tool steel.

The western portion of North America is particularly rich in the extent of its mineral resources, yet, except for the mining of gold, silver, copper, lead, zinc, fuel and iron and their by-products, and some quarrying of structural material, this great natural wealth is largely undeveloped.

In Colorado molybdenite has been developed 1 mile east of Climax, Summit County. The silver and iron ores of Lake County produce considerable manganese which is used in the manufacture of spiegeleisen, and also as a flux by the smelters. Colorado is also one of the chief sources of crude tungsen ores in the United States. The vanadium and uranium deposits of the State are likewise receiving some attention.

Wyoming is credited with producing asbestos, graphite, grindstones, metallic paint, platinum and tin. South Dakota has done but little in the development of these mineral resources beyond the work on its tin mines, and the shipment of considerable spondumene for its contained lithia minerals, and wolframite (iron-manganese tungstate), of which there is considerable in the tin regions.

Montana is attracting attention as an arsenic producer, as the output continues from the white arsenic plant at the Washoe copper smelter at Anaconda, which collects and condenses the arsenical fumes formed during roasting of copper ore. Near Dillon and near Ophir molybdenum deposits have been developed to some extent, and at times some manganese ore has been produced. The grindstone industry is also receiving some attention. Idaho occasionally produces some cobals ore.

Washington has been a leader in the production of arsenic. The Crown Point M. Co., in Chelan County, has marketed crystals of molybdenum, and a talc deposit has been worked seven miles from Marblemount in Skagit County. Graphite has been found near Bossburg. Besides some quicksilver and platinum, Oregon's contribution to the minerals under discussion has been borax, which is found at Chetco, Curry County, as priceite, occurring as pockets in serpentine, and in Harney County, 130 miles north of Winnemucca, Nev., as borate of soda in marsh lands. Nevada, likewise, has produced some borax and also some quicksilver. A tungsten property near Osceola, White Pine County, has been slightly developed. Nevada and Utah are listed among the States producing sulphur. Utah is also credited with producing manganese ore, uranium, vanadium and sodium chloride.

In Arizona metallic arsenic has been found at Washington Camp, in Santa Cruz County, in masses attached to the walls of small pockets in dolomitic limestone. At Troy extensive work has been done in developing and concentrating wulfenite as a source of molybdenum. Near Dragoon, Cochise County, hubnerite and scheelite, used in the manufacture of ferrotungsten and metallic tungsten, has been mined. Asbestos is being developed in the Grand Canyon of the Colorado.

The U. S. Geological Survey's report on the mineral resources of the United States, from which much of the data for this article has been obtained, credits California with a greater diversity of mineral products than any other State. This includes lithium minerals from San Diego County, asbestos from El Dorado, borax from San Bernardino, Lake, Tehama, Mono and Inyo Counties, chromite, graphite, infusorial earth, magnesite, manganese ores, metallic paint, platinum, pyrite, quick silver, salt, talc and tripoli.

"Mining and Scientific Press."

ELECTRIC BATTERIES; THEIR CONSTRUCTION AND USES.

FREDERICK A. DRAPER.

Principles of Battery Action.

The multiplicity of types and kinds of galvanic batteries and the variety of uses to which they may be adopted, is more or less confusing to the novice in electrical work. These chapters are written, therefore, for the information of those who contemplate steady and experimental work involving the construction and use of batteries, the examples selected being those best adapted to the work for which they were designed and which best lend themselves to construction by the inexperienced in such work.

As an introduction, it will be advisable to briefly present the principles which underlie the action of batteries in general, reserving detail mention of the action of each particular kind for the chapter in which it is described.

It may also be well to state at this time that a battery does not "generate" electricity, although for the purpose of convenient expression, it is frequently so stated. The function of a battery is to maintain a current of electricity through or along a conductor by means of the chemical action set up between two metals, immersed in a liquid possessing a chemical "affinity" for one of them.

The energy with which this combination of metal and liquid takes place, determines the E. M. F. (electro motive force) peculiar to the particular metals and liquids used. Every element possesses a specific amount of latent or potential energy, knowledge of which enables us to calculate the E. M. F. to be obtained from a given combination of elements.

These combinations of elements are always in certain, fixed proportions, which has led to the assigning of numbers to each element, representing the proportion by weight, which the element forms of any compound. These numbers are known as the "Atomic Weights," and represent the relative weights compared with Hydrogen, the lightest of the elements, which has been taken as the unit.

As different combinations of the same elements form different substances, it is evident that elements must be capable of replacing one another. The weight of an element which will replace unit weight of another element is known as the "chemical equivalent," or combining weight. This may be the same or different from the ratio of the atomic weights of the two elements. The ratio of the atomic weights to the chemical equivalent is known as the "Valency" of the element, and is also the number of atoms of hydrogen required to replace one atom of the element.

The substance formed by different combinations of elements are designated by symbols, those of particular interest in these chapters being shown in the following table, together with the atomic weights, chemical equivalents and valencies.

Element	Sym.	Atomic wt.	Chem. equiv.	Valency.
Hydrogen	H	1.	1.	I
Potassium	K	39.04	39.04	I
Sodium	Na	23.00	23.00	I
Manganese	Mg	55.	27.5	II
Aluminum	Al	27.3	9.1	III
Zinc	Zn	65.2	32.6	II
Tin	Sn	118.	59.	II
Iron	Fe	56.	28.	II
Nickel	Ni	58.6	29.3	II
Lead	Pb	206.4	103.2	II
Copper (Cupric)	Cu	63.3	31.7	II
Mercury	Hg	200.	100.	II
Silver	Ag	107.9	107.9	I
Gold	Av	196.2	65.4	III
Carbon	C	12.	3.	IV
Platinum	Pt	196.	49.	IV
Oxyden	O	15.96	7.98	II
Chlorine	Cl	35.4	35.4	I
Iodine	I	126.	126.	I
Bromine	Br	79.8	79.8	I
Nitrogen	N	14.02	2.81	V

This arrangement is also in accord with the electrical condition of each element, electro positive to the ones below, and electro-negative to the ones above it. To illustrate what has been stated we will study the action which takes place in a very simple form of cell.

A strip of chemically pure zinc is placed in dilute sulphuric acid; no action follows. A piece of copper or carbon is also placed in the acid; still no action. The exposed ends of the zinc and copper are allowed to touch or are connected with a short piece of copper wire representing an external circuit; the acid immediately attacks the zinc, the latter is dissolved, zinc sulphate formed and hydrogen liberated in minute bubbles. This chemical action sets up a current from the zinc (anode) through the liquid (electrolyte) to the copper or carbon (cathode), carrying with it the hydrogen bubbles which collect upon the surface of the cathode. The function of the cathode is mainly that of a conductor of the current from the electrolyte.

The chemical action which takes place, as mentioned above, is as follows: The affinity of the electrolyte for the anode and resulting combination and changes has set up a difference of potential between the terminals (electrodes) of the cell, which is equalized by the current flowing through the external circuit. The current flowing through the electrolyte, breaks up the compounds previously formed, and restores in part the potential energy to the atoms, which again unite with the metal forming the anode maintaining the E. M. F. and a continuous flow of current. The current continues to flow only while the circuit is closed, and ceases as soon as the circuit is broken.

If, instead of chemically pure zinc, commercial zinc be used, action within the cell does not cease when the circuit is broken. Commercial zinc is not sufficiently refined to remove all the other metals usually associated with it in the ore, and the traces of copper, iron, etc., remaining therein, cause the chemical action to be continued, and zinc is consumed without doing useful work. This is known as " local action, " and is undoubtedly caused by the foreign metals which serve as minute cathodes for the flow of local currents.

If the action of this cell be continued by keeping the external circuit closed the hydrogen bubbles will not all rise to surface, but an increasing number will collect upon the surface of the cathode, interfering with the free flow of the current. As the hydrogen bubbles are electro-positive like the zinc, the cathode or negative plate is thus gradually converted into a positive one. This action is known as " Polarization, " and is a source of great loss of constancy in cells of certain types. As will be shown in later chapters, it is possible to select and arrange elements which will overcome this excessive tendency to polarization, while at the same time a current is flowing through the circuit. There are several ways of doing this, the one most commonly employed being the addition of some substance in the cell, with which the hydrogen gas will readily combine. Such substances are known as " depolarizers, " but the rate of their action is dependent upon several conditions. No depolarizer will maintain the E. M. F. of a cell constant with varying currents, the construction of the cell and its size having much to do with the amount of hydrogen liberated and the amount which can be absorbed by the depolarizer.

From what has been stated, it is evident that to obtain a cell giving a high E. M. F., the metal chosen must be one, for which the electrolyte has great affinity, but this is limited by the necessity that little or no action occurred except during the passage of the current. For these reasons zinc is the metal most extensively used, as well as the fact that it is the cheapest metal, excepting iron.

By the consumption of zinc, then, do we obtain electrical energy. It requires but little calculation to show, however, that as a source of energy on a large scale for lighting or power purposes, the cost of materials, and maintainance is prohibitive in competition with dynamos which can supply current at a fraction of the cost from batteries, and far more conveniently.

For such uses as ringing bells, lighting gas or igniting engines or for laboratory experimental work a suitable battery is efficient and easily and cheaply maintained.

HORSE POWER.

How It Compares with that of a Man.

At his very best, the strongest man stands in pretty poor comparison, even with a horse, for hard, continuous labor. He might perform for a few minutes one-half horse power of work, but to keep it up for any great length of time would be impossible. Thus the gain in forcing horses to do a part of the world's work was enormous. One horse could exhaust a dozen men in a single day, and still be ready for the next day's work.

The measurement of a horse's power for work was first ascertained by Watt, the father of the modern steam engine, and he expressed this in terms that hold today. He experimented with a great number of heavy brewery horses to satisfy himself that his unit of measurement for work was correct. After many trials he ascertained that the average brewery horse was doing work equal to that required to raise 330 pounds of weight 100 feet high in one minute. So he called this one horse power.

This work, however, is not continuous, for the horse would have to back up after each pull to lower the line of the pulley, and thus he would work four hours a day in pulling 330 pounds in the air at the rate of 100 feet per minute, and four hours in slacking up the rope. Consequently no horse can actually perform continuously what is generally called one-horse power. The horse was never born that could tug at a rope for eight hours a day pulling 330 pounds each minute without rest or change. Consequently when we speak of horse-power we refer only to the average work a horse can do in one minute—that is to say, the rate at which he can work.

A strong man might pull half that weight 100 feet in the air in two minutes, but he could not repeat the operation many times without being exhausted.

For all needful purposes the expression of one-horse power is accurate enough, and practically shows the measurement of an average horse's abilities for working. As a rule a strong man can in eight hours work at a rate of about one-tenth of one horse power; that is, it would require ten men to pull 330 pounds 100 feet in the air in a minute, and then slack up and repeat the operation throughout the eight hours of a working day. The world's gain in labor when horses were first employed to help man in his work was then tenfold.

GAS ENGINE CYLINDER COOLING.

To obtain the greatest economy from the cylinder of a gasoline engine, the temperature should be as high as possible to permit of successful running and proper lubrication. This necessitates the use of a cylinder oil which has good lubricating qualities and will withstand a high fire test. The oil should contain but little carbon, and yet have sufficient body and vicosity to maintain a close film of oil around the piston.

When operating on a heavy load and the explosions occur at more frequent intervals, a little judgment and experience are required to keep the cylinders from getting too hot, and an occasional cleaning of the piston and ring grooves may be necessary, as these often become clogged with burnt carbon.

Of the two methods of circulating the cooling water —viz., depending on the difference in temperature of the water or a circulating pump—the latter gives the best results and a more uniform temperature of water can be maintained. When using a natural circulation, the water in the cylinder is apt to remain inactive for a time until steam is generated, when it will be forced over into the tank and a quantity of cooler water will be taken into the cylinder to be overheated, as the previous supply. Such a condition would cause an uneven temperature in the water, with less efficient results. A forced circulation would keep the water immediately around the cylinder from reaching the boiling point, and if a throttle valve were installed, a uniform temperature of, say 165° F., could be maintained.

If the water shows a tendency to get too hot, a freer circulation would cool it to the desired point, and vice versa.

When using natural circulation, a large tank is preferred, and this should be filled to the mouth of the return pipe, so that a slight change in the temperature of the cooling space will cause an immediate flow of water from the tank.

Improper cooling will result in the waste of much fuel, and too cool a cylinder will have the same effect, Thus over cooling as well as over heating should be guarded against for efficient operation of the engine.

HECTOGRAPH FORMULA.

A reader recently asked for a formula for making hectograph pads, and through the courtesy of Mr. H.E. Smith, chemist and engineer of tests of the L. S. & M. M. S. R. R., we are enabled to furnish the following information:

Clear hide glue, 1 lb.

Water, 1½ pts.

Glycerine, 2½ pts.

The glue should be of good quality, and the kind that comes in transparent, light brown sheets, as the white or brown opaque glue does not give as good results. Break the glue into small pieces and soak it in the water over night in a covered vessel. Then melt it in a water bath, and add the glycerine, which should previously be heated to the same temperature as the melted glue. Stir only as much as is necessary to mix the glue and the glycerine, as too much stirring introduces air bubbles, which are difficult to remove. Pour the hot mixture through a cheesecloth bag into the pans.

When the pans are filled and the jelly is still quite fluid, sweep off air bubbles or impurities from the surface with the edge of a card. Let the pans stand 48 hours before using. This formula calls for much less water than is usually required by other formulas since it is preferred to secure the requisite softness by means of the glycerine, which does not evaporate and allow the pads to dry out, as does the water.

In writing the original copy always use hard, glazed paper, and write with hectograph ink. In making the negative, moisten the surface of the pad with a cold, wet sponge, wiping off the excess of moisture. Dry off with a newspaper and let stand for two minutes. Place the original face down on the pad for from one to three minutes, rubbing down to a perfect contact, and then carefully remove.

In printing apply a clean sheet of any kind of paper so that it touches the hectograph at all points, rubbing as little as possible. Never use hot water for removing the negative; as soon as the copies are all made, wash off with a sponge and cold water and dry well with a newspaper. Never let the pad stand with ink in it after the copies are made, and always keep it closed when not in use.—"Am. and Eng. R. R. Journal."

SPECIFIC GRAVITY OF MINERALS.

The specific gravity of a mineral is its weight compared with some substance taken as a standard. Distilled water is taken as a standard for liquids, air or hydrogen for gases, the weights of bodies being proportional to their masses, therefore the specific gravity of a body is equivalent to its relative density. It is the density or compactness of a substance that gives it its weight, the more compact the heavier. If a mineral weighs twice as much as water, its specific gravity is low, being but two. If three times as heavy, its gravity is three, and so on. To obtain the specific gravity of a mineral, weigh a bit of the same, using a fine balance, then suspend the mineral by a hair or silk thread, or platinum wire, to one of the scales; immerse it, thus suspended, in a glass of distilled water and weigh it again. Subtract the second weight from the first by the difference obtained; the result is the specific gravity. The loss by immersion is equal to a weight of an equal volume of water. The water should be at a temperature of about 60° F.

PHOTOGRAPHY.

PASSE PARTOUTS FROM NEGATIVES.

WILLIAM A. INGRAM.

Passe partout binding strip is a very useful article for an amateur photographer to possess. It can be used for a number of purposes, among which may be mentioned masking negatives, binding lantern slides or transparencies, making a defeetive camera light tight, and sealing up a box of plates or dark slides. With its aid waste glass negatives, when the film has been removed, may be used as covers for photographs, thereby converting them into acceptable gifts, possessing that " personal touch " which adds much to the value of a gift.

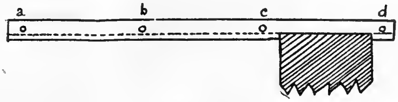


FIG. 1.

One experiences a certain charm in being able to make profitable use of " by products. " More pleasure is often derived from the conversion of an over-developed print into a transparency than from a print made specially for that purpose. The same may be said of a glass positive which has been used as a means for obtaining some other result, but is afterwards used as a transparency. Waste negatives, like the poor, are always with us, and a means by which some of them can be used to advantage is well worth considering.

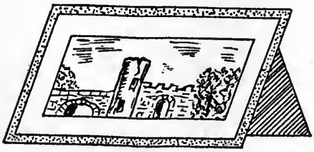


FIG. 2.

The amateur who uses but one size of plate is necessarily somewhat restricted as to the size of passe partout " frames " he can make from his waste negatives. Still if he is not an early beginner he will doubsless be able to find some negatives which can be permanently or temporarily masked, or prints which can be trimmed to sizes suitable for use with the waste negatives he may possess. While it may be rightly considered bad practice in ordinary cases to trim prints to suit a particular size of frame, still there is certainly some latitude admissible where a print is not exhibited as an artistic production, but rather as a photographic memento of a face or place one might wish to preserve.

Before being able to use to waste negatives the film must be removed. The perversity of some inanimate objects is proverbial, and waste negatives are a case in point. Should one inadvertently allow some developing solution to become a few degrees too warm there is a difficulty in keeping the film on the glass, but when one desires to remove the film after it has become thoroughly dry, it is quite another matter. This fact suggests a remedy applicable in some cases. When upon developing a plate it is seen to be useless, increase the temperature of the solution, and the film can be removed without difficulty. If the film has become dry, soak the negatives for several hours in cold water and then transfer to hot, when the gelatine will come away in one piece, or readily dissolve. The glass can be polished with any glass cleaning preparation.

The mounting of photographs for passe partout work calls for no special mention. Mounting card can be purchased at about ten cents a sheet, each of which will cut upwards of 20 four by five mounts. A variety of colors can be obtained, but should anything special be required, drawing paper may be colored to the desired tint with water colors, and pasted over the ordinary mounting card.

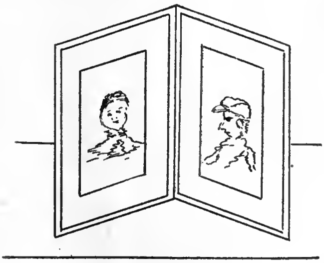


FIG. 3.

To center a photograph, take a strip of plain paper, the length of the glass to be used for a cover, and cut from it a portion equal to the length of the glass to be used for a cover, and cut from it a portion equal to the length of the trimmed print. Divide the remainder into two equal parts, and this will give the width of margin for the sides of the print. Obtain the size of margin for the top and bottom in the same manner. If the print be measured when dry, and mounted wet, an allowance should be made for the expansion of the paper. While this may not be necessary with small prints, it certainly should not be lost sight of with large ones, especially when the margin is narrow, in which case the difference in the width of margins is only to learned by experience.

To ensure the binding strip being placed correctly in position on the glass the following procedure is advised. Fasten the strip to a board with thumb tacks, gummed side upwards. With a pencil and ruler make a line on the strip, showing the position the glass is to occupy. Moisten a portion equal to the length of one of the sides of the glass on the strip, as shown at Fig. 1, in which *a*, *b*, *c*, *d* are the thumb tacks, and the shaded portion the glass. When this side is firmly fixed cut the strip and follow the same procedure with the three remaining sides. If one has any choice in the matter, glasses should be selected which have perfectly square sides. The mounted photograph must be exactly the size of the glass, placed in position, and the strips moistened one by one and turned over to the back of the mount, making the edges as square as possible, and neatly moulding the corners.

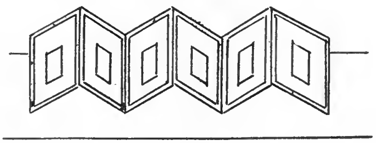


Fig. 4.

Some means of support or suspension must be provided. If the picture is to rest on a table or any similar place, it needs a support. Easels may be bought in a variety of styles which answer this purpose. However, a satisfactory method is to fix a support as shown at Fig. 2, which is simply a piece of stout cardboard hinged to the back of the picture with strips of cloth passe partout binding. A piece of cloth strip, or tape, one end of which is glued to the back of the picture and the other to the support, will keep the picture at the most suitable angle of inclination. If a rigid support be desired, a piece of card may take the place of the tape. When the picture is to be suspended a silk ribbon or cord loop should be firmly glued to the back. If cord be used, it is advisable to unravel about one inch of the ends, in which form it will make a much stronger connection with the back of the picture.

