AMATEUR WORK

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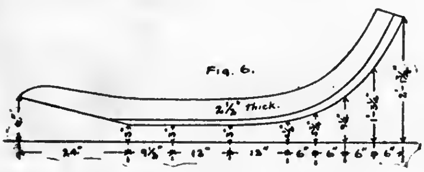
A TWENTY FIVE FOOT AUXILIARY YAWL.

CARL H. CLARK.

I. General Description and Lines.

This boat is designed as a general knockabout boat for sailing, and also to offer fair cruising accommodations for two to four persons. The yawl rig makes her very easy to handle, and the auxiliary power allows her to be handled in calm weather or light head winds. The general design shows a boat with somewhat of a dory model, with a large standing room and a fair sized cabin. The engine is located in the middle of the standing room.

The model is somewhat similar to that of the regulation dory, but is wider and deeper. The dory model gives the best boat for the least work that it is possible to obtain, the single plank bottom and flat stern making the work of construction very simple. The model also is, from the nature of it, a very able one, with good sea-going qualities. The moderate beam makes it easy to drive, thus requiring small sail power and allowing a good speed under engine power. A boat of this type has been found to be exceedingly satisfactory for general sailing and short cruises. The auxiliary feature adds very greatly to the usefulness of the boat, as one may have all the pleasures of sailing and still be relieved of the uncertainty from lack of wind.

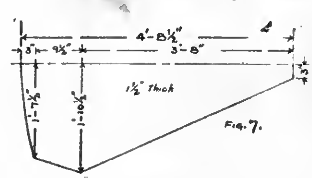


While the model has many of the dory features, the laps of the dory have, however, been dispensed with and the smooth seam construction used instead, as it is more durable and more yachty in appearance.

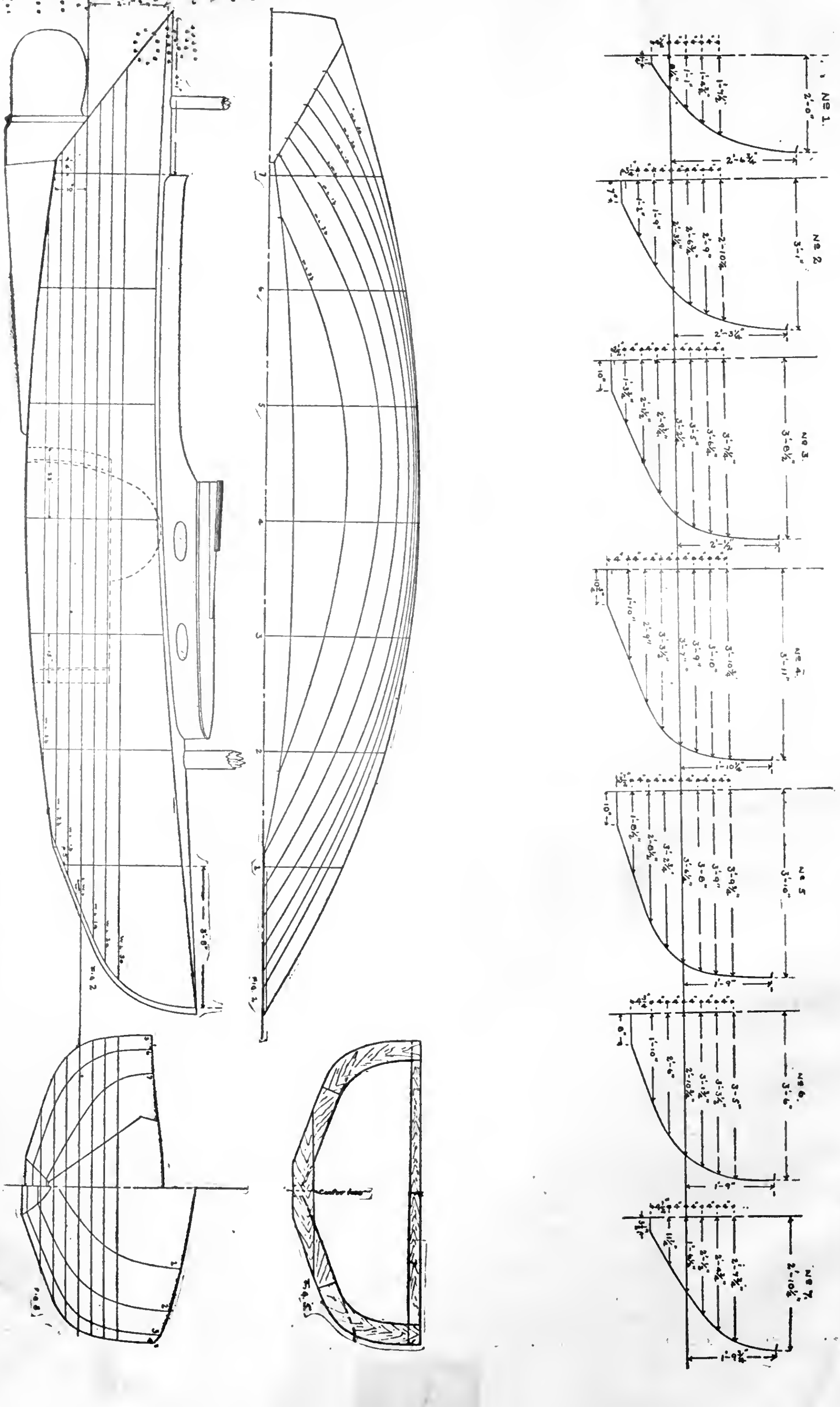
The yawl rig is fitted and she should be readily handled by one man in almost any kind of weather. The engine, also, is of a size to give her a fair rate of speed under power alone.

The cabin is arranged with a wide transom on each side of the centerboard trunk, and cooking and toilet arrangements forward, allowing two or even four people to cruise in comfort.

This boat is so simple to build that there is no reason why it should not be undertaken by any one having the ability to properly use carpenter's tools.



Figs. 1-2 3, show the ordinary drawing of the lines, which is put in to give a general idea of the shape of the boat and to aid in laying it out on the floor. It will hardly be necessary to lay out the entire boat on the floor, as the detailed measurements of the moulds are given in Fig. 4. These moulds should however, be each carefully laid out full size on a smooth floor or large piece of paper. The dimensions given are to the exact size of the moulds, the thickness of the plank having already been deducted. A mould, or form, must now be made to the shape of each mould. The method of construction of the moulds is as shown in Fig 5; any rough stock may be used, but they must be accurate to shape. The center line should be marked on both lower and upper cross pieces for use in setting up. Fig 6 shows the outline of the stem with all necessary dimensions for laying it out. The stern board is also shown in Fig. 7, one side only being shown; this can, of course, be easily duplicated for the other side, paper patterns of both should be made. The actual construction work will be begun in the next chapter.



LINES AND MOULD DIMENSIONS OF TWENTY FIVE FOOT YAWL.

MACHINE FOR GRINDING TELESCOPE SPECULA.

W. FORGAN.

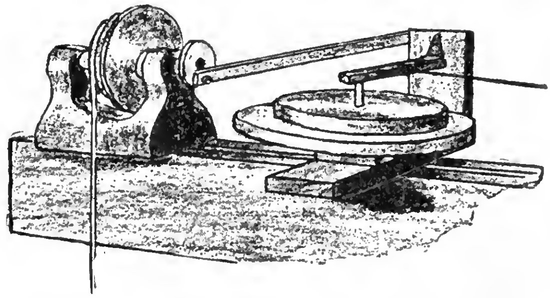
The simple addition to an ordinary lathe for the purpose of grinding telescope specula has been of so much benefit to the author that it was thought, if made known through the medium of the Society of Arts, it might become useful to others interested. Up to about fifty years ago the whole of the specula of reflecting telescopes were made of what was termed speculum metal, a composition of copper and tin in the proportion of their chemical equivalents. This metal, when highly polished, is stated to reflect only about 65 per cent of the incident light. Just about fifty years ago Liebig made known his method of reducing nitrate of silver to the metallic form by means of grape sugar. The silver thus thrown down is pure, and when polished, authorities state it reflects over 90 per cent of the incident light.

A mirror having upon it a film of pure silver will be seen to possess a very great advantage over one of speculum metal. A mirror made of speculum metal may in the course of time lose its luster and polish, and require to be again polished. This may result in the original figure being destroyed and lost. When made of glass and silvered on the face by Liebig's process, the silver may, and no doubt does become oxidized in the course of time; but the silver has only to be dissolved off, and the mirror resilvered as often as may be necessary, without affecting in any way its original figure.

The construction of mirrors made of glass very soon became general after Liebig's process was known. The first to make them was Dr. Steinheil of Munich, in the year 1857, and about the same time Foucault of Paris, and Draper of New York, also made glass specula. The construction of glass specula has now become very general among amateur astronomers, and it is with the view of showing how very simple an addition to a lathe may be effective for that purpose that the present communication is made.

Before describing briefly the machines used in grinding mirrors, it may be well to indicate the first step of all. Take, for example, the tool necessary to construct a speculum whose diameter is 6½ in., and focal length, say, 5 ft. 6 in. This is a size to which those beginning such work might do well to restrict themselves. The first thing is to make two grinding tools—a convex and a concave—each having a radius of curvature of 11 ft.

A templet must be struck by means of a long wooden rod, through one end of which a nail or bradawl is passed into the floor, and at the distance of 11 ft. another nail or cutter of some sort makes a circular mark or cut upon a piece of zinc or brass 6½ in. broad, lying on the floor. When the metal is cleanly separated by clipping and filing at the mark, we have two templets—a convex and a concave. A piece of board is then placed on a lathe chuck and turned on its opposite faces to correspond to the above templets, and 6½ in. in diameter. Two castings are then obtained either in iron, brass or zinc, from this pattern and worked upon each other, the convex surface of the one into the concave surface of the other, until either by turning, filing or grinding, they fit each other perfectly.



The convex surface of the one is cut into squares with a file, the grooves so cut being about ½ in. apart, the depth of the grooves being immaterial. This is all the preparation necessary previous to beginning the operation of grinding. The most perfect system of grinding is that in which the whole operation is done by the hands alone. But hand-grinding is so laborious, slow and fatiguing, that almost everyone desires the assistance of a machine of some kind to lighten his labor. Now, it may be stated that no machine has ever been made or can be made, to grind a perfect speculum by itself. Machines require constant alteration of the stroke during the process, and it is with the view of showing why this is necessary that reference to them requires to be made before describing the simple method devised by the author.

There are three essential things which require to be kept prominently in view to insure success in grinding mirrors, either by hand or by a machine. The first is that in grinding, a true spherical surface must be got. (Sir Howard Grubb states in one of his articles that a true spherical surface is only got by chance.) The second is the length of stroke used, while the third is the side stroke. According to Sir John Herschel, the second and third seem to be essential. A beginner will have much difficulty with the first, less difficulty with the second, but the third is the most important of all.

Reference is here only made to the case in which the tool is made to work over the speculum either by strokes entirely straight, or partly straight and partly circular. While the speculum is slowly revolving on the machine, the grinder is caused to move across the speculum at a short distance from its center; this movement constitutes the 'side stroke." If this were not done, and the center of the grinder pass invariably across the center of the speculum, a truly sperical curve could not be obtained, and the center would be ground down much more than it ought to be.

Another point requires to be mentioned in reference to machine grinding. The motion of a machine is regular, and at certain times the strokes of the grinder recur oftener at certain places than at others, giving rise to nodes and, of course, causing a circular groove or zone in the speculum at these points There may be one or more of these zones. Thus, if the machine causes its strokes to meet with regularity at a definite point, there will be a depression at that zone all round the mirror, and instead of a circular curve there will be a wavy form; a speculum with such a surface will naturally be of no use. It is difficult to see these defects until the mirror is partly polished, when they are at once detected by reflected light. By a skilful and judicious use of the side stroke, a mirror can be made without any zones.

It occurred some months ago to the author that this difficulty of the side-stroke could be got rid of in the case of small specula up to, say, 8½ or 10 in. in diameter by using jointly the lathe and the hand motions, and he believes that he has been successful. The drawing of the simple addition to a lathe is subjoined. It will be seen to consist of a board 1 in. thick, 3 in. broad, and 15 in. long, firmly bolted down to the lathe bed. A short upright piece is attached to the off-end by two strong iron hinges which allow it to swing forwards and backwards through the action of a wooden rod attached to a crank-pin fixed to a chuck on the lathe mandrel. The other side of this upright piece has a wooden rod which engages with a pin on the back of the grinding tool. A cord passes from the small groove on the lathe-wheel, which is 1 ft. in diameter, to a 6 in. wheel in the mandrel, and when the lathe is worked the grinding tool is made to move across the speculum by means of the two wooden arms.

The crank is set so as to produce a motion of one-eighth the diameter of the speculum, which rests upon a piece of thin wood somewhat larger than its diameter, and while the motion of the lathe continues this piece of wood is turned round more or less by the left hand, either backwards or forwards, thus giving an irregular motion of the very best kind, superior in every way to a mechanical one.

Now, if this were all, any number of zones would be the result, and this has been found to be so in actual practice. These are got rid of in a very simple way. A piece of string is hooked on to a nail in the middle of the wooden rod which drives the grinder, while the other end is attached to some fixed point. The string allows the center of the grinder to pass over the center of the speculum; but to get the side-stroke the the pointer finger of the right hand is pressed on the string more or less, and the grinder in this way can be moved while the lathe is running, to the necessary extent off the center of the speculum, and thus obtain the necessary side stroke in the very simplest possible way.

The stroke is a straight one; but notwithstanding this, the motions given by the actions of the two hands entirely eliminate the zones, and the result is a nearly spherical surface if, indeed, it is not as true a one as can be desired. Two specula, each of 6½ in. diameter have been ground in this way, and the results given by them are exceedingly good. They are still unsilvered and, of course, reflect somewhat under 5 per cent of the incidental light; but they undoubtedly show both by trial on stars, on the moon and Jupiter, that the movement forms a means of obtaining a nearer approach to the spherical surface than can be obtained in any other way.

It may be thought that too much has been said about obtaining a spherical curve; but it seems to be the foundation, and the correct one, for getting the necessary parabolic one. The difference between a parabolic and a spherical surface is so small that it is assumed by most that the conversion to the parabolic form is got in the polishing. Mr. Ritchey gives in his Memoir the difference in regard to some mirrors, and these are in decimals of an inch:

1.	His own 2 ft., of 93 in. focus	.0004
2.	Lord Rosses 6 ft. of 60 ft. focus	.0001
3.	The Yerkes 4 ft. mirror of 25 ft. focus	.0006

It will be seen from these figures that in the first one the difference is only 4-16 000 of an inch, an amount which it seems could without difficulty be removed in the polishing after a true spherical surface has been obtained.

The lathe runs so easily with the grinder and acts so rapidly with the motion that when it is making 120 strokes a minute a 6½ in. polished speculum can be put on the machine, the top portion ground with flour of emery and made ready for polishing again in about an hour. The two 6½ in. specula which are at present used were treated in that way.

Most of the obelisks in existence were taken from the quarries of Syene in Upper Egypt, and are of red granite or syenite. They are the monolyths of the ancients. Some of them measure over 100 feet, and to extract a vast piece of stone of this size meant great care and toil. At Syene an unfinished obelisk shows the way they were cut. The obelisk was cut out of the solid rock and polished on three sides before the fourth was disengaged. A deep fissure was then made along the under side, where the separation was to be made, and wooden wedges introduced into it, which being frequently moistened, expanded and gradually effected the separation without any shock.

MINIATURE GRANDFATHER'S CLOCK.

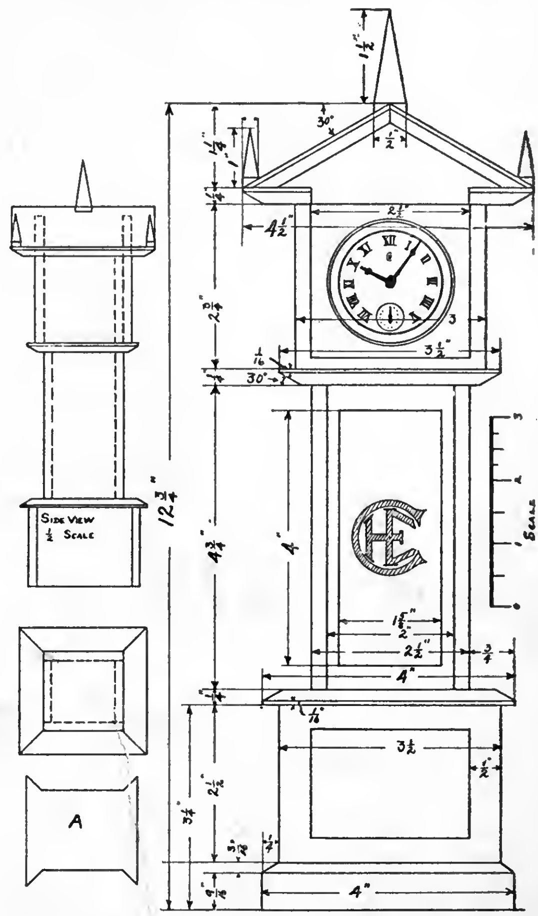
IRA M. CUSHING.

The clock illustrated and described makes a very pleasing gift, and well repays the maker for the time and small expenditure given to it. The drawing given is well dimensioned as well as drawn to scale. The material used will depend somewhat upon the finish desired and upon the maker's resources. A nicely grained maple or quartered oak finished with a Flemish or weathered oak stain or a mahogany stain give a very fine effect. However, the clock can be made of cigar-box wood, filled and stained.

The base should be constructed first, making it 3½ in high, fastening the baseboard on outside. The top of the base should set into the box flush with the top of the sides. It should be fastened in well as this supports the rest of the clock. The bottom should be top put in before fastening the baseboards in place. It might be well to wait until the middle section is in place before putting in the bottom piece. The caps of the base should now be put on This will leave a space 2½ in. square and ½ in. deep on top the base into which the middle section will fit.

The middle section will be a box 5 in. long. The bottom of it should fit inside and should be fastened in rigid. The top of this box will also constitute the bottom of the clock section, and should be cut as shown at *A*. The sides cut out should be filled in with pieces which have the grain running at right angles to the top. This will follow out the scheme of the base and give a uniform appearance on all sides. If desired, the front panel of this middle section can be fitted with hinges and a lock, making a good jewelry case. The middle section can now be assembled with the base by small screws, or nails and glue, through the bottom into the top of the base.

The clock section is another box 2¾ in. long and 3 in. square. The front should set in about ½ in. and the diameter of the hole for the clock will, of course, depend upon the clock purchased. The back of the clock section should be made removable. The neatest method is to use hinges and a thumb catch to fasten it. The method of fastening the clock in place will also depend upon the shape of the clock and will be left to the ingenuity of the maker. It should, however, be easily removable for cleaning and repairs. The bottom of this section should be set in and the assembling done the same as the base and middle sections. The roof is made next and is 4½ in. square at the eaves. This should be made removable for access to the clock. The best way is to put hinges at one side and a hook and pin at the other. The hook should hang and fasten on the clock section. If it were on the outside it would detract from the appearance of the inside of the clock. The pinnacles on the roof have a square cross section. After all parts have been assembled the clock should be sandpapered, taking care not to round the edges. Leaving these edges and corners sharp add very much to the general appearance, and the clock will resemble more nearly the old colonial clocks.



I would suggest that thin glue and small wire brads be used to make the clock. Care should be taken that all joints fit even, and that all parts are symmetrical. Inequalities show up very quickly in a small piece like this. I think it would be well to put a weight, like a piece of lead, in the base. This would prevent the clock from tipping too easily. It can be put in the last thing, just before fastening the bottom in, and should be securely held in place.

A number of little things could be done to add to the beauty of the clock. The front of the base and middle section could be paneled, as shown on the drawing. Small wooden balls could be added to the top of the pinnacles. The value of the clock to the one to receive it would be much increased if, in paneling the front of the middle section a simple monogram of the recipient's initials was left raised. The drawing shows H. E. C., worked into a monogram. Then, when the clock is stained, more of the stain should be rubbed off the letters, leaving them lighter than the surrounding wood. If a door is made of the front the inside may be lined with plush of appropriate color and hooks put up for hanging jewelry.

BOOKS RECEIVED.

A First Course in Physics. Robert A. Millikan and Henry G. Gale. 488 pp. 7½ x 5 inches. 461 illustrations and several portraits. Price $1.25 Ginn & Co., Boston.

This one year course in physics has been developed from the experience of the authors at the School of Education of the University of Chicago, and in dealing with the physics instruction in affiliated high schools and academies. The book is intended for third year high school pupils, and is a simple, objective presentation of the subject as opposed to a formal and mathematical one. The historical aspect of the subject is treated in a most interesting way, enabling the pupil to obtain an excellent perspective of the development of the science.

The text throughout is exceptionally clear and the various topics are presented in a most interesting way, having the life and spirit well calculated to arouse and sustain the interest of the pupil.

All the experiments in the book have been carefully chosen with reference to their usefulness as effective class-room demonstrations. It would certainly seem impossible to have a dull, lifeless class when this book is used.

Designs for Small Dynamos and Motors. Cecil P. Poole. 186 pp. 9½ x 6 inches. 231 Illustrations. Price $2 00 McGraw Publishing Co., New York.

Most of the chapters of this book originally formed articles written for the "American Electrician" and many of them are included in "Electrical Designs" a book published by the same publishers. Twenty-two designs of various types and sizes of motors and dynamos are given, of which eleven are one-horse power or under. The text is confined to specific directions about each machine and does not include any theoretical matter.

Anyone wishing to make elecctical machines of the types described will find the book of much value.

Handbook of Mathematics. T. Claudel Translated by Otis Allen Kenyon 708 pp. 9½ x 6 inches. 422 illustrations. Price $3.50. McGraw Publishing Co., New York.

This book is intended primarily as a reference book for the mechanic, engineer or teacher, but it is also well adapted to home study for anyone desirous of quickly learning some particular mathematical process needed for work in hand. Owing to the wide scope of the book only essentials are given, but this is what makes its greatest value for the purposes mentioned. With the exception of a few pages in life insurance, which follows the French methods, the processes are in accord with the accepted American practice. In France the book has quickly passed through seven editions, and an equal success is predicted for this country.

ELECTRICITY ON THE FARM.

Although applications of electric lights and power to farm work are few and widely scattered, occasionally conditions which permit of one or both of these applications are readily seized. An instance of this kind was recently reported from the agricultural state of Nebraska. Three farmers, having combined and installed a small gasoline engine for pumping purposes, embraced the opportunity to make further use of this engine when it was not pumping water. They secured a small dynamo, and placed it so that it could be driven from the engine. They then installed electric lights in their houses and barns, so that now they are enjoying one of the luxuries of country life—a safe, convenient and economical light.

In spite of its backward state, the application of electric power on the farm is sure to develop rapidly before long. At the present such uses are limited generally to the estates of so called gentlemen farmers, who farm for pleasure rather than for profit. A drawback to the wider use of the motor is its first expense; but if farmers would form groups, as has been done in the instance mentioned above, and divide the cost of the machinery among them, this objection would no longer hold. The machinery needed for such an arrangement is not large; in fact, it need hardly be larger than that required for a single farm.

The principle of the rifled gun has been applied to pipes for pumping oil in California, where the crude oil is mostly thick, viscous and difficult to pump through long lines. The pipe is rifled on the inside, so that the oil, mixed with about 10 per cent of water, is caused to whirl rapidly. The water, being heavier than the oil, seeks the outside, and forms a thin film, which lubricates the pipe for the passage of the oil. The friction is thus so far reduced that the oil has been easily pumped through a line 31 miles long.

In anticipation of the large demand for alcohol for light, heat and power, preparations are being made for the erection of plants through the South to work up the mountains of sawdust made at the sawmills. The first plant, using a new mechanical process and costing $250,000, is nearly completed at Hattiesburg, Miss.

NURSERY FURNITURE.

JOHN F. ADAMS.

In response to a number of requests for furniture "for the children," a few pieces likely to be most in demand are given with the hope that a large number of children will enjoy their play as much as have the little ones who possess the articles from which this description is taken.

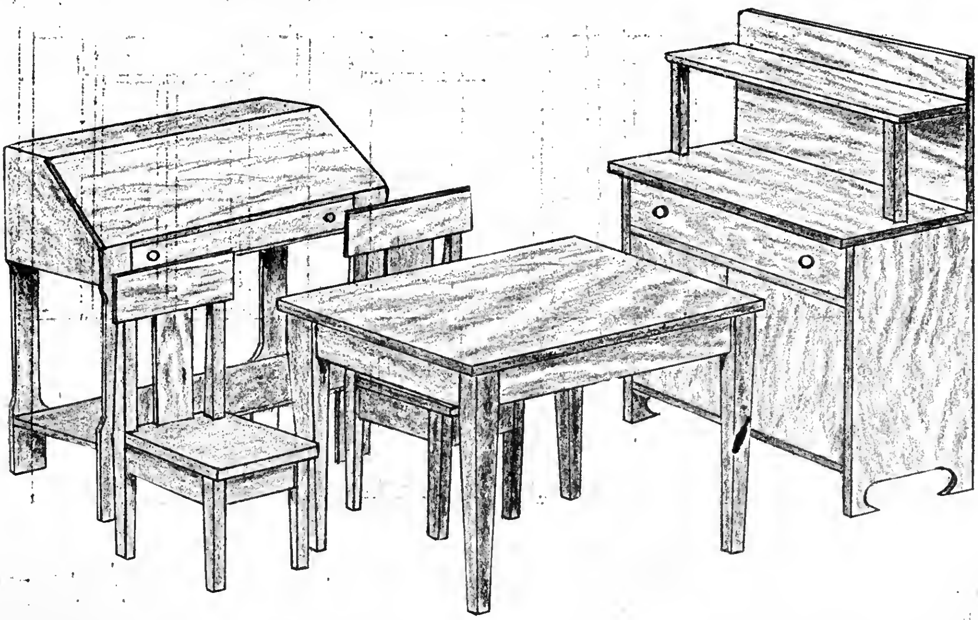
And quite as important as any single piece of furniture is the

FOLDING SCREEN PLAYHOUSE,

which adds such a touch of reality when playing "house." Nor is it entirely a plaything, as on windy and cool nights it serves as a screen against drafts. As it can be quickly folded up and put away in a cupboard, it is in that respect superior to a wooden one, and has the great advantage of being usable throughout the year, and especially on stormy days.

The framework is made of spruce strips 1½ in. wide; 12 pieces 5 ft. long and 20 pieces 3 ft. long being needed. Both doors and windows are hung with hinges and similar strips 1¼ in. wide and 3 pieces 6 ft. 6 in. long; 12 pieces 30 in. long and 9 pieces 18 in. long are needed.

The screen is made in four sections, each 5 ft. high and 3 ft. wide, and fastened together with hinges so that the two end sections swing towards the back and the middle joint the reverse. The three sections having windows are alike, the other sections having a door. The framing of the window and doors are fully shown in the illustration. Joints should be carefully made using mortise and tenon pretty generally throughout the frame. Across the top of the windows and doors nail strips 3 in. wide and about ½ in. thick, which make a better representation of the frame and also serve to prevent door or window from swinging by.



The framework being completed, it is covered on both sides with extra heavy wrapping paper, or light cardboard, using glue liberally for the purpose. On this covering is put red cartridge wall paper, which is lined off to represent brickwork with white paint, the thin pieces over the door and windows covered with gray cartridge paper to represent stone cap pieces. Or a wooden house can be represented by getting a roll of wall paper showing strips of sheathing, this pattern being frequently put on a kitchen. The light strips are cut out and pasted on in horizontal layers, to show as clapboards, and the dark strips run vertically at the corners and around the doors and windows to form the casings. The door is also made up from the same paper, the lighter strips forming the panels and the darker one the styles and rails. The glass in the windows can be nicely provided for by using transparent card stock, obtainable at paper houses handling card stock for printers, and ordered through a local printer, who would be willing to have it come forward with an order of his own. Other schemes of decoration will undoubtedly suggest themselves to the reader, but those given are probably the easiest to make up in most localities.

Having a house, the next thing is to furnish it, and for this two chairs and a table will be needed, and a sideboard, desk and other fittings can be added if the interest of the reader, and the wishes of the children do not conflict with each other.

THE TABLE

has a top 20 in. long, 16 in. wide and ¾ in. thick. The four legs are 22 in. long, 1¼ in. square at the top and 1 in. square at the bottom. The longer pieces connecting with the legs are 2½ in. wide and 16½ in. long, which allows ½ in. at each end for tenons. The pieces at the ends are 12½ in. long, with the same allowance for tenons. The mortises in the legs are centered and are ⅜ in. wide and 2 in. deep, being open at the top.

THE CHAIRS

are of simple construction, and have seats 12 x 10 in. and ⅝ in. thick. The front legs are 12 in. long, 1¼ in. square at the top and ⅞ in. at the bottom. The rear legs are 2 ft. long and 4½ in. square at the center, tapering off at the bottom the same as the front legs and at the top remaining the same width but thinned down to ⅝ in. thick. The rear corners of the seat are cut out to fit around them. The cross pieces under the seat are 1¼ in. wide, ⅝ in. thick and 9¾ in. long, allowing ⅜ in. for tenons. The joints must be well made and secured with glue and screws. The top piece of the back is 3 in. wide, ⅝ in. thick and 12 in. long. The center piece at the back is 4 in. wide, ⅝ in. thick and 10 in. long, the lower end being fitted to a slot cut in the seat, and fastened with screws which serves to give needed strength to the back.

THE DESK.

This will require a little more skill than the previous pieces, but if care be taken in the work, no great difficulty should be experienced. The general dimensions are: Height, 3 ft.; width, 2 ft., and depth, 14 in. Whitewood or red gumwood are best suited to secure a light, attractive desk. All except the wood used for the pigeon holes is ¾ in. thick. The pigeon holes are made of ¼ in. stock.

The top is 24 in. long and 6 in. wide, the drop lid 24 in. long and 14 in. wide; the top over the drawer 21½ in. long and 13½ in. wide, the lower shelf 24 in. long and 12½ in. wide. The dimensions of the front and back legs and deck ends are given in the illustration. The pieces under the shelf are 16 in. long and 2 in. wide, allowing ⅜ in. at the back for tenon. The drawer is 18 in. long, 3 in. deep and 13 in. wide. This may be omitted and a plain piece substituted, which would be 19 in. long and 4½ in. wide, allowing ½ in. on end for tenons. The shelf is 9 in. above the floor. The grain of the ends of the desk runs vertical.

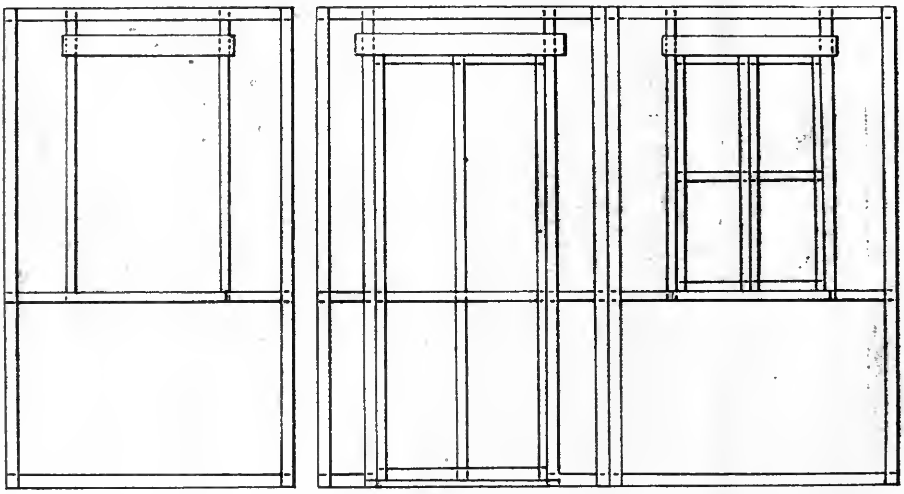
THE SIDEBOARD.

To complete the appointments of the house, and enable the children to play with all possible resemblance to "grown ups" a sideboard may be added to the pieces previously described. The general dimensions are: Height, 3 ft.; width, 27 in.; depth, 12 in.

The ends are 2 ft. long, and 11 in. wide with the lower ends cut to the shape shown in the illustration; the height of this cut is 3 in. The top is 27 in. long and 12 in. wide and the board at the back is the same size. The shelf is 27 in. long, and 5 in. wide and rests on posts 1 in. square and 8 in. long. The posts are attached to the top by short pieces of ⅜ in. dowels, boring holes for same in both posts and top and setting up with glue.

The back board is attached to the cabinet by means of cleats 2 in. wide fastened with screws and long enough to reach 6 or 8 in. down on the back of the cabinet. The bottom of the closet is 24 in. long and 10½ in. wide, the under side set even with the upper edge of the openings in the ends.

A drawer may be made as shown or the whole space under the top may form a cupboard. If a drawer be made, it should be 24 in. long, 3 in. deep and 10¾ in.



FRAMEWORK OF PLAYHOUSE.

wide. A rectangular frame is made for the runs for the drawer, the front strip being 1 in. wide. This makes the size of the doors 16 in. high and 13 in. wide.

A strip about 1 in. square and 24 in. long is nailed to the under side of the back of the top piece, set in from the back edge ½ in. and the back sheathed up with ½ in. sheathing. The ends of the sheathing are nailed at the top to the strip just mentioned, and at the lower ends to the bottom of the cupboard. Suitable knobs and catches are added to the cupboard doors and drawer pulls or knobs to the drawers.

The preferable finish to all the furniture described is weathered oak or dark brown stain and varnished, as the pieces are all in the old mission styl. A word of caution to those using stains for the first time is: Do not use too much stain. Apply a little at a time, and with a soft rag rub off the excess stain until the grain shows clearly. Dark stains are likely to conceal the grain after drying more than they appear to when moist.

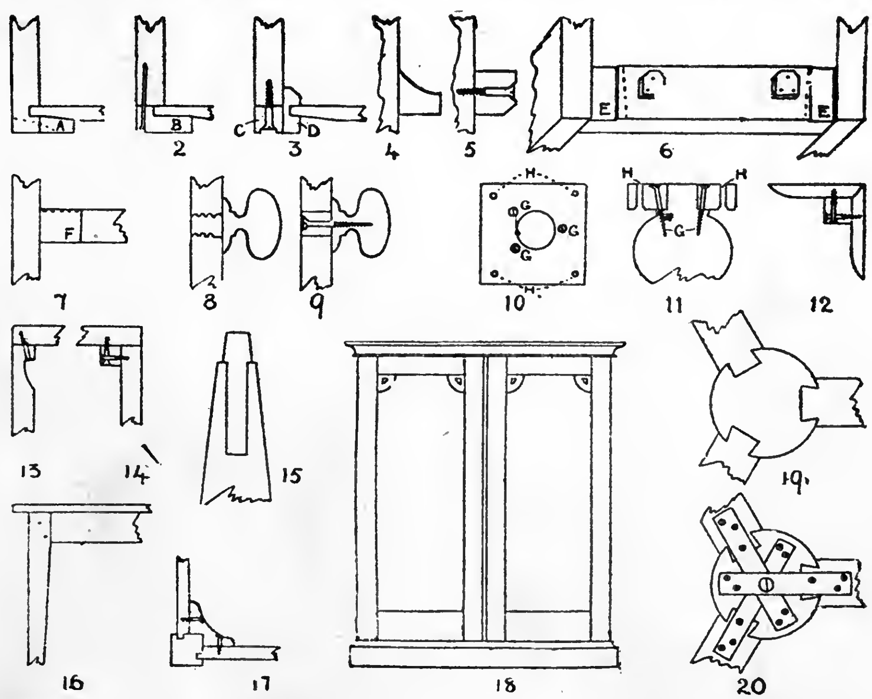
REPAIRING FURNITURE.

In the present article we will endeavor to show how some at least of the ills to which all articles of furniture are liable may be remedied, and we cannot do better than make a start with drawers, the constant wear and tear of these, to which in many cases, may be added ill usage, making them particularly liable to get out of order.

When new, the running corner of a drawer is, or should be, as Fig. 1, but sooner or later, according to the material, or whether fitted properly or not, the side wears off as shown by dotted lines, and when this wear has once commenced, it goes faster, until the drawer can only be used with difficulty, and the longer it is used in this condition, the worse job it is to repair satisfactorily.

The proper method of repair is shown in Fig. 2. First remove the drawer-bottom by withdrawing the nails at the back and carefully uplifting away the runners, *A* Fig. 1, then cut away the sides to the extent of the groove in which the bottom slides, and fix on with nails and glue, rebated strips as *B* Fig. 2. These strips should be of hard wood, and it is necessary that they fit well at the joint, otherwise the glue will fai to hold properly, and it will not do to depend on the nails alone.

In case the foregoing method proves too difficult for some of our readers, we give in Fig. 3 an alternative, in which the sides of the drawer are planed off in the same way, but instead of fixing on rebated strips the width of the side strips, as *C*, and after these are dry the grooved strips *D* are glued and screwed on inside the drawer, the bottom of the latter being reduced in size, so as to slide in these new grooves, as shown.



At all times when the drawers are worn as above, the bearers on which they run will be found to be in the same state as shown in Fig. 4, the remedy is to remove the worn part and renew, as shown in Fig. 5. This is, as a rule, comparatively easy to do, but it is absolutely necessary that the top of the new bearer should be at the same height as the old one was when new.

In addition to the drawer runners and bearers being worn away, the front rail, where there is one, is also likely to be affected, as at *E*, Fig. 6. To remedy this, cut away to an even depth and insert pieces of wood of the required thickness, covering them at the front by letting in pieces of veneer neatly, as *F*, Fig. 7. These latter will fit better if made slightly taper, as shown; they can then be driven in as a wedge.

Knobs on drawers and cupboards have often a tendency to work loose, especially when screwed in as in section Fig. 8. A simple and effective remedy is to remove the knob and cut off the screwed portion, also clear out the hole in the drawer and glue in a well-fitting ply of hard wood. When this is dry, clean off level with the surface of the drawer front both inside and out, and then fix on the knob with a long slight screw, as Fig. 9, just touching the face of the knob with glue to prevent it working off by unscrewing.

The turned feet with which chests of drawers are often fitted have a bad habit of getting loose, owing to the shoddy method of fixing. The foot proper is, as a rule, fitted into a block of soft wood, which speedily splits off and off comes the foot. The remedy is, make a block of hard wood, as Fig. 10, screwing through it into the foot with three screws *G*, and then fixing to the chest with four screws at the corners, as *H*. This is shown sectionally in Fig. 11, and it will be found a firm, substantial job.

Instead of the turned feet, two shaped pieces at right angles are sometimes used, and as these are too often simply glued on, they will not stand much rough usage. They may be, however, improved by screwing through the angle block, as in Fig. 12, and can also be prevented from leaving the drawers by fixing with screws as Fig. 13, or with another angle block, as Fig. 14, using glue as well in each case.

Castors have a bad habit of becoming loose and after being re-screwed a few times, there is no wood left to fix to. An effective remedy for this is to cut off what is left of the spigot, bore down into the leg and insert a piece of wood with a new spigot turned on the end, as Fig. 15; if this latter is made to fit and fill the socket of the castor entirely, there will be no difficulty after, the whole of the original fault lying in the fact that when the castors are fitted at first, the wood does not fill them, thus allowing a certain amount of free play, which increases more and more, putting all the strain on the small screws.

Table legs are apt to work loose where they join the rails, either through the pins becoming fractured, or through the leg splitting at the pin holes; in either case they must be forced together and glued, inserting new pins if required, and to prevent a recurrence of the trouble, angle blocks should be fixed on the inside. Fig. 16 shows the position of the fault, and Fig. 17 the remedy.

On removing heavy furniture, especially wardrobes, it is often found that the doors or drawers will not work as they should do in their new position, rubbing at the top or bottom, and much surprise is often felt that it should be so. The cause is in the slightly varying level of the floors, and the remedy is a simple one. Fig. 18 shows a wardrobe in position; now if the left-hand door rubs at the bottom, it is probable that the right hand one will rub at the top, and instead of planing both to make them right, we simply insert a chisel under the plinth at *I*, so as to lift it up, and when the doors swing clear a wedge inserted between the plinth and the floor will make them right. The same remedy applies to chests of drawers and boxes, these latter often locking easily when empty, but when filled will not do so, the reason being that the weight of the contents brings the bottom of the box to the floor, displacing the catch of the lock slightly, a fault which a slight wedge will correct at once, far more quickly than altering the catch itself.

Tables which are made with a central pillar, from which branch out three claw legs, are often a nuisance owing to the claws giving way and leaving the stem. If these are turned up, the claws will be seen to be dovetailed in, as Fig. 19, and the wood holding the dovetails being only side grain, will stand very little strain, hence the fault. The remedy is to replace the claws neatly as possible, and fix each one with a thin brass or iron strap, as in Fig. 10. All the straps may be fixed with one central screw into the stem, also two small screws, and they must be bent to the shape of the claw and screwed firmly to it, as shown, and this will effectually cure the fault. In addition to tables, music stools are often in need of such a remedy, as above.

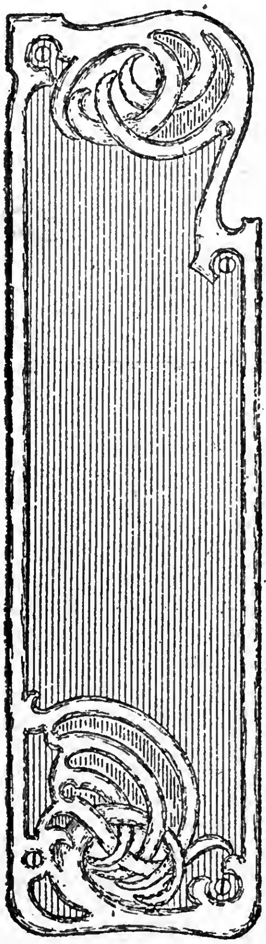
EXPLANATION OF DRAWINGS.

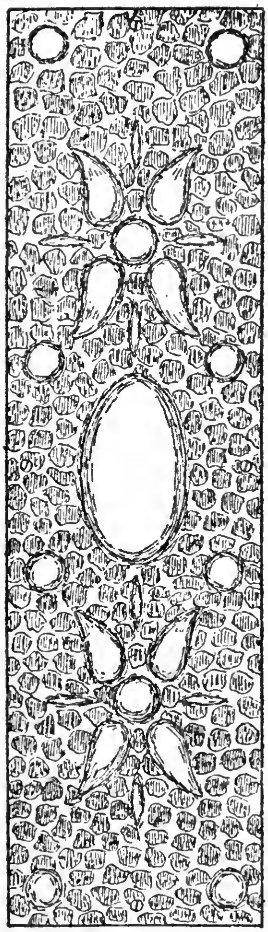
Fig 1. Drawer runner wore away.
2. New runner fitted.
3. Alternative method of fitting runner.
4 Bearer for drawer worn away.
5. New bearer fitted.
6. Front rail worn away.
7. Front rail repaired.
8. Usual method of inserting drawer knob.
9. To refix drawer knob.
10. Refixing foot to chest of drawers.
11. Sectional detail of Fig 10.
12. Strengthening shaped foot.
13. Fixing shaped foot.
14. Alternative method of fixing shaped foot.
15. Inserting new spigot for castor.
16. Faulty joint in frame of table.
17. Strengthening frame of table.
18. Readjusting wardrobe door.
19. Method of fixing claw legs to central stem.
20. Strengthening claw legs.

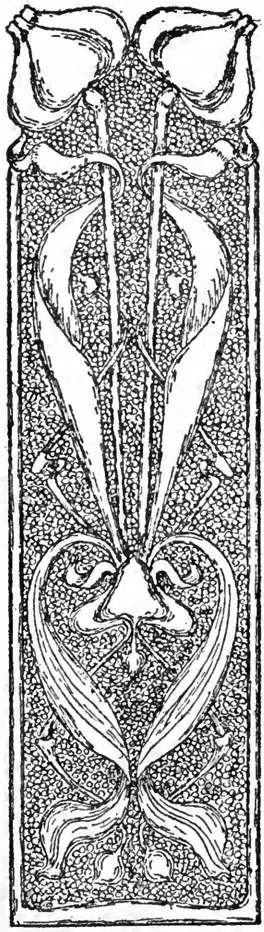
REPOUSSE METAL FINGER PLATES.

EDWIN TURNER.

The finger plate shown in the accompanying illustrations are designed with the object of forming graduated studies for the beginner in repousse metal work. In Fig. 1 is shown a Celtic strapwork design, which can be executed almost entirely with a tracing tool from the front. The ornament in Fig. 2 is raised from the back, and no tracing is required on the front; therefore the design should be drawn on the reverse side. Fig. 3 is more elaborate in design, and in execution will require a combination of the methods adopted in the two other plates.







Cut for each plate a piece of metal 1 ft. by 3¼ in and scour with emery cloth and oil. This done, transfer the designs to the plates, noting that the design in Fig. 2 is to be drawn on the back. Point in with a scriber or tracing point and fix the plate on the pitch-block. Fig. 1 is worked entirely from the front and, with the exception of the ground, which is pushed back with a grounding tool, the work is executed with a steel tracer. To obtain higher relief, the work should be traced a second time with a blunt tracer, tilting the tool in such a way as to force the metal towards the design, thereby causing it to stand out from the groundwork at a sharper and more clearly defined angle. Great care must be taken not to force the tracer through the metal.

The ground should now be levelled down, and all tool marks carefully worked out, finishing it perfectly flat and smooth all over. The spaces between the strapwork, shaded with the dark vertical lines, are cut out and should now be worked with a sharp steel tracer; also cut out all round the plate with the same tool. Examine to see that all is correct, then remove from the pitch-block. Trim all around the edges with a file and emery-cloth; drill holes for screws; and finish with polish and lacquer.

For Fig. 2, fix on the pitch-block face downwards and commence raising at once. The small end of the mallet should be used at first in the center oval, the edges being afterwards sharpened with brass raising tools. A round brass tool will be found useful to do the other parts. In all cases it is best to use the largest tool that can comfortably be worked in the part to be raised. Remove the plate from the block, turn over and refix, after levelling the pitch-block and cleaning the pitch off the plate. The tool marks in the ground are done with a large raising tool; they should not be too even, but rather irregular. After the ground is finished satisfactorily, remove the plate from the block and thoroughly clean it; then drill the holes for the screws and polish and lacquer.

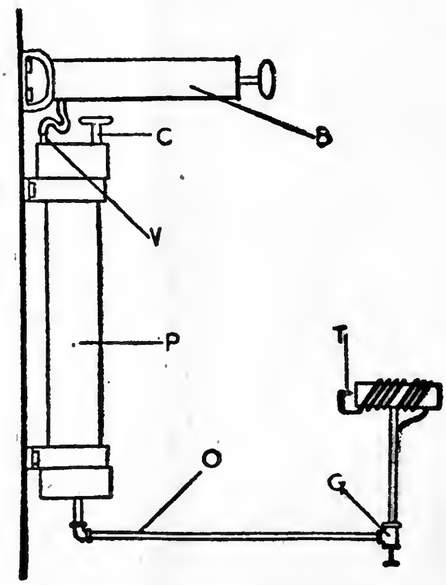
Fig. 3 will require very great care in all stages to insure a good effect. Fix the plate on the pitch-block in the usual way and wait until it is cool before commencing the work. Then trace all the lines of the flowers, stalks, leaves and borders of the plate, finishing the treatment of the front by tooling the ground all over with a pearl tool. Take the plate off the block and clean away all pitch that adheres to it; then refix face downwards and raise th design with suitable tools. The illustration will give a fairly correct idea of the parts to be raised, and the amount of relief to be given to each part. The tulips at the top, the leaves and the central figure between the lower leaves will stand out the most prominently, whilst the finer tendrils and buds will only be slightly raised, and will be almost obscured in the background. The border will also require raising. This done, the plate may be taken off the block, cleansed with turpentine and the holes drilled for screws.

If the metal gets bent and twisted in working, it may be straightened by laying it face downwards on the sandbag and beating it straight with the flat end of the mallet. The plate may be greatly improved by again fixing it on the pitch-block, after filling up level all the hollows at the back with the pitch composition, and working round the outline, as in Fig. 1, with a blunt tracer, taking care not to work the ground too low. At this stage any inequalities in the raising should be corrected, and any necessary improvements made. When this is done detach the plate and again clean with turpentine. After this, bring to a high polish with a suitable powder and finish with a coat of lacquer to preserve the polish.—" Work."

To keep machinery from rusting, take one ounce of camphor, dissolve in one pound of melted lard, take off the scum which forms and mix in as much powdered plumbago or black-lead as will give it an iron color. Clean the machinery and smear it with this mixture. After 24 hours rub clean with soft linen cloth. It will keep clean for months under ordinary circumstances.

GASOLINE BRAZING TORCH.

A gasoline brazing torch which fastens to the wall in front of the work bench and swings back out of the way when not in use may be made, says the " American Machinist," as follows: Thread both ends of a 2 ft. length of 2 in. gas pipe. In a 2 in. cap drill a hole to receive a single tube bicycle valve, *V*; drill another hole and tap it to receive a ½-in. pipe, *C*, 5 in. long, on which weld a piece of iron to form a handle or T for convenience in replacing the piece after filling the



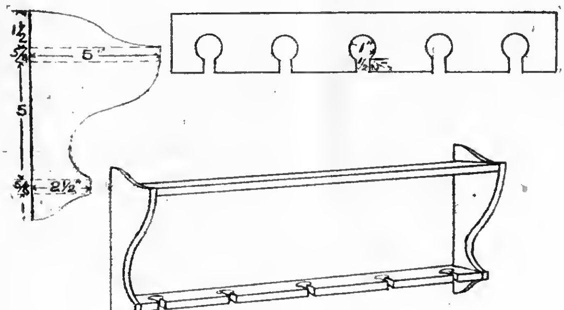
tank by way of the lapped hole. Fit the 2in. cap on the top of the 2 in. pipe. Drill and tap the cap for the bottom for a ¼ in. pipe, *O*, 3½ ft. long and threaded at both ends. Make the burner a piece of bicycle tubing with a 2 ft. length of small sized tubing coiled around it. An angle valve *G* controls the supply of oil to the burner. The arrangement of the burner causes a continuous generation of gas by the blast. Make a hole not larger than a pin prick in the cap, *T*, at the end of the coiled tube. Fasten a bicycle pump *B* to the wall just above the tank in use in keeping up a constant pressure in the tank.

Oil may be prevented from entering the boiler with the water condensed from steam by putting an upward extension on the pipe leading to the boiler, and providing it with a means of tapping off the oil that will rise in the pipe above the horizontal pipe connecting with the boiler.

When anthracite coal is used in boilers, it is necessary to employ wide grates of large area and a comparatively low firebox. When consuming bituminous coal, narrower grates of smaller area and a high firebox are necessary.

PIPE RACK.

As making Christmas gifts is the thought in many minds at this season of the year, a pipe rack is offered as a suggestion to those readers who may have relatives or friends who are smokers. This rack is simple in design but possesses one point of merit lacking in most of them, and that is a shelf wide enough to hold the tobacco jar, match safe, etc., thus bringing all the smoking articles together in one place.

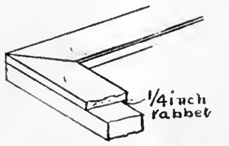


The shape and dimensions of the ends and pipe shelf are shown in the drawings. The upper shelf is 16¼ in. long and 5¼ in. wide. If made in bass or pine it may be decorated by pyrography, or made of white wood, maple or mahogany, as desired.

INEXPENSIVE PICTURE FRAMES.

Many persons accumulate in time picture taken from magazines or from other sources, which they would like to have framed but which lack sufficient value to make it worth while to purchase a frame. For such cases the home-made frames here described will be quite appropriate as they are more attractive in the large sizes than the small.

Obtain several cypress clapboards, selecting those having the most distinctive graining. These can be secured from nearly any contracting house builder. The thin edge is then cut off, leaving a tapering strip, the width being determined by the size of the frame to be made.

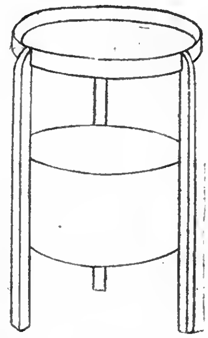


Strips of pine or spruce about ¾ in. thick are then planed up, the width to be about ¼ in. less than that of the clapboards, with the outer edges of both even, a rabbet being formed on the inner edges.

The frame can now be made up as with ordinary picture moulding, the corners being mitred and set up with glue, drying between the clamps. The frame is then stained to any desired shade, dark green, brown, gray or mahogany being attractive; in fact, about any color can be used that will harmonize with the room in which the picture is to be hung. The final finish may be dull, using a wax; or bright, using shellac and varnish. Anyone having skill in applying gold or silver leaf can use it in place of the stain, making a very attractive frame.

CHEESE BOX SEWING STAND.

An ordinary cheese box and four pieces of wood 1 in. square and 30 in. long are the materials required to make a very serviceable work stand, having the much desired storage capacity for small articles on the top, and a sizable receptacle for the work underneath.



As the box is of somewhat less diameter than the cover, the top ends of the legs, which may be three or four in number as preferred, are cut out, and also rounded off, as shown in the illustration. Long round hard wood screws are put through to secure the legs to the top, and also the bottom part. In addition, several short screws are put through the sides of the lower box from the inside.

The table may be finished by staining and varnishing, provided the box is an attractive one and has been nicely smoothed up. Otherwise, a covering of light, figured cloth will be preferable, although wall paper can be used to good advantage. This part of the work is left to the artistic skill and resources of the reader.

The element of power is the most vital of any that enters into the cost of the manufactured article, therefore, the constant endeavor has been and is, to produce power at the lowest cost. The enormous loss which lies in the conversion of coal into work is due to the large number of transformations which the thermal units are obliged to pass through before the desired result is obtained. Fuel burned directly at or in the engine has been found to accomplish the purpose by reducing the number of intermediate transformations. This type of engine is the gas engine, which has now reached the point of economical and satisfactory operation.

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.

NOVEMBER, 1906.

This number begins the sixth year of publication of this magazine. We take this occasion to thank our readers for the cordial support that they have given it, and to say that plans are now being perfected for increasing both the size and scope of the contents of future numbers. The many complimentary letters which we are constantly receiving is most encouraging evidence that the magazine is of practical value to those reading it. Repeated instances have come to our attention where articles in this magazine have been utilized for direct monetary benefit. Two of these instances are given as illustrations: A carpenter in a near-by city made, during his leisure time, several pieces of furniture described in the magazine. A visitor, chancing to see them, was so much pleased with their appearance that he purchased them at a price which gave the maker a substantial return for the time spent in making them. The success of these articles being so satisfactory, he continued making furniture, finding a ready sale for the same, and is now giving a very considerable portion of his time to this work, finding it more productive than his regular trade. He has made, in the interim, a foot power saw table and band saw, which greatly facilitates the work. Another carpenter, living in a sea-coast town, has made quite a number of skiffs which he sells readily to yachtsmen at good prices. It is quite probable that many other readers who have leisure time and a fair degree of skill in woodworking could develop a similar line of business.

We would again call attention to the necessity of giving both the old and the new address whenever change in the mailing directions is sent us. We have also received a number of letters recently, without signatures. Should any one have failed to have received a reply to their inquiry or letter, the reason for this may be as above.

The time is approaching when we begin to think of Christmas and what we will do in the way of Christmas gifts. For that reason quite a number of articles are described in this number which are particularly suitable for that purpose, all of which may be easily made by one possessing ordinary skill with tools. The back numbers of the magazine also contain many articles describing things equally suitable. The advertising columns of the September issue give a list of articles on furniture, and in this number is a list of games, etc. A gift which is the product of the giver's skill carries with it associations not found in things purchased, and the enhanced sentiment adds much to the pleasure of both the giver and the receiver.

The auxilliary yawl, a description of which begins in this number, is a type of boat which has become very popular during the last few years, and we are confident that readers interested in boat building will welcome these articles. The boat is large enough to be comfortable for cruising along the shore, and yet not too large to be beyond the capacity of the amateur builder. We shall in an early number give the lines for a boat 30 feet long, so that those who prefer a larger boat can build the same from the description given, which will be very complete regarding the details of construction.

The cordial reception given the recent articles on boat-building has been very gratifying, and we shall hereafter, in addition to the descriptions published, give the lines of various types of boats which would be of interest to amateur builders.

Owing to the large demand for back numbers containing the descriptions of small boats, we have published a reprint of the following boats:—20 foot speed launch, sailing dory, rowing skiff, 9 foot skiff tender, sectional skiff and canvas canoe, which together with "Boat Sailing for Amateurs" are issued in one book, which will be sent postpaid for 25 cents.

A barrel of crude petroleum is 42 gallons, or 5.9146 cubic feet; a barrel of refined petroleum 50 gallons, or 6.684 cubic feet.

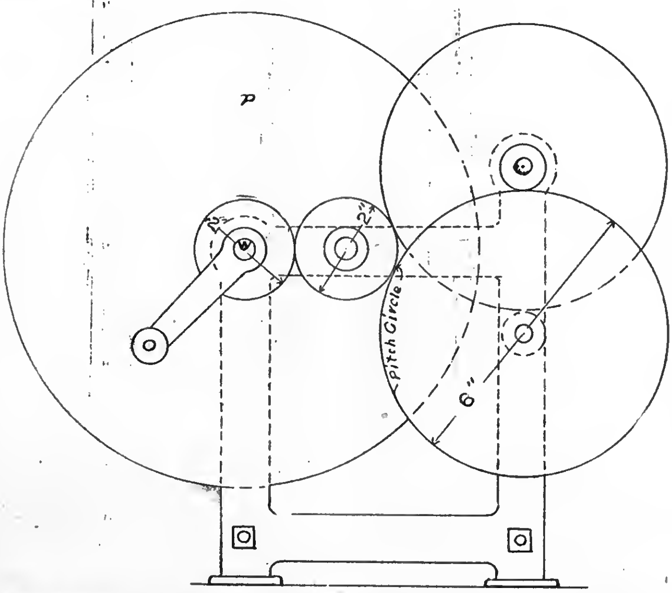
INDUCTION COIL WINDING MACHINE.

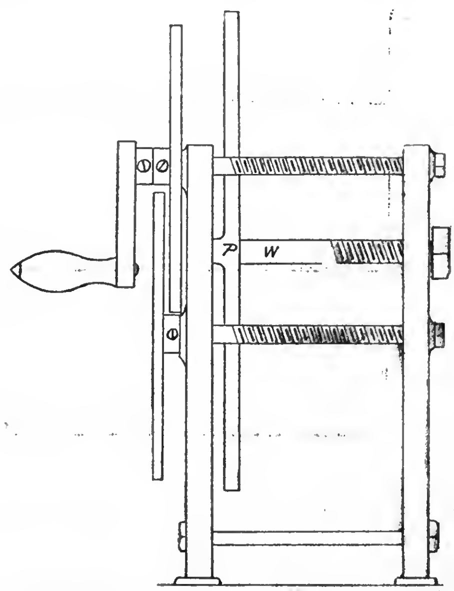
FREDERICK A. DRAPER.

A method of coil winding described in the October issue of this magazine required the use of a screw-cutting lathe with gears set as for cutting 60 threads to the inch. As many readers who might like to make coils after this method may not possess a screw-cutting lathe, and as a simple yet adequate winding machine can be made at small expense, such a machine is here described. It also possesses one decided advantage over a lathe, and that is the ability to stop winding, instantly at any time. While a lathe is very apt to run over or the wire to twist or break if too sudden a stop is made.

The way to use such a machine is to mount the bobbin on the winding shaft, pass the bare wire between the two screws and fasten the end to the bobbin, allowing sufficient free wire for subsequent connections. The wire is then held by the fingers so that, as the winding proceeds, the wire will be in the turns of the screw and be guided across the bobbin. To reverse the direction it is simply necessary to use the other screw, the top side of the lower screw and the under side of the upper screw turning in opposite directions.

The construction of the winder is shown in the accompanying drawings. The frames are of cast iron,





that on the right side having no winding shaft bearing or supporting arms. A ½ in. hole is drilled for the winding shaft, *W*. The shaft is fitted with a face plate *P* of the size required for the coils to be wound, and a turning crank fitted to the left end outside the gear. The right end is threaded to receive a nut for tightening up another faceplate or bobbin end. A shaft 6 in. long will be ample for all ordinary needs, 3½ in. of this length being to the right of the inner face plate.

On this machine secondary windings may be wound up to 10 inches in diameter; a size quite as large as any reader is likely to attempt. In Fig. 2 will be noted two screws with 20 threads to the inch. On the left ends of these screws are gears of 6 in. pitch diameter, meshing with an intermediate gear 2 in. diameter, which in turn meshes with a 2 in. gear on the winding shaft.

It will be noted that the ratio of the gear on the winding shaft to those on the screws is 1 to 3; three turns of the former are required, therefore, to get one of the latter. As the screws are cut twenty threads to the inch, this enables wire to be wound on the bobbin turning on the winding shaft with 60 turns per inch; the number specified in the article on coil winding referred to. By varying the ratio of the gear any number of turns of wire can be provided for. The intermediate gear may be of any convenient diameter.

The screw shafts are about 6½ in. long; 2 in. at the left end being ⅝ in. in diameter, without threads, then 3¾ in. threaded, 20 threads per inch, and 1 in. on the right end turned down to ¼ in. The gears fitted to the screws should have hubs and set screws, for fastening to the screws. The intermediate gear runs on a stud. In drilling the holes in the frame for the bearings of the shafts, care must be used in spacing them so that the gears wi run without binding or too much play. The easiest way to be sure of this is to have the gears made and at hand before drilling holes for the stud and screws.

At the bottom of the frame are two tie rods with nuts at the ends, these being necessary to secure a rigid frame. The gears have such light duty that they need not be over ¼ in. thick, except the intermediate gear which must be thick enough to drive both screw gears or about 5-16 or ⅜ in. thick. The threads on the screw shafts may be cut with a common die, any broken threads being smoothed off with a V needle file, so that the wire will not catch and break.

A B C COMBINATION MONEY BOX.

This is a box which is both useful, amusing and educational. With it any word of three letters can be formed, and it can be set to open by forming one particular word.

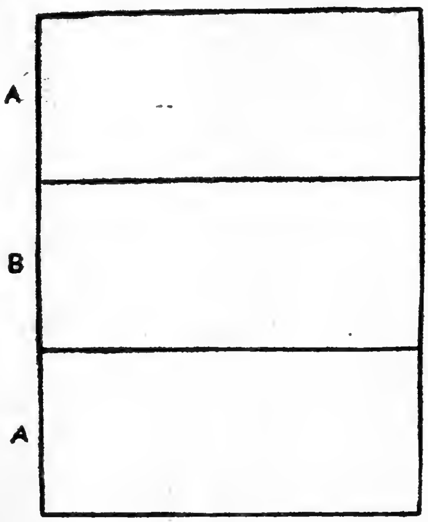


Fig. 1.

The box may be turned from good sound wood, and is composed of three parts, a cylinder with raised band in center, and two lids. These are shown in Fig. 1, *A A* being the two lids, and *B* the band of cylinder. Fig. 2 is a sectional drawing showing the thickness of cylinder and lids and also illustrating the interior mechanism. *C* is a rod screwed firmly into center of top lid. D is a flat disc with bent prongs under it, as shown, and having two slots at its outer circumference, through which *F F* can pass. *F F* and the slots are shown by Fig. 4, which represents *D*. *E* is another disc with a washer under it of sufficient thickness to keep it in position so that the prongs of *D*, after passing through two slots in *E*, may work freely under it. *E*, together with the washer, is screwed down to center of lower lid. The lid and *E* with the slots, is shown by Fig. 3.

A groove is made round the cylinder at *G*, and a hole is bored at each end of the lower lid at *G G*, and into each hole, while the lid is on the cylinder, a peg is inserted, so that the lid may be revolved, but will not come off. It will be seen upon studying this mechanism, that it is only when both lids are in certain position relative to the cylinder, that the top lid can be taken off, as *D* being turned by the top lid, must be

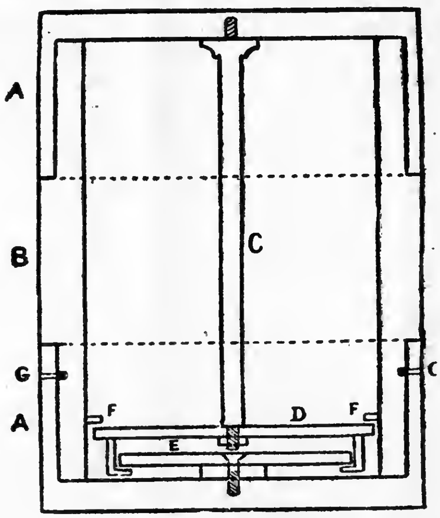


Fig. 2.

brought into position so that its slots will pass *F F*, and *F* being turned by the lower lid must be brought into such a position relative to *D* that it will allow of the prongs passing through its slots.