The above remarks apply to pictures treated individually. It is often advantageous to group two or more together, and the different methods of doing this seem almost limitless. Two may be hinged side by side, as shown at Fig. 3, or from the top with a piece of tape to regulate the angle of inclination. So arranged, they will, of course, support themselves. Pieces of cloth binding strip will make an effective hinge and take the place of the ordinary strips along the sides when they are used. More than two may be fastened together in a zig-zag manner, as shown at Fig. 4. This arrangement will sometimes be found convenient with panoramic views, thereby dispensing with the trouble of matching and joining the component parts. Such a combination may be made to fold, and thus occupy very little space when not displayed.

A passe partout photographic calendar makes a useful article. The calendar should have a piece of stout paper for the bottom sheet, which may be fastened to the outside of the glass with passe partout binding.

A pleasing variety of frame is made by using two different colors of binding strip. If one of these colors is white, or any light color that would easily soil, providing it is the color used for the inside border, it is advisable to place it inside the glass, for obvious reasons. This can easily be accomplished by fastening the white strip to the photograph mount, and then using the other colored strips is previously explained. Of course strips of more than two colors may be used if it be thought advisable.

A method of making significant pictures out of comparatively small photographs is to arrange several together. A piece of card is required the size of the whole of any such combination, and the photographs mounted thereon in such a position as the size of the glasses necessitate. The glasses are placed over the photographs and the binding strip used for the outside edges in the usual manner. Strips may be cut of suitable width for using between the different glasses. When such combinations are used the mounting card should be thick to prevent warping. In some cases it may be advisable to use two thicknesses of card. To a certain extent the tendency to warp may be avoided by pasting a piece of paper the size of the photograph on the opposite side of the mount.

An Italian inventor has produced a photographic machine with a film so sensitive that it will record 2000 separate impressions per second.

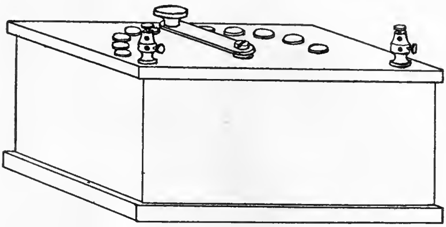
At a recent meeting of the Royal Society of England J. A. Flemming and R. Hadfield gave the results of some of their investigations on the magnetic properties of alloys. They have found that an alloy composed of manganese 22.4 per cent, copper 60.5 per cent, carbon 1.5 per cent, silicon 0.37 per cent, and iron 0.21 per cent, has magnetic properties which are identical with those of materials which are naturally feebly magnetic, and that the permeability is between 28 and 30, which is not much inferior to the values reached for a low grade of cast iron for small magnetic forces. This alloy can also be permanently magnetized. This leads to the surmise that the magnetic properties of the alloy result from a similarity of molecular structure to that of the ordinary magnetic materials, such as iron, nickel and cobalt, and that, if the proper molecular arrangement can be found in an alloy, it may be possible to construct a material which is quite as magnetic as iron, and possibly even more so.

RESISTANCE FOR "WIRELESS" RECEIVER.

ARTHUR H. BELL.

The resistance coil mentioned in connection with the "wireless" telegraph receiver in the August number of this magazine, is not a single coil, but rather a set of coils of very fine resistance wire, wound non-inductively to prevent inductance when the current is passing through them. The construction of such a resistance suitable for distances of not over 25 miles transmission work is quite simple and can be made at small expense.

A wooden box is made, the top and bottom of which is 5 x 7 in. and ½ in. thick. Sides are made of 3-16 in. stock 2 in. wide, and of lengths to give the top and bottom a lap of about ½ in. all around. The bottom is nailed on, and the top attached with round head brass screws after being fitted with the attachments to be described:



With dividers lay off a half circle the radius of which is 2¾ in. and the center 1⅝ in. from one side of the box. Bisect this arc and lay off five points ⅝ in. apart on either side, making 11 in all. Bore holes at these points of a size to receive with a tight fit the threaded part of some thumb screws with flat heads. At the center bore a hole for a brass machine screw with two nuts, which is to hold the arm made of a strip of spring brass 3½ in. long and ½ in. wide.

This arm or lever has a hole at the center end to fit the machine screw with a loose fit, but without play, so that it will turn without binding. Fit a hard rubber knob at the outer end, ½ in. in from the line of the arc. The center screw is placed in the hole at the inner end; one of the nuts is then threaded on till it almost touches the arm, the screw is then put through the hole in the top and the other nut put on and screwed tight, thus holding all firmly, but allowing free movement of the arm.

The coils are then wound of insulated resistance wire to give a resistance of two ohms to each coil. In purchasing the wire, which should be at least as fine as No. 36 gauge, and No. 40 would better, inquiry should be made to learn the resistance of the wire per foot. It is then cut into lengths to give 2 ohms per length. Taking a piece of wire, fold it at the center and then wind it double over a round rod of about the size of a lead pencil, winding it carefully to avoid breakage. The coils, when wound in this way, have little or no inductance, as the current through one-half of the coil neutralizes that through the other half. When the coils have been wound remove the insulations at the ends and solder to the ends of the thumb screws projecting from the under side of the top, one end to one screw and the other end to the next adjoining. The first coil would connect the first and second screws, etc. In seldering it will be well to first deposit on the ends of each of the screws a small bead of soft solder, and then with a blow pipe, heat it up to the melting point, and when just soft enough put the end of the solder, immediately removing the flame.

Two double binding posts are then mounted, one in each corner of the top in line with the ends of the arc. To the left post connect the first thumb screw, and to the right one connect the screw upon which the arm turns. Use covered magnet wire for these connections and solder all of them. The top is then ready for attaching to the box. Double binding posts are necessary, as the local battery wires and wires from aerial and telephone receivers are connected thereto.

The telephone receiver for use with the wave detector, previously described, should be that known as the double head receiver, and should be of very high resistance, 1500 ohms being desirable if one cares to go to the expense of having one as high as that made up. The object of using a double head receiver is to exclude outside sound, so that for one ear may be a dummy, padded to make it sound proof.

The scarcity and rarity of radium will be best appreciated by the following statements: To obtain one kilo or two and three-tenths pounds, five thousand tons of uranium residues must be treated and the process of reduction consumes six weeks of time. Prof. Currie says that for all the work done in Germany and France in the past three years searching for this substance, only about a pound of radium salt has been obtained.

Concerning the amount of radium in America, it is estimated that if all the various grades were reduced to the strength of one million, so-called, there would be between four and five grammes or a half thimbleful, or not more than enough to be heaped on a nickel 5 cent piece.

IRREGULAR IGNITION OF GAS ENGINES.

An essential point in obtaining a strong spark is that a good contact shall be made before the contact points are forced apart.

In practically all make and break igniters, the movable electrode passes through an iron or a bronze bushing and the current must pass from this bushing to the axis of this electrode before reaching the contact points.

Under certain conditions the contact between the outer stem and its bearing, *i. e.*, with the metal of the engine, may be so poor that only a small current could flow; so that on breaking the contact the spark is too feeble to light the gas.

Oftentimes when this condition exists it can be seen by shielding the igniter mechanism from the light. If the contact between the igniter stem and bearing is poor, small sparks may often be noticed around the igniter parts outside of the cylinder.

The cause of this trouble may be due to the presence of too much oil on the igniter bearings; it is, however, more often due to wear and a poor fit between the stem and its bearings; for where the bearing is poor the gases and burnt oil flow through and by reason of the high temperature which the stem reaches after a few minutes running, the oil and soot bakes on it, forming with the "fire rust" a coating that is an extremely poor conductor.

Add to the resistance thus offered, that due to the accumulation of fresh or of burnt oil on the contact points proper inside the cylinder, an amount of resist ance is easily reached which prevents the passage of enough current to give a satisfactory spark.

When the stem is flooded with oil a good contact is not formed for the current, as oil is a poor conductor, and when it completely surrounds the stem the insulation is absolute. Yet when well oiled the igniter works better than when the bearing is dry. The prevention of the loss of this oil and the keeping of the bearing in good condition could be obtained by making a valve shoulder near the outside end of the bearing or by surrounding the outer end with a stuffing box and lastly a perfect metallic contact should be had—either by soldering a flexible wire direct to the igniter stem —or to a copper brush pressed against the stem at its extreme outside end. Where such provision is properly made it will be found that an ample spark for all purposes can be furnished with from one-shird to one-half the battery power usually found to be necessary. —"Gas Power."

The cost of a kilowatt-hour of current delivered at the switchboard of any of the larger central stations will not get much below one-quarter of a cent. For the larger New York stations, the figure is around .26 of a cent, and it probably will not go much over one cent for a small non-condensing station.

REPAIRING ASBESTUS GAS LOGS.

HENRY C. FLACKE.

In many houses and offices, at certain seasons of the year, gas fire-place logs are used for heating purposes. After being used for several seasons, however, these logs lose their efficiency, fail to radiate heat properly and give off objectionable odors of the gas. Users frequently wonder at the cause of these troubles, call in a plumber who looks at the connections and generally goes away without making proper repairs. He fails to locate the trouble which, in a majority of cases, is the wearing off of the asbestos covering.

When newly purchased, the asbestos fibres are quite long, from one to one and one-half inches in length, but after being used for a while they become broken and even entirely worn away in places. The gas, in such a case, instead of heating these fibres to incandesence and radiating its beat therefrom, passes away into the air more or less unconsumed, and failing to give the maximum heat.

To remedy this condition, take an old knife or putty knife and scrape off all the asbestos from the face of the log. Get about a pound and one-half of asbestos wool, which will be sufficient for a large surface. Then get about a pint (or pound) of silicate of soda, which, like most everything you buy at a drug store, costs about a dollar an ounce, or fifty cents a gallon; the more you get the cheaper it comes. However, ten or fifteen cents is a fair price for what is wanted. This silicate of soda is a mucilage, and is used to stick the asbestos to the fire face. Pour a saucerful of it and spread your asbestos out on a paper ready for use. With the fire surface cleaned, take a brush and cover the whole surface of the iron with a coat of silicate, using care to keep your hands clean and dry. Pick up a pinch of asbestos and dip it lightly in the dish of silicate and, beginning at the top of the log, stick it on, being careful not to cover up the small flame or gas holes. Repeat this, pinch after pinch, in a row across the top, then another row just beneath, and so on across the plate, row after row from left to right and top to bottom until the whole surface is covered. Put the asbestos on thick; the thicker you can get it on and still have it stick, the better. Now after it is all on you can turn on and light the gas; you need not wait for the silicate to dry. Heat cannot hurt it. Wherever gas flames come through the little holes, open them with a pointed wire or sharp needle. After the silicate is dry the loose fibres of asbestos can be shaken off by lifting the log from side to side.

The maximum working load in pounds that may be allowed on a wire rope equals the square of the circumference of the rope in inches multiplied by 600. Hence a wire rope 4 inches in circumference should not have a load to exceed 9600 pounds.

CORRESPONDENCE.

No. 103. SANTA BARBARA, CAL., Aug. 8, 1905.

I would like to ask a few questions relative to using an alternating current to excite an induction coil giving a two-inch spark or larger capacity.

Can good results be obtained by using an alternating current of 7200 frequency and 110 volts?

Can a condenser be used in this arrangement? If so, how is it connected? W. C. T.

Alternating currents are frequently used for coil work, where the coil is large enough to permit of it. If the current is obtained from a commercial circuit, a lamp or other resistance will be necessary, unless the coil is a very large one. Specific directions cannot be given without knowing the primary winding. Consult the manager of the central lighting station on this point.

The frequency you mention is so very high that you have undoubtedly confused it with the frequency per hour. In all probability it is the usual circuit of 60 cycles (120 frequency.)

The condenser should be used and connected across the secondary.

No. 104. KANSAS CITY, MO., Aug. 18, 1905.

I am very much interested in AMATEUR WORK and eagerly read each copy as soon as received.

I would like to have you publish an article on how to build a boiler capable of furnishing steam for ½ to 1 h. p. engine or steam turbine, Also one on the building of a steam turbine of about these powers, and a four pole dynamo with semi-enclosed fields to run direct connected with same.

Referring to the boiler, I think directions for burning crude oil as fuel would be of interest to those living in the sections of the country where such oil is cheap. L. E. P.

We gladly welcome letters containing suggestions like the above. Those mentioned have been receiving our attention for some time, and articles are already under way for most of them. The steam turbine will undoubtedly fill a very important place in the motive world in the near future, and amateurs will naturally be interested to study the principles of their construction and operation through model making. We would also add that motive powers of various kinds will be given a prominent place during the forthcoming year.

No. 105. DAVISVILLE, N. H., Aug. 11, 1905.

I have a wireless telegraph pole which is set upon the roof of my house. The pole is about 28 feet high. I have a telegraph wire on each side of it. Would this pole be all right for sending and receiving messages for a distance of about two miles? W. L. K.

It has been frequently stated in this department that the distance over which wireless telegraph messages may be transmitted cannot be determined from any one part of the apparatus, but is dependent upon the design and construction of all parts, and also the character and elevation of the country in which it is used. An efficient sending station would lose much of its value if the receiving station was not equally as efficient.

In the location and height of the pole the object is to obtain a clear and open interval between stations. as high above the intervening country as convenient, so that influences likely to disturb the transmission of the wave impulses may be avoided.

No. 106. LOMPOC, CAL., July 19, 1905.

I would like to see an article describing how to make a simple water motor of about ⅛ to ¼ h. p., the turning work on same to be done on a lathe like the "Amateur." T. D. L.

Our experience with water motors leads us to believe that to make one which would work satisfactorily requires a metal-working lathe, that same may be perfectly balanced. An unbalanced water-motor is about the noisiest and most troublesome device which can be used for power. To develop ¼ h. p. at 90 pounds pressure would require an 8 or 9 in. wheel, or larger than the capacity of the "Amateur." lathe. We expect to soon be able to offer an efficient water motor as a premium upon such favorable terms as to make it much easier to obtain it in that way than to try and make one.

The driving and holding powers of nails have been investigated by Prof. Carpenter of Cornell, whose experiments seem to show that much more force is required to drive a cut nail a given distance than a wire nail; that more force is required to start a cut nail than to drive it, and that it invariably starts much harder than a wire nail; that the work required to drive cut nails is much more than to drive wire nails; and that the work in withdrawing cut nails is about equal to that in withdrawing wire nails, it being sometimes less and sometimes greater. The relative efficiency which is here considered as the ratio of the work of pulling to that of driving is much higher for the wire nail than for the cut nail. The cut nail bruised and broke the fibres of the wood, principally at the end of the nail, whereas the wire nail simply crowded them apart, and probably did not move them much beyond the point from which they would return by elastic force, and hence the nail would be grasped much stronger per unit of area of surface by the wood. Presenting less surface, there would be, however, less resistance to starting. To see what the effect of change of form would be, a number of tenpenny cut nails were sharpened on the point by grinding to an angle of about 30°, so that the fibres in advance of the nail would be thrust aside and not bruised and broken. This increased the holding power of the nail, decreased the force necessary to start it, and increased the resistance to withdrawal.

GOVERNMENT OWNERSHIP OF RAILWAYS.

Government ownership and reduced rates are popularly assumed to be synonymous. But it may work the other way, says the "Railway Age." After years of increasingly unprofitable operation of the Intercolonial Railway, the Canadian Government has been compelled to announce an increase of freight rates. In 1904 every dollar of earnings cost $1.14 in operating and maintenance expenses alone, with no interest charges on the heavy investment, and for 1905 the excess of expenses over receipts will be still larger. The taxpayers are tired, and an influential journal notifies the prime minister that "the people of the country will not much longer contiuue to pay from four to six millions a year out of their taxes to keep in operation a railway that has cost 80 millions of dollars for the benefit of the political machines." Per contra, the unhappy ministry will be denounced still more roundly along the lines of the Intercolonial for raising the rates. It is the popular assumption in this country that railway charges are unnecessarily high, and that government ownership would mean far lower rates for transportation, and also large returns on the public capital invested. But suppose the Government roads were unprofitable? Even with the rates which are declared to be excessive a majority of the roads in this country have been bankrupted; a fractional decrease in rates—so small as not to be felt by shipper or consumer—applied to the principal articles of freight—might bankrupt many roads now. If Government owned the roads, sweeping reductions would be demanded by every locality and interest, and when the earnings got below expenses the experiences of Canada with its unprofitable railway, would probably be repeated, on a vastly greater scale. The country that has all the benefits with none of the risks and losses of railway ownership, may consider itself fortunate.

CELLULUSE FROM CORNSTALKS.

After extensive and elaborate experiments by the United States Government, it has been discovered that cellulose in considerable quantities may be extracted from corn stalks, and the industry promises to grow to gigantic proportions almost at once. Cellulose, as is well known, is the essential constituent of the framework or wall membrane of all plant cells. It is a secretion from the contained protoplasm, but in the advancing growth of the plant the walls become incrusted with resin, coloring matter, etc. It composes the cells of a honeycomb. Cellulose, by reason of its peculiar properties, is being largely introduced into shipbuilding, as, due to its property of swelling rapidly when wet, it prevents leakage through holes below water line. Up to the present century the only available material from which cellulose for this purpose could be prepared in sufficient quantities was the cocoanut shell. The ground fiber of the cocoanut shell, with a small percentage of the original fiber, constituted the cellulose of commerce.

BOOKS RECEIVED.

THE NAVAL CONSTRUCTOR. George Simpson, M. I. N. A. 585 pp. 6½ x 4 inches. Flexible leather. Price $5.00. The S. Van Nostrand Co., New York.

The rapidly increasing importance which naval architecture and construction is assuming in the curriculum of technical schools and which will become even more prominent with a more general application of the steam turbine as the motive power, makes any book written by an author of such wide experience as Mr. Simpson, of the greatest practical value. The above handbook has been prepared with the object of supplying a ready reference to those engaged in the design, construction or maintenance of ships,—such a work as should give simply and concisely information on most of the points usually dealt with in the theory and practice of marine architecture, and in addition much that is new and original, all of which is in line with present day requirements.

PHOTOGRAPHIC AMUSEMENTS. Walter E. Woodbury. 114 pp. 9 x 6 inches. Paper. Price $1.00. The Photographic Times Pub. Asso., New York.

The purpose of the author in writing this book was not to prepare an instruction book of photographic practice, but to present the novel and curious effects that can be obtained by the aid of the camera. It requires but a slight examination of its pages to show that the author has been eminently successful. Here we learn how our fishermen friends are photographed as witnesses to their piscatorial skill, how a man can wheel his own head in a wheelbarrow, become a tall, lean man, or a short, fat one, and numerous other photographic "stunts," which prove of interest to the amateur photographer who likes to experiment.

Steel as a material of construction has made its way because of its strength, its resistance to the elements, or because of its economy of space, or for other resons appealing to the engineer. It is evident in the apparently increasing dangers of crowded modern life, that steel will come into increasing use because it affords greater security to human life. In the past twenty years the metallurgical engineer and the mechanical engineer have worked together to cheapen it so that the civil engineer could employ it more freely. It is safe to predict that a still larger factor in the steel tonnage of the future will arise from uses which are optional today, but which public sentiment will then make compulsory.—"The Iron Age."

SCIENCE AND INDUSTRY.

Every railroad wreck that has as one of its horrors the burning to death of imprisoned passengers, calls attention afresh to the steel car and the larger place it must take in the construction of passenger as well as freight cars. The resistance of steel to the terrific impact of the train recently derailed at Mentor, Ohio, might have saved a number of lives. Certainly with steel cars there would have been no kindling pile and no charred bodies. The purchase of steel cars for the New York Subway was prompted chiefly by the desire to make the best provision against fire, derailment and collision. The latest of the tube railways in London is equipped with steel cars for the same reason. It would seem that the large death list from fires on steamers, in public halls, hotel buildings and in railroad wrecks in the United States in the past eighteen months have given sufficiently terrible emphasis to the need of a larger use of non combustible materials for buildings, cars and vessels.

By resistance, electrically speaking, is meant something placed in a circuit for the purpose of opposing or resisting the passage or flow of the current in the circuit or branches of the circuit in which it is placed.

Intense cold, as is well known, burns—if we may use the term—like heat. If a "drop" of air at a temperature of 180° below zero were placed upon the hand it would have the same effect as the same quantity of molten steel or lead. Every one who has the care of horses ought to know the pain inflicted by placing a frosted bit in a horse's mouth. It burns like hot iron.

Heating the feed water of a boiler will save from 25 to 30 per cent of the fuel. A good heater will utilize the exhaust of the engine, which will raise the feed water almost to the boiling point.

At sea level the rending force of black powder is deemed better for coal mining than dynamite, the former breaking it into convenient shape, the latter tending to waste by shattering it into dust.

The Atchison, Topeka & Santa Fe Ry. is making a series of experiments with an oil burning locomotive on its lines in Kansas. A very heavy crude oil which, it is claimed, cannot be refined, is being used. Particular interest is attached to these tests because of the fact that this company has mines of coal from which it gets very cheap fuel for its lines in Kansas, and if the oil proves to be cheaper and safer in this case, it will have a large influence in extending its use for locomotives in other parts of the country.

What must surely be the oldest steam-engine in the world is described by a correspondent of the American Machinist. It was still working, when the writer came across it in 1899 or 1900, at the Douglas Bleachfield, Forfarshire, and was considered by experts to be one of the best examples of Watt's earlier work. It was originally built for a Newcastle firm, and after many years' work was sold into Scotland in 1797, where it saw a hundred years of active service. The fittings of the machine include a good deal of leather and buckles, and a quaint story was told of a machinist who was once called in to do some repairing on it, in the absence of the usual man. This man thought he would be all right if he took a hammer, a monkey wrench and a chisel with him. When he saw all the straps, harness, buckles, etc., he called up the superintendent and said to him, "Hi, mister, it's a saddler you want, and no an engineer, for this job!" The machine is now enjoying a well-earned retirement at Dundee.

According to documents found in the archives of Genoa, the discovery of America by Columbus cost a little over $7000. The fleet of Columbus was worth about $3000. His salary was $200 a year.

When a column of liquid is heated at the bottom, ascending and descending currents are produced. It is by these that heat is mainly distributed through the liquid and not by its conductivity. These currents arise from the expansion of the inferior layer, which, becoming less dense, rise in the liquid, and are replaced by colder and denser layers. The mode in which heat is thus propagated in liquids and gases is said to be by convection.

Red lead, the most important of the oxides, is made by heating litharge in a reverberating furnace, the metal's color being changed thereby from yellow to red.

The Bessemer process of steel making was invented in 1856, but it was not until 1876 that open hearth steel has been introduced.

The operation of producing liquid air is, air compressed to 1200 to 2000 pounds to the square inch; passed into receptacles where it is purified by separating the moisture, oil, etc., and passed thence into expansion chambers and through coils of pipe of considerable length. During the process it becomes intensely cold, reaching finally 312 below zero, at which point it becomes liquid. It is drawn off into insulated vessels, where it is kept for days, gradually lessening in quantity until it is entirely evaporated.

Kerosene is the main product of the distillation of petroleum, the crude domestic oil yielding up to 75 per cent of its weight in kerosene.

A good mixture for use as a slush to prevent the rusting of machinery is made by dissolving one ounce of camphor in one pound of melted lard; skim off the impurities and add enough black lead to give the machinery carefully, smear on the mixture. It can be left indefinitely, or if wiped off after twenty-four hours will prevent rust for some time. When removed the metal should be polished with a soft cloth.

Carborundum is the result of the fusing of coke and pure silica (quartz) in the electric furnace, and is at present only done in the United States at Niagara Falls.

Concentrate ! A one inch stream at close range is more disastrous than a three inch torrent at one hundred yards.

Henry S. Pritchett, president of the Massachusetts Institute of Technology, says: "To the great essential qualities of character, which good men must have —energy, sincerity, devotion, moral courage, unselfish purpose—must be added that rarest of all human endowments which we call common sense; that is, the ability to think straight, the power to see both sides of a question."

If the devious and important processes of painting putty plays an indispensable part. It comprises the material and process of making good the existing defects of wood and metal, and without it the painter would find himself in a sorry plight. It may be said, in good truth, that there is positively no limit to the putty mixing formulas in use, but for ordinary purposes of an average grade of work, the formula next following is probably best adapted: Dry white lead, three parts; bolted whiting, one part, mixed to the proper working consistincy in equal parts of quick rubbing varnish and coach japan. Some thoroughly good painters prefer to vary this formula to the extent of omitting the whiting. In either case the putty may be accepted as reliable, if kneaded completely and worked out in mass fine and smooth. Such a putty under proper drying conditions should sandpaper clean and without tearing up in texture at the expiration of 48 hours. A slower but more elastic putty is made of three parts of oil ground lead and two parts of dry white lead, mixed in elastic rubbing varnish and gold size japan.

Meerschaum is a mineral of white or grayish color and is a hydrous silicate of magnesia. It is of soft, earthy texture, has the appearance of chalk, has a hardness of 2.5 and a variable specific gravity, very light however, as when dry it will float on the water. An impression can be made in it by the finger nail and has a smooth feel. The principal source of the mineral is Asia Minor, where it occurs in vein form and mined at places from pits and horizontal galleries in a much similar way to coal. When first brought to the surface it is white with a yellowish tint, and is covered with red clayey soil. It is sold as brought from the mine. Its only treatment is in cleaning and drying, which takes place in the open air in summer time, requiring five or six days of heat to perfectly dry. Meerschaum has been found at a few places in the United States, but sparingly in each instance. It has been found in serpentine quarries in Chester County, Pennsylvania, in Delaware County, Pennsylvania, and at Richmond, Massachusetts, and in Utah and New Mexico. Its main use is in the manufacture of pipes and holders for tobacco smokers. The heavier mineral is the most valuable. Meerschaum of very light weight is too porous for producing the best pipes. Meerschaum is a most valuable commodity, and a deposit located anywhere in the United States would be of much value.

TRADE NOTES.

The new catalogue of files and rasps. manufactured by Henry Disston & Sons, Philadelphia, Pa., should be on the desk of every teacher of metal working in the manual training schools of this country. It is very completely illustrated and a valuable source of information to any user of files. We also note the statement contained in the catalogue that this company make their own steel, and are thereby enabled to secure an absolute uniformity of quality.

Kendrick & Davis, Lebanon, N. H., in response to a demand from jewellers and others who have occasion to do electro-plating of small articles, have got out their No. 9 Generator with windings especially adapted for this work.

Amateur boat builders who contemplate building a boat during the coming winter, should secure the catalogue of the Brooks Boat M'fg. Co., 4208 Ship St., Bay City, Mich. It contains a wide variety of designs for which the company furnishes patterns and directions for building. Those who have no experience in boat building will find their help to be invaluable, and even experienced builders use them, as they effect a large saving of time in getting out stock.

The drafting-room tables and equipment manufactured by the Economy Drawing Table Co., 1309 Utah St., Toledo, Ohio, are of the most durable and finished character. The designs are up-to-date in every particular, and purchasers of these goods have only words of commendation for them.

In equipping rooms for metal working, the vises made by The Charles Parker Co., Meriden, Conn., should not be overlooked. For quality of material, workmanship and design, these vises are unequalled. Few large manufacturing plants of the country but have these vises, and the lead of the experienced buyer and user can profitably be followed by others.

The rapid sketching device made by the Universal Drafting Machine Co., Cleveland, Ohio, is a practical aid to laying out work or designs which should receive the attention of every designer or engineer. It is of sufficiently light construction so that, while strong enough for the work, it will not tire the user. The ease with which any angle may be obtained makes it a valuable time saver.

AMATEUR WORK

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MODEL MAKING FOR AMATEURS.

PROPOSED SOCIETY OF MODEL MAKERS.

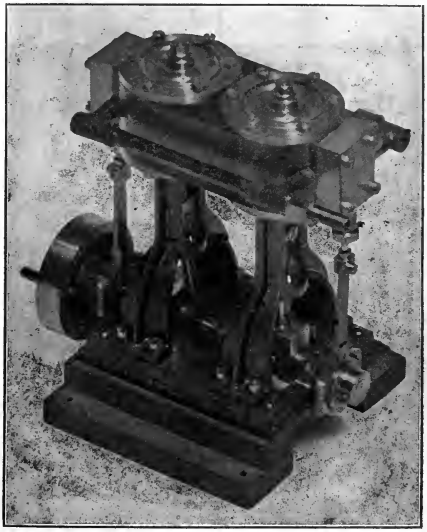
The accompanying photographic view and drawings illustrate one of several small models obtained by Mr. Parsell of Parsell & Weed, New York, during a recent visit to England. His collection is a very interesting one, as it includes both single and double vertical and horizontal engines, several types of feed pumps, and other accessions, required for the proper operation of the models, all of which are accurate representations of their large prototypes, so far as mechanical requirements will permit. The engine here illustrated is about 5 in. high and 5 in. long, the drawings showing each piece the full size. All the parts are of brass, except piston rod and shaft, crank shaft and crank. All the work is exceptionally well done, so that the friction of bearing and glands is but little.

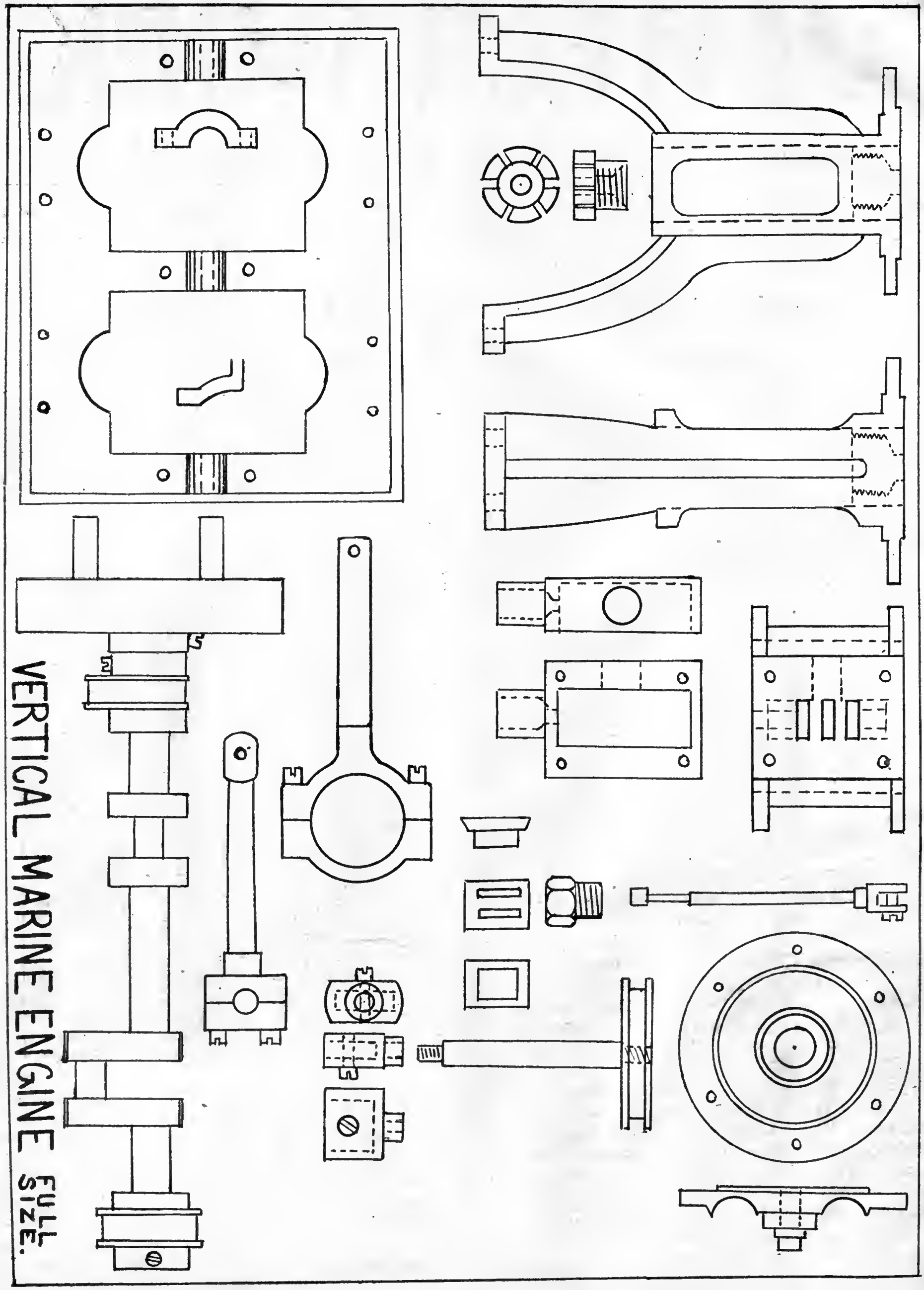
The ease with which the crank turns is surprising, and with a proper boiler the engine will undoubtedly develop power enough to drive a 3½ or 4 ft. model steamer, although no tests have been made by Mr. Parsell to ascertain the actual power it will give.

An inspection of the various parts, when taken apart shows nothing in their construction which should be found at all difficult by the mechanic of ordinary skill, keeping in mind, of course, the necessity of being accurate with all fits. For this reason the adaptability of such models for construction by amateurs, and especially senior pupils in manual training schools, makes it worthy of their careful attention. Such work is very popular in England, where model enthusiasts are organized into a very popular and beneficial society, known as the "Society of Model Engineers." This society has numerous branches, holds regular meetings and exhibitions at which valuable prizes are offered for models of various kinds. A "Junior Branch" gives suitable opportunity for beginners and the younger class, who have not reached the proficiency and experience of the members of the regular society.

As the educational benefits to be derived from work of this kind are considerable, and contribute directly to practical results of importance, the desirability of increasing the interest in this country is worthy of attention.

Undoubtedly there are many readers of AMATEUR WORK, who would be glad to take up work of this kind, if assured that designs, castings and the necessary construction information would be forthcoming. Let those who are interested write to the editor and express such interest, adding also any suggestions that may come to mind. If a sufficient number should desire, an "American Society of Model Makers" could be organized, and the editor of this magazine may be counted on to give all the assistance towards making it a success, which lies in his power. Such a society, however, cannot be made of interest and value to




VERTICAL MARINE ENGINE
FULL SIZE.

its membership, unless those constituting it are willing to attend meetings, canvass for new members, participate in competitions and exhibitions, and do all they can to start the society in a manner which will make it worthy of the attention of capable and ambitious mechanics. If the idea of such work and such a society appeals to you, take the time to write and say so at an early date so that the organization may be started, and the winter devoted to placing it upon a sound and permanent foundation.

WAVE LENGTH IN WIRELESS TELEGRAPHY.

OSCAR N. DAME.

Since it has been determined that the velocity of all etheral waves is the same, practically, it may be noted that the length of each wave varies inversely with the frequency.

To explain this more acceptably to the average reader let us consider a rod of steel held in a vise at one end and strike a sharp blow. The rod will vibrate at a frequency depending upon the length of the rod. The frequency of vibrations under varying length of rod is noted by the higher or lower pitch of sound.

In the case of the vibrating rod, the period of vibration will be the same at all parts of the rod, and the amplitude will vary from nothing at the fixed end to a maximum at the free end.

Similarly, if a wire having one end insulated while the other end is held at a constant potential by earthing the end, be struck an electrical blow, electrical oscillations will be set up in the wire, the frequency of which will depend entirely on the length of that wire, while the amplitude will vary from nothing at the earthed end to maximum at the free end. In this case amplitude of oscillation is the alternating potential.

If we had struck the steel rod a series of light blows accurately timed, the same amplitude of vibration could have been obtained as by the single heavy blow, but these blows must be properly timed.

Because of the oscillating nature of an electrical spark it is not feasible to erect a wire in the air and operate by means of one solitary spark-crash, so to get the same results in radiating effect, the frequency of the oscillating "blows" must be suited to the natural frequency of the wire.

This accord of spark frequency with aerial wire is called "resonance." When perfect resonance is obtained by having just the proper length of wire in use to harmonize with the spark oscillations in use, the aerial wire vibrates freely and sets up an electrical disturbance in the ether, which experiment proves to be proportional to the length of the aerial wire. It will therefore be seen that one might have a wire hundreds of feet into the air, and if the other factors did not harmonize, the results would not be as satisfactory as when a much shorter wire is used.

In a plain aerial installation, one secondary terminal of the coil is connected to one knob of the spark gap to the aerial wire; the other terminal to the other knob of the gap and to the earth.

By proper choice of length of aerial wire suited to the electrical properties of the coil and spark gap, a degree of resonance may be obtained, but the capacity of the aerial wire is comparatively small, hence the small quantity of electricity set in oscillation, while the resistance of this open circuit with a spark gap in series is very high, therefore the oscillations die out quickly because of this dampening, and the form of wave produced by a single charge from the induction coil is

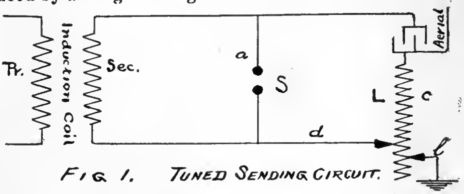
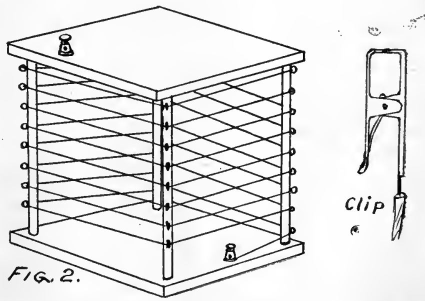


Fig. 1. Tuned Sending Circuit.



neither harmonic nor calculated to break down the distant coherer as required. In other words, a circuit as just described is purely experimental and not of value in sending signals by the dot and dash method over any great distance.

In the closed circuit installation, as shown in Fig. 1, the coil charges the Leyden jars until the potential is sufficient to jump across the spark gap. Then an oscillating current is set up between the coatings of the jars through the induction *L*, and the spark gap *S*, by way of *d*. Owingto the amount of capacity of the jars and shortness of the spark-gap, the oscillations are well sustained. The aerial wire is attached to the point *s* and the earth at *E*, and the open radiating circuit is aerial wire through *L* to earth *E*. It will be noticed that induction *L* is common to both open and closed circuits, and if the open circuit is brought into resonance with the closed circuit, an oscillation will be set up in the aerial wire which will be well sustained by the heavy oscillation in the closed circuit. The reader should trace out these open and closed circuits on the diagram so as to fully comprehend the text, for this theory of balanced and harmonized circuits appears in nearly every system of wireless telegraphy.

The train of waves set up by one discharge of a coil through this circuit rises after a few oscillations to a maximum, remaining there some time, and then dies out. Their effect on a suitably constructed receiving aerial properly belongs to another article which will appear in a future issue of this magazine.

In constructing the tuning coil for sending, a great deal of latitude may be given in the choice of materials and their arrangement for use. One coil, which the writer has seen in use for some months, is of the bird-cage pattern, consisting of four upright strips mounted on a base board.

Following are the specifications as given by the builder: Four pieces of birch dowelling 3 ft. long and 1 in. in diameter; two pieces of whitewood or pine 10 in. square and 1 in. in diameter. In the corners of each square were bored 1 in. holes and the dowels fastened therein securely with glue. This forms a framework much like a hollow cage. Some very small screw eyes with holes just large enough to carry No. 12 bare copper wire were screwed into the corner posts on the outside, commencing at the bottom and continuing to the top at equal intervals of one inch. Into the bottom baseboard was fastened a large binding post to which was soldered the first terminal of the coil. Continuing, the wire passes through the screw eyes in coil or spiral form until the last one at the top is reached, where the end is also affixed to a binding post. All the woodwork is heavily shellacked. The flexible wire "*d*" which comes from one of the coil discharge knobs, has a metal spring clip, like the ordinary suspender clasp, on the free end, as does also the flexible wire "*t*" connected to the earth. With these clips any portion of the coil may be brought into use and any changes readily made, the coil, of course, being shut off while this is being done.