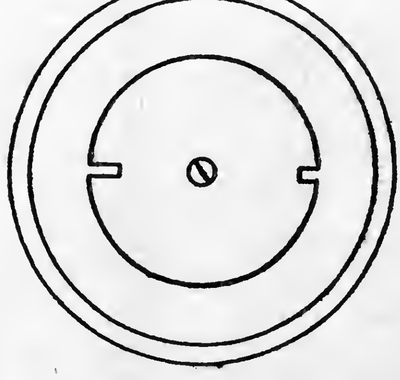


Fig. 3.

Fig. 5 shows a set of three alphabets on the outside of the box—one on each lid, and one off the band of the cylinder. It will be seen that the letters in the il-

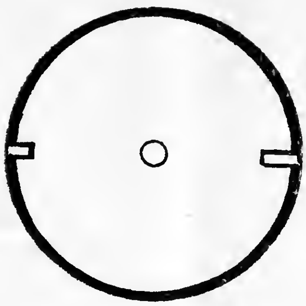


Fig. 4.

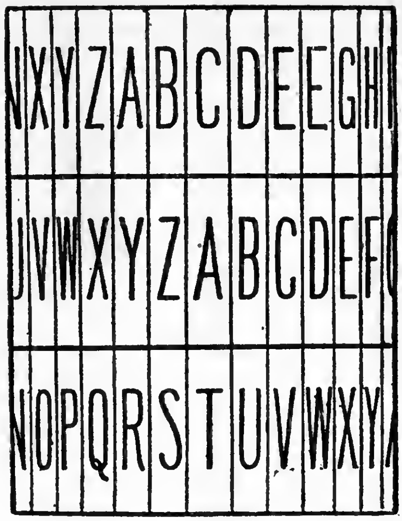


Fig. 5.

.ustration spell CAT. Now if the discs *D* and *E* have been set so that their slots will pass *F F* and the prongs through them when this word is put together, the top lid can be removed. A slot to admit the coin can be made in the top lid. Any other word can be used.—"Hobbies," London.

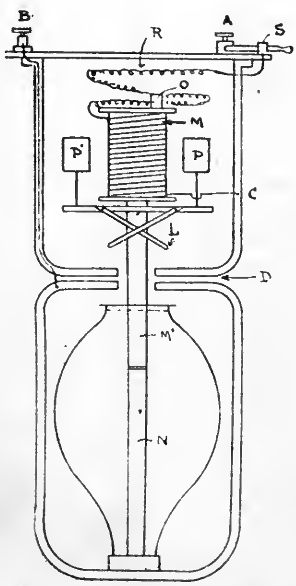
PRACTICAL HINTS ABOUT ARC LIGHTS.

To the practical man, the history and theory of the arc lamp are not a necessity, but the knowledge of its mechanism and mode of operation are absolutely essential. So long as the lamp needs only trimming and cleaning, the average attendant will ignore its mechanism, and in all probability no attempt will be made to comprehend its operation. The moment the lamp fails to light, strenuous efforts will be put forth to try to discover the reason for such failure.

When the lamp fails to light, assuming that it has been properly trimmed, one or all of the following causes may be looked for: 1st, the resistance coil may be burnt out; 2nd, the magnet coils may be burnt out; 3d, the framework may be grounded, thereby preventing sufficient current to flow through the carbons to produce an arc; 4th, broken or grounded connections; 5th, when the movable carbon is continually in motion, thus preventing a steady light; 6th, when the clutch fails to lift the carbon. These six difficulties will be the principal ones met with in practice.

The mechanism of an arc lamp is shown in Fig. 1, and while the shape and construction may vary with different manufacturers, the underlying principles involved in its operation will be found practically the same. Some lamps have their resistance coils wound on separate spools, others have no spools, while still others have their resistance coils wound on one large spool. Again, some lamps are fitted with two magnet coils, while other lamps are only fitted with one. The mechanism of the carbon clutch also varies in different lamps, as do the dash pots employed to resist or counteract the solenoid magnet.

The shell or outer casing varies in shape, the methods for taking off and putting on are different; in some arc lamps the resistance coil must be removed before the outer shell can be taken off, and in other cases the



shell can be taken off without disturbing the lamp mechanism. Then, the method employed to convey the current to the movable carbon is not always the same; some manufacturers solder a flexible wire to the carbon holder of the movable carbon, so as to insure this carbon with a positive supply of current, while others depend upon the frictional contact of the carbon holder to insure current supply to the upper or movable carbon.

Referring to Fig. 1, the mains carrying the current are connected to the binding posts *A* and *B*. The current flowing through *A* passes through the switch *S* and resistance coils *R*, thence through the magnet *L*. The current is grounded on the upper frame of the lamp, as shown at *C*. The wire *B* is insulated from the upper frame work of the lamp, and the wire is grounded on the lower frame work. Thus it will be seen that the frame of the lamp is divided into two parts and insulated from each other at *D*. It follows, therefore, that when the carbons are inserted at *M'* and *N*, a passage for the current is provided and if we procure a mechanism to move the carbon *M'* upwards or the carbon *N* downwards, an arc will form between the carbons and light will result.

If the carbons are moved only a slight distance apart, a poor arc will be obtained, accompanied with little light; hence, to obtain a more powerful light the length of the arc must be increased, the amount of which will be dependent upon two factors, namely, the amount of the resistance cut in the circuit at *R* and the lifting power of the magnet *M*. If the magnet *M* is in good order and the arc still remains short, too much resistance is cut into the circuit, which must be lessened by moving the clip at *O*, thereby reducing the length of the resistance wire. The length of the arc should now increase, and consequently a more powerful light should be obtained. If the clip D is moved so as to increase the resistance *R*, the arc will decrease.

Sometimes, no matter how much resistance is cut out, the arc will not increase in length. In this case it will be found that the magnet *M* is either wholly or partially burnt out, in which case the magnet must be replaced with a good one. Before discarding the injured magnet, however, it will be a good plan to test it, by allowing the current to flow around it and then by placing a screwdriver or some iron or steel tool against the magnet, its lifting power can be determined. Should the magnet be found strong and therefore not burnt out, then the trouble will be either in the lifting mechanism shown at *L* or in the dash-pots shown at *P* and *P*.

The object of the dash-pots is to resist the lifting of the carbon too suddenly. Should the carbon be lifted with a "jerk," there is a possibility of drawing the carbon out of the field of the arc, thus breaking the arc and no light results. The correct working of the dash pot is an important factor of arc lighting, and to determine if it does operate correctly, it should be seen that it requires considerable force to press the plunger into the pot quickly. From this it is learned that a blow or push will be resisted by the partial compression of the atmosphere, hence the sudden action of the magnet is controlled, and the carbon is maintained within the field of the arc and light is formed the moment the contact of the carbons is broken.

Whenever a lamp becomes grounded, the movable carbon sometimes traverses its entire stroke without forming light. Of course, this ground must be removed and the simplest way to do it is to remove the outer shell or casing, then trip the lamp and throw on the current, when the ground should make its appearance and can be easily removed.

When continuous arcing occurs it will be found that the plungers of the dash pots are worn sufficiently to permit of a rapid lifting and dropping of the carbon and in such a case as this, satisfactory lighting is impossible. Sometimes the lamp will not burn satisfactorily, although the lamp mechanism and trimming are all right. This is often due to the arc traversing the perimeters of the carbons instead of being central. Impurities in the carbons will cause this, and in order to overcome this difficulty, hollow and cored carbons are employed.

In the latter case, the center of the carbons is filled with a soft carbon which is easily vaporized, thus lessening the tendency of the arc to traverse the circumference of the carbons, thereby preventing avoidable shadows. With enclosed arcs, when opalescent globes are employed, the shadows will not be noticeable to any great extent, as this form of globe diffuses the light more equally than clear globes.

It is important to have the upper carbon the hottest, as this will deflect the light downwards. When an arc lamp is first connected to the mains, it may not be wired so that the upper carbon will be the positive carbon. If, however, the current be thrown on and lamp allowed to burn for a few minutes and then cut off the current, it can easily be seen which carbon is the hottest, and should the lower carbon be the hottest, the lead wires to the lamp must be reversed.

It is sometimes necessary to know what voltage is maintained across the arc. For this purpose, a portable voltmeter can be used and connected to the upper and lower carbons. The arc being formed, the voltmeter will register the necessary voltage to maintain the arc and by connecting the voltmeter to each arc in the circuit and by shifting the resistance in each lamp, an approximate equality of the voltage can be maintained throughout the various lamps and each lamp will properly do its share of the lighting.

The length of time a carbon will last depends upon the amount of air which is admitted to it; hence, to prolong the life of the carbon, the inner globe is often made as air-tight as possible. The inner and outer globes should be kept clean, as this will materially assist in the proper diffusion of the light.—"Practical Engineer."

No place on earth is immune from earthquake. A short time previous to the Charleston earthquake, the city of New York was visited by a slight but very noticeable shock.

PHOTOGRAPHY.

USE OF DEVELOPING PAPERS.

C. H. CLAUDY.

II. Developers and How to Use Them.

Developing papers are developed with any good developer, all those which act upon plates to produce negatives giving some kind of results on the paper. But some are much better than others for this purpose and some unsuitable, among these being pyro. Hence it is advisable to have a special developer for that purpose alone. Now I do not pretend to be able to say which of the various organic developers is the best for paper use. But I do not think there is any question that Metol-Hydrokinon is the most used for that purpose. This developer is made up in a dozen different formulas, according to the particular wishes of the maker and the kind of prints wanted. For instance, if hard prints are wanted, as in line work or from very weak negatives, the metol may be reduced to a trace, or left out altogether—and for very soft prints the proportion of metol may be equal to that of the hydrokinon. My own formula, which is an adaptation of several, is as follows:

50 oz. water, temperature 50 F.
½ oz. metol.
1 oz. hydrokinon.
7½ oz. sulphite soda, crystals.
12½ oz. carbonite soda crystals.
1-16 oz. bromide potassium.

These chemicals are fully dissolved, in the order named, in hot water, with care that each chemical be fully dissolved before the next is added to the water. Particular care should be taken to dissolve the metol first and the hydrokinon second, and not reversed, as if this particular is not attended to the hydrokinon will crystalize out after cooling. Immediately all the chemicals are dissolved, the solution should be bottled, filling to the neck and well corking them. When they have cooled, the solution will have shrunk a little, and the bottle should then be filled full again. The object of filling them to the brim is to insure the exclusion of air, and if this is carefully done the stock solution will keep for a long time—I might almost say indefinitely. I have kept it nine months in this way and found it clear when it was finally used. It is obvious that small bottles should be chosen if the developer is not used up rapidly, so that when part of a bottle is used, there is not much left for air contamination. Four ounce bottles are excellent.

To use this developer take one ounce of the stock solution to seven ounces of water for the hard papers and two ounces of stock to six ounces of water for the soft papers. More stock and less water means softer prints. Less stock and more water means harder prints. This is exactly the reverse from the effect on a plate. Consequently the softest print can be obtained by using undiluted stock solution.

The fixing bath must be acid, and must contain alum. Whether the acid be organic or not, or the alum plain or chrome does not make so much difference. I have used both with good success, but prefer the plain acetic acid bath, the formula for which follows:

Water 64 ounces.
Hypo 16 ounces.

Dissolve thoroughly and then add solution made up as follows:

Water, 10 ounces.
Sodium sulphite crystals, ½ ounce.
Acetic acid 12 per cent. (commercial) 3 ounces.
Powdered alum ½ ounce.

If the acid is not commercial the proportion must be calculated from its per cent, which the druggist can probably tell you if it is not marked. I usually buy 36 per cent acid and of course use one ounce in place of the three which would be used were the acid 12 per cent.

This solution keeps perfectly and can be used until it turns milky, when it should be discarded for fresh.

An important point, particularly in hot weather work is the arrangement of the trays. They should be in the following order, side by side. Developer, clear water, hypo, and preferably from left to right. If the print is to be wetted down before development, have an extra tray of clear water to the left of the development tray. Another important point is a stirring rod of glass, bent at an angle in the middle and mounted in a wooden handle. The handle is a sure marker of which is the hand end of the rod, and the bend makes it easy to stir up the print in the hypo.

There are several methods of getting the developer on the paper. With small work and much developing to do, the easiest is to slip the print into the tray of developer, edge first, being sure that it goes under the surface swiftly and without a break in the movement. With larger work and not much to do, it may be wise to empty the developer into a graduate between each development, lay the exposed sheet in the tray and pour the developer on with the same movement one uses in covering a plate with the solution. But prints as large as 10 x 12 may be slipped into the pan of developer with a little care and practice. To do this successfully, take the tray in the left hand by one edge and tilt until the developer runs toward the left hand. Hold the paper by the right edge in the right hand and the hand under it so it lies flat. Let the left edge of the paper drop into the developer at the same time letting the tray become horizontal, while the right hand lets go the paper. The developer will cover the paper evenly in one sweep. For an 8 x 10 print not less than 8 ounces of solution should be used with this method.

With larger sheets of paper it may be easier to thoroughly wet the paper first and then pour the developer on. Nothing but disaster can be expected in attempting to slip a wet limp sheet into the tray, so if the paper is wet down always pour on the developer from a graduate. The object of the wetting is to cause the developer to run on without stopping. Sometimes the developer makes the image come up streaked, a phenomenon due to impure sulphite of soda; the wetting down of the print will prevent the trouble. With small work, however, wetting down is an evil, as it is unnecessary and quickly dilutes the developer.

No definite time can be set for completion of development. As in a plate the development should be for some particular part, usually the high lights. If the shadows are too black by the time the high lights have their detail it is a sign of under, not over, exposure. Prints usually develop in from ten seconds to one minute, depending on the temperature of the developer, the kind of paper and the amount of exposure. The temperature should not be above 65° F. in summer or 70° F. in winter, and inattention to this point will result in either flat or muddy prints, if the solution is too warm or mealy, over constrasty or weak prints if the developer is too cold.

A few seconds before development is completed, get hold of one corner of the print. When the print has gone far enough, pull it quickly from the developer and souse immediately into the clear water bath—run it through quickly and then dump it into the hypo. Immediately pick up the rod and stir the print up well so that the hypo reaches all parts of the surface. Prints had better be thrown into the hypo face up, inasmuch as air bubbles can be better destroyed with the rod, but care should be taken that the rod is not used too roughly on the surface of the print, otherwise, particularly in warm weather, the emulsion may tear. The fixing bath is better cold than warm—and a fresh bath is therefore indicated in warm weather—a fresh bath being very cold on account of the action of the hypo and water together, an action, by the way, not at all understood any more than that of sulphuric acid and water, which generates heat without any apparent chemical change.

Prints should be fixed fifteen minutes and turned over several times in that period to insure thorough access of the bath to all parts of the film. But longer fixing does no harm. I have left prints in the bath two hours, while at work on more prints, and have seen no ill results. The Eastman Co. put out a non-abrasion developer which contains iodide of potash, resulting in the prints being turned canary yellow in the development. When this color disappears in the bath fixation is supposed to be complete. I have seen it go in thirty seconds in a clean bath yet they advise the time of fixing given above. At any rate, thorough fixing does no harm and is no more trouble than quick fixing.

After fixation, prints should be washed in running water from half an hour in summer to two hours in winter, and the prints should be kept moving. A pile of motionless prints in the bottom of a tray into which and from which water is running, are not being washed. If the force of the water cannot be so graduated as to keep the prints in motion, stir them up every few minutes with the hand. When washed they should be swabbed off with a tuft of cotton to remove dirt and sediment and then laid out to dry. Face down on cheese cloth, after they are surface dry, is a good method. Personally, I dry on newspapers or blotters face up because I am usually in a hurry and find no difficulty in straightening out my prints by drawing them over the sharp edge of a desk or table.

These are one or two points connected with development it may be well to notice. In cool weather the print may be lifted some time before development is completed, and the finishing of the process watched closely, of course, with the print shaded by the body or screen from any direct light. In warm weather the print with developer on it should be exposed to air as little as possible. Most of the brownish stains in the whites which are the bane of the process, are caused by oxidized developer, either in the hand or in the fixing bath, the print not having been moved about sufficiently.

Hand development of prints can be accomplished by using a couple of brushes, and plenty of glycerine, as in the platinum process, but the brush work must not continue more than a couple of minutes at the outside in cool weather, otherwise the developer will oxidize and a stain result. The print, of course, in that process, should be supported on a piece of glass.

There is a great deal of latitude in the exposure which can be given this class of paper, yet some one exposure is always the best. As a general rule, Velox and papers of its class are under exposed. The blacks are too black and the whites are too white. A more prolonged exposure with the same time of development is wanted. The first time you get a fairly good print, try another one from the same negative with double the time and note that both are presentable but that the contrast of one is greater than the other.

Regarding the surface, the dead smooth and the glossy are a little harder to work than the roughs, as development may leave marks if the solution is not entirely pure. On the glossy paper are often found marks looking like pencil marks, caused by abrasions of the surface. They can be easily removed from the dry print by scrubbing gently with cotton slightly dampened, not wet, with alcohol. The other two remedies are, not to use this paper or to use a non-abrasion developer. If glossy paper is to be squeegeed, be sure the fixing bath is fresh and strong, otherwise the film will not be hardened sufficiently and may stick to the surface of the squeegee board.—"Photographic Times."

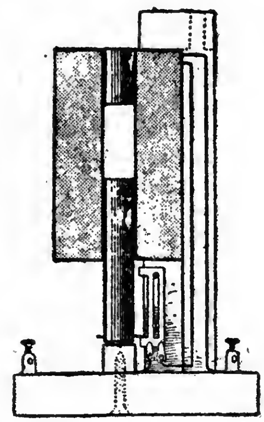
HOW TO MAKE AN ELECTRIC HAMMER.

The following instructions for constructing a hammer actuated by electricity will be found useful in making any device in which a "sucking solenoid" is required. The sizes of the parts, the gauges and proportions of the wire given, are suitable for a small hammer capable of working off a 4 volt accumulator, or off a couple of quart size bichromate batteries, connected up in series; but by increasing the size and varying the amount and gauge of the wire used to wind the solenoid, the size of the hammer can be increased and the winding altered to accomodate the E. M. F., or "voltage" of the current supplied. In order to render our instructions perfectly intelligible, we give a sectional view of the complete arrangement.

The operator will begin by procuring a piece of round soft iron, 4 in. long, ½ in. in diameter. This he will divide by sawing into two unequal lengths, one piece being 1 in. long, and the other 3 in. The ends of the pieces should be filed up smooth and level and the longer piece made very smooth by rubbing over with fine emery cloth. This latter piece we shall for the future call the "hammer." A piece of thin brass tube 9 16 in. inside diameter, 3¾ in. in length, is now selected, into which the "hammer" can slide freely, and its inside is made quite smooth and bright by polishing with a straight round stick dipped in powdered brickdust. This being done, two "heads" or flanges, 2¼ in. in diameter, are cut out of thin brass sheet, a hole about ⅝ in. diameter put through the center of each.

The exact size of these central holes must be such as to admit the aforesaid brass tube being fitted tightly in them. These two flanges are then soldered, one at each end of the tube, so as to form a light metal reed or bobbin. To insulate this and thus prevent any chance electric leakage between the wire which has to be laid on, and the brass of the bobbin itself, it will be advisable to paste one turn of fairly stout brown paper round the tube itself, and a circlet of similar paper on the inner face of the heads.

The neatest way of effecting this latter portion is to strike out with the compasses the two circles on brown paper, cut these out, as also the ⅝ in. central apertures, and then give a radial snip with the scissors from circumference towards the center. The central tube can be pushed in this radial slit, and the paper circlet be then pasted smoothly down on the face of the flange. The operator will now require about 2 pounds No. 17 d. c. c. wire, with which he will wind this bobbin. Beginning at one end close against the flange, he will tie one end down with a bit of silk twist, leaving about 6 in. free for future attachment to a terminal, etc., and then proceed to wind the wire closely and evenly round, until he reaches the opposite flange. This will take about 56 turns of wire.



He then winds back again, always coiling in the same direction, until he returns to the first flange, and so on until he has laid on 19 layers and ends at the starting flange. Here he ties down firmly as before, the bight of wire to prevent uncoiling, cutting off any excess beyond 6 in. which will be required for connection. The bobbin having been thus wound and converted into a "solenoid" is to be fitted at its upper extremity, *i. e*, that at which the wire ends are situated, with the shorter piece of iron.

For this purpose a sufficient number of turns of brown paper are glued and rolled tightly round the 1 in. length of round iron until it makes a tight fit in the upper end of the brass tube. It is then painted over with a coat of thick shellac varnish, and forced into the tube until the surface of the iron rod is level with the ends of the tube. In order to give a finished appearance to the solenoid, and to prevent the wire from getting soiled or accidentally uncoiling, it will be well to give the last layer of wire a coat or two of varnish, which may be made by mixing a half teaspoonful of Brunswick green or Chinese red powder with sufficient "white hard" varnish to produce a rather thin paint.

This coat of varnish should be allowed to dry in a warm room for about 24 hours. While it is drying we proceed to make the stand for supporting the solenoid, the contact breaker and the anvil. For the base of the stand a piece of any hard, well seasoned wood, 4 x 4 x ¾ in. thick, when planed up, will serve admirably. In the center of this, to serve as an anvil, should be placed a cylindrical back of zinc, easily cast from the melted metal in a plaster of Paris mould, that should be held in place by a screw passing through the base from below. This anvil should be ⅝ in. in diameter and ⅝ in. in height.

To support the solenoid centrally over the anvil at a height of 1½ in. above it, we prepare a wooden upright 7 in. long by ¾ in. square section. Having procured a similar piece of hard wood, 1½ in. long, we put through it at ½ in. from one end, a round ½ in. hole. We then round the upper end of our upright for a length of ¾ in. into the shape of a peg ½ in. in diameter, leaving a truly square shoulder below it. We then glue the peg of the upright into the hole just made, so that the arm stands at right angles to the upright. With a mortising chisel we cut a ¾ in. square hole in our base board at such a point along one side thereof that if the solenoid be held firmly against the upright, the center of the solenoid shall coincide with the center of the anvil beneath. The lower extremity of our upright is now served with a little good hot glue and inserted in the hole just made, care being taken to have it quite firm and perpendicular.

While the glue is drying we cut out of rather thin sheet brass a flat ring or "washer" ½ in. inside diameter, ⅞ in. outside. This we push on the extremity of our hammer, (the 3 in. length of soft iron) for a depth of about 1-16 in., and solder it firmly thereto from the outside. We now slip the "hammer", washer end outwards, and hold the solenoid centrally over the anvil, resting on one side against the cross arm of the said upright. While being held in this position the exact distance, about 2½ in., between the face of the base board and that of the lower flange of the solenoid is measured, and a nicely squared piece of wood prepared of this length, ¾ in. square, that shall, when glued against the inside of the first upright, wedge the solenoid tightly in place, and at the same time not impede the free motion of the hammer and its washer up and down the solenoid tube.

If two thin brass strips, about ½ in wide, be bound, one above and one below, round the solenoid, and then fastened to the upright by little brass screws, not only will the rigidity of this latter be greatly exalted, but the appearance of the whole will be much improved. The woodwork may now receive a coat of black cycle enamel. All that remains to be done is to make and fix the sliding switch or "contact breaker," and couple the wires up to this latter and the terminals. To make the contact breaker we procure a piece of sheet brass 1-16 in. thick, about 1⅞ in. long, ½ in. wide. With a fine file we remove the central portion until we have reduced the brass to the shape of], the inner edge of the gap in the center being made absolutely straight, 1 7-16 in. wide by ⅜ in. deep. The lower arm must be left ½ in. wide, the upper arm ⅛ in. wide.

A similar strip of brass, ⅛ in. wide, 1 7-16 in. long, is now inserted between the two arms of the gap, and soldered to them at such a distance from the back as to produce a slot that will admit of the free passage of screws 1-16 in. diameter in the shank. It is needless to remark that the edge of this piece must be perfectly straight and parallel to the back. This contact breaker is now fastened loosely by means of two screws inserted in the slot on the side of the upright in such a position that when the hammer falls its washer pushes down the lower limb, and when it has risen to its full height it engages in the upper limb, thus drawing the contact breaker up.

Just below this sliding piece are arranged two light brass springs, pressing lightly toward the upright; one of these is connected to one end of the solenoid winding wire, the other being taken to a terminal on the base board for connection to battery. The other end of the solenoid wire is taken direct to a second terminal on the base board, and is coupled up to the other pole of battery. The action is as follows:

When the hammer is in its normal position on the anvil, its weight drives the sliding contact down, so that it completes the circuit between itself and the two springs; the current circulates round the solenoid, and the hammer is now sucked up into the tube. On reaching nearly to the top of its stroke the washer on the hammer catches in the upper arm of the sliding contact, thus raising it and breaking contact below. The hammer immediately falls, and in so doing its washer catches in the lower arm, driving down the slide and re-establishing the contact.—"Hobbies."

A good use for the phonograph is its employment for preserving records of rapidly decaying dialects of the Isle of Man and Guernsey. In the former island the dialect language is one of the Gaelic group, and so rapidly is it disappearing, that it is anticipated that it will become extinct during the present generation. The Manx Language Society is despatching phonographs to remote parts of the island, the aged inhabitants of which still retain a pure accent, and the numerous records thereby obtained are to be preserved. In Guernsey the dialect is the old Norman French, and in its main features is exactly the same as that used by the cultured class in England in the early centuries. In this instance, it is said, the phonograph is to be utilized for the collection of the dialect poems, folk songs and folk lore of the island.

To clean smoky chimneys, dilute a teaspoonful of sulphuric acid (oil of vitriol) with five or six times its bulk of water. Dip into the solution a piece of flannel tied to to a stick and draw the flannel through the chimney, then rinse in water and wipe dry.

CONSTRUCTION AND MANAGEMENT OF GASOLINE ENGINES.

CARL H. CLARK.

VI. Jump Spark Ignition.

The jump spark ignition is very simple in appearance, the only engine attachment being the commutator, or device for making and breaking the primary circuit whenever a spark is desired; this does away with a considerable amount of gear and simplifies the engines. The engines represented in Figs. 11 and 18 are of this type.

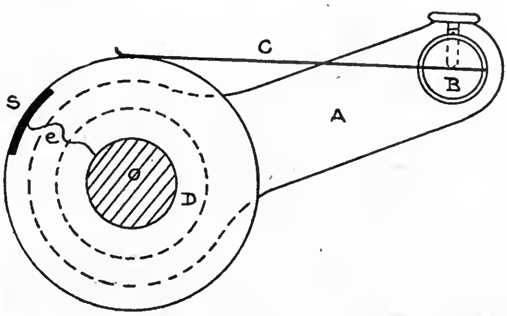


Fig. 31.

Fig. 31 represents the simplest type of make and break device. This particular device is usually located just behind the flywheel. *O* is the engine shaft: *D* is a disc of fiber or other insulating material, which is

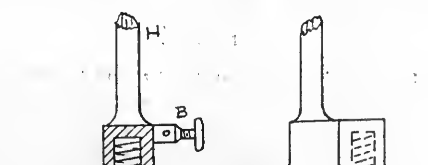


Fig. 32.

fastened to the shaft and revolves with it. This disc, *D*, has on its circumference a small sector *S* of brass or other conducting material, which is in electrical connection with the shaft by the wire or clip *e*. The frame *A* encircles and is held by the end of the engine bed, but may be revolved around it. The outer end of the arm carries a binding screw *B*, to which is attached the edge of the disc *D*. One terminal is fastened to *B* and the other to the engine. As will be seen, when the spring *c* rests upon the fiber, there is no circuit, but when the segment *s* passes under it the circuit is completed through the engine shaft and body of the engine. By turning the arm *A* around the shaft the relative time of sparking may be changed. The engine shown in Fig. 11 has a commutator, or timer, of this kind: the handle for regulating it may be seen just behind the flywheel.

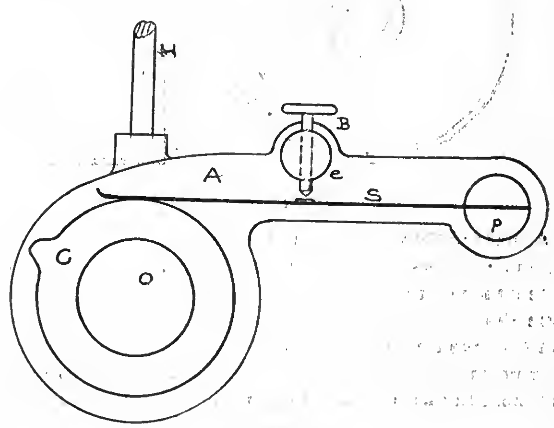


Fig. 33.

Fig. 32 shows two views of a similar form of timer; in this case the plunger *P* makes the contact, being pressed out by the coiled spring *s*. *B* is the binding post for fastening the wire from the batteries. A handle fastened at *H* is provided for changing the time of ignition.

Another form of timer is shown by Fig. 33; the shaft is shown by *O* as before, the cam *C* is fixed on the shaft and turns with it. this cam has a projection or "nub" on its face, the casting *A* encircles the hub of the bearing and has the arm *A*, at the end of which is the post *p*, supporting the contact spring *s*, which rests normally upon the round face of the cam *C*. At *B* is a binding post having the adjustable contact screw *e*; this post *B* is insulated from the frame *A* and the contact screw *e* is adjusted to leave a slight space between it and the contact spring *s*. The lead wire is attached to *B*, and in the position shown no current will pass. At the time of ignition, however, the "nub" on the cam *C* will pass under the spring *s* and force it up into contact with the point of the screw *e* and thus complete the electrical circuit through the metal of the engine. *H* is a handle for regulating the time of sparking by revolving the whole around the shaft, thus causing the cam *c* to strike the spring earlier or later.

The timers thus described are for single cylinder engines, but may be adapted to two cylinders by duplicating the mechanism in a diametrically opposite position. Timers of this description would hardly be used for more than two cylinders; they are also best suited to two cycle engines, as they give a contact for each revolution; this class of timer is, in fact, most commonly fitted on two cycle engines of medium and low price.

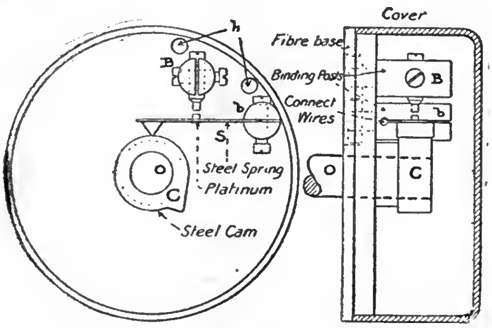


FIG. 34.

A more pretentious timer is represented by Fig. 34. It is entirely separate from the mechanism of the engine and is run from a separate shaft, such as the half time shaft of the four cycle engine, or an independent shaft driven by gears from the main shaft of a two cycle engine. It is rather similar to that described in Fig. 33, the cam *C* pressing the steel spring *s* outward

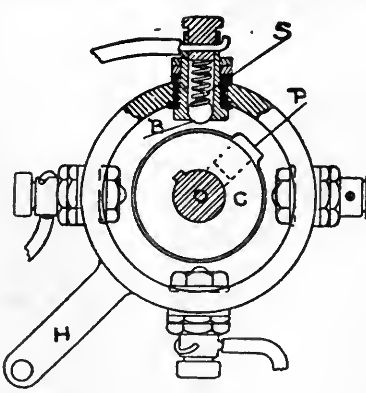


FIG. 35.

so as to bring the platinum point on the spring into contact with that on the binding post *B*, completing the circuit. In this particular timer both posts are insulated from the body of the timer, a wire to each passing through the metal of the engine. The whole is covered with a removable cover, as shown. The engine illustrated in Fig. 11 is fitted with a timer of this kind located on the rear end of the valve shaft. A little consideration will show that the timer of a four cycle engine should be governed by the valve shaft in order to give the proper timing, since the four cycle engine gives an explosion for each two revolutions; the timer must be so arranged as to give a spark in the same interval.

Fig. 35 represents a timer for a four cylinder engine; it is similar in action to that shown in Fig. 31, the steel balls *B* are pressed out by the coil spring *s*; the cam *C* having the projection *P* is revolved by the shaft, the wires are attached, as shown. At the proper time the projection *P* rubs past the ball *B*, thus completing the circuit. The ball holders must, of course, be insulated from each other and the body of

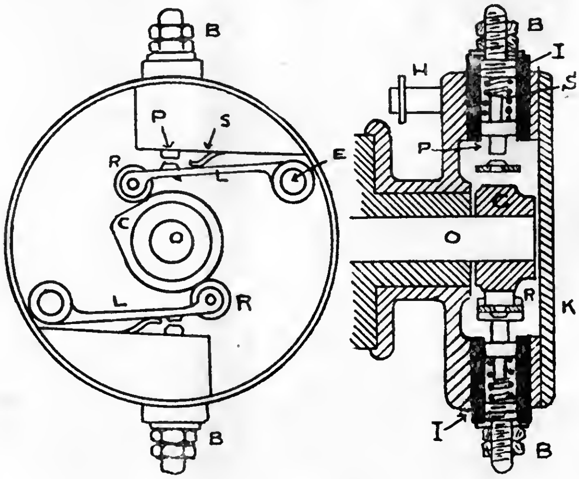


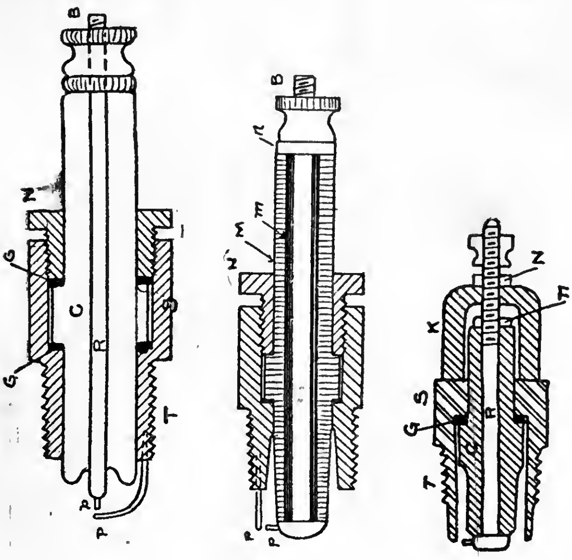
FIG. 36.

the timer; it is indeed common to make the entire body of fiber or hard rubber. In this form the timer shaft and body of the engine form a part of the circuit. There must, of course, be as many binding posts as there are cylinders. In order to change the time of ignition the entire case is turned slightly by an attachment to the lever *H*. The case is covered by a removable cap protecting it from dust and moisture.

When a timer of this type is fitted to a two cycle engine it is very convenient to place it on the end of a vertical shaft standing in front of the cylinders and just behind the flywheel, and driven by bevel gears from the engine shaft.

Fig. 36 shows two views of another type of timer on the same principle as that of Fig. 33. The binding posts *B* are insulated from the metal of the body by the rubber sleeve *I*, the contact point is forced out by the coil spring *s*, but is in electrical contact with *B*. The lever *L*, pivoted at *e*, carries in its outer end the roller *R*, the flat spring *s* presses the roller in and maintains it in contact with the cam *C*. The projection on the cam *C* passes under the roller *R* and raises the lever *L*, bringing it into contact with the point *P*, and completing the circuit through the timer shaft and the metal of engine. The whole is covered by the cap *k*.

A very common form of spark plug is shown in Fig. 37; it consists of an inner spindle or rod *R* and an outer sleeve *s*, with an insulating core *C* of porcelain or mica. At the end of the rod *R* is a spindle point *p*, and a similar one *P* projects from the outer shell *s*. At *T* is a thread by which the plug is attached to the engine, a threaded hole passing through the water jacket and allows the sparking points to project inside the cylinder. The core is passed through the shell *s* and is held in place by the internal nut *N*, two rings of asbestos packing, *G G*, are inserted to prevent the gases



FIGS. 37, 38 AND 39.

from blowing out between the core and the sleeve. Nuts *B* on the end of the rod *R*, serve as a binding post for the lead wires. The points *p*, *P*, are separated by a small amount 1 32 to 1-16 in. When the plug is screwed into the cylinder there is no electrical connection between them; if one wire from the coil is grounded on the engine and the other is fastened to *B* the current will jump across the gap between the points when the contact is made.

Fig. 38 shows a type of mica insulated plug. The insulating core consists of a layer of mica wound around the rod; outside of this layer of mica is a series of mica discs slipped on over it; the head on the end of the rod holds the washers against slipping off and allows them to be pressed tightly together by the nut *n*. The remainder of the plug is similar to the one above.

In the form shown in Fig. 39 there are two porcelain insulators, the inner one *C* as before, and the outer one *K*; they are held in place by the nuts *N*, *n*. The metal shell *s* is prolonged and the spark takes place between a point on the end of the rod and the edge of the shell *s*.

It is necessary that the insulation between the two portions of the plug be very complete, as the secondary current used with this form of ignition is of very high voltage and will easily penetrate any of the ordinary forms of insulation. Porcelain, mica, or some kinds of homogeneous stone are the only satisfactory insulating materials for this use. The plug is one of the most sensitive portions of the engine, as well as one of the most important; it must, therefore, be well taken care of and kept in good condition.

The details of coils and wiring are to be considered in the following chapter.

GERMAN FARMERS DISTIL ALCOHOL.

Representative E. J. Hill, of Connecticut, who assisted the Commissioner of Internal Revenue to formulate the rules under which the free alcohol law went into effect on October, spent most of the summer in Europe with Commissioner Yerkes in investigations on this subject. Mr. Hill states that Germany was the country in which the most progress was found to have been made in the direction of applying denatured alcohol for the development of industrial purposes. There are 70,000 farm distilleries in Germany, many of them being very small, and Mr. Hill was asked how the German Government could afford to furnish an inspector to each one of these distilleries. He replied:

"There is no difficulty in that respect. The stills have to be made in a certain way, which includes a tank that can be locked with a Government lock and sealed with a Government seal. The small farm distilleries do not operate all the year round. They operate in the winter when the farmer has leisure to do something other than straight farm work. The farmer has to give the Government thirty days notice as to the time he wants to begin to operate his still. Some time during the thirty days an inspector comes along and looks the still over to see that it is clean, etc., and then he locks and seals the tank, after which the still is ready for the farmer.

"He may go ahead and distill until the tank is full. Then he informs the person who is to buy the alcohol from him, after which he notifies the Government, and an inspector comes and removes the seal, measures the contents of the tank and collects the revenue. If the farmer wants to denature the alcohol on the spot he can do so in the presence of an inspector, when the amount of the tax will be returned to him. But generally the farmers sell through the great central selling agencies, which denature at a central point and in large quantities, and collect the rebate from the Government in considerable sums. Thus the Government agents are not required to spend any appreciable time on any one farm, and one inspector can cover a large territory. Meanwhile the central selling agency pays the farmer on the basis of beverage alcohol and rebates for all that is denatured. It is a good system and not very expensive to the Government."

HOME BOWLING GAME.

FRANK W. POWERS.

Visitors to many summer resorts and pleasure grounds during the past season may have seen a new type of bowling alley which seemed to provide much entertainment for the players. In place of the customary pins, however, were to be found swinging wooden plates which, when hit by the ball swung up and were held until again dropped in place by pulling a cord which released a catch. This arrangement dispensed with the necessity of constantly setting up pins, and permitted the game to be played much more rapidly than formerly, and so greatly increased the interest in it.

similar piece E, 6 in. wide. Also cut out another piece, F, 3 in. wide, which is located about 3½ in. back of the front piece but is not fastened in place until the swinging pieces are placed. To this piece are attached the spring catches, holding the swings as shown at S, Fig. 3.

Having cut off the corners of the swings G, as shown in Fig. 2, draw lines across the back 3 in. from the top ends, and centering upon these lines, fasten the curtain rod supports, R, with short screws, locating them about ½ in. from the edges of the swings. In doing this, it is best to place them upon the rod, as they

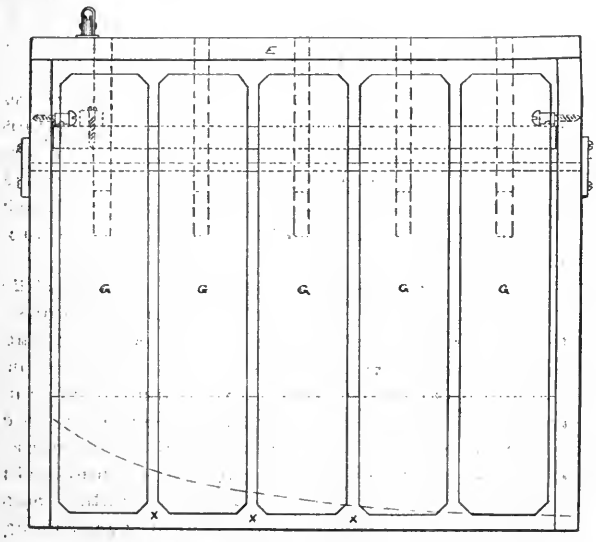


Fig. 2.

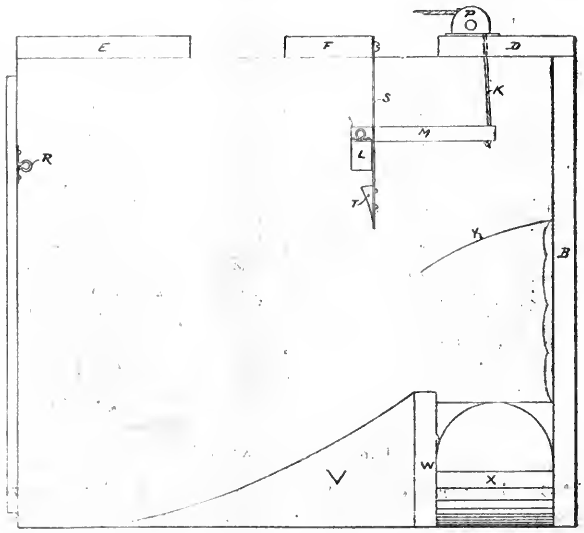


Fig. 3.

A modified form of this game is here described, which adapts it for home use and greatly reduces the noise incident to a game of this kind. The expense for materials is small, as much of the material can be taken from a small packing case made of wide boards. In addition there will be needed:

5 strips of maple or birch 15 x 3 x ⅝ in.

2 pieces ⅝ in. brass curtain rod supports.

1 small brass pulley.

5 pieces spring brass 6½ x ½ in., and screws, sheet tin, etc.

The first work will be to cut out the pieces for the sides 19 in. long, 16 in. high and ⅝ in. thick. The piece forming the right side has an opening cut in the rear, lower corner, as shown in Fig. 3 to form an exit for the balls. The back D is made from a piece 17 in. long, 16 in. high, and ⅝ in. thick.

Across the top at the back, nail a piece, D, 18¼ in. long, 4½ in. wide and ⅝ in. thick, and across the front a

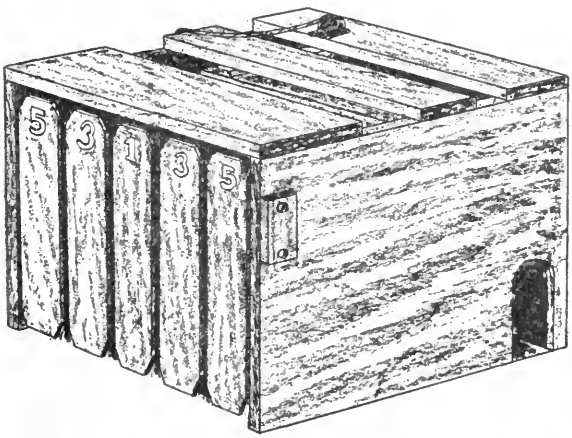
must swing freely. Holes are then bored through the sides to hold the ends of the rod carrying the swings, the front sides of which should be even with the front edges of the sides of the box.

To space the swings on the rod, cut four pieces 1 7 16 in. long from the wooden part of a bundle carrier; the kind used by grocers and provision dealers for packages. The hole is about the size to slip tightly over the curtain rod. The ends of the pieces should be smoothed off with a file, and one piece is put between every two swings. The pieces at the ends of the rod are ⅝ in long, which will space the swings ⅝ in. apart.

The spring catches are next made. The spring brass straps should be sufficiently flexible so that when the swing flies up the stop T will be pushed back and yet return quick enough to catch the swing and hold it. On the lower end of each spring a wedge-shaped piece of brass or hard wood is attached, brass being preferable and wearing better. The upper ends are fastened to the piece *F*, which is then fastened in place, the end swings being used to locate the correct position.

The release, *L*, is then made. It consists of a piece of hard wood 16 15-16 in. long, having a curtain rod support at each end and swinging on a rod similar to the arrangement for the swings. In addition is the lever *M*, one end of which is fastened to the piece *L* with screws, after boring a hole to allow the curtain rod to pass through it without binding. The release is located so that the under edge of *L* will be ⅜ in. above *T*, and the rear edge just touching the springs *S*.

Bore a small hole at the rear end of the piece *M* for the cord *K*, and at the proper place above attach the pulley *P*. A stout cord, long enough to reach to the position of the players is used, a strong pull forcing back the springs *S* and allowing any of the swings held by them to drop.



At the bottom of the box is next fastened a piece of wood, *W*, 17 in. long, 4½ in. wide and ½ in. thick. Two pieces of ½ in. wood are then cut to the shape shown at *V*, Fig. 3. A piece of sheet tinned iron 17 in long about 13 in. wide is then nailed to the pieces *V* and W.

Two pieces of ½ in. wood are then cut to the shape *X*, as shown by the dotted line in Fig 2, and a piece of tin 19 in. long and 4 in. wide is nailed to them; the whole then being fastened in the space back of the piece *W*, with the lower edge at the opening in the right side previously mentioned.

The portion of the back just above the runway just described is upholstered with strong cloth and cotton wool, and another piece of tin or a piece of wood about 5 in. wide is placed at an angle, as shown in Fig. 3, forming a hood to catch the balls and direct them to the runway.

When everything is finished, as above mentioned, a coat of paint or varnish is given the whole, and the swings numbered with large numbers at the top ends. The numbering is as follows: 5 3-1-3-5, the outer swings having the highest values, owing to the possibility of not hitting any. The balls used may be of wood if noise is not objectionable, but cheap base balls will serve nearly as well and make but little noise when striking the swings.

TURBINES ON THE LUSITANIA.

The Cunard liner "Lusitania" has been designed for a speed of 25 knots an hour, a speed which is a knot and a half in excess of that of the fastest of the existing ocean greyhounds the "Kaiser Wilhelm II," of the North German Lloyd. To propel the great hull through the water at this speed the "Lusitania" is provided with turbine engines developing 63,000 indicated horse power, and driving four screws. The turbines are the largest so far constructed for similar work. The low pressure engines alone weigh nearly 430 tons. The diameter of the rotor of the latter is 15 ft. 8 in., the blades having a maximum length of 12 in. toward the low pressure end, giving a maximum diameter of the rotor of 19 ft. 4 in. The peripheral speed of the rotor under normal conditions of working will attain a maximum of 142 ft. a second. The engines have been designed with the greatest care, and in them have been incorporated the latest advance in turbine construction. Especially is this true of the castings, which have been carefully proportioned to resist circumferential stress without undue weight. By the use of the turbine, and by great increase in displacement, it has been possible to add enormously to the engine power in order to obtain the increase in speed, though this is comparatively slight in itself.

RIGIDITY OF THE EARTH.

Lord Kelvin in 1866 sought to determine the rigidity of the earth from observations of the tides of the ocean. His conclusion was that the earth as a whole is certainly more rigid than glass, but perhaps not quite as rigid as steel. The late Dr. Dawson of the Canadian Geological Survey, about 1880, concluded after carefully studying the fortnightly tides that the earth was more rigid than steel. Now Prof. T. J. J. See of the United States navy, by mathematical processes, contends that, according to Laplace's law, the density at the center of the earth is equal to that exerted by a vertical column of quicksilver as long as from St. Louis to San Francisco.

By considering the pressure throughout the whole earth, Prof. See finds that even if fluid the globe would have a rigidity greater than that of wrought iron. He finds that the average rigidity of the whole mass is nearly equal to that of nickel steel. He further contends that the rigidity of the earth's crust is about equal to that of granite, which is one sixth that of steel, and that toward the center the rigidity rapidly increases. At the earth's center the imprisoned matter is at an enormously high temperature.

In sandstone the grains of sand are rounded, having no sharp edges as in granite.

SCIENCE AND INDUSTRY.

Hot water and steam heating systems have their respective advantages. The fuel cost is generally in favor of hot water, since the amount of heat given off by the radiator may be varied to suit the weather conditions by varying the water temperature; whereas, with steam, unless a vacuum system be used, the water must be raised to 212° F. before the radiators will become heated Furthermore, some pressure must be generated in the system in order to drive out the air which collects in the radiators. With hot water the system is noiseless, whereas with steam, unless both valves on each radiator are properly operated, water hammer will occur.

The name of Skagway, a prominent town in the early rush to the Yukon gold field, means "Home of the North Wind." The fare on the railroad from Skagway to White Horse—a distance of 112 miles—is $20 one way.

A large and fast locomotive, constructed at Munich, and now being exhibited at Nuremburg, is said to be capable of pulling a passenger train at the speed of 93 miles an hour. The German State Railway will shortly make experiments with the new locomotive for regular service on through routes.

Prof. Chas. L. Norton, of the Institute of Technology, gives the heat unit of various kinds of fuel obtainable for one cent, as follows: "Coal, $12 per ton, 23,000; wood, $10 per cord, 27,000; oil, 12 cents per gallon, 15,000; coke, $10 per ton, 24,000; gas, $1 per 1000 cubic feet, 6500."

An acetylene blow-pipe, in which oxygen is used with acetylene, has been invented. With its use a very high temperature is obtainable, owing to the absence of inert nitrogen from the flame. It is claimed that with it a rod of pure iron serves as a soldering stick, and the heat is so great that a little of the carbon in the flame unites with the iron, converting it into mild steel.

To clean gas stove burners badly incrusted with grease, boil them in strong lye water or, in very bad cases, heat them to the point of redness over a fire. In heating burners to clean them, extreme care must be used to prevent them overheating, or they will be ruined.

Mirrors are silvered with amalgams. The simplest of these is composed of one part tin and three of mercury. A better grade of amalgam consists of two parts bismuth, one each of lead and tin and four of mercury.

Recent experiments are said to have demonstrated that cadmium gives protective coatings for iron much superior to zinc, being much more adhesive and harder. Like zinc, it finally becomes tarnished, but less rapidly. It withstands the effects of acid fumes better than zinc.

When driving out bolts, where you have no protection for the thread, strike the hardest blow you can give with a heavy hammer. Light blows with a small hammer will upset or rivet the bolt ends.

To prevent lamp chimneys from easily breaking, put them in a pot of cold water over the fire and add some common table salt. Boil well and let cool slowly, then take out the chimneys and wash them well.

A fraction of one per cent of sulphur destroys the malleability of iron when hot; while the presence of carbon lowers the fusing point by several hundred degrees.

A lubricant recommended for reamers by an American mechanic is a mixture of tallow and flake graphite. With this lubricant, he says, any old, out of round, hand ground reamer works smoothly.

Amber varnish is amber heated with linseed or nut oil and thinned when cool with turpentine. It is insoluble, hard, tough, and of permanent color. It dries slowly and forms an excellent mixture with copal varnishes, making them hard and more durable.

A substitute for platinum for use in electrical appliances is a new alloy consisting of 16½ ounces silver, 4½ pounds nickel, ½ ounce bismuth and 53 pennyweights gold. The cost of these ingredients is approximately $73.55, while an equal quantity of platinum is worth $2162.83.

The alloy of gold with mercury is known as amalgam. Mercury alloys with gold with great avidity, this being due not only to the marked affinity of the metals, but also to the fact that mercury is a metal which exists in the molten state at an ordinary temperature.

The task of separating the diamonds from the blueground in South Africa requires months. From the shaft the ore is conveyed to what are called the "floors"—great stretches of ground cleaned off like a tennis court. The ore is taken there in trucks or cars, which are fastened 10 feet apart to an endless cable, propelled by the power from the engine room. Each floor is 400 feet square, but their combined territory covers a great area of land, one mine alone having "floors" which extend five miles.

These "floors" are nothing more than the dumping grounds. Upon their smooth surface is spread the blueground to a depth of about 10 inches. Being very susceptible to the action of air and water, the blueground disintegrates after being exposed six months and is beginning to become pulverized. The harrowing is done by steam plows drawn back and forth over the "floors" by a cable. Any of the blueground that is not decomposed by the long exposure is taken to the crushing machine, where it is pulverized. All the pulverizing blueground is taken to the pulsator or separating rooms.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

Vol. VI. No. 2. BOSTON, DECEMBER, 1906. One Dollar a Year.

A 150-WATT DYNAMO.

IRA M. CUSHING.

This dynamo is capable of delivering 10 amperes at 15 volts pressure when driven at a speed of 2200 R. P. M. The field frame and base should be cast in one piece. The outline of the base is shown in the lower right hand part of the illustration, which gives a plain view of half the machine. The base should be cored out underneath as much as possible in order to reduce the weight.

The field poles are square with well rounded corners. They are 1¼ in. vertical dimension and 2¼ in. wide in the direction of the shaft. The bearing pedestals are of course, cast separate from the bed plate and can be made of any suitable metal. Cast iron of same grade as field frame is probably the cheapest. They should be carefully set up in the lathe with the point where the center of the shaft will be as a center, and feet turned off to a radius of 3 5-32 in. This I would suggest as the first operation towards building the dynamos. Do *not* bore the bearing at this time. Note that the two bearing pedestals are different. The one at the commutator end has the bearing lengthened on the inside to support the brush yoke.

The field frame should now be centered on the lathe, clamped to the carriage and the fields bored for the armature. The bore is 2 9-16 in. or 2.5625 in., and extreme care should be exercised not to exceed it, as upon this turns as upon no other single operation, the successful working of the completed machine. I would even suggest that skilled workmen may slightly reduce the diameter of the field bore.

After boring the fields, and before taking the machine from the lathe, the place for the bearing pedestal at the side of the dynamo frame nearest the lathe head may be bored. The depth of the cut will depend upon the success attained in turning off the pedestals. If these were accurately turned the cut in the base should have a chord of 2 in. The field frame should now be turned end for end and, carefully centering it again with the aid of a mandrel, the location for the other pedestal can be turned out.

The pedestals should now be clamped in position and the holes for the machine screws that fasten them in place can be drilled and tapped. The field frame with pedestals in place should be centered on the lathe again, and the pedestals bored out to receive the brass bushings for the bearings. The boring should be ⅝ in. diameter. For bushings use a brass tube, with wall thick enough to give a chance to drill out for a running fit for the shaft, which is .375 in. diameter. The bushings should be driven into place and bored out before again removing the field frame form the lathe.

A simple way to prevent trouble from the bushings coming out again or turning would be to cut with a cold chisel a slight niche in the edge of the hole in the pedestals, both on the armature side and outside, and then with a prick punch upset the brass close to the niche. This will force the brass into the niche and hold the lining in place.

The pedestal at the commutator end can now be set in the lathe and the place for the brush yoke turned off. This should be .875 or ⅞ in. diameter and ½ in. long. The pedestals should then be drilled for the oiling device. A plain hole can be drilled or can be drilled and tapped for oil or grease cup. If an oil cup is used a wick feed would be advisable. The grease cup would, however, probably give the best lubrication.

The field frame with its bearings can be set aside and the armature core and shaft started. The shaft consists of a piece of steel at least 11¼ in. long. This allows for a pulley at one end. Two inches should be added to this if the builder wishes a pulley at each end. It is not advisable, however, to make the shaft any longer than necessary, as it is a difficult part to turn. The steel, to start with, should be at least 9-16 in. in diameter. Beginning at the commutator end the shaft is .375 or ⅜ in. in diameter for a length of 4¼ in. The diameter is then increased to .5626 or 9-16 in. for 3¼ in. and then reduced to .375 in. again for the length.

A No. 14 thread should be cut for about 5-16 in. on the commutator end of the enlarged part of the shaft and to fit this should be made a brass or steel nut ¼ in. thick. A steel washer 1½ in. in diameter and ¼ in. thick should be fastened rigidly to the enlarged portion with its outer face ¼ in. from the shoulder of the shaft at pulley end. The easiest way would be to fit a brass pin through the washer into the shaft.

Between the nut and washer should be fitted enough discs to fill tightly the space of 2½ inches. These discs are 2½ in. in diameter, with a 9-16 in. shaft hole, and have twelve ⅜ in. holes, with their centers on a circle 2⅛ in. in diameter, punched around the edge. Both in making and assembling care should be taken to get the holes lined true. This can be done by putting a ⅜ in. rod through them and keeping the rod parallel to the shaft all the time. Clamps can be used to make the bundle of discs as compact at possible and the final tightening of the holding nut should be done with as much strength as can be used on a 6 in. wrench.

If the builder has a milling machine at hand he could assemble the blank discs on the shaft and cut 12 slots 7-16 in. deep by 3-16 in. wide. This would give approximately the same winding space. One objection to slots instead of round holes is that binding wires are necessary to prevent the armature wires from coming out when running at high speeds.

The finishing touch to the armature core is to chuck it in the lathe and take off a fine chip. This to make it as true of balance as possible. The better the armature is balanced the less will be the vibration when running. This is a very important factor in the machine, as the bearings will last the longer the less the vibration, and screws and nuts will not be always working loose.

The armature can now be prepared for its winding. For each end of the armature there should be made 2 fibre washers about ⅛ in. or 1-16 in. thick, 2½ in. in diameter and cut out in the center to fit, one over the nut and the other over the steel washer at the ends of the core. Holes or slots should be cut in the fiber to correspond with the holes or slots in the core punchings. These are to prevent the sharp corners from cutting the insulation on the windings. Now cut out two round pieces of fairly heavy cotton cloth about 2 in. in diameter. The center of one should be cut out ⅝ in. in diameter and the other 9-16 in. in diameter. These are to cover the nut and steel washer.

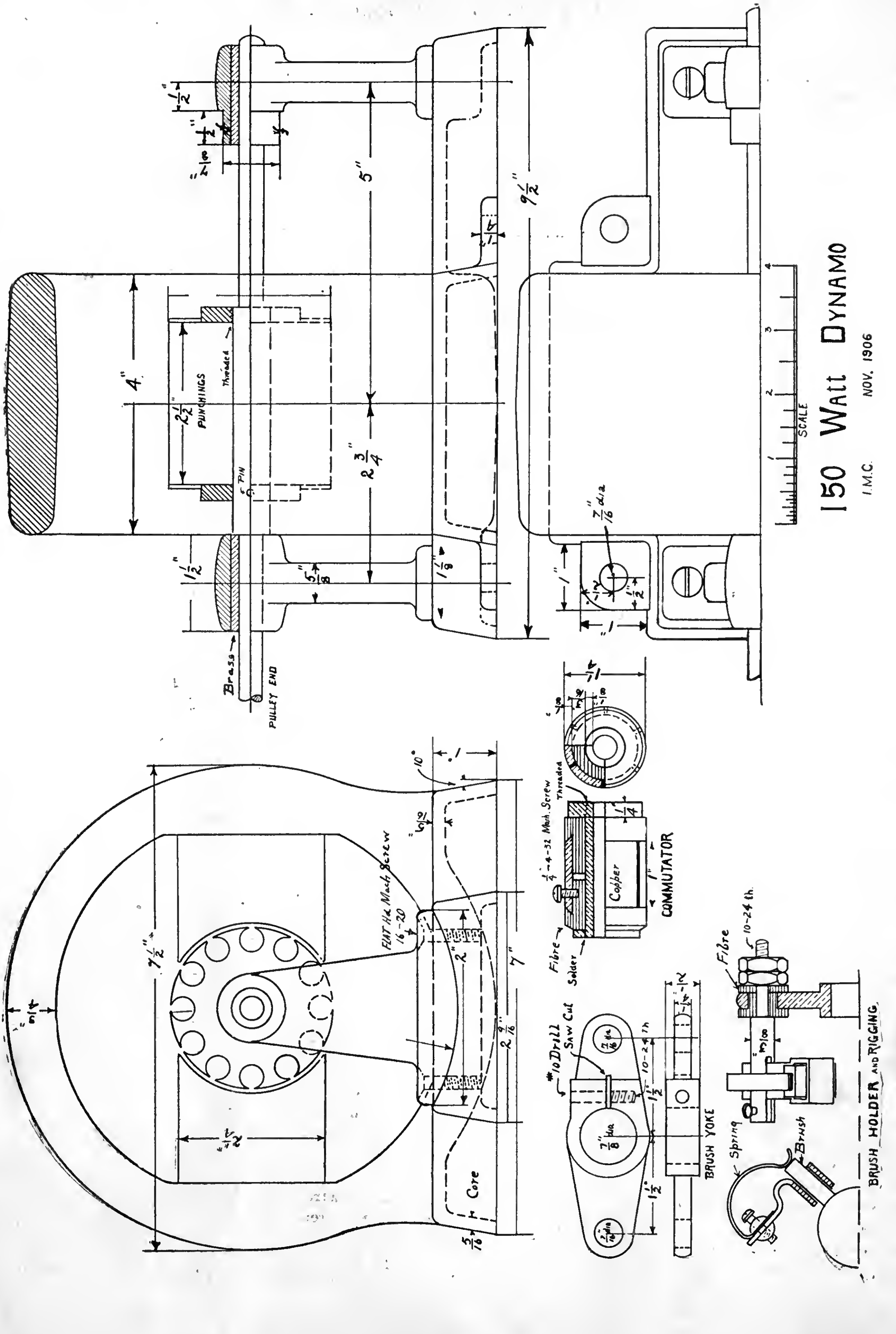
The next thing to make is twelve tubes of white drafting paper to fit in holes of the core. If the armature is slotted, troughs should be made instead of tubes. These should be 3 in. long and with the tubes I would suggest the circumference of the tube be a little greater than that of the tube. The builder will find this of much benefit when he winds the armature, as it will prevent the sharp edges of the iron cutting the insulation as the wire is slipped through. The paper tubes should be well shellacked on the outside and then slipped into place, slitting the ends which project and turning them back against the core. The ends of the core should then be well shellacked and the cloth washers slipped into place, smoothing them down.

The fiber washers should be shellacked on one side and slipped on to be held in place by wire or string threaded through the holes. These fiber pieces will also hold the cloth and paper in place. This work completed, the armature should be set aside to dry. If put beneath the stove or in a very slow oven the drying will be hastened considerably.

While the armature is drying the field spools can be wound. Each pole will require 490 turns of No. 20 single cotton covered magnet wire. This can be wound directly on the pole piece or, what is better, wound on a frame aud slipped on the pole completed. The form can be made as follows: Cut a piece of wood just the shape and size of the pole pieces. Its length should be that of the over all lengths of the field spool, which is 1¼ in. Wrap two layers of medium drawing paper around the form, shellacking both layers together. Do not shellac the paper to the form. Then cut the fiber ends for the field. These are made from 1-16 in. stock. The one to go next to the frame will be quite narrow, only ½ in. wide. Slip those onto the form and screw some pieces of wood on the ends to hold the fiber while winding.

Next put two more layers of paper around the form, using paper wider than the inside space, letting it come up on the fiber. Shellac the paper into place and against the fiber. Drill a hole through the large fiber and close to the bottom, and draw the end of the wire from inside out about 8 in. Now center the form in the lathe and wind. The first seven layers, or until the top of the small fiber end is reached, are wound the full length. After that drop one turn per coil at the small end until the requisite turns are on. Between every six or seven coils I would suggest putting on a layer of paper. This will help to keep the wire even. Give the coil a good coat of shellac and take it off the form, setting it aside to dry. It might be a good idea to see that plenty of shellac gets between the wire and fiber ends and then set the coil up in clamps so that the ends will stick firmly to the wire. Care should be taken that the second coil is wound in the right direction. It should be so wound that the winding in both coils turn in the same direction when in place.

Another good way to make the field spool is to use one turn of sheet tin in place of the first layers of paper. The tin should project out each side of the form and the extra part be bent over so as to hold the fiber ends in place when the coil is taken off the form. The size of wire and turns given require a field current of 1.5 amperes. If the builder is careful it is possible to to get approximately 730 turns of No. 22 wire on the spools, making the inside fiber piece 1 in. wide. This winding would require only 1 ampere of current and is,


150 WATT DYNAMO
I.M.C.
NOV. 1906
SCALE
PUNCHINGS
Threaded
PIN
Brass
PULLEY END
Core
COMMUTATOR
Copper
Fibre
Solder
BRUSH YOKE
Saw Cut
BRUSH HOLDER AND RIGGING
Spring
Brush

therefore, more desirable, giving a machine of higher efficiency. The field coils of No. 22 wire are recommended.