NEW EDISON BATTERY A SUCCESS.

Thomas A. Edison makes the important declaration that he has at last solved the problem of providing cheap and serviceable storage batteries for vehicles. He is quoted as saying: "By October my light battery will be ready for the market and we will be ready to equip automobiles of all descriptions. To reach a definite conclusion of its possibilities, I manufactured 11,000 cells and equipped about 160 conveyances. In Washington we attached the batteries to a number of express delivery wagons, with the result that after many months the cost of operation has been found to be 58 per cent that of horses. The batteries manufactured varied in types, so that I might obtain the happy average I wished to strike, and I am prepared to make the unqualified statement that the Edison battery will revolutionize the storage battery problem. As to its power there can be no question. I had a big two-ton car brought to my factory in Orange, where it was fitted with cells, and we took it out and sent it over the roads of New Jersey at 33 miles per hour."

MAGNETIC PROPERTIES OF ALLOYS.

At a recent meeting of the Royal Society of England J. A. Flemming and R. Hadfield gave the results of some of their investigations on the magnetic properties of alloys. They have found that an alloy composed of manganese 22.4 per cent, copper 60.5 per cent, carbon 1.5 per cent, silicon 6.37 per cent aluminum 11.05 per cent and iron 0.21 per cent, has magnetic properties which are identical with those of materials which are naturally feebly magnetic and that the permeability is between 28 and 20, which is not much inferior to the values reached for a low grade of cast iron for small magnetic forces. The alloy can also be permanently magnetized. This leads to the surmise that the magnetic properties of the alloy result from a similarity of molecular structure to that of the ordinary magnetic materials, such as iron, nickel and cobalt, and that, if the proper molecular arrangement can be found in an alloy, it may be possible to construct a material which is quite as magnetic as iron, and possibly even more so.

NEW ARMOR PLATE MILL.

The successful test of the first lot of armor plate made by the Midvale Steel Co., is a master of more than common interest. It has been generally held that it was idle to expect the discovery of any process capable of producing such plate of a quality equal to that of the established manufacturers, says the "Engineering Record." Even if such a discovery were made, the probability that it could become commercially successful so that large deliveries could be made on time was considered still more problematical. The event leading to the recent tests at Indian Head show that not only is the Midvale Co. able to make good plate, but is also able to turn it out on time, and it is important to recall in this connection that the company's contract was taken at a considerably lower figure than the prices in the tenders of the Carnegie and Bethlehem companies, which have heretofore had a monopoly of the business in the United States.

PHOTOGRAPHY.

PORTRAITURE INDOORS.

I am sure I do not know why, but one of the first an amateur attempts to do is to take a portrait. Sometimes he is successful and gets something that pleases his sitters, and sometimes he does not—more often the latter.

Now, indoor portraiture is one of the easiest things imaginable if one goes the right way to work. Our best photographers have studios beautifully equipped with blinds, etc., but very often they block out most of the light, and have only as much—sometimes even less—than an amateur can get in an ordinary room. It is the use of the light that is the secret, and not the after manipulations of developing and printing. If a beginner were given an undeveloped plate exposed by a professional he would perhaps get as good a negative as the more experienced man. It is in the lighting of the sitter that the beginner errs. Let us then look into it, and to do so properly a diagram must be used.

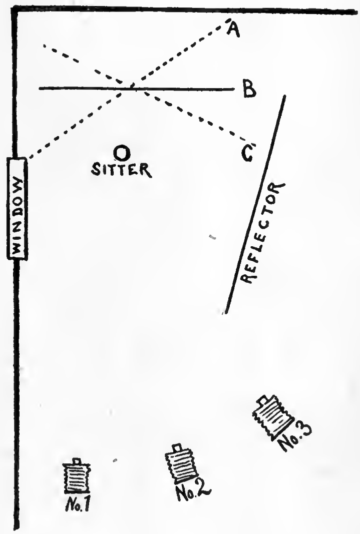
The sketch shown is meant to represent an ordinary room with one or more windows, but as we only require one window the others must be darkened, as the lighting from several windows will confuse us, and give cross lighting. The usual way of going to work is to place the background as *B* and the camera in the position marked No. 2. The background for portrait busts should be of medium tint, and different shades may be secured on this one background by placing it at various angles to the window, as shown in the dotted lines, *A* and *C*.

Now, if the camera be placed at No. 1 and we focus the sitter, what do we see? Simply that we have all the light on one side of the face and none on the other, and this is exaggerated upon the negative. The dry plate seems to increase the high lights and to deepen the shadows, and, although we may with the eye be able to see all details in the shadow part of the the face, the dry plate would have to receive a fairly long exposure, and the light side of the face would be blocked up owing to the gross over-exposure it would receive.

What we have to do, then, is clear; we must diffuse the light, take some from the light side of the face and use it on the darker side. This is easily accomplished by means of reflectors and screens, all of which may be home-made.

We may start by placing a reflector made of white paper or a sheet somewhere about the spot shown on the diagram. It matters little of what material the reflector be made, as long as it serves its purpose. Some workers use a large mirror, but this does not diffuse the light enough. So far so good, and this is the point at which most amateurs arrive and then fail. Why?

Simply this. There is still too much light on the window side, and it should be diffused. This may be done by means of tissue paper pasted over the lower half of the window, or better still, the dodge recommended by Richard Penlake in his book on the subject. Get a large wooden hoop, such as children use, and cover it with one thickness of tissue paper. Attach this to the bottom of the blind, if there be one, and by raising or lowering the blind we may get almost any quantity of light and shade we require. It is the working of this diffuser between the window and the sitter that is the great secret of home portraiture. Having got this window screen to work, the rest is simple. By placing the camera at 1, 2, or 3, and the background at *A*, *B* or *C*, it is possible to secure lighting equal to some of the best studios. The position of the reflector, too, can be varied.



Be careful to have enough light to light up the lower part of the face, either by carrying the reflector low down, by a sheet of white paper on the floor, or by manipulating the window screen. Focus the eyes, use as large a stop as possible, give a full exposure, develop carefully, and aim for a soft negative. Your indoor portraits should then be a success.—"Photo American."

PHOTO'S ON WATCHES AND THE LIKE.

There is evidently a growing taste for photographic portraits on such articles as watches, gold or silver cigarette cases, match boxes, etc., and the jewellers who undertake to get this class of work done usually charge a pretty good figure for it.

As the carbon method of producing pictures of this kind may be of service to many of our readers, we shall assume at once that the reader is already quite familiar with the practical working of that process, for we here say that anyone who takes up the working of this process for the first time and attempts to apply it to the present purpose, must not expect to meet with any great success in his first few essays. It goes without saying, that it is the double transfer system that must be employed—the picture being developed on a temporary support, and then transferred to the article desired. It will at once be seen by practical workers that the ordinary commercial flexible support is not suitable for the reason that it is too thick and unyielding to be pressed into sufficiently close contact on a convex surface, such as the dome of a watch-case, for example, to obtain a perfectly finished transfer. It may, however, sometimes be successfully used for quite cylindrical articles.

For the above reasons it will be obvious that a more flexible and yielding support must be employed. One is the India rubber support as first used by Swan; another is a film of collodion. We will deal with the former first. Some thin "foreign post" paper, the thinner the better, so long as it will withstand the warm water in the development, is coated with a solution of India rubber about the consistency of thin treacle. The best way of obtaining this is to get a tin of solution from the rubber stores and thin it down with benzole to the required consistency. It is poured into a dish and the paper floated upon it and then hung up for the benzole to evaporate. The paper had best be coated a few days before it is required for use, so as to ensure that all the solvents of the rubber have thoroughly evaporated.

This India rubber support is used in precisely the same way as the ordinary flexible support, the exposed tissue is squegeed upon it, developed, and then allowed to dry. The picture need not be alumed; indeed, it will be better for our present purpose if it is not. The picture is now ready for transferring to whatever may be required, which for the moment, we will assume to be the dome of the watch-case. It is unnecessary to mention that it must be removed from the watch; this a neighboring watchmaker will do for one. The dome is then cleaned with benzole, to remove all traces of grease or dirt. It is then coated on the outer side with a solution of gelatine containing a little chrome alum, such as that used for double transfer paper. The following is a good formula to employ:

Nelson's No. 1 gelatine	½ oz.
Water	10 oz.
Chrome alum dissolved in 1 oz. of water	6 gr.

The dome is evenly coated with this and allowed to dry. To make the transfer neatly, trim the print to the required size and put it and the watch dome in cold water for ten minutes or so. Next, put the latter in warm water at about 105° to 120° Fahr., until it just feels slimy. Then take the print, having previously marked it as a guide to position, and put it into contact with the dome, of course avoiding air bubbles, and remove the two and press in close contact with a soft dry handkerchief, gently rubbing towards the edges with the fingers so as to remove all superfluous water. It is then allowed to become thoroughly dry spontaneously. When dry the back of the paper is moistened with benzole, and after resting for a minute or two the paper can be slipped off, leaving the picture firmly attached to the metal. It now only remains to varnish the work. This may be practically a cold lacquer, and when dry is hard and durable as is the lacquer on our lenses. It is simply flowed over and drained off, and it dries in a few hours.

We mentioned just now that collodion might be used as a temporary support, and perhaps on the whole it is the best to employ. Here is the method: A glass plate, after being waxed, or prepared with French chalk, is coated with ordinary enamel collodion, thickened with two or three grains per ounce of pyroxiline, so that it yields a thick film. After the collodion has thoroughly set, the plate is put into a dish of water to soak, and is afterwards washed under the tap to get rid of the solvents of the collodion. The exposed tissue is then squeegeed on that, developed in the ordinary manner and allowed to dry. When dry the film can be stripped off and trimmed and then mounted on the metal, as just described. It is a good plan to trim the picture while it is still on the glass—a wheel trimmer and zinc shape is convenient for the purpose. The collodion film has an advantage over the rubber support, inasmuch as it is transparent, so that air bubbles can be seen and the picture better arranged in position. After the transfer the collodion can be dissolved off with a mixture of ether and alcohol.

In conclusion, it may be mentioned that for carbon pictures on metal a tissue should be selected that contains a large proportion of pigment to gelatine, and should also be printed from a tolerably thin negative, so as to avoid a high relief in the image, which is objectionable in this class of picture, and, moreover, it serves to indicate the method by which it has been produced, which, in some instances, it is not desirable to do.—"British Journal."

According to a contemporary, a square foot of uncovered pipe, filled with steam at 100 lb. pressure, will radiate and dissipate in a year the heat obtained by the economic combustion of 393 lbs. of coal. Thus, 10 square feet of bare pipe corresponds approximately to the waste of two tons of coal per annum.

FACTS CONCERNING PATENTS.

A Paper read by Mr. F. W. Winter befo.e the Mechanical Section of the Engineers Society of Western Pennsylvania.

CONCLUDED FROM THE SEPTEMBER NUMBER.

Several Claimants for Same Invention.—It is never absolutely certain that a patent can be obtained until it is actually granted. Several parties may apply for a patent on the same invention, and in that case the applications will be put in what are known as "interference" proceedings, in which the parties will be required to take testimony to prove who is the first inventor, and the patent will be granted accordingly.

The first inventor is the person who first perfected the invention and put it into a form capable of actual use, or, as it is technically known, "reduced the invention to practice". The best evidence of a completed invention is an actual commercial use thereof. But there is a rule that the filing of an allowance application for patent is the "constructive reduction to practice" and has the same force and effect in a contest on priority of invention as an actual commercial use.

While the general rule is that the first inventor is he who first reduced the invention to practice, an exception is recognized in favor of the party who was the first to conceive of the invention but the last to reduce it to actual practice, providing he was using reasonable diligence in perfecting and adapting the same. What constitutes reasonable diligence depends upon the particular circumstances of each case. The means at the command of a person, his employment, and other surrounding circumstances, his health, the complication of the invention, and cost of perfecting it, are all factors which enter into this question. What the law requires is reasonable and not the utmost diligence. But the Patent Office does not look with favor upon delays, and it requires a good excuse in all cases. The theory is that the party who first adapts an invention for actual use should not be barred by the stale claims of a prior conceiver who had slept on his rights.

The Patent Office does not require mechanical perfection, but will allow an application which shows a theoretically operative device and clearly describes the principle thereof. Since the filing of such an allowable application, in a contest of priority of invention, has the same force and effect as an actual use of the device, it is advisable for inventors to make application as soon as they have theoretically perfected the invention and not wait until they can put it into actual use, unless, of course, they are so situated that they can speedily give the invention an actual test.

Even after a patent is granted another party may file an application for the same invention and be put in interference with the patent. If he is able to prove by evidence which does not admit of a doubt, that he first completed the invention, a patent will also be granted to him. The Patent Office, however, cannot call back or annul the patent first granted. It will merely be decided that the patentee was not the first inventor and a patent will be granted to the applicant.

The Patent Office has no jurisdiction over a patent after it is granted except to declare an interference between it and a subsequent application, or to grant a reissuance of the patent in case it is invalid or inoperative by reason of a defective or insufficient specification.

Patent Does Not Guarantee that Invention Can be Used.—The grant of a patent is no indication that the device covered thereby can be used without infringing prior patents. This is a point upon which much misunderstanding exists. Many persons assume that because the Patent Office grants a patent, the patentee has a perfect right to use the device covered thereby. This is an error. The Patent Office does not pass upon the question of infringement, but merely decides whether the applicant has made a patentable improvement over prior devices, and it frequently happens that there are still in force prior patents which cover fundamental principles of the device, and which will be infringed by the improved device, if the latter performs the same function by the same or equivalent means. To illustrate:

The original Bell Patent covered the fundamental principles of transmitting speech electrically. Within a few years thereafter, and during the life of that patent, others invented and patented many different forms of transmitting which were improvements upon the transmitter shown in the Bell patent. These improvements were clearly patentable; but they were just as clearly infringements of the Bell patent, because they of necessity operated on the principle covered by that patent.

But in many arts today the existing patents are limited to such specific improvements that other improvements do not infringe.

All patents are prima facie valid. They may, however, be invalid for many reasons. The examiners in the Patent Office are human and liable to error. They also have not available the material for all the grounds upon which a patent might be refused or invalidated. Patents can be refused upon publications or descriptions of the invention in scientific and technical journals or books in all languages. The Patent Office has not files of many publications, and many which they have are not available within the limited time in which the examiner must dispose of a case. So, too, a patent may be refused upon a prior use of the invention in some remote part of the United States, and which may be known to only a limited number of persons. Obviously the Patent Office is not in a position to know of all uses.

There are, therefore, many elements entering into the validity of a patent upon which the Patent Office passes no opinion. A more extended examination through periodicals and prior uses than is possible for the Patent Office to make, will frequently show, either that the patent is entirely void, or that it must be so restricted that infringement can be avoided.

Who May Obtain a Patent.—It is essential to the validity of a patent that it be granted on an application signed and sworn to by the original and first inventor or inventors, or his or their executors or administrators. No other person, even with the consent of the inventor, can sign or swear to an application that will support a valid patent. The Patent Office has no means of ascertaining these facts, and will necessarily be governed by the oath of the application. Should it, however, afterwards develop that the party making the application was not the inventor, the patent will be invalid.

The fact that a person furnishes capital, machinery or material for developing the invention, gives him no right to make or join in the application for patent. Such person may acquire an interest under the patent, but this can only be done by an assignment executed by the inventor and transferring to him the whole or any fractional portion of the entire right to the invention and to the patent. If such an assignment is recorded in time the patent will be issued to the assignee, or jointly to the assignee and the inventor, as the case may be.

The builder of a new machine or device is not the inventor if he did not himself originate the ideas or principles contained in such device. In other words, an inventor may employ others to construct and mechanically perfect his invention without losing his exclusive right thereto, and without giving the mechanic who constructs it any right to the patent, unless it has been agreed upon by contract between the two parties. Even in that case the mechanic will take his right only by reason of the contract and under a properly executed assignment.

If a person conceives the general plan of an invention and employs another to construct and perfect the same, and the latter under such employment originates improvements which are included in, or, as the court said in one case, an ancillary to, the general plan, such improvements nevertheless belong to the person furnishing the general plan and can be included in any patent for which he may apply.

All patents and patent rights can be assigned without restriction by the owner or owners thereof, either before or after the patent is granted, or even before the application for patent is filed. All such assignments must be executed by the party or parties who have the legal title to the invention at the time the assignment is made. An assignment may cover the whole right under the patent or any fractional portion thereof.

An assignment must be recorded in the Patent Office within three months after the execution thereof. Otherwise it will be void as against subsequent purchaser for a valuable consideration and without notice of such assignment.

Patent Rights between Employer and Employee.—Employees as well as employers are entitled to their own inventions and to patents granted therefor. This right can be modified by contract, but in the absence of a contract to the contrary an employee is entitled to a patent for any invention which he makes, even though it may relate to the business of his employer. If he develops the invention in the time, and at the expense and with the tools and material of his employer, then the latter will have an implied license or shop-right to use such invention in his business, but he cannot demand an assignment of the patent.

Employers who wish to secure inventions relating to their own business, which are made by others while in their employ, should have a contract with the employee. Even with such a contract the employer cannot apply for a patent in his own name, but the patent must be applied for by the employee and assigned to the employer.

Joint owners of Patents.—Patents may be owned jointly by two or more parties, and these may have different fractional interests. A common misapprehension is that one joint owner of a patent may make, use or sell the patented invention without the consent of, and without accounting for profits to, his co-owners. This is an error. In the absence of a contract to the contrary, any co-owner of a patent, no matter what fractional interest he may hold, is free to assign his interest in the patent, or to manufacture, use and sell the patented device, or license others to do so, without the consent of his co-owners and without accounting for any part of the profits.

If, therefore, a person owns merely a one-hundredth share of the entire patent right, he may manufacture, sell or use the patented device without the consent of or accounting of the profits to, the owners of the other ninety-nine one-hundredths. By reason of superior facilities for manufacture or superior business ability, he may even monopolize the field so as to practically exclude his co-owners from deriviug any income whatsoever from their share of the patent. He is nevertheless entirely within his right. The only way this can be prevented is by a properly drawn contract between the co-owners.

Applications for Patents.—Only a small percentage of patent applications are allowed as first filed. Generally the officials find some objections against the specifications or claims, generally the latter. It frequently happens that a patent is not secured until after repeated considerations. An inventor should therefore not be discouraged because in the first instance his application is rejected. The rules give ample opportunity for overcoming rejections either by amendment or argument, or both, or even appeal to a higher tribunal.

Amendments may be made to applications at any time prior to the allowance, so as to more clearly or definitely claim the invention, or restrict the specification and claims to that which is found after examination to be new. But no new or additional matter can be incorporated in an application after it is filed. Anything which is found either in the specification, claims, drawing or model as originally filed in the Patent Office, is not new matter, but anything outside or beyond these will be refused, or if added, the patent will be invalidated thereby. This rule is very strictly followed.

The writer desires to emphasize this point, as his experience is that many inventors think that references which the Patent Office cite against their application can be evaded by making changes or alterations in, or additions to, the application. All efforts in this direction are futile. Modifications and alterations which come within the scope of the claims allowed in the application are covered and protected by the patent. But all other alterations or modifications are not protected by the patent. If they are of sufficient importance to constitute an independent invention, they can be protected by making a separate application therefor.

Marking Patented Articles.—The owner of a patent must mark the patented articles plainly with the word "patented," or similar word, together with the date of the patent, or otherwise give sufficient notice to the public that the device is patented. The failure to so mark will prevent the recovery of damages forinfringement occurring prior to actual notice of the patent to the infringer.

No person should mark an unpatented article with the word "patent" or other designation which would lead the public to believe that the article is patented. For each such false marking, with intent to deceive the public, the marker is liable to a penalty of $100. While the application is still pending the manufactured article can be marked "patent pending" or "patent applied for." This will warn the public, and in most cases will prevent infringement.

Caveat.—There is a common misapprehension that a caveat is a short-term patent. On the contrary, it is a mere notice to the Patent Office that the party has made an invention and wishes further time to mature the same. It continues in force for one year and it may be renewed from year to year by the payment of the required government fee. If during the term of the caveat, or any renewal thereof, another person files an application for patent for the invention shown in the caveat, the caveator will be notified thereof and will be required to file his application within three months from the time of receiving the notice. The two applications will then be put in interference and testimony will be taken to prove who was the first inventor and the patent will be granted to such party.

A caveat is not a patent at all, nor even an application for a patent, nor can it by any possibility mature into an application. No one can be sued for infringement under a caveat. It is a mere notice to the Patent Office, and if the caveator wishes afterwards to obtain a patent he must file a regular application in the usual way.

Foreign Patents.—The patent laws of no two countries are the same, and a device which is patentable in this country may not be patentable in foreign countries, and vice versa, devices which are not patentable here may be patentable in some foreign country. In Germany it is difficult to obtain patents, the laws and their interpretations being very strict. Many of the small improvements which are patentable in this country find no favor under the German law. In other foreign countries, notably Belgium and France, no examination into the novelty or patentability of the invention is made, but the patent is granted as a matter of course. But this does not mean that the patent will be held valid, as it may be overthrown if it is found that the invention was not new in that country at the time the application was made. It is essential, therefore, in these countries that the prior state of the art be thoroughly investigated before the patent claims are drawn.

The cost of obtaining a patent in most foreign countries is greater than in the United States, and the conditions of maintaining the patent are somewhat burdensome. In this country, no taxes or renewal fees are necessary, nor is the patentee even compelled to manufacture the patented device or put it into use. In most foreign countries the patents are subject to annual taxes or renewal fees. These vary in the different countries, being generally quite low the first few years of the patent term, but gradually increase. Such taxes amount to a considerable sum in the aggregate, and if the patent is not producing a revenue they are a burden.

So, too, in most foreign countries the inventor must put the invention into actual use in that country, or at least make such arrangements for manufacturing and so advertise the fact, that any person wishing to procure the patented article can be supplied. The manufacture of the articles in this country and importation into foreign countries does not comply with this provision of the laws of those countries.

In most foreign countries patents must be applied for before corresponding patents are issued in this or any other country. Canada is an exception, as patents can be applied for within a year after the issue of a patent in another country.

THE DESIGN AND CONSTRUCTION OF INDUCTION COILS.

BASIL GRAVES.

It has occurred to me that not a few of our readers would appreciate a brief contribution upon this subject in general, if I may be permitted to judge from the number of queries dealing with the matter which have been reiterated during the past twelve months. The induction coil is one of those modern appliances now of more than mere theoretical interest, so numerous are its applications, not to mention the numberless instances where its use is necessitated. Not a few instances conducive to its universal use are afforded in the method of igniting the explosive charge of internal combustion engines, its utility in radiography, and, to a certain extent, electro-therapeutic work. Nor must we omit to consider the value of a coil as far as work in experimental research is concerned. It constituted the key to the innumerable experiments conducted by Hertz in his endeavors to solve the problem of the Berlin Academy of Science— viz., to establish experimentally any relation between electromagnetic forces and the dielectric polarization of insulators. The investigations which he pursued with a view to effecting this purpose resulted in the discoveries which, I need scarcely say, laid the fundamental basis of that modern application of the effects of electric oscillations—namely, wireless telegraphy. Here again the induction coil becomes of paramount importance; it constitutes the very heat of the apparatus employed. In spite, however, of these facts, the induction coil has continued to remain, comparatively speaking, an expensive piece of apparatus. Perhaps, from the manufacturer's point of view, I am not justified in making such a statement, for it certainly is to be confessed that the requisite time and trouble entailed in the construction of coils—especially with regard to those of the larger type—is considerable. But there are many who, given the means wherewith to proceed, and the necessary time, prefer themselves to attempt the work of construction. It is to these persons individually that the purchased article appears so expensive, and to whom, in particular, these remarks apply. Small coils are comparatively simple to make, such as those capable of giving a ½ in. spark for the ignition work of internal-combustion engines, or 1-in. as suitable for working in conjunction with ozonizers or illuminating tubes for spectrum analysis. Coils capable of giving sparks between 5 and 12 in. in length are in demand for work in radiography and X-rays, while those yielding sufficient potential difference between their secondary terminals to spark across an intervening air-gap still greater than this last, are suitable for theurapeutic work with high-frequency apparatus, and signalling without wires over long distances.

With regard to the smallest coils, these may well be wound in sections containing continuous layers of wire; but with the larger type of coil it is necessary to subdivide these sections. Taking the former type into consideration first, those up to the ½ in. size may be wound in two sections—*i. e.*, the secondary is divided into two equal portions by a central intervening disc of insulating substance; 1 in. coils, again, should be wound in four sections, and 2 and 3 in. in six. Above this size the method of winding must be different and will be discussed hereafter.

The secondary wire utilized for the purpose should in all cases be single silk covered; cotton, besides possessing comparatively poor insulating properties, requires much more space than silk. It may here be said, however, that a double covering of silk is superfluous, no benefit being derived from its use. Preparatory to commencement, let the bobbins of wire be well warmed to effectually cause the evaporation of any moisture contained in the insulation. They should then, if possible, be kept in a warm, dry place until the moment when required for use.

The paper utilized for this insulation of the respective layers of the secondary should be thin and thoroughly dry. It should not, however, be soaked in wax previous to use; it is far preferable to cover the layers with unwaxed paper to commence with, and so soak the whole winding in wax for 24 hours after completion. The reason of this is that it is difficult to closely cover a layer with paper that has been previously soaked in wax, and, moreover, when this is done, the paper occupies about three times more space than in the unwaxed state. The wire may, however be fed through a small trough of wax, with the result that the insulation will take up a sufficiency of this latter to saturate the paper when, after completion, the whole secondary is heated in a paraffine bath.

The layers of wire should never be wound so close to the edge of a section that there is any risk of one turn slipping below the level of its neighboring turns, for in the event of this occurring the high potential difference which would ensue between the adjacent layers would inevitably result in internal sparking and consequent failure. It is best to discontinue the winding of all layers at a distance of about 3-32 in. from the extremities. This will obviate any risk of such occurrence. The secondary must not, of course, be wound directly on to the ebonite tube, as this latter would not stand the heat if soaked in wax. The best mode of procedure under the circumstances is to make a thin tube of shellacked paper to exactly fit over the ebonite tube, and by means of paraffined discs of cardboard, to divide it into the requisite number of sections. This tube is then mounted on the winder and is ready to receive the wire; then, after completion, the whole secondary is ready to be slipped bodily over the ebonite tube containing the primary and core. With reference to the direction of winding of the respective sections, each section should be wound so that the current will be in the same direction through all sections.

Before giving definite particulars as to the specific dimensions of the various parts of small coils, let me make one more remark applicable in general to these —namely, as to the winding of the primary. Where possible this operation should be performed with the aid of a lathe, or other suitable winding appliance, in order that it may be done as evenly as possible; and to effect economy as regards space, let both layers be wound with right-handed helices, as in the case of the primary of larger coils, in order that the successive turns of the second layer may occupy the grooves formed by those of the first. These points as to the primary winding are important, in order that the latter may be a good fit within the insulating tube without unnecessary waste of space.

I now append a table showing the dimensions of the most important parts of coils up to those capable of giving a 3 in. spark. In the case of the condenser the reader will understand that the figures imply the approximate total superficial area of foil. I leave it to the reader to determine upon the size and number of sheets that he will utilize to obtain the total area required, as this will vary to suit individual requirements.

	$\frac{1}{2}$ in. Spark.	1 in. Spark.	$1\frac{1}{2}$ in. Spark.	2 in. Spark.	3 in. Spark.
Length of core	$6\frac{1}{2}$ in.	$7\frac{1}{2}$ in.	8 in.	9 in.	11 in.
Diameter of core	$\frac{5}{8}$ in.	$\frac{7}{8}$ in.	1 in.	1 in.	$1\frac{1}{8}$ in.
Gauge of primary wire	20 S. W. G.	18 S. W. G.	16 S. W. G.	14 S. W. G.	14 S. W. G.
Internal diam. of ebonite tube	$\frac{7}{8}$ in.	$1\frac{1}{8}$ in. (full)	$1\frac{3}{8}$ in.	$1\frac{1}{2}$ in.	$1\frac{5}{8}$ in.
External diam. of ebonite tube	$1\frac{1}{8}$ in.	$1\frac{3}{8}$ in.	1 11-16 in.	$1\frac{7}{8}$ in.	2 in.
Approx diam. over secondary winding	$2\frac{1}{2}$ in.	3 in.	$3\frac{1}{2}$ in.	$3\frac{3}{4}$ in.	4 in.
Distance between coil heads	$4\frac{1}{2}$ in.	$5\frac{3}{4}$ in.	$6\frac{1}{2}$ in.	$7\frac{1}{2}$ in.	9 in.
No. of sections for secondary winding	2	4	4	6	6
Quantity of secondary wire	$\frac{3}{4}$ lb.	$1\frac{1}{2}$ lb.	2 lb.	$2\frac{1}{4}$ lb.	$3\frac{1}{4}$ lb.
Condenser (total area of foil)	700 sq. in.	1.000 sq. in.	1,500sq. in.	1,800 sq. in.	2,300 sq. in.

We must now direct our attention to the larger type of coil—viz., those ranging in size between 4 and 12 in. Before considering the definite dimensions of various large coils, there are certain points dealing with the general design which I venture to suggest, among which some that I am not aware of being given elsewhere may prove of value to intending makers.

Firstly, I need scarcely say that it is essential that the secondary of any coil capable of giving upwards of a 4 in. spark should be wound in insulated sections of never more than $\frac{1}{8}$ in. thickness, and that the method of winding in double, yet insulated sections, according to Hare, is not to be beaten, both in point of efficiency and convenience. Perhaps a simple disc, composed of two superimposed thicknesses of paraffined blotting-paper, suffices to separate the sections in the case of coils ranging in size between 4 and 8 in.

Beyond this, let Hare's method be adopted. With 4, 5 and 6 in. coils, I do not consider that the annulus of cotton wound into the section-former preparatory to feeding in the wire is necessary. It is better in this case, to allow the diameter of the central aperture of the section to slightly exceed that of the main insulating tube, so as to admit of a small interstitial space wherein wax may be poured when mounting each section on the tube after winding. In the case of 3 to 12 in. coils, the potential difference between the two extreme ends becomes so great that it is necessary to gradually increase the thickness of the insulating medium separating the primary winding from the secondary at the extremities of the coil are approached. This is effected by winding into the section-former, preparatory to feeding in the wire, thoroughly dry paraffined cotton until an annulus of the desired depth been formed. In the case of 8 in. coils the depth of this may be 0 at the center, gradually increasing to $\frac{3}{8}$ in. at either extremity, while with 12 in. coils, $\frac{1}{4}$ in. at the center, tapering to $\frac{1}{2}$ in. at the extremities.

When mounting the sections of the secondary the insulating properties of the coil may be materially increased by interposing at about every sixth section, a disc of thin sheet ebonite of a diameter slightly exceeding that of its adjacent section and having a central aperture of just sufficient size to permit of its being slipped over the main insulating tube. The thickness may well be 1-16 in., so that in a coil having forty-eight double sections, this would only result in an increase in the lateral measurements of half an inch.

In the secondary of a large coil it is advantageous that the contour of the winding, when finished, should conform with the direction of the magnetic lines of force of the core. The sections may therefore taper from a smaller diameter at the extremities to one somewhat larger at the center.

Before leaving the subject of the secondary let me add one more suggestion dealing with the winding of the sections, and that is, instead of merely feeding the wire through a small trough of wax, let the whole reel be immersed, whilst winding, in a paraffine bath. Then the wire will be heated throughout, and the wax which is absorbed by the insulation thus prevented from solidifying on its way to the section-former—an important point, as the mechanical stability of the sections is dependent upon this.

The iron core, though in every way the very heart or essential part of a coil does not, in my opinion, receive sufficient attention by those who essay to construct their own coils. It is comparatively simple to make the cores of small coils such as those figured above. But the core of a large coil is a more formidable thing. The amateur, or even anyone who is not in possession of a special machine for cutting and straightening the individual wires, will find it impossible to satisfactorily make a large core. Even though he may take the greatest care in endeavoring to straighten each wire separately, he will find that, at most, he can only get his core to weigh two-thirds that of the purchased article, size for size. The reason is that all the wires of those that are machine-cut lie side by side, and parallel, throughout their entire length, with the obvious result that no space is wasted and the core consequently contains the maximum quantity of metal. The reader will find this factor figured in the table given, and if he is successful in his attempt at construction, then by all means let him profit by it; otherwise I strongly urge the purchase of a machine-cut core. In either event it will be necessary to anneal the core, which during the operation should be enclosed in a metal tube.

As regards the primary winding, I do not consider that on the whole any advantage is to be derived from the use of more than two layers of wire. Let each layer, however, be wound, as previously mentioned, in right-handed helices,—that is, the second lying in the grooves of the first. A double covering of cotton to this wire will afford sufficient insulation, provided the whole core, with the primary winding when complete, be first of all heated in an oven and thence transferred direct to a paraffine bath constructed for the purpose, and left therein for about 24 hours, or in other words, until air bubbles cease to be emitted. In all cases where a coil is designed for experimental work, it is advantageous to arrange, as suggested by Hare, that the layers of the primary may be connected either in series or parallel as desired.

The condenser, for convenience, should be built in four separate sections connected to a four-way plug key in such a manner that the capacity may be varied at will. The whole should be clamped between two good pieces of ½ in. mahogany, or some other hard wood.

Small coils are always of one shape—namely the simple "bobbin" form on an enlarged scale. But in the case of large coils, the shape of the body of the coil proper, and also the mode of fixing it to the base differ. It is desirable in all cases that the secondary terminals which are mounted on the top of the coil heads should be as far as possible from any metal or other conductor, and especially from any part of the core or primary circuit. With a view to effecting this, over the extremities of the main insulating tube fit short auxiliary lengths of a larger piece of tubing. Each of these is threaded with a male screw thread for a distance of ½ in. at one extremity and ⅜ in. at the other. The former fits a corresponding female thread in the center of the ½ in. ebonite cheek, while the latter screws into the main support at each end. A distance of 2 in. is thus left between the two opposed faces respectively of the coil-heads and supports. It is absolutely essential that these coil-heads be of ebonite; but the supports, which are best cut square, with the tops ornametally rounded off, need not necessarily be of that material, well seasoned mahogany or teak, stained and polished black, affording a good substitute. It may here be mentioned incidentally that an infusion of logwood only must be used for the purpose of staining, as lampblack, as generally employed, is a partial conductor.

Now, the mode of fixing the coil to the base, and of making the connection to the primary circuit, may be such as to enable the coil to be bodily removed from the base when desired with little or no trouble, and to be replaced with corresponding ease. This is extremely useful where the coil may be required for transport, and in numerous other instances. It consists in allowing for a protrusion of about 1 in. in length and ½ in. in thickness at each of the lower corners of the main supports when cutting these latter, so as to form, as it were, small projecting "feet." Then instead of permanently screwing the supports to the base from beneath, four medium sized bolts are fixed upright through the nut in such position that when the supports of the coil rest on the base the bolts may protrude upward through holes drilled through the four feet. A small mill-headed brass nut is then provided for and screwed on to each bolt, thus firmly securing the coil to the base, but in such a manner that it may be instantly taken off whenever it is desired.

The method of making the connections through from the primary coil to the base is best done by fixing to each of the two supports two telephone pattern terminals, one on either side of the central aperture. thus making in all, four, to which the four ends of the primary winding respectively are connected. Then directly beneath and reaching to each terminal, an upright length of ½ in. brass rod is fixed through the base and connected with the wires below, so that when the coil is placed on the base these shall pass through the holes in the terminals, as the bolts through the holes in the projecting feet of the supports.

In the tables of the sizes of large coils which I now append, it must be understood that those of the 4, 6, 8 to 10 in. size are of one of the designs referred to. Above this size, however, the design suggested by Hare is to be preferred as affording better mechanical stability in the case of these very large coils, which are extremely heavy. This fact should be borne in mind when reference is made to the table.

Before concluding, let me advise readers against the use of the Wehnelt or other electrolytic interrupter in conjunction with coils, unless the latter be specially designed for this purpose, which means additional insulation throughout all parts of the secondary wind-

	4 in. Spark.	6 in. Spark	8-10 in. Spark.	12-14 in Spark.
Length of core	10 in.	13 in.	17 in.	18 in.
Diameter of core	1⅛ in.	1¼ in.	1½ in.	1 11-16 in.
Weight of core	2½ lb.	4 lb.	7½ lb.	8 lb.
Gauge of primary wire	14 S. W. G.	14 S. W. G.	14 S. W. G.	14 S. W. G.
Internal diameter of ebonite tube	1¾ in.	1¾ in.	2 in.	2 3-16 in.
External diameter of ebonite tube	2⅛ in.	2¼ in.	2½ in.	2 11-16 in.
Average diameter of secondary sections	3½ in.	4 in.	5½ to 6 in.	6 to 7 in.
Number of double sections	30	38	48	48
Distance between coil-heads	7 in.	9 in.	12 in.	14 in.
Quantity of secondary wire	4½ lb.	6½ lb.	9 lb.	15 lb.
Condenser (total area of foil)	3,000 sq. in.	4,000 sq. in.	8,000 sq. in.	10,000 sq. in.

ing. The use of this type of break with an ordinary coil will certainly impair efficiency, and finally cause the breakdown of the whole coil, either as the result of internal sparking or, what is worse, fusion of the secondary wire.

Moreover, in radiography, no ordinary tube will stand the excessive discharge of the coils actuated by these breaks, the anti-kathode invariably being fused and the tube consequently destroyed. It is necessary in these cases to employ a specially constructed tube, having a hollow water-cooled anti-kathode, that the excessive heat which is generated may be conducted away as rapidly as possible. But even if this is the the case, another trouble will ensue—namely, rapid and frequent alterations in the degrees of vacuum of the tube. The reader is therefore strongly urged to adhere only to the platinum and mercury breaks. Among the former of these, that type known as the "Vril," is by far the best and most efficient. With its use, by reason of the principle of mounting the platinum contact-piece on a separate spring, the maximum degree of magnetic saturation of the iron core is obtained at every contact, which is impossible in the case of the simple type of platinum break.

Care should be taken that when working, the tension screw is not turned back too far, as when this is the case the platinum surfaces remain in contact for a longer period then it necessary to effect the abovementioned purpose, and consequently a needless waste of current ensues. If accumulators be utilized as the source of energy, this is liable to impair their efficiency through causing an over-excessive rate of discharge. When the current is switched on let the tension screw be gradually turned only until the maximum efficiency of the coil is reached, and no further.

To obtain without risk the best results from a large coil, the rotary mercury, or any other well-known type of mercury interrupter is excellent. A comparatively simple yet efficient break of the former type is not difficult to construct. It consists of a circular disc of thin sheet brass, about 2 in. in diameter, having four equidistant projections protruding beyond the periphery, which is attached to the extremity of the shaft of a small drum-armature motor. A small receptacle containing mercury is so placed under this metal disc that when this latter is rotating, the four protruding blades may alternately make and break contact with the mercury. The edges of the blades should be circular, so that by raising or lowering the level of the mercury, the period of contact can be correspondingly regulated. The frequency of the interruptions may be regulated by the speed of rotation of the motor, which is best effected by including a rheostat in the circuit of the motor and its source of supply—preferably a four or six volt accumulator.

The interrupter is included in series with the main primary circuit of the coil, the current passing through the mercury and shaft of the motor, by way of the revolving metal disc. It is sometimes advised that the contacts of the platinum break should be screwed together, and the mercury interrupter included externally in the circuit. This, however, is inadvisable, as by so doing the function of the condenser is destroyed. The correct way is to connect, as usual, the source of current with the main terminals of the coil, to separate the contacts of the platinum break, and then to connect the mercury interrupter to the respective pillars of the latter, for which purpose terminals should be provided for the base of the coil. The condenser is then not short circuited, with the result that the full effect is produced with the coil.