While the field coils are drying the armature may be wound. The wire to be used is No. 16 single cotton covered, and wind 18 wires in each slot. Before winding wrap the enlarged part of the shaft at the pulley end with cloth or tape for about ⅝ in., and put a fiber tube of ⅝ inside diameter and ¼ in. long on the shaft against the core at the commutator end. These insulate the wire from the shaft, and the fiber tube also serves as a stop for the commutator to bear against. In winding do not exceed the limits of this insulation.

To begin winding, wrap the end of the wire two or three turns around the shaft and go through a slot coming back through the fifth slot to the right, looking at the core from the commutator end. In winding always have this end towards you. Wind on the 18 turns, taking care to have the wires as straight and even as possible and have them lay as tight as possible against the end of the core, remembering the limits set on the shaft for the wire. The wire from the last turn should be twisted into a loop about 2 in. long for material with which to connect to the commutator, and then carried over to the fifth slot beyond. With this slot as number one wind the second coil between this and the fifth slot away. Repeat this operation until all slots are full, when the last turn from the last coil will come in sequence to the loose end of the beginning. Twist these together and there will be six twisted loops sticking out for the armature. Numbering the slots to the right, looking at the commutator end, the coils will come as follows: Coil 1, slots 1-6; coil 2, 11-4; coil 3, 9-2; coil 4, 7-12; coil 5, 5-10, and coil 8, 3-8.

After the wire is all on give the coils a good coat of shellac, especially at the ends and again dry the armature in a slow oven or under the stove. Do not place in too hot an oven as insulation would be likely to charr. In using the single cotton covered wire great care should be taken not to scratch or break the insulation. If the builder could afford it double silk covered magnet wire would be much better. After winding each coil it should be tested with a lamp resistance on 110 volts to see that there is no ground between the coil and the iron core.

The small fittings can be made now while the windings are drying. An easily made commutator for this dynamo is shown on the drawing. The foundation for it is a brass tube ⅝ in. in diameter and 2⅛ in. long, bored for a driving fit on the shaft. On one end should be sweated (soldered) a brass washer ⅛ in. thick and 1 in. in diameter, while the other end should be tapped and fitted with a nut ¼ in. thick. The insulation of the commutator is of fiber. Take a piece of fiber and turn it into a piece 1¼ in. diameter, 1⅝ in. long and bored to fit over the tube. In the center turn a groove ⅛ in. deep and ⅝ in. wide. Cut the sides of the groove in at an angle, as shown in the drawing.

Next cut the fiber in two about in the middle of the groove. Take a piece of copper tube with inside diameter sufficient to slip over the grooved part of the fiber and a wall at least ⅛ in. thick. Set this on an arbor and turn the ends at an angle in the fiber making the outside just 1 in. long. The inside will be longer so as to fit under the fiber. Cut the copper tube into six equal parts lengthwise, clean the saw marks and burrs off carefully with a fine file and set the parts between the fiber pieces.

To fill the space between the segments, cut pieces of fiber the shape of the cross section of the copper. Now set the parts together and drill, and tap each of the segments close to one end for a ¼ in. 4-32 machine screw. Set the commutator in the lathe and carefully turn the surface down true, but do not take off any more material than necessary. In case the dynamo is is being wound and used for a high voltage I would suggest the spaces between segments be filled with a paste made of powdered mica and shellac which, when dry, is very hard, durable and a good insulator. It will be necessary to also fill the space between the fiber pieces with this paste. Possibly the commutator may have to be wrapped with paper to hold the paste in until it dries.

The brush poke can be cast or cut out of ½ in. brass stock. The dimensions are given on the drawing and can be followed, or the builder can design one which might better suit his fancy. The center hole should be carefully drilled to a running fit on the bearing pedestal. Any type of clamping screw may be used that would draw the sawcut together. A simple and easily made brush holder and rigging is shown in the drawing. The brush holder stud is insulated from the yoke with a fiber bushing and washer, as shown. It has a sawcut at the other end wide enough to admit the brush holder and spring. A machine screw should be fitted at the end to bring the two halves together, clamping the holder in place. The brush holder is of sheet brass, bent into the shape shown. The spring is made of spring brass. The brush is of woven wire ¼x½ in. and about ⅝ in. long. It should be carefully fitted to the commutator in order to give a good current carrying contact.

The commutator should be assembled on the shaft and connected up to the winding. The loops connected to the next segment beyond the one opposite the coil from which the loop comes. This will bring the brushes in a position which will require the yoke in a horizontal position. Set the brush yoke in position and assemble the armature in place, turning it with the hand to see that it runs freely, then assemble the brushes and adjust the spring.

To drive the dynamo use a pulley 2½ in. in diameter with 1½ in. or 2 in. face and use a 1 ¼ in. flat belt. Connect the field coils in series so that the current will traverse them in the same direction. Connect the outside wires from the field, one wire to one brush stud and the other to the other brush stud. One of these studs will be the positive and the other the negative terminal of the dynamo.

The machine is now ready to run, but inasmuch as no current has passed through the fields, it is quite probable that it will not generate. It would be well, therefore, to connect the fields to one or two cells of battery in order to get sufficient residual magnetism with which to start the dynamo. If everything is connected up correctly the machine should now generate current. Should it fail to do so try reversing the field leads, or test for an open circuit. As the dynamo will run as a motor a good way to test it is connect it to a battery of 10 or 12 cells, and if everything is right it will run, and turn in the direction in which it should be driven as a dynamo; the only difference being in the position of the brushes. As a generator the brushes will have a lead; that is, it will be ahead of the neutral line of the armature, in the direction of rotation, while as a motor the brushes will lag.

The finish of the dynamo can be made to suit the builders' fancy, a dark green or dark brown enamel or bicycle paint would look very good. The material for this dynamo would cost between $7 and $10, depending upon the facilities the builder has and the proximity to source of supplies. When complete the dynamo should easily be worth $20.

The amount of wire required will be approximately 4½ pounds of either No. 20 or No. 22 for the fields and about 1½ in. pounds of No. 16 for the armature. To generate 55 volts, wind the armature with No. 20 wire 60 turns per coil. This would require 1½ pounds of wire. Wind the field with No. 26 wire, 2930 turns per pole. This winding will take ½ ampere of field current. As a generator with the above winding will give a current of 3 amperes.

TECHNICAL EDUCATION.

JOHN CASSON WAIT.

Abstracts of Founder's Day Address at the Thos. S. Clarkson School of Technology, Potsdam, N. Y.

The foundation of a technical training consists of nature's laws and phenomena, and as nature's laws are fixed and inexorable, a student possessed of a knowledge of what has been, knows what will be, and it is this that forms the groundwork of the twentieth century system of education. But this is not all; it should go further; it should elevate the new genera- to a higher plane than mere investigation; it should cultivate powers, a higher ideal and a struggle for genius, the divine, the creative.

An education implies first, a student or scholar to be educated, second, a process or method by which the education is to be acquired, and third, an ulterior purpose or ultimate utilization of the education to some good aim and end.

When the high school or seminary training is finished, several questions present themselves to a young person, among which are three, viz.: 1. What shall I do or become? 2. Shall I attend school or become an apprentice? 3. Shall I enter the general or technical courses of instruction? The first question must be answered by the tastes, qualifications and opportunities possessed by the person. The second question is usually determined by the pecuniary limitation of the person. The third question depends upon the advantages to be secured or benefits to be derived, and is a subject for discussion under our topic.

It is not a new subject, but there may be some new things in it, in the light of another's experience. I do not advocate an extended general course in college as a condition precedent to technical training.

I am no advocate of sixteen years of education before a man or woman becomes self-supporting. He or she is depending too long upon charity or is assuming a debt which he may never repay. It dwarfs the spirit of independence and self reliance which the twentieth century needs so much. A young man who accepts his parents' or relatives' support to the age of twenty-four or twenty-six years has forfeited one of the heavenly attributes of human character, that of manly self-reliance. I would not expect great things of such a young man. If not blessed with influential relatives or friends he must gain his experience and acquire a clientele. His married life is postponed and his ideal life shortened by a decade.

* * * * * * * * *

In the general courses the studies that you pursue are determined, in the larger universities, by the student's own election. The tendency is towards this plan. By it the student may take his collegiate course and at the same time pursue courses required in the professional classes. This will lead to the three years' collegiate course and is a step in the right direction, if the work of the student be directed or supervised. If he be required to elect this profession or business and to take subjects prescribed or acknowledged to be advan.ageous in the vocation adopted, then it is, to my mind, most desirable. If he elect the elementary subjects in the various departments, acquire what is popularly known as genera; culture and secure the requisite number of points or half courses, he can graduate with a degree, though that may mean positively nothing as an indication of what the student knows.

There is the choice of schools to consider; the large and the small, those in cities, in the country, the general and the technical. But outside of these there are also for consideration the systems that prevail. Some of the schools believe in pursuing several subjects at once, while others pursue one or two subjects only at at a time. The various systems have many advocates. Each maintains that its system is the system. There is the choice between the elective and the prescribed courses of study, the experimental and the theoretical systems of teaching sciences.

In my opinion, it is these institutions which combine the theoretical and the practical, which limit to a moderate degree the number of courses, which prescribe courses for lower classmen, and upper classmen, and leave the election to upper classmen, that truly derive the benefits of both systems.

Cultivate exquisite care and practise heroic effort. As our country grows older and competition becomes greater, the requirements of an education increase. Students who expect and hope to excel in the competition that prevails in our great cities, must have something better or something different from that possessed by others.

Refinement should be applied to all that you do and undertake. Your mental training should be refined on the same plan. That is what makes the artist; it is what distinguishes the actor and soldier from the business man or laborer, and it is what makes the successful technician or engineer in the present day.

Technical training, as offered by our industrial schools, tends to develop abnormally particular lines of the intellect and greatly enlarges the scope of one's observations and power in certain directions. Such a development has been compared to the abnormal development of the five senses. Yet the world has need of such men. He may not be wanted frequently, but occasionly his services are required when they command great prices.

The prevailing idea is that a complete education should be acquired at school. The average graduate from college or technical school hails his degree as the final goal of his educational ambitions. Few study or expect to study after graduation except, perhaps, in short crams for a civil service or professional examination.

Such is not the object. The school's aim is to qualify you to study. If you do not continue with your studies you are soon going backward and at a rate which will appall you when you come into competition with some recent graduate fresh from his studies.

A far-seeing man will, before spending very much time or money for a thing, enquire what specific uses he will make of it, and he will select the object of his purchase with a view to its qualities and its adaptations. A young man who enters college or a technical school, should have some idea of what his tastes and capacities are and should be directed in the lines where his abilities would be best applied and cultivated. I am not one to advise that every man should be a perfect man; neither do I advocate that a whimsical and indolent youth should be permitted to escape essential training in mathematics and the sciences by his declaration that he does not like them and he does like music, art and other subjects which gain flattery and applause. Yet for one's life work it is a grave misfortune for one to school himself or herself in a business for which they have not a real liking and to which they cannot bring enthusiasm. Elect something to your liking and something in which there are opportunities and for which there is a demand.

The utilization of technical training in the industrial pursuits and development is everywhere apparent in this country. To no other one element are the country and the people more indebted for their wealth and prosperity. The physical comforts at home, of business and of travel are due to the marvelous provision of the technician.

The economic value of this training is illustrated by the trade, domestic as well as foreign. No country can have claims to world power until it develops the industrial talents of its people and the natural resources of the land. The balance of power remains where the scientific, industrial and mechanical arts are best treated.

A writer in "Popular Mechanics" recently explained his method of overcoming the difficulty of making paint adhere to zinc, his desire being to make zinc be the support of a plate surface, and painting the surface with a paint composed of shellac in alcohol containing a solution of pumice stone and lampblack. The method employed was as follows:

A portion of the 'paint' was diluted with alcohol and the surface of the zinc well sand-papered while thoroughly wet with the solution—the intention being not to allow any of the surface to come in contact with the air during or after the operation of sand-papering. The paint was thick enough to cover thoroughly as it dried. When every part had been gone over thoroughly, a number of coats were added, in order that the low places might be filled up and the surface ground with pumice stone. Time has proved the success of this experiment. Many years have gone by, but the coating holds perfectly and the matter is now brought forward with the hope that the suggestion may have useful application in ordinary painting.

The theory on which this experiment was based is that zinc oxidizes instantly wherever a fresh surface is exposed to the air. This oxide is so thin that it is not visible. Nevertheless, it is present, and forms an unstable attachment for the paint as commonly applied, thus preventing the same from coming in absolute contact with the metal itself. The sand-papering operation, under cover of the wet paint, produces a different condition of things.

A WINDOW CONSERVATORY.

JOHN F. ADAMS.

The arrangement for winter plants here described is the result of much planning to obtain considerable more room for plants than could be spared conveniently inside the room to which it was fitted. As will be seen from Fig. 1, it is much like a small bay-window, and is attached to the outside of the house, thus affording room for quite a large stock of plants without infringing upon the interior of the house. It is located against a window on the sunny side of the house, the sash of which is removed, care being taken to prevent the window cords from running through the pulleys by tying knots in them. In the more northerly and colder states it will be advisable to fit curtains, which are lowered on extremely cold nights, and in addition, a small lamp may be used for heating. During much of the time, however, the heat from the adjacent room will be quite sufficient for most kinds of plants.

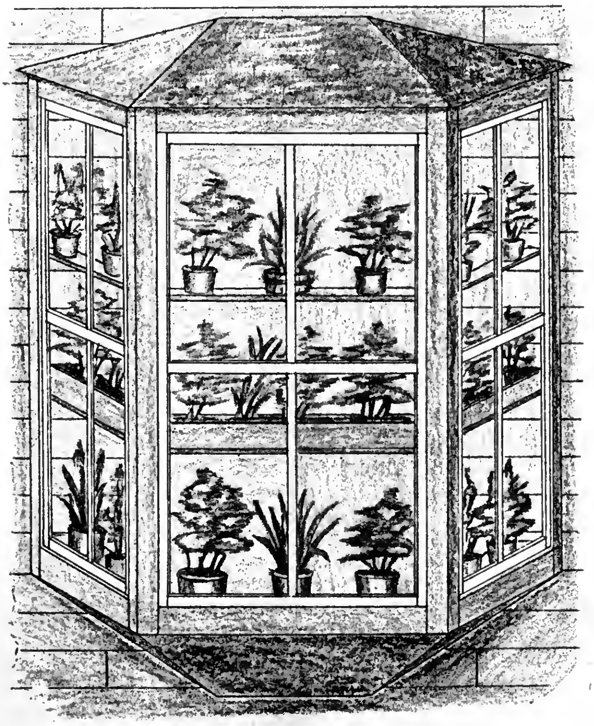


FIG. 1.

It will hardly be possible to give exact dimensions, owing to the great variation in the sizes of the windows to which such a frame can be fitted. The first requirement is to make a dimensioned drawing of the window to be used; then purchase one full-size and two half-size outside windows, the larger one having a sliding pane, which may be opened for ventilation whenever the weather is mild.

A framework is then made of 2 x 3 in. planed spruce, as shown in Fig. 2. The ends are first made with halved joints for the front cross pieces. In the ends of the vertical pieces tenons are cut as in Fig. 3. It will be noted that the outer end edges of the vertical pieces are bevelled to the angle formed by the side. The windows fit snugly between the various pieces of the frame, the front edge of which is from 12 to 15 in. from the rear edge against the side of the house, varying according to the size of the windows used. The ends of the cross pieces connecting the ends are halved, as before mentioned, and attached with strong wood screws.

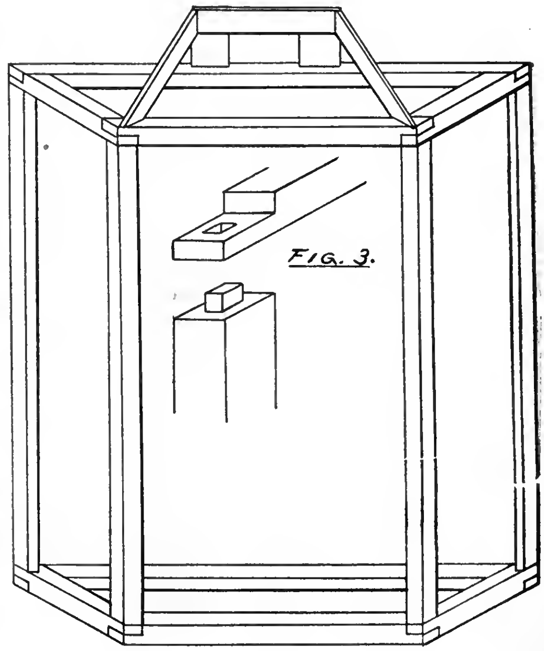


FIG 2.

The under side may be covered with matched sheathing, planed both sides, or splayed as shown in Fig. 1. In the former case the work is done before the frame is attached to the house; but if splayed the work must be done in place to secure accurate fit and tight joints which is also true of the top. That part of the frame of the top, and also of the bottom, if splayed, which is attached to the rear cross piece must also be cut out and fastened in place. The height in the clear is about 6 in. and length about one-third that of the width of the window.

The frame is then firmly attached to the side of the house, using small angle irons for the purpose and screws long euough to reach through the clapboards into the siding. The weight of the window, when loaded with plants, is considerable, and ample strength should be secured by using plenty of angle irons.

The roof, of matched sheathing, is then added, the lengths of board being sufficient to give an overhang of about 3 in. A smooth surface is desirable, as roofing paper is to be used for the final covering. This can be obtained of any hardware dealer, together with directions for laying. The chief difficulty will be to secure a tight fit between the boards at the rear edge and the clapboards on the house, and in addition to accurate marking, considerable "cut and try" work will be needed. After the roof is covered with the roofing paper, a strip of electrician's tape can be used to cover the joint with the house, which will prevent rain or melting snow from entering.

The frame is then completed by putting on strips 3 or 4 in. wide, on the outside forming a casing much like the outside of any window. It should lap over the edges of the timber frame work about ½ in. The joints at the corners will have to be bevelled, and it will be advisable to halve the joints between the vertical and cross pieces. Tight joints are absolutely necessary to exclude both cold and rain.

The windows may now be put in, fastening with a few screws, or strips of wood may be fastened to the wood frame with screws, this method being preferable, as it makes an additional break to the joint. If the joints are not then tight enough to keep out the cold, run electricians tape around all the joints, which will completely close them; in fact, it is desirable to do this as some of the joints are liable to open up during a winter.

Curtains are next to be fitted and then the shelves, either three or four in number, according to the size of the plants to be grown. The shelves, 6 or 7 inches wide, are put up on brackets or large angle irons. By cutting the ends where they join to an angle, a screw can be put through the bracket into the ends of each shelf.

It will also be found desirable, in place of flower pots to use wooden boxes about 6 or 7 inches wide and deep, and filled three-quarters full of rich loam. The boxes at the large window reach clear across; those at the ends having one end cut to a mitre to fit without loss of room. These boxes are most attractive when painted green. On the top shelf, the plants are best handled if in pots, as it is not convenient to handle boxes so high.

Nothing has been said about painting, this, of course, being determined by that on the house. A priming coat of lead paint is necessary before putting on the last coat. A pleasing selection of colors is to paint the windows to match those on the house, and the woodwork to match the trimmings.

HOW TO COLOR BRASS BLACK.

To produce a black color on brass, the following is the formula: Dissolve 1 pound of plastic carbonate of copper in 2 gallons of strong ammonia; first boil the brass that is to be blackened in a strong potash solution to remove all grease and oil; rinse well and dip in the copper and ammonia solution, which should be heated to 150 to 175° F., until the desired degree of blackness is acquired. The color produced is very uniform and has little tendency to peel off. The process works best on brass containing much copper, or on what is known as "red" brass. Directions are also given for making the plastic carbonate of copper as follows: Blue vitriol (sulphate of copper) is dissolved in hot water, and a strong solution of common washing soda is added to it so long as any precipitate forms. The precipitate is allowed to settle and the clear liquid is poured off. Hot water is now added and the mass stirred and again allowed to settle. Again the clear water is poured off and the operation of adding hot water, settling and pouring off is repeated until everything has been washed out of the green carbonate of copper which remains at the bottom of the vessel. This is the plastic carbonate of copper referred to.

THE TURQUOISE.

The turquoise runs in blue veins through the rocks, with now and then the concretions called nuggets, which afford stones of value. At the present time the bulk of the world's supply of fine turquoise is drawn from New Mexico, and experts say that that the output is equal to the best turquoise from Persia. Indeed, it is in one respect superior, holding its color better. About $200,000 worth of turquoise are sold annually. For the first time in centuries it is possible, jewelers say, to make a turquoise necklace of perfectly matched stones. The turquoise occurs in a rock of a pretty reddish color, being so mixed up with it ordinarily as to be valueless. But the idea came to a gem expert in New York not long ago that it would be a good idea to take selected pieces of this stuff and polish them, offering them for sale under the name of matrix turquoise. To his own astonishment, the idea proved immensely popular; a fad for stones of this kind rapidly grew; and today, following out the same idea, jewelers sell matrix sapphires, matrix emerals, and matrix rubies. In fact, almost any flawed gem, filled in with ordinary rock stuff and impossible for cutting, will bring a high price as genuine matrix.

That quartz is opaque is due largely to the myriad cavities which it contains. These cavities may be vacant, but often they contain water and liquified carbonic acid gas. Sorby discovered the fact that they may be so microscopic in size that a thousand millions of them in a cubic inch is not unusual, and the enclosed water often constitutes one to two per cent of the volume of the quartz.

A TWENTY FIVE FOOT AUXILIARY YAWL.

CARL H. CLARK.

II. Making and Setting Up the Stem, Stern and Bottom.

The outline of the sternboard having been shown in Fig. 6, the complete stern is shown in Fig. 8. It is of 1¼ in. oak or other hard wood, fastened together with cleats 1¼ in. thick. It should be formed of a wide piece in the middle, narrower pieces added on the sides to make the necessary width. No joint should come in the middle, as it would make fastening difficult. The cleats are fastened on with galvanized boat nails, and the lower cleat should be at least 15 in. from the lower end, to allow fastening of the stern knee. The round of the upper end need not be cut at present, neither need it be bevelled until set up in place.

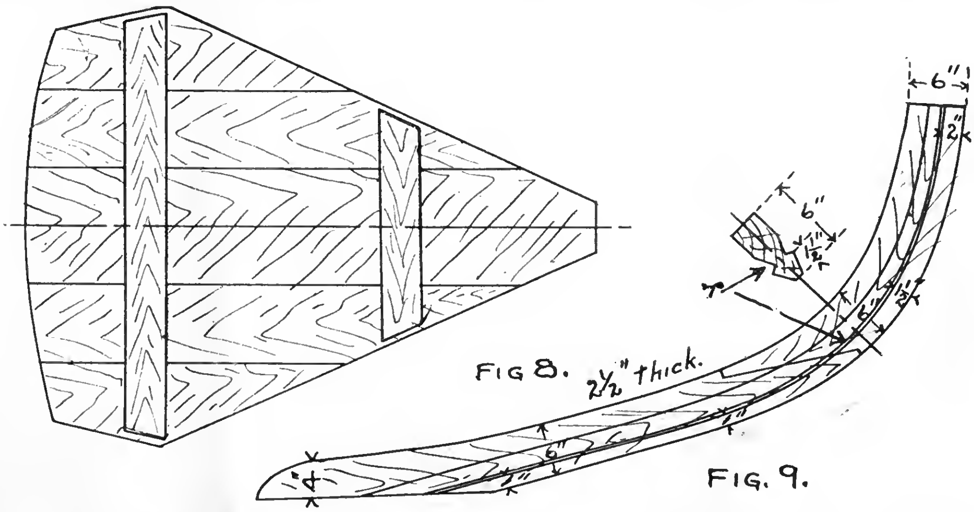


FIG 8.

FIG. 9.

Fig. 9 shows the completed stem, the outline of which is given in Fig. 6. It is 2½ in. thick. While it may be possible to obtain a curved piece out of which it may be cut, it is not likely; therefore it will probably be made in two parts scarphed as shown in the figure. The length of the straight part of the scarph should not be less than 10 in., and its exact position will depend upon the stock obtainable. The two portions are cut out separately and fitted together to match the paper pattern already laid out. They are fastened together with pieces of ⅜ in. galvanized rod riveted over washers inside and outside.

In Fig. 9 *r* represents the rabbet or triangular groove to take the ends of the plank and bring them in flush with the sides of the stem. The dimensions for laying out this rabbet are given from the face of the stem; these are laid off on both sides and a curve drawn through them. Starting with this line the groove is cut as shown in the small cross section, being about ¾ in. deep and about 1½ in. wide. It need only be roughed out now, leaving the finishing to be done after it is in place. The upper end should be left about 6 in. larger than shown, to fasten shores to hold it in place. The flat part outside of the rabbet may also be bevelled off, as shown, to about ⅞ in. on the face.

The outline of the bottom is shown in Fig. 10, and the complete bottom in Fig. 11. It is 1¾ in. thick and is best made in three pieces, joined as shown. The pieces are planed on the edges and fitted together. If necessary, two or three temporary cleats may be fastened on to hold them; a center line is struck and the mould points, 3 feet apart, are laid off along it and lines drawn across. The widths from Fig. 10 are now laid off on each line as shown; a fair line may be drawn through these points by using a batten about ¾ in. square, held in place by rails driven each side of it. The center-board slot should also be laid out.

The boards may now be separated and trimmed down to the line, leaving a square edge. The slot may be cut by boring a few holes near one end sufficient to be sawed out, and then trimmed up with a chisel. The boards are then fastened together permanently by the cleats, as in Fig. 11. These cleats are of oak 2 in. square and about 6 in. longer than the width of the bottom.

The positions of the cleats are as shown, and they all extend across the bottom except the two between moulds 3 and 4, which are cut 2¼ in. clear of the centerboard slot. The cleats are square with the cen-

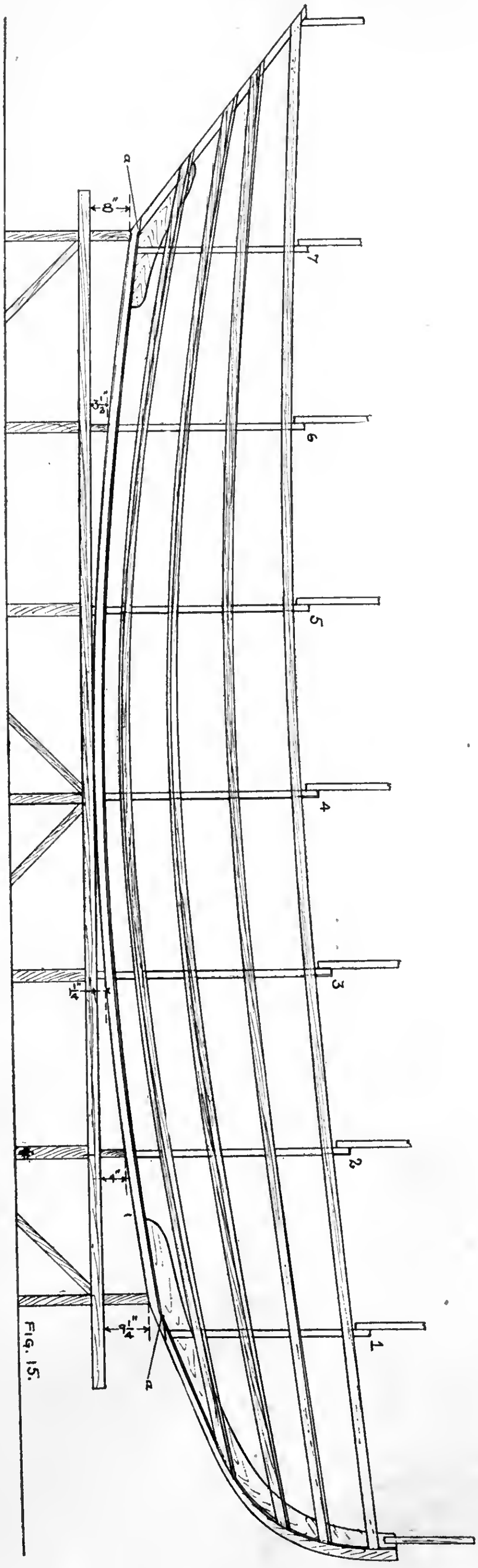


Fig. 15.

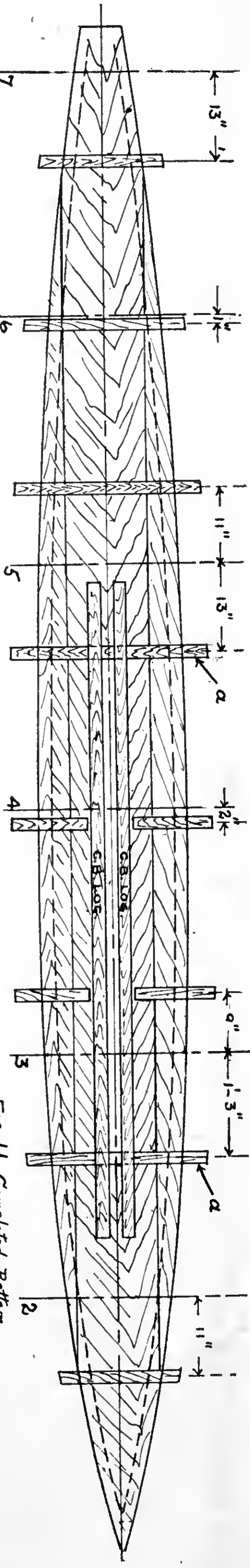


Fig. 11. Completed Bottom.

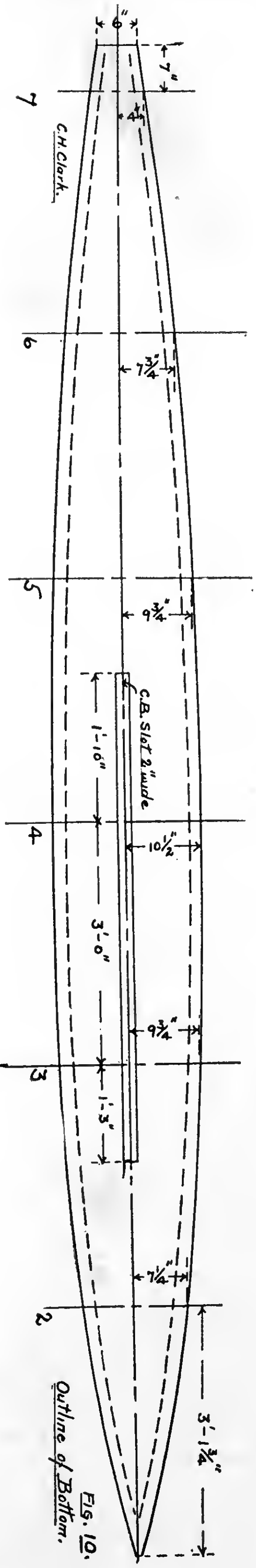


Fig. 10. Outline of Bottom.

ter line, and are fastened on with heavy galvanized nails or screws. They should be put on in about the position shown in order to clear the other frames; those marked *a a* are exactly even with the ends of the centerboard slot.

The bottom may now be turned on edge and a rabbet cut out on the edge, as shown in Fig. 12, using a mallet and heavy chisel. Near the ends it should be cut rather steeper than shown on account of the sharper angle of the frames. This may be accomplished by reducing the 1¼ in. dimension to 1⅛, and finally to 1 in., the others remaining the same. While this rabbet must be carefully cut, it need not be entirely finished now, as there will be small variations of the angle which cannot be determined until the boat is set up.

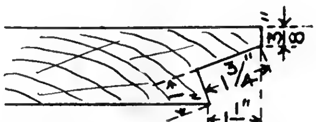


Fig. 12. Detail of rabbet.

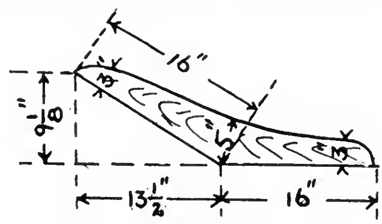


Fig. 14. Stern knee.

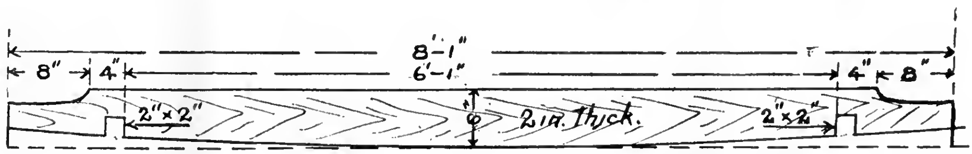


Fig. 13 Outline of C.B. Legs.

The stern house, shown in Fig. 14, should be cut to the dimensions given, out of a piece of 3½ in. stock with the grain running from point to point. The exact angle of this knee is quite important, as it fixes the angle of the sternboard, and consequently the shape of the after end of the boat.

The stern and sternboard are now set up in their proper positions on the bottom and clamped temporarily in place; the center line of each must agree with that of the bottom and they must be in the correct fore and aft line or, in other words, point directly ahead and astern, and not to one side. To aid in setting these, the bottom may be laid on a level floor, and a cord stretched from the center of the sternboard to the center of the stem.

A short plumb line may then be held alongside of this cord, and the coincidence or deviations of the point of the bob with the center line of the bottom will show whether they are correctly set. When properly adjusted they may be fastened into place with ⅜ in. galvanized iron rivets. Rivets for this and other purposes may be bought with the head already formed, or may be formed of a piece of ⅜ in. rod sawed the proper length and headed at either end; the latter is the cheaper way and just as satisfactory.

A foundation must now be built upon which to set up the boat in order to bring it to a convenient height for working. This foundation is built as shown in Fig. 15, of a 2 in. spruce plank about 12 in. wide and 20 ft. long, supported about 15 in. above the floor. The supports or braces are pieces of 2 in. plank shaped as in Fig. 16, or other shape which is sufficiently rigid. These supports should be so spaced that one comes under each end and under each mould, as in Fig. 15.

For building the boat a place should be chosen, if possible, where there is a wood floor and strong rafters overhead, as both of these are necessary for ease of bracing and holding the several parts. The foundation should now be set up in the place chosen; it must be strongly built and well braced, both sidewise and fore and aft. The upper surface must also be straight and level both ways.

The bottom, with the attached stem and sternboard must now be bent in as in Fig. 15. Blocks are cut to the widths there given, which are fastened to the foundation in the proper places. The bottom is laid on and forced down into the shape thus prepared by shores from the beams above; the judicious use of wedges will help in this operation. The bottom is bent down until it touches the foundation at the middle brace. This operation will require some care, as the bottom is a fairly stiff piece of timber and will require some force to bend it. Owing, also, to the stock which has been cut out at the centerboard slot it will have a tendency to bend more easily at this point, which must be guarded against. A liberal amount of boiling water poured over the bottom, or cloths saturated with hot water, will take out some of the stiffness and allow it to bend more easily.

An ample number of shores should be used and the final shoring should be placed on either side of the center line, leaving a clear sight down the middle of the boat. The shores must also be kept clear of the mould points.

The moulds, which have already been made, may then be set up in their right places on the bottom, the lower edge of each being slightly bevelled to fit the slope of the bottom at each mould. It is to be noted that the moulds forward of No. 4 are placed forward of the mould point, or with the mould point even with the after face of the mould, and those aft of No. 4 are placed aft of the mould point.

The moulds must be set plumb and also square with the center line fore and aft and must also have their middle points in the center line. The line already used may be again stretched and the moulds adjusted so that the center point already marked on the cross piece will fall under it. As each mould is adjusted it is fastened by braces, as shown in Fig. 16, run diagonally to the beams overhead. The moulds are fastened to the bottom by cleats nailed to both mould and bottom, and by nails driven in diagonally.

The correctness of the slant of the stem and sternboard may be tested now; the distance from mould point No. 1 to the rabbet at the top of the stem is 3 ft. 8 in. as given in Fig. 2, and from mould point No. 7 to the corresponding point on the sternboard is 4 ft. 1 in.

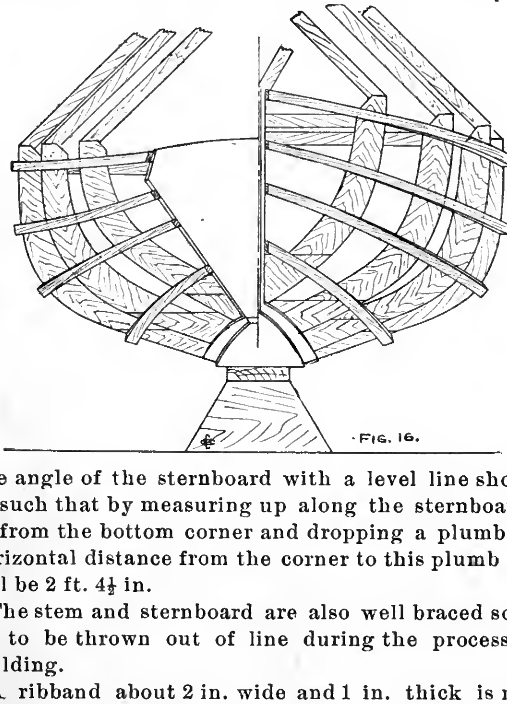


FIG. 16.

The angle of the sternboard with a level line should be such that by measuring up along the sternboard 3 ft. from the bottom corner and dropping a plumb the horizontal distance from the corner to this plumb line will be 2 ft. 4½ in.

The stem and sternboard are also well braced so as not to be thrown out of line during the process of building.

A ribband about 2 in. wide and 1 in. thick is now bent around the moulds near the top and fastened in place. As it is bent around, a portion of the edge of each mould is bevelled to allow it to bear evenly on the entire thickness of the mould.

The entire edge of each mould may now be bevelled so that the ribbands, run as in Figs. 15 and 16, will bear evenly at all points. The fairness of the different moulds may now be tested, as the ribbands should bear evenly on every mould and make a fair sweep from stem to stern. Any unfair spots may be corrected, either by trimming off or shimming out as may be necessary.

The rabbet in the bottom and around the stem may be finished out to the correct angle and made ready to receive the plank. The angle of both of these must be such that a plank lying on the moulds will bed fairly into the rabbet at all points. The edge of the sternboard also must be bevelled to the right angle. When this work is completed three or four additional ribbands are bent around when the boat should look as shown in Figs. 15 and 16. Screws should be used, as the ribbands must be removed from time to time.

At the points *a a*, Fig. 15, where the stern and sternboard join the bottom, stop-waters are to be fitted to prevent the water running in along the joint. A 5-16 hole is bored right through, and a tightly fitting plug driven in and cut off even with the outside surface.

METHOD OF OBTAINING EXPERIMENTAL WAVE LENGTHS.

There is a considerable gap of unexplored wavelengths intermediate between these of Hertzian waves and what is commonly known as heat. The shortest Hertzian waves which have heretofore been produced are of the order of one millimetre in length. In this communication Prof. Reginald A. Fessenden describes a method of obtaining waves of intermediate length. The method was discovered by the author some years ago, but he has been unable to carry on any work with it. If two copper rods are placed against the plane surfaces of two plano convex lenses having the convex surface directed toward each other and separated by a very short air-gap, and are charged from a source of high potential, discharges will take place across the gap between the lenses, and these discharges will have short wave-lengths. If the lenses be replaced by metallic bodies the capacity of the system will be considerably increased and the wavelengths considerably lengthened. But with glass lenses, as described, the wave-lengths of but a few ten-thousandths of an inch are obtained, and there appears to be no necessary limit to the frequency. Inert gases of the helium type seem to give the best results, but good results are obtained by using quartz lenses in air. Quartz is used because it does not seem to become conducting when heated by the passage of the discharge, as does gas. For this reason the wave-length remains more constant.—"Nature."

The deepest hole in the world is one that is located near Leipsig, Germany. The object of the hole was in determining whether coal was there and likewise the man making the boring was of a scientific turn of mind. The hole has attained the great depth of 5790 feet. At the surface the hole was about half a foot in diameter, and at the bottom had tapered off to less than an inch in diameter. Diamond drills were used and the rods weighed 20 tons. It took ten hours' work to take the rods apart and put them together again.

SECRET OF AERIAL NAVIGATION.

The Tissandier brothers of France moved an airship by means of electricity generated by bichromate of potash cells. Redard and Krebs of Germany also attempted the feat of governing the motion of a huge gas bag through the circumambient atmosphere. Electricity from batteries, power from steam and gas engines, and finally energy from the very air itself, represents the efforts made to build a useful, reliable and consequently durable air ship. Like an ignis fatuus it has been dancing before the eyes of the public for more than a century as a thing apparently within our clutch, yet constantly evading us. But the record of advancement in this field has at least been the record of engineering efforts to create a definite machine.

From this standpoint the air-ship problem is no longer confined to any haphazard class of experimenters in the strict sense of the word. But it may be regarded as a possible development in the field of mechanical or electrical engineering. It may be expected to develop greatly in the very near future; and it is therefore imperative to keep in touch with its various phases of growth in order to appreciate the science, the art and the logic which culminate in its successful issue. Electricity has had a hand in its development, though of late it has been superseded by the gasoline aud steam engine, for the simple reason that, pound for pound, including the source of power—fuel and water or both—the motor and batteries are out of the race. As an ignition feature of the gasoline engine, electricity cannot be safely dispensed with. With all this preamble though, the problem arranges itself into three parts. The gas bag providing the flotative force coming first, and which though strongly made today does not differ fundamentally from that sent up in the air by the Montgolfier brothers many years ago.

The steerable or dirigible balloon comes next; of which, perhaps, the Santos Dumont type is most characteristic at the present time, and to which the ship of the Tissandier brothers belonged. The last is of the aeroplane type, developed to a remarkable extent by Prof. Langley of the Smithsonian Institution. Thus the air-ship has passed through three stages of growth, which can be divided, however, into two distinct fields of experiment. The older field follows along the lines indicated by the use of a self-flotative body, such as a balloon. The newer field takes the bird as a model and attempts success with a non-flotative but withal self-supporting machine, essentially heavier than its own bulk of air.

An investigation of this latter class of machines discloses one elusive feature. They are able to rise into the air only in the teeth of the wind. The supporting element is therefore derived from this source, and according to such authorities we have, birds themselves, of the so-called soaring class, rise or support themselves in this manner. The swift winging class, however. represent a curious anomaly, in that their weight represents, a much greater wing surface than the heavier soaring birds. To quote from R. Von Lindenfields's remarks in the conclusion of an article by him, whose data was obtained from measurements of the weight and wing surface of flying creatures of all descriptions and embodied in an article called "Relation of Wing Surface to. Weight": "According to the foregoing, if the combined weight of the body and the mechanical flying apparatus amounts to 90 kilograms, 198 pounds, in order to sail like an albatross a man would require 90,000 times 30, or 2,700,000 square millimeters of wing surface; that is to say, two wings furnishing together 2.7 square meters, 20 square feet of surface."

In conclusion it may be stated that the value of such information is entirely dependent upon the drift of experimentation. At present the imitation of the bird is the basis of all activity in this field. That it is a heavy body that readily supports itself in the free air with little effort is obvious. For this reason we must look to air currents for the source of its flotative power, more than its wing effort. But the fact that it springs into the air when it operates its wings—and if a soaring bird, does not stop flapping until it reaches a certain point in the air—shows clearly that the power of a flying machine will only be greatly called upon to raise it into the air to a certain height. At this point the navigator will be required to find an air current to bear his ship, and in particular will be forced to exercise skill to preserve its position in space.

Along these lines, aerial navigation will probably be carried out, when the secret of construction and control are a little better crystalized than at present.

Coals are classified upon the ratios which the volatile materials or hydro-carbons bear to fixed carbon. Anthracite coal is low in volatile material and high in fixed carbon. Soft coals are high in volatile matter and low in carbon. The percentage of coal in volatile hydrocarbons runs as follows:

Anthracite	3.6
Semi-anthracite	6.12
Semi-bituminous	12.18
Bituminous	18.50

The remaining components of the coals are absorbed moisture, fixed carbon and ash. The ash in a first class coal should not be above 8 per cent.

The so-called sulphur springs, those whose waters are of bad taste and odor, are not really sulphur springs, they getting their odor and taste from the hydrogen sulphide contained therein.

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 advertisements 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, 1906.

In this issue will be found a design and description of a 150 watt dynamo, the first of a series of articles by Mr. Ira M. Cushing, E. E. Other sizes of the same design to be described are: 75, 300 and 550 watt; the latter size being especially adapted to a small, isolated house-lighting outfit. In connection with the description of this size will be given full directions for installing and operating the auxilliary instruments necessary to such a plant. Mr. Cushing is also preparing a series of articles on "Elements of Dynamo Design," which will be very complete, and yet without the abundance of mathematical formula generally found in text-books. For that reason they will be of special interest and value to electrical students who have not the advantage of a technical college training. We are confident these articles will interest a large number of our readers.

With either the January or February issue the size and scope of the magazine will be increased by several pages. In this connection we would call attention to the fact that, owing to the size of pages and the type used, the volume of reading matter that is at present being given is fully equal to that of a number of the popular magazines sold at the same price, but which, using larger type and for that reason having more pages of a smaller size, seem to give more matter, while not actually doing so. It is also a fact that technical writers receive a much higher rate of payment than is given for general literary matter, a matter of decided importance to the publisher, although often overlooked by the reader. We feel, therefore, that the magazine, even at present, and especially when increased in size, gives an ample return for the moderate subscription charged. That this is also the view of many of our readers is evidenced by the many complimentary expressions found in our correspondence.

We are constantly learning of some excellent devices or constructive work made by readers, but are not always able to induce the makers to prepare descriptions for publication as quickly as desired. To secure a quick and large response from those who can supply interesting articles, we offer the following liberal prizes for the best descriptions suitable for publication in the magazine: First prize, $25.00; second prize, $15.00, and third prize, $10.00. Other prize offers for special subjects will be offered later, but this one will be open to all classes of workers. For acceptable articles received, but which are not awarded a prize, regular space rates will be paid. All articles intended for this competition must be received not later than Dec. 20, 1906. The right is reserved to withhold any or all of the prizes should the articles offered not be deemed of sufficient merit to entitle them to prizes, calculated on the basis of double regular space rates. Articles, to be acceptable, must describe how to make something which would be of interest to a reasonable number of readers. All accepted articles to be the sole property of the magazine. Here is a chance to secure your Christmas presents if you set about it promptly.

A remarkable achievement in wireless telegraphy is reported in the Navy Department from the Pensacola station. This plant has been able to keep in constant communication with the United Fruit Company's steamer Preston from the time that vessel left New York until it arrived at Honduras. The station also received messages from the Preston while she was entering New York harbor, where she was undoubtedly bathed in electric waves from other stations and ships. A curious fact is that the Pensacola station has not been able to repeat this performance with any other steamer than the Preston, notwithstanding the fact that the plants are alike on all of the United Fruit liners.

Fuller's earth consists of clay mixed with just enough fine silicious material to take away the plastic properties, so that it disintegrates into powder mixed with water.

CONSTRUCTION AND MANAGEMENT OF GASOLINE ENGINES.

CARL H. CLARK.

VII. Spark Coils—Wiring Diagrams.

COILS.

Coils for use with gasoline or gas engines are of two kinds, the plain coil illustrated in Fig. 40, and the induction coil shown in Fig. 41. The former is used in connection with the make and break ignition, and the latter with the jump spark system.

The plain coil shown in Fig. 40, consists of a core or bundle of soft iron wires *C*, surrounded with a coil, *W*, of rather coarse wire. While only one layer is shown, there are in reality several layers, one over another.

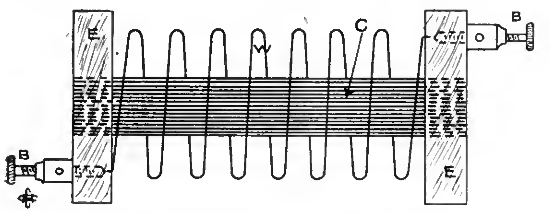


FIG. 40.

The ends, *E E*, are of wood, and hold the binding posts, *B B*, to which the ends of the coil of wire *W* are fastened. The complete spark coil will thus be seen to consist simply of a continuous coil of wire surrounding the iron core. The coil is introduced into the battery circuit, and the current simply passes through it. As to the electrical action of the coil, it will be sufficient to say that the passing of the current around the iron core greatly intensifies the spark at the breaking of the circuit.

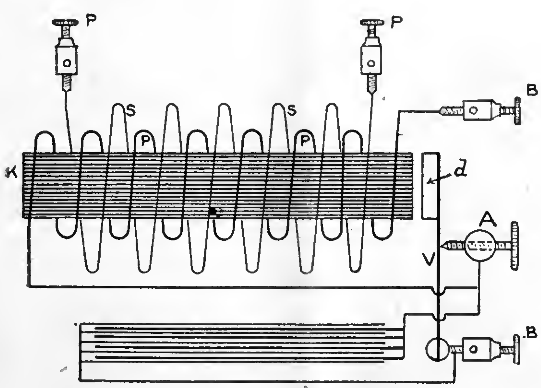


FIG. 41.

Fig. 41 shows a diagram of a jump spark or induction coil. This coil is quite similar in principle to the ordinary induction or medical coil. It consists of a core of soft iron wire, surrounded by a primary winding, *P*, made up of two or three layers of coarse wire. Outside of this winding, and thoroughly insulated from it, is the secondary winding *S*, made up of many turns of very fine wire. Each time that the current is made or broken in the primary coil a corresponding current tends to flow in the secondary. If, then, the terminals of the secondary coil are connected to a spark plug, a spark will pass each time the circuit is made or broken in the primary. The terminals of the primary coil are connected to the binding posts *B B*, and those of the secondary to the posts, *P P*. During action of the coil, the iron core is alternately magne-

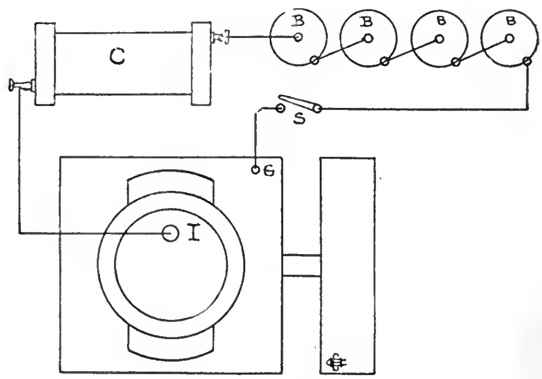


FIG. 42.

tized and demagnetized by the passage of the primary current. The vibrator spring *V* is fastened at its lower end, and on its upper end carries the iron disc *d*, which stands opposite to and a short distance away from the end of the iron core. The vibrator adjusting screw *A* bears against the vibrator *V*. One terminal of the primary is connected to the adjusting screw *A*, and the stationary end of the vibrator is electrically connected to one of the binding posts, *B*. If, then, the battery terminals are connected to the posts *B B*, a continuous circuit is formed through the vibrator spring, adjusting screw and primary coil, allowing the current to flow through the primary coil, and by induction setting up a current through the secondary coil.

The flowing of the current around the iron core magnetizes it and causes it to attract the iron disc or armature *d*, thus drawing the vibrator out of contact with the adjusting screw *A* and breaking the circuit, causing a current to pass through the secondary in the opposite direction. The breaking of the primary current also causes the demagnetization of the iron core, releasing the disc *d* and allowing the vibrator to spring back into contact with the screw *A*, again completing the primary circuit and allowing the previous action to be repeated. This automatic interruption of the primary circuit, which is extremely rapid, causes a series of alternating currents to pass through the sec-

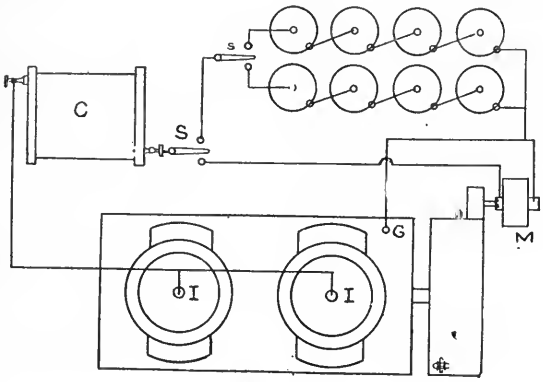


FIG. 43.

ondary, and if the spark plug is connected to the terminals *P P*, a rapid series of sparks will pass. Owing to certain electrical effects, the current passing the secondary coil when the primary circuit is completed, or at the "make," is not as strong as that which passes when the primary circuit is broken, and it is the sparks caused by the latter which is visible in action.

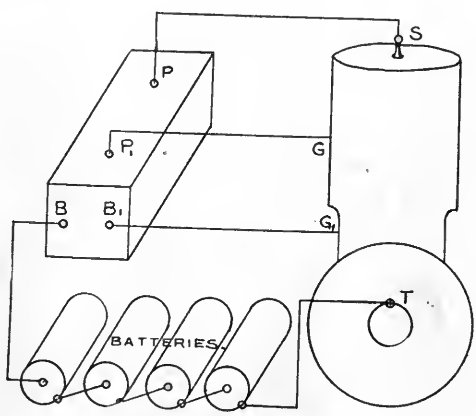


FIG. 44.

The current in the primary circuit is of small voltage and of relatively larger volume, while that in the secondary is of extremely high voltage and of small volume. The relative proportions of the two are regulated by the size and amount of the wire in the two coils.

A condenser is shown at *C*, consisting of layers of tin foil, insulated from each other, alternate sheets of which are connected to two terminals, which terminals are connected, as shown, with the vibrator screw and the terminal *B*. The electrical action of the condenser need not be dwelt upon here, except to say that it greatly intensifies the spark at the "break." The entire coil is enclosed in a box with only the binding posts and vibrator in sight.

BATTERIES.

The ordinary form of dry battery or some form of liquid battery may be used, as desired. The latter are supposed to be more reliable than the former, and certainly do cost less in the long run. Dry batteries are, however, much less troublesome to handle, are more convenient, and may be depended upon with a reasonable degree of certainty if well taken care of. It is always advisable to fit batteries in duplicate sets, either of which may be used

On an engine of any considerable size, batteries should not be depended upon for continuous running, but a magneto should be used except for starting, allowing the batteries to retain their strength. A double throw switch serves to throw in or out either battery or magneto. Batteries are connected in series, the zinc of one cell with the carbon of the next, and so on.

ACCUMULATORS.

Storage batteries may be used, but are as yet little used in marine work. They are especially useful where a miniature lamp or two is desired, to facilitate handling the boat at night, as when coming to a mooring, as the lighting circuit can be taken from the same battery that is used for sparking the engine.

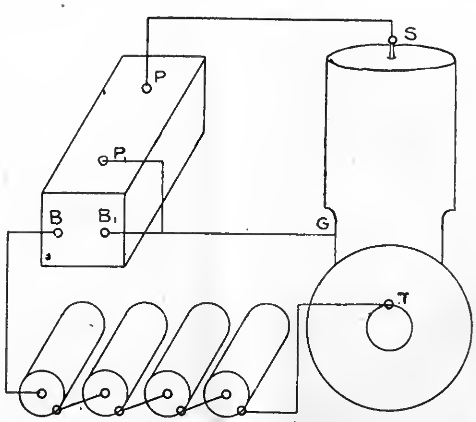


FIG. 46.

MAGNETO.

This is a small dynamo electric machine used to give electric machines wound to give an alternating current; it is run from the flywheel by means of a belt or friction wheel. A magneto should be used for steady running, and should be wired so that it may be switched into the circuit after the engine has been started on the batteries. They are comparatively inexpensive, and their use will effect a considerable saving in battery expense in a boat used very frequently.

WIRING.

Fig. 42 shows the simple wiring for a single cylinder, make and break spark. The batteries *B* are connected in series, as before stated; one terminal from the batteries is wired to one terminal of the spark coil *C*; the other terminal of the coil is connected to the insulated electrodes of the igniting gear. The other battery terminal is fastened to or "grounded" on the metal of the engine. The circuit is thus complete, and may be made and broken by the sparking gear as before described. A switch, *S*, is inserted to open the circuit and prevent waste of batteries.

When duplicate sets of batteries are used the connections are as shown in Fig. 43, a three point switch *s* allowing the use of either set.

When a magneto is used in addition to the batteries, one terminal of the magneto is connected to the ground-wire *G*, and the other terminal to a three point switch, *S*. allowing the use of either magneto or batteries.

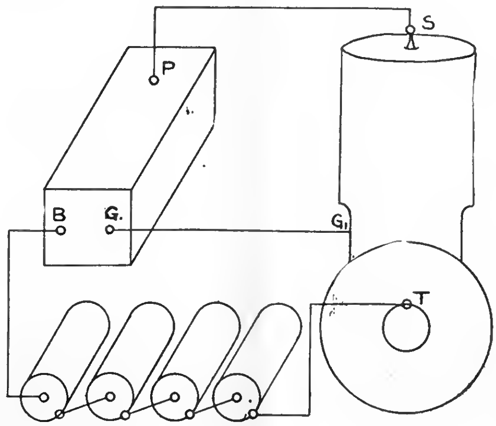


FIG. 46.

The typical connection for a jump spark coil to a single cylinder engine is shown in Fig. 44. The coil is represented at *C* with the binding posts *P P*, *B B*, as before; *T* is the insulated electrode of the timer, and *S* is the spark plug. *G* is the "ground" or connection to the metal of the engine. The batteries are connected in series, as shown; from one battery terminal a wire is run to the timer, and the other terminal is connected to one of the primary posts, *B*. From the other post *B* a wire is led to the ground *G*. It is evident that the primary circuit is complete except as made or broken by the timer.

One of the posts *P* is connected to the spark plug, and the other to the ground, thus making a circuit for the secondary except at the spark gap where it jumps. It will be plain that whenever the connection is made or broken by the timer *T* a spark, or series of sparks, will take place at the plug *S* igniting the charge.

It will be noted that there are two ground wires, one leading from each of the posts *P* and *B*; these two wires may be replaced by a single wire when the connections are as in Fig. 45, which might be taken as the standard wiring for a four terminal coil.

Since the posts *P'* and *B'* are connected, it is becoming the practice to connect them inside of the coil box and thus dispense with the post P_1, making a three terminal coil, as shown in Fig. 46, which also shows the connections, which are practically the same as in Fig. 45. In Fig. 47 is shown the additional wiring for two sets of batteries and a dynamo.

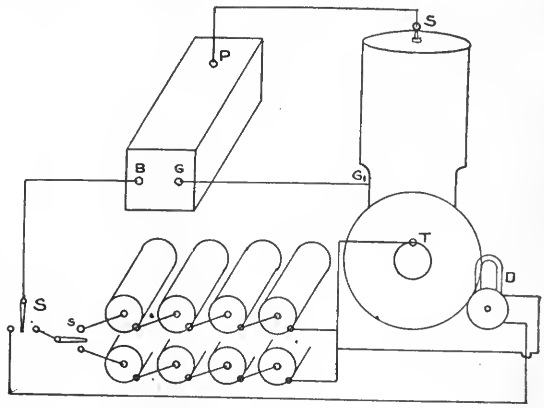


FIG. 47.

In certain cases, also, a single coil may be used for a double cylinder engine. These are principally in cases of the double opposed type, or in the four cycle type with the pistons moving together. The connections then are as in Fig. 48, using a double pointed cam with a single terminal, giving two contacts for

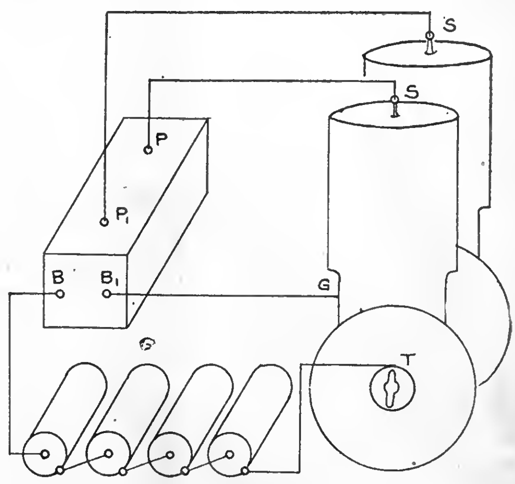


FIG. 48.

each revolution. The usual practice is, however, to use one coil for each cylinder, as in Fig. 49, the general connections being similar to Fig.46. Three terminal coils are shown, but if four-terminal coils are used. one of the secondaries is connected over to one of the primaries, as shown by the dotted lines, in a manner similar to that of Fig. 45; there are two insulated posts on the timer, one for each cylinder.

It is customary for multi-cylinder engines to combine all the coils into one box for compactness and simplicity. A common form of duplex coil with con-

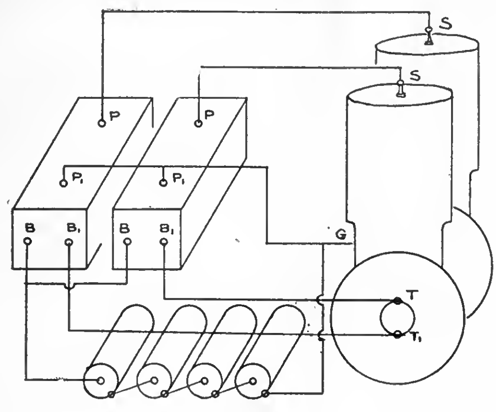


FIG. 49.

nections is shown in Fig. 50, which should be sufficiently plain without further explanation. Another, and perhaps more usual form of duplex coil, is illustrated in Fig. 51, some of the connections being made inside of the box; this sketch again is self explanatory.

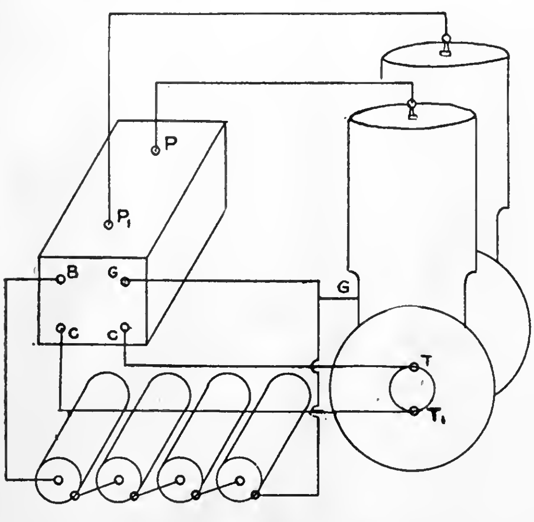


FIG. 50.

These sketches can, of course, show only the connections of the most common forms of coils. Coils are usually accompanied by wiring diagrams showing the connections for different conditions but with the above in mind no difficulty should be experienced. In any of the above diagrams the extra connections for the additional set of batteries or the dynamos may be easily added by following the principle of Fig. 47.

A device for distributing the secondary current is called a "distributor." It requires the use of only one coil as the secondary current is taken from the coil and sent to each cylinder in turn. In appearance and principle it is like the ordinary timer, in fact both timer and secondary distributor are contained in the same case. The principle is illustrated by Fig. 52 where *T* is the primary circuit breaker consisting of a cam having as many projections as there are cylinders; these projections rub past the insulated contact piece *C* and thus make and break the primary

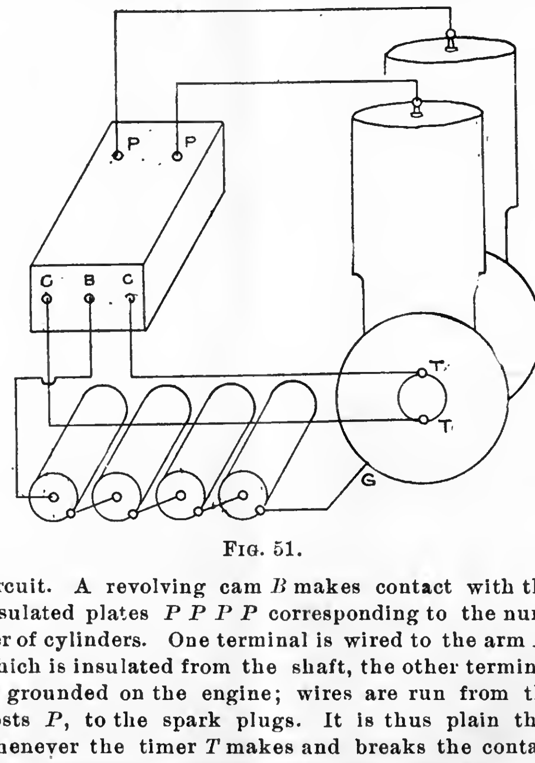


FIG. 51.

circuit. A revolving cam *B* makes contact with the insulated plates *P P P P* corresponding to the number of cylinders. One terminal is wired to the arm *D*, which is insulated from the shaft, the other terminal is grounded on the engine; wires are run from the posts *P*, to the spark plugs. It is thus plain that whenever the timer *T* makes and breaks the contact with *C* the arm *D* will be in the proper position to deliver the secondary current to the proper plug.