Here, as with platinum breaks, however, let care be taken not to render the period of contact longer than is absolutely necessary to effect the full degree of magnetization of the iron core, for the reason explained above. It should be borne in mind that the inductive effect between the primary and secondary windings occurs only at the moment of the alternate make and break of the current, and no advantage is to be derived from a continuous flow of current. To obviate risk, therefore, of this occurrence, especially when accumulators constitute the source of energy, the period of contact when the current is switched on, should be small, and then gradually increased until the desired effect is obtained.—"English Mechanic."

The General Electric Co., Lynn., Mass. are developing apparatus for the equipment of combination gasoline-electric business vehicles and rail cars, and will soon bring out a full line of gasoline engines, dynamos, controllers and motors suitable for a variety of applications.

AMATEUR WORK.

DRAPER PUBLISHING CO., Publishers,

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A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month for the benefit and instruction of the amateur worker.

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Single copies of back numbers, 10 cents each.

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New advertisments, or changes, intended for a particular ssue, must be received at this office on or before the 10th. of the previous month.

Entered at the Post Office, Boston, as second class mail matter, Jan. 14, 1902.

OCTOBER, 1905.

The present number completes the fourth year of the publication of this magazine. We take this occasion to express our sincere appreciation of the cordial support given us by our readers, and of our intention to deserve a continuance of their patronage by furnishing a magazine which will contain so much of value to its readers that they cannot dispense with it.

Merit is the great criterion of success in these days in all lines of industry, and by that standard we shall shape our work. Our readers can render valuable assistance if they will, by suggesting topics they would like to have written up, and suggestions of this kind will be thankfully received and acted upon as far as practical.

Also, in another line valuable help can be given. If readers will but call the attention of friends to the magazine, the number of readers can be largely increased, which increased patronage will, in turn, enable us to further enlarge the size and scope of the magazine to the advantage of all.

In this number will be found a brief description and drawings of a model steam engine. The November number will contain one of a horizontal engine of equally diminutive size. Our purpose in presenting these descriptions is to learn if our readers are interested in them, or similar models. If a sufficient number of requests should be received, patterns and castings will be prepared and offered as premiums. Suggestions as to variations from these designs will also be welcome. In the event of a sufficient demand, descriptions of boilers, suitable for furnishing steam will also be given. If you are interested, therefore, write and tell us so, as this is the only way we can learn of it.

Model making as a means of studying engineering subjects, is not appreciated in this country to near the extent which it deserves. A model steam engine and boiler, if well made and complete in its parts, taken in connection with a good text-book, afford all that is required to become sufficiently familiar with steam engine running to enable one to successfully pass the examination for a second-class engineer's license. Such a license places the holder in the position of being able to readily obtain work at fair wages; better by far than is received by the dry-goods clerk, whose clothes may be cleaner and necktie larger than the engineer, but who has little or no future advancement to look forward to. In a similar way, a telegraph outfit will enable the owner to learn telegraphy, and good openings for temperate men are always available. It pays to have an aim in life, and by beginning early and working steadily, the goal is reached in time. Get a hobby, then, and ride it.

The number of inquiries regarding the offering of premiums not included in our regular list make it necessary to again state that any article desired by a subscriber will be offered as a premium upon request, at terms as favorable as possible. Many have obtained numerous electrical or mechanical tools or instruments, and others could, if but willing to make a little effort. Fill up your tool chest in this way; it is easily done.

ELECTRIC BATTERIES; THEIR CONSTRUCTION AND USES

FREDERICK A. DRAPER.

II. Polarization—Single and Double Fluid Cells.

As noted in the previous chapter, during the action of a cell, the hydrogen bubbles which are liberated collect on the surface of the negative plate or cathode, and unless removed by chemical or mechanical means, obstruct the chemical combination producing the difference in potential between the electrodes of the cell, and the current flowing through the external circuit is decreased. This is known as "Polarization," and its removal is termed "Depolarization."

Several methods have been used to remove the hydrogen bubbles, such as agitation of the fluid, which causes the bubbles to rise to the surface and pass off into the air; accomplishing the same result by heating fluid or by forcing air through it. These methods are all of external operation, the power usually being of clockwork except in the case of heating. They have no advantages over the method in general use, the chemical one, in which the negative element is surrounded by a solid or liquid substance possessing great affinity for the free hydrogen. The free hydrogen readily unites with the depolarizer, providing the current developed by the battery is not great enough to evolve hydrogen in excess of the capacity of the depolarizer to unite with it. It is evident, therefore, that the design of a cell, and the area and quantity of its elements must be proportioned to the current to be drawn from it.

The depolarizing chemical is one rich in oxygen, which uuites with the free hydrogen to form water, thus gradually diluting the electrolyte until eventually the cell is so weak as to require a new supply of electrolyte for continued use. Where a depolarizing chemical is used, it is also necessary to select elements which will have little or no affinity for the depolarizing chemical, else when no current is passing through the external circuit, the action within the cell, known as "local action," will continue, and the elements used up without having performed useful work in the external circuit. It is necessary then, in order to have a practical cell, that the elements composing it should be without action, except when the electrolyte is decomposed by the passage of the current.

It is also desirable that the difference in potential between the electrodes be as great as possible, that the output of the cell be large. Here again the depolarizer may be of value, as, if possessing affinity for one element only, the resulting combination therewith develops a potential difference which is additional to that of the decomposition of the electrolyte, and so increase the E. M. F. in the external circuit. On the other hand, if more than one element in a cell has an affinity for the depolarizer, combination takes place, independent of the decomposition of the electrolyte, and the E. M. F. in the external circuit is reduced. This explains why two cells in which the same metals are used, but with different electrolyte and depolarizer, do not give off the same E. M. F. in the external circuit, or continue in efficiency for the same length of time. The reason for the wide variety of combinations to form the numerous cells on the market is also evident, each type having uses for which it is best adapted, and to explain which is the purpose of these articles.

The metal most nearly answering to the requirements already noted is zinc, which, in proportion to the energy whieh may be developed by chemical combination, is also the cheapest metal which can be used, and hence we find it in almost universal use in those forms of cells in common use. Unless refined for electrical use, the impurities usually to be found in commercial zinc cause local action which diminishes the efficiency of the cell and which is avoided by amalgamating the surface with mercury.

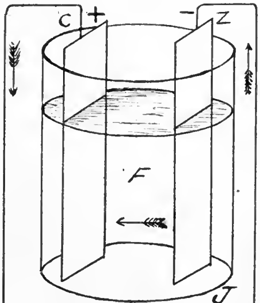


FIG. 1.

A convenient way of amalgamating zinc is to first thoroughly clean the surface of the metal of grease with common washing soda and warm water and then rinsing it in running water, with a pledget of cotton wool which has been dipped in dilute sulphuric acid (water 10 parts, acid 1 part, by bulk), rub the surface of the metal, and while rubbing, pour on the mercury, drop by drop, spreading it over as great a surface as possible with the pledget. Another way is to mix the mercury with the acid solution and apply with the pledget. In either case care must be taken to avoid the use of too much mercury, as it causes the zinc to become brittle and easily broken. Amalgamating the zinc is of value only when an acid electrolyte is used; with a saline solution it has little or no protective effect.

In some forms of cells the formation of free hydrogen is not great enough to seriously affect the normal action of the cell, even if no depolarization is used, or if one be used, it is in solution with the exciting fluid. This leads us to divide the various forms of batteries into general classes, viz., "single fluid" and "double fluid" cells. The single fluid cell is illustrated in Fig. 1 in which *J* is the containing jar, *F* the exciting fluid, which may or may not have in admixture with it a liquid having affinity for the liberated hydrogen; in this fluid are the plates *Z* and *C*. The plate marked *Z* is a metal readily acted upon chemically by the exciting fluid and *C* a metal which is a good conductor of electricity, but upon which the exciting fluid has little or no action. The function of plate *C*, is to collect and convey to the external circuit the electrical force resulting from the chemical action between the exciting fluid and the plate Z.

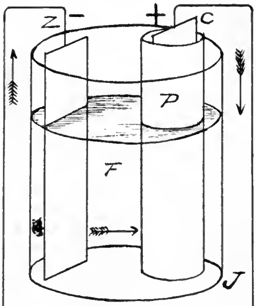


FIG. 2.

As the chemical action starts at the plate Z and the E. M. F. develops at this point and flows in the cell from this element to the element *C*, it is usual to term the element Z "positive," having as it does the higher level of energy, and the element *C*, which receives and transmits to the outside circuit, is termed the "negative" element. As regards the outside circuit, however, these terms are reversed when applied to the points of junction with the outside circuit, and known as the "poles" of a battery. The positive pole is that from which the current flows, and the negative pole that by which it returns to the cell. Keeping in mind the fact that the point of origin is positive, whether applied to element or pole, will serve to keep clear this apparently contradictory application of terms.

In the double fluid cell, as illustrated in Fig. 2, we note the addition of the porous pot *P*, in which is placed the carbon plate, and also some fluid or substance having great affinity for the free hydrogen which would ordinarily collect upon the surface of the negative element *C*. Either positive or negative element may be placed in the porous pot, providing always that the depolarizer shall accompany the negative element.

It is also important that the pot be very porous, for while it serves to separate the exciting fluid and depolarizer, it must offer the least possible obstruction to the action of the cell causing the flow of the current.

MATCH MAKING.

In the latest match making machine, the wood from which the match splints are made is pine plank two inches thick which, after thorough drying is re-sawed into lengths one and seven-eighths to two and one-half inches, representing the length of the matches to be made. The knots and cross-grained parts are cut out of the blocks and these blocks are put into the automatic feeder of a machine, the paraffine and composition for the head of the match having been properly prepared and placed in their respective receptacles, where they can be replenished without stopping the machine. The knives or dies that cut the match splint from the blocks are so placed in head block of the machine that when the splints are cut they are separated by a quarter of an inch and placed or set in castiron plates made into an endless chain by link attachments. At each revolution of the machine 44 matches are cut and set, the machine making 175 to 250 revolutions a minute. From the cutting end of the machine the endless chain moves along over a drying or heating block prepared for this purpose where the match splint is heated to a degree nearly equal to that required to melt paraffine so that the paraffine may not chill on the stick when the splint passes through it. but that the end may be thoroughly saturated. The chain moves on to the composition rollers where the match receives its head, and then comes into contact with blasts of cool dry air for an hour and a half, when it returns to the place of beginning, just before reaching which the matches are punched out of the chain by an automatic device into small paper or strawboard boxes varying in size, containing 65 to 500 matches, the boxes having been fed into the machine automatically. Two million or more paper or strawboard boxes are consumed each day in the packing of matches in this country. One million and a half pounds of chlorate of potash are consumed annually in the manufacture of matches.

The most remarkable fall of meteorites known to history was that which occerred at L'Aigie in France in 1803. Between 2000 and 3000 meteoric stones fell over an area of nine miles long by three wide, some of which weighed 50 pounds or more.

A CHEAP NINE-INCH REFLECTOR.

M. A. AINSLEY.

V. Apparatus for Testing Lenses.

Presuming that the reader has mastered Chapter IV, giving the theory of the pinhole test at the center of curvature, I will briefly describe my apparatus:—It simply consists of a wooden baseboard (metal would be even better) to support the lamp, taken from a cheap bicycle, which gives a flame $\frac{1}{2}$ in. wide. Immediately in front of the flame is a vertical wooden board (4 in. x $2\frac{1}{2}$ in.), which has a $\frac{1}{2}$ in. hole level with the brightest part of flame. This supports, on the flame side, a brass plate with a hole 1.160 in. in diameter. This I got drilled by a watchmaker with a drill .15 millimetre in diameter. The plate with a hole in it can be easily removed or placed in position, and a screen of tin round the lamp shields the eye from its light.

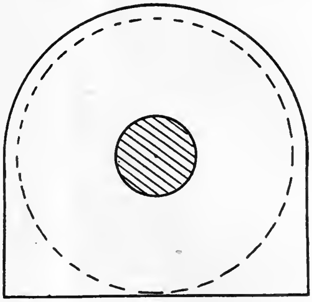


FIG. 1.

Immediately to the left of this lamp, and so that its center line is not more than $2\frac{1}{2}$ in. from the pinhole, and on the same level, is a brass tube supported on two wooden Vs and, of course, parallel to the line joining flame, pinhole and mirror. A line is cut round the tube, accurately at right angles to its axis, as an index, and the position is measured by an ivory millimetre scale attached to the Vs; 1 mm. = 4-100 for all practical purposes, and it is easy to estimate to $\frac{1}{4}$ mm., or 1-100 in. The mirror is supported against a stout board and rests on a shelf on the board. It is placed at a somewhat lower level than the apparatus. If the tube used is, as in my case, the "draw-tube" into which the e. p.'s screw, an efficient "occulting screen" be made by removing the lenses of a low-power eyepiece and using the diaphragm or stop, which limits the field of view.

The testing apparatus and speculum should be supported on firm supports, tripods if possible, on a stone floor; but testing may be carried on, as I found, even in an upper room, if it is done late at night so that no one is moving. The distance between pinhole and speculum is approximately twice the focal length; not exactly, because the image of the pinhole is a few inches further from the mirror than the pinhole itself. This makes no practical difference in testing, though if the pinhole were much nearer the mirror, the formula for aberration would have to be altered.

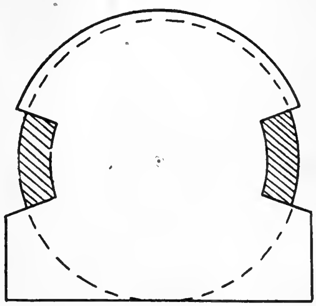


FIG. 2.

The screens used for hiding the parts of the mirror are two in number Figs. 1 and 2 and, these may with advantage be combined into one, Fig. 3. The central slide may be 2 to $2\frac{1}{2}$ in. in diameter, and the segment left in the outer zone, Fig. 2, may be 1 in. broad

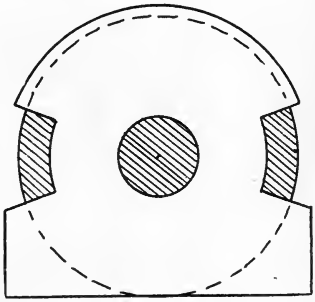
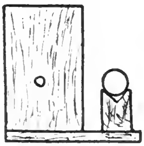


FIG. 3.

and 3 in. long. I found the combined screen easiest to work with. Provide also a white paper cap to fit over the front end of the tube; this is useful in adjusting the position of the apparatus.

Light the lamp and see that the brightest part of the flame is opposite to the pinhole. Remove the pinhole and let the light shine on the mirror through the hole in the vertical board; place the tin screen round the lamp to darken the room; the room, of course must be otherwise dark, or nearly so. Then place the apparatus at a distance from the mirror, approximately equal to twice the focal length of the mirror, *i. e.*, the radius of the curvature. Move the mirror about until the image of the flame, seen through the ½ in. hole, is received on the paper cap at the end of tube; remove the paper cap and view the mirror through the tube, taking care that the tube is accurately pointed to the center of the mirror. Move the apparatus to or from the mirror until the image of the hole is at the eye end of the tube; insert the plate with the pinhole in the testing apparatus and focus the image with eyepiece or lens of some sort.



We may now take a preliminary examination of the image. As in Chapter IV, the appearance of the image inside and outside the focus will give an idea of the class to which the curve belongs, remembering that Class A (oblate spheriod) gives bright center outside and dark inside focus; Class B (sphere) gives the same uniform appearance inside and outside focus; Class C (ellipse, parabola, hyperbola) give bright center inside and dark center outside the focus.

Next, remove the lens, or lenses, and bring the image, by moving the apparatus to the edge of the screen used for testing, *i. e.*, if the diaphragm of the eyepiece is being used, bring the image to the right-hand side, so that further movement of the apparatus to the left will cut off the light. The image must be kept level with the center of the tube, and the whole apparatus packed with paper until it is so. A slight pressure with the hand on the left-hand side of the baseboard will just cut off the light, and the tube is pushed or pulled until the illumination of the mirror disappears as evenly as possible, the eye being meanwhile placed as close as possible to the image, so that the mirror is seen as it were flooded with light.

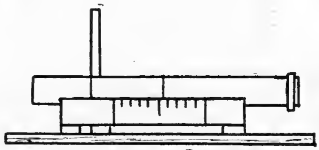
It is important that the mirror rest against a backing of uniform color, a piece of black velvet or cloth being most suitable; also it must be left to get thoroughly cool after polishing, or the image will be irregular and the testing unsatisfactory.

The mirror must be handled as little as possible. A finger placed on the surface for a half a minute produces a slight elevation which is easily visible in testing; in fact, once the mirror is in position, it ought not to be touched at all until testing is completed.

The adjustment of the mirror to reflect the imag through the tube is a long job at first. A large sheet of white paper held behind the testing apparatus to receive the image of the hole is a great help.

I assume now that the polish has became perfect all over the glass. This is a question of time, but if the polisher is properly made, should not take more than four hours, and that the curve is either A or B—*i. e.*, still on the safe side of the sphere. We may now bring the mirror screen into action. First of all, place the testing screen (by which, to save confusion, I shall denote the diaphragm in the eyepiece mount placed close to the eye, as described in my last) as near as possible to the image of the pinhole, and observe whether the shadows seen on occulting the image are regular. If, owing to the faulty construction of the polisher, any rings or irregularities appear, it may be necessary to return to the latter stages of the fine grinding; but such irregularities are easily perceptible in the earlier stages of polishing, and can be avoided by care in making the polisher and in adjusting the position of the central square, as before described. I have not been troubled with "rings" in my own work, and I believe they can always be completely avoided with care.

Now put in front of the screen No. 1, or if one screen only is to be used, No. 3, and gently and slowly alter the position of the tube in its Vs until the testing screen, when brought across, darkens the central part of the mirror uniformly. By keeping up an intermittent pressure with the hand on the left side of the baseboard of the testing apparatus, the mirror may be made to darken and brighten alternately, and the tube is moved very gently with the right hand until the appearance of a shadow advancing across the mirror, or rather the central portion left by the mirror screen, is lost, and the darkening is even all over. Read the



scale, estimating to ¼ mm. or 1-100 in. This should be repeated many times, the testing-screen being placed, to start with, alternately outside and inside the focus. The mean of all the reading is then taken.

Now concentrate attention on the outer zone. As will be seen in Figs. 2 and 3, only two segments of this zone are visible, one on each side, and to get the best results, the testing screen, at the point where it occults the image, must be vertical—*i. e.*, the image must be level with the center of the aperture whose edge is being used for testing. A vertical bar across the end as the tube does as well as the eyepiece diaphragm; but I found the latter more convenient. The scale is read again when the two segments are found to darken simultaneously; and, from the greater convergence of the rays from the two sides of the mirror, it is rather easier to observe the exact focus than when the central 2½ in. of the mirror is observed; in any case, however, the mean of several readings should be taken.

The difference between the final means gives the actual difference between the focus of the mirror (for rays diverging from the center of curvature, of course) for the center edge of the mirror. If the focal length for the center is large,—*i. e.*, if the first reading was greater—the mirror belongs to class A; if the focus is the same for both, the mirror is spherical, class B; and if the reading for the outer zone is greater than for the center, class C.

It is desirable, after reading off the scale for the outer zone, to make another set of observations of the the center, to make certain that the testing apparatus has not shifted. It should be heavy enough to remain still. The use of the combined mirror screen, 3, I found a great advantage, as I could remain perfectly still during the whole time, and thus risk of shaking mirror or testing apparatus was avoided.

We now know exactly what sort of curve we have got, and we now want a formula which will give the exact difference between the readings ("aberration" is the name commonly used) for the parabola, C^2.

The formula giving the necessary aberration for the parabola is $\frac{D^2}{8F}$, where D is the mean diameter of the zone, and F the focal length. It may also be written $\frac{r^2}{R}$, where r = means radius of zone, and R = radius of curvature of the mirror, which is twice the focal length (= 2 F.)

N. B.—The distance from pinhole to screen is equal to the radius of curvature. Either formula gives the same result, but I prefer the former. It will be noticed that the aberration is twice the depth of the center of the mirror below the line joining opposite middle points of the zone—e. g., if the zone used on a 9 in. mirror of 6 ft. focus is 1 in. wide, its mean diameter is 8 in., and its depth, measured from the plane of the 8 in. circle, is $\frac{(8)^2}{16 \times 72}$ = 1-18 in., while the aberration to be aimed at in the figuring would be $\frac{(8^2)}{8 \times 72}$ = 1-9 in. = .11 in., or 3⅜ millimeters. It will be seen that this is but a small quantity; but it must be measured accurately, as on it depends the whole performance of the mirror.

It must be noticed, however, that this is the theoretical value. As I was told by an expert, "Here mathematics must take a back seat," and he further told me that the practical value is somewhat less. I did not find it so; but, in any case, it is safest to carry on the figuring process, (to be described later) until the aberration is about ⅔ of this, or, in the case under consideration, about .08 in. The final testing must, after all, be done in a telescope, on a star, and with a good eyepiece. I would again quote Sir J. Herschel: "That is a good form which gives a good image." If the aberration becomes too great at any time, the curve becomes C^3 (the hyperbola, and it is very difficult to get back. A, B and C all mean safety, but C^3 means danger. When my mirrors appeared to give perfect results in the telescope, I found, in testing with pinhole and screen that they gave the theoretical aberration. "English Mechanic."

GALVANIZING PROCESS.

Consul-General Guenther, of Frankfort, writes that German papers report that Mr. Cowper Coles, an Englishman, has invented a new process of galvanization, and has recently demonstrated the same with samples of iron, copper, aluminum, and other metals. The objects to be galvanized are simply heated to 260° in a bath of zinc vapor, the duration of which depends upon the desired thickness of the coating, but which is always short. After heating the objects are thoroughly coated with a layer of zinc, which on the surface has formed an alloy with the other metal by penetrating into it to a considerable depth. A copper rod can in this way be almost entirely transformed into brass, while the temperature employed remains far below the melting point of both metals. A great advantage of the process lies in the evenness of the coating, which is so perfect that such zinc-galvanized screws and bolts afterward fit perfectly into the nuts, while with other methods they have to be polished. It is also very convenient that the objects to be galvanized have not first to be cleaned.

The retorts in which the heating takes place are of iron, and are heated from the outside. Another peculiar advantage is that the zinc does not adhere to the walls of the retort, but that these, after months of use, are entirely clean. The explanation for this is that the walls of the retort are heated most, so that no zinc vapor condenses on them. Experiments to use the the process with metals other than zinc have been so far made with copper and antimony, and have been partly successful, but not to a degree to make them of practical use.

One of the recent patents in the gas engine line is a starting device using superheated steam as the motive power. The starter contains a series of coils of pipe of small size which aggregate about 60 feet of heating surface. A pint of water injected into these coils by a small force pump, within 10 seconds is converted into steam at a pressure of from 100 to 1000 pounds, as desired. There is no reservoir, and the steam is released automatically into the gas engine cylinder before it reaches the tested capacity of the starter.

THE PRACTICAL UTILITY OF MANUAL AND TECHNICAL TRAINING.

Abstracts from an Address delivered by Wm. Barclay Parsons before the National Educational Association.

Not being engaged in education, I approach the topic of this evening's discussion, namely, "The Practical Utility of Manual and Technical Training." not as an educator, but as one engaged in practical work, where both manual and technical training play their parts, and I shall speak, therefore from the point of view of results achieved and of ends to be attained.

The statement is almost axiomatic that, any particular educational work, precisely the same as work of other kinds, must pass the supreme test of practical efficiency if it is to assume a permanent place.

Unless special educational training can show some actual value in making men or women better able to meet the ordinary demands of life, no matter how desirable it may seem, it has no reason to exist and must in the end give way to other work or to other subjects that will employ the student's time more profitably. It is, therefore, by actual results that we are to judge of the value of any teaching, and by this same standard, of the practical value of manual and technical training. The question is, whether students are sufficiently improved thereby to compensate them for the time spent.

Subjects that are taught in our schools and colleges may have one or both of two values: they may be useful in developing the reasoning faculties, thus fitting the student to deal later with the actual problems of real work in the same way as gymnastics develop the muscles of the body, and are thus useful, though one may not become a gymnast; or the subjects may have a direct value, *per se*, as do all subjects that will later have bearing on actual daily vocations. It is not for me, in a gathering of educators to discuss the relative importance of any subject of the former class. Others who will address you will cover the value of manual training from the standpoint of mental devolopment—if that phase of the question requires any consideration or argument—while I, within the narrow compass of this paper, will invite your attention to a considera tion of the subject solely from the standpoint of practical utility, and with regard to better fitting young men for the actual demands of work to come.

When manual training was first brought forward, it as with a view of its use as a means of mental development; it has, however, a much wider field, a more precise application, and an actual educational value of great practical utility. We are all conscious of the tremendous progress in mechanical development that has taken place within the last fifty years, more especially during the last twenty years, and that is still going on at an increasing ratio. It was not so very long ago that the great source of wealth was in agriculture, where work was performed by the most rudimentary unskilled labor, while even in mining and in the mechanical arts, implements were of the crudest form. On the strength of men's legs, arms and backs was the main reliance for power. Today it is hard to call to mind a single trade in which machinery of intricate form does not enter in some degree, and usually to a great extent, machines requiring on the part of the operative some knowledge of mechanics, some experience in manipulation, and some skill in manual dexterity.

The hand needle has given way to the sewing machine, the farmer's foot loom and spinning wheel, to exceedingly complicated machines of great capacity, engine driven; the telephone is used in place of the messenger; a machine and not a pen writes our letters, while our stables are repair shops for motor cars. Such are but few of the many examples in our every-day life that occur to one, where mechinery is displacing hand work, and where skilled labor is taking the place of the unskilled.

A measure of the number of persons dependent upon mechanical pursuits can be obtained from the reports of the United States Census Bureau. The report for the decide ending 1900 shows that there were then 29,000,000 persons engaged in various occupations. Of this number there were no less than 8,000,000, omitting entirely all those engaged in agriculture, employed in occupations where tool and machine knowledge formed the basis of work, while in nearly all of the others some such knowledge was desirable and in many cases essential. It is not an exaggeration to say that machine and tool work form a large part of the daily vocation of a majority of the working classes in this country; that there is not a single calling where the worker is not required to show some familiarity with tools and where some proficiency in mechanical dexterity will not lead to his advancement. In fact, it would seem that after the great foundation of all education, reading, writing and arithmetic, there is no one subject of so widespread practical benefit as that of teaching the art of using the hands. With the masses an education that develops the thinking power alone is of small value; it produces a development that is ineffective, that cannot be used. Give a man a rudimentary education, with an understanding of how to do things, and the educational foundation of productive capacity has been laid, which capacity governs the wage-earning power. The practical utility of manual training is the instruction of the rising generations in the use of tools, the education not only of the the mind but of the hand and eye, and in teaching a subject that will later be an actual portion of the life of the majority of students.

The limit to which manual training should be carried is to be considered from three points of view: the elementary work in the lower grades, the specialized work in the trade schools, and the higher in the technical colleges. As to its practical value in our technical colleges, we must differentiate between the technical college and the highest grade of trade school, especially in the matter of manual training. The one aims to turn out the professional engineer, educated not only in the technical sciences, but in the liberal arts as well, to whom time and money spent in procuring an education are quite a secondary consideration as compared with an education itself; the other aims to develop the highest grade of mechanic and general foreman.

Although there is a great difference in the scope of the educational work in the technical college and the most advanced of trade schools, yet there is the similarity that both deal with mechanical appliances, but with this distinction, that the men of the latter will in practice have to do with their own hands their own work, while those of the former will direct other hands to do it. It is not essential, therefore, that a technical college should carry manual training to the same point of development as the highest grade of trade school does. In the education of the engineer there should be enough manual training to make him understand how things are made, to sufficiently familiarize him with casting and forging, hand and machine tools, engines and their adjustment, the winding of dynamos and the connections of electrical devices, so as to give him the requisite knowledge of how to design, how the engine should be used and how construction results can be accomplished. In short, to make him conversant with principles rather than to develop manual dexterity.

This brings us to the question of the practical value of technical training itself and whether it is better that young men who are to follow a professional life in engineering should get their education in the office of an older practitioner, as has been the custom in England, and is still to a large extent the universal custom in teaching the allied subject of architecture, or to gain the same end by passing through a technical college, the practice in America and Germany. To quote the growth of technical colleges is not necessarily a rational argument, but it certainly goes to show popular appreciation. In 1870 there were less than half a dozen institutions in the United States where a good technical education could be had, and the number of students was small. Today there are no fewer than 43 such institutions, with over 23.000 students enrolled.

Before considering the practical value of technical education, let us define what is an engineer and what the vocation known as engineering. The word "engineer" is used here in its broadest sense, including all branches of professional work in applied science or construction. The word "engineer" is not, as is popularly supposed, derived from the word engine, a machine. There were engineers before steam was practically applied, or before the development of engines in the modern acceptation of the term began. Both the words "engineer" and "engine" come from the same derivation, the Latin "ingenium," whose prime meaning is "natural quality, character, genius," and it in turn is derived from "gegno"—to produce. The engineer is, therefore, a man of "natural quality"—one capable of producing.

The profession of engineering, in its broadest sense, was defined by Thomas Tredgold, when founding the Institution of Civil Engineers, as being "the art of directing the great sources of power in nature for the use and convenience of man." It is difficult to imagine a field of work of higher order, of wider scope, and for which a more complete technical training is essential.

The powers of nature, those great and mighty forces that surround us, that sustain and govern not merely our own small earth but the whole universe; powers that are without limit as to time and space, whose laws never vary, whose manifestations may undergo change but which never suffer loss, and which are the only things that we have cognizance of that are of perfect truth—these forces in all their might, from the great energy of the engine capable of lifting mighty weights, or the violence of an explosive rending mountains of rock, to the gentleness of the watch spring in your pocket, regulated to a variation of less than a second a day, are by the study of the engineer controlled and directed for the use and convenience of his fellow men.

How little did Smeaton foresee the development of civil work, to which he applied such a designative title! How little did Tredgold realize the far-reaching effects of a calling to which, it is true, he gave unlimited bounds! The responsibility of educated men who are to follow Smeaton, who are to realize the ideals of Tredgold, who are to understand, direct and make useful the powers of nature, rests upon such as you who make up this audience. It seems but necessary to repeat that definition of engineering which in simplicity of language, in directness of thought, in broadness of conception, has never been excelled, to at once answer the question whether such education is better given in special technical colleges or in the office of some one practitioner. What are these powers of nature? They are not only those that we see or feel every moment—light, heat, steam, gravity, but also those studied by the electrician, by the chemist, by the physicist, by the geologist, and by the other disciples of pure science; those intricate forces that, whether matter consists of many or few elements, give it such a manifold and diversified character.

When the total of human information of these several branches of science was comparatively limited, when the engineer could depend largely upon precedent, when progress was made by short and careful steps, it was possible for a sufficient education to be acquired under the tutelage of a single man, leaving it to the inherent genius of the pupil to self-develop. With, however, the vast and constantly broadening field of modern scientific knowledgo, it is quite impossible for one man, or such a limited group of men as one office may contain, to impart to the young student the requisite instruction in all the properties of the forces and materials of nature that he should have as a general framework of his professional education.

Although engineering, like other learned professions, is divided into separate branches, nevertheless the modern engineer must know something of machine design, of electricity and its practical application, of hydraulics, transportation, structural constraction together with physics, geology and metallurgy. If such a structure be built on the solid foundation of a good education in the liberal arts, so much the better will it be, and obviously such a preparation can only be given in an institution with a corps of specialists. It seems a contradiction to say that as any profession becomes more specialized, at the same time it becomes broader, but as a matter of fact, the range of subjects to be studied does become wider. It is not necessary, in fact it is impossible, for any one to become expert in all branches; yet so interdependent are the several divisions, so interlocked are the various nature forces that some knowledge should be had of many subjects and much knowledge of few.

TECHNICAL EDUCATION IN GERMANY.

Though the average American is far ahead of the German or Frenchman in inventive talent, he is handicapped by lack of technical knowledge, reports Richard Guenther, Consul-General, Frankfort, Germany, February, 1905. The little town of Sonneburg, in Germany, for instance, has an industrial school which has been in existence for twenty years. This school gives instruction in drawing, painting, modelling, turning in wood and ivory, wood carving, geometry and arithmetic. The principal object is to train young people for the manufacture of toys and ceramic ware, which are the chief industries of the district. The school has 24 students, and the cost of tuition is but 50 marks ($12.90) per year. Additional technical schools, giving instruction in glass blowing, painting on porcelain drawing, modelling and carving, are located in Schlakau, Limbach, Lauscha, and Rauenstein, which are quite small places in the Sonneburg district. The town of Sonneburg has also a commercial school attended by 152 pupils, who are instructed in commercial knowledge, political economy, the English, French and Spanish languages, bookkeeping, stenography and typewriting, calligraphy, and arithmetic. The efficient training given by such schools makes Germany capable of successfully competing with countries possessing superior natural advantages, nnd accounts in part for the wondersul rise in Germany's export trade and merchant marine.

PURIFYING WATER WITH OZONE.

The Ozone Plant in West Philadelphia is in operation and tests of its work in water purification have been made by Messrs. Rivas, Jackson and Hale. Raw Schuylkill River water contains as high as 2,500,000 bacteria per cubic centimeter. After rough straining this number is reduced to 250,000 to 700,000, and after the ozone treatment to 5 to 55. These few are all harmless varieties, and the water is also deoderized and freed from color. The process, which is controlled in this country by the United Water Improvement Co., is substantially as follows: An electric current is taken from the city's wires to operate a motor generator, producing a current of 100 alternations, which is raised by transformers and condensers to a 10,000 voltage. By the operation of reactance coils and condensers, voltaic arcs are prevented and sparks are limited, and the current passes as a pencil of blue light from each of some millions of metallic discharge points across a short air-gap to nickel receivers. Atmospheric air is drawn across this gap by means of an air pump, and in so passing it is partially converted into ozone. The ozonized air is then forced through a stand-pipe, in which it meets a current of water flowing in the opposite direction. The contained bacteria are instantly destroyed by the ozone.

THE FLIGHT OF METEORS.

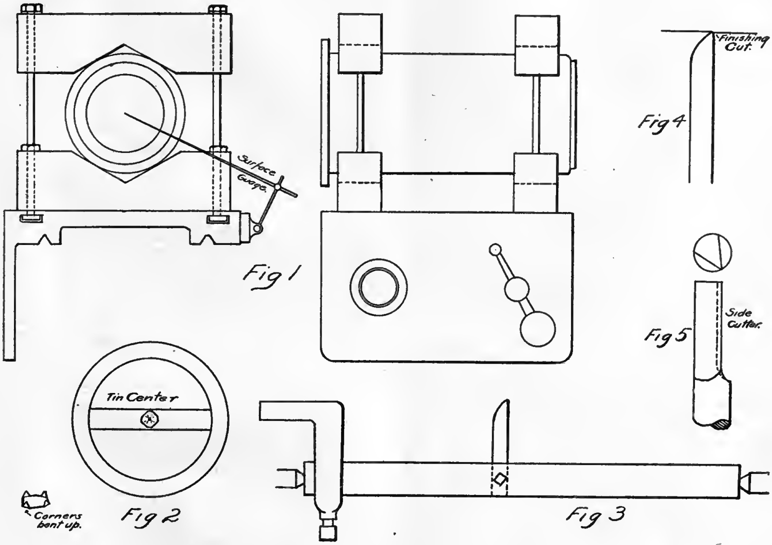
Meteors, before encountering the earth's atmosphere are invisible to us traveling in their own orbits about the sun. Immediately on striking the earth's atmosphere their kinetic energy begins to be changed to heat and at a heighs of 75 to 100 miles they become visible, where the air is more rarified than under the oxhausted receiver of an air pump. This rarefaction of the upper air does not, however, save them from the effects of their impact with the atmospheric molecules. It takes only a fraction of a second to consume the smaller meteors. Even if meteors, instead of moving about in space, were without motion and were encountered by the earth in its flight their fate would be similar, for the velocity of the earth in its orbit is at the tremendous speed of 19 miles each second of time, and a meteor coming in contact with the earth's atmosphere would immediately assume a temperature estimated at 600,000 degrees, which would mean total obliteraiton.

THE METAL WORKING LATHE AND ITS USES.

ROBERT GIBSON GRISWOLD.

VI. Boring Cylinders.

The screw-cutting lathe is a machine peculiarly adapted to the boring of cylinders, field castings for motors and dynamos and, in fact, almost any long, cylindrical holes in any piece that can be fastened to the carriage of the lathe. To do this work properly, the piece must be firmly supported and secured to the carriage. Most lathes have a carriage mounted on very long V bearings which give great stability, and these bearings are provided with T slots into which bolts may be fitted for strapping work to the blocking placed on the carriage. Many of the small amateur lathes are not so provided, but with a little thought it is possible to rig up the carriage so that a very respectable job can be done.



Let us consider the case of boring a three inch cylinder for a small gas or steam engine. A block of hard pine or oak is cut to such a shape as will support the cylinder in question at both ends, and for this purpose the V shaped bearing is by far the best, as it will prevent slipping better than a circular seat. In Fig. 1 is shown how these blocks may be secured to the carriage. The bolts *aa* are of such a length as to pass completely through the two blocks, and one end is threaded for the greater portion of the body length. This enables the nut to be screwed down to the lower block, and another nut may be brought to bear against the upper block, using only one bolt in each end.

It is a good scheme in doing this class of work to lay out the carriage full size on a piece of paper, then mark the exact height of the lathe center above the carriage, draw in the section of the cylinder, and then the determination of the best sized block is readily determined. The V should not be too shallow, neither should it be so deep as to cut nearly through the piece. While requiring a little more time, it is a very good thing to tack a piece of sheet copper or brass in the V upon which the piece may rest. This has a two-fold object. It not only prevents the cylinder being driven into the softer wood by the pressure of the clamp above, but it adds greatly to the holding power of the clamping arrangements. The metal, being soft, takes a firm grip on the casting, and it will require a greater force to twist it under the pressure of the tool. This also admits of a deeper cut being taken, although in the case of amateur work it is always advisable to work a little more slowly, take smaller cuts and secure a finely finished job, which is not always possible when the work is hurried.

Having determined about the size of our V blocks, the holes are drilled in the ends slightly larger than the bolt diameter so that they may be shifted to bring the cylinder exactly into line. They are then placed in position and clamped in place. If your lathe is not provided with slots for the reception of the bolt-head, it will pay you to drill four holes for this purpose, tapping them to receive the threaded end of the bolt, which then becomes a stud.

The cylinder is now placed in position and lined up by placing small strips of sheet metal between the bearing points and the block so as to raise the center, if necessary, until it coincides with the center-line of the lathe. To determine the exact position of this center is not very difficult, but it should be done with care, else when the cylinder is bored it may be found that the bore is not perpendicular with the flange or parallel with the sides of the casting. Perhaps the easiest method is to stretch a fine iron wire through the spindle of the lathe, securing it at the farthest end by twisting about a small nail which may be placed across the open end of the spindle. The wire is then passed through the center of the casting and secured to the tail spindle, which is not so easy. A wooden plug may be fitted to the tail-center seat and a small hole drilled in its end through which the wire may pass to be fastened at the small end of the taper. The moving of the spindle outwardly will then draw the wire taut. It is now a simple matter to test the center of the casting with a pair of inside callpers, measuring on all four sides until the wire passes exactly along the center-line of the casting, coinciding therewith. This method is used in a great many cases where it is impossible to get a plane of reference from which to work with a surface gauge. This can, however, be done on a lathe, because the ways are perfectly parallel with the center line. The open ends of the cylinder are provided with sticks driven in so that they pass over the center, and a small piece of tin is fastened to the flat side as shown in Fig. 2, by bending up the four corners of a square and driving into the wood. Then with a pair of hermaphrodite callipers the center is scribed on the tin and located by a very light prick-punch mark.