The question as to the use of one or the other systems must be a question of the individual conditions; the make and break system is very simple from the electrical standpoint, as the wiring is simple and only low tension current is dealt with. The igniting gear, on the other hand, is apt to be rather complicated, with many small parts which wear and become noisy. This system is well suited to working boats, which are likely to receive little care, and to others where the whole outfit is liable to be exposed to the weather. For extreme high speed the igniting gear is apt to be somewhat erratic, as the springs do not act quickly enough to operate between strokes and it is certainly very noisy at high speed even when in good condition. The cleaning of the sparking points is also likely to be a considerable nuisance, as they are seldom so arranged as to be easily gotten at.

The jump spark system makes possible a very simple engine, as the only parts required for the ignition are the timer and plug. The engine is free from all ignition gear requiring oiling and care, trouble in the system is usually easily located and remedied; trouble at the sparking points is easily overcome by replacing the plug with another and cleaning up the first at leisure; the timer, also, is easily gotten at and simple.

On the other hand, the wiring is rather more complicated and must be most carefully done; the current in the secondary wires is, as before stated, of a very high voltage, and special insulation must be used to prevent leakage. The secondary wiring and coil

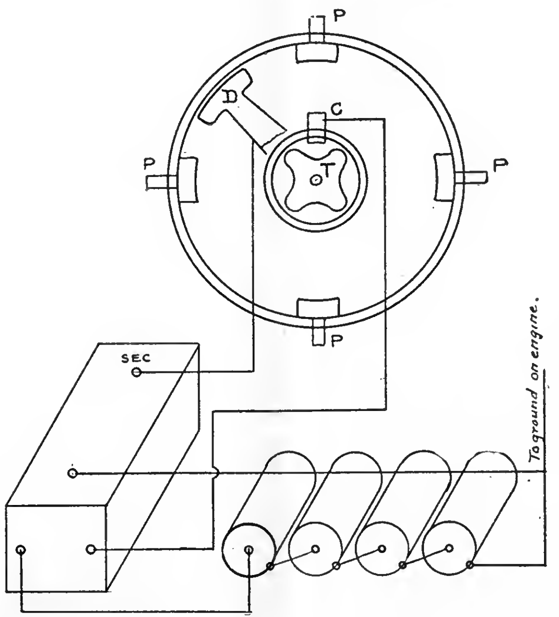


Fig. 52.

must be protected from rain or spray, as moisture is sure to cause a short circuit. It is also quite uncomfortable if the current becomes short circuited through any part of the person. With care, however, these points may easily be guarded against and the jump spark system becomes very simple and satisfactory. The outfit of coils and timer is, of course, more expensive than the outfit for the make and break system, but these parts are durable and permanent, and the cost of the complicated igniting gear is saved so that when the complete outfit of engine and accessories is purchased the slight additional cost is not felt. For cabin boats where the machinery is protected from moisture the jump spark is particularly well suited, and there is no reason why it may not be used if desired in almost any circumstances. The secondary coil must, of course, be protected from spray and rain, but this can easily be done by stowing the coil in a convenient locker or box, and in the case of a shower a piece of canvas may be thrown over engine and wiring.

Distributers are as yet little used and are fitted for engines of four or more cylinders where the wiring would be more complicated; for small engines their use would not be advised at present.

SOLDERING PASTE.

Soldering paste has come into extensive use in electrical work as a flux for soldering, says the "Brass World." This has been brought about by the requirements of the electrical trade that in certain forms of soldering no acid shall be used. For soldering copper wires for electrical conductors, soldering paste is almost exclusively used. It has also entered other fields of soldering, particularly in instances where spattering and corrosion are objectionable.

Soldering paste which is now used in the electrical trades consists of a mixture of a grease and chloride of zinc. The grease which is commonly used is a petroleum residue such as vasaline or petrolatum. Such a material is about right in consistency. The proportions which are used are as follows:

Petrolatum	1 lb.
Saturate Solution Chloride of Zinc	1 fluid oz.

The use of petrolatum instead of vasaline is recommended. While they are identical in composition, the name "vasaline" is registered as a trade-mark and commands a higher price on this account. Petrolatum is much cheaper.

The chloride of zinc solution is made by dissolving as much zinc in strong muriatic acid as it will take up. An excess of zinc should be present and all the acid neutralized. This will form a thick, oily solution. The petrolatum and chloride of zinc are mixed and thoroughly incorporated by means of a mortar and pestle, or by vigorous stirring. The advantage of this soldering paste lies in the fact that it does not spatter and is not corrosive.

The chemical composition and character of crude petroleum oils vary greatly in the different localities where the oils are found. They are all complex hydrocarbon compounds. The more carbon they contain the greater their specific gravity and the higher the temperature required to evaporate them. The petroleums of Russia belong generally to what is known as the naphthene series. Those of Pennsylvania, Ohio, Colorado and Wyoming have a paraffine base, and those of California and Texas have an asphalt base.

The only commercially successful method of producing aluminum is by electrolysis, and all attempts at making aluminum in the electric furnace by reduction of aluminum with carbon have been unsuccessful. Although it is possible to prepare alloys of aluminum by reduction of the oxide by carbon in presence of such metals as copper and iron, yet when it is attempted to obtain the pure metal by direct reduction, the product is almost exclusively aluminum carbide.

ELECTRICAL EQUIPMENT OF A WAYSIDE INN.

W. A. WAKEMAN.

While on a short trip into the country some time ago, I stopped at a wayside inn, and seeing evidence of an electric equipment, I found the engineer and expressed a desire to see his plant. He proceeded to show it and explain its details in a way that made it appear as a pleasure to him, and certainly was a source of satisfaction to myself. Although the plant is not large it is one of the most complete that I have ever seen, and on account of the precautions taken to prevent interruption of the service, it is well worth a complete description in order that others may profit by the foresight herewith displayed.

Fig. 1 is a plan of the plant and is explained as follows:

A horizontal tubular boiler of about 50 horse power is shown at 2, furnishing steam for an old-fashioned automatic cut-off steam engine, 3 having a cylinder about 10 x 30 inches. The fly-wheel of this engine is belted to the main pulley 4, which is on a shaft overhead in the room, and it was located high enough to be well out of the way.

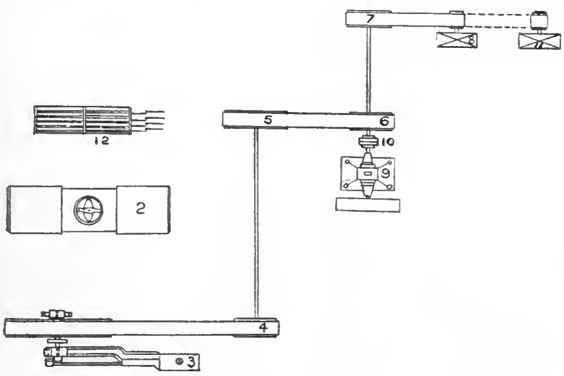


FIG. 1.

On the other end of this shaft there is a larger pulley 5 on which is a belt that drives a smaller pulley, 6, thus increasing the speed of the second shaft, which is only about 7 feet above the floor, and is supported on floor stands in the usual way. This shaft carries another pulley 7, which is belted to a dynamo 8, which supplies current at 110 volts to lamps in all parts of the main building, also in several smaller structures and for a beautiful lawn.

The above description covers the plant as run under normal conditions. As the engine runs at a slow speed with three belts between it and the dynamo, it cannot be considered up-to-date and it is not illustrated for this purpose, but it supplies light that is satisfactory for this particular place, and the whole plant was installed at a very low cost.

A vertical high speed engine is shown at 9 and on the outer end of its crank shaft there is one-half of a coupling, 10, and the other half is on the counter-shaft. There are no bolts in this coupling, therefore the shaft is free to revolve while the engine remains at rest under normal conditions, but if the larger engine should be disabled from any cause, the belt on 6 would be thrown off, bolts put in 10, and the engine, 9, started without delay, thus continuing the service.

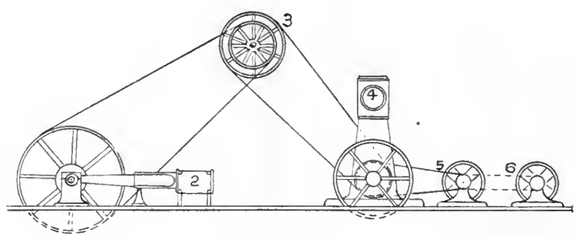


FIG. 2.

This inn was a well and favorably known resort long before trolley lines came into existence, but now a 550-volt system is in operation, a few rods from the house, and from this, a reserve or "break down" service is secured as follows: In case both engines, 3 and 9 are disabled, or if the boiler 2 should be thrown out of commission so that steam could not be supplied to either engine, the belt on 8 would be thrown off. A 550-volt motor is shown at 11, taking current from the street service, as above mentioned. The belt in dotted lines would be put on, thus making it possible to drive the dynamo 8 by the motor 11.

Current is not taken direct from the street service and used for lighting purposes on account of the difference in voltage, as the former is 550 while the latter is 110. Of course it could be done by wiring five 110 volt lamps in series; but that is not best practice, because if one of these lamps should burn out it would disable four more. Another reason for this arrangement is that it is always desirable to keep the voltage as low as possible, and as the distance over which current is carried in this case is short, there is no need of a high tension.

Although we usually think of a rotary transformer as a compact machine without belts, as both motor and dynamo are on one shaft, still a consideration of this outfit shows that the dynamo 8 taken in connection with the motor 11 with a belt connecting them, constitutes a rotary transformer for a direct current, reducing it from 550 to 110 volts.

A storage battery is shown at 12 that is charged during the day for use in an emergency at night, therefore if both engines 3 and 9 were disabled and the trolley service cut off from 11, the lights could still be supplied for one evening from this storage battery.

Fig. 2 still further illustrates this plant, as it is an elevation of it, in which 2 is the slow speed engine belted to the main shaft 3 from which a belt is carried down to shaft near the floor that can be coupled to the vertical high speed engine 4 whenever it is wanted to drive the dynamo 5. The motor is shown at 6 with the belt to be used in emergencies in dotted lines.

As the trolley line above mentioned is several miles long, there is more or less danger of lightning striking it and following the wires into this plant, especially as a portion of the trolley line extends over a mountain. To prevent accidents from this source a lightning arrester was installed at the inn. A few days previous to the time that I saw it lightning did come in over the line, and it did not leave enough of that arrester to make decent scrap. Instead of providing a more efficient arrester they simply connected the two ends of the line together and concluded it was just as well to get along without anything of the kind.

This appears to be a wrong idea, as it is about the same as running a boiler without a safety valve. It will do no harm so long as only a low pressure is carried, but nobody knows how soon a high pressure will be generated, proving disastrous. We are told that lightning does not strike twice in the same place, but this is not strictly true, and if it was it would not prove a safeguard to this place, because the line might be struck several miles distant and current at a very high tension carried into the inn and cause a disastrous fire.

An elevated tank is provided at this place from which a supply of water under pressure is available. A low service direct acting steam pump is provided for filling this tank. In addition to this, the regular boiler feed pump is piped so that by opening and closing certain valves, it can discharge into the tank in case the low service pump fails.

If both of these pumps are disabled or there is no steam by which to operate them, a hot air pumping engine is installed so that it can be used for this service, and this, of course, is entirely independent of all other sources of power. A wind mill is used for filling this tank when a brisk breeze is blowing.

The buildings comprising this establishment are heated by steam and the water of condensation flows into a receiver from which it is taken by a pump in the usual way, and pumped into the boiler. As there is always at least a slight loss of water in such cases, arrangements are made whereby fresh water can be turned directly into this receiver, thus making this pump a complete boiler feeder independently of the regular cold water pump.

When the receiver pump is out of order, hot water from the drip pipe is allowed to run to waste temporarily, while fresh water is pumped in by the regular boiler feeder, thus providing two ways of feeding the boiler.

The foregoing description is not intended to convey the idea that the machinery in this plant is more liable to be disabled than that installed in other places, but it is expected to illustrate the good judgment shown in designing the plant to prevent accidents that will interfere with the continuous service expected, and in this respect it is far superior to some more pretentious plants that are found in cities, where everything is supposed to be almost or quite perfect. —"National Engineering."

SILVER SOLDER.

For a brazing solder, no other alloy can approach silver solder. It has the advantage of a low melting point, together with toughness, qualities not possessed by the brazing brasses composed of copper and zinc. Such brasses must be high in spelter in order to obtain the necessarily low melting point and they are, therefore, hard and brittle. They do not "flush" as well as silver solder nor give as clean a joint. The melting point of silver is lower than that of copper and as it does not oxidize when heated it is admirably adapted for use in brazing solders. Its cost is the only thing in its disfavor.

The old, time-honored silver solder mixture which is the one so extensively used, consists of:

Fine Silver	2 parts
Pin-Brass	1 part

Pin-brass is supposed to consist of 2 parts copper and 1 part of zinc. As it is difficult to obtain brass scrap that is free from lead, the use of copper and spelter is recommended. The mixeure consists of:

Fine Silver	6 oz. or 66.66 per cent.
Copper	2 oz. or 22.22 " "
Zinc	1 oz. or 11.12 " "

This mixture is called "common silver solder." It answers for the majority of purposes.

A cheap silver is now sold on the market which gives good results in many operations. It contains less silver than the previous formula. The mixture is as follows:

Fine Silver	3 oz. or 50.00 per cent
Copper	2 oz. or 33.33 " "
Zinc	1 oz. or 16.67 " "

The first mixture has a whiter color than the second. The color of the first mixture is slightly yellow and particularly so when tarnished. Both mixtures roll sheet well or draw into wire.—"The Brass World."

It is said that one of the best and healthiest trades in the world is that of dye-making from coal tar. Tar and the smell of it is the best of all tonics and tissnebuilders. The average life of a tar worker is eighty-six years. The mortality is 30 per cent lower than in any other factory trade.

MAGNESIUM AND ITS USES.

Two properties render magnesium a valuable metal: First, its lightness. It has even a less specific gravity than aluminum. Second, its affinity for oxygen. This fact renders it of great value in deoxidizing other metals.

Magnesium is made in the same manner as aluminum by means of the electric furnace. Chloride of magnesium is produced. The discovery of magnesium is due to Sir Humphey Davy, but Bussy, in 1830, first obtained it in the coherent condition. The price was then very high and it is only recently that the price has been reduced so that it can be economically used in the arts. Only a few years ago the price was over $5.00 per pound.

Magnesium belongs to the zinc family of metals. Zinc, cadmium, magnesium, and beryllium constitute this group, as they are quite similar in their properties. For example, magnesium burns in the air like zinc, and with the formation of the oxide.

In color magnesium is much whiter than aluminum and has more of a silvery lustre. The specific gravity of aluminum is 2.56 and magnesium is 1.75. It will be seen, therefore, that magnesium is much lighter than aluminum. This very fact renders magnesium of much value in the manufacture of aluminum and magnesium alloys. Such alloys are lighter than aluminum, and are strong and stiff. There is no other metal that can be added to aluminum to harden it except magnesinm which will not increase its specific gravity.

For light alloys, magnesium opens up an entirely new field, and as alloys, lighter than aluminum and equalling brass in strength, can be made from a mixture of aluminum and magnesium, many new uses will be found for them.

The fact that magnesium has more affinity for oxygen than any other metal renders it the strongest deoxident. It is the only deoxidizing agent that will decompose carbon monoxide when it is present in a melted metal. It entirely eliminates all gases from a molten metal, therefore, and sound castings result. In this direction it will accomplish results impossible with other deoxidizing agents.

Magnesium has such an enormous affinity for oxygen that when in a finely divided condition, it will burn with the formation of an intense light. This property has brought about its use in flash light powders used in photography.

A popular belief exists that, inasmuch as magnesium in the form of powder will burn, that large masses will likewise burn easily. This is not so and a large mass of magnesium, such as the commercial sticks cannot be made to burn any more than zinc under similar condition. It is only the finely divided material that is combustible. In a flash light powder it is not the magnesium itself that is explosive, but the mixture of the magnesium powder and chlorate of potash. Magnesium itself, either in powder or masses, is not dangerous to use.

Heretofore, many failures in the use of magnesium occurred on account of the impurity of the commercial magnesium that was on the market. Much of the magnesium contained sodium, silicon, and other impurities, which interfered with some of its uses. It is possible at the present time, however, to obtain magnesium of great purity and in an easy form to use. It is now sold in the shape of sticks about half an inch square and a foot long. These sticks have been sawed out of a solid block and are very covenient to use.

The difficulty which has been experienced heretofore in using magnesium as a deoxidant has been in the use of too great a quantity. Only enough should be added to reduce the oxide and gases that are present. The addition of several per cent. of magnesium as frequently recommended, is not conducive to good results. The large excess of magnesium in copper, for example, renders the casting dirty. The quantity of magnesium to be added is usually about 2 oz. of magnesium to 100 pounds of metal. Frequently less will do the work and give better castings. — "The Brass World."

The first vessel to navigate the great lakes was the "Griffon," built by La Salle and his party in 1679, near the site of the present city of Buffalo, on Lake Erie. The "Griffon" was about 50 tons burden, and and carried La Salle with 34 men and five guns safely from the point where she was built to Mackinac, and thence to Green Bay. She started to return with a cargo of furs in the following year, but was lost, probably on Lake Huron. From the 50-ton "Griffon" to the 7500-ton iron ore carrier of today is a long step.

Engraved diamonds show some very beautiful effects. It is reported that a French jeweller, Bordinet, has invented tools for diamond engraving, and it is said that only his son is permitted to use them. Among the surprising things produced is a diamond cut in the form of a ring, polished on the inside, and covered with delicate engraving on the upper surface. Another is an engraved diamond fish. Diamonds are also engraved with armorial bearings.

Quartz crystals, unless large and without flaws, are of but little value as cabinet specimens. Fine, large, clear crystals or twin crystals are valued, particularly the latter. Twin crystals of quartz, when perfect, bring high figures, $100 or more having been known to be paid for superb quartz crystals from Japan.

A SEWING STAND.

W. E. SHEPLEIGH.

The sewing stand here described is one that was redesigned from a Japanese table, simplified to permit of more easy construction. The original from which it was taken was an extremely useful piece of furniture, but which from long usage reached that dilapidated condition which forbade further repairs, hence a successor was needed, the design of which is shown in the drawing.

The wood used for its construction was mahogany or, more correctly, Mexican baywood, which is so commonly passed off to the novice as mahogany. In this case, however, the less valuable wood is the best to use, owing to the straight grain and easier cutting.

The drawing shows pretty clearly the design and construction, and the work is of such simple character, so that anyone having a fair degree of skill with woodworking tools may turn out a very presentable piece of work.

The legs are 29 in. long and 1¼ in. square. The top is 16 in. long, 14 in. wide and ⅝ in. thick. It would be advisable to fit cleats 2 in. wide and ⅝ in. thick to the ends, to prevent warping, although these are not shown. If the top is glued up from three or four narrow pieces, the cleats will not be necessary.

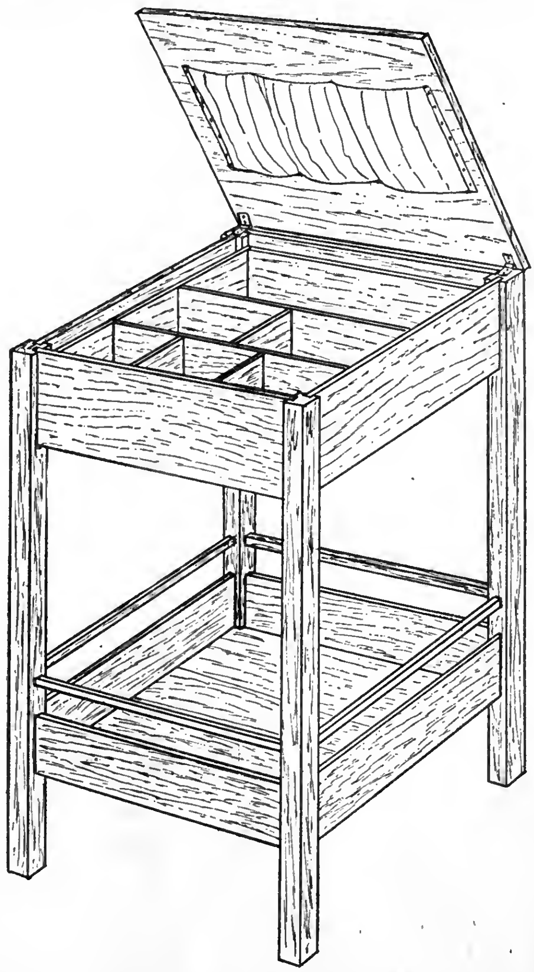
The ends of the top tray are 12 in. long, which allows ½ in. on each end for tenons; they are 6 in. wide and ½ in. thick. The sides are 14 in. long. These lengths are also those for the lower tray, the pieces for which are 4 in. wide and for the rods above it, which are ⅝ in. wide, and are 1 in. above the upper edges of the pieces below, which are 6 in. above the floor.

These dimensions will permit laying out the stock and cutting all the mortises in the posts, which should be very carefully done.

The bottoms for both upper and lower trays are 13¼ x 11¼ in. and ½ in. thick. The corners are cut out to fit around the posts, and they are nailed in place with 1¼ in. wire nails of small wire and heads, after all parts have been fitted and assembled.

The movable tray in the upper part can be replaced with simply the partitions, or it may be made as a separate fixture, as shown. In this case the sides are 12½ and 9¾ in. long, 4½ in. wide and ⅜ in. thick, provided cloth pockets are desired on the top, or may be 5½ in. wide, if without the pockets. The partitions are made of pieces ¼ in. thick, the center cross one having finger holes cut about 1 in. from the top for lifting in and out. The arrangement of the divisions shown is a good one, but can be varied to suit the fancy of the builder. The bottom of the movable tray is 11¾ x 9¾ x ¼ in., the width of the partitions being ½ in. less than as given for the sides.

The cloth pockets are made of cretonne or similar material, tacked to the top with upholstering tacks at the ends and bottom. The upper edge is fitted with elastic, tacked at the ends and at the divisions, which



are also made with tacks. The hinges are fitted to the ends of the posts, with the pins flush with the rear edge, which permits the top to be lifted to a vertical position without going further backward.

A factor of safety for a laced belt is one-sixth its breaking weight for leather, and one-eighth for rubber. A belt traveling 3500 feet per minute will require a tension of but 9.5 pounds for each inch in width, in order to transmit one horse-power, and one having a width of 100, divided by 9.5, equalling 40.5 inches, will transmit 100 h. p.

A PAIR OF STEPS.

The steps shown complete in Fig. 3 are most useful and at the same time most durable, notwitstanding the various other kinds which have been introduced of late years, the sole merit of which, as a rule consists in novelty.

The full height of those shown is four feet six inches, which is sufficient for all requirements in the average house, but if anyone wishes for higher steps, the sizes of the timber given hereafter will be ample for anything up to ten steps, or seven and a half feet high.

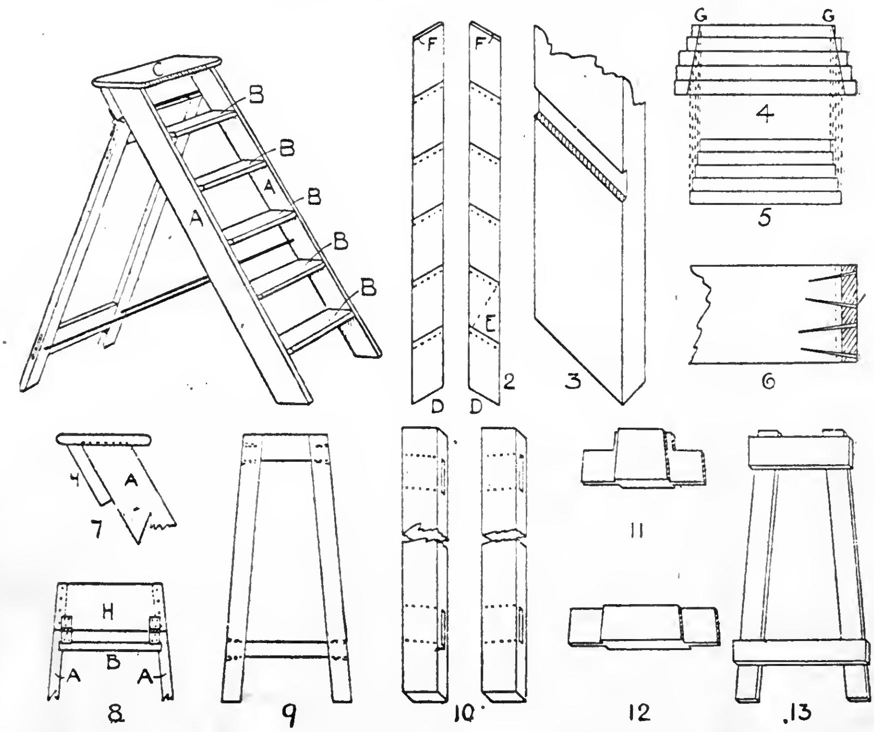
The principal portion of the steps consists of the two sides *A*, the steps *B*, and tbe top *C*. The sides should be about four inches wide by an inch thick, the steps the same thickness, by about five inches wide, and the top about eight inches wide.

The setting out of the sides is the most important part, it being necessary to make the trenches in which the treads fit at such an angle that they will be level when the steps are open. The angle shown is a very suitable one, and it can be taken from the drawing.

To set out, lay the two sides flat on the bench, as in Fig. 2, and first striking the bottom level at *D*. Measure up from this, and strike the next one, and so on, till the top is reached. These lines represent the treads (or steps), and the thickness of these must be taken downwards, as per dotted lines, the trench being formed by cutting away the wood between.

In measuring from step to step the rule must be held at right angles to the lines, as dotted line *E*, the distance from top to top being nine inches. At the extreme top the thickness of the top board *C* must be taken off the length, which gives the line *F*, and to this must be added the quarter of an inch as shown, being to fit into trenches made in the top to receive them. The sides must be trenched to a uniform depth of a quarter of an inch, as in Fig. 3, taking particular care not to cut deeper, or the sides will be weakened.

We now come to the steps (treads) which, owing to the top of the steps being narrower than the bottom, have all to be of different lengths. A suitable width is fifteen inches at the bottom. and twelve inches at the top. To ascertain the length of the various treads required, lay them all on edge, as in Fig. 4, and set off the above dimensions on the top and bottom, connecting these points by two bevelled lines, as *G*. Then square off each tread from these lines, the result being as Fig. 5.



In theory the end of each tread should be cut off slightly, but the angle required is so near a right angle that it is not worth troubling about, the nailing in of the treads making them fit in a satisfactory manner.

It is often recommended that one or more of the treads be tenoned through the sides, but this is not necessary. Nailing will hold them quite firmly, provided that the nails are driven in at various angles, as in Fig. 6, which causes the nails to hold one against the other, so that to get the sides off the nails must be bent, requiring great force.

The sides being nailed to the treads, the top must next be put on, the position of the trenches in same being found by placing it on the sides and marking round them.

The back piece *H* is nailed to both sides and top, and should be about six inches wide, finishing off level with the sides as shown in Figs. 7 and 8.

The back legs of the steps should be made as Fig. 9, the full width is given by the steps themselves, while the length should be about six inches less than the distance from the back piece to the bottom of the sides. Suitable dimensions for the back legs are three inches wide by an inch thick for sides and bottom rail, the top rail being an inch wide.

Fig. 10 shows the two sides mortised ready for putting together, the slope of the mortises being shown by dotted lines, while the top and bottom rails are shown in Figs. 11 and 12 respectively, with tenons cut.

Fig. 13 shows the method of setting out the mortises in the sides and the tenons on the rails. The former are laid flat at the required distance between, at both top and bottom, and the latter are laid on them in their correct position, when it is easy to mark both the mortises and the shoulder lines with a certainty of getting a good fit when cut.

The back legs should be hinged to the back piece with a pair of strong flap hinges, these being shown fixed in Fig 8.

The two cords which prevent the steps opening too wide should be placed as in Fig. 1. They will then hold the back legs firmly, and will not get entangled in the steps when these are closed up. If the cords are fixed there is great strain on the latter, and the steps are never firm, owing to the bending of the sides of the back.

The writer has a pair of steps made as above, which have withstood extremly rough usage for over fifteen years and not a nail has started.

BOOKS RECEIVED.

The American Annual of Photography and Photographic Times Almanac for 1907. 354 pp. 9 x 6 inches. Copiously illustrated. Cloth, $1.25; paper, 75 cents. George Murphy, Sales Agent, New York.

This photographic annual is now too well known to all interested in camera work, to require other than a simple announcement of its publication. As noted by the editor, it has with this volume attained its majority, this being the twenty-first book of the series. As becomes such an auspicious occasion, the contents by well known contributors are of more than usual excellence, and both the amateur and professional will alike find much of value. The numerous illustrations are finely done; the practical end is taken care of by some seventy pages of formulas, making in all a book well worth the price.

Hints and Helps for Young Gardeners. H. D. Hemmenway. 60 pp. 9 x 6 inches. 18 illustrations. Paper, 35 cents. Published by the author at Northhampton, Mass.

This book was written with a view to furnishing a low-priced guide to school and home gardeners. Not only is it suitable for youthful gardeners, but also for those young in experience. It contains just the information required by one desiring to cultivate a small flower or vegetable garden, tells where and how to plant, both indoors and out, as well as the care of plants after planting. It is brim full of directions, clearly expressed.

Practical Lettering. Thomas F. Meinhardt. 15 pp. 14 x 9 inches. Illustrated. Paper, 60 cents. The W. W. Henley Publishing Co., New York.

The author gives special prominence to a mechanical scale for laying out letters and the spacing between them, which enables letters of any size and style to be correctly drawn. The principle having been acquired, this being facilitated by several alphabets of different styles, which are sectioned according to the scale, the worker is able to dispense with much of the scale work and yet accurately draw and space the letters. It is more particularly adapted to sign painters than for draftsmen, and should be very useful to anyone desiring such instruction.

Complete Examination Questions and Answers for Marine and Stationary Engineers. Calvin F. Swingle, M. E. 367 pp,. 7 x 4½ in. 212 illustrations. Flexible leather, $1.50. Frederick J. Drake & Co., Chicago, Ill.

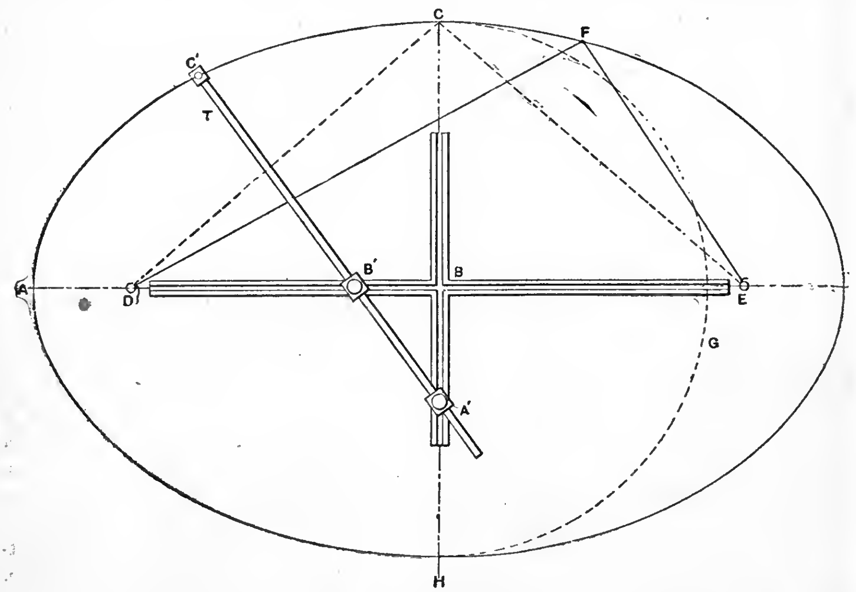
The author imparts his information in the catechetital form through some 800 questions and answers. As the questions are short, although carefully worded, and the answers quite full, the result is an exceedingly instructive book, especially adapted for study without an instructor, and during odd moments of leisure time. In addition to the recipocating type of engine, the turbine receives appropriate mention.

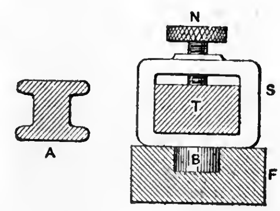
Paraffin softens and becomes very pliable at many degrees below its melting point. It burns with a pure and brilliant white flame when supplied with sufficient air for complete combustion. Candles made entirely of paraffine are not suitable; but by mixing stearic acid or vegetable wax, etc., this defect may be overcome.

One gallon of water weighs 8.33 pounds and contain 231 cubic inches. One cubic foot of water weighs 68.5 pounds and contains 1728 cubic inches or 7.5 gallons. A miner's inch is a flow of water equal to 1.5 cubic feet per minute, or 11.25 gallons per minute.

INSTRUMENT FOR DRAWING AN ELLIPSE.

It may be interesting for some of the readers to know how to draw an ellipse of any size, as well as an egg shaped figure or oval, Fig. 1, similar to the cross section of a sewer, writes W. McD., in "Carpentry and Building." The instrument for doing this consists of two parts, one of which is cross shaped, the pieces being at right angles to each other and having a groove in their top surfaces. The other part of the instrument consists of a beam with two sliding buttons having round pins on the under side to fit into the grooves of the cross piece, also a pencil fixed into a button at the end.





I might mention that I saw this apparatus about 25 years ago in a large horticultural concern where I was designer. The trammel is exactly the same as the beam of a beam compass, with this difference, that it has a circular button to fit into the groove instead of a needle. Again, the beam or trammel of the beam compass is usually I-shaped, as shown at *A* in Fig. 2, but this is flat, as the sleeve *S*, which holds the knob or button, keeps it sufficiently rigid, as indicated in the larger section. The salient feature of the apparatus is not so much the trammel as the grooved cross shaped frame in which it works. The principle could be applied to the generation of a large ellipse by simply having two lines laid off at right angles representing the major and minor axes of the ellipse, and then taking a batten and putting in nails at the length of the half major and half minor axes. Then when the nail representing the minor axis is placed anywhere on the major axis, and the nail representing the major axis is swung around until it rests on the minor axis, then the end of the batten is the point of the ellipse

In order to generate an ellipse make C′ B′ of the diagram equal to C B, which is half the minor axis of the ellipse, and make A′ B′ equal to A B, which is half the major axis of the ellipse. Now place the buttons in the slots or grooves and slide them along so that when B′ moves along the horizontal slot A′ will, simultaneously move along the vertical slot, then C will generate an ellipse.

To generate an ellipse by means of a cord we first draw the major and minor axes and then take half the major axis A B and with C as a center draw an arc bisecting the major axis in D and E. By this means D and E are established as the focii of the ellipse. Place pins at D and E with a cord around them and then stretch it until it comes to C; now with the cord kept taut, generate the ellipse. While this is an easy method of doing the work, the one first described is more exact. For generating a still larger ellipse a wire can be used instead of a cord, as the latter stretches and the whole value of the operation consists in its exactness.

A temperature of –60 to –80° F. is not dangerous to human beings who are properly clothed, if the air is still, while 30 or 40° higher, if accompanied by a gale of wind would kill every living thing before it. Very low temperatures almost invariably coincide with perfect atmospheric quiet.

Tubing of copper, one inch inside diameter of standard thickness, will stand a heat of 700° F.

CORRESPONDENCE.

No. 159. MOOSE LAKE, MINN., Oct. 26, 1906.

Can a Ruhmkoff induction coil be used with a jump-spark gasoline engine with good results, and what should be the rated spark far a small 3-h. p. engine.

C. A. J.

This inquiry is quite fully answered elsewhere in this issue, in the chapter on "Gasoline Engines." The ordinary coil sold for sparking purposes for jump spark ignition should give a fat spark of from ⅜ to ½ in. long when operated with four new dry cells of battery.

No. 160. ASHEBORO, N. C., OCT. 9, 1906.

Is gasoline vapor lighter or heavier than air? Where should the igniter be placed on a vertical gasoline engine. Does the charge of air and gas have to be taken into the cylinder of an engine before it will gnite.

W. C. A.

Gasoline vapor is heavier thon air. Because of this fact the ventilation of boats and shops having engines using this fuel must be carefully attended to. A leaky feed pipe in a boat or building will allow an explosive vapor to accumulate in any enclosed place, and when the odor of such vapor is noticed, no flame should be allowed in the neighbrhood until after a strong current of air has circulated long enough to ensure the absence of danger.

Read the chapters recently published on "Gasoline Engines" for information about igniters.

The power of a gas engine is largely dependent upon the compression of the explosive vapor previous to ignition. Without compression, no useful work could be obtained from an ordinary gas or gasoline engine. Toy gas engines are made which, withont compressing the charge, revolve at a high speed, but develop little or no power.

No. 161. BELMONT, MASS, OCT. 23, 1906.

Will you please give the B. & S. gauge numbers for the primary and secondary wire for the 1½ and 3 in. spark coils described in the October, 1905 number.

I have a standard pony relay wound to a resistance 20 ohms. Would it be suitable for wireless work if rewound for a higher resistance?

What size of wire would be required to give a resistance of about 100 or 125 ohms? J. H. P.

For the primary winding of a 1½ in. spark coil, the No. 16 B. W. G. may be replaced with No. 14 B. & S. G., and for the 3 in. coil the No. 14 B. W. G. with No. 12 B. & S. gauge, these numbers being sufficiently approximate to answer. For the secondary winding use No. 36 B. & S. gauge for general eqperimentnl work, and No. 34 gauge for a coil for wireless work, using about one-quarter more wire and making a larger coil in the latter case.

A "standard" relay is a full size instrument; a pony relay is smaller. Fifty feet of No. 36 copper wire gives 20 ohms resistance, which would have to be replaced with 200 ft. of the same gauge to give 100 ohms or 250 ft. to give 120 ohms. This is the quantity for both coils of the relay, each coil having one-half the wire. No. 38 gauge has 1 ohm resistance for each 1⅝ ft. It will probably be necessary to use single silk covered wire to rewind to the higher resistance, owing to the limited space.

No. 162. MARION, ILL., NOV. 13, 1906.

With an air wire, the top above all obstructions, and using a coherer receiver and a 1-inch spark coil, will a wireless outfit work about 6 miles?

Where can I buy the platinum wire sealed in a tube, as described in the June, '06 number, for use in wireless telegraphy?

Will a 2-inch spark coil operate an X-ray tube successfully? O. L.

The statement has been repeatedly made in this column that no reliable estimate can be made of the distance a wireless outfit will operate successfully. The conditions vary so greatly that actual tests are necessary to determine the capacity and power of such instruments. It is extremely doubtful if the sizes of the instruments you give, have sufficient capacity for even half the distance you state.

You will leave to make up the receiver described in the June, '06, number.

A coil giving a fat 4-inch spark in about the smallest that can used for X-ray work and even with a coil of that size the tube must be a small one. A 6 or 8-inch spark coil is ordinarily used. A 4-inch coil in series with a Tesla coil, will give much better results than the 4-inch eoil alone.

No. 163. MOSGROVE, PA., NOV. 20, 1906

Will you please advise me if there is any danger of lightning coming in over an "aerial" wire of a wireless telegraph outfit and damaging the instruments.

L. O. H.

Every aerial wire should be fitted with a lightning arrester and ground as described in the Nov. '05 number of this magazine. If not so protected the instruments, even if any trace of them could be found after a "burn out" by lightning, would be of no value.

No. 164. CARMINE, TEX. NOV. 16, 1906.

How many feet and what gauge wire is used in winding a 20-ohm telegraph sounder?

How many dry batteries should be used to operate a 1-inch spark coil? R. A.

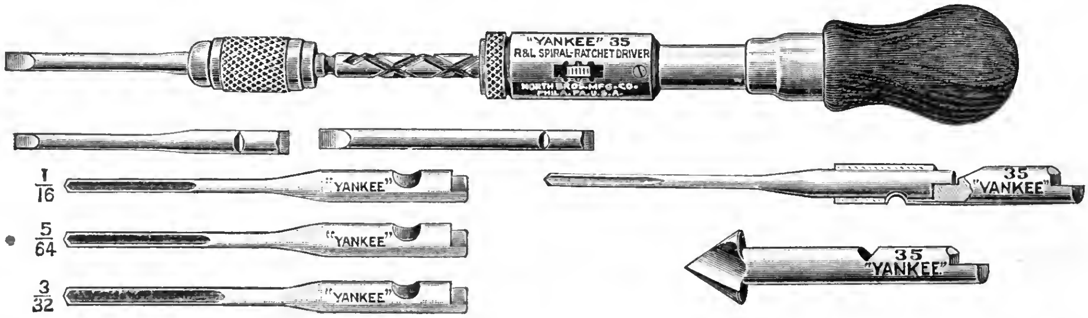
See answer to No. in this 161 column. Five or six dry cells should be sufficient to run a 1-inch spark coil of ordinary construction. With a suitable primary winding as many as eight cells may be used.

Blanks for nickels for coinage cost 14 cents a hundred, and blanks for cents cost 7 3-10 cents a hundred. They are sent to the mint in Philadelphia, where all minor coins are made, and each one is struck with the design that gives to it commercial standing.

TRADE NOTES.

The spiral-ratchet screw driver here illustrated is intended for electrical workers, cabinet makers, carpenters, boat builders and mechanics having a large number of small screws to drive, and where a light weight tool will be more sensitive and convenient than the standard pattern.

It is small enough to be conveniently carried in the pocket, measuring 7 inches long when closed and without bit, and weighs complete less than 7 ounces. It drives screws in or out and holds rigid when closed or extended. The bits are straight, so they can be used to drive screws through holes in insulators, etc., where the flattened pattern of blades, etc., will not pass through holes. It has attachments of chuck for holding drill points and countersink.



That it is an admirable tool is shown by the enormous sale in the short time it has been upon the market, 500 dozen being sold in the first ten days. It is manufactured by North Bros. M'fg. Co., Philadelphia, Pa., who make the popular "Yankee" tools of a similar character.

The attention of readers is called to the advertisements of White, Van Glahn & Co., 5 Chatham Square, New York City, well known hardware dealers, who make a specialty of mail order trade. Located, as they are, in the center of the hardware district of that city, they possess exceptional facilities for filling orders promptly and at lowest market prices. Unlike some mail order houses, they handle goods of the best quality, and anyone purchasing through them may have the fullest confidence that orders will be filled in an entirely satisfactory manner.

The Carpenter foot power motors should receive the attention of mechanics who desire an easy working, powerful drive for small machinery. It possesses a decided advantage over other foot motors in the speed at which it may be run, making it adaptable for many uses not hitherto possible for foot power. Polishers and grinders, small lathes, etc., but indicate a few of the uses to which it may be put. It is substantially made, and sold at a most reasonable price by tho Carpenter M'fg. Co., 30 Oliver Street, Boston, Mass.

Renew your subscription before you forget it.

SCIENCE AND INDUSTRY.

The waters of the Dead Sea contain from 20 to 26 per cent of solid matter in 1000 parts. This includes 7 to 10 per cent of common salt, as much more of magnesian salts and 2½ to 3½ per cent of calcium carbonate and sulphate, also some bromides and alumina.

It is a curious fact that up to 1856 there was no limit on the cent as a legal tender. One might offer ten thousand cents in payment of a debt of one hundred dollars. Since then, however, the cent has been legal tender only up to twenty-five cents.

To clean varnished paint work make up a solution by boiling spent tea leaves in water, and apply this hot with a soft piece of flannel, always rubbing one way. Rub dry with a soft cloth or with clean white waste.

In cutting rubber for gaskets, etc., have a dish of water handy and keep wetting the blade of the knife. It makes the work much easier.

Steel corrodes more readily than common bar or sheet iron under similar conditions, probably due to the finely intermingled atoms of carbon present in the steel.

Gold powder or bronze, is made by grinding gold leaf in a mortar with honey, extracting the honey with hot water and drying the powder. It is used in illumination and miniature painting.

An interesting example of the use of electricity in an emergency occurred recently in Philadelphia. At the Mint a well is being bored which has reached a depth of some 540 feet. A few weeks ago one side of the jar rein of the drill, 18 in. long and weighing 19 pounds, broke off and wedged crosswise in the hole at the bottom. The contractor doing the work fished for ten days trying to recover the broken piece without result. The problem was solved by the construction of an improvised electro-magnet consisting of a piece of steel 5 in. in diameter, on one end of which was wound a coil protected by copper sheathing. Long leads were attached and the apparatus was lowered down the boring. According to the "Electrical Review" of New York, the current, 1¾ amperes at 220 volts, was then turned on, and the magnet was pulled up, bringing with it the broken tool and all the metal particles that were in the well from the boring.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

Vol. VI. No. 3. BOSTON, JANUARY, 1907. One Dollar a Year.

SAW BENCH AND BORING MACHINE.

ELMER C. HUTCHINSON.

The amateur woodworker, and especially he who is given to cabinetmaking, soon tires of using a hand saw for getting out his stock, and longs for a saw bench. If possessed of a long purse, he may easily gratify his desire by purchasing one of several excellent makes of machines; but not all of us are so fortunately circumstanced as to be able to do this. For the benefit of those obliged to give careful thought as to ways and means, I here describe a machine—the

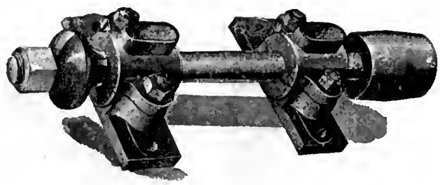


Fig. 1.

second, and decidedly the best one made—which will serve to make easy and rapid much of the work of the amateur furniture and boat builder, and which may be built at small expense and with no great exercise of skill, other than using care to see that joints and fittings are well and accurately made. The table is 30 in. long, 28 in. wide and 35 in. high. The frame was made of 3x4 in. spruce, planed all over, but I would recommend that oak, maple or hard pine be used, as being heavier and stronger. Weight, if not too excessive, is an advantage in a machine of this kind. The saw mandrel, as illustrated in Fig. 1, was purchased; it being necessary to specify that pulley should be on the right end, so that the nut will screw on in the direction opposite to that of rotation. The dimensions here given are for an 8-inch saw; this being about the largest size that can be driven by a simple treadle drive. The saw projects 2 in. above the top of the table, permitting 2 in. plank to be sawed with a slow feed. In place of having two saws, a cross-cut and rip saw, a mitre saw, as illustrated in Fig. 2, was used, as this type of saw gives an exceptionally smooth cut either with or across the grain, and avoids having to frequently change the saw for different kinds of work.

A study of Figs. 3 and 4 will show the frame work. All mortises and tenons should be carefully marked out with a marking gauge, and care used to obtain accurate and tight fit. Cross pieces B, at the top of both front and back, are only partially indicated in Fig. 3, as it was necessary to clearly show the arrangement of mandrel and boring attachment. An ad-

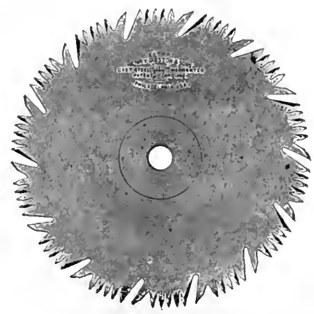


Fig. 2.

ditional piece, C, at the front, a little below the center of the posts A, and another one D, at the back near the floor are needed. These pieces are 26 in. long, and the posts, A, are 20 1/2 in. apart.

The cross pieces on the ends are 28 in. long; the posts A being also 20 1/2 in. apart. The upper pieces, E, are located with their upper edges 2 1/2 in. below to top of the posts A; the pieces F 14 in. below. Attention is called to the locations of the tenons on all the cross pieces; those on B are cut with the upper edge flush with the top, and those on E, with the lower edge flush with the under side. It will also be noted that the piece D, has the wide dimension horizontal.

The treadle requires two pieces G for the ends, 35 in. long, 2 1/2 in. wide and 2 in. thick, which is tapered down to 1 in. thick at the front, starting the taper at the center. Two pieces, K and L, 31 1/2 in. long, 3 in. wide and 7-8 in. thick form the front tread and rear cross piece. These pieces should be very firmly fastened to the ends with heavy wood screws or short lag screws. Slots are cut in the ends G, 3 in. long and 5/8 in. wide, with centers 15 1/2 in. from the rear ends, to receive the treadle rods. Horizontal holes are bored on these centers for the 5/8 in. bolts, which hold the treadle rods. The inner ends of these holes are squared out to receive the heads of the bolts.

rag; not very much oil is needed. The cardboard should come up even against the shaft. The under side is then closed with putty, and the shaft carefully centered. One side is then poured, the babbitt metal being hot enough to flow freely with slow pouring, using care not to close up the opening fully with the metal when pouring, and not to pour too fast. As soon as one side is done, open the box, chip off any featherings; wipe the shaft and babbitt surface with oily rag, replace the cardboards, and pour the other side. The other box is poured in the same manner. When completed, all excess metal is chipped and scraped off, oil groves are chipped parallel to the shaft

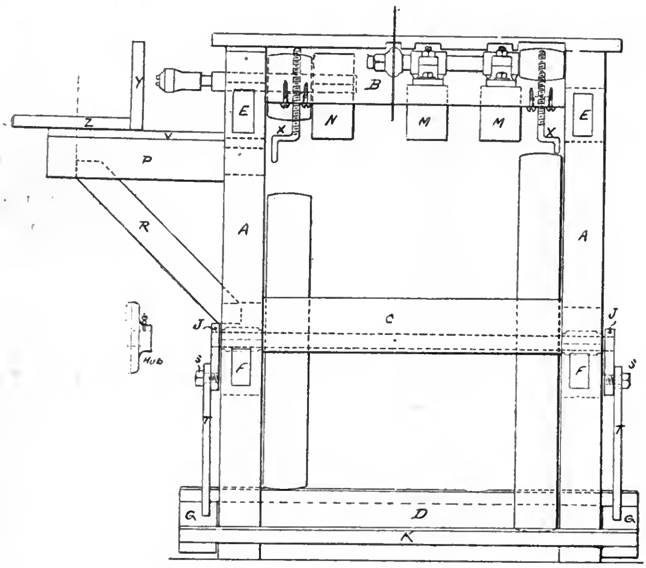


Fig. 3.

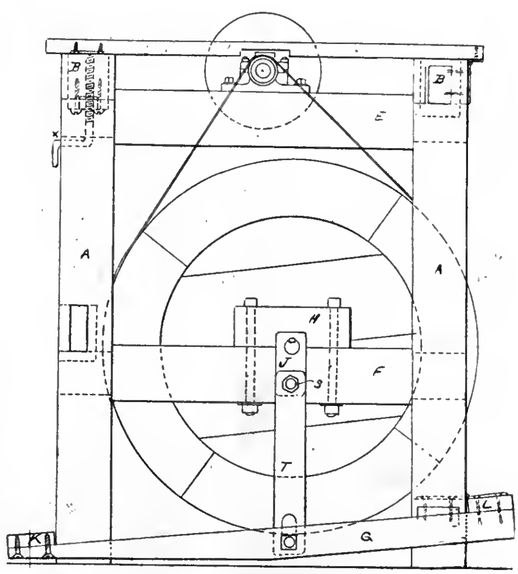


Fig. 4.

Next in order are the boxes for driving shaft, the center of which is 12 1/2 in. from the inner edges of the front posts. The cap pieces H, are 8 in. long and 2 3/4 in. square. The edges bearing on F should be perfectly flat. Bolts 7 in. long and 1/2 in. diameter are fitted at each end; preferably with the heads sunk into the pieces H. The center point of the shaft is then marked, and 1 1/4 in. holes bored as near the true line of the shaft as possible. This done, remove the caps H, and with a sharp chisel, remove about 1/4 in. of wood in both F and H, leaving a thickness of 1/4 in. at each end. Also bore two or three 1/4 in. holes at varying angles to a depth of about 1/4 in. The boxes are then babbitted, using the shaft for that purpose. The shaft is 27 1/2 in. long, and 1 in. diameter, of cold drawn steel.

To babbitt the boxes, turn the frame on end, wrap paper over one end of the shaft to center it in the lower box, put some pieces of medium cardboard between the cap H and piece F, and bolt down the cap. The shaft should first be wiped over with an oily

in the upper half, and an oil hole bored through from the inner side. If well done, these boxes will wear a long time, and while the process may seen difficult to follow, it will be found easy enough if these directions are followed.

The two drive wheels are made in the following manner: The wheel for the saw is 26 in. diameter and for the boring attachment 24 in. diameter, and both 3 in. thick. They are made up of four layers of 3/4 in. oak; the two inner layers of full diameter, with grain crossed, and the outer layers cut in circular form with a width of 4 in. The layers are roughed out with a compass saw, or taken to a mill, if one is convenient, and cut out with a band saw. They are then firmly fastened together with glue and screws. In gluing see that the pieces are clean and warm, and the glue hot. Holes are then bored for the shaft, and the hubs then fastened in place with screws.

The hubs for the drive wheels were cast iron, a pattern being made as shown in Fig. 5. The castings, four in number, were then taken to a machine shop, where they were bored and faced off on the inner edges, and a hole drilled and tapped in each for a set screw. This method insures a true running and firmly fastened drive. The outer surfaces are turned true and crowned after the treadle is attached, the services of a friend being utilized to turn the wheels while they are being turned true. After turning, should they be out of balance, by turning one or the other on the shaft a balance can be obtained, the weight of the treadle is counterbalanced by boring holes in the rim and pouring in babbit metal or lead after the wheels are turned.

The cranks J are made of two pieces of flat bar iron, 4 1/2 in. long, 2 in. wide and 5/8 in. thick; a hole for the shaft being bored with center 1 in. from end, and a 5/8 in. hole bored and tapped for the stud of the treadle rod, with center 2 1/2 in. from the shaft center. These pieces are keyed to the shaft with round or flat keys as may be most convenient. The studs are short 5/8 in. machine screws, with no threads for about 5/8 in. under the heads. It was necessary to get larger bolts and cut them off to correct length, 1 1/4 under the head. The treadle rods, T are 13 in. long, 2 in. wide, and 1/2 in, thick; 11/16 holes with centers 1 in. from each end being bored for the stud at the top and bolt at the bottom. The hole at the bottom may well be lengthened out to about 2 in. long, so that the treadle will not pinch the foot, should it happen to be underneath on the down stroke.

The supports M, for the saw mandrel can now be made. They differ from the pieces E, only in having the upper corners cut out to fit the under side of pieces B, so that the upper edges will line with those of E. This is also true of the piece N, for the boring arbor. The dimensions of the saw mandrel are carefully taken off and the pieces M, located in the correct positions for holding the bearings of the mandrel. They are fastened to the pieces B with lag screws, holes being bored for same, and washers put under the heads to give a solid bearing. Careful attention must be given to getting the saw spindle in line with the driving shaft, so that the belt will stay on.

The boring attachment may be fitted up in several ways, but the one used was to make boxes with babbitt metal, as for the driving shaft. The spindle was a piece of 3/4 in. drawn steel tubing, double thick walls, but a piece of shafting will answer quite as well. The length is 9 1/2 in. A bit-brace chuck was obtained from a hardware dealer, same being ordered separately. It had aligator jaws and will hold any ordinary bit firmly and true. It was fastened to the spindle by boring out the latter to size to fit the shank of the chuck, and a hole bored through both in which was driven a pin. The bits used in the chuck are ordinary twist bits, with the square taper shanks cut off with a hack saw.

The boring table consists of the pieces P, 14 3/4 in. long, allowing 2 3/4 in. for tenons, 1 3/4x2 3/4 in.; the pieces R, 16 in. long, over all, and 14 in. long on the under side in the clear. Stripes V, 1/2 in. square are fastened to the top of P, a little over 1/2 in. apart, and similar strips to run between them are fastened to the under side of the boring table at each end. The table consists simply of two pieces 28 in. long, Y being 6 in. wide and F 8 in. wide; fastened together with screws, and strengthened with 6 in. angle irons put on the outside. At the center of Y a hole is bored to allow the bits to come through. In using this table, it is necessary to block up most of the work to bring it to the correct height, and for that purpose, several pieces of boards of varying thickness were kept at hand. The services of a friend are also necessary to push the treadle when using the boring attachment for heavy work; the drive wheel being run in the opposite direction to that for the circular saw.

The top of the saw table is 30 in. long, 28 in. wide and 7/8 in. thick. Maple is most suitable, but having some excellent oak on hand, this was used, but is not as clean as maple would be. Two or three boards are carefully planed up, and then glued together in clamps. Cleats 3 in. wide are put on the under side at front and back, so they will not interfere with the frame. The top is attached at the back with two heavy hinges, and ordinarily rests flat on the frame. For rabbeting or similar work, the front is raised by means of the two screws X, which are simply pieces of 3/4 in. iron rod 10 in. long, threaded for about 6 in. and then turned in a vice to form the cranks for turning them. Nuts, sunk into holes cut on the under side of the piece B, and held in place with 1 1/2 in. round head screws receive the screws. Bearing plates over the ends of the screws were made of small pieces of brass, holes being drilled at each end, and the plates sunk into the table top. The saw slot was cut by the saw itself, by slowly leting down the table onto the saw, which was turned rapidly and easily cut the slot. As the saw came through the top of the table the feed was quite slow. It was also necessary to cut the under side of the table to allow room for the belt, and the oil cups on the boxes.

The saw fences and grooves for same were made as follows: A piece of 1 in. heavy square brass tubing was split into two pieces, which were then a trifle over 7/8 in. wide and 3/8 in. deep inside. A grove was cut along the table top to receive one piece of this tube with a snug fit, and it was fastened down with a number of 1/2 in. brass screws, countersinking the heads deeply. This groove was located 3 in. away from the saw. A piece of bar brass 6 in. long, 7/8 in. wide and 3/8 in. thick formed a runner for the groove. In one end a 1/4 hole was drilled and countersunk for a 2 in. screw, which went up into a piece of maple 12 in. long, 3 in. high and 1 1/4 in. thick. On the bottom of this piece of maple, (oak) was fitted a 5 in. half disk of brass, the circumference of which was correct for the screw above mentioned acting as the center. This disk was cut out of a piece of sheet brass about 1/8 in. thick. In place of a brass disk, a wooden one may be used but will not be as durable. A thumb bolt was fited to a hole bored and tapped on the brass runner, so that the maple strip could be turned to any angle and fastened quickly and firmly in place.

A piece of the remaining half of the square tube 15 in. long was then sunk into the table top at the right side of the saw, and a similar fence made for it, but without the disk as the fence for ripping is always parallel with the saw. Or in place of making the fence in this way, a piece of wood 30 in. long, 2 1/2 in. high and 1 1/4 in, thick may be fitted with brass clamps at the ends and held in place by screwing up, but care must be used in setting it each time.

There is nothing to prevent using the saw mandrel for cutting dado or other narrow mouldings, by securing suitable cutters and a cutter head; also for grooving. A fret saw attachment is being planned and if it proves successful, a description will be given if desired.

A few words of caution about using a circular saw: if you would avoid souvenir markings of carelessness on the hands. Always see that the work is firmly held against the fence, and that the groove is clean so that the work will travel in line with the saw. In ripping, keep to one side of the work, as the strips will sometimes fly back with great force.

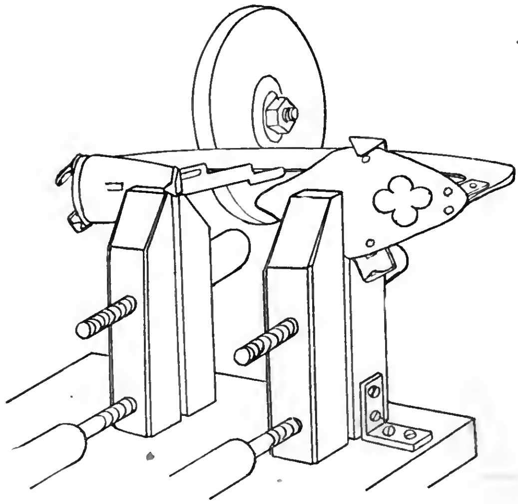
SHARPENING SKATES.

ALBERT T. MACKLIN.

Anyone who has tried to sharpen a pair of skates on an emery wheel knows how difficult it is to maintain one angle throughout the full length of the skate. Many regular skate grinders do not make any too good a job of grinding, because of this difficulty, due to the trouble in supporting the skate when holding it against the wheel. If the following described method is adopted, skate grinding will be made an easy and accurate matter, available to anyone having an emery grinder operated by either hand, foot or water power.

Assuming that it is a water motor grinder, that being the kind used by the writer, who has one which attaches to the faucet, a platform of suitable height is built to temporiarily fit the sink just in front of the motor. No dimensions can well be given for this part of the equipment, as sinks vary so in size, locations, etc. If set laundry tubs in a basement are available, they make an ideal location for grinding, as no necessity for taking off the motor, to meet household demands for water is then likely to arise. The platform above mentioned should be 12 or 15 in. wide, and of a height to bring the sharpening surface of the skate, when placed in the skate holder, slightly below the center of the emery wheel.

The skate holder is shown in the drawing; it is simple, easily made at small expense, and holds the skate rigidly at a uniform angle, as regards the side of the runner, no matter what part is placed against the wheel. To make the holder, buy two 5-inch wooden hand clamps, and cut out a piece of board 9x5x3/4 in. Faster the clamps to the board with 1 1/2 in. angle irons, attached to one jaw of each clamp, as shown. The clamps are located about 1 1/2 in. from each end of the board. and 1 in. from one edge.



The handles to the upper screws, which project towards the back, are cut off at about the center, so that they will clear the emery wheel. The loose jaws of the clamps are also cut off on the lower ends, to enable them to be moved without binding on the board; or thin shims may be put under the rear jaws, before screwing down to the board, thus raising the clamps slightly.

The skate is secured between the jaws of the two clamps, any adjustment to secure the right angle against the emery wheel being made with small wedges placed either above or under the points of contact. other adjustments as to height are made by placing boards of various thickness on the platform previously mentioned. The runner may then be placed against the wheel and rapidly ground by simply moving along the base board with the hands. An emery wheel about 1/4 in. thick is a good size to use, and a moderate presure used, as too rapid cutting may draw the temper of the steel.

All the salt ponds on Turk islands, West Indies, are owned by the government and are leased on a royalty of 70 cents per 100 bushels shipped. This goes into the general revenue; a further tax of 10 per cent. on the industry is charged for the upkeep of the ponds and roads leading to them.

Herodotus says that Croesus was the first sovereign to make coins of gold

ELEMENTS OF DYNAMO DESIGN.

IRA M. CUSHING.

The young Electrical Engineer, after he has passed the age of batteries, electric bells, miniature motors and the like, has a very natural ambition to design and build a piece of electrical apparatus that may be put to practical use. In looking over the field he finds a machine which at once seems to be the most important one for the production of the electric current, and also seems to be simple enough for his limited ability, to construct.

This machine is the dynamo. It is simplicity itself:—A substantial frame of iron with copper wire wound upon it and a revolving part, also of iron, and some wire coiled on it. The young engineer is very much discouraged, however, when he begins to read various books on Dynamo Design, and is bewildered with the vast array of formulae and theory. The object which the author has in mind in writing this series of articles, is to aid the beginner in his study of this subject by stating the principles in as clear a way as posible, and by presenting the formulae for the simpler and most common form of generators in such terms that they can be readily understood and applied.

The reader must remember that the subject is very broad and full of infinite and intricate detail into which it is imposible to enter in the scope of these articles. It will be necessary, therefore, to make statements without proofs of their truth, but which can be verified by a further study of the subject in other publications. A list of books will be given at the end of the series, the perusal of which, if not the study, we recommend to the student after he has mastered this treatise.

Some of the formulae given have figures in them. They remain the same for any value of the letters, and are therefore called constants. There is a reason for these and the young student must now take them for granted. A study of the more exhaustive books will explain their derivation.

The student should be warned at the start of many of the pitfalls along the path of Dynamo Design. One of the greatest sources of error arises from the fact that most, if not all, the formulae were worked out on the C. G. S. (centimeter-gram-second) system, and must be transposed into the inch-pound-second system, which prevails in this country. The changing is very confusing, and unless care is exercised the terms are mixed and inaccuracy with bad results follow. In this work, however, the formulae are given for inches and no tables or formulae are given for dimensions in the metric system. The latter may be found, however, in other works to which the reader is referred.

Another idea to be noted is that dynamo design is, and is not, an exact science. It is exact in so far as the formulae themselves are concerned, but when it comes to the substitution of numbers for the letters, it becomes a matter of individual judgement or engineering how to choose. The reason for variations or doubt is that the quality of material used varies greatly. For illustration, the ability of iron to carry magnestism varies in different parts even of the same piece.

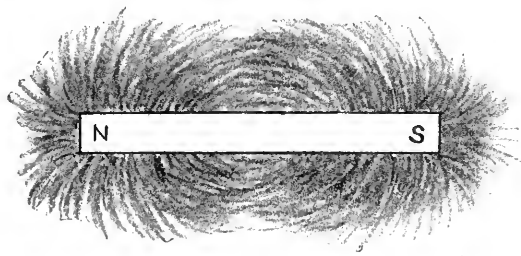


Fig. 1.

The design of the mechanical parts of the dynamo is more a matter of personal engineering than the mere use of formulae. The shape of the frame, the proportioning of the parts one to another, are all matters requiring a personal judgement. Before designing a dynamo it would be well for the novice to study carefully all the different machines, large or small, he can find; the dynamos themselves if possible, but lacking these all the illustrations he can obtain. Find out, if possible, why one is more particularly adapted to a certain kind of work than another; examine critically the mechanical design. The controlling idea should be to design a machine as simple as posible which will perform its work satisfactorily. The revolving parts should be light but substantially built, and designed with a view to withstanding the centrifugal force exerted.

Magnetism performs a very important function in the generation of electricity in a dynamo, and for this reason its principles should be thoroughly understood at the outset.

The name magnet was first given to an iron ore, found at Magnesia in Asia Minor, having the peculiar property of attracting to itself other pieces of iron. Further experiments showed that if a piece of this ore was suspended free, the same end always pointed towards the north. It was also found that a piece of ordinary iron, after being rubbed with the magnet ore, had the same characteristics. The end, therefore, pointing toward the north was supposed to contain "north seeking magnetism" and similarly the other end "south seeking magnetism." By common usage, however, this has been shortened to "North pole" and "South pole." These two poles are inseparable. It makes no difference how many times a magnet may be cut into parts, each part is found to have a North and South pole.

Many years later it was discovered that a current of electricity passing, by means of a number of turns of wire, around a piece of soft iron, produced the same

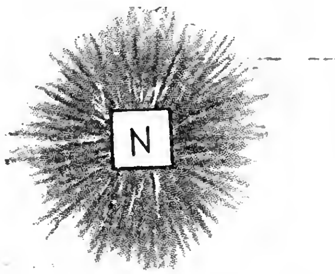


FIG. 2.

effect in the iron, namely, made it a magnet while the current was flowing. This property of the electric current has made posible the size and efficiency of the present dynamo.

be shown. Place a bar magnet on the table and cover it with a piece of smooth paper. Sprinkle some iron filings over it and tap the paper gently. The filings will arrange themselves end to end and form smooth curves from pole to pole of the magnet as shown in Fig. 1. If the magnet be placed with its axis vertical to the paper, one pole touching it underneath, and the filings put on, the result will be as in Fig. 2. Fig. 1 shows that the lines of force pass from pole to pole, Fig. 2 shows that they eminate in all directions from the poles. Another point to be illustrated could best be shown by first placing a horseshoe magnet beneath the paper. The irons filings show quite an intense "field of force" between the ends or poles, diminishing as you go down the legs. Now place in position the keeper or "armature," as the piece of iron usually kept across the poles is called, and again sprinkle on the filings. Any rearrangement of the particles is hardly noticeable. This would indicate that the iron is so greatly a better conductor of magnetism that the keeper has taken practically all the lines of force. See Figs. 3 and 4. A particular point which should be noted is that no lines of force cross, all are either parallel or diverging.

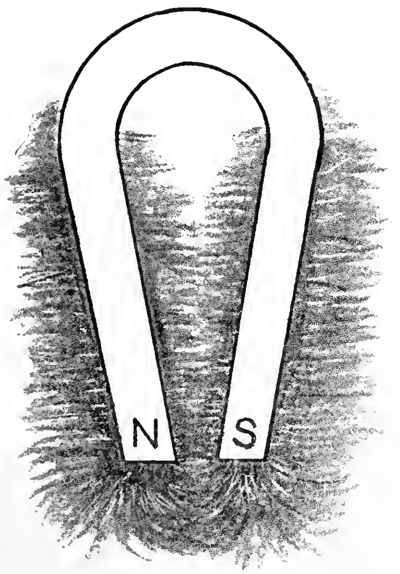


FIG. 3.

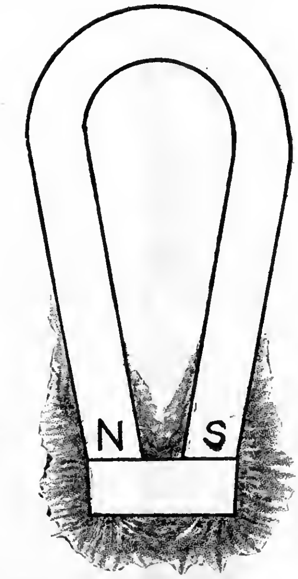


FIG. 4.

It is very evident that a power comes from the poles of a magnet. In order to assist in calculations scientists have assumed that this power eminates in invisible lines called "Lines of force." The number of lines must be nearly infinite and therefore, to further simplify the mathematical work an arbitrary value of one line per unit area has been assumed. These lines of force lie in even, closed curves stretching between the north and south poles. The direction in which they travel cannot be determined, but has been assumed as being from the north to the south pole.

The presence of these lines of force can very easily

The discovery has been made, by experiment, that a current passing through several turns of wire about an iron core will produce these same lines of force and further that the magnetizing power of the coil or force exerted by the coil was proportional to both the number of turns of wire and the intensity of the current. Let I represent amperes, S equal turns, k, a constant (a number whose value is the same for all values of the other letters) and H equal magnetizing power, then

$$H = kIS \quad (1)$$

This is the force exerted at a point. To produce work, this force must be expended through a measurable distance as, for example, around a horseshoe magnet. It has been found that the resulting force diminishes in proportion as the length increases. Hence, let L equal the length of the magnetic circuit, then formula **1** will become

$$H = \frac{k\,I.S.}{S} \qquad (\,2\,)$$

This is true for all coils or solinoids of moderate length. In coils of excessive length some of the lines of force pass out before reaching the last turns thus reducing the power at the ends. With the length given in inches k will equal 0.3132.

The expression I.S. is called "Ampere turns." It has been found experimentally that the value of H in (**2**) does not vary with the changes in I and S, provided their product remains the same. In other words, if I.S. equals 50, it makes no difference in the resulting magnetizing force whether one ampere flowed through 50 turns, or 50 amperes passed through one turn. This principle becomes very useful in dynamo design and should constantly be kept in mind by the student.

THE PITCH OF SCREW PROPELLERS.

C. C. HERBERT.

The question of the proportions and action of propellers is, on the whole, perhaps the least satisfactory of all with which the marine engineer has to deal. The dimensions of a propeller for any given purpose are usually almost entirely a matter of trial and experiment; as calculations along this line are not only complex, but are not always entirely satisfactory.

The principal features of a propeller may be taken to be:—Diameter, Pitch, Blade Area, Speed of revolution and Slip. The Diameter is that of the circle described by the tips of the blades. The Pitch, considering the propeller to be a portion of a screw, is the amount which it would advance in one turn, supposing it to travel in a solid medium. The Blade Area is the actual area of all the blades.

The Speed of Revolution is customarily reckoned in turns per minute. The Slip is the difference between the amount which the propeller actually advances per turn and the amount which it would advance if turning in a solid medium. For example, if the pitch of a screw is 30 in. it would advance 30 in. at each turn if there were no slip. Suppose that it only advances 20 in. per turn, then the slip is 10 in. per turn, or as it is usually figured in percent, or 33 1/3 percent. As a further example, suppose a propeller of 30 in. pitch turning 300 turns per minute drives a boat at the rate of 6 miles per hour. The advance of the propeller in feet per minute is $\frac{30}{12} \times 300 = 750$, while the advance of the boat is $\frac{6 \times 5{,}280}{60} = 528$ ft. per minute. The slip is then 750—528 = 222: or as a percentage, $\frac{222}{750} = 29.6$ percent. It might seem at first thought that a perfect screw propeller would have no slip; but this is a practical impossibility; it is also theoretically impossible for a propeller to work without slip.

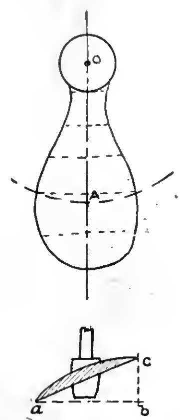
The most important dimension from the standpoint of the absorption of power, is the blade area. A certain blade area may be obtained by a relatively wide blade on a small diameter or by a narrow blade on a relatively large diameter. In the former case the area of the blades bears a greater proportion to the area of the circle through the tips than in the latter case. There are certain limits for this proportion of blade to disc area for well designed wheels beyond which it is not well to go. These are as follows:

For two blades	.20 to .25
For three blades	.30 to .40
For four blades	.35 to .45

This means that for a 24 in. diameter propeller, whose disc area 452 sq. in. the blade area for a three bladed wheel will very from

.30 x 452 136 sq. in. to
.40 x 453 181 sq. in. depending

upon the power to be absorbed by it. The blade area should not, for ordinary use, be made greater than



these proportions as the blades then become so wide as to interfere one with another. Of course, where a propeller must, for shallow draft, be of unusually small diameter, the proportion of blade area must be increased, but at the expense of some loss of economy. Strictly speaking, for a well balanced propeller, the blade area fixes the amount of power which the propeller can deliver, while the pitch, combined with the turns per minute governs the speed. As a matter of fact, for the average propeller the two are closely related, each having a certain influence upon the other. To illustrate, a propeller may have a small blade area and so great a pitch that the blades act somewhat like fans and simply churn the water, offering great resistance and absorbing the power, but doing little effective work. In this case while the power of the engine is absorbed, but little effort is exerted towards driving the boat. This propeller would be improved by decreasing the pitch to a reasonable figure and increasing the blade area to take up the power.

The opposite case is shown by a propeller of large blade area and very small pitch where the blades are almost flat. Here the blades tend to simply revolve edgewise through the water and the power is absorbed by the surface friction. In this case the engine can turn up to a high rate, but has little effect on the motion of the boat. This propeller will be improved by increasing the pitch and reducing the blade area.

There are certain well defined limits for the proportion of pitch to diameter; for instance, in the 24 in. propeller mentioned above the ratio of pitch to diameter is $\frac{30}{20} = 1\ 1/2$. The pitch should not be less than the diameter nor as a rule greater than 1 1-2 times it.

The blade area is the most important feature, as if this is of the correct amount to absorb the power, the pitch will, within certain limits, take care of itself. This explains why most engine builders can furnish a certain propeller with a certain engine without regard to the conditions under which it is to be used. As a rule the same propeller will be furnished for a heavy working boat, which can only be driven at a low speed, as for a light, high speed launch, and it will appear to work equally well in both cases. This is due to the difference in the slip; in the first case the wheel is working with a large slip, and in the latter case ewith a moderate or low slip, but with a fair efficiency in both cases, provided that the blade area is of proper amount.

An average slip for a good working propeller is usually taken at from 10 to 20 percent. A propeller may work efficiently at a high slip, but the revolutions of the engine may then be unnecessarily high. A slip of over 30 percent will usually indicate that a different wheel would probably give better results. The shape of the after end of the hull also influences the slip, a very full run hindering the flow of the water and increasing the slip. The remedy for this is a larger diameter, to reach out into the clear water beyond. To measure the blade area of a given propeller the center line is drawn down the middle of the blade and the length of the bladed divided into several equal spaces. At these divisions lines are drawn across the blade as shown in the sketch. The widths of the blade at each of the lines is measured, all the widths are added together and multiplied by the distance between the cross lines, giving the orea of one blade. This is then multiplied by the number of blades for the total area.

To find the pitch of a propeller it is laid upon a flat surface with the shaft exactly vertical. The pitch at any point, as *A*, may be found as shown in the lower sketch; *A*, *C* is the width across the blade; *C*, *b* is a vertical line at one edge and *a*, *b* is the width on a horizontal line. It is plain that in the distance *a*, *b*, along the circumference, the advance of the propeller is *b*, *c*. The circumfeoence of a circle passing through *A* is 6.28 X *O*, *A*. Now the pitch will bear the same relation to *b*, *c* that the circumference of the circle through A bears to a b or

$$\frac{\text{Pitch}}{\text{b. c.}} = \frac{\text{circumference}}{\text{a. b.}} = \text{Pitch} = \frac{\text{b c} \times \text{circ.}}{\text{a b}}$$

The pitch at different points of each blade is likely to be different, in which case the average pitch is used.

It is hoped that these few hints may be of some help to those who may be unfortunate enough to have unsuitable or poorly designed propellers.

USES OF LIQUID AIR.

At the time of the first commercial production of liquid air, several years ago, a number of untenable claims were made as to its practical applications. One of the most valuable uses to which the liquefaction of air has been put is that of the subsequent separation of the oxygen and nitrogen by fractional distillation and rectification. The possession of such a substance as liquid air, however, has proved of much value in the study of the behavior of various materials at low temperatures. It is generally assumed, for instance, that at very low temperatures metals become brittle and even fragile, and in numerous cases the breaking of steel rails in winter weather has been attributed to this cause. By the use of a bath of liquid air it has been found pacticable to test various metals and alloys at temperatures as low as —180°, and this has led to the discovery that while many steels have their tensile strength increased, their ductility lowered and their brittleness raised at low temperatures, this is not always the case. R. A. Hadfield, a well known British metallurgist, has shown that a nickel manganese steel can be made which will be as tough, if not tougher, at —180° C. than it is at ordinary atmospheric temperatures, and this, too, without material change in the tensile strength. Liquid air has also been used for quenching specimens after tempering, and some instructive information has been obtained about the process of hardening in this way.

Lake Bonneville in Utah, of Pleistocene age, twice filled a basin which is now a desert. The lake at one time covered an area of 20,000 square miles, and was 1000 feet deep.

MERCURY ARC RECTIFIERS.

JOSEPH ALDEN.

A new device has been put upon the market within the last few years for converting alternating current into direct current. This is the mercury arc rectifier. It is quite probable that the readers of this magazine are more or less familiar with its peculiar, greenish light, as they are in use in garages, and many private residences where the electric automobile is used and only alternating current is available. Its chief use at present is the charging of storage batteries, which it does to a degree of nicety that is remarkable, and its high efficiency has reduced the cost of charging considerably.

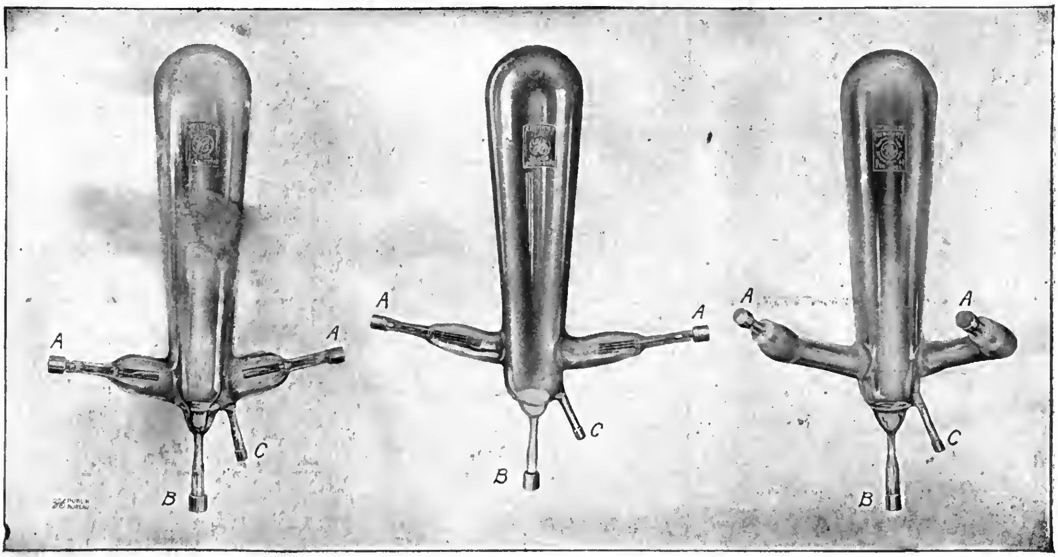


FIG. 1.

The prominent and most important part of the outfit is the mercury tube, which is a glass vessel from which the air has been exhausted. Into this protrude four terminals or electrodes—one at the bottom, one a little way up the side, and the other two on opposite sides and well up on the tube. The electrode at the bottom is covered with mercury, and the one on the side is just high enough so that the mercury will not touch it when the tube is vertical. The terminal at the bottom is the cathode, the one part way up the side the starting anode and the two well up on the sides the main anodes. Fig. 1 is the type of mercury tube manufactured by the General Electric Co.; *A*, *A* are the main anodes, *B* the cathode and *C* the starting anode.

Although mercury itself is an excellent electric conductor, mercury vapor, produced in vacuum by heat, has a very high resistance. Nevertheless if the vapor becomes electrified or "ionized," it becomes a good conductor, but allows the passage of current in only one direction and that towards the terminal immersed in mercury. Only a few volts are required to sustain this passage after it has been started, but the starting of the arc was a puzzle for a long time to the experimentors. They finally discovered that if a spark was produced between a terminal and the mercury the vapor would be sufficiently ionied to start and sustain an arc from the main anodes. The starting anode was therefore inserted, and by a slight shake contact is made and broken between it and the cathode giving the necessary spark.

To understand the working of the mercury tube, a conception of the nature of alternating current is necessary, so the following explanation is given for the benefit of those not familiar with it. Any complete circuit, whether alternating or direct current, requires two wires. Let these be numbered 1 and 2. An alternating current is one which first goes out on wire No. 1, coming back on wire No. 2; and then goes out on No. 2 and back on No. 1; that is, it alternates in direction between wires No. 1 and No. 2. Two of these alternatious or reversals make a complete cycle, and the number of complete cycles per second is called the frequency. The most usual frequency for lighting at present rate is 60 cycles per second.

The two wires of the circuit are connected to the anodes, and one end of the direct current load is connected to the cathode. As stated before, the ionized mercury vapor allows the current to pass through it in only one direction, so when the current comes on wire No. 1 it passes into the tube at *A* (See diagram No. 2) and when it comes on wire No. 2 it passes in at A1. It can be seen therefore that half the alternations goes through from one anode and the other half from the other anode. As only half goes through at a time the direct current voltage will be approximately one-half the alternating current voltage. Theoretically this should work, but experiment has shown that there is

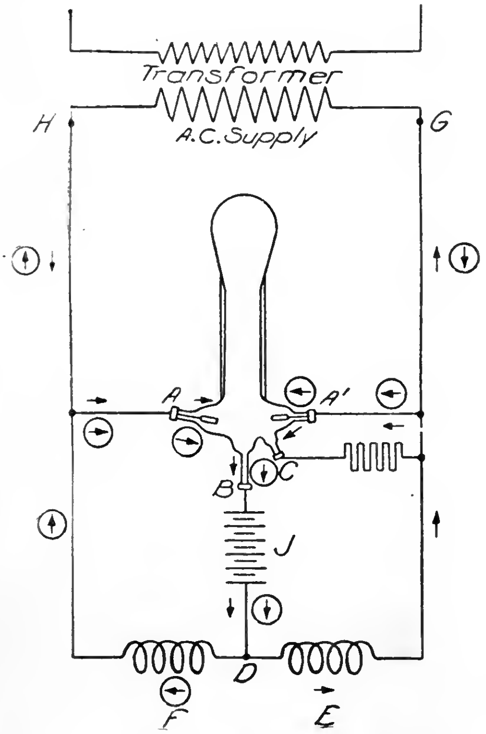


FIG. 2.

sufficient time between the alternations (at the turning point of course the voltage is zero) for the vapor to lose its excitation and the tube would go out. Experimentation was carried on to find if possible a frequency that would work, but the tube would go out with a current having 10,000 cycles.

It was necessary, therefore, to put something in the circuit to bridge the zero point and the two coils *F* and *E*, were introduced. These have what is termed capacity, that is, they can store up voltage while the main current is increasing, and discharge it into the tube while the main voltage is at zero. The other terminal of the direct current load is connected between the reactances. The operation of the complete rectifier outfit can now be explained by diagram No. 2. In this the two directions of the alternating current are represented, one by a plain arrow and the other by an arrow in a circle. The current can be assumed as first starting from *H*, and is shown by the plain arrow. It passes into the tube at *A*, out at *C*, to the load *V*, through the reactance *E*, thence back to the source. Reactance *E* stores some of the current, and when the main current comes to zero it discharges into the tube at A1, serving to keep the tube going until the main current builds up again in the opposite direction, as shown by the arrow in the circle. The operation is thus repeated for the other

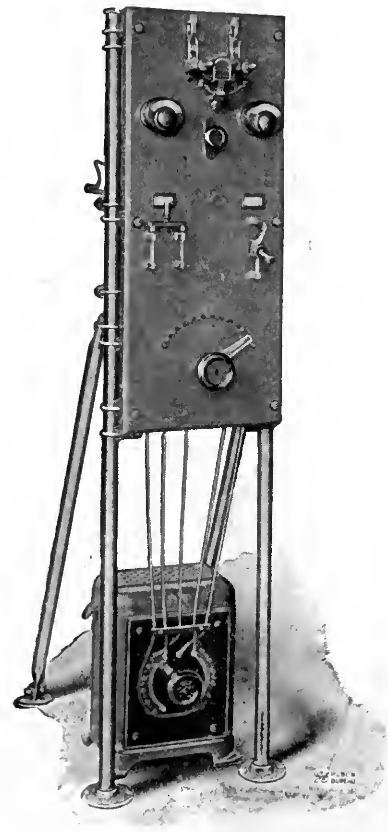


FIG. 3.

alteration, using reactance *F*, and a cycle is completed. This action repeats for every cycle in the alternating current.

A resistance is connected between the starting anode and the line, which allows just enough current through to start, but prevents a short circuit. Various devises are introduced into the circuit for the control and regulation of the output.

Theoretically this rectifier should have an efficiency of 100 per cent.; that is, the volts, X the amperes, direct current, or power, should equal the volts X the amperes, alternating. This is not so, however, due to a slight loss in the reactance, and also to the fact that it requires a certain number of volts to maintain the current in the tube. The efficiency obtained, however, is in the vicinity of 75 or 80 per cent. for high D. C.

voltages, which is very good and very much better than any other small converting outfit.

Although it is used mostly for charging storage batteries, it is also being used to run lights, small motors, and similar work. It is necessary, however, to keep a small constant load on the tube all the time it is in use, as it would go out if the motor, for instance, was shut

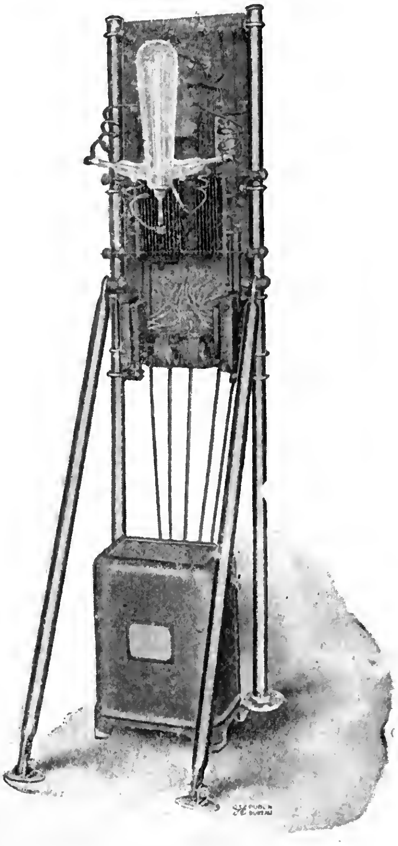


FIG. 4.

down or lights turned off. The General Electric Co. is making small outfits for running direct current dental motor drills, the size being very handy for experimental work as well.

Figs. 3 and 4 show the front and back view of a Mercury Arc Rectifier Panel, made by the General Electric Co. for charging storage batteries. With 110 volts A. C. it will give 40 Ameperes at about 46 volts D. C.; with 220 volts A. C., 40 Amperes at about 115 volts D. C.; and with 330 volts A. C., it will give 40 Amperes at 175 volts D. C.

The instruments on the panel are as follows: at the top, the circuit breaker in the D. C. lines, next the voltmeter and ammeter, then a hand wheel for shaking the tube; which is mounted on the back. On the next line the switch at the left controls the A. C. line, and the switch at the right is for starting. Next it a series controlling reactance, which is inserted in the A. C. line to get fine variations in voltage. Beneath the panel is the main reactance. The back view shows the tube and series controlling reactance mounted on back of the panel.

Fig. 5 shows the connections of this panel, the diametric location of all the different devises; and also a table of connections, whereby it is possible to obtain many different D. C. voltages.

Since the D. C. voltage is about a half the A. C. voltage, the D. C. current is about twice the A. C. current. The 75 to 80 per cent. efficiency is obtained only where nearly the maximum D. C. voltage is used. The efficiency will, therefore, go down as the D. C. voltage

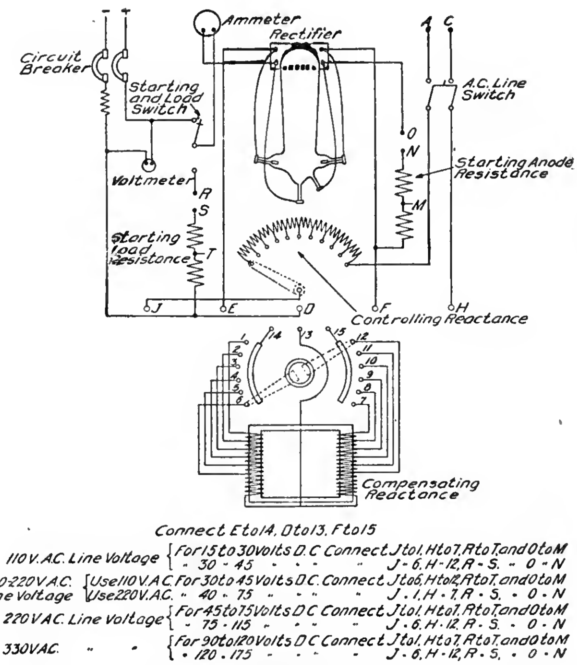


FIG. 5.

is lowered, as it is impossible to raise the current beyond the tube capacity. There are four sizes of tubes, 10, 20, 30 and 40 amperes. An attempt to take more than the rated current would heat the anodes and break the tube.

The latest development of the mercury tube is the use in connection with constant current transformers and series arc lamps. With this combination it is possible to get a direct current for the arc lamps and yet have an alternating current source. The direct current arc lamp is much better than the alternating current lamp, as it gives a much steadier lamp, and is free from the humming which is always present in the alternating current lamp. A number of these outfits have been installed, and are giving very good satisfaction.

Before the days of coined money the Greeks used copper nails a scurrency.

SOME FACTS ABOUT VARNISH.

GORDON MONTAGUE.

The word "varnish" is understood to be derived from the Latin vitrinere, meaning to glaze or produce a glass-like surface. Of the greater variety of gums used in the making of varnish, shellac is the most useful for spirit varnishes. Although the annual consumption of gum shellac in this country is now about 5,000 tons, there are points about it not generally known or understood. It is not a resin in the strict sense of the word; i. e., it is not the simple juice of a tree, but results from the action of certain insects on the juice and contains several very peculiar resins.

Next to shellac sandarac ranks as the most valuable gum for spirit varnishes. As for the regular gums, although the list in books is a long one, practically all that varnish makers are interested in may be counted on the fingers of the hands, and this can be further reduced to four, viz., Zanzibar, Kauri, Manila and Damar. The impression prevails that great quantities of these gums are shipped to the American market, but such is not the case. The imports for the year 1905 were not much in excess of 13,000 tons, and of this about 50 per cent. was Kauri.

Zanzibar stands at the head, being the hardest of all gums, except amber, which need not be considered. It derives its name, as may be inferred, from the port of shipment, as indeed most other gums do, excepting, perhaps, Manila. We speak of all these hard gums as "fossils," because they are found in a fossilized condition in the ground, sometimes hundreds of feet below the surface. Zanzibar is dug out of the sands of the African desert, and the curious indentations which give this gum the appearance of goose skin are simply sand impressions. The Zanzibar gum is scarce and very expensive.

Next in point of costliness, but far in advance in point of usefulness to the varnish maker, are the New Zealand copals, commonly called "Kauri" gums. They range in color from a creamy white to a dark brown, and are so graded. Much of this gum is not available for use, and the assorting requires skill and care. The lower grades contain pitch and swamp gum, the former being taken from the forks of trees 100 feet or more above the ground. It is a soft, spongy mass, and it is extremely difficult to incorporate with the oils. Ninety per cent. of what is imported, however, may be classed as good hard gum, differing only in size, color and clearness.

Manila gum is a soft copal exported from the Dutch East Indies. It is in more or less demand, but varnish makers have no great use for it. However, a small quantity sometimes helps to give elasticity to harder gums, and occasionally it is used in spirit goods. For general use its greatest drawback is the difficulty of eliminating the pyroligneous acid, of which it carries quite a large per cent. There are many other varieties of gums in the same class as Manila, but they are not used to any considerable extent, perhaps 1,000 tons would cover the annual importation.

The blacks are a small line mostly used in baking or air drying japans and varnishes. Originally our supplies of asphaltum, which is supposed to be the product of decomposed animal and vegetable matter, came from the shores of the Dead Sea, and "Egyptian" continues to be one of the best grades. We now get a considerable quantity from both Trinidad and Barbadoes, and Cuba sends us an asphaltum that is densely black. In this country Colorado and Utah mine very heavily. There are other blacks besides asphaltum, but as a rule they do not interest the varnish maker—such as coal tar pitch, resin-pitch, candle-pitch, etc. There is more or less interest attached to all these crude materials which enter into the composition of varnish, but space will not permit of my dwelling on them at length. One other, however, I will mention—China wood oil. This is a much more expensive oil than linseed, and very hard to manipulate to get proper results, but is none the less a most valuable article for those varnish makers who have mastered its secrets. When worked in the same way as linseed oil it makes a harder, more elastic and more durable varnish.

As for the different grades of varnishes, the numerous catalogues which are issued show what a large variety of varnishes there are for sales purposes; but the classification may be considerably modified. Originally there were but two classes on the market—carriage varnishes and furniture varnishes. The introduction later of so many beautiful woods in building operations made an architectural line imperatively necessary. Outside of the above the manufacturers' lines and specialties make an almost endless list; yet they are all modifications of a general line to suit certain conditions and for the most part are obtained by blending.

All the better grades of varnish, no matter what the line, are made of selected gums and are specially prepared oils, with pure turpentine as a thinner. The cheaper grades will naturally carry poorer gum, and be thinned with either naphtha or part naphtha and part turpentine.

Speaking of naphtha and turpentine thinners, it may be interesting to know what the essential difference is. The turpentine varnish undoubtedly works easily, and it dries from the bottom up. With naphtha these features are reversed. Sometimes it forms a skin over the top, keeping out the oxygen, and so retarding the drying. Another serious fault with naphtha goods is that they do not flow as turps does. Both, however, are used merely as distributers, for neither stays where it is placed, but evaporates in due course. Most of the difference between the two liquids lies in the fact that turpentine carries a percentage of oils and naphtha does not. It is easier and better to thin with turps because it can be added at a higher temperature—350° to 360° Farenheit—and at this temperature the combination of gum and oil is more perfect.

There are many terms in the technology of varnish which convey no definite meaning to the outsider; yet they are full of suggestions as to the possibility for use of said varnish. For instance, the varnish maker speaks of "slack melt." By this it meant that the gum is melted in a covered kettle to a semi-liquid condition before the oil and thinners are added. The result is a large yield, good color, hard working and a false body. The batch takes a large quantity of thinners, which in itself causes a loss of gloss. The object is simply good color, or large yield, or both. There is more or les moisture left in this varnish, and if mixed with pigment it would be apt to liver. If it did not do that it would not mix well. So for this purpose the using of a "slack melt" is to be avoided.

An "open melt" is when the cover is left off the kettle, the object being to throw off as much moisture and copal oil (the oil that is in the gum) as possible. When this is not done the varnish is liable to "bloom," and the oil mentioned retards the drying.

For a "close melt" the cover is left on and a larger yield is produced, as most of the gum is retained in the kettle. This is used for the cheaper grades than the best. Good results are also obtained in a "close melt" by different manipulation. One way is to melt the gum to a liquid state before the oil is added. In doing this color and yield are sacrificed to a certain extent, but finer results are produced as to gloss, drying, freedom of working and wearing qualities. In all gum melting too strong a fire is to be avoided or the gum will be burned.

Zanzibar and other fossil gums are difficult to handle. Usually the heat varies from 550° to 640° for the harder gums. Japans (outside of the grinding varieties, which are made with shellac and gums) and liquid dryers are usually made by boiling lead and manganese with linseed oil, combining as much metal as possible with the oil, and driving off the oxygen with long sustained heat.

It is a truism that good varnish depends more on the makers than on the material. This has frequently been proven, since with the same material one man has made a good varnish and another a very poor one. Thoroughly competent men for this work are scarce. It requires brains, nerve, judgment and a perfect knowledge of materials—not merely the crude material, but of the finished product, and what it has to accomplish. He must be weather wise also, for under certain circumstances the weather is a most important factor to consider. For instance, the atmosphere indicates posible mugginess, with little or no draught. He realizes at once that he must make up the strongest kind of a fire before he runs the kettle on, otherwise the contents will simmer, darken and spoil. Or again, he may wish to make a varnish of another class, which requires a bright, clear day, with not too much wind. The successful varnish maker must be able to cope with all of these conditions. He must be a man of discernment, capable of perceiving possible danger or loss before the actual crisis arrives, and a man of resource, so that he can constantly meet, counteract and overcome any troubles which may arise to hinder the successful making of his varnish.—"American Exporter."

ARTIFICIAL RUBBER FROM CEREALS.

Consul F. W. Mahin reports from Nottingham that according to a current newspaper item an inventor named Carr, in Middlesex, proposes to make artificial rubber from cereals—wheat, corn, etc.—for use as bicycle and automobile tires, and also as golf balls.

It is explained that the artificial rubber is obtained by treating any cereal with phyalin. It is reported that a syndicate of capitalists, interested in tire manufacturing, has offered Mr. Carr over $1,000,000 for his patent rights. The inventor's response is not stated. Mr. Carr, it is announced, proposes to make six grades of artificial rubber from a liquid solution suitable for waterproofing to a hardness available for golf balls. In the latter the substance is credited with the lightness of cork and the toughness of chilled steel. The intermediate grades are expected to be serviceable for tires, tubes, linoleum, and slabs or sheets for pavements.

Prof. Alexander Winchell is credited with the invention of a cement that will stick to anything. Take two ounces of clear gum arabic, one and one-half ounces of fine starch and one-half ounce of white sugar. Pulverize the gum arabic, dissolve it in as much water as the laundress would use for the quantity of starch and sugar in the gum solution. Then cook the mixture in a vessel suspended in boiling water until the starch becomes clear.

The cement should be as thick as tar, and kept so. It can be kept from spoiling by dropping in a lump of gum camphor or a little oil of cloves or sassafras.

This cement is very strong indeed, and will stick perfectly to glazed surfaces and is good to repair broken rocks, minerals or fossils. The addition of a small amount of sulphate of aluminum will increase the effectiveness of the paste, besides helping to prevent decomposition.

Julius Caeser was the first man to engrave his own image on a coin.

A 75-WATT DYNAMO.

IRA M. CUSHING.

The dynamo here described is designed to light 14-volt miniature series lamps connected in multiple; driven at a speed of 2800 R. P. M. it will give 5 amperes at 15 volts. The accompanying illustration gives the outline and important dimensions.

The field frame and base should be made of a good grade of cast iron and cast in one piece. The frame and bearings should be made and assembled as described for the 150 Watt dynamo in the December number of Amateur Work. The bore of the field should be a scant 2 1/8 in. or 2 3/32 in. The closer to the latter figure the builder can come, the more efficient the machine will be.

There is only one difference between the bearings for this and the 150 Watt machine. The shaft for this generator is .3125 in. diameter in the bearings. The brass tube for bearing lining should therefore have an internal diameter of less than 5/16 in. in order to bore it out for a running fit.

Another way to make a good bearing would be to run melted babbit or bearing metal into the bearing in place of the brass tube and when cool bore out for the shaft. In boring use a size smaller drill than required and ream to a running fit.

For lubrication, an oil hole should be drilled through the top of the bearing. If the generator is to be run very long at a time this hole can be tapped and fitted with a grease cup or a wick feed oil cup.

The shaft is aproximately 10 in. long and .3125 in. diameter in the bearing. The enlarged portion begins 4 3/8 in. from the commutator end and is 7/16 in. in diameter. This part is 2 1/2 in. long. At the commutator end of the large part is cut a No. 14 thread for about 5/16 in. The nut and retaining washer should be 1/4 in. in diameter and assembled as on the 150 Watt dynamo, the edge of the washer to be 1/4 in. from the pulley end of the enlarged portion.

The armature core is made up of enough sheet iron punchings to fill tightly the space of 1 1/2 in. The punchings are 2 1/16 in. diameter with 12 5/16 in. holes in the periphery, with their centers on 1 3/4 in. diameter circle. The assembling and insulation of the core should be as for the 150 Watt dynamo.

The commutator and brush holder rigging described and illustrated for the 150 Watt machine, will be correct for this generator with a slight change. The brass tube upon which the commutator is built should have small enough inside diameter to be bored out for a driving fit on the shaft. Otherwise the yoke, studs, brush holders and brushes will be of the same size as before described.

Wind the armature with No. 20 D. C. C. magnet wire putting 34 wires in each slot. Since this core has the same number of slots as the 150 Watt dynamo the winding scheme will be the same. There will be six coils with 34 turns in each coil. Calling the slot No. 1 where the first coil starts the six coils will fill the slots as follows:—Coil 1, 1—16; coil 2, 11—4; coil 3, 9—2; coil 4, 7—12; coil 5, 5—10; coil 6, 3—8.

Much care should be taken in winding to lay the wires straight, even and tight. If the finances of the builder would allow I would recommend double silk covered wire. This would give more leaway for getting all the wire in the slots, as the double silk does not take up as much room as the double cotton. Single cotton covered wire can be used but great care must be exercised in winding not to break the insulation. Insulate the shaft each side of the core; at the pulley end with tape and at the commutator end with a fiber tube 3/8 in. long and 5/16 in. inside diameter. Carefully test each coil for a ground with the core as it is wound.

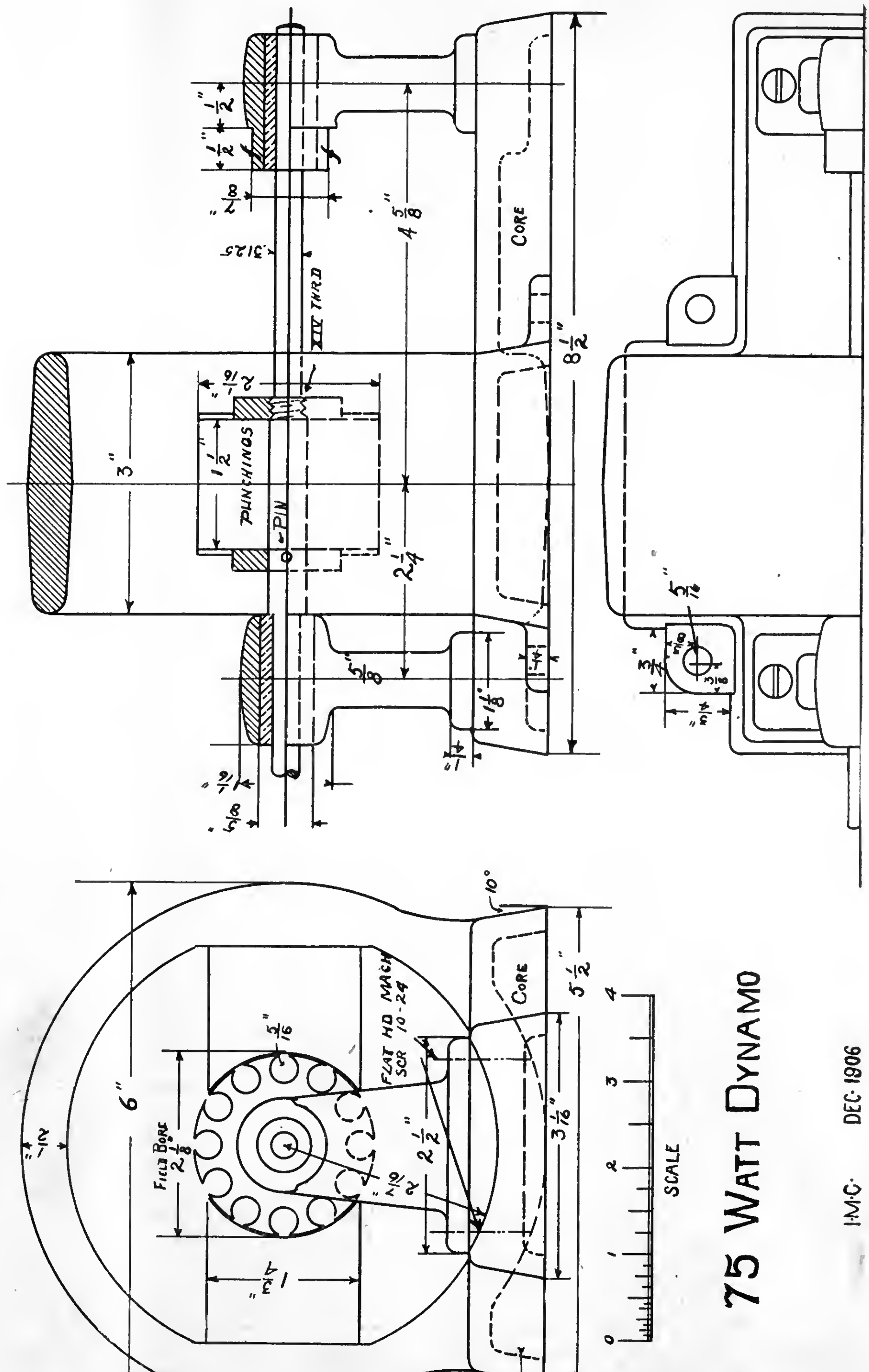
Testing each coil as wound may save rewinding the whole or part of the armature to remove a ground. This test should be made with a voltage of at least 30 volts, but 110 volts is better if at hand. Have a lamp in series with the testing wires when using 110 volts, as otherwise the worker may get a severe burn in case of a ground. Besides, the lamp will readily indicate the ground.

The commutator should be assembled on the shaft and connected to the windings as on the 150 Watt dynamo, connecting the end of a coil to the segment next beyond. In winding and making connections neatness is a very important factor. It not only gives a better appearance to the machine but it also results in a better working machine. Wires that are laid evenly, straight and tight will stay in place very much better than wires laid haphazzard.

The field should be wound with 714 turns, or more, of No. 20 S. C. C. magnet wire to each pole. Wind the poles as full as possible; if more than the above number of turns can be put on the more efficient will be the dynamo. The same method of winding should be followed on this machine as described for the 150 Watt generator. This and the 150 Watt dynamo are shunt wound machines, and so the connections of field and armature will be the same.

Use a 1½ in. pulley with a 1½ in. face and drive with a 1 or 1¼ in. flat belt. Determine the direction to drive the dynamo by applying current from 10 or 12 dry cells, or any source having 15 volts. It will run as a motor in the same direction as driven for a generator.

The field winding will require approximately 4 lbs. of No. 20 wire and the armature will require about 1/2 lb. of No. 20 wire.


75 WATT DYNAMO
DEC 1906
I.M.C.
SCALE
CORE
PUNCHINGS
PIN
FLAT HD MACH SCR 10-24
FIELD BORE 2 1/8
8 1/2"
4 5/8"
2 1/4"
3"
6"
5 1/2"
3 1/16"
2 1/2"
1 1/2"
1 1/8"
.3125

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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New advertisements 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, 1907.

SKILLED OR UNSKILLED.

The present strenuous condition of manufacturing finds the supply of skilled labor entirely inadequate to meet the demand, and employers are obliged to accept even the most ordinary applicants and pay them full journeymen's wages, that orders may be filled without too great delay.

The city of Boston recently opened a free employment bureau, and during the first two days, over 1500 applicants for work were registered, of this number about 1100 were young men, physically able and willing to work, but possessing no vocation; that is, were classed as "unskilled." Quite a large proportion of this number had received a common school education; a smaller number were graduates of grammar and high schools. All professed to be anxious for work of any kind, but unable to obtain it, largely owing to lack of skill.

The coincidence of these two conditions points a lesson to every youth in the country; one also, which parents should consider to a far greater extent than is generally the case. Had the applicants for work at the employment agency been trained in any of the leading trades, all would have been able to obtain employment at good wages, and the manufacturers of the country would be able to enlarge their output to more nearly meet the demands.

The underlying cause for a lack of skilled labor and an excess of the unskilled, may be, to quite a large extent, traced to the desire of school graduates to obtain a "position," and "overalls" are not looked upon with much favor. The error in such views is not seen until later in life, when the skilled mechanic, shop foreman or superintendent enters a store and from a well filled purse, pays a former school companion for a tool or article purchased.

The difference between a skilled craftsman and a store or office clerk lies in the fact that the former possess in his skill something for which there is always a demand, and which alone will bring advancement and increased reward. It differs from the knowledge of merchandise or office routine acquired by a clerk, in having a much wider field and more fixed scale of remuneration, making the matter of employment largely one of skill rather than locality or time.

The clerk without employment, on the other hand, must search until an opening is found of a like or similar nature to that for which he has been trained. Conditions may be such that this is a very difficult thing to do, and the personal necessities so pressing that some other and less desirable kind of work be taken.

In the way just mentioned arise that large class of "unskilled," or only partially skilled or trained; the degree of skill or training not having reached a point sufficiently in advance of a multitude of others to command a sure place in the industrial system. It is quite probable that in the near future the opportunities and inducements for learning trades will be greatly enlarged, and anyone desiring information regarding opportunities for learning a trade will be given every possible assistance.

The supply of complete sets of bound volumes of this magazine are being rapidly disposed of. They supply more information of value to the amateur than can be found in other books costing many times the price. If you wish for a complete set, send in your order at once. Sets will be sold in partial payments of $2.00 per month for four months, to anyone furnishing two acceptable references.

Owing to the large demand for castings for the dynamos being described by Mr. Ira M. Cushing, we are having patterns made up and shall be able to offer the castings and parts as premiums at an early date.

Be sure and enclose stamp for reply to letters of inquiry. No reply will be sent to postal requests, other than those relating to the magazine.

An increase in size of four additional pages in this number.

The shadings of all colors begin with white and end with black. White may, therefore, be considered as the color from which all other colors emanate and black as the one in which all others disappear.

Homer mentions brass money as in use 1184 B. C. among the Greeks.

CONSTRUCTION AND MANAGEMENT OF GASOLINE ENGINES.

CARL H. CLARK.

VIII. Lubrication and Lubricating Devices.

The question of lubrication is one of vital importance in gasoline engine operation. The thoroughness of the lubrication has a very direct effect upon the life of the engine. An engine may be badly damaged by a short run because of insufficient lubrication. The cylinders especially must be well lubricated, as a lack of lubrication under the extreme heat conditions will cause the piston to stick and finally cut the cylinder.

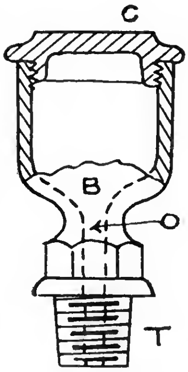


Fig. 53.

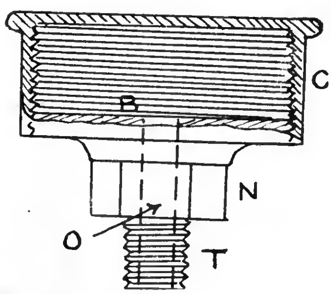


Fig. 54.

The principle means for feeding the oil are illustrated in Figs. 53, 54 and 55. The first, or plain oil cup, is simply a brass casting *B*, screwed into place by the thread *T;* the screw cap *G* allows the body to be filled with oil, which gradually feeds down to the bearing through the hole in the stem. This style can be used for ordinary bearings where there is no outward pressure. Fig. 54 shows a grease cup for feeding the solified grease. It consists of a cap *C*, which is threaded inside over its entire surface. The end of this cap is closed by the flat disc *B* which fits the interior thread and is provided with a stem and thread end *T*. In operation, the cover *C* is filled with grease, and then screwed down over the disc *B*, the pressure forcing the grease out through the hole*O* in the stem and on to the bearing. The cover *C* can be gradually screwed down until all of the grease is exhausted. This form is used where the pressure on the bearing is great, as on the main journals.

Fig. 55 shows a sight feed oil cup for feeding oil against pressure, as to the cylinder. It consists of a section of glass tube, *G*, closed at the ends by the heads *C* and *F*. The entral tube is a projection from the lower bead *T*, having its upper end threaded, over which the head *C* screws. The head *C* is screwed down tightly, with a ring of packing placed under the edges of the glass *G* to make a tight joint.

A threaded stopper *f* allows the body to be filled with oil, which can flow through the small opening *o*, down through the central opening and so down to the bearing. A section of smaller glass tube *g* is inserted, as shown, and the body has a circular opening *o* through which the flow of the oil from above may be observed. A side tube *P* leads from the lower chamber

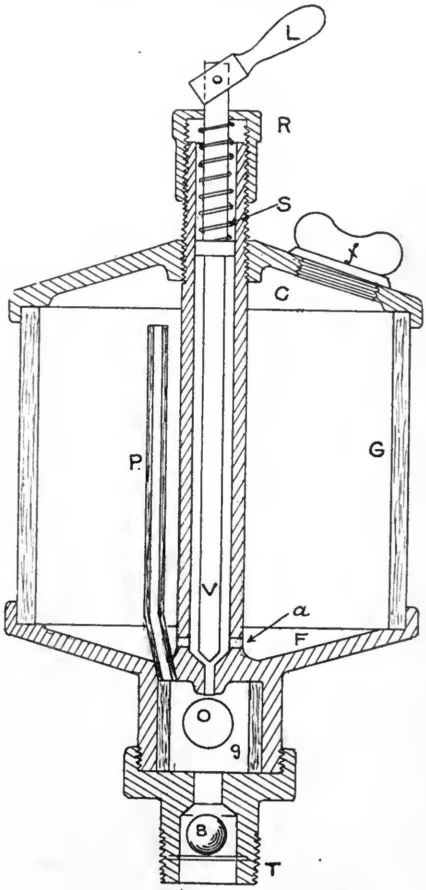


Fig. 55.

up above the body of the oil to admit the pressure and prevent the formation of a partial vacuum above, which would finally prevent the feeding entirely. The small plunger *V* fits into the seat just below and is held in place by the coiled spring *S*.

The lever L is pivoted to the end of the plunger V; when this lever is horizontal it is free and the plunger *V* is in its seat, stopping the flow of oil. When *L* is raised to a vertical position it raises the plunger *V* and allows the oil to feed. This lever *L*, in its upright position, bears on the top of the cap *R*; this cap is threaded on the end of the central stem, and may be raised or lowered, thus regulating the amount which the plunger *V* is raised by the lever *L*.

The ball *B* is designed to prevent a sudden inrush of pressure by being carried up into and closing the opening just above. The whole device is, of course, exposed to the same internal pressure, so that the oil

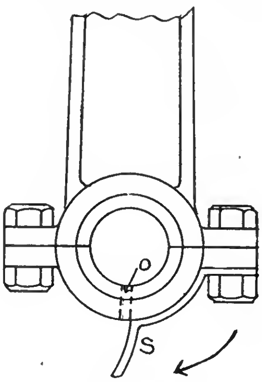


FIG. 56.

can feed by the action of gravity. The ball *B* prevents the pressure blowing through into the cup above and allows the plug *f* to be removed and the cup filled while the engine is running. By turning down the lever *L* the supply may be stopped when the engine is not running.

The lubrication of the cylinder is done by means of a sight feed cup so placed as to deliver oil at a point near the middle of the piston stroke. This oil cup is

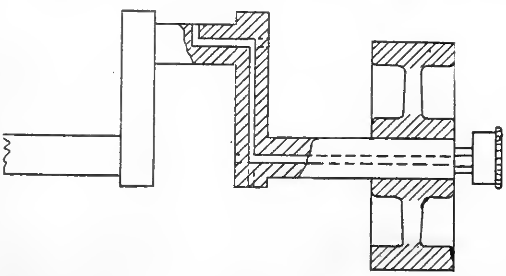


FIG. 57.

shown at *O*, Figs. 8, 9 and 11. The lubrication of the piston is one of the most important and is perhaps the most difficult point to lubricate.

The high temperature of the cylinder, which is estimated at at least 1500 degrees, is sufficient to burn almost any kind of oil. The carbon deposit thus formed gathers in the counterbore, and passages, and on the igniting gear or spark plug; such a mass of carbon will frequently become heated and fire the charge during the compression stroke, causing pre-ignition. The gathering of the soot on the sparking points also insulates them and partially or entirely prevents sparking. Cylinder lubrication and, in fact, all lubrication is improved by a judicious use of graphite. This substance has the quality of filling up the small pores of the iron and rendering the surface smooth and glassy. A new cylinder especially is greatly benefited by the use of graphite, as with even the most careful finishing of a cylinder there are innumerable minute cavities, each of which is a small producer of friction. Graphite will fill up these cavities and give the surfaces of piston and cylinder the glassy effect which denotes the proper condition. The smoothness of the surfaces allows a better fit of the piston rings, which increases the compression. The lessened friction also increases the life of the cylinder.

Graphite may be fed into the cylinder with the oil through the regular cup. This, however, is not advisable, as it is apt to clog the small openings and an independent method is desirable. If a priming cup is fitted to the engine the graphite may be fed through it after being mixed with a small amount of kerosine or cylinder oil. It may also be fed in through the spark plug opening, but care must be taken to not allow any flakes to lodge upon the spark plug, which will cause a short circuit. It is not always advisable to depend upon the graphite alone, but by its use less oil and a thinner oil will be needed, with proportionately less trouble from carbonization.

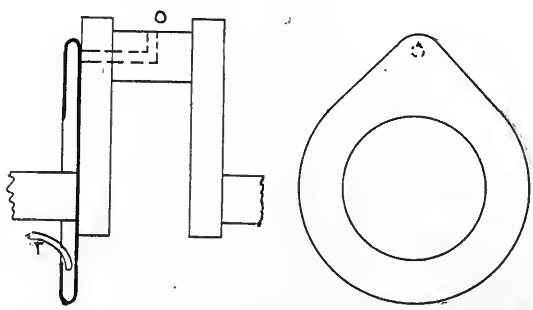


FIG. 58.

The wrist pin as a rule requires and receives scanty lubrication. An axial hole is usually provided with a radial hole opening into the bearing. Oil from the cylinder walls is supposed to work its way along this hole and into the bearing; very little, however, can do so. The rotation of the rod is slight, however, and much oil is not required.

The crank pin is lubricated in one of several ways, the most common of which is the splash system, mentioned in connection with Fig. 8, a detail of which is shown in Fig. 56. The small scoop *S* is made of sheet metal, and held in place by the bolts as shown. The base is partially filled with oil, a small portion of which is scooped up at each revolution and delivered to the bearing above through the small hole *O*. The direction of revolution is shown by the arrow. By the splashing of the connecting rod, some oil is also delivered to the cylinder walls. A very reliable method of crankpin lubrication is illustrated by Fig. 57; a small hole is drilled in the center of shaft, crank and pin to the surface of the crankpin bearing. It is drilled, as shown by the dotted lines, and plugs inserted to close the openings. This hole extends through to the front of the engine where a grease cup is fitted into the end of the shaft; in this way the grease may be placed directly upon the bearing. This method is good, but is somewhat in the way when using the starting handle. Another idea, which is used on some high grade engines is shown in Fig. 58. It consists of a shallow receptacle with an open centre forming a sort of ring, which is fastened to the side of the crank. This receptacle is drawn out at one point, at which there is a hole communicating with the axial hole *O* in the crank pin. Oil is delivered into the lip by the tube*T* from an oil cup above. As the shaft revolves the oil is thrown into the circumference of this ring and finds its way to the bearing through the hole *O*. In this way a continuous feed may be had.

The main bearings of two cycle engines are usually fitted with grease cups, as at *G* in Figs. 8. 10, and 11, mainly because the grease by its viscosity prevents the loss of base compression by leakage through the bearings. Where an open base is fitted, as in Figs. 16 and 17, a cup for oil may be used as at or even a cup like Fig. 53.

On engines with several cylinders it is customary to fit a multiple sight feed oiler, having several supplies, each operating like Fig. 55. Each important bearing is then fed by a separate supply.

There are several varieties of forced feed oilers consisting of several small pumps run by a common shaft and each supplying a bearing. The shaft is run by gearing or belt from some part of the engine. The use of the forced feed oiler assures a steady supply to each bearing, and this supply stops automatically on the stopping of the engine.

The smaller bearings are fitted with the screw cap oil cups or simply a countersunk hole to receive a few drops from an oil can.

It is a practice of some people to mix the lubricating oil with the gasoline in the proportion of about a pint of oil to five gallons of gasoline. The presence of the oil seems not to affect the vaporization, and the oil is thus carried to all the working parts of the engine which are in its path. It also avoids the necessity of filling and watching the oil cups.

The question of the amount of lubrication is a matter of experience with the particular engine in operation and can only be settled after a considerable amount of experiment.

MORTISE AND TENON JOINTS.

A tenon is a tongue or projection of reduced size formed at the end of a piece of wood, and a mortise is a corresponding slot or recess cut to receive it in the side of another piece. The end of the tenoned piece thus fits into the mortised piece, preventing lateral movement of the parts in relation to each other, permitting them to meet in the same plane, and forming a joint which can easily be held together by glue, pins, or other means.

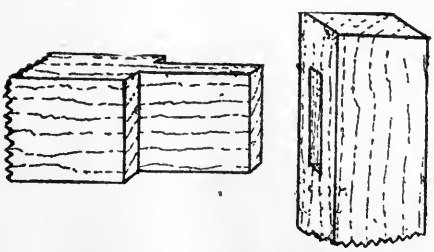


Fig. 1.

These joints are very common in carpentry and joinery, and in a less degree in pattern-work. They are suitable for framed articles where the members are long but compact in section. For broad surfaces they are never used, and for long-edge joints only when end grain meets side grain in which mortices can be cut; but, even then, they are rarely employed.

There are many varieties of mortise-and-tenon joint, but the differences are chiefly in the shape and proportion of the tenons in relation to the member they are formed on. There are first two important differences in the length of tenons. In one, the tenon, and consequently the mortise, cuts through the mortised piece, the end of the tenon usually being flush with the external face. In the other, the tenon only penetrates to a short distance, the mortise being correspondingly

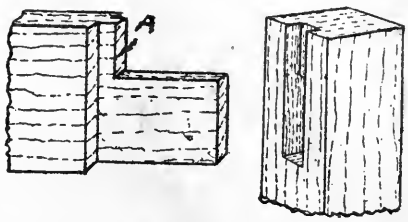


Fig. 2.

shallow. Both these forms are very commonly employed, the first being a through, or ordinary, tenon; the latter a stub, or stump, tenon. The through tenon makes a stronger joint, but there are a number of considerations which make the stub tenon quite as popular, even in work where strength is the first consideration.

The main function of the stub tenon in heavy work is usually not to hold the parts together, but to prevent their getting out of place laterally, the holding together being accomplished in some other way. In other cases, though not very often, a through tenon

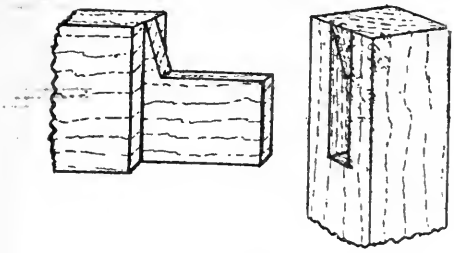


Fig. 3.

would be so long that a shorter one would hold equally well, or quite as well as necessity demanded. Another consideration is the weakening effect of a deep mortise, which diminishes the strength of the piece it is cut in.

In its simplest form an ordinary tenon is proportioned as in Fig. 1. It is made the full width of the

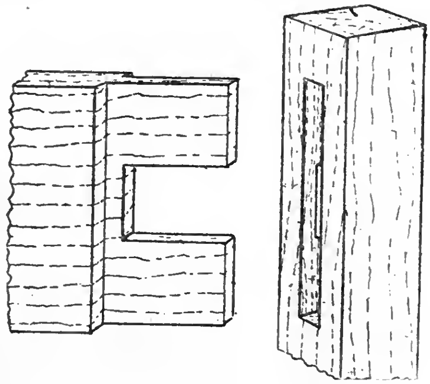


Fig. 4.

piece it is formed on, and of one-third the thickness. When the width exceeds five or six times the thickness, it is advisable either to reduce the width of the tenon, or to divide it into two parts. The former plan often

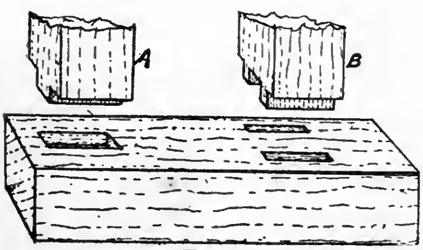


Fig. 5.

has to be adopted in cases like Fig. 2, where the mortise occurs at the extremity of the member, and it is desired to avoid cutting through the end grain. The tenon, then, even if well proportioned in itself, is reduced in width as shown, generally with a short stump called a haunch, A, but sometimes the cut-away portion extends completely to the shoulder. The advantage of the haunch is that it prevents warping or twisting of the members in relation to each other, as completely as if the tenon extended the full width. Fig.

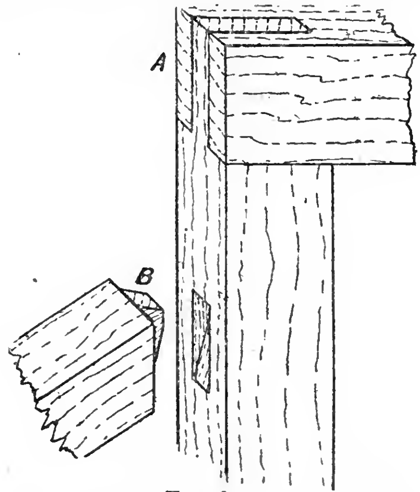


Fig. 6.

3 shows how the haunch may be tapered to nothing at the top, so that it will be invisible when the parts are together. This slightly reduces its efficiency. In Fig. 4 a pair of tenons are shown with a haunch between.

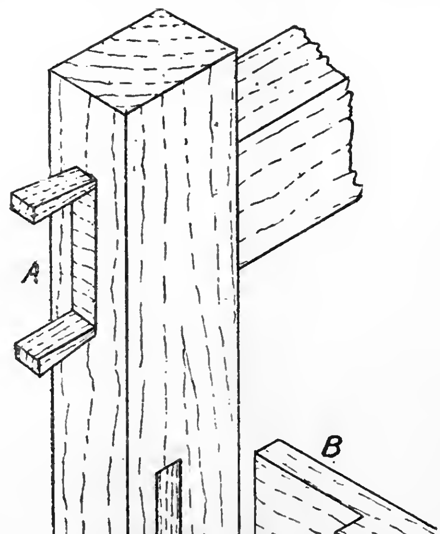


Fig. 7.

In this case the piece is so wide that a single tenon running completely across would be no stronger, and would be more likely to cause trouble through warping and shrinkage than when its middle part is removed as shown. The mortised member, on the other hand, is decidedly stronger with the mortise divided than it would be with one long mortise for a single tenon. The opposite course might be adopted of having a single reduced tenon in the midle with haunches on each side, and circumstances sometimes necessitates this; but such a joint would not be so secure as one with a tenon at each end.

A stub tenon is shown in Fig. 5 at A. Its length depends on the proportions of the parts and on other circumstances; but it is seldom made to penetrate far.

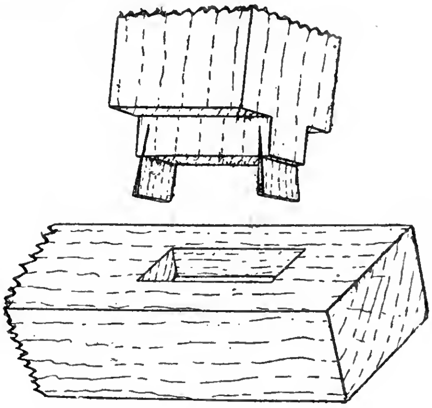


Fig. 8.