Now when the casting is ready for setting, a surface gauge is placed on the top of the lathe bed, and the point adjusted so that it exactly coincides with the points of the lathe centers at either end. If the lathe centers are out of line in this respect they should be fixed at once, as accurate work cannot be be done on them. If found correct as to height, the casting is placed on the blocks and set up with "shims" (the small strips of sheet metal spoken of above) until the center marked on the tin coincides exactly with the point of the surface gauge at either end. You will find when adjusting this casting that the movement of one end to secure exact coincidence will probably throw the other end out, especially if it has just been accurately set. But this can be nothing more than a "cut and try" method, and the differences must be halved at either end by repeated trials until it is just right.

Then the gauge is set (it is better to have another gauge for this work) so that it may be used from the side of the ways for lining the casting in that direction, as shown in Fig. 1. The upper blocks must be screwed down on the castings very firmly after the setting is about right, and the alignment tested again, as the pressure of the upper block will very likely throw it out somewhat.

Another very simple method, but not always applicable, is to use the points of newly sharpened centers, bringing them into coincidence with the centers marked on the tin. Sometimes these centers cannot be readily seen, but if they can, the method may be used, but it will be found somewhat more difficult to work in the cramped space thus provided between the ends of the casting and head and tail-stock.

Presuming that the casting has been properly set and secured, a boring bar is passed through the middle of the casting and swung on the points of the head and tail centers. (If this bar is perfectly true and straight, it may be used instead of stretching a wire from center, measuring from its periphery to the inside of the bore exactly the same as was directed for the wire.) The cutter is sharpened and placed in position so that it extends exactly the same amount on either side.

For those not familiar with the boring bar, it may be well to give a description of how one may be made. No matter what the work is upon which it is to be used, make it stiff—of as large a diameter as practicable. The bar is supported on the lathe centers, and the pressure of the cut will easily spring it out of line, if not quite stiff. For the 3 in. cylinder above mentioned, a bar not less than 1¼ in. in diameter should be used, and about 18 in. in length. One or more holes may be drilled into it to accommodate the cutters, which may be made of ⅜-in. Stubb's drill rod, or self-hardening steel. A set screw is let into the side to firmly clamp the cutter in position, as shown in Fig. 3.

It may be possible that the novice will experience some difficulty in setting a cutter that cuts on both ends so that it will cut even, and it would, in that case be better to use a shorter cutter, cutting on one side only. The bar will spring some, especially when cutting through the scale. But any irregularity may be corrected by taking smaller cuts afterwards. Never crowd the work nor expect the cutter to do too much. You may move your casting slightly on the blocks, which would cost more time in setting than would be required in running half a dozen small cuts.

Start the first cut so that not more than a good thirty-second of an inch is taken off, and with a feed of not over 1-100 in. to the revolution. The feed, of course, is secured by moving the carriage, and the change gears at the end of the lathe may be so set as to secure almost any feed desired. After the hard scale is cut through and cleaned out then the feed may be increased to a 64th, and the depth of the cut increased slightly, but if foot power is being used, this will be found quite as much as one wishes to push.

For the finishing cut grind the tool to round point shown in Fig. 4, but do not have it take too broad a cut as it will cause chattering. Measure carefully both ends of the cylinder to make sure that the bore is perfectly cylindrical, as lathes will sometimes bore slightly taper, owing to the centers not being exactly in line. If there are any ports in the cylinder, which is usually the case with a two-cycle engine, it may be necessary to take exceedingly fine cuts while passing these openings, as the pressure of the tool is then relieved and the bar will spring back to its original shape again, causing the tool to cut slightly out of true when it takes hold again on the opposite side of the hole.

While the cylinder may and should be faced while thus set to insure that it will be exactly perpendicular with the bore, it requires great patience and care. The cutter will have to be sharpened on the side so as to make a side tool of it, as shown in Fig. 5, and very light cuts taken while the carriage is fed along by hand. A very good job may be done in this way, however, and it will be truly perpendicular with the cylinder bore. After the cylinder has once been moved or removed from its setting, it will be next to impossible to get it exactly into line again, so one must use great care throughout the work to insure that it does not slip.

REFERENCE BOOK HOLDER.

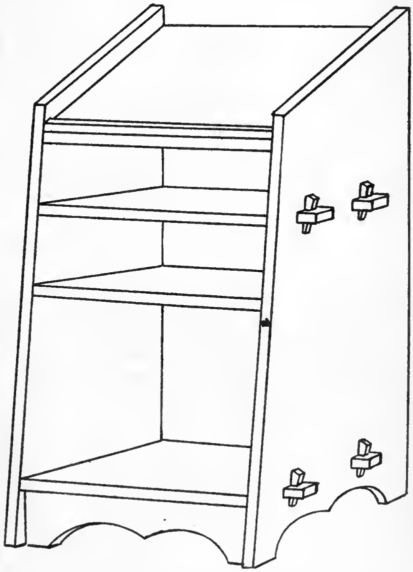
JOHN F. ADAMS.

Such bulky volumes as the dictionary, atlas, and similar books, are frequently to be found in rather inaccessible places, and consequently are not used as often as might be desired, owing to the bother of lifting around to an empty space large enough to receive them. The holder here described is just the right arrangement for making such books available for the uses intended, and readers of this magazine who make frequent use of these books will find the holder will repay the work of making it.

Oak is the wood giving the best effect, but gumwood, cypress or Georgia pine may be used, and when stained with "weathered oak" stain will show the markings of the wood to good advantage. The two side pieces are 36 in. long, 16 in. wide at the bottom, and 12 in. wide at the top, with the top ends cut to the angle for a length 4 in. less than at the back.

The top and middle shelve are 16 in. long or, if the ends are sunk into grooves ¼ in. deep cut in the side, which is recommended for additional strength, the length is 16½ in. These pieces are each 13¼ in. wide, which allows enough for bevelling the front and back edges of the top piece, which is put in with the top side 2 in. below the top of side pieces. At the front edge of this piece a ½ in. square strip is nailed on to make a ledge which serves to prevent the slipping of any book placed thereon. The middle shelf is placed 10 in. below the lower front edge of the top.

The two shelves with projecting ends to receive the wedges are 20½ in. long, the top one 12¾ in. wide and the bottom are 14¾ in. wide; the latter is placed 4 in. above the floor, the upper one 5 in. above the middle shelf previously mentioned. The shelf proper is, of course, the same length as the others, 16 in. with projecting ends 2¼ in. long and 2 in. wide. The ends at the rear are 2½ in. from rear edge of sides; in the upper one; the front ones are 4½ in. and the lower one 5½ in. from the rear ones. The wedges are 2½ in. long, ⅞ in. wide, ¾ in. thick at top and ⅝ in. thick at bottom. After cutting holes in the sides for the ends of the shelves, mark out the location for the holes for the wedges and cut as accurately as possible.



The piece under the lower shelf at the front is 16 in. long and 4 in. wide, with any ornamental curves cut out as desired. It is placed ½ in. back from the front edge of the lower shelf, and fastened with nails.

In staining furniture in which nail or screw holes have to be puttied up, it is quite necessary that the putty be stained to as deep a color as the wood will be when stained, otherwise wherever putty is used the difference in color will be noticeable. As putty is mixed with oil, an oil stain should be used, the puttying to be done after staining, taking off any conspicuous marks with a cloth wet with the stain. A water stain, if applied after puttying will not take whenever the puttying has been applied, even if no putty remains on the wood; the oil from the putty leaving its impression sufficiently to make unsightly places in the staining.

BOOKS RECEIVED.

WIRELESS TELEGRAPHY, ITS HISTORY, THEORY AND PRACTICE. A. Frederick Collins. 297 pp. 6 x 9 in. 323 Illustrations. $3.00. Supplied by AMATEUR WORK.

This volume may properly be classed as one of the most enterprising, instructive and inspiring treatises of the year.

It is a book written (not compiled) by one who has gone into wireless work with the genuine enthusiasm of the hobbyist; and the personal observations of the writer prove fully as valuable as the descriptive text. The illustrations are appropriate and up-to-date, the references liberal and exact as to title, volume and number.

The first sixty pages cover in detail the theory of Ether, Electric Waves, and the method of propagating waves by means of disruptive discharges. The chapters devoted to oscillations are especially thorough in their treatment, as well as those on capacity, inductance and resistance, with numerous formulæ provided to explain the mathematical values in wireless telegraphy.

In the chapters on Induction Coils and their Operation, the author provides full specifications of coil construction and explains many points pertaining to coil windings, which we never have before seen in print. Especially valuable are the illustrated descriptions of vibrators and interruptors.

The articles on transmission, aerial wires and receptors describe the apparatus, both experimental and practical, in use in America and foreign conntries, and many of the illustrations are directly from photographs made especially for this volume.

All the systems of merit in use in this and other countries, find full treatment with one exception, that of Mr. John Stone Stone of Cambridge, mention of whom is made in paragraphs on multiplex systems and predetermined length of waves. We believe more recognition of this system will appear in later editions when the results of government tests become public, as Mr. Collins has shown every evidence of impartiality throughout his book.

We commend this treatise to both the amateur and the professional. In the reference library it will prove a fitting companion to the able volumes of Vreeland and Lodge.

MACHINE SHOP TOOLS AND METHODS. A. S. Leonard, 562 pp. 9 x 5½ in. 700 Illustrations. Cloth. John Wiley & Sons, New York. Price $4.00. Supplied by AMATEUR WORK.

This book is an enlarged edition, for the first time in book form, of loose leaf instruction papers for the students of Michigan Agricultural College. It is undoubtedly much the best thing which has yet been published upon the subjects included therein, which in general include the tools to be found in a well equipped machine shop and the uses thereof. The opening chapter deals with tools for measuring, followed by hammers, chisels, files, surface plates and scrapers, the vise and accessories, drilling machines, drills, drill-sockets, chucks and accessories, lathes, planers, shapers, slotting machines, milling machines, grinding machines, and the various attachments accompanying each.

Anyone interested in metal working, be he amateur or professional, and especially manual training school teachers, will find this book of great value, and we cordially recommend its purchase.

MODERN INDUSTRIAL PROGRESS. Charles H. Cochrane 647 pp. 9 x 6 in. Numerous illustrations. Cloth. J. B. Lippencott Co., Philadelphia, Pa. Price $3.00 net. Supplied by AMATEUR WORK.

A pleasing feature of this book, which at once attracts the attention of the reader, is the excellence of the illustrations, which are both numerous and well selected to supplement the text. The author has a singular adaptability for his work and keen appreciation of what is necessary to make a book of this general character both interesting and valuable.

It is not possible in the space available to more than indicate the wide range of subjects presented; electricity, in its numerous developments, is given a prominent place, flying machines, vessels of all kinds, implements of warfare, iron from the mine to finished tools of many kinds, and hundreds of other interesting topics, making it virtually a reference book of industrial progress. It will be found of great value to anyone desirous of being informed upon the industries of the day. It would seem especially adapted for public library use, and readers who may not find it convenient to purchase are recommended to propose it to the proper committee of their library.

The extreme length of Mexico is 1600 miles and its greatest width 750 miles. The lofty Rocky Mountain plateau fills it nearly from ocean to ocean leaving but a narrow strip of coast. Its total area is 765,560 square miles, and the population about 14,000,000.

CORRESPONDENCE.

No. 107. TIPTON IND., SEPT. 6, 1905.

How are coherer filings made?

Is there a relay sensitive enough to operate when waves powerful enough to click in the telephone receiver enter upon a wireless receiver made of two carbon blocks and a steel needle laid across the same?

R. A. L.

With a very fine file, prepare equal parts of nickel and silver filings, from U. S. coins, and placing same in an iron spoon bring to a bright heat over a gas burner or live coals. Then bruise the particles, when cold, until they are as fine as possible. Some coherer manufacturers use one part silver and two parts nickel; other use half and half. We have seen coherers with silver and antimony filings in equal parts, also iron and silver. Amateurs will find by experiment the mixture most sensitive and reliable for use with their apparatus.

No relay has been devised to operate when messages are received from any considerable distance on such a device. The telephone receiver and the human ear together form the most sensitive electrical receiver, and when once accustomed to the sounds, operators find the work as easy as reading from the sounder. The advantage of a relay would be in connection with a dot and dash recording device, with which permanent records are made on paper tape.

No. 108. COLUMBUS, OHIO, SEPT. 4, 1905.

Why is the primary core and winding of an induction coil so much longer than the secondary.

I. P. M.

The most active part of a primary is near the ends, and the attraction is from the ends towards the middle, so all the lines of force pass through the secondary winding horizontally as well as vertically, thus giving a stronger saturation to the winding. There is, however, a chance of extending the core too far from the ends of the secondary, thereby increasing the impedence and choking the free action of the primary or saturating current. The design of a primary core and winding depends on the speed of the vibrator, the kind of primary current to be used, and the purpose for which the coil is to be used. For all ordinary purposes we believe the primary core and winding should extend at each end a distance of one-half the full diameter of the end of the secondary. As to the gauge of wire to be used in winding a primary for a small coil of less than 3 in. spark where primary battery is from 10 to 15 volts, amateur coil-makers will find more efficiency may be had with three layers or even four of No. 20 wire than in less layers of coarser wire. The old rule in coil construction was No. 16 wire, two layers. It will prove an interesting experiment for amateurs to wind their primaries with No. 20 or even No. 22 wire and note the results. The batteries will last twice as long, and the secondary spark will show the effect of an increased magnetic field. In every instance this may not prove satisfactory, but it is worth trying.

No. 109. MEDFORD, MASS., SEPT. 7, 1905.

Will a long roll of poultry netting buried in permanently moist soil answer for a wireless telegraph ground?

Where can I buy an experimental coherer, or the parts of one?

Has a 20-ohm sounder any advantage over a 4-ohm sounder for local work? C. O. M.

It will answer very well until it rusts and falls to pieces.

Address any electrical dealer advertising in this paper.

No. The 4-ohm is better, as it uses less battery and makes as clear and loud sounds as any.

No. 110. ROCKLAND, ME., SEPT. 5, 1905.

Can a common magnet from a telephone be used to operate a spark coil? If not, what changes are necessary to make one work to satisfaction? Also, please tell me whether a magneto could be used to charge small storage cells, and what changes should be made in the magnets? H. L. D.

We are in doubt as to the meaning of the first question. Telephones are sometimes fitted with coils having primary and secondary windings, but such coils, even after being fitted with cores, vibrators and condensers, would develop only a very minute spark. The better way, if only a small coil is wanted for experimental purposes, is to make one from specifications to be found in article published in this number. A telephone magneto cannot be used for charging small storage cells, as the current therefrom is alternating, and constant current is necessary for such work.

No. 111. HUNTINGTON, PA., SEPT. 2, 1905.

Will you kindly inform me if the articles on "Amateur Runabout" are to be completed, and when? Would you advise a single cylinder engine of 5 to 7 h. p., or would a double opposed air-cooled engine of the same power be more desirable? I live in a very hilly country, and do not know whether air-cooled or water-cooled would be most efficient in climbing hills. What would you advise? H. G. C.

The articles on the "Amateur Runabout" will be continued as soon as the constructive work on the one being built has advanced enough to provide new matter. The motive power in the one being built has been changed to steam, however, as the writer was desirous of testing steam power in comparison with another of about the same size, using gas engine. Regarding type of engine best adapted for your use, if you are enough of a mechanic to be able to take care of the few additional fixtures required by the two-cylinder engine, it is the best to use in a hilly country. The best one-cylinder engines make slow work of hills, even on low speed, unless the power is large in comparison with weight of car. Air-cooled engines are doing good work in hilly countries, and any tendency to get overheated can usually be overcome with a fan run from fly-wheel or shaft.

No. 112. LARSON, WIS. AUG., 30, 1905.

What size of magnet wire for primary and secondary for making a 4-in. spark coil? Also how much of each? Size of bobbin? What size of spark coil for a wireless telegraph 80 rods long? What should be the dimensions for same? How can I drill holes through plate glass? How can circular discs be cut from glass? What is the resistance for 225 ft. of No. 32 magnet wire?

Specifications for coils of various sizes are given elsewhere in this magazine. A ½-in. spark coil would operate for wireless work over a much greater distance than 80 rods, but as that size is easily made at small expense, would recommend it. The drilling and cutting of glass discs is fully described in the April, 1902, number of this magazine, a copy of which will be mailed you for ten cents. The resistance of 225 ft. of No. 32 magnet wire is nearly 27 ohms.

No. 113. MALDEN, MASS., AUG. 26, 1905.

I am about to make a wireless apparatus to operate to a friend's house about 1500 feet away. What size spark-coil would I need for such a line? Do I need a pole? Do the aerial wires have to be of the same height? What would be the best and cheapest receiving apparatus? Would the receiver described in the April '04 number answer? If so, please explain the wiring for that instrument, as I do not fully understand it. How many cells of battery would I need for above? E. W. P.

A coil giving 1-in. spark would probably answer, but a 2-in. spark would be better. Much depends on the nature of the ground over which messages are to be sent. If thickly settled with electric light and other electrical lines frequent, aerial terminals should be at least 75 feet from the ground, which could be secured by mounting a short pole on the roof of the house. The stronger coil would be almost a necessity. The heights and lengths of the aerials should be approximately the same. The receiving apparatus described in the April, '04, number would be a good one for first experiments, and when skill and knowledge of the local requirements had been obtained, the one in the August, '05 number could be made, the latter being much the most sensitive, but more difficult to make and operate. The receiver, or more properly wave detector, is connected in series between the aerial and ground, and the telephone hearing receiver is in shunt with same, being taken from the two center binding posts, as illustrated in the April, '04 number.

A study should be made of the different circuits shown in connection with the various articles on wireless apparatus, as published from time to time. The battery requirements for coil are dependent upon size and wiring of primary circuit, also type of battery used. If dry cells, the primary circuit should have three or four layers of No 18 or 20 wire. If accumulators, the usual winding of two layers of No. 12 to 16 wire is best.

No. 112. SO. FRAMINGHAM, MASS., Aug. 28, '05.

I have made a spark coil for a gas engine, but cannot seem to get a spark from it. Can you give me any idea as to what is the matter with it? The coil is made as follows: Core, 7 in. long, 9-16 diameter, soft iron wire covered with heavy paper (dry.)

The primary is three layers of 103 turns each of No. 18 d. c. c. magnet wire, 1 in. outside diameter. On top of this is wound 1 lb., 15 oz., of No. 26 cotton covered magnet wire, making 203 turns and 30 layers in the length of the coil, which is 5 3-16 in. inside the ends. Between each layer of the secondary is a piece of tissue paper (dry). The outside diameter is 2⅝ in. By dry paper I mean paper that has no coating or preparation on it. C. I. G.

Your description of the coil makes no mention of insulation between primary and secondary winding. The two should be well insulated by a pasteboard tube thoroughly soaked in paraffine or shellac. If coil has such insulation, and gave spark when first tried but no longer does so, the insulation of secondary has broken down, and secondary will have to be rewound. If the coil never has given a spark, or a spark of at least ¼-in. length, there is undoubtedly a break in the primary or secondary winding, probably the latter. Test windings by sending the current from two or three cells of battery through them, and by means of a galvanometer learn if a current flows through windings. If not there is a break and rewinding will be necessary. You also omit to mention vibrator. Has coil been fitted with one? If so, make it vibrate with a small stick, and watch for results from secondary. A simple galvanometer can be made from a cheap compass placed over a few turns of wire on a block of wood.

India furnishes 56 per cent of the world's output of mica, while the United States and Canada produce nearly all of the remainder.

The highest concrete chimney ever built is located at Tacoma, Washington. It is 307 feet high and was designed for a smelter to carry away the deadly fumes developed in the reduction of the ores so that the surrounding vegetation will not be injured or the residents in the vicinity annoyed.

In May, during the progress of some excavations on the estate of Lord Normanteau, near Crowland, Peterborough, Eng., workmen exposed a subterranean forest some ten feet below the surface and about three acres in extent. Some of the trees were in an admirable state of preservation, and one large oak measured fifty-four feet in length. Although buried for unknown ages, the trees were found in such state of preservation that different kinds of wood could easily be determined. A kind of fir tree was most abundant. The surrounding clay contains quantities of remains of lower animal life.