At B, Fig. 5, a double stub tenon is shown. These are employed to prevent twisting when the thickness of the parts is considerable. Being divided in this way, the mortised part is kept a great deal stronger than it would be if an equally effective single tenon was employed. A point to be remembered in cases of this kind is that the longer way of the mortise should always run with the grain of the wood. Double tenons, therefore, are often necessary, where, if only proportions had to be considered, a single tenon at right angles to the grain would be simpler.

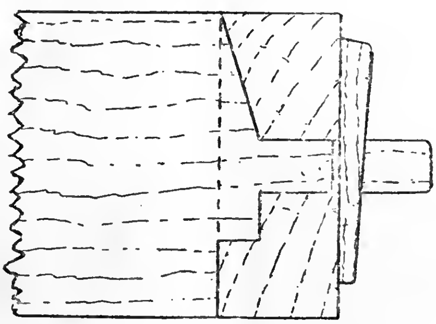


Fig. 9.

Fig. 6 A is a case where the tenon is not haunched, as in Fig. 2. It is not so often employed as the latter, and, of course, cannot be wedged, but must be screwed or pinned. It is more suitable for heavy work than for light; but in many cases a half-lap joint would be employed in preference to it. Fig. 6, B, shows a stub tenon for parts meeting at an angle. A through tenon in such cases is seldom employed. There are numerous other slight variations of the form of stub shown. Very often the tenoned timber is notched into the surface of the other as well as tenoned.

When mortise-and-tenon joints are not held together by external attachments, they are secured either by pins or wedges, and in joinery and small work are usually glued. In very light work glue alone is often relied on; but when this is not sufficient wedges are generally employed as well. Pins are better adapted for rough work, either with or without glue. Wedges hold the parts together by being driven either into, or alongside of the end grain of the tenon, making it club or dovetail shaped, the mortise being tapered to suit, so that the parts cannot be withdrawn while the wedges are in place. To make a secure point, therefore, glue should be used with wedges. In Fig. A, an ordinary joint is shown with wedges partly driven in. The mortise is cut slightly larger, and tapered to receive them, and the glue holds them to the tenon after they are driven. The ends, of course, are trimmed off flush in finishing the work. In cases where extra security is required the wedges are driven into saw-cuts in the tenon itself. Sometimes four wedges are inserted, but two is the usual number.

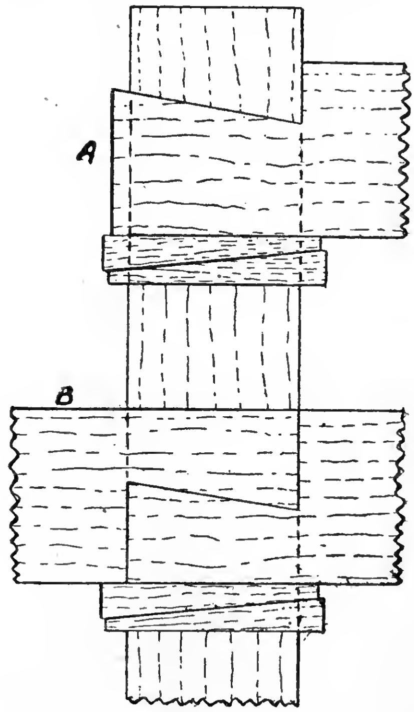


Fig. 10.

Fig. 7. B is a barefaced tenon. This differs from an ordinary tenon in being shouldered from one face only. It is employed chiefly for thin rails which have to be made flush on one side with the posts they are tenoned into.

Fig. 8 shows how a stub tenon is fox-wedged. The wedges in such a case cannot be inserted after the parts are together, and so they have to be forced home by the closing of the joint. Generally, however, stub tenons are not wedged. Fig. 8 also shows how the saw-cuts, both in stub and ordinary tenons, should be slightly out of parallel with the tenon, to lessen the risk of withdrawal.

When pins are employed for holding the joint, they are inserted from one face of the work, at right angles to the direction in which wedges are used. Screws or nails are often employed in this way, but more commonly wood pins or pegs, roughly pared to octogonal section, with a slight taper lengthwise, which are glued and driven into holes bored for them. Usually they do not go completely through the parts, but remain visible only from the face they are driven in at. When pins are used, they are made to assit in pulling the parts together by draw-boring; that is, by making small holes in the tenon slightly out of centre with the larger ones in the side of the mortise where the pins are entered. The work is usually cramped together before the pins are inserted, so that their function is not so much to pull the parts together as to maintain them so when the cramps are removed.

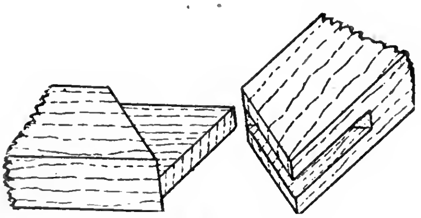


Fig. 11.

In some joints the end of the tenon is made to project considerably beyond the mortise, and a tapering pin is driven through the tenon only, as in Fig. 9. In such a case no glue is used, but the pin itself pulls and holds the joint together as tightly as may be required, and also permits it to be taken apart again by knocking the pin back. Fig. 9 is called a tusk tenon, and is employed for uniting heavy timbers which meet in a horizontal plane, the joint being designed specially to afford the maximum support to the tenoned end, with the minimum weakening of the mortised timber which supports it. As a beam is strained least in the central plane, it is only in that part that the tenon is allowed to pass through. Below the root of the tenon a short tusk is formed to prevent its geting sheared off, and it is similiarly strengthened above by a projection which tapers to nothing at the top, in order to cut as little as possible from the mortied beam. The weight of the tenoned timber is carried partly by the portion the tusk rests on, and partly by the longer support in which the slender tenon bears. In some cases, when the supporting beam is wide, or when timbers enter on both sides, the tenon is not carried through, but held by a pin inserted through a hole in the mortised timber. All the parts of a tusk tenon are of the same width as the timber they are formed on.

Fig. 10, A and B show dovetailed tenons held in place by folding wedges. In A, one timber only is tenoned into the post, which is usually thicker than the timber that enters it. In B two ends meet, entering the mortise from opposite sides. These joints are employed more for work which has to be taken apart than for fixtures. They are suitable when the timber in which the mortise is cut is thick, and the tenoned pieces thin. The latter, in fact, are generally not, strictly speaking, tenoned at all, but enter at their full thickness, and are dovetailed on one edge. Stub tenons also can be secured in this way.

Fig. 11 is an open mortise and tenon with shoulders mitred instead of square, like Fig. 6 A. It is, of course, not so strong as the latter, and is mitred for appearance. In cases where only one face shows, its strength is often increased by mitring the front only, and leaving the back shoulder square.

In large well-equipped shops, mortises and tenons are cut by machines. By hand, mortises are partly bored out with a bit, and finished to the lines with a mortise chisel, or they are cut by chisel and mallet alone. Tenons are sometimes sawn to the line, but more frequently their shoulders are finished with a chisel, and their faces with a rebate-plane. Scribed and guaged lines are used everywhere in preference to pencil. The thicknesses of tenon and mortise are gauged with a mortise-gauge, which markes both lines simultaneously. The shoulders of the tenon and ends of the mortise are marked with square and scribe. If the tenon is a through one, it should be long enough to allow for dressing off after it is in place. A stub tenon should be a trifle short in its mortise to insure a close fit at the shoulder. The latter should be slightly undercut to insure close contact at the exterior.

THE ORIGIN OF PEARLS.

Many suggestions have been made as to the origin of pearls. According to one theory, pearls arise from secretions caused by the presence of some foreign object, such as a grain of sand, within the shell of the oyster. But it has been shown that fine pearls are not thus produced, but only pearly concretions. Another theory is that pearls are the result of disease in the oyster. M. Seurat of the Oceanogaphic Museum of Monarco, believes that the origin of pearls is to be ascribed to the presence of a parasite. The species of parasite differs with the species of oyster, but this mode of origin is general with all fine pearls. To restore the luster of a "dead" pearl the outer tarnished envelopes may be removed by acids. Thus the effect produced upon a tarnished pearl by causing a fowl to swallow it is accounted for by the dissolvent action of the gastic juice.

SOME NEW IDEAS AS TO EXPOSURE AND DEVELOPMENT.

WALTER ZIMMERMAN.

Beginning with the successful result of the theory that like development produces like results in the making of negatives, a theory upon which the writer has worked for some years and which has been put into practice by the tank developing machines, there are many things which are new to the photographer who still adheres to the old methods. It is useless to enlarge upon the uniformity of tank development except to say that special attention to each individual negative is usually labor wasted.

The man who wants the same class of negatives every time, has only to get the right developer, one to suit his plate or film, and then find the time of development for either, as the case may be, and save his time for other things while the developer is producing better results than if the negatives were being handled and watched.

There is, however, a long step beyond all of this. The photographer, amateur or professional, may obtain any effect that he may desire from pactically any one kind of photographic surface by thoroughly grasping the higher principles of exposure and development. This may seem to apply a contradiction to the former theory; on the contrary, by true development each operator obtains or may obtain just what suits his particular purpose and each will obtain individual results by his individuality of method as manifested in exposure, strength of developer and duration of development. This then brings us to the newer theory concerning which I am now writing.

In negative making let us observe first, what different effects would be wanted by different workers or by one photographer for different purposes. For instance, by A, a very thin negative full of detail for "soft," "low-tone" printing. By B, a negative giving strong effects and printing great contrasts in lights and shadows. By C, and by the great majority, a negative with good detail and with sufficient variety as to light and shadows. By D, a negative in three tones, light, dark and middle, with elimination of detail. We will say that A works for low tones for exhibition purposes and is strictly non-commercial. B is an amateur whose ideas of beauty in photography is the strength of the negative and the contrast in the print. C is a commercial photographer or an all-round amateur who does not reach after impressionism. D is an exhibition photographer, an impressionist, at the other end of the scale from A and may be A himself working on totally different lines as if frequently shown in a collection of one man's work producing both "low-tones" and "poster" effects.

Many readers will say that but one result can be obtained with one particular plate and one paticular developer. The man who so believes may want to read this article; the man who can successfully produce the four effects from one plate and one developer may not. The former will probably say that for four kinds of results he must use four kinds of plates and four kinds of developers. He shows his advancement by being able to obtain these varied results by any means whatever; but he will show still greater advancement by being able to obtain all with a single set of tools instead of four. The "easy" way to get the four effects is thus: For A's negatives, a fast plate usually, instantaneous orthochromatic, over-exposure and weak developer, such as dilute metol. For B's negatives, a slow plate, just sufficiently exposed, and strongly developed. For C's negatives, a fast or medium fast plate with full, not over, exposure and medium development with strong metol-hydroquinone or pyro. For D's negatives, a slow plate decidedly underexposed and greatly over-developed, such as with hydroquinone. It will be something, at least, for many of our readers to know how these very different results may be obtained, even if, as I say, by different sets of tools.

Now to work on the practice of our advanced theory; we have several kinds of plates giving, as is supposed, as many different effects in negative making. They are generally the 1st, extra rapid; 2nd, extra rapid orthochromatic; 3rd, medium fast; 4th, the slow; 5th, the very slow, and, 6th, the double-coated fast plate. Illustrations of these six general classes of dry plates are:

1st. Cramer's Crown, Seed's 27, etc.
2nd. Cramer's Instantaneous Isochromatic, Seed's Rapid Orthochromatic.
3rd. Cramer's Anchor, Seed's 23.
4th. Cramer's Contrast.
5th. Seed's Process.
6th. Seeed's Non-Halation and Standard Orthonon.

Can the theory be made to apply successfully to these six classes of plates? The relative exposure required to produce the usual average results with each are as follows: Nos. 1 and 2, one; No. 3, three; No. 4, six; No. 5, ten and No. 6, one and one-half. After learning the average exposure of each of these varieties we can proceed to work out our theory. The non-halation plates are placed last in the list for the reason that with strong development they give even greater contrasts than classes 4 and 5.

Let us suppose the No. 1 class as being the only kind of dry plates that the worker has on hand and the stock solution of metol-hydroquinone is the one developer. The formula is as follows:

Water, nearly hot	4 ounces.
Metol	1/2 ounce.
Sulphite, dry	4 ounces.
Hydroquinone	1/2 ounce.
Carbonate, dry	6 ounces.

For ordinary use dilute with equal quantity of water. To produce A's effects: over-expose the plate, make developer one-fifth average (with stock solution, one part to ten of water), and give three or four times, instead of ten to twenty times, period of development with usual solution. Use no bromide. To produce B's effects: expose barely enough for shadows and use normal developer, full development. Use slight excess of bromide. To produce C's effects: give correct exposure for shadows and normal developer and development, normal use of bromide. Further modifications may be made in the use of intensifiers and reducers; ferricyanide-hypo intensified increasing while the persulphate-ammonia diminishes contrasts and any intensifier increasing contrasts. The whole theory as to development stands largely upon the axiom that strong development exaggerates contrasts and that weak development diminishes it.

Now go to the other extreme and to obtain the four kinds of effects from the slow or very slow plate. Plate clases 4 and 5; the difficulty seems greater, and to many the thing will seem to be imposible, but we will proceed. First of all one must learn the requisite exposure of the slow plate emulsion to be used, in order to obtain full and complete detail in all shadows regardless of what may happen to the parts of the negative representing the high lights. There are very few who know how to give full exposure for slow plates. With this knowledge work in this way: For A's effects, give at least five times the exposure for complete detail in the shadows and develop with a developer diluted with twenty times the normal amount of water, no bromide. For the stock solution given herein use forty parts of water. Ordinarily, the slow plate develops much more rapidly than the last one. For A's negatives with twenty times diluted developer give ten times usual development with normal developer.

Right here should be given the caution that in using very dilute developer, the development should be by tank or with very deep trays filled to the brim in order to have a sufficient quality of the chemicals to produce the necessary results. For B's effects with a slow plate, give nearly full exposure to shadows and use normal developer. This kind of plate is ideal for B's results. Use a little bromide. For C's effects, that is, to obtain the usual "good" negative, slightly over-expose for shadows, make developer one-fifth usual strength and give five times usual period of development, omitting bromide. For D's effects, use the slow plate which is ideal for poster work. Expose for high lights and use normal developer, with bromide. Of course the average or medium plate, class 3, is for the average work and to this class our theory is particularly applicable as obtaining the greater variety with greater ease. Exposing for shadows should be learned as with the slow plate.

For A's effects with class 3 plates, expose several times over that for shadows and weaken developer to one-tenth; under-develop and use no bromide. For B's effects: expose for shadows and use normal developer with some bromide. For C's effects: expose for shadows and use developer one-half normal and no bromide. For D's effects: expose for high lights, use normal developer with bromide and full development.

The things which the writer, as well as the reader, has to contend with in learning the means of working on this interesting theory are, the lack of exact knowledge on the part of far more than nine-tenths of the bulb-squeezers and button pushers. Please, reader, do not feel offended, as this cannot posibly mean you, as to two or three important points referred to, for instance: "normal development," "exposure for shadows," and the correct use of bromide of potash, so that a brief reminder on these points will be useful. Normal development means such development of a properly expressed plate as will give correct definition in the lights and the darker parts of the resulting print. Exposing for shadows means disregarding the effects of the strong lights and exposing for the poorly lighted colored parts of the view or subject. The correct use of bromide is that which will avoid the darkening of the unexpected film by the chemicals.

I writing technical articles of this kind, one need lay aside personal ideas as to his individual methods and treats only of the general idea of getting every thing in the negative. An article of this kind is meant to show what an average worker does in order to produce a given effect, nevertheless the four general effects here described will cover fairly well those sought for and obtained by the photographic workers of all schools and classes; for instance, A, illustrates the "low-tone" impressionist; B, the very new amateur; C, the average "good" photographer, and D, the "broad" impressionist.

In order to obtain good results from the working out of this theory the photographer should ignore a third theory; that of factoral development. It is a theory that will not work in all-round practice. The factoral theory is, this: multiply the time of the appearing of the image by the factoral ratio of the developer. The theory answers very well with a normally exposed plate but it is the most fallacious when applied either to the over-exposed or under-exposed plate. Let readers who like to experiment try for themselves, follow instructions and observe results. The treatment for the best negative from an under-exposed plate is prolonged development with rather weak developer, the tray and plate being, of course, covered to exclude even red light, and the tray rocked ocasionally. The best results from an over-exposed plate are obtained by considerable over-developing and afterwards reducing to the proper printing density. Hundreds of over-exposed negatives are thrown away by failure to know or act upon this simple rule which is in flat contradiction of that of fractoral development.

Laying aside the subject of producing varied effects from one form of dry plate and with one developer, there can be great variety in the effect of the photographic print acording to the printing paper employed. For illustration: To print for softness and full detail, use a printing out or toning paper, and for richness of tone, as well as fair detail, use platinum paper. While these facts are interesting and useful, they are also well known to the advanced amateur or professional.

Let us now continue the illustration of our theory by showing how varied effects can be obtained from any one printing medium and with any one reducing agent or developer. The quick thinking reader will probably have already foreseen part of that which may be said on the subject, as the result of the description of the methods for working dry plates just given. Taking the printing mediums in the order in which I have named them, the printing out or toning paper has the least possible elasticity in the methods of working it. Some small modification can be made, even here, for the contrast may be increased by over-printing and then using toning and fixing baths made to "cut" the print, or else by having the toning and fixing considerably prolonged in action. The "Regular" Velox is next in its resistance to variety in printing effects but a considerable over-exposure and an inversely weakened developer with omission of bromide will produce flatness or softness with detail while the usual exposure and development tends to strong contrasts with this paper. The several grades, however, give a wide variety of results. Bromide paper is very much more like the dry plate in producing varied effects for the same negative in contact work, the rules briefly being as follows: To produce a soft detailed print from a dense, harsh negative, the worker should know, to begin with, that the proper or normal printing distance for contract work with bromide paper is five or six feet from the printing light. To produce softness and detail from a harsh negative, hold the printing frame one foot from the printing light and give double normal exposure using weak developer without bromide. Suppose that normal exposure five feet distance were twenty-five seconds, normal exposure at one foot would be one second, double exposure two seconds. The experiment is most interesting.

To produce contrast, print from a weak negative using bromide paper, supposedly a difficult thing to do, one may cut down the light to say one twenty-fifth or better, make the exposure at five times the normal distance; that will be twenty-five feet and the normal exposure will be twenty-five times that at five feet, in order to obtain the same depth of printing. Under-exposure, say fifteen times instead of twenty-five times that at five feet, and use strong developer with some excess of bromide.

To produce alternately, soft and hard results from the same negative, follow first the rules for the over-exposure at one foot and then those for the under-exposure at twenty-five feet, bearing in mind that the proportionate normal exposure at the two distances is as one to six hundred and twenty-five or as one second for one distance and ten minutes and a quarter for the other. The reader may know all of this but a reminder may save him good printing paper.

Singularly enough, platinum paper is capable of greatly increased or diminished contrast but this discovery was fully treated in my article on the subject which appeared in this magazine two or three years ago. Those who have read it will recall that to obtain great contrast the paper was to be over printed until the image should be reversed, development being by cold water only. For contrast and detail, print until the paper is almost uniformly darkened prior to reversal and develop with hot water. For softness from harsh negatives, print nearly to normal and use saturated developer, nearly boiling. I give this repetition very briefly for the reason that former issues (I won't say back numbers, for Camera Craft never is a "back number"). are unobtainable, having been destroyed in the great San Fransico fire. It is at the urgent request for "copy" on the part of my good friend the Editor, who has had his full share in the heavy losses from the fire, that I have very hastily prepared this treatise on a subject which ought to be a very interesting one.—Camera Craft.

VAPOR LAMP GIVING WHITE LIGHT.

The mercury vapor light, developed by American inventors, which in the form of long, glowing tubes, produces more light at less cost than any other practical method of illumination, and would be extensively used if it were not for the color of the light. It is strongest in the violet end of the spectrum, extending far beyond the limits of visibility in that direction and including an abundance of rays that can be photographed but not seen with the naked eye. This mercury glow light has made the "while you wait photography" of the pleasure parks a possibility, but it is too ghastly for common use. But recently German chemists have overcome this difficulty by putting into the electrodes other metals besides mercury, thus changing the character of the light. Zinc with 10 per cent of bismuth and a trace of sodium is used for this purpose.

A TWENTY FIVE FOOT AUXILIARY YAWL.

CARL H. CLARK.

III. Setting up the Frames and Planking.

After the moulds are all correctly set and the ribbands fastened, the form is ready to receive the frames. These frames are of oak 1 in. x 1½ in., and are spaced 9 in. apart, center to center. This brings three frames between each two moulds, with another bent in to take the place of the mould when the latter is removed. The positions of the frames are marked off on the bottom, and also on the top ribband to guide in bending them in evenly. The frames should be of rather green stock, as thoroughly dry stock is two brittle to bend readily. It is, in fact, many times advisable to obtain a fresh green stick and have it ripped up at the mill to the proper size. This green stock bends very readily and after it seasons in place there is no tendency to change shape.

In building a boat of this size, a steam box is very desirable, as there are many pieces which will require steaming to render them pliable. It should be about 12 ft. long and 10 or 12 in. square; it may be built of rough boards, but should be fairly tight. One end is closed and the other has a door. It should be placed in a convenient position and steam led to it from a wash boiler or teakettle, which may be heated by any convenient means, such as an oil stove.

A number of frames can be steamed at once, they being drawn out as required. The frames should be steamed until they are heated all through and very limber. A frame is then taken out and bent partially to shape over some convenient forms, such as a stiff barrell or similar shape. It is then put into the proper place in the form and bent out until it bears evenly against all of the ribbands; it is then clamped solid in place. Care must be taken to bend the frames quite sharply at the point where they leave the flat of the bottom, to take up the curve of the sides. A monkey wrench clamped on to the frame is sometimes used to obtain a sharp bend; one must, however, use care not to break the frame and destroy its strength. The frames extend to the center line of the bottom and may be fastened at once by two or more galvanized nails driven through it into the bottom.

The timbering may be begun at any desired point, but should continue equally on each side of the boat. As soon as each frame has cooled somewhat, the clamps may be removed for further use, and the frame held in place by pieces of wire wound around both frame and ribband, or in any other way which may be convenient. Very little fastening is necessary after the frame has "set." The top of the frames should be allowed to extend above the upper ribband a foot or more; a rope is then passed around the tops of the opposite frames and the tops drawn together somewhat to assure that the frames will not have too great an outward slope.

At the ends of the boat the frames will have a considerable amount of twist, and instead of following a square up the side, will tend to slope more towards the ends, giving them a sort of radiating appearance. There is no particular harm in this, and it makes the bending much easier. Abreast of the center board slot the frames should be kept clear the same as were the bottom cleats.

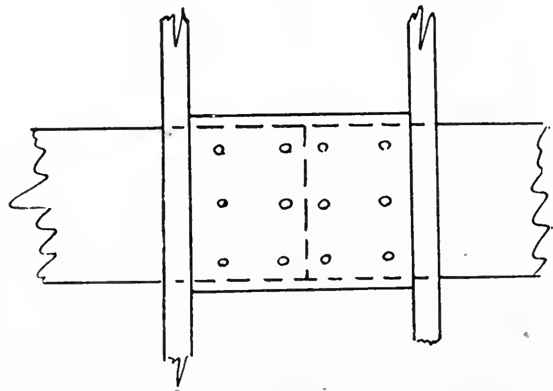


FIG. 17.

It is desirable that the frames be finished somewhat before putting in as there are certain places where they will show. Those between molds 2 and 5 especially should be quite well finished and the inside covers bevelled, as they come in the cabin and will show if the latter is not ceiled.

When the above work is done the frames should all be fair and touch all of the ribbands evenly; any small irregularities will of course work out during the planking, but any great unfairness may be removed by giving the frame an additional bend.

Stock for the planking should be 7/8 in. thick, and of cedar, pine, cypress or hard pine. The two former are the lightest, but cannot now be obtained generally in long lengths nor in wide boards owing to their scarcity. Cypress has lately come into use for boat building; it can be obtained in almost any length or width and is on the whole a very satisfactory material for planking. Hard pine is rather heavy, but is extremely strong and durable and easily obtainable. It is, however, harder to work than any of the others.

The kind of stock used must in any case depend upon the locality and what is obtainable; other things being equal, however, the writer would recommend cypress. Whatever stock is used should be gotten in lengths of about 15 ft. so that each plank will have no more than one butt or joint in it; the widths also should run from 8 to 12 in.

A little consideration and inspection of the form of the boat will render the work of planking much easier. A thin batten 3 1/2 in. wide, 1/2 in. thick and about 15 ft. long, and as near straight as possible, should be gotten out for future use. If this batten is laid up against the bottom of the boat about 4 in. from the rabbit, it will be noted that the straight line of its edge does not follow the rabbit in the bottom, but lands well up on the stem and stern board. The same effect will be noted if the batten is bent around the bilge. It is thus seen that the edges of the plank cannot be straight, but must have a curvature in order to bring the ends down to a reasonable height. It is for this reason that the stock for planking must be so much wider than the actual plank. The garboard, or plank next to the bottom, is the first to be fitted. Undoubtedly the garboard is the most difficult plank to fit and must be done first. Following out the above principle the garboard will be made narrow amidship and as wide as possible at the ends, so that the planks above will not have an excessive amount of curvature. The width amidships should be about 4 in. and at the ends about 12 in.

Perhaps the best way to fit this garboard will be to make a pattern from a piece of 1/4 in. stock. The forward and aft ends should be fitted separately. The 1/4 in. piece may be easily bent around and fitted by trial. It must fit nicely into the rabbit of bottom and stem at every point. When each portion of the pattern has been fitted they should be tacked in place, and the upper edges trimmed down until they join in an even, smooth curve. The pattern is now laid on the board, marked around and the shape cut out, one of each for each side. The plank itself must now be fitted by trial, but only a small amount of trimming should be necessary. To hold the plank in position, clamps may be hooked around the moulds, and shores may also be wedged between the plank and the floor. Care must be taken not to split the plank; a piece of board must always be placed under the end of a shore or clamp screw. When the two portions of the plank have been fitted they should be clamped in place and the over-lapping ends cut off just even and half way between two frames.

The fastenings of the plank to the frames may be one of three kinds, copper nails riveted over burrs or washers inside the frames, galvanized iron nails, or brass screws. The first is the most expensive, and the most work, but in the long run is probably the best. The second is the cheapest and perhaps the most common method. When carefully done so as not to split the frames in the proces it is a good fastening. The nails must, however, be clinched, merely driving them into the frames is not sufficient on such light work as

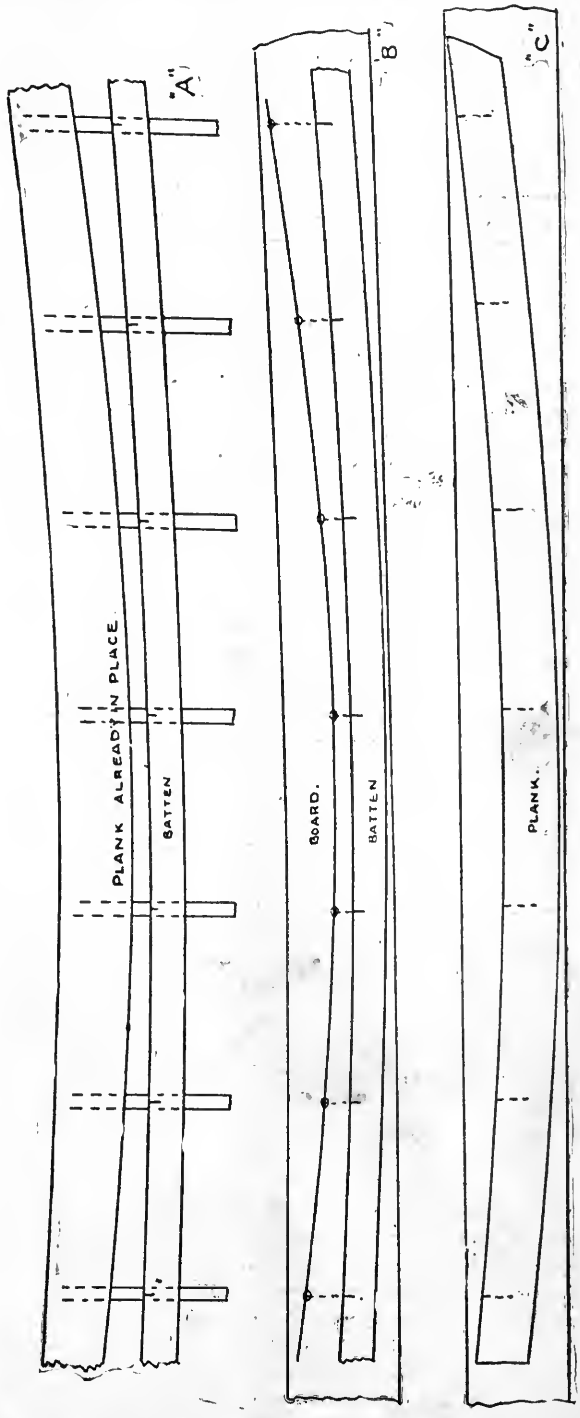


FIG. 18.

a small boat. The third method is a very good one if screws of sufficiently large wire are used. If the screws are too small the shrinking and swelling of the wood will break them off and destroy the fastenings. The writer is inclined for the present purpose, to recommend the galvanized nails. They should be the chisel pointed boat nails 2 in. long. A hole must be bored for each of such a size that the nail requires only a moderate amount of driving to set it up into place. The nails are driven with their points parallel with the grain of the frame, so as to clinch easily. They are driven so that their heads are sunk just below the surface of the plank, and the point clinched across the grain of the timber. To prevent the nail from backing out during the clinching, a heavy, pointed piece of iron, such as the head of a top-maul is held against the head; this allows the nail to be solidly clinched and the plank drawn up solid on to the frame.

If copper fastening is used, the nails should be of such a length as to project about 3/8 in. inside the frame, a copper burr, or washer is then driven on, the point is cut off about 1/8 in. outside of the washer, and headed down, the iron being held against the head.

If brass screws are used they should be about 3/8 in. diameter under the head and 1 1/2 in. long. Two boardings must be made, one through the plank, of the size of the body and another in the frame of the size at the bottom of the thread. The screw should be smeared with soap or grease before driving, and a bit brace with a screw driver bit used to set them up. Fastening by this method can be very quickly done.

The garboard can now be fastened in place in the manner chosen. Fastenings should be placed about ¾ in. from the edge of the plank, and should be spaced about 3 in. apart. A row of fastenings is also driven through the garboard into the overhanging rabbet of the bottom. These are about 4 in. apart and are driven carefully so as not to split either the garboard or the rabbet.

The joint between the two portions of the plank is now to be covered by a butt-block of hard wood, fastened over the joint on the inside, between the frames. This butt block should fill the space from frame to frame, as in Fig. 17, and be about 1/8 in. wider than the plank. Fastenings are then driven through the ends of the plank into the butt-block. The ends of the plank at stem and stern are fastened with either nails or screws.

The distance around the mould No. 4 from the upper edge of the garboard to the sheer line on No. 4 mould should now be divided into equal spaces of about 6 in. each. The distance on each of the other moulds is divided into the same number of equal parts, the length, of course, decreasing towards the ends. These lines are for use in fitting the other planks, to give an equal taper to all.

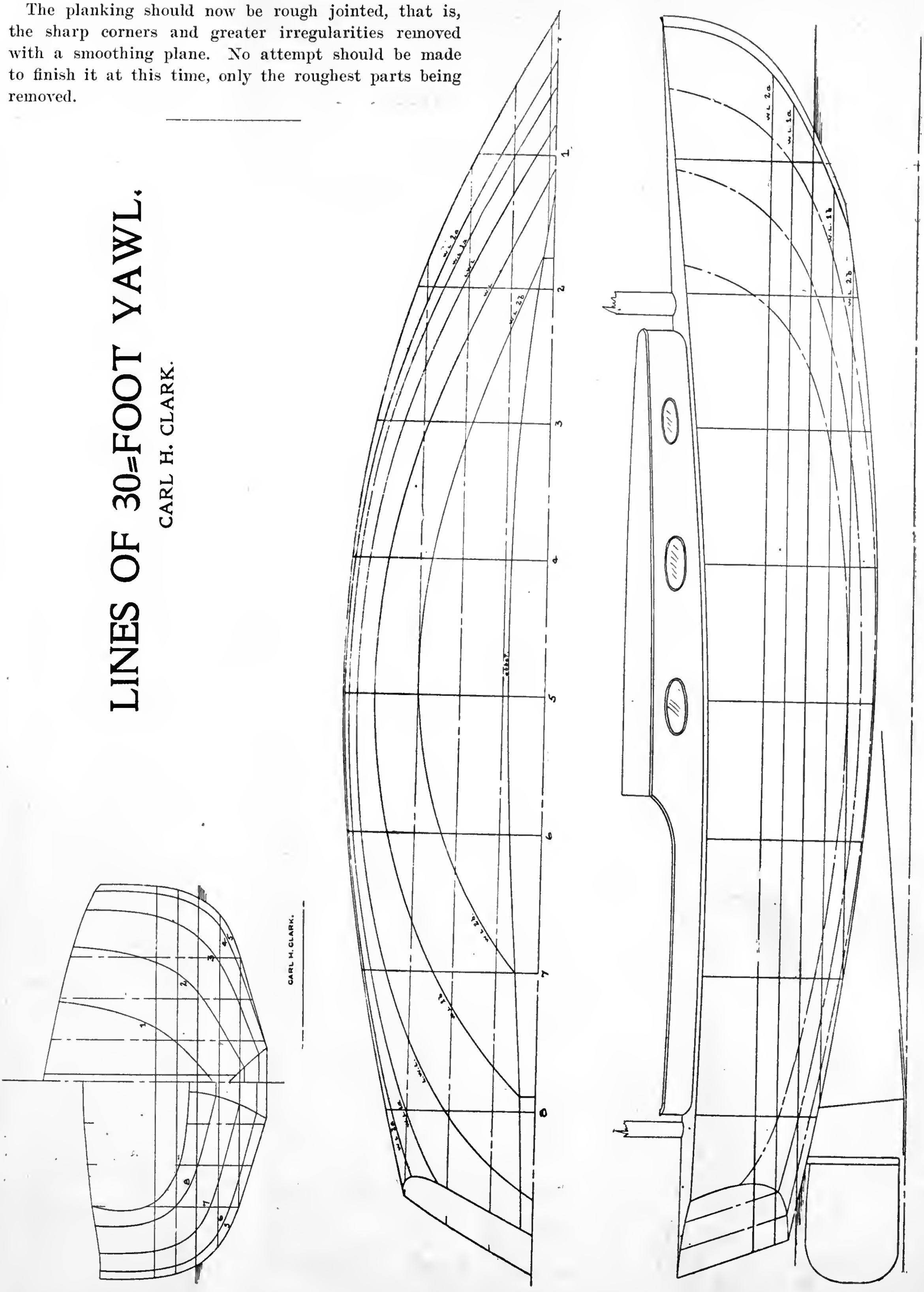
To fit the next plank a "spiling" must be taken, using the thin wide batten before described. The batten is clamped around the frames about 1 in. from the edge of the garboard and allowed to take its own natural curve without any forcing sidewise. The batten will diverge from the edge of the strake in a gradual curve.

Referring to Fig. 18, cut *A* shows a view looking up at the bottom, showing the plank already in place, the batten and the frames. The distances from the edge of the batten to the edge of garboard at each frame are measured and recorded, the centre of each frame is also marked in chalk on the batten. The batten is then transferred to the board from which the plank is to be cut, as in cut *B*. The distances just taken are then laid off from the edge of the batten at the proper point, giving the points on the curve as shown. This is the outline of the lower edge of the plank. The widths of the plank are then measured on each mould and laid off as in cut *C*, giving the upper edge of the plank. The plank is then cut out and fitted in place on the boat. The butt on this plank should not be placed over that in the garboard, but should be shifted about three feet away. The plank when cut out will require a certain amount of fitting, which is done by trial. Before fastening into place a duplicate should be marked out for the other side. When fitted, the plank may be fastened in place as already described. Planking should be continued up around the turn of the bilge, removing the ribbands as necessary. The top streak should now be fitted, great care being observed to have a good sheer line. The remainder of the plank are then fitted successively one below the other until the space is closed up. All the joints should be as close as possible and each plank should be forced down against the preceding one as firmly as possible. In order to make room for the calking each edge of the plank should be beveled slightly so that, while the planks are close together on the inside, they are about 1/16 in. open on the outside. The planks around the bilge will probably need to be hollowed slightly on the inside to get sufficient curvature without splitting the plank. Each plank should be fastened into place before fitting the next one. There are many schemes and devices which cannot here be described, but which will occur to the builder as the work proceeds. Numerous clamps are a necessity in planking and a very handy device consists of a chain passing down to the foundation, with a crew clamp for forcing the plank down against its neighbor. The various butts in the planks should be distributed as widely as possible and those in corresponding planks should be in the same position.

The projecting ends of the planks at the stern may now be trimmed off even with the stern board.

Several braces should be fastened across the top of the boat from frame to frame to prevent it from spreading and the mould may now be removed. If any change of shape is noticed upon the removal of the moulds, braces should at once be fitted to restore it. When the moulds have been removed, frames are to be bent in in their places and fastened.

The planking should now be rough jointed, that is, the sharp corners and greater irregularities removed with a smoothing plane. No attempt should be made to finish it at this time, only the roughest parts being removed.



LINES OF 30-FOOT YAWL.

CARL H. CLARK.

BOOKS RECEIVED.

MODERN MILLING MACHINES. Joseph G. Horner, M. E., 304 pp. 8 3/4x5 1/2 in. 269 Illustrations. Cloth, $4.00. The Norman W. Henley Pub. Co., New York.

Anyone at all familiar with the books previously written by the same author, expects much of any new one which may be announced. This one is no exception to the clearness, accuracy and attention to detail which characterizes all his writings, and the mechanic, foreman and superintendent, as well as the technical instructor, will obtain much valuable information from it.

In the present day specialization of manufacturing processes and the wide variety of work possible to certain twpes of machines, separate treatises are necessary to adequately treat them. This is particularly true of the milling machine, and the advent of this book is most opportune. As a guide to the correct and best methods of handling work it is invaluable, that of a character requiring special skill being given special attention.

The illustrations are numerous and many of them are fully detailed drawings reduced from workshop prints; the matter of obtaining speeds and feeds having received careful attention.

It is most certainly a book for every library making any pretentions towards supplying the needs of the technical reader.

PUNCHES, DIES AND TOOLS, for Manufacturing in Presses. Joseph V. Wodworth, M. E. 483 pp. 9x5 3/4 in. 702 Lllustrations. Cloth, $4.00. The Norman W. Henley Pub. Co., New York.

This book, like the one above mentioned, is devoted to a special class of metal work, and gives, therefore, a mass of detail and practical information of the greatest value to those engaged in that special line of manufacturing. It is somewhat of a companion volume to "Dies, Their Construction and Use," by the same author, but treats the subject in a broader and more comprehensive manner, containing much matter not covered in the previous volume.

A large number of valuable and interesting processes, rules, formulas and designs have been embodied in the work, making it of inestimable value in connection with the construction, use and adaptation of dies and presses tools which form the subject matter of the books.

So much in the way of sheet metal working can be and is done today in prcsses that anyone in charge of a shop where such work is done must be alive to all the kinks of the work, and this work will be of great value to all such. Instructors in advanced technical schools cannot well do without it; the larger technical libraries should have it on their shelves.

ALCOHOL FROM CORNSTALKS.

The Department of Agriculture is developing a new industry in the production of alcohol from corncobs, which, the department says, promises to be of much commercial value. Investigations are being made at Hoopeston, Ill., and have proved that the large quantities of corncobs which every year go to waste can be made to produce alcohol in sufficient qualities to justify the erection of a distilling plant in connection with a corn cannery.

So far the department has succeeded by simple methods of fermentation in getting a yield of 11 gallons of alcohol from a ton of green cobs, and, by similar methods, in getting 6 gallons of alcohol from a ton of green cornstalks. A department official says that these tests show that there are 240 pounds of fermentable substance in a ton of green field cornstalks, which will yield about half of their weight in absolute alcohol. In round numbers, a ton of stalks will produce 100 pounds of alcohol or 200 pounds of proof spirits. As a gallon of alcohol weighs nearly 7 pounds, there should be 15 gallons of alcohol in a ton of stalks. The addition of the corn on the cob adds further to the possibilities of alcohol obtainable from a ton of cobs, and will have its influence in bringing the quantity to a greater figure.

AMBER IN SANTO DOMINGO.

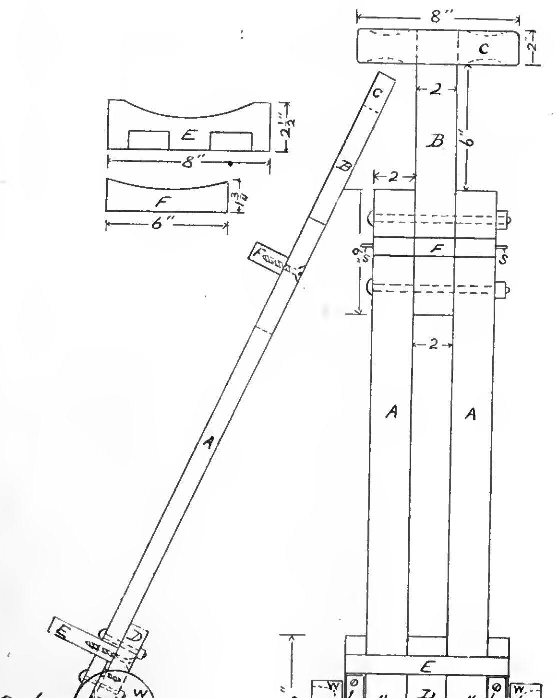
Santo Domingo is one of the few places in the world where amber occurs in any quantity. The bulk of the supply comes from the vicinity of Konigsberg, on the Baltic seacoast. There it occurs in the lower oligocene, and appears to have been deposited originally in glauconitic beds of clay, which was afterward eroded by wave action and the amber distributed, though much of it is taken from beds in which it was originally deposited. Amber is simply fossilized rosin, derived apparently from certain coniferous trees. The conditions under which it occurs in Santo Domingo do not appear to differ substantially from the Baltic seacoast. It is found near Santiago city, associated with lignite, sandstones and conglomerates. These beds probably belong to the oligocene formation and are found containing amber at a number of places on the north coast, as well as on both flanks of the Monte Cisti range. It also frequently occurs in the streams flowing through these beds. The amber is usually in ovate lumps, from the size of a pea to a man's fist, often flattened, dull on the exterior, being covered with a kind of brownish crust.

Distillation is the only process to obtain absolutely pure water. In the United States navy water aerated during distillation and run through a bone black filter for the purpose of improving its taste is exclusively used for drinking purposes.

ASH BARREL TRUCK.

WILBUR S. CHANDLER.

The periodical wrestle with the ash barrels that falls to the lot of city residents, where weekly collections by the official wagon necessitate regular attention to this dusty work, make any device welcome which will lessen the trouble and dirt. The simple truck here described is easily made, the materials costing but a small sum, and with it large barrels full of ashes may be removed from any cellar, the exit of which will allow of portable ways made of two boards held together with a few cleats, and spaced to allow the truck wheels to run thereon.



The general dimensions and design are clearly shown in the drawings. The framework is made of any straight grained hard wood, preferably oak; although birch, maple or white ash will be quite suitable. First make the arms consisting of the pieces A, B and C, using stock 1 1/2 in. thick, and nicely planed all over. Then fasten the piece D, using 1/2 in. bolts 2 or 2 1/4 in. long, and boring holes of close fit. The handle C should be carefully mortised to B, and may be cut out to give a beter grasp to the hands. The wheels are next to be considered. Two 4 in. heavy scale wheels were used for this truck, the same being obtained from a scale agency at a cost of 40 cents. The axle, 11/16 in. diameter, is 12 1/2 in. long. A piece of cold rolled shafting was used, and it was necessary to take it to a machine shop and have two 1/8 in. holes drilled in it, each a scant 3/4 in. from the end. These holes are for the pins holding the wheels in place. The axle is attached to the back of the piece D with U bolts, but if these are not obtainable, a groove can be cut in a piece of board and fastened to D with several screws. If scale wheels are not to be had, wooden ones cut from 2 in. oak plank can be made, and bushed with brass or steel tubings will answer nearly as well.

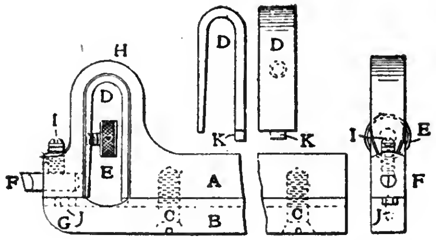
Two 4 in. heavy angle irons L are then firmly attached with screws, the projecting ends serving to take up and hold the barrel. The pieces E and F are curved on the upper sides, and provide a rest for the barrel, preventing it from rolling off to one side when passing uneven places. They are attached to the pieces A with long screws. Countersink the heads of all screws. One end of a piece of long link dog chain 5 1/2 ft. long is fastened with a staple S to the left end of the piece F, and another staple driven out the right end. After the truck has taken up the barrel, this chain is carried around it, and the nearest link placed over the staple, a heavy wire nail or other pin holding it. This pin is attached with cord to the end of the right piece A. A coat of varnish or paint makes the truck easier to keep clean. In addition to its use for ash barrels, flour and apple barrels are frequently handled.

Pewter has been used in most countries of the Old World for the last 2000 years. It was the substitute for silver and was to be found upon the tables of the well-to-do classes of the Middle Ages. Later it took the place of "treene"—wooden dishes, platters and bowls—in the homes of the peasantry and it was in general use until superseded through the adoption of cheaper materials, china, earthenware and Britannia metal. Like silver fine pewter oxidizes slowly, and unlike those of copper or brass, its oxides are harmless. Tim forms the greater part of pewter, the finest varieties, sometimes called "tin and temper," being simply hardened by a small portion of copper. Ordinary pewter is a mixture of tin and lead. The law of France restricts the content of the lead to 16.5 per cent.,this mixture being claimed as proof against sour wine and vinegar. Britannia metal is really a pewter of good quality, containing tin, antimony and copper.

SPRING THREADING TOOL.

Mr. A. B. French, in the "American Machinist," gives the following information regarding a spring threading tool:

The drawings show a special spring threading tool that gives satisfaction and produces nice smooth threads. The body of the tool is in two pieces A and B, both made of tool steel. The bottom B is of 1/4-inch square stock and has a 1/4x1/8-inch slot in it as shown. The top A is made of 1/2x3/4-inch stock and has a 1/4x1/8-inch tongue, a nice fit in the slot in B. A and B are held together by the screws C.



The front end of the body at G is hardened. The tongue and slot are ground and lapped and should be a nice sliding fit. The neck of the tool H is about 3/16-inch thick, the space for the spring is 3/4x1 5/8-inches. The spring is made of spring steel, tempered. On the bottom of the spring there is a tongue K to fit into the slot in the body B. The adjusting screw E is 1/4-inch, 20 threads, it is to adjust the tension of the spring. The thread tool F is made of 1/4-inch Stubs steel flatted on the top. It is held by the set screw I, the hole in the body not being drilled quite through so as to back the tool up. The small pin J is 1/8-inch diameter driven into the lower half of the body B; in the upper half A there is an elongated slot 1/8x3/16-inch for it to work in.

This tool is not designed for heavy work; the largest I have ever used it on was a 1-inch 8-thread tap.

By adjusting the screw E you can get any tension on the spring you want to suit the size of thread being cut. As the nose of the tool is supported the tool cannot spring downward or to the side; when it strikes a hard spot it springs back.

SCIENCE AND INDUSTRY.

A knowledge of geology is indispensible to the complete education of the miner, the prospector, the civil engineer, and the military engineer, and a first hand acquaintance with at least its elements is eminently desirable for the agriculturalist, the geographer, the traveler, and the biologist. Many may even be willing to admit that the literary man and the man of culture would be the better for knowing something of its principles and its conclusions.

Among the numerous uses for charcoal are, as a fuel, polishing powder, in blowpipe work, in filters, as a defecator and decolorizer of liquids, an absorbent of gases and aqueous vapors, a non-conducting packing in ice houses, safes and refrigerators, an ingredient of gunpowder and fireworks, and in the galvanic battery and electric light.

The iron in mineral springs is chiefly in the form of carbonate, the best form for medicinal purposes. Carbonic acid in the water keeps the carbonate of iron in solution, and when the water is at rest its surface shows a yellowish rust. Chalybeate springs are numerous, the more important being at Saratoga, New York; Harrogate, England; Santa Catarina, Italy, and St. Moritz, Switzerland.

The discovery of extensive underground deposits of calcium borate practically revolutionized the borax industry in this country. The greatest mine at present being worked is situated at Borate, in the southern part of the Mojave desert, 12 miles north of the Santa Fe railroad in California. This deposit takes its name from its discoverer, W. F. Coleman. The colemanite is developed by 2 shafts, which at present have been sunk 600 feet and levels opened from them. The shafts are equipped with cages operated by gasoline engines, each of 50 h. p. About 250 men are employed in the mine. The colemanite is obtained in lumps of various sizes, only a small percentage coming to the surface as fines. The mineral of lowest grade is sent to Marion, California, where it is calcined. The high-grade mineral and the product of the Marion plant are sent to Bayonne, N. J., where the most complete plant in the world has been constructed for making this into borax.

The sciency of chemistry, which deals with the composition and transformation of matter, had its origin in remote antiquity. In its earliest form it was purely empirical, a mass of disconnected facts which were brought to light in the natural course of development of various industries. In the extraction of metals from ores, in the preparation of drugs and medicines, in dyeing and the like, many chemical data were discovered, and of such facts a large number were known to the ancient Egyptians. Indeed, one plausible deriation of the word "chemistry" is from Khem, an early name of Egypt, which has reference to the blackness of the soil. With this name the Arabic word "chema," to hide, appears to have some relation, and when it is remembered that much ancient learning was preserved for us by Arabian scholars the description of chemistry as the Egyptian science or as the hidden or occult art, become intelligible. The modern distinction between elements and compounds was first clearly stated by Robert Boyle in 1161.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

Vol. VI. No. 4. BOSTON, FEBRUARY, 1907. One Dollar a Year.

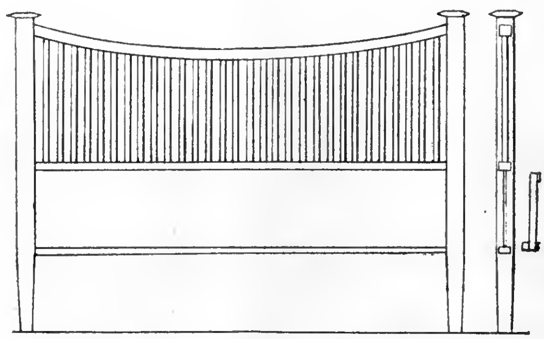
AN ATTRACTIVE BEDSTEAD.

JOHN F. ADAMS.

The bedstead here described is an English design which appeared in the early part of the 19th century, and has a light yet strong appearance, which is very attractive. For a dark wood mahogany is the most suitable, and as the required quantity of lumber is not large, the cost for same would not make it at all expensive. Or bird's-eye maple, with light pearl stain, would be quite pleasing and would be out of the ordinary effects.

The head and foot boards are alike with the exception that the headboard is 6 in. higher that the footboard. The corner posts are 2 1/4 in. square and are 3 ft. 10 in. and 3 ft. 4 in. long, respectively for head and foot boards. The bottom ends are tapered down to 1 3/4 in. square, the taper beginning 10 in. from the ends. They are 4 ft. 6 in. apart, and allowing 1 1/2 in. on each end for tenons the top rail is 4 ft. 9 in. long, 1 3/4 in. wide and 1 1/2 in. thick. The curve in these pieces reduces the lineal length by 2/3 in., so the mortises in the posts are only 1 1/4 in. deep and 1 in. wide. It will be best to have the rails steam bent, as otherwise the assembling will be a vexatious matter. If steam bending cannot conveniently be done, the rails can be clamped down to a piece of rough timber, blocking up the center 3 in., and the mortises for the spindles cut to the proper angles.

The spindles, 30 in number, are spaced 1 in. apart, and require 30 pieces 3/4 in. square and 38 in. long; these being cut to give the long and short pieces for head and foot boards. The pieces at the bottom of the spindles are 4 ft. 7 1/2 in. long, allowing 3/4 in. tenons on the ends, 1 3/4 in. wide and 1 1/4 in. thick. In addition to the mortises for the spindles cut in the top sides, grooves 3/8 in. wide and deep for the panel board are cut on the under side. This can best be done with a 3/8 in. grooving plane, a wooden one costing but little and is always a handy tool for cabinet work. The pieces under the panel boards are the



same length and width as the pieces above, but are only 1 in. thick. Grooves are cut on the upper sides of these pieces. The tenons on the ends are 1 in. wide and 3/4 in. long. The panel board is 4 ft. 7 in. long, 10 1/2 in. wide and 3/8 in. thick, grooves 3/8 in. wide and 1/2 in. deep being cut in the posts between the mortises for the pieces above and below it. All grooves and mortises are centered in the pieces in which they are cut.

The sideboards are 6 ft. 2 1/2 in. long, and require two pieces 10 in. wide and 7/8 in. thick; four pieces of moulding 1 in. wide along the top and bottom outside edges, and two strips 1 1/2 in. wide and 3/4 or 7/8 in. thick, on the lower inside edge in which are cut slots for the bed slats. By inspecting any wooden bed, the spacing and dimensions of the slats may be obtained; the slats may be purchased of any furniture dealer. The moulding mentioned should be a plain pattern without sharp edges, which would splinter or break off with wear, and is fastened on with glue and wire brads.

It would also be advisable to bore holes and drive wire nails through the tops and bottoms of a few of the spindles, to hold the top rails from lifting away from the spindles. By cutting off the heads of the nails only small holes will be needed, which can be fitted with stained putty, using an oil stain. The tenons on the rails and pieces above and below the panel board should also be similarly pined with larger nails or wooden pins.

The tops of the posts are covered with caps cut from pieces 3 1/2 in. square and 3/4 in. thick; the edges being beveled off to a thickness of about 1/8 in. Shallow mortises fitting the tops of the posts are cut on the under sides of these caps, which are fastened in place with glue and a few long wire nails of small gauge.

The hangers for the sideboards should be a kind which can be attached with long screws, as it is a difficult matter to put in the kind commonly used on wooden beds, unless one has a small circular saw with which to cut the slots. The castors most appropriate are those having square ferules covering the ends of the posts, but whatever castor is used should have a screw plate large enough to prevent undue strain on the post, else it might be split when moving the bed about for house cleaning. The ball bearing castor which does not require cutting into the post is quite suitable. The materials for this bed will cost from $8 to $10, depending upon the price paid for the lumber.

INVENTORS SHOULD CONSIDER.

The young man who has, or thinks he has, made an invention has need of much sense and sound advice before he puts any appreciable amount of either time or money into his invention, says Irv. in "American Machinist." Otherwise, as soon as he sees he has something which he thinks is to revolutionize the porticular class to which it belongs he rushes off to a patent attorney with a rough model of the device, is assured that no doubt a valuable patent can be secured for the invention, and then begins a series of expenses and disappointments which end in a poorer but wiser young man.

The inventor should not let his invention run away with his common sense. He should look for criticism rather than praise. He should weigh carefully its bad points as well as its good ones. Great blame is laid, and rightly, at the doors of unscrupulous patent attorneys, but the stubborn, bound-to-go-ahead inventor has made it possible for such attorneys to do a thriving business. The attorney who is honest enough to suggest that the invention is patentable, but that the patentable part is so small and easy to get around, that it will be throwing money away to take out a patent, is likely to be looked upon with either suspicion or scorn, and see the patent taken out by some less honest competitor.

The young man who has invented or intends to invent should carefully consider several things. He should confine himself to the class of work with which he is familiar. When he has made one invention he is liable to think that he can take a casual glance at most any line of work and improve upon it, but many have tried it to their sorrow. He should carefully consider whether the device is worth patenting, and not whether the device can be patented. There are several ways of arriving at a fairly accurate answer to this all-important question. In the first place, is the new device an improvement on that which is already on the market? Is it simpler? Is it cheaper? Is it so much better that a buyer would be willing to pay a little extra in the way of a royalty over the old device? Let the inventor put these questions to himself, weigh them carefully, and answer truthfully. But even if he can say yes to these questions or to most of them, let him not be satisfied with that. It is essential that he should next find out what others have done along the same line. This is not so difficult as it may seem. For the sum of ten cents he can obtain from the Patent Office a copy of the Classifications of Inventions, giving all the classes and subclasses into which the United State patents are divided. Having ascertained the sub-class in which the device would be classed, let him write and find out the cost for one copy of each patent contained therein. If the cost is not great he should get them by all means. He may find the same thing or a dozen better, and be saved the expense and disappointment of going ahead blindly and obtaining a patent at considerable cost which will be as easy to get around as falling off a log.

The best way of all, is for him to first buy the patent papers and study them carefully. Then let him improve on what he finds there. If he cannot improve on what he finds there, he will do well not to go ahead with a vague idea that in some unaccountable way, to be revealed in the hereafter, the soundheaded business man is going to pick out and adopt the invention disclosed in his patent even though it isn't quite so good as some old patent which can be used without any payment of royalty.

DESIGN OF A 12-INCH INDUCTION COIL.

WM. B. EDDY.

The aim of this paper is to show the application of the principles of induction coil design, taking for illustration a 12-in. coil. It is not to be expected that an amateur without experience or a study of the work of others should be able to design an effective and efficient coil, since there is no definite and fixed course that can be followed to obtain a desired result. Therefore, in many places it is necessary to accept the experience of others as well as using "cut and try" methods.

The design below is for a good all round coil for laboratory use, one that will give a good spark with a small amount of current, and which will also deliver a comparatively large amount of power when required; a coil that can easily produce a 12-in. spark.

THE COIL.

We will begin the design for such. The core will be made 2 1/8 in. diameter by 24 in. long, composed of a bundle of No. 22 iron wire well annealed. Several writers advise a core 1 1/2x19 in. for a 12-in. coil, but a more powerful field than such a core can produce will be obtained from the core selected. The diameter of the core selected compared to its length is about 1 to 11 1/3, which is a good ratio for such a coil, and will allow the use of a high speed interrupter when desired.

The primary will be wound with about two and a half layers of No. 12 double-cotton-covered wire. This will give the maximum number of ampere turns which will probably ever be required and the winding for the last of only a half layer will enable one to bring out the taps without inconvenience; the extra flexibility of this arrangement compensating for the space wasted at the end of the half layer.

From wire tables it is found that there can be wound about 10.4 turns of No. 12 double-cotton-covered wire to the inch, so if an inch of space be allowed at each end of the core 230 turns can be wound in the

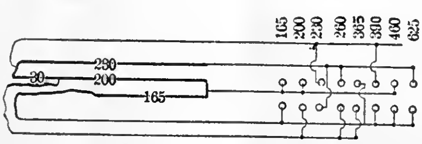


FIG. 1.

remaining 22 inches. The layers will be made continuous by bringing out a connection at the end of each layer and tapping the second at the end of 30 turns and winding only 165 turns for the third layer. Two thicknesses of impregnated paper between layers will be sufficient for insulation.

The sketch of Fig. 1 shows diagramatically the arrangement of these layers and taps; the variable inductance feature may be worked with either switches or plugs to obtain any one of the 8 combinations. These connections cut into the primary circuit the following numbers of primary turns—165, 200, 230, 260, 365, 395, 460 or 625.

THE INSULATING TUBE.

Before determining the thickness of the insulating tube it is necessary to find the voltage that this tube must withstand.

Curve A of Fig. 2 shows the ratio of spark length to voltage in air between needle gaps as determined and used in high-potential transformer testing; but this voltage is as read by an alternating-current instrument and is based on a sine wave, the meter registering "root mean square" values. The ratio of the maximum is to this effective value for a sine wave as $1:\sqrt{2}$ Since it is the maximum value which determines the sparking distance, curve B has been drawn to show

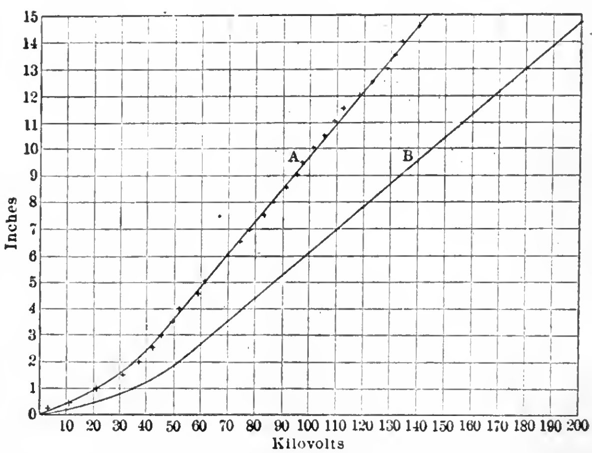


FIG. 2.

these maximum values. The abscissas of this curve represents potentials and the ordinates represent sparking distances and the potential in kilovolts can be read off directly from the curve for any spark length in inches.

It will be seen from curve B that the coil which must give at least a 12-in. spark must withstand a potential of about 170,000 volts. Experience has shown that it is necessary to insulate for only 3/4 of the maximum spark length, which in this case would mean about 130 kilovolts.

Hard rubber, or ebonite, will be selected for the material for the insulating tube, and from Table I it is seen that the rupturing voltage for this substance varies from 900 to 1500 volts per inch of thickness. If the lowest value given be used and a factor of safety of 4 be taken on a safe value of 175 kilovolts per inch, a thickness of 3/4 in. will be required for the insulating tube. The length of this tube for a 24-in. core should be at least 26 in.

The inside diameter should be such that the primary and the core will fit snugly inside of it. The layers of the primary, even with the insulating paper between them, will fit into each other to a certain extent, each turn falling between two turns of the adjacent layer; therefore if the paper is .006 thick and two thicknesses be put between each layer and the next and a half dozen or more between the primary and the core, at least 5/8 in. inside diameter must be allowed for the primary. This will give 2 3/4 in. for the inside and 3 1/2 in. for the outside diameter of the insulating tube.

It has just been found while calculating for the insulating tube that a secondary potential of 170 kilovolts will be encountered. There must be therefore such a number of secondary turns as will, under normal working conditions of the primary, give this potential.

From 50,000 to 80,000 turns represents good practice for a 12-inch coil. Simple calculations will show that at the primary tap giving 260 turns, which is a fair working point, and with an interrupter working on direct current giving an effective e. m. f. across the primary of 40 volts, the number of secondary turns for 170,000 volts should be 55,000.

The above calculations assume that with the given design of coil all the secondary is wound in the most effective part of the field and a large current is used such as would fully magnetize the core before "break." It is desirable, however, with the present design to obtain the spark with a comparatively small amount of current and it is preferable, therefore, to take advantage of data obtained from experience in the construction of other coils and use somewhere in the neighborhood of 70,000 turns.

For the secondary wire No. 34 is best adapted. It is best also to wind the sections in "pies" of 1/8 in. thick. This size of wire can be wound after it has been through a bath of hot paraffin wax, on an average of about 912 turns to a pie of cross section 1/8x1 in. and by a cut-and-try method it is found that 70,000 turns can be placed in 60 pies having an average cross section of 1/8x1 3/8 in. The secondary winding should have about 1 in. for insulation between it and the insulating tube, to prevent the spark from jumping to and across the surface of this tube. At the ends of the coil where normally the potential is highest this insulation should be increased. Thus the insulation between primary and secondary would resemble a series of steps from the centre outward.

Applying these additional considerations to the calculations of the number and size of the secondary pies, the design will be as follows:

18 pies 4½-in. int. diam. and 1½-in. cross sec'l length.
18 pies 4⅝-in. int. diam. and 1⅜-in. cross sec'l length.
24 pies 4¾-in. int. diam. and 1¼-in. cross sec'l length.
giving 60 pies and approximately 74,000 turns.

This will give a uniform outside diameter of 6 in. which is in good proportion for a 12-in. coil with the chosen core dimensions.

It is proper to assume that the laboratory coil will sometimes be used with condensers across the secondary and that it will be desirable to choke back high frequency oscillations. For this purpose there will be added two coils at each end wound with No. 28 double-cotton-covered wire, to the same thickness, and external diameter as the other pies and 4 3/4 in. internal diameter. This will add less than 1000 turns; so that there will be approximately 75,000 turns on the secondary.

Even when wound with less than 60,000 turns on the secondary, the above coil would give a 12-in. spark but would require, when tested under the same conditions in the primary circuit, one-third more current than the present coil; while a coil wound with about 53,000 turns of the same size wire, cotton covered and thus more wasteful of space, would require one-half more current, using in each case a Wehnelt interrupter.

TableI.—Rupturing E.M.F. in Kilo-Volts per Inch.

Substance.	Rupturing e.m.f..	
Ebonite	900—1,500	
Glass	500	
Window glass	380—1,000	
Gutta percha	250—1,000	
Mica	1,500—5,000	
Micanite	2,500—7,500	
Paraffin wax	330— 650	
Petroleum	230	
Impregnated paper:—		
Thickness.		
.0047	1,000	Thin printer's paper.
.0035	1,300	Tisue paper.
.0071	1,100	Manilla paper.
.0051	1,600	American linen paper.
.0055	1,350	Linen typewriter paper.
Boiled-out linseed oil	215	
Light mineral lubricating oil	120	
Paraffin oil sp. gr. .28	165—250	

With the same dimensions a coil for wireless telegraphy work would have required a primary with three complete layers of No. 10 wire and No. 32 for the secondary, wound more effectively since the smaller number of turns for an equal bulk of this wire would give a lower potential, which would require less space for insulation. The coil could probably no longer be rated at 12 in., but it would be far better adapted to heavy wireless work, because of the decreased resistance of a shorter length of larger secondary wire and the increased ability to handle a large volume of current. Since in this class of work an extremely rapid interrupter is not advantageous, the coil could have been improved by making the core of larger diameter and thus increasing the amount of iron, thereby having in common for the two coils only the length of the core.

In joining up the separate pies the insides and outsides of consecutive coils should be connected together with the necessary thickness of insulation between them. When dealing in such large numbers and using factors of safety of 3 or 4 it is necessary to estimate only approximately, and slide rule calculations are wholly adequate for most of the preliminary work.

Assume that the impregnated paper between the pies has a thickness of .006 in. per sheet. This insulation must withstand, for the method of connection which has been chosen, double the potential generated by a single pie, or 6000 volts, roughly. From the accompanying table it is seen that this paper will rupture at 1200 volts per 1/1,000 inch. Using a factor of safety of 4 there will be obtained 1800 volts per sheet, which would require four sheets between each pie or section.

The winding will now take up 60 pies × 1/8 in. each = 7 1/2 in. and another 1/2 in. for the four end coils, making 8 in. Four thicknesses of paper × .006 in. per sheet × 64 coils = approximately 1 1/2 in. for the total thickness of the paper and 9 1/2 in. for the entire secondary. It has been found that a good length for the secondary might be considered that of the sparking distance of the coil if it is desired to err on the side of safety and have the least danger of the spark jumping inside of the secondary or across the surface. To prevent this on the outside it is necessary to increase the thickness of the insulation if a short secondary is used, and this has its disadvantages. In the coil being designed it is desirable to make everything as immune from breakdown as possible, and therefore another two or three inches will be utilized for insulating purposes.

From the manufacturers' standpoint, paper discs are a more expensive insulation than the wax in which coils are imbedded, so that it might be well to increase the number of paper sheets from 4 to 6 and use the rest of the space for insulating compound, or for oil if the coil is to be immersed. It is convenient to cast the secondary in a number of sections, and between these sections the remaining space will be distributed. The paper discs should extend beyond the winding at both the inside and the outside diameters.

It will now be interesting to compute the length and weight of the secondary winding. The average diameter of the larger pies is 5 1/4 in., which multiplied by X/12 gives 1375 ft. for the average length of one turn: 1375 ft. × 18 sections × 1368 turns per section = 33,900 ft. for the number of feet of wire in the larger sections in the center of the coil. Computing in the same way there are obtained 31,400 ft. for the intermediate and 38,600 ft. for the end sections, making a total of 103,900 ft., or about 19 3/4 miles of No. 34 wire weighing about 15 lb., and having a resistance of about 27,000 ohms at 20° C. The four end coils add a weight of about 1/2 lb. of No. 28 wire. The primary contains over 400 ft. and weighs over 10 lb. and the core will weigh about 20 lb., so that the wire and iron alone in the coil weigh nearly 50 lb. without insulation or mountings.

THE CONDENSER.

Working with a Wehnelt interrupter the coil will require no condenser. With a slow vibrating hammer break and heavy current it should not require more than one microfarad of condenser capacity. The capacity should be made adjustable for different conditions of working and different currents and interrupters.

The formula for the capacity of a condenser in microfarads is

$$C = \frac{885 \times \text{effective area in sq. cm.} \times K \times 10^{10}}{\text{thickness of dielectric in cms.}}$$

If the same paper is used as before, .015 cm. thick, there should be two sheets, which will make a thickness of .03 cm., and from

Table II.—Average Specific Dielectric Capacity

Air	1
Ebonite	2.5
Glass	
Flint	5—10
Crown	3—6
Gutta percha	2.7
India rubber	2.3
Mica	6.5
Shellac	2.8
Sulphur	3—4
Paper impregnated with paraffin	3.7
Paraffin wax	2
Petroleum	2.5
Turpentine	2

18	4 1/2	1,368	24,624
18	4 5/8	1,254	22,572
24	4 3/4	1,140	27,360
4	4 3/4	175	700
64			75,256

Table II. it is seen that the value of K for this paper is 3.7. Let us now find the capacity per sq. ft. of active surface. One sq. ft. = 930 sq. cm.

$$C = \frac{885 \times 930 \times 3.7 \times 10^{10}}{.03} = .01 \text{ m. f.}$$

Thus one can easily calculate the number of sheets of foil and paper for any desired capacity by taking the value of .01 m. f. per sq. ft.

SUMMARY OF RESULTS.

Core, 2 1/8 in. by 24 in.; insulating tube, 26 in. by 2 3/4 in. inside diameter by 3 1/2 in. outside; primary, 2 1/2 layers No. 12 wire, 230 turns per layer; secondary, No. 34 wire wound in 1/8 in. sections, each 6 in. external diameter.

Number of Sections.	Inside Diameter.	Number of Turns.	Total No. of Turns.
18	4 1-2	1,368	24,624
18	4 5-8	1,254	22,572
24	4 3-4	1,140	27,360
4	4 3-4	175	700
64			75,256

The above coil when worked on with direct current at 110 volts with a Wehnelt interrupter will give a 12-in. spark on about 12 amp. of current, using 165 primary turns, and a 14.5-in. spark using 13 1/2 amp. The secondary terminals should be so placed as not to allow a greater spark than 14 1/2 in. Using two full layers of the primary winding and 10 amp. of current there can be obtained a heavy and powerful discharge across an 8-in. gap.—"Electrical World."

GRINDING GAS ENGINE CYLINDERS.

I have found, what I suppose everyone has who has had much to do with gas engines, that the finish and truth of the cylinder bore, piston and rings should be the very best possible. To attain this perfection I have designed and made for my own use two different rigs to grind the bore of cylinders. Fig. 1 shows a rig for the lathe that does the work well. The drawing is not to scale, but shows the idea, and any machinist can work out the details. A is a chuck which centers and holds one end of the cylinder, the other end being centered in the revolving steady rest B. C is the revolving part of rest carrying the four jaws D, which center and hold that end of the cylinder. E is a gray-iron casting that bolts to the cross slide of the carriage and has a gib under the bar F bolted to the carriage. When set for the cut the gib can be set up, making all rigid. The casting E has through its center, running in bearings, a shaft carrying an emery, corundum or carborundum wheel at one end and a driving pulley at the other. G is the end of a casting from the same pattern as E. The end is counter-bored to receive a machinery-steel piece slotted across the face to receive a square piece of tool steel. A set-screw holds the end piece from turning and a long steel bolt with a hole at one end and a nut at the other holds the cutting tool secured. This is used for boring. Fig. 2 shows a grinding bar to use between the centers of the lathe when the work is secured to the carriage and bored with a boring bar. It consists mainly of a gray-iron casting A with a drived fitted to it; the larger part is cored out and has a flange at the end. The core cutting through at one side in the middle, as shown, allows the grinding wheel to project. This casting is bored and the flange finished all over and then secured by three solid studs to another flange carrying a short shaft. Of course this short shaft should be re-centered and finished in perfect alinement after the studs are fitted. This shaft carries a pulley running loose, to which is secured an internal gear B, which drives a rawhide pinion secured to the shaft of the pulley C, a belt from which drives the grinding arbor. A larger view of the flange of A shows the means for adjusting the grinding wheel. A casting D is turned to fit nicely the bore in A. D is bored eccentrically to receive a casting E, which carries in proper bearings the grinding-wheel arbor. These castings are made in skeleton form to save weight as much as possible. A steel piece F is fastened to the flange and in it slides a steel piece G that fits into a counter bore in E, the grinding arbor passing through it. A tangent screw is provided for fine adjustment. The construction and use of it is too obvious to need any further description. A bearing H is secured to the bed of the lathe and adjusted to relieve the center of any belt pull. J. S. Rounce in "American Machinist."

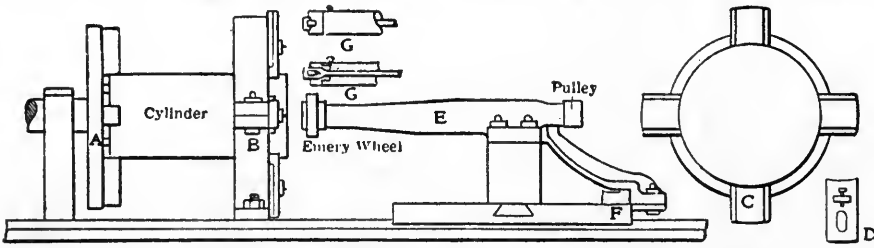


FIG. 1

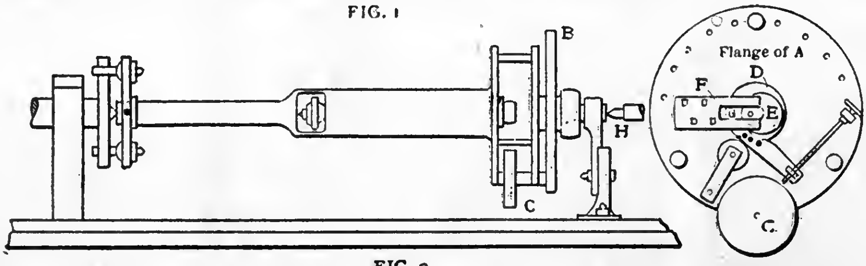


FIG. 2

DECORATIVE ENAMELLING.

I. Kinds of Work and Utensils Needed.

There are few of the artistic crafts more fascinating than enamelling, and certainly none more beautiful. To enter into the work seriously a muffle furnace is required, but small pieces of work in both Cloisonne and "Limoges" may be done in a crucible, with a large blowpipe or in a large methylated-spirit flame. Small articles of jewellery may easily be enamelled, and a considerable insight into the work may be gained with a comparatively inexpensive outfit.

The process consists of coating the surface of copper, silver or gold with a layer of melted glass. The glass is made from silica, red-lead and potash, either carbonate or nitrate, and in various proportions, which form, when in combination, which is produced by melting in a crucible, a flux. The flux is transparent and colorless, capable of adhering to either of the above metals without cracking after it has been fused or melted. The coloring is done by the addition of various oxides of metal and made opaque by means of tin or lead. The principal oxides used are those obtained from gold, copper, iron, cobalt, manganese and antimony, the gold oxide giving ruby; copper, both green and turquoise blue; iron, brown and orange; cobalt, ultramarine blue; manganese, purple; and antimony, yellow. It is possible to mix them together, and they will combine similar to water colors. Enamels require a long heating, anything from five to thirty hours continuous melting; the harder enamels being those which require the greatest heat to melt and which are certainly the best to use, although it is very convenient to have a soft enamel, which will melt or "run" at a fairly low temperature.

The different methods of using enamel are as follows:—Cloisonne; Champleve, Plique-a-jour, Bassitaille and Limoges or painted enamel. The first process on the list will be found most useful for general purposes, and will be very fully described. It may be considered as a method of filling up small spaces made on a piece of metal by means of narrow strips, with enamel ground to a fine sand, and then fused in a furnace crucible, or in a spirit flame, according to size, the amount of heat required depending on the hardness or softness of the enamel used. The metal strips of rectangular wire are called "Cloisons," hence the name cloisonne, and the enamel is usually opaque; these cloisons are not necessary to hold the enamel together, but should be used to form the design, for the enamel adheres quite as well without the cloisons as with them. Champleve-enamelling consists in carving out of a thick piece of metal different spaces which will form a design, leaving the edges of the spaces to form the outline, if necessary, of the ornament. Into these spaces, opaque, or sometimes transparant enamels are run, which form the design. The work requires great skill in cutting out the spaces, and the best metals to use, either bronze or very hard brass. It will be noticed that both the above processes are similar, the difference being mainly in the method of making the spaces which, in cloisonne are built up with soldered walls of thin metal, and in Champleve are sunk below the surface, the metal itself forming the divisions.

FIG. 1.

The method of applying the enamel and firing it being the same in both cases, there will be no need to treat them separately. The next process, that of Plique-a-jour, is somewhat similar to thee above, but without a back, and is really a method of enamelling the spaces between a network (as the word means) of gold, silver or copper wire, and it may be considered as cloisonne without the necessity of keeping the neamel in place while it is being fused, the method being to place the work vertically in a very fierce muffle. The work may consist of soldered pieces of wire forming a suitable design, or as is more often the case, the spaces are cut away with the fretsaw, and the divisions left in the metal itself. Very beautiful effects can be gained by this process, which is very fairly light and delicate, and it is well worthy of a trial. The next process, Bassitaille, is not a commonly-practised method, mainly on account of the great artistic skill and technical knowledge required. The word means "low cut," and the effect is gained by carving out the design, sunk below the level of the metal usually, in low relief, or in repousse, in high or low relief, and then the metal is entirely covered, both sides, with transparent enamel or enamels, allowing the details of the carving to show through the enamel. It is a very beautiful process, but as it is usually in gold, and is seen to its greatest advantage with that metal, it will be found rather too expensive for ordinary art workers.

The remaining process to be described is "Limoges" or painted enamel, so called because it was first practised at Limoges, about the end of the fifteenth century, and the enamelling is done in the simplest and most straightforward manner, compared with the difficult and tedious preparation of the metal in the methods described above. Very small articles of jewellery may be made by this process, but it is in the painted panels of some few inches in area that the finest work is seen. The enamel is ground down to a fine powder, mixed into the consistency of paint, and then used much in the same way as water colors, the work being somewhat limited, but making up in depth of color what it lacks in tints. The subject is painted on a domed plate of copper, which is covered with a ground of enamel, black, blue or some suitable color. Upon this ground the painting is done in semi-transparent white enamel, known as grisaille. The grisaille is fired. other enamels of various colors are painted over and again fired.

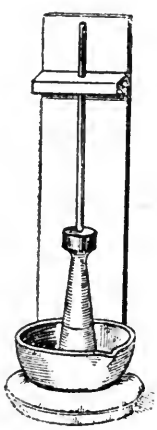


FIG. 1.

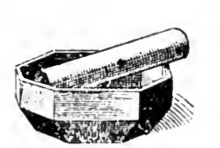


FIG. 2.

To make satisfactory Limoges enamels, considerable practice in enamelling is necessary as well as artistic taste and skill. Of all the above processes, those most useful to the artworker who wishes to make jewellery are Cloisonne, Chempleve and Limoges, the others being left with advantagee until the easier methods have been practised.

We shall therefore describe these three processes in turn, for the reasons which we have given, commencing with the more simple methods of work, and Cloisonne being perhaps the most useful of the three, will be the best to begin with. The first thing to be considered is, or course, the enamels, and they are purchased in all colors similar in form to lumps of glass.

It is quite necessary to know how to prepare the enamels, so the process will be described. The required piece of enamel is taken and pounded up into small pieces, in a mortar, with a pestle having a wooden handle(Fig. 1), a Wedgewood No. 3 size costing about 2s. 3d., or a porcelain of the same size only 1s. 6d. A wooden mallet will be necessary in beating the pestle to thoroughly pulverise the glass, but of course great care will be needed that the side of the mortar is not broken. The pestle should be held directly over the pieces of enamel, and the blow given exactly on the head of the pestle. As soon as the enamel has been reduced to a coarse grit, it should be further reduced, and this is done by grinding it to a fine sand; the pestle is held firmly in the right hand, and holding the mortar in the left, rotate the pestle until it is sufficiently ground. Considerable pressure is required. and a contrivance similar to that shown in Fig. 2 will be found very useful in easing the work. A long iron rod should be fitted either into the top of the pestle, and a bracket fixed either to the wall or to the bench, and through the top should be passed the other end of the rod; lead weights may be placed on the rod resting on the top of pestle, and any pressure almost may be exerted on the pestle. It will be seen that the water becomes cloudy as the grinding progresses, so that the enamel should be washed, if it is transparent, but not if opaque, and the washing is done by agitating the sand while in the mortar, and continually changing the water. The fluid may be poured into jars and allowed to settle, the residue being used for backing the plates, for the enamel is useless for anything else, being opaque and cloudy.

For Limoges work the enamel will have to be ground to a powder in an agate mortar (Fig. 3), but this will be rather expensive, for the smallest agate mortar, with pestle, costs $1.00, and is only 2 inches in diameter, and the larger sizes about 4 inches, costing $5.00 or so. It is quite necessary, if really good work is to be done, to invest in this piece of apparatus, for the trace of foreign matter will spoil an otherwise good enamel.

It is much better to use enamels as soon as they are ground, but if this is not possible, then keep them in jars under water and then not more than a week or so, or else in bottles securely corked. If the powdered enamel is old, or has been exposed to the air, it will become disintegrated, but where it is necessary to use it, it should be washed for a few minutes with weak hydrofluoric acid, about 1 part to 12 parts of water, and then, after washing away all trace of the acid, it may be used. Great care must be taken in using this acid, as its fumes are highly poisonous.

While tungsten is considered one of the rare elements, tungsten compounds are of considerable use. Sodium tungstate is largely employed for impregnating fibers to make them fire-proof. It is also used as a mordant in dyeing. Tungsten bronzes are largely employed as bronze powders and pigments. The chief consumption of tungsten in recent years has been, however, for highspeed tool steels and for hardened steel for armor plates and large guns.

SOUND BOX FOR GROMAPHONE.

This article describes one of the latest forms of sound-box for a gramophone. The details can be slightly varied to meet requirements, but the general design and dimensions should be adhered to, as the instrument is the product of much experiment. The whole of the work can be carried out with hand tools, but the slide-rest is desirable. The illustrations are reproduced full size.

The body (Figs. 1 and 2) and the ring (Figs. 3 and 4) are brass castings; the patterns must allow for shrinkage and machining. Mount the body on a face

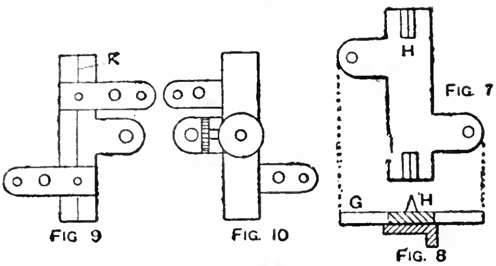


FIG 9 FIG. 10 FIG. 7 FIG. 8

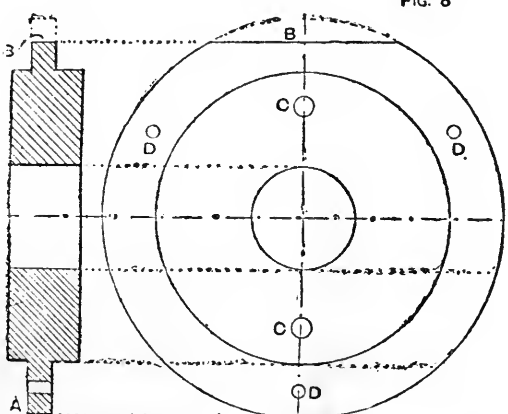


FIG. 2 FIG. 1

plate or in a recessed hardwood chuck, bore out the centre to 9/16 in., and face up. Remount on a truly turned spindle, and finish both sides and rim to the dimensions as follows: Greater diameter 2 1/16 in., lesser diameter 1 1/2 in., thickness of latter 3/8 in., thickness of central flange 1/8 in. Then scribe lightly a circle exactly 2 in. in diameter on the face of the flange at A (Fig. 2). Remove from the chuck, grip between lead jaws in the vice, and file the flat B (Fig. 1) to within 1/8 in. of the lesser diameter. The holes indicated should be bored, the two at the back of the body C (Fig. 1) to a depth of 1/4 in., and tapped 1/8 in. thread (see Fig. 5), and the three D, in the flange, 3/64 in. clearing. The ring (Fig. 3) is a light casting, and is conveniently chucked in recessed hardwood and the face machined. Then reverse and tool out the recess E to 1 3/4 in. diameter and 1/4 in. deep, leaving a flange which when finished is 1/64 in. to 1/32 in. thick, its inner diameter being 1 5/8 in.

Re-chuck on a hardwood mandrel that fits the recess accurately, and turn the rim to 2 in. in diameter, its width being 1/4 in. full to 9/32 in. While still in the chuck, file the flat F (Fig. 3), leaving 1/15 in. substance to the recess. Then remove from the chuck and hard-solder on the fitting G (Figs. 3 and 6), which is of 3/16 in. brass, 7/8 in. long, 1/4 in. wide, and 3/4 in. over the lugs. A plan and elevation of the fitting G is shown by Figs. 7 and 8. The small knife-edge projections H (Figs. 3 and 6) are 1/8 in. wide and 1/16 in. high. They can be formed in the material by filing or planing, in which case 1/8 in. brass must be used; or they can be riveted into the 1-16 in. metal and trimmed up. The holes, tapped 3/64 in., are spaced 3/8 in. apart, in line with, and 5/8 in. apart across, the ring. The body (Fig. 1) and the ring (Fig. 3) are now assembled by the scribed gauged circle A (Fig. 2) the screw holes D marked, bored, and tapped in the ring 3/64 in. by 1/8 in. deep as at J (Fig. 3).

The fiting, shown by Figs. 9 to 12, is now built up and hard-soldered together. The base, of 1/16 in. brass, is 7/8 in. long, 3/16 in. wide, and 7/16 in. over the central lug. It has a shallow saw-kerf centrally on its under side as at K (Fig. 9) to engage with the knife edges of the ring fiting G. The needle socket is of 1/4 in. brass rod 3/8 in. long, bored to suit the needle shank and tapped at the side 3/64 in. for the set screw.

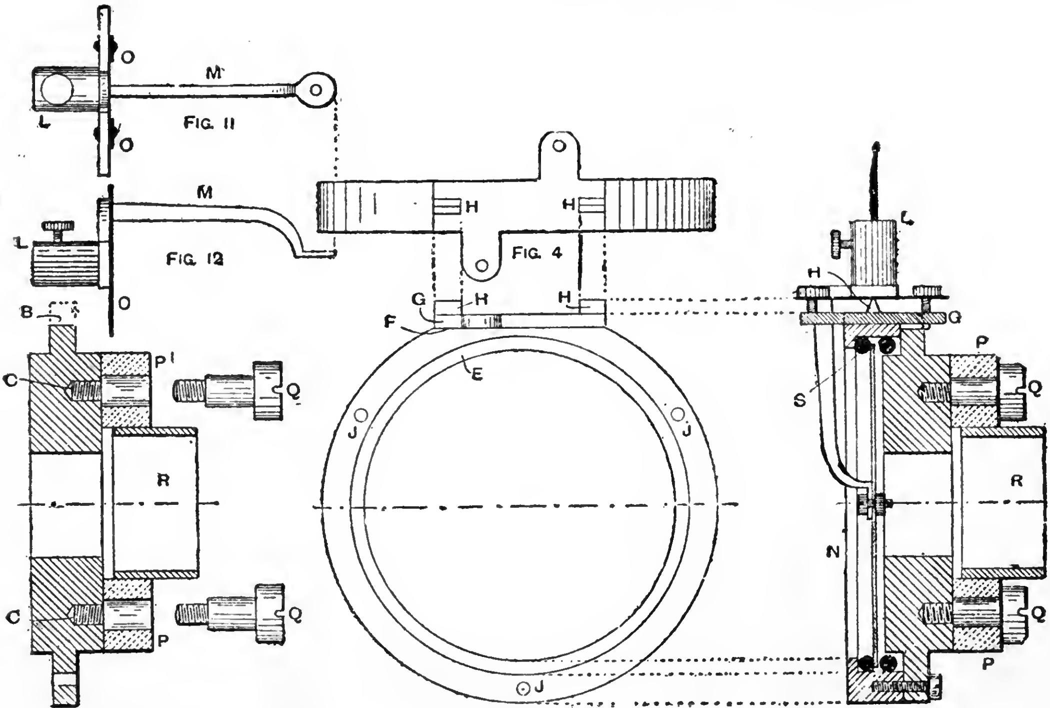
The diaphragm finger M (Figs. 11 and 12) is 1 1/16 in. long from the under side of the base to its central hole; it is of 1/16 in. brass, and tapers from 3/16 in. to 1/16 in. at its terminal disc, through which, and the talcum diaphragm N (Fig. 6), passes a small screw, nutted at the back of the diaphragm. Two pieces of steel, or hard brass, spring 1/2 in. long by about 1/8 in. wide are riveted to the base, as shown at O (Figs. 9 to 12), equidistant from its centre and 3/8 in. apart. In the ends 3/64 in. holes are bored, to correspond with those in the ring plate G. When attached, these springs are bent equally towards the needle socket L, so that when the screws are passed through them, an equal tension can be exerted on the diaphragm finger M.

A disc of rubber P (Figs. 5 and 6) 1 1/2 in. in diameter and 1/4 in. thick, with a 3/4 in. hole in its centre, is attached to the back of the body with two 1/8 in. cheese-headed screws Q 1/4 in. plain under the head. Into the central hole is cemented a 7-16 in. length of brass tube R having a 11/16 in. bore. This tube must not be in direct contact with the body, the object of the rubber being to insulate the vibrations of the sound-box from metallic connection with the tone-arm or trumpet.

Fig. 6, which is in part section, is intended to facilitate the assembling of the parts. Before this is done, the work should be polished and lacquered, or nickel-plated. First secure the rubber buffer P and the tube R to the back of the body (Fig. 1). Then loosely attach the finger fitting (Figs. 9 to 12) to the ring (Fig. 3).

diaphragm centre. The small screw is then passed through the finger end and diaphragm, and secured with a small flat nut at the back (see Fig. 6). A speck of hard wax can be melted into the joint, to arrest possible vibration at this point.

The sound-box is now complete, and will be found to weigh between 4 oz. and 5 oz., which is about correct for modern disc records. The tuning-up must be carefully attended to by actual trial on a machine, the tension screws being used for the purpose. Theoretically, the diaphragm should be submitted neither to much pressure nor tractive strain, its own elasticity determining its normal set.



Select a good mica disc N of 1 11-16 in. diameter, and bore a fine hole in its centre. Cut a length of 1/8 in. rubber tube, with scarfed ends, to neatly fit the recess in the ring. Lightly dress the edge of the diaghragm with adhesive, and place it on the rubber within the cell, working it carefully to a central seating, not touching the cell at any point. Apply light pressure and set aside to dry; do not stick the gasket to the flange. When set, fit a second rubber gasket to the back of the diaphragm, without adhesive, and assemble the body and the ring by the three screws to fit the holes D, when the two rubber rings S will evenly and closely grip the diaphragm N. For the sake of clearness, the rubber tube gaskets S are shown conventionally, in Fig. 6, as black circles. In practice, of course, they will flatten under pressure, and spread considerably.

The finger fitting is now gradually screwed up, half a turn at a time on each side, until fairly rigid with the main body, the terminal disc just bearing on the

If facilities for brazing and silver-soldering are not available, the joints can be made with soft-solder, using zinc chloride as a flux; but this method is less satisfactory.—"Work," London.

The blood rains of Central Asia and Mediterranean areas are showers of grayish and reddish dust mingled with rain. The dust is largely made up of microscopic organisms, especially the shells of diatoms, the red color being due to the presence of a red oxide of iron. These rains occur where violent huricanes, following periods of drought, carry the dust from dried lake bottoms and river beds into the upper regions of the atmosphere. At times the dust is transported hundreds of miles before it is precipitated, and it may even reach the high altitudes and be carried down by snow in which case the phenomenon is red snow.

THE ENGINEER'S FUTURE.

The electrical engineer of today who has confined his work entirely to theoretical fields has, comparatively speaking, very little chance in competition with his brother worker who, in addition to much practical experience, has been trained in commercial ways. It was not very long ago that the salesman handling electrical apparatus was of the ordinary type, that is to say, his success depended entirely upon his ability as a salesman, and the engineering side of his education, admitting for the sake of argument that he knew the difference between a shunt motor and a rheostat was one of the smaller considerations. Engineers at that time were not considered as possessing the requisite instincts of good salesmen, and such men did not have, and were not expected to have, commercial training. Then there came into the field the theoretically trained engineer, with practical experience in the actual handling of apparatus, and in whom the commercial instinct was strongly developed. In competition with such a man the mere expert salesman had no chance. Slowly but surely the change has been made, and we find that our salesmen of today are all trained practical engineers who are constantly called upon to use their engineering knowledge in connection with their work. We could mention several names today which have become famous simply because the owners, besides being capable engineers, are good business men. These men have interested themselves not only in the engineering of many projects, but have had the financial side under their care, with the direct result that matters entrusted to their attention have turned out successfully. The young man as he comes from college today with his diploma has two serious handicaps. both of which must be overcome before he can be successful even in a modest may. In the first place, he thinks, to use an old explanation, that all it is necessary for him to do is to announce the fact that he is ready to take a position, and then put a placard outside his house, reading to the effect that the line will please form to the right. This clearly is a mistake, and it is not long before the young engineer makes a radical change in his opinion of his own importance. When the immediately expected position at $5000 a year dwindles down to a six months' wait at the end of which he finds $30 a month, the effect is very beneficial, and our engineer "finds" himself. The other point is lack of practical experience, and this experience can be obtained only through years of hard and constant work. To our mind the ideal engineering education would consist of a public and high school training, which would be followed by about two years in college. Then our man should enter upon an appreticeship course, such as can be obtaineed in the shops of several of our largest manufacturers, and should spend at least three years at this work. The remuneration is small and there are many stumbling blocks, but without strenuous work success cannot be obtained. On the completion of his shop course the engineer should go back to college and there finish his education, taking, as the case may be, either one or two years more according to the calendar of his college. If he has in him the inherent qualities of a good engineer he will leave his college a first-class man in every respect. His education may have taken seven or eight years to complete, and he will be pretty well along in years, comparatively speaking, when he is ready to start his life's work, but the time will not be wasted; for such a man the $5000 position is waiting, and the $30 a month job need not enter into consideration. The young engineer should never for one moment overlook the importance of the commercial side of engineering, for without this side the technical part of the business would be non-existent. He may be inclined to consider that commercialism is below him, and if such be his attitude he would probably be better in some other line of work, unless of course he be aiming at a professorship in some college. One of our leading consulting engineers advised us not long ago that every year at the close of the midsummer college term, he receives anywhere from twenty to thirty applicants for positions in his office, and upon advising such applicants to enter shop work or work with a commercial company, has almost invariably received replies to the effect that consulting work was desired. Where such a notion originates is difficult to say, but our colleges should make every effort to eliminate such high-toned ideas from the minds of their graduates. The statement so often made that the electrical profession is overcrowded is absolutely untrue. There are thousands and thousands of $30 and $50 a month men, and a lamentabley small number of five and ten thousand dollar men. For each of the latter there are dozens of positions waiting and there always will be, for the demand exceeds the supply, many, many times. Therefore we say that an engineering education, to be worth while at all, should be complete, and no young man entering college who has made resolutions to really complete his education, fully and thoroughly, need have any fear of his future in electrical engineering.—"Kuhlow's German Review."

The touchstone of the jeweler is known as basanite, a silicious rock or jasper of a velvety, black color. It is used to determine the amount of alloy in gold, the mark of the specimen on the stone being compared with the various known grades of gold.

CONSTRUCTION AND MANAGEMENT OF GASOLINE ENGINES.

CARL H. CLARK.

IX. Multiple Cylinder Engines.

There are many considerations which make an engine of two or more cylinders particularly desirable. It is a self-evident fact that when the limit of size of a single clyinder is reached. it is necessary to add other cylinders if greater power is desired. Even for moderate or small powers there are many advantages. Among these may be noted the fact that with the proper arrangement of cylinders the impulses may be made to occur at shorter intervals than with a single cylinder engine. Thus with a two cylinder engine the cylinders may be so arranged that the impulses will occur twice for each revolution instead of once as in a single cylinder. This gives a more even turning effect on the shaft and consequently steadier running, and also requires a less heavy fly-wheel. The vibration also is much less, as one set of working parts may be made to travel upwards while the other is travelling downwards, thus neutralizing the throw of each and lessening the vibration.

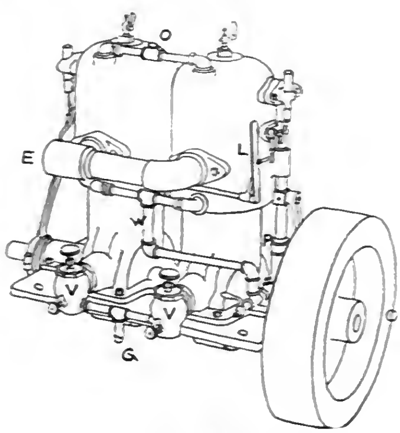


Fig. 59.

In the case also of the disablement of one cylinder there is the chance of getting home on the remaining ones. The weight, power for power, of the multiple cylinder engine is less than that of the single cylinder engine, as the weight of the flywheel and other working parts is less.

While for marine work single cylinder engines have been built as large as eight or ten horse power, they are so large as to be rather cumbersome and the practice now is to build engines of more than six horse power with two or more cylinders. There are several firms who are making double cylinder engines as small as four horse power, which both as to weight and reliability are much superior to those of a single cylinder.

The original method of constructing a multiple engine, and one which is still used by some builders, is to simply use two or more single cylinder engines copuled together. This is a cumbersome method and takes up a great amount of space. The simplest method which can be recommended is that shown in Fig. 59. It consists of two single cylinders mounted on a common base of special design bringing the cylin-

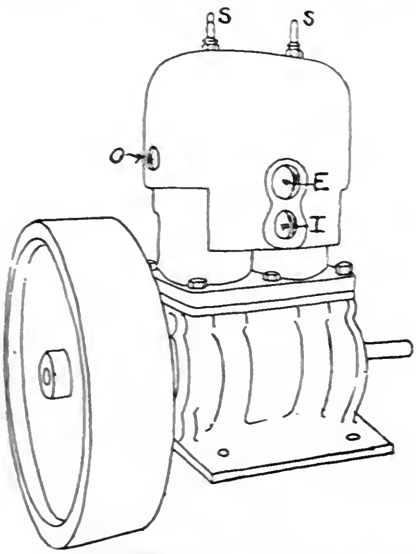


Fig. 60.

ders much nearer together than when a coupling is fitted to connect two separate engines—as the shaft can be made in one piece. This particular engine is of the two port type, two vaporisers V-V being used. The gasoline enters at G and branches to each vaporiser. The pump is shown at P with the discharge at W, piped with a branch to each cylinder. The cooling water outlet is at O. The exhausts are connected to a common pipe with the outlet at E. The igniting gear for each cylinder is independent and on opposite ends. By means of the lever L, which is connected to both igniting gears, the time of ignition is regulated and kept the same on both cylinders. This allows multiple cylinder engines to be built with very few extra parts, as the cylinders, ignition gear, etc., are the same as in the single cylinder engine.

A common form of two cylinder engine is shown in Fig. 60. The two cylinders are cast together and bolted to the base. This particular motor is of the three port type with the inlet at I. The exhaust port is E. The cooling water inlet is at O. the outlet being on the other end of the engine. S-S are spark plugs for jump spark ignition. This engine is of the high speed type, carbruettor and timer not being shown.

In Fig. 61 a four cycle engine of common type is shown. The cylinders are independent, and are bolted to a common base. The carburettor is shown at C

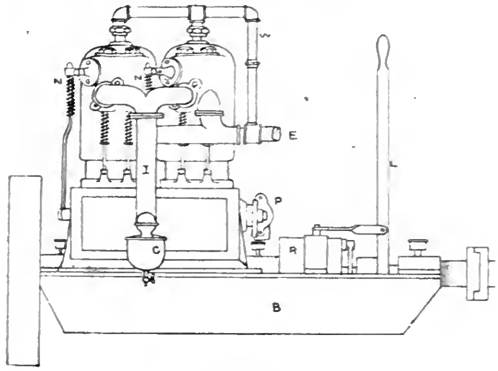


FIG. 61

with the inlet piper I leading up and branching to each cylinder. It is quite important that distance from the inlet pipe to each cylinder should be the same. In this way only can it be certain that each cylinder draws the same amount of mixture.

The cooling water pump is at P discharging water directly into the jackets. This water comes out at the top of the cylinders and discharges into the exhaust pipe E into which the two cylinders also exhaust.

A cast iron base B supports the engine and also carries the reverse gear R. This base holds everything in line and has flanges for bolting to the bed.

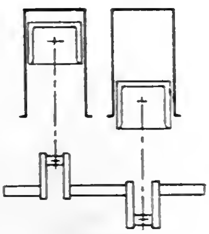


FIG. 62

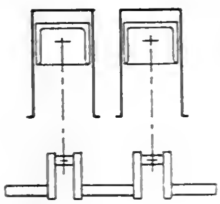


FIG. 63

Three or four cylinder engines are arranged in much the same manner. A four cylinder engine of the type of Fig. 60 has two pairs of cylinders as shown, bolted to a common base. In the three or four cylinder four cycle type such as is illustrated in Fig. 61 additional cylinders are added with the proper base.

The pistons and cranks may be arranged in a variety of ways. Fig. 62 shows the best arrangement for a two cylinder two cycle engine. The cranks are opposite, one piston ascending while the other is descending. Each thus balances the throw of the other. This arrangement also gives an impulse in each cylinder for each revolution.

Two cylinder four cycle engines may have the cranks arranged either as shown in Figs. 62 or 63, in the

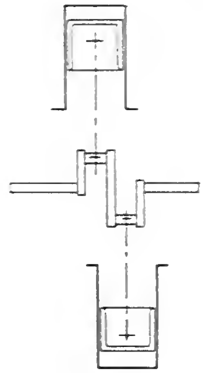


FIG. 64

former the pistons are balanced, but the impulses occur irregularly two occurring on adjacent strokes, with an interval of one revolution before the next two. In the latter, Fig. 63. both pistons move together; this arrangement so distributes the impulses that they

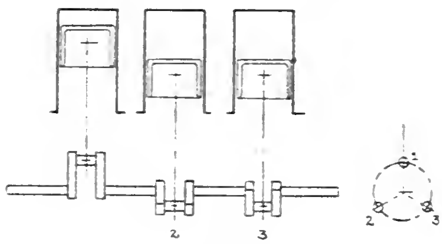


FIG. 65

occur regularly, one during each revolution. This arrangement, however. requires heavy counterbalances on the opposite ends of the crank, to belance the weight of the pistons; and it is likely. under certain

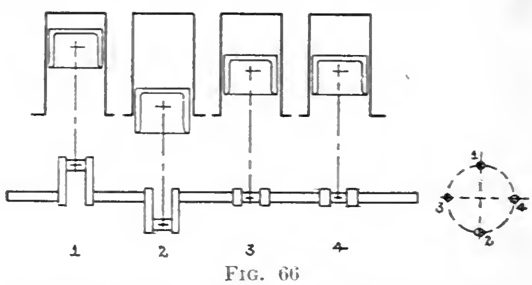


FIG. 66

conditions to cause considerable vibration. Both arrangements are used, however, in representative engines.

The arrangement shown in Fig. 64. or "opposed" motor has some advantages. It is almost absolutely balanced as the parts are moving either towards or away from each other and thus absorb the throw.

In the two cycle motor of this type the impulses occur together and on each revolution. In the four cycle they occur regularly and one for each revolution. This arrangement has some advantages, as it lies very low in the boat and may even be placed under a transverse seat. For auxiliary work it may be placed under the standing room floor.

In the cylinder engines of either two or four cycle types the cranks are almost always arranged as in Fig. 65—or 120° apart. This arrangement gives a good mechanical balance. The two cycle engine thus has three impulses for each turn and the four cycle has three for each two turns, they occur regularly, and are so timed that one cylinder is receiving its impulse while another is compressing, which is conducive to steady running.

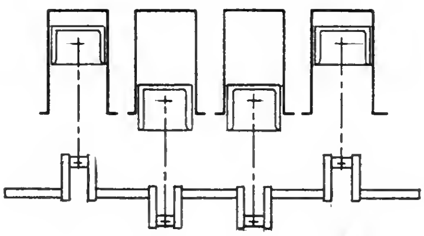


Fig. 67

Although for automobile work the three cylinder—four cycle engine has been discarded it is still popular and satisfactory for marine work. Four cyclinder engines of the two cycle type are very commonly arranged as in Fig. 66. The cranks are arranged in pairs, the two cranks of each pair being opposite each other, and the planes of the two pairs being at right angles. This makes the engine well balanced, each pair being balanced in itself. It also gives an even turning effort with four impulses per revolution, occurring regularly.

Four cycle four cylinder motors are probably best arranged as in Fig. 67, the cranks being all in one plane. The positions of Nos. 3 and 4 may, however, be reversed, bringing 1 and 3 up and 2 and 4 down. The former is, however, considered to be the better. Either arrangement may be made to give regularly occupying impulses, four during each two revolutions.

For high powers a larger number of cylinders are used—six or eight. A six cylinder engine would consist of two units like Fig. 65 coupled together and an eight cylinder, two like either Figs. 66 or 67 coupled together.

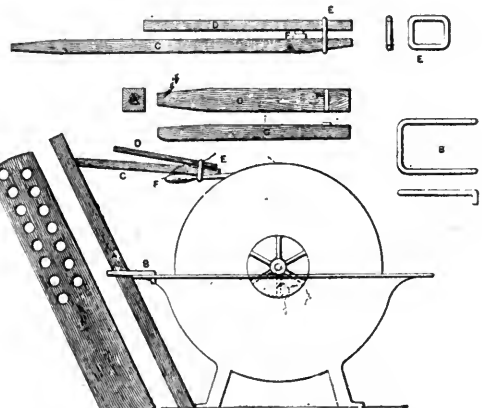
The advantages of multiple cylinder engines are becoming better appreciated and their use is increasing, even in small sizes; the exception being in working and fishing boats and other cases where cost is a prime consideration.

GRINDSTONE TOOL HOLDER.

GEORGE A. SEATON.

In many shops there are numerous chisels, cutters and plane bits that must be ground from time to time and if they all must be held by hand the process not only requires much skill but becomes very tedious long before it is completed. If a clamp is installed like the one here described the work is hastened, the results are better, and the job now can be entrusted to a boy.

First a board must be fashioned similar to A, two inches thick, six inches wide and long enough to come slightly higher than the top of the stone when attached as shown in engraving. The lower end of this must be beveled so that it rests flat on the floor when in position. The board is held in position by a hook forged of a light rod of iron with the ends passing down



through the holes in the trough that originally were intended for attaching the name-plate. In this board, A, must be bored a number of holes in such a direction that they are about parallel to the floor. These afford a number of resting places for the clamp proper, C D.

The clamp is made up of two pieces of inch stock as wide as the widest plane bit and with one end of C rounded to fit the holes in A. Upon strip C is fastened a little rib, F, which serves as a fulcrum for the piece D. At the end of D is fastened by staples an iron rectangle E made of welded strap iron which holds the chisel or plane bit against the lower side of C when the hand is passed down upon the other end of D.

By moving the chisel forward or backward in the clamp or by raising or lowering the rear end of C, any angle desired may be secured upon the chisel as it is pushed back and forth across the stone. By the use of this clamp the speed of grinding can be much increased as all the weight may be thrown upon the chisel edge and no thought need be given to the angle. The device illustrated is in use upon a Keystone grindstone but could easily be modified for any other stone.—"Wood Craft."

TRANSPARENCIES.

J. GARFIELD GIBSON.

When the ground is covered with Kipling's "Beautiful" to the depth of several inches and the chilling north winds remind us that straw hats and shirt waists are no longer seasonable, the average amateur folds his tripod, pokes his head under his focusing cloth and as far as photography is concerned calmly awaits the coming of another spring.

It is to this class of photographers that I hope, as the country orator says, "my few scattered remarks" will prove beneficial.

Many of the greatest pleasures of photography are those which can be experienced in the dark-room during the long winter evenings. Of the many novelties which can be made by the amateur there is nothing more beautiful than the natural color and tinted transparencies which we often see hanging in windows suspended by chains. These are very easily made, as I hope the following article will clearly demonstrate.

First it is wise as a start to choose what you would call a good negative: That is one which has been timed about right and developed to about the correct density. The plates upon which the transparencies are made need not of necessity be other than the ordinary plates used in general work. Special plates are, however, made for this work with a border of ground glass around the edge and are of course preferable.

Before printing be sure and dust off both negative and plate very carefully. As regards exposure—this will have to be learned by experience and much depends on speed of plate, density of negative and light used for making exposure. But an ordinary plate with an average negative held about 18 inches from a gas jet requires from one to six seconds. The exposure being made, the plate can be developed at once or kept in a tight box until some future time.

For developing we have as wide a choice as for ordinary work but I have found hydrochinon to give the best results and the following formula works equally well for either transparencies or lantern slides:

No. I.

Sulphite Soda (crystals), 400 grains. Dissolve, filter and add water to make 6 ounces.

Hydrochinon ....120 grains.

No. II.

Carbonate of Potassium ....240 grains.

Water to make .... 6 ounces.

For use take 1 oz. each of Nos. 1 and 2 and add two ounces of water. This water may be decreased or increased as may seem fit. Development should be carried on until the picture comes out clear and distinct.

The fixer for transparencies should be a little weaker than for ordinary plates. After fixing wash and dry as usual.

If you are using regular transparency plates your task is now completed, otherwise you must back it with a piece of ground glass, same size.

You can now bind your finished article in one of the metal frames supplied by all dealers or hang it by chains, doubling the chains at the corners.

Many beautiful effects may be obtained by coloring the transparencies and I give below some formulas for so doing.

Having proceeded as described above immerse plate in any of the following baths until desired tint is obtained.

Red Bath.

Carmine (in grains). .... 5 parts.
Liquid Ammonia .... 15 parts.
Distilled water ....120 parts.

Blue Bath.

Prussian Blue .... 50 parts.
Oxalic Acid .... 50 parts.
Distilled water ....120 parts.

Yellow Bath.

Gamboge .... 50 parts.
Saffron .... 50 parts.
Distilled water ....150 parts.

(Above yellow bath must boil five minutes and then be filtered.)

After being treated in any of the above, plates should be washed in several changes of water and be dried free from dust.—"Western Camera Notes."

A new process of making quartz-glass in much larger quantities than has hitherto been posible has been discovered by the employment of high temperatures and pressures. In a quartz-glass vessel, gold, copper, or silver may be melted or even vaporized without injuring the receptacle. Quartz-glass expands scarcely at all; hence cold water will not break it, if poured over it even while hot. It transmits freely the ultra-violet rays of light, to which ordinary glass is almost opaque.

The discoveries connected with radio-activity have enormously increased the estimated stores of energy surrounding us, but these stores have not yet yielded up mechanical effect for the use of man, if we except the radium clock.

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 advertisements 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.

FEBRUARY, 1907.

The prize offer in the December number produced such a large number of articles that the judges have been able to make only the awards for the first two prizes, as follows:

First prize, Elmer C. Hutchinson, Philadelphia, Pa.

Second prize, H. K. Carruthers, Otawa, Ont.

The third prize will be announced in the next number. The article by Mr. Hutchinson, "A Combined Circular Saw and Boring Machine," was published in the January number. The one by Mr. Carruthers, "A Water Motor," will appear in the March number. Other interesting articles received in this competition will be published in early issues.

Owing to the very successful results from this plan of obtaining articles of interest, we are now arranging for similar competitions, but shall allow a longer time for preparation, as several competitors have advised us that the previous offer did not allow enough time to enable the writers to prepare articles requiring considerable drawing and taking off of dimensions, and that some of the articles sent in could not have been finished in time, had they not been in preparation before the offer. In anticipation of subsequent offers, readers having any machine or device which they think would be likely to be of interest, will find it advisable to get the descriptions and drawings in hand, so that when an offer is made the preparation of an article can be given the necessary attention so that it will be complete in both a literary and mechanical way.

It is not customary for us to refer to our advertisements in this column, but owing to the character of the one received from the General Electric Co., West Lynn, Mass., and its importance to many of the younger readers of this magazine, we do so for the purpose of emphasizing the exceptional opportunity offered to young men desiring to learn a trade. A personal visit by the editor of this magazine to the works of this company, shows that the company have provided a most complete equipment of tools, and well selected class of work for those entering their employ. In addition, a school is maintained, with regular instruction periods, the instruction being given by practical mechanics who have shown special fitness for that work. Especially noticeable was the intelligent and gentlemanly character of the young men at work, ensuring proper and agreeable companionship to anyone joining their ranks. Our purpose in mentioning this matter in this was is that those at a distance, who have not the opportunity of personal investigation, may rest assured that everything connected with the learning of a trade will be found entirely satisfactory. We hope to publish in an early issue a full illustrated description of the system, which we are sure will interest a large number of our readers. Those who have the matter of learning a trade under consideration, but have hesitated because of lack of knowledge of a suitable place, should obtain further information by applying to the company.

Our supply of complete sets of bound volumes is being rapidly sold. If you want a set order at once, or you may be unable to get them.

Anyone scanning the Official Gazette of the United States Patent Office will find much interesting information, which is not quite submerged beneath queer spelling and rudimentary grammar, says the "Mining Press." This record of the inventive minds of the country is eloquent of the multifarious channels into which its energies are directed. Apparently drinking is an important function of our people, for the non-refillable bottle is the elusive goal of so many ingenious people and next to it comes its complement the bottle-stopper. The importance of railroad operations is reflected on the pages of the Gazette, for nut-locks, automatic switches, car-couplings, and signaling apparatus are invented every month. The farmer is in the mind of the inventors who take out patents for disc-harrows and self-closing gates. While the art of printing and the multiplication of writings has progressed rapidly, there is hope of further advance, for printing devices and typewriting machines are commonly found among the new patents. Toys bespeak a love for the little ones and it is satisfactory to observe that the amusement of children should be regarded as a profitable business. Finally, the childlike in man is expressed in the many garment supporters, clothes-presses, and hat-hangers which are designed each month. It argues at least a regard for neatness, to which cleanliness is allied, and a growth of taste in one of the small, but salient features, of the manner of living usually termed civilization.

A TWENTY FIVE FOOT AUXILIARY YAWL.

CARL H. CLARK.

IV. Finishing Frame and Deck Beams.

The boat is now clear on the inside and all plank fastenings have been done. The entire inside would best be treated to a good coat of linseed oil and painted, to prevent its shrinking during the remainder of the work. The inside work may now be put in, beginning with the clamp, shown in Fig. 23 and in the enlarged Fig. 20. This clamp is 2 1/4 in. x 2 1/4 in. of spruce; it fits into the angle between the frames and deck beams and supports the latter.

The frames are cut off square at the level of the top of the top streak. The clamp is now bent around on the inside of the frames 1 1/2 in. in below the edge of the top streak and held in place by clamps until it is carefully adjusted. It may then be fastened into place with 1/4 in. galvanized iron rivets passing through plank, frame, and clamp, and headed over on the inside. The clamp should be in one length for each side and extend from the inside of the stem to the stern board.

Knees are fitted at the ends as shown in Fig. 21, a corner keen at the after end and curved breasthook at the bow. For the bow knee or breasthook a piece of a natural growth knee will be required. It is shaped as shown in order to fill the open space between the clamp and the plank and give a good fastening for the latter. If it is impossible to obtain the clamps in one piece the joint should be made about amidships, and a scarf piece about two feet long, fitted on the inside, as shown in Fig. 24, and through riveted.

The deck beams may now be gotten out. They are cut from stock 1 1/2 in. thick and are 1 3/4 in. deep. They are curved in such an arc that the "crown" or curvature is 3 1/2 in. in 8 feet; or in other words, if the beam is rested upon the floor its middle point will be 3 1/2 in. above the floor; four of these beams should be of oak and the remainder of spruce. These deck beams can best be cut out at a mill where a band saw is availible. They may then be smoothed up by hand.. For the half beams alongside the standing room and cabin straight pieces are used 1 3/4 in. deep and 1 in. wide. Fig. 20 shows the method of fitting the beams. They are placed just aft of each frame. The top surface of the clamp is about level, while the under surface of the deck beam slopes, so that a notch is cut into the clamp at the right angle to fit the slope of the beam and deep enough to bring

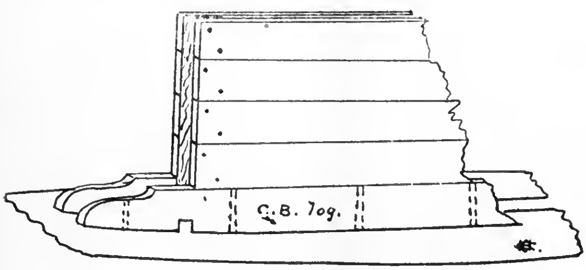


FIG. 19.

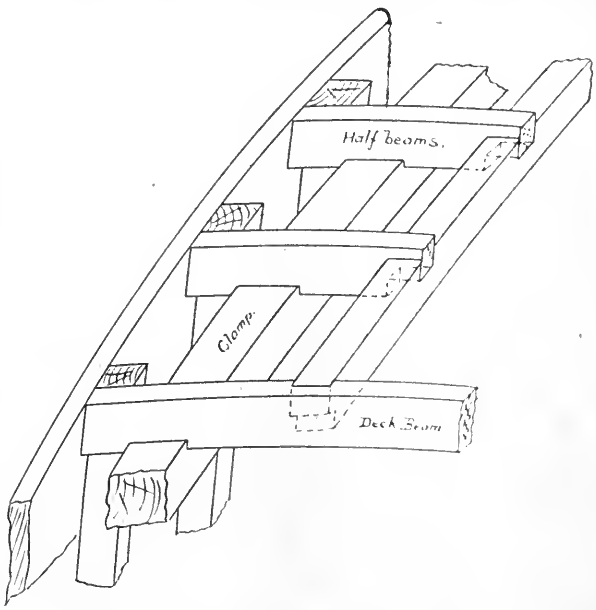


FIG. 20.

its upper surface even with the top of the top streak.

A bilge stringer must be fitted on the inside of the frames just below the turn of the bilge as shown at b[1] Fig. 23. It is 5 in. wide and 3/4 in. thick and should run the full length in one piece. It may be tapered in width to 4 in. at the ends if desired. It can be bent without steaming and fastened with nails into each frame. Hard pine is very good material for these bilge stringers, as it is strong and comes in good lengths although cypress or even spruce may be used.

The first beams to be fitted should be those at the forward and after ends of the cabin house and at the after end of the standing room. The oak beams are used for this purpose. These beams are placed at No. 2 mould, one frame aft of No. 4 mould, and at No. 7 respectively. Before cutting off the beams measurements should be taken to make sure that the widths of the hull are correct and that it has not changed shape. When the proper width is assured the beams may be cut off and fastened in place as before described. They are held into place by 1/4-in. rivets driven through beam and clamp. The remaining oak beam is now put in on the next frame forward of No. 2 mould, these two forward beams forming the mast partners. These four beams are the main stiffeners of the deck frame and must be well secured in place. The beams forward of the cabin and aft of the standing room may then be fitted, using the spruce beams. Each beam, as already mentioned, is placed just aft of each frame, being neatly let down into the clamp and fastened with a rivet. If desired as an additional fastening a galvanized nail

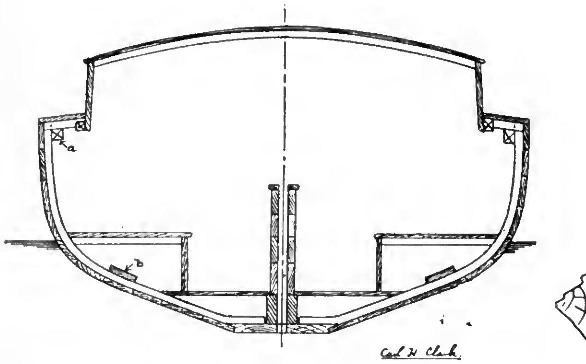


Fig. 23.

may be driven diagonally through the end of the beam into the frame, but this is not wholly necessary.

The half beams are next gotten out; they are 1 in. thick, 1 3/4 in. deep and 8 in. long. They are notched down into the clamp in the same manner as the others. Their inner ends will be supported by the sill, as shown in Figs. 20 and 21. The ends of the beams are notched up 3/4 in. and 1 3/4 back, to fit a corresponding notch in the sill.

The sill is in two lengths on each side, one length extending the length of the cabin trunk and the other the length of the standing room. The sills are let into the heavy beams at the ends and have notches at the proper places to take the ends of the half beams. The notches for the half beams are cut 3/4 in. deep and I in. wide; this brings the top of the sill about 1/4 in. below the tops of the heavy beams. The notches in the heavy beams are so cut that the inner edge of the sill is 9 in. from the outside of the plank and parallel to it. Sill and half beams are now fastened in place, taking care that all beams are fair and that the sill is parallel to the outside of the plank. The sills are fastened to the half beams and to the heavy beams by galvanized nails driven diagonally. The rounding corner pieces, as shown in Fig. 21, are 1 1/4 in. thick, and are fitted into the corner between the sill and the beam as a support for the curve.

The top of the stem is now cut down, leaving only the tenon as shown, about 1 in wide. The upper edge of the stem board is also trimmed off to the same line as the deck beams, so that the deck plank will be evenly across. The edge of the top streak is bevelled slightly to conform to that of the deck.

At the masts and bitt-post oak blocks are fitted between the beams and fastened through. They are 1 1/2 in. thick and about 1 1/2 feet long, with the grain running as shown. They must fit neatly under the deck and it will be necessary to plane them off somewhat rounding on the upper face to accomplish this.

The boat is now ready for the deck, which should be of fairly clear pine, 3/4 in. thick; the middle plank of the deck may, if desired, be of oak about 10 in. wide. In this case the middle plank should be laid first, taking great care that it is exactly in the middle; a line stretched from stem to stern will help in this. The other planks should then be put on about 6 in. wide, straight fore and aft. The edges of the plank should be tongued and grooved, as this makes a very tight and neat deck, which does not re-

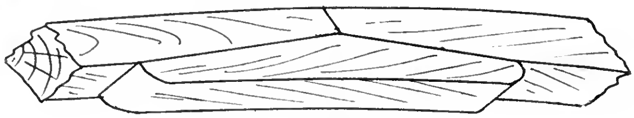


Fig. 24.

quire calking. At the edge of the deck a very wide board should be used, as in Fig. 21, at least 15 in. wide being desirable, as the curve of both cabin and gunwale are cut from it. The deck planks are nailed to each beam and to the edge of the top streak, 2-in. nails being used and the heads being "set" slightly below the surface. All joints and the under side of the deck planks should be painted before putting together. The edges of the deck plank may now be trimmed down even with the side plank on the outside, and on the inside just even with the sill and curved corner pieces.

The cabin trunk is next to be worked in; it may be of either pine or oak. It will be in two pieces joined at the forward end, each piece being about 9 ft. lang, 14 in. wide and 3/4 in. thick. A template should be made from 1/4-in. stock, by bending it around in place and laying out the outline on it. The trunk is 11 in. high at the after end, 7 1/2 in. high at the point where the curve begins at the forward end, and about 6 in. high in the middle. Having these points, the curve of the top edge can be drawn, and also the curve of the lower edge. The template is now taken down and the outline cut out. The two boards are then cut out to fit the template. The bending and fitting of these trunk sides is perhaps the most difficult part of the entire construction, on account of the width of the boards and the sharp bends, with

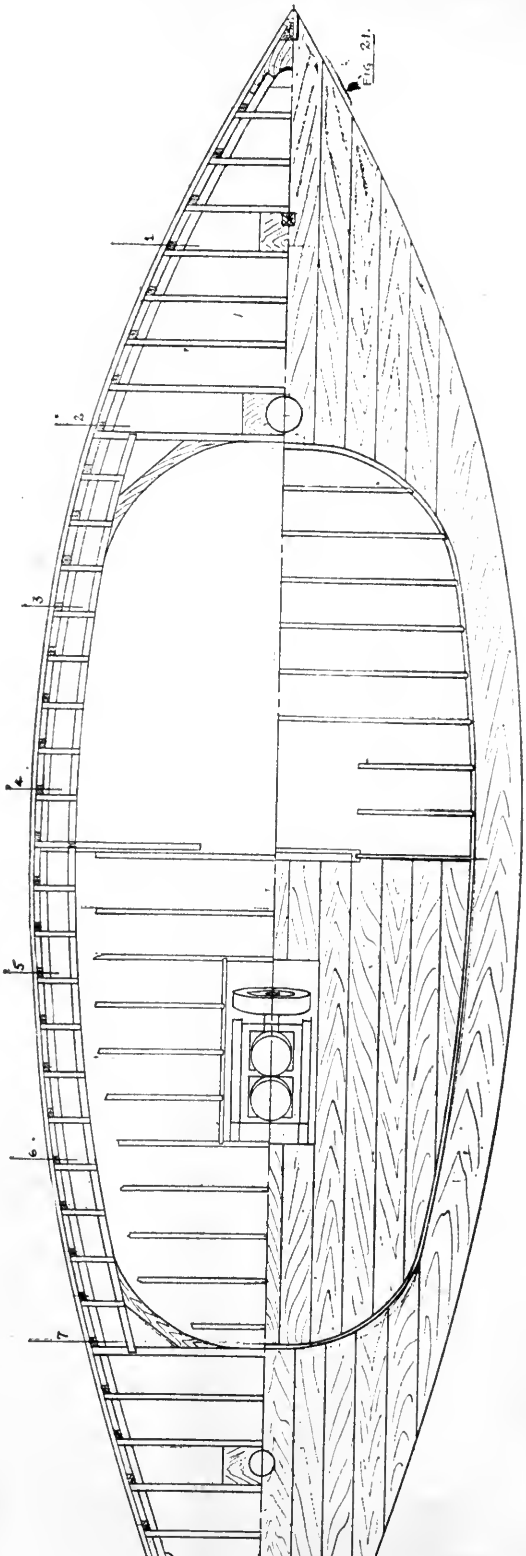


FIG. 21.

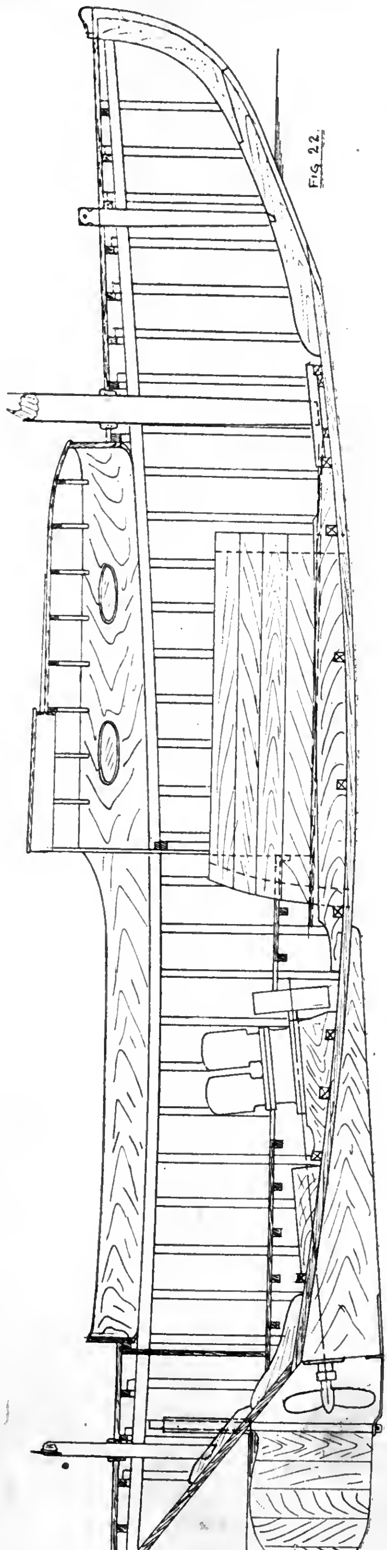


FIG 22.

the consequent tendency to split. They must be bent one at a time and thoroughly steamed on the end which is to be bent. A rough form should be made of about the same curvature as the end of the house. When the board is sufficiently limber it is bent around the form and fastened in place to cool. More curve should be given to it than is necessary, as this makes it easier to force it into place. When it has cooled and "set" it may be set into the boat and drawn up into place by clamps. This operation is apt to split it if great care is not used; it may, however, be prevented by placing a block under each clamp to distribute the pressure. The trunk is fastened in place by screws driven through it into sills, corner pieces and beam, drawing it up tightly into place. The sides of the trunk should not be exactly vertical, but should slope inward slightly. The forward ends of the two parts of the trunk should be allowed to overlap, while fitting and fastening them in place. Both may then be cut off together to exactly fit end to end. A block of the same width and thickness is fastened on the inside to cover the joint. A brace should be fastened across the top at the end of the trunk to prevent the sides springing out.

The coaming around the standing room is of oak 5/8 in. thick, standing 6 in. above the deck at the side. The method of fitting it is the same as for the trunk, but much easier, as it is narrower. Where it joins the trunk side it is trimmed down to 1/4 in. and let into the latter to make a smooth joint. A butt joint is made between the two portions, at the after end, in the same manner as the trunk sides.

The trunk should be painted inside and out, but the standing room coaming should be left bright and finally shellaced.

AFRICAN VANILLA CULTURE.

Consul-General Richard Guenther, of Frankfort quotes from the exhaustive report of Richard Gomolla in the "Tropenpflanzer" the following summary as to the cultivation and preparation of vanilla in German East Africa:

The best variety of vanilla comes from vanilla planifolia, which requires a mucky, porous soil. The plant thrives up to a height of about 1600 feet above sea level and as its fleshy roots do not penetrate deep into the soil it requires only a proportionately thin layer of soil. The plant bears merchantable fruit in the third year, sometimes even in the second year, which require from seven to eight months to mature, and the harvest takes place from April to June. Five to seven harvests are made from the same plant before it is exhausted. New plants must not be planted in the same place as the old.

Protection against wind, also shade, is of great importance for the growth of the plant, and therefore the fields must be surrounded by trees and hedges. Grubs and snails are enemies of the vanilla plant; the former eat the roots, the latter the young sprouts and beans. While in the third year only about one-tenth part of the plants blossom, the percentage increases from year to year up to the seventh. The cultivation of vanilla in German East Africa is impeded by the absence of insects which are instrumental in fructifying the vanilla blossoms. Each separate flower has therefore to be fructified by human hands, the cover of the stigma being raised by means of a thin little rod and the pillen, which is just above the cover, is pressed against the stigma.

When the young beans have grown to the length of a finger, they must be closely inspected and all defective ones must be cut off. The beans mature from seven to eight months after the fructification process. The ripe beans have a yellowish green color.

The way of preparing the beans varies, but an ever-increasing temperature is required to dry them and obtain the well-known brown-black color. In this way, the thin-skinned bean with its fine aroma is produced. If hot water is used for heating the beans, they are placed in baskets and immersed in it. The water has a temperature of 80° to 84° R. Afterwards the beans are packed into wooden boxes, which are lined with woolen cloth, and closed. The next day they must have a glassy appearance. They are then again wrapped in dark woolen covers and laid in the sun to dry. If the weather is rainy, they must be dried in a dry-room at a temperature of 50° R, but an after drying in an airy room of from two to four weeks is necessary. After that the dry beans are packed in tin boxes, where they, however, require close inspection, and have to be repacked every week in order to remove diseased beans or such which have become moldy.

The value of the beans is measured by their length, which is from 12 to 25 centimeters. For shipment they are sorted, bound in bundles, and put into tight but not soldered tin boxes, which are now lined with paper instead of tinfoil, as formerly. Black mould is especially dangerous to the beans, while white mould is rather harmless.

In the bulbs of incandescent lamps it is noted that the incandescence is no longer produced if the proportion of oxide of cerium added to the oxide of thorium is less than 1 per cent. The incandescence is due to an oscillatory oxidation—that is to say, one that is alternately produced and extinguished. When oxidated the cerium might combine with thorium, when there would soon be decomposition, then reoxidation and combination, and so on. These reactions, produced millions of times a second, occasion the luminous oscillations of the ether which produce incandescence.

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ATTACHMENTS FOR SPEED LATHE.

C. TOBYANSEN.

The ambitious carpenter who has a small private workshop should by all means include a turning lathe among his possessions. It will pay for itself, if only in the time saved by an emery wheel attachment for grinding tools. The initial cost need only be a head and tail stock. The rest, such as lathe bed or ways and flywheel, tool rest, etc., can be largely made by the carpenter himself.

Most every user of tools, be he an amateur or practical mechanic, likes to manufacture articles useful or ornamental for his home and fireside; often, also, small fancy products suitable for presents wherewith to endow friends and relatives on festive occasions, thereby saving heavy drains on his purse. And articles so made and given have a far greater valuation than a purchased present equally costly, because of the closer personal associations a home-made article brings with it, bearing more or less the stamp of the individual ingenuity, skill and taste of the maker.

Turning enters largely into the manufacture of such products, as also into the making of household furniture of all kinds. But it is not in the sense of turning only that the lathe can be made useful. By simple home-made attachments one may perform most any of the mill operations, so-called, on a small but effective scale. A fret or jig saw is a much needed complement in all kinds of woodworking operations. Such an attachment is shown in Fig. 1 of the illustrations. where A A represents the lathe bed or ways and B the back table. Upon this rests the jig saw, which may be fastened by screws into the ways. The attachment is made entirely of wood, as shown. The frame proper consists of the two arms D D and the pack piece E, shown in dotted lines, and on which the two arms are rigidly fastened. This frame carries the saw blade at F F and swings on the pivot at G, which is an iron bolt, passing through from side to side. As will be understood from the sketch the frame is incased between the pieces and swings freely up and down, still not so loosely as not to be properly guided. The pivot should be in the line with the top of the saw table K. The piece L is adapted to slide back and forward in order to give freer access to the lower arm for adjusting saw blade. The rod M is stationary between the sides of the case H, and is a guide for steadying the blade in the cut. It is fitted with a small, round, hardwood piece slotted to receive the blade. This hardwood piece has to be renewed from time to time as it wears, and is merely struck into a hole bored in the end of the rod for this purpose. The saw blade should be of such

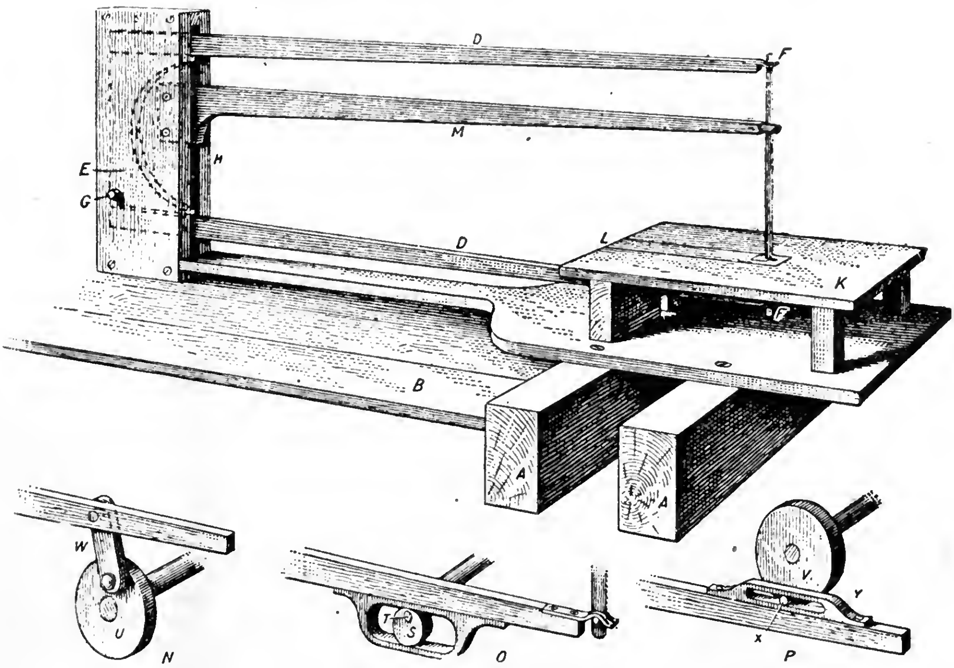


FIG. 1.

length as to slightly force the arms D together, thus keeping the blade taut and stiff. The arms have at the ends a small brass plate fastened on with screws projecting about 1/2 in. beyond the wood and slotted to receive the blade. This is more plainly shown in the sketch O on the same figure, which shows the end of the lower arm. As will be seen the brass plate mentioned has a slight curvature upward. On the upper arm this curvature is downward. The saw is fastened by means of a brad passed through a hole drilled in the end of blade for this purpose. In order to drill this hole without breaking the blade it is advisable to draw the temper at its ends. If the blade is a very fine one a thin wire may be wound about the ends serving the same purpose, or the end may be slightly upset by placing the blade in a vise and hammer lightly on the extreme end, thus raising a burr thick enough to prevent the saw slipping through the brass jaws. The slide L in the saw blade may also be fitted with a sloted brass plate to receive the back of the saw blade, thereby giving a steadier vertical motion. This is rather necessary if the saw frame has worn slack in the case.

At N, O and P are shown three different devices for transforming the rotary motion of the lathe into the reciprocal motion of the saw. The small eccentric S in the sketch O is operated by the shoulder T reaching between the centers of the lathe. This form is more especially adapted to a lathe run by steam power. This journal should be made as long as needed to give sufficient swinging room for the work, and may be further steadied by passing through blocks or rest on each side of the saw tablt, close fitting enough to prevent vibration, but still not tight enough to cause friction. Lampblack will be found an excellent lubricant to prevent the latter.

The devices shown at N and P are both adapted to operate directly from the face plate of the lathe, U and V representing face plates. In sketch N the connection with the saw bar is made by the driving rod W, which is bolted loosely to both. At P the peg X is fastened firmly to the face plate and extends through the slide Y, fastened to the saw bar. These two latter devices are equally adapted to a foot-power lathe. The saw table should be high enough to allow the lathe head to pass entirely under it, bringing the face plate close up to the saw bar.

In Fig. 2 is shown a circular saw attachment, the need of which is too important to the woodworker to need comment. The saw blade is mounted on a steel arbor, which can be purchased of any machine dealer. The saw blade in the sketch need not exceed 8 in. in diameter and should be of light gauge. The arbor B is hung between two pointed centers and a dog connects it with the slotted face plate, thus complying with the motion of the lathe. The bed table D is fastened to the lathe bed by the bolt F, which reaches down to the plate F underneath the bed. A wedge driven between this and the lathe bed will fasten the

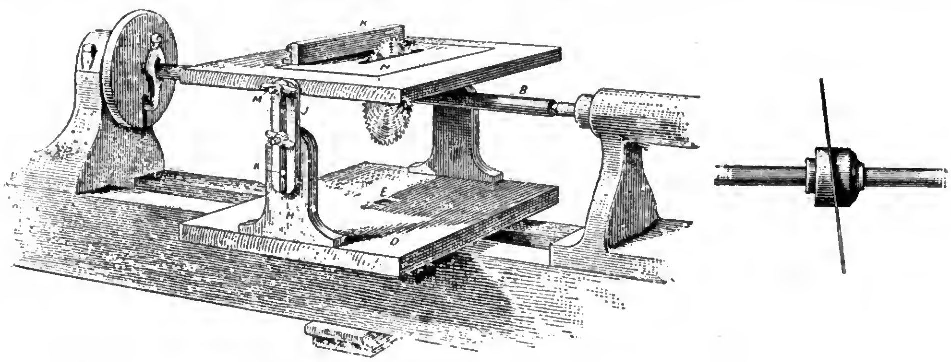


FIG. 2.

saw stand firmly. This same device may be used equally well for the jig saw. The brackets H H are fastened firmly to the bed table. The slotted piece J, which connects the bed, table and the saw table proper, is guided by the peg K and fastened by a wing nut. The table can thus be raised or lowered at will, admitting of any desirable depth of saw cut. It is further adjustable by the wing nut M, which adapts the table for bevel cutting. The piece N, inserted loosely in the saw table, is beveled in the slot on the underside to admit clearance for the saw in bevel cuts.

By placing a beveled collar on each side of the saw blade, as shown at the right in Fig. 2, the saw may be placed out of line and can be adjusted according to the bevel given the collars, which are made of wood. This is a useful arrangement, for many purposes where a wide cut is desirable, such as plowing, rabbeting, notching out for dentals, and the like. When such a saw is used the piece N must be replaced by one having a wider slot. The guide R must also be removed and replaced with a cross cuting guide adapted to cross the table and slide against the saw, the construction of which may be safely left to the reader's ingenuity. By the way, the bevel saw arrangement mentioned above is commonly called "a wabble saw."

An emery wheel can also be fastened on a saw mandrel. But it would be advisable to procure a second mandrel, so as to prevent too much changing about. A cheaper way is simply to turn a hardwood spindle to fit the hole in an emery wheel, so it will drive fast on the spindle, and we have our grindstone complete.

In Fig. 3, is shown an easy method whereby the edges of the work in hand may be molded in simple designs. A shows a sectional view of a center chuck, which generally is included among the fixtures when a lathe is purchased. It fits into the spindle of the headstock as an ordinary center, and is meant to carry boring bits by inserting them in the hole and fastening by set screw B. In this case a cutter is inserted, as C, while E is a false table resting on lathe bed, built up to suitable height, F being a strip of wood serving as a guide for the piece L, which is being molded.

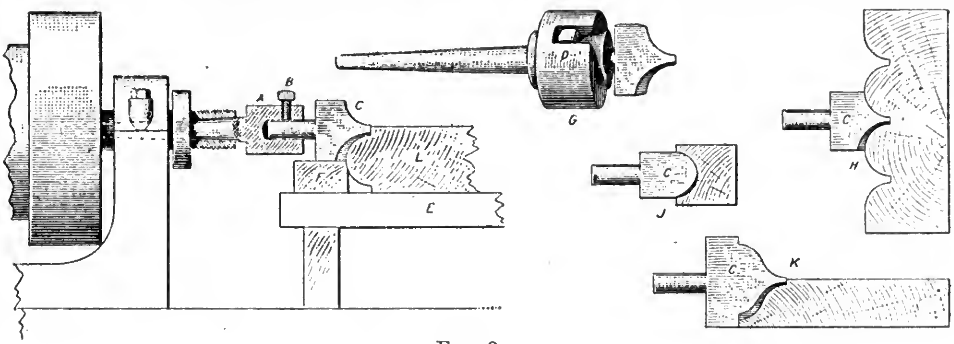


Fig. 3.

It will be understood that the molding surface is limited to one-half of the cutter. It is desirable, however, to grind both halves alike in order that both may cut. It makes better work and is easier and steadier to operate. The cutters can be made out of old files ground to shape on the emery wheel and touched up by filing where needed. The temper must be drawn first in order to file, and they can be retemperd if desired for hardwood cuting. In order to form the full bead on the edge of piece L it has to be reversed—that is to say, one-half cut from each side running it steadily against the guide F. By raising or lowering the table several beads may be formed with the same cutter, as indicated at H in the drawing, C showing the cuter blank.

Fluting may also be done with a half round cutter, as at J. An ogee mold is shown at K suitable for table tops, giving a pleasing finish.

The head of set screw, like the one shown at B, projecting as it does is a dangerous affair and the cause of many injured fingers and hands, hence the ounce of protection shown at G in the form of the ring D. It is simply a hardwood ring fitted properly over the center chuck, thick enough to come flush with the bolt head and having an opening cut for the same large enough to admit of turning it around with a socket wrench.

SEAWEED IN NORWAY,

Seaweed burning in Norway produces an annual income of £30,000. Along the shores of Joderen, on the southwest coast of Norway, the seaweed grows in veritable forests. This is not the common grass variety, but actual trees from 5 ft. to 6 ft. in height, with stems like ropes and leaves as tough as leather. It begins to sprout in March and April, and gradually covers the ocean bed with a dense impenetrable brush. In the fall the stems become tender, the roots release their suction-like grip on the rocky bottom, and the autumn winds wash it ashore in such great quantities that it looks like a huge brown wall along the entire coast. The fall crop is of comparative small value. The only use that can be made of it is for fertilising purposes, because it is only in the spring that it can be successfully burned, and at this time there is such a demand for it that every stalk and leaf is gathered. The weed-burning season is the busiest of the year, and every member of the household is drafted to assist in gathering, drying and burning. At the close of each clear day the whole coast seems to be aflame from thousands of bonfires that are kept burning far into the night. Owners of farms located where the weed seems to have a predilection to drift produce as much as 3000 lb. of ashes a year, which sells for from $1.75 to $3.75 a pound.

Generally speaking, electric furnaces may be divided under two main headings—namely: those in which the heating effect is produced by the electric arc established between two carbon or other electrodes connected with the source of current, commonly known as arc furnaces; and those in which the heating effect is produced by the passage of the current through a resistance, which either forms part of the furnace proper, or is constituted, by a suitable conducting train, of material to be treated in the furnace. The principle of the later type is analogous to that involved in the heating to incandescence of the ordinary electric lamp filament, and such furnaces, are as a class, known as resistance furnaces.

HOW TO MAKE A MICROTOME.

J. E. PAYNTER.

A microtome is an appliance used for cutting very thin sections of the stems, leaves, etc., of plants, for examination under the microscope. One of the most common methods adopted by those who do not passess a microtome is to hold the stem or other object between two pieces of pith or potato, and then take off very fine parings of the potato, and, at the same time, of the object embedded therein, with a razor. This is not an ideal method, as it is difficult to obtain very thin sections; there is also an element of danger in the operation, seeing that the razor used for cutting has to be very sharp.

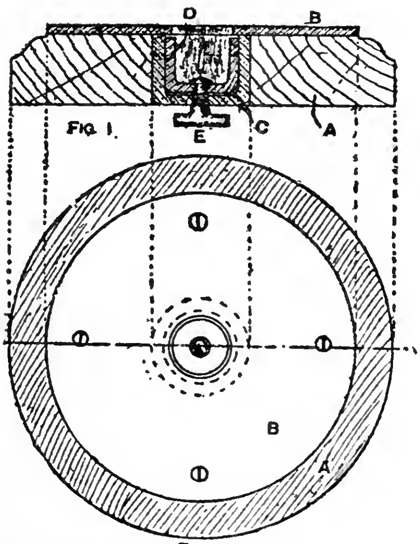


FIG. 2

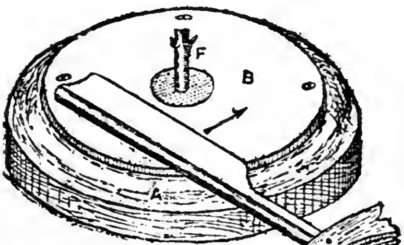


FIG. 3

Some mechanical aid, therefore, is necessary if really satisfactory work is to be produced. There are many expensive and elaborate patterns of microtomes made for this purpose, but the one to be described will serve very well for all ordinary requirements, and can be put together at a very slight cost. Those who desire to make them for profit would have no difficulty in selling them at a remunerative price among botany and biology students.

Figs. 1 and 2 are section and plan respectively of the appliance, Fig. 3 showing the method of using it. The first thing needed is a circular disc of wood A, from 4 in. to 5 in. in diameter and 3/4 in. thick. A gas block, such as is used for fixing gas brackets to walls, suits the purpose admirably, and will be ready turned to shape, moulded on the edge, and polished. In the centre of this block bore a hole, 1 in. bare in diameter, entirely through the thickness. Next cut a circular piece B, of thin brass or zinc, to the same diameter as the top of the wooded block. Before screwing this plate to the block, drill a 5/8 in. hole in the centre of it, taking care to make it centre correctly with the hole in the block. Then file off the top surface of the plate, and smooth it with emery and oil.

Now procure a blank cap C (Fig. 1)—that is, a piece of brass pipe with one closed end—of 1 in. external diameter, and file it off so as to make the length equal to the thickness of the wooden base. A hole is drilled through the closed end of the blank cap, tapped to suit the thread of a milled-head screw E, which should be about 3/16 in. in diameter. Cut the screw off, if necessary, to about 3/4 in. long, measured from under the milled head, and, by filing, or by turning it down in the lathe, form a step 1/32 in. deep and 1/4 in. from the end. This end of the screw is to pass through an inner cylinder D, as shown in Fig. 1, and after being inserted must be riveted over to prevent its withdrawal. The inside cylinder, for which another brass blank cap may be used, must be made to fit closely into the outside cap C, but with just enough play to allow it to work easily up and down. The inner cylinder D is cut so as to be 1/16 in. below the under side of the surface plate B—that is, 1/2 in. or 9/16 in. long (see Fig. 1).

When these various pieces have been fitted neatly together, the external cylinder C, with its fitings, is driven tightly into the 1 in. hole previously bored in the wooden base, until it comes up tight underneath the surface plate. The microtome is now ready for use. When the milled-head screw is turned, the inner cylinder will be raised or lowered within a limit of 1/16 in. the underneath side of the surface plate preventing it from raising farther.

Now a word as to the method of using the microtome. Suppose it is desired to make a very thin cross section of the stem of a plant. First melt together some white wax and olive oil, so as to form a solid block when cool. A small quantity can then be used as required. Take a little of this prepared wax, melt it, and, having turned the milled-head screw so as to lower the inner cup as far as it will go, pour the molten wax through the hole in the surface plate into the cup until the wax reaches the level of the surface plate; then, while the wax is still liquid, stand the plant-stem F (Fig. 3) upright in the middle, as shown. Allow the wax to cool, and then turn the milled-head screw about a quarter of a revolution, so as to raise the inner cup very slightly, and with it the wax and the embedded stem.

Now take an old razor, and grind one of its faces perfectly flat, and sharpen it up from one side only as if it were a chisel. Press the flat side of the razor in close contact with the metal plate, and push it forward, slicing off the top of the wax, and paring the stem level with the face of the plate. Then turn the milled-head screw very carefully for another quarter revolution, or less, so as to raise the inner cup and wax very slightly higher. Repeat the work with the razor, when it will be possible to pare off an extremely thin slice of wax, with a very thin section of stem embedded in the centre. Do not attempt to handle the delicate section with the fingers, but float it off the razor with a camel-hair brush into a little alcohol, which will dissolve the wax. The section may then be strained, and mounted on an object-glass in the usual way. It may be necessary to add that as the milled-head screw projects below the microtome, a hole should be bored in the bench top sufficiently deep to take the projecting milled-head screw, thus serving the double purpose of allowing the microtome to rest firmly on the bench, and preventing it from sliding along the bench when the razor is being used.—"Work," London.

BRAZING.

E. A. SUVERKROP.

In spite of the fact that there are hundreds of brazed flanges on the average steam ship it is surprising how few engineers know anything at all about the job. This is no doubt due to the feeling among engineers in general of "every man to his own job." The ability to do a fair job of smith work is no doubt of great assistance to the engineer at times and why should he not be able to do a fair job of brazing? Brazing is considerably easier than smith work. I would undertake to make a good brazer of any intelligent man in from twenty minutes to an hour, but who could make a smith of a man in that time?

I will first take the general principles of brazing under consideration. Brazing is the joining together of two pieces of metal by means of another metal having a lower melting point. It is practically the same as soft soldering excepting that it is done at a higher temperature and the solder of spelter used is an alloy of copper, tin and zinc or copper and zinc instead of tin and lead. The joints to be brazed should be as nearly clean bright metal as the job permits. Grease and dirt are antagonists to a good job. The parts to be brazed should be securely held in relation to each other, either by pins put through them or by wiring to each other or by other means. The heat applied should also be clean. Hard coal fires are fairly good, a fire of soft coal charred is also good, but perhaps the best is a gas and air blast. Gasoline or oil blast also give good results.

In brazing a flux must be used. Formerly borax in one form or another was the only thing that would do. Some brazers used it powdered, some in crystals, some mixed it with water, some didn't. Some melted it in a crucible; it was then called "burnt" borax. It was then broken to various degrees of fineness according to the individual whim of the brazer, each one of whom would declare that his way of breaking the borax was the prime reason why he produced good work. The drawback about borax is that while it is a good flux it becomes as hard as glass after the job is cold. In this state it is difficult to remove and ruins the hardest file. A better flux than borax in any form is boris (also called boracic) acid. It comes in crystals or powder. I prefer the crystals for some work as the powdered form is apt to curl up and blow away while the crystals do not. Boric acid does not form a hard scale and if you know how to handle it does not leave any scale that cannot be almost rubbed off with the hand.

In jointing up ready for brazing the joints, one need not leave room for the brass to run in. They can be drive-fits, for if the heat and flux and spelter be applied in the right manner the brass will run into the tightest joint. The beginner, however, had better not fit his pieces too tight; just make them an easy drive fit, put one or more pins in to hold the pieces together.

We will assume that we have a steel flange to braze on a steel pipe. The flange has been bored or filed to fit on the end of the pipe which has also been filed or burned bright, the joint is clean, bright metal to metal. The job should be put in the fire so that the pieces are heated as evenly as possible. In this case we will assume (what is generally the case) that the flange is heavier than the pipe. It stands to reason that it will not heat as quickly as the pipe which is lighter, we therefore heat the flange first, placing it in the hottest part of the fire. While the heat is coming up the brazer applies the flux to the joint with a brazing "spoon." I generally make my brazing spoons out of a piece of 1/4 or 5/16 inch iron rod of suitable length, say two feet, with the end heated and beaten out flat about 5/8 inch wide by 1 1/2 inches long. As the heat increases and the flange and pipe become a dull red the flux melts and runs all over the job, some of it runs into the joint where we want it but the bulk of it is lost. As it is cheap this does not signify. When the job reaches a so-called cherry red, that is to say, a heat at which one would temper a chisel, it is time to put a little spelter on as this heat is very near the melting point of the spelter. The spelter is applied with the spoon together with more flux and is guided into the top of the joint by the spoon. In a few moments the brazer will notice that the spelter has begun to flow and run about all over the joint almost the same as mercury. The heat is kept on a little longer, say a minute or so according to the size of the job, while more spelter and flux is applied. The job is then lifted from the fire, being handled carefully so as not to jar it, and while still red hot the flux is brushed off with a steel brush. This treatment applies especially when borax is used as it eliminates a good deal of hard work later. The job is then allowed to cool till it is at such a temperature (a dark red) that immersion in water will not harm it. It is then put into a saturated solution of sal soda water or strong soap water. When cool the scale is easily brushed off, leaving the steel and brass clean and bright.

The spelter to be used varies according to the material on which it is to be used. On steel any kind of brass can be used, as the melting point of any brass is below that of any steel. I have also brazed steel with copper when no brass was at hand.

For brass and copper a soft brass with a low melting point must be used and great care must be exercised in order to avoid melting the job itself, especially so if it is brass, as the chances are that there may not be much difference between the melting points of the job and the spelter.

It is often desirable to repair a piece of cast iron that has been broken. A great number of very good brazers assert that cast iron cannot be brazed, and an equally large number of people having some patent process or another assert that it can but only by their particular method. Both are wrong, cast iron can be brazed with common brass and common borax or boric acid. There is no mystery about it. The joint should be thoroughly clean, the pieces should be firmly pinned together so that they cannot alter their position with relation to each other, the heat should be applied slowly and steadily while plenty of flux and spelter are applied and the job should not be hurried in any way. Let the job stay in the fire for a long time, to use a blacksmith's phrase, "Let it soak in the fire." A braze made in this way will be just as good if not better than one made by any of the patented or secret (?) processes.—"The Marine Review."

SPONTANEOUS COMBUSTION.

A peculiar case of spontaneous combustion is described in Cassier's Magazine by S. E. Wowell, who says that on February 17, 1906, two large refrigerator cars of young rose bushes were received at Hannibal, Missouri, from a nursery in California, for cold storage and general distribution throughout the surrounding country. They were shipped in wooden cases containing numerous auger holes for ventilation, and they were carefully packed with wet sphagnum, or California swamp moss, to prevent chafing and to support their vitality. No ice was put in the cooling tanks, and the covers of these, as well as all other openings in the cars, were closed as tightly as possible. The cars were ten days in transit. The outside temperature was 60° F. at the start, and 158 at the end of the trip. Upon arrival, steam was issuing from every crevice of the cars. On removing the tank covers, it rushed out in large volumes. The doors were opened and the ice was put in the tanks; the free circulation of cold air then soon cooled the contents of the cars. In unloading it was discovered that some of the two upper layers of boxes were badly damaged by heat, which naturally was the most intense near the top of the cars. No signs of actual combustion were found, but this would probably have occurred in a short time had not the cars been quickly cooled. The temperature must have been nearly up to the burning point, as many of the green stems of the plants were black and brittle.

SEEPAGE OF WATER IN THE EARTH.

All rocks are more porous than glass, and hence the ocean bottom everywhere permits the water, by the force of pressure and capillarity, to seep into the bowels of the earth. The rate of the seepage will depend on the depth of the sea, the porosity of the underlying rock and the temperature. Owing to the pressure at great depths in the earth's crust the rate of seepage would diminish, but it is increased by the effect of high temperature, which causes the steam to diffuse in the earth, just as gases have been found to do in hot steel under experiment. That water readily diffuses and steam is abundantly absorbed in hot rocks is proved by the vast clouds of vapor given off by molten lava as it pours from a volcano. Water, chiefly from the oceans, may seep down into the earth until it comes in contact with hot rocks, then steam develops, and when the accumulation is great enough the earth is shaken till the strata move at the nearest fault lint, of a volcano becomes active. The experiments made in France by the veteran geologist Daubree many years ago show that water and steam may by force of capillarity enter a region of greater counter pressure and actually increase the pressure within, thus accumulating a subterranean strain which will eventually cause an earthquake or a volcanic eruption.

ELEMENTS OF DYNAMO DESIGN.

IRA M. CUSHING.

II. Magnetic Circuits—Field Magnets.

The magnetic circuit has been found to have many properties in common with the electric circuit. There is a difference of magnetic potential causing lines of force to flow from the north to the south pole, just as there is a difference of electric potential between the terminals of a battery. The total power of the magnet or magneto motive-force (M. M. F.) is equal to the sum of the M. M. F. of each turn of the coil, just as the total electromotive force of a battery is the sum of the E. M. F. of each cell when connected in series.

Some materials conduct magnetism better than others, in the same manner that some conduct the electric current better than others. Also, the reluctance, which is the resistance in materials to the passage of magnetism, is proportional to the length of the path, and inversly proportional to the cross section of the path, which is true of the electric circuit.

As stated above, materials have a reluctance to the passage of magnetism, and this is called Reluctivity. The opposite to this is called Permeability. Various definitions have been given for this property, and one of the clearest is as follows:—Permeability is the ability which a material has to transmit magnetizing force, and is expressed numerically as the ratio between the magnetic lines per unit area and the magnetizing force. Let B equal the lines per unit area and the permeability represented by μ then

$$\mu = \frac{B}{H} \quad (3)$$

If a column of air in a coil is given a magnetizing force equal to H, the lines per unit area or flux density will be the same, or in other words, air has a permeability of 1. It has been found by experiment that if a piece of iron is placed in the coil and subjected to the same force H, that the flux density B is much greater. For illustration; if the iron were given a magnetizing force that would produce 10 lines in the air, it would be found to contain 4070 lines per unit area. Then, by dividing the flux density of the iron by what it would be in the air the permeability is found to be 407. That is, the iron has the ability or capacity of carrying 407 more lines per unit area than the air at this density. All non-magnetic materials like paper, coton, brass, etc., are considered as having a permeability of 1.

Continued evperiments brought out the fact that the permeability of iron and steel varied much for different degrees of magnetization. It actually seems as though the magnetic lines occupied space, and there soon comes a point at which the iron becomes saturated and any increase in the flux density requires more power in proportion than it did before saturation was reached. The résult of these experiments have been ploted in curves with B for ordinates and H for abscissae. Fig. 5 shows approximately the curves for different irons and steels. These curves show very clearly the point of saturation to be where the curve turns and runs nearly horizontal. They also show that some varieties of steel and iron have a greater capacity than others. For example, soft annealed iron requires nearly three times the flux density that cast iron does to become saturated.

The practical working limit of flux density B in

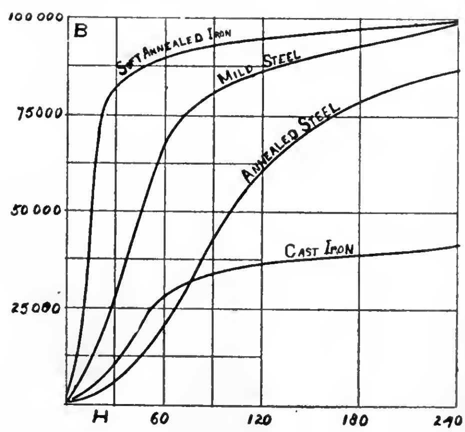


Fig. 5.

good wrought iron is about 125,000 lines per square inch and in cast iron the working limit is reached at about 70,000 lines. However, the permeability of different pieces of the same kind of iron vary so that in extremely nice calculations it is necessary to test the piece to be used. In ordinary work, and especially in small dynamo designs, this degree of nicety is not necessary; there being other points in the design which would have more weight in their variation than this.

Joints in the iron of a magnet circuit seem to add a reluctance, or magnetic resistance, to the lines of force, requiring additional M. M. F. to drive a given number of lines. The exact effects have to be determined experimentally and vary in proportion to the number of lines of force. For a low unit intensity

(H—) the loss due to a joint amounts to about 20 per cent., while with a large density the loss runs as low as 2 per cent. The joint is really a very small air gap, and it is presumed that with the increased magnetic density the resulting attraction of the pieces of iron will reduce the air gap which would account for the decrease in loss. With very high magnetic density, of say 100,000 to 125,000 lines per sq. in., the attraction of one piece to the other at the joint will cause a pressure of approximately 200 lbs. per sq. in.

It is evident that an air gap in a non-magnetic circuit, or a space filled with non-magnetic material, which would have a permeability of 1 would require a considerable increase in M. M. F. to force the same number of lines as in the iron itself. The adjustment of air gaps in dynamos and motors, particularly small ones, needs much care both in designing and making the machines. If a large air gap is present, greater power is needed to force the required lines of force across it, as the evident power is drawn from the armature it is evident that its output is reduced and therefore the efficiency of the machine.

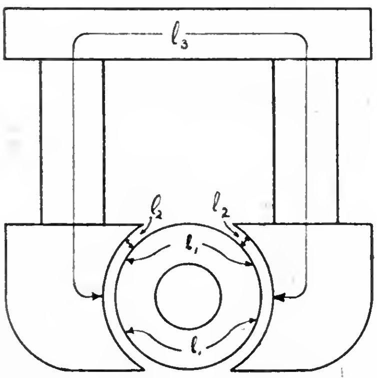


Fig. 6.

As stated before, some magnetic materials retain magnetism after the source has been removed. Illustrations of this are steel, especially hard steel, and hardened irons. These have this property to a large degree. This remaining magnetism is termed Residual Magnetism. The ability of holding residual magnetism is not, however, confined to steel and hard iron. The softest iron will retain a slight amount. This property is a very fortunate one for dynamo designers, as it makes it possible for a dynamo to start generating current without an external application of magnetism to the fields every time the machine is started. This residual magnetism can be removed by reversing the magnetism with a coil of wire or by heating. Reversing the magnetism is uncertain as too strong a force in the opposite direction will produce residual in that direction. Heating iron to a dull or cherry red will remove all traces of the magnetism.

Another magnetic property of iron and steel is Hysteresis. This is a lag in the building up to their full number of the lines of force in the iron behind the force which producees them. In other words, there is an appreciable time between thee application of the force and the building up of the lines to the full number. Hysteresis is much less in soft iron than in steel. Reversals of magnetism take place every revolution of the dynamo, so it is necessary to make the core of as soft a grade of iron as possible. Hysteresis is a loss, and shows itself as heat in the iron, which accounts for some of the heat in the armature core. This, however, is a more important factor in alternating current design, especially transformers, as there large masses of iron are subjected to the reversals.

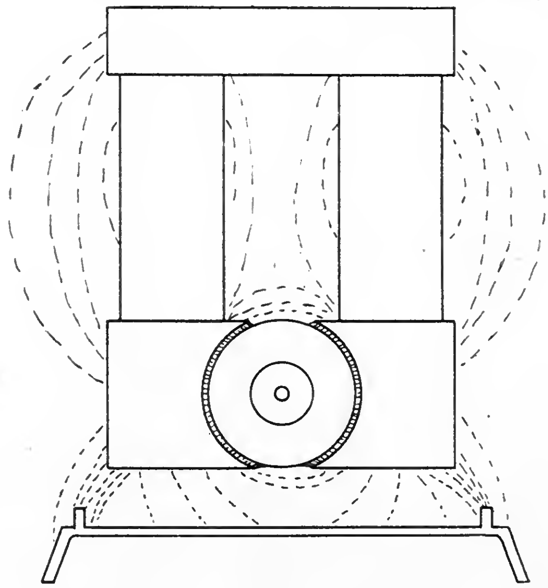


Fig. 7.

Having mastered some of the fundamental principles of magnetism, the field magnet will be the first part of the dynamo to consider although in the actual design of the machine it is the second part to calculate, the armature being the first.

The magneto-motive-force required to drive a given number of lines through an iron core, or across an air gap, depends upon the reluctance of the iron and the number of lines of force. Let H equal the magneto-motive-force, N the total flux, and R the reluctance, then.—

$$H = NR. \quad (4)$$

But from formula (1) $H = k\ I\ S$. then

$$k\ I\ S = NR \quad (5)$$

When the unit of length and area is given in inches k equals $1 \div 0.3132$ therefore the ampere turns

$$I\ S = NR\ 0.3132 \quad (6)$$

It was previously determined that the reluctance of a magnetic circuit varied directly in proportion to its length and varied inversely to its area and the permeability of the iron, that is,—

$$R = \frac{l}{\mu A}$$

and formula (6) will be,—

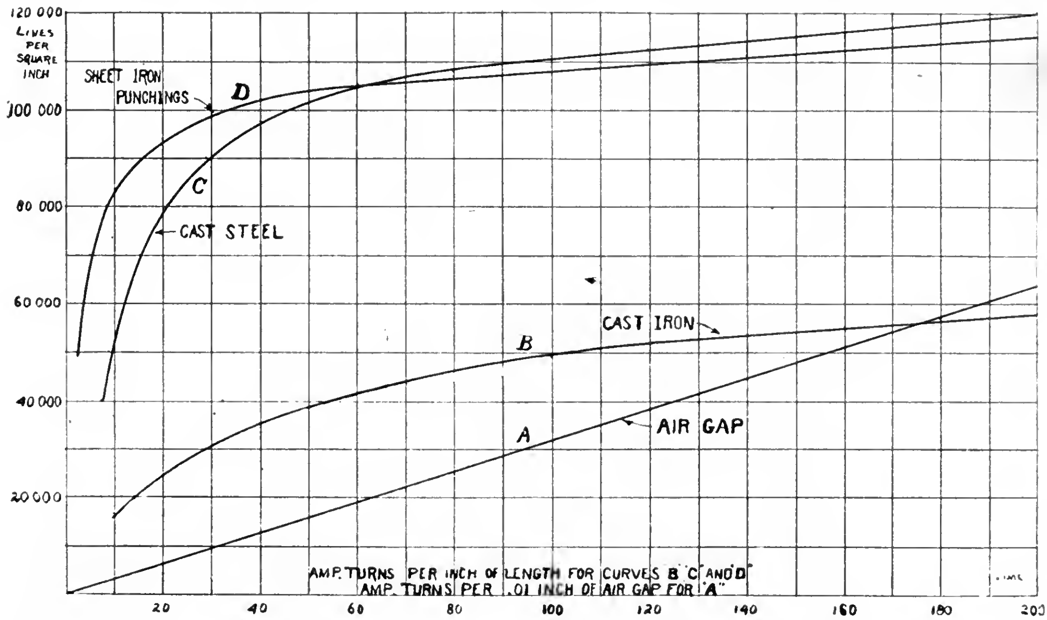
$$I S = \frac{N l\, 0.3132}{\mu A}$$

It will be readily seen from Fig. 6 that the length of the magnetic circuit is divided into at least three parts having different magnetic characteristics. This figure of a simple dynamo in which l^1 represents the average length of the armature magnetic circuit, l^2 the aid gap and l^3 the average length of the lines of force

This formula can be presented in another form which may be a little easier to handle. Since N ÷ A equals the unit density B, then (8) would become I S equals B l 0.3132 ÷ μ, and assume S = 1 in., then for each inch of length of the magnetic circuit the ampere-turns required will be

$$I S = \frac{B\, 0.3132}{\mu} \quad \textbf{(10)}$$

From this formula can be had two variables, ampere-turns (I. S.) and lines per sq. in., B, and by using these as ordinates and abscissae, a curve can be plotted giving at a glance the ampere turns required for every inch of magnetic circuit, air or iron, with a



through the field. Then the ampere turns for the armature would be N l^1 ÷ μ A 0.3132 where μ is the permeability and A the sectional area of the field core. As the permeability of air is 1, the ampere turns for the two air gaps would equal 2 N l_2 ÷ A_2 Due to the fact that there is a certain amount of leakage of lines of force around the field poles, which do not enter the armature, the flux will have to be increased by an amount v which varies according to the types of field frame, and the capacity of the dynamo, from 1.1 to 1.4. The ampere turns for the field will therefore equal v N l_3 ÷ μ A 0.3132. The total ampere turns will then equal

$$I S = \frac{N l_1\ 0.3132}{\mu_1 A_1} + \frac{2 N l_2\ 0.3132}{A_2} + \frac{N l_3\, 0.3132}{\mu_3 A_3}$$

$$\text{or } I S = N\, 0.3132 \frac{l}{\mu_1 A_1} + \frac{2 l_2}{A_2} + \frac{l_3 v}{\mu_3 A_3} \quad \textbf{(9)}$$

which is the formula to use when length and area is given in inches.

given magnetic density. Such a curve is given in plate I. Curve A is laid off with ampere turns per .01 inch of air gap for ordinates, and lines per sq. in. for abscissae. Curves B, C, and D are for iron, cast steel and armature punchings respectively, and are laid off with ampere turns per inch of magnetic path as abscissae and lines per square inch as ordinates. These curves should be used with some allowances to make up for variations in the grade of the iron or steel. It is not desirable to work too fine with the numbers, as the results given by these curves are only approximate. Use round numbers. For example, if the curve gave 2523. lines call it 2600; or if 122 1/2 ampere turns are the result of computation make it 125. Liberality of design in this part of the machine will be of great benefit and will help make up dificiencies in other parts.

The form of the field magnet does not matter if it is magnetically and mechanically correct. All parts carrying lines of force should be so designed that they will not offer too much resistance to the magnetism (reluctance), but at the same time should not be so large as to add unnecessary weight to the dynamo and look clumsy. Care should also be used to cut down as much as possible the leakage of lines of force around the armature. These lines would be useless and at the same time would require an extra number of ampere turns above those needed to send the lines through the armature.

An example of bad design in this respect would be to carry the field pole tips well around the armature until they nearly touched. This would allow probably nearly 40 per cent. of the total lines in the field to jump across in the air, instead of going through the armature, which is usually crowded to nearly its saturation point. In such a design, therefore, it would be necessary to add 40 per cent. more ampere turns than were actually needed by the armature. In all cases, however, there is a certain amount of leakage of the lines, which either jump from pole to pole in the air, or get back to the other end of the field spool through the air outside the coil. Fig. 7 gives the outline of a dynamo with the leakage shown in dark lines. This is the old familiar Edison type dynamo. It is mounted on a wooden base, which in turn rests on an iron bed plate with sliding rails. The figure shows plainly how many lines are lost in the air, and also that many pass from pole to pole through the bed plate. This type of field is very wasteful of magnetism.

The modern multipolar dynamo is designed to obviate as much as possible this leakage. This type is shown in No. 1, Fig 8. The field poles point inward towards the armature from a solid iron ring which forms part of the magnetic path, the completion of the path being through the armature when it is needed. It will be seen that the iron forms nearly the shortest path for the lines of force. There is, however, a slight leakage from pole tip to pole tip in the air. This is taken care of in formula 9 by the letter V as explained before.

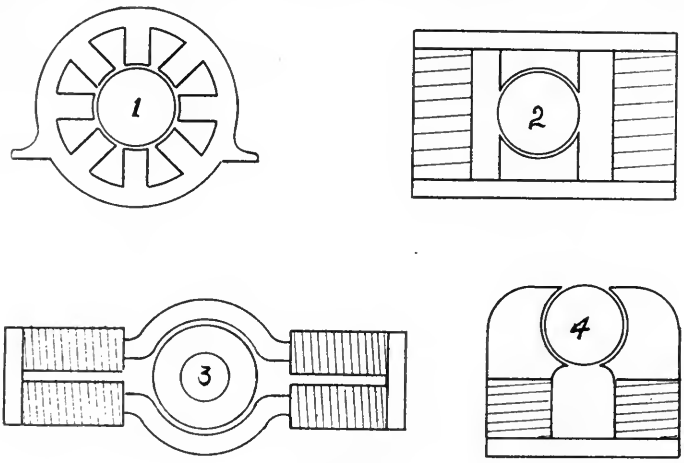


FIG. 8.

The application of these formulae will be treated in later chapters. The size of wire depends upon the amount of current flowing. The determination of these will also be taken up later, and a table will be given showing the current capacity, diameter of bare wire and with insulation for the different sizes of wire.

There are a number of rules given for determining the direction of the flow of magnetism induced by an electric current. Ampere's Rule, which follows, shows the direction of the field of force which surrounds a current flowing in a conductor. "Suppose a man swimming in the wire with the current, and that he turns (his body) so as to face a (compass) needle, then the N seeking pole of the needle will be deflected towards his left hand." In other words, in facing the direction a current is flowing in a conductor, the lines of force pass around the conductor clock wire, or in the direction the hands of a clock move. If this conductor be multiplied into a number of conductors so as to make a coil, and the current in passing along the wire comes up in front and over the top of the coil away from the observer, it is very evident that all the lines from each conductor added together will make a north pole at the left and a south pole at the right. Also, if the current passes down and under the coil away from the observer the north pole will be at the right and the south pole at the left.

Another good rule is this:—Facing a North pole, the magnetizing current would be flowing about it in a counter-clock-wise direction, and facing a South pole the magnetizing current would be flowing in a clock wise direction. If the direction of current is known (which is generally the case), this rule can be used, for if the observer is facing the end of an electro-magnet and finds the current flowing clock-wise, then the nearest end of the magnet is the South pole. Similarly, if the current is flowing counter-clock-wise the nearest pole is North. With these rules, it makes no difference in which direction the current passes along the spiral; that is, it matters not whether the coil is wound right or left handed. These rules are very important and should be memorized.

The forms of field frames are many, and it matters but little what form is used provided it is designed for a minimum leakage, and that the coils have sufficient copper wire to produce the required field of force for the armature. Fig. 8 gives a few standard forms; No. 1 is the multipolar form, which is used almost exclusively at the present time for medium and large size generators. The familiar Edison bipolar is shown in Figs. 6 and 7. Refering to Fig. 8 again, form No. 2 is the Manchester type; No. 3 is an early form of Siemen's dynamo; No. 4 is a favorite type of the present day with some manufacturers for small size machines. It is practically the Edison bipolar inverted, which removes the objectional leakage of magnetism in the base frame. In deciding upon a field frame it is obvious that one with the least number of joints in the magnetic path will require less field excitation and therefore give a dynamo of greater efficiency.

The subject of the field magnet and frame is not by any means exhausted in the foregoing but has only been touched upon. Much has been written on the subject, more in fact than the average student can read. In a later chapter a list of books will be given which the student may examine and study those portion referring to the work at hand.

NEW BOOKS RECEIVED.

ELECTRICAL WIRING AND CONSTRUCTION TABLES. Menry C. Horstman and Victor H. Tousley, 118 pp. 6x4 in. Full Flexible Morocco. $1.50. Frederick J. Drake & Co., Chicago, Ill.

This book, which is a companion volume to "Modern Wiring Diagrams," is a pocket hand-book that would be of especial value to inside wiremen and to them presents material that should be of considerable benefit. It is a very good interpretation of that bewildering "Natural Electrical Code." For direct current work and data on wire and wiring material it seems to be complete enough for those who should use it. With regard to the alternating current part, the book seems to be unfortunately lacking in some things. The selection of voltages for the motor charts does not correspond to the present practice. Very little work is being done with 440 volts. This has been raised to 550 or 600 volts. The 1000-volt chart should have been worked out for 1150 volts, but even this is being superceded by the almost universal use of 2300 volts for high tension transmission in cities. No table is given for this latter voltage. The size of wire can be approximated, however, for these voltages from the data given, but this book does not tell how.

A little data on pole line work is given but not enough to be of any great value. Nothing is said about the dimensions of poles, cross-arms, fins, insulators, etc.

The alternating current formulae are of no great value to the user of the book as some of the factors in them would require a considerable knowledge in mathematics to determine and no tables are given from which these could be obtained. These factors are "P. F. for power factor of load;" "I. F. for inductance factor or sine of angle of lag;" "L. for inductive drop in line." Power factor is a derived quantity which cannot be determined except under actual working conditions and it varies constantly. For all practical purposes, however, it can be approximated by those having experience. "Inductance factor" and "inductive drop" require careful computation.

In formulae given for current in conductors (alternating) the factor W is used to represent watts. No mention is made as to whether this is indicated or recorded watts. As a matter of fact indicated watts are used. These same formulae use P. F. (power factor) as one of the elements in the equation. It would be much easier for the worker to read the current, volts and indicated watts than try to find out the power factor.

A table near the last of the book gives full load currents for motors, but does not state whether for A. C. or D. C.

The book is very well indexed and except for the few things mentioned should be a great help to wiremen and wiring contractors.

ALTERNATING CURRENT MOTORS. A. S. McAllister, Ph. D., 278 pp. 9x6 in. 122 illustrations. Cloth, $3.00. McGraw Publishing Co., New York.

Readers of the Electrical World, American Electrician (now combined with the Elec. World and Eng.) and the Sibley Journal of Engineering will be very glad to know that Mr. McAllister's articles on alternating current motors, which appeared at various times in the above publications, have now been collected and published in book form. Those not familiar with the articles cannot afford to lose the opportunity to obtain and study this book very carefully.

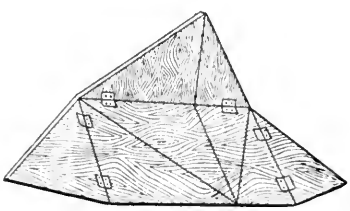
The increasing use of alternating current, due to the ease of transmission and raising and lowering, makes it imperative that some form of apparatus be used whereby the alternating electric power can be changed into mechanical power. The more knowledge there is to be had on this apparatus, the more intelligently and advantageously can it be used. The apparatus now most extensively used is the alternating motor. Too little is known about these outside the designing rooms of the motor manufactures.

This book is a long stride in the direction of a clearer understanding of the alternating current motor, and in this catagory is included the alternating current commutating motor and rotary converter. It is technical and assumes that the reader is familiar with the lower branches of mathematics, electricity and magnetism, and also the graphic method of representing alternating voltages, currents, etc. The book is not so technical, however, but what the average electrical engineer can thoroughly understand and follow clearly the theory and formulae derivations.

The volume is very well indexed and should make very valuable reference book. It should not only be in every electrical engineer's library, but should be carefully studied. All libraries having technical books should have it on their shelves for the use of those unable to pay the moderate price.

GEOMETRY IN WOOD.

Richard Inwards, a correspondent of the "English Mechanic," contributes to that journal some particulars of a suggestive model designed for the improvement of the student's knowledge of practical geometry. He says that a new technical school is to be furnished with such models, and that the use of these is not to prove but to exhibit the facts and that furthermore, if the students are set to work on triangles of different proportions they must be dull indeed if they do not absorb the facts.



It will be seen that the triangle is cut up and the parts hinged together to show that triangles can be folded to make two parallelograms. The model is expected to impress the following facts upon the pupil: That all the angles of a triangle make 180 degrees, or two right angles when added together; that any triangle can be divided into two rectangles; that any triangle can be measured by multiplying its base by half its height; "any boy can understand the measurement of a rectangle," pointedly remarks Mr. Inwards, and that any triangle can be divided into two right-angled triangles.

TEMPERING HIGH SPEED STEEL.

At a recent meeting of the Master Blacksmiths' Association, Mr. George Lindsay, in discussing annealing of high speed steel, said he had been called upon to make a forging of this material at short notice and it occurred to him that, if the exclusion of air was the most important thing in the process, it would be well to try a lead bath. Accordingly, a piece of 4-in. pipe about 12 in. long was welded solid at one end to form the pot, which was filled two-thirds full of lead. The lead and the pot were raised to a high temperature, the steel was placed in it and they were allowed to cool together. After it had cooled down to the melting point of lead, or about 630 deg. Fahr., it was reheated sufficiently to remove the steel, which was then allowed to cool slowly. After this treatment it could be cut, in a lathe, like ordinary carbon steel. The suggestion is made as a convenient shop wrinkle.

The same speaker said that in hardening this peculiar metal it was necessary to forge it, lay it down to cool and then heat it again, but not far back from the cutting edge. Great care must be taken in the heating, notwithstanding the common opinion that it cannot be made too hot. Too rapid heating is apt to fuse the edges, so that they will become brittle and crumble. The steel should be given time to absorb the heat. Another danger in rapid heating is that the blast is apt to get through the coke of the fire and oxidize the edges. When the tool is removed from the fire the scale should be carefully removed and the air applied at the back, especially in the case of lathe tools. For milling cutters, taps, reamers and similar tools, where long and slow heating is required, a furnace is almost indispensable, though hollow fires may be made to do good work. An oil bath should be used for cooling, and the temper drawn as in carbon steel.—"Railway Gazette."

The use of soapy water as a lubricant for air-cylinders is recognized as good practice, says the "Mining Press." Even where oil is used as the regular lubricant, soapsuds should be fed in from time to time to clean out the valves and discharge ports. There are many well-authenticated cases in which only soapy water is used as the lubricant. Soapsuds and Dixon's flake graphite mixed make an ideal lubricant for air-cylinders, for by the addition of graphite far less soapy water is necessary than would otherwise be required. Hand oil pumps will pass soapsuds and graphite perfectly satisfactorily, or the graphite may be fed separately in a dry state through a separate cup, while the soapy water passes through the regular lubricators. There is only one caution necessary in this method, namely, to introduce sufficient oil before shutting down the compressor to prevent rusting of the cylinders and valves when the machine remains idle. Rust, however, forms very much less rapidly in the presence of graphite than upon surfaces not thus coated—in fact, it cannot form at all upon a surface completely covered with a film of graphite.

AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

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A BALL BEARING WATER MOTOR.

H. K. CARRUTHERS.

To the Amateur Worker, power from any source, excepting foot, is his one dream. To instal a miniature steam engine is out of the question to a large number, and a gasoline engine or an electric motor are both costly. With the water pressure to be found in both large and small cities, this dream can be achieved and by simply turning on the faucet in one's own home, the power is there.

The following instructions are to tell how a motor was made, and on a 75 lb. pressure over 1/4 h. p. was easily realized. It is made of sheet zinc using three different thicknesses; 16 gauge, a thin sheet zinc or tin about 22 gauge and a thick zinc about 6 or 8 gauge. Brass or copper may be used throughout and galvanized iron for the water jacket. Sheet zinc may be purchased of hardware dealers or plumbers; sheet brass is carried only by a few hardware dealers in the larger cities, or machine shops having special uses for it. If you know of any machine shop or brass workers who have a circular saw for cutting metal, take your patterns to them and have them cut out in less than half an hour. Read the instructions over and carefully study the drawing, and you will find the making of an efficient motor not at all difficult.

First procure a bicycle hub with sprocket wheel, one which has been discarded for the coaster break style, and upon the flanges where the spokes are run through solder a piece of brass tubing the required length as at a in Fig. 1, (in this machine the tubing was 2 in. diameter by 2 3/4 in. long,) Fig. 2, shows the wheel ten inches in diameter with hole in center large enough to fit snugly over tubing on hub. The wheel has six openings, which with the metal removed, makes it easier to true up when buckets are attached. This is cut out with a hack saw from the No. 16 gauge zinc, and the little slits at a are cut 1/4 in. deep to receive the buckets. Be careful to cut them in a straight line with the point in center of wheel. After filing wheel up neat and true, solder it to tubing at b, Fig. 1. Should you find the wheel warping when applying the hot solder, true it up by soldering at different intervals wedge shaped pieces of metal shown at c, Fig. 1. I did this to mine and it makes a very strong job.

The two brackets or supports for hub and wheel are cut from the heavy metal and are made to size, as in Fig. 3. At a is shown the position where braces, Fig. 4, are soldered. The four braces, Fig. 4, may now be cut and soldered in place.

The base is made from the heavy metal and is 14 1/2 in. long by 8 1/2 in. wide. An opening is cut in center 5 in. long by 1 3/4 in. wide, Fig. 5. Around the opening at a is soldered a flange from thin zinc about 2 in. dep. This is the outlet for the waste water. Fig. 6 is a diagram of the base showing the exact position for the supports, water outlet, and lower half of water jacket.

The water jacket can now be made for the lower half. Cut two pieces from the heavy metal 2 x 6 1/4 in., and for the sides two pieces from the thin zinc 13 1/4 x 7 1/4 in., Fig. 7. The dotted lines at a are 1/2 in. from edges and this portion is bent to an angle of 45°; b is a half circle cut out for hub to set into. These sides are soldered to the edges of the 2 in. strips just cut, and to make a neat job of it try the scheme, shown in section in Fig. 8; a shows where the solder is run in. When finished, file and sand paper off any roughness and lay on base in position as indicated by dotted lines, Fig. 6. The lower flange is soldered securely to base and will appear as at a Fig. 9. The supports can now be soldered on to position shown on diagram, Fig. 6.

Set the wheel in place now and adjust the cones, then tighten the nuts. This will afford a good opportunity to fasten the buckets in place. Take a strip of the zinc 3/4 in. wide and about 24 in. long and cut from this 24 pieces 7/8 in. long. Bend on dotted lines, Fig. 10, to the angle shown at a. When all are bent press into the slits at a, Fig. 2, and solder, taking care to distribute solder evenly so as to insure an even balance. The work done so far will look like Fig. 9, excepting for the nozzle shown.

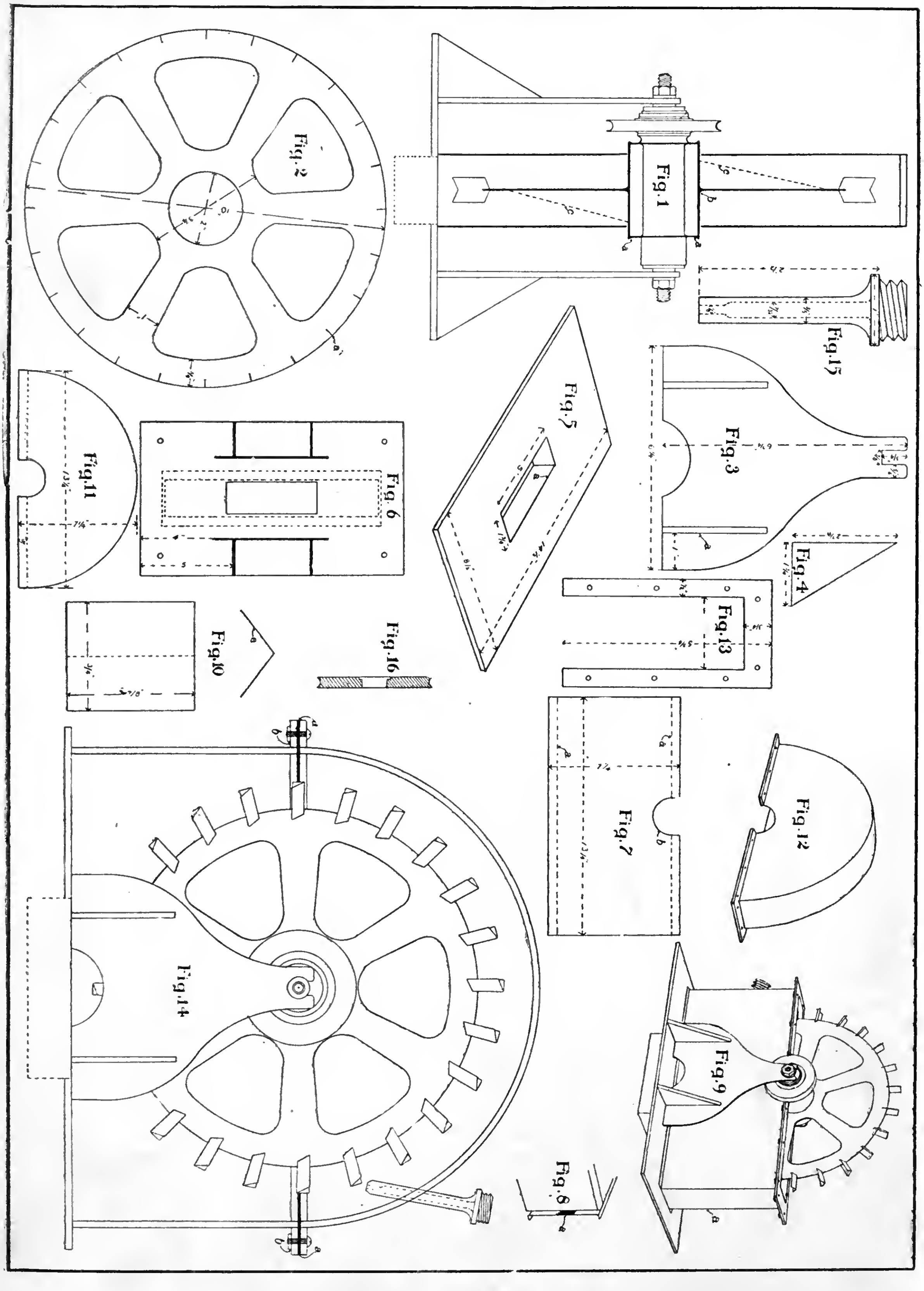
Fig.1
Fig.2
Fig.3
Fig.4
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Fig.6
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Fig.9
Fig.10
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Fig.12
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Fig.14
Fig.15
Fig.16

The top half of water jacket in which the nozzle is located is made by cutting two pieces of thin zinc shown in Fig. 11. Next take a strip of the heavy metal 2 in. wide and long enough to go round the half circle and have a tinsmith bend it for you to proper shape. Solder sides to this similar as described in Fig. 8, when finished will look like Fig. 12. Cut from the heavy metal 4 pieces the size given in Fig. 13, and drill holes as marked. Two of these are soldered on flanges in Fig. 12 and under the flanges in Fig. 9. This helps to stiffen the sides and keep the holes in line with one another . Clamp two of the pieces together when drilling, thus insuring the holes being in line, when top half of water jacket is placed on lower half. Use 5/8 in. stove bolts. From the same pattern, Fig. 13, cut two pieces of thick sheet rubber and lay between flanges as shown at a, Fig. 14. Punch holes to correspond with metal pieces.

For the nozzle, Fig. 15, you can have a machinist make it or you can make it yourself. Buy a 10 cent hose connection and use the male part. Make a paper cone 1 in. long to fit on shank, plugging the end, pour in from the threaded end hot solder and when set take off paper, and have it drilled similar to Fig. 15.

The sprocket wheel can be used with a chain belt but prefer a wooden wheel, and a cross section of it is shown in Fig. 16.

This will complete the making of your motor and all that remains to do is to give it a couple of coats of a good dark machine enamel, both inside and outside. This prevents any rust taking place.

PRODUCTION OF PLATINUM.

F. W. HORTON.

The year 1905 saw a phenomenal rise in the price of platinum and a greatly increased production in the United States. Early in March, 1905, the price of ingot platinum advanced from $19.50 per ounce to $21, surpassing gold in value. On April 1, 1905, the price fell to $20.50, and remained firm at this quotation until February 1, 1906, when it jumped to $25, where it remained until September 1, when it leaped to the unprecedented value of $34. The production of platinum in the United States increased from 200 ounces in 1904 to 318 ounces in 1905.

The rise in the price of platinum and its increased production in this country may be ascribed to two causes: the growing demand for the metal and the reduced yield of the Russian placers, which usually furnish about 90 per cent. of the world's supply.

The anxiety felt by the platinum dealers during the Japanest-Russian war has not abated since the settlement of international difficulties, but has, rather, increased as Russia's internal dissensions have developed. Even before the uprisings, it is said, the large Russian mines were purposely curtailing their production. This reduction of the output is due to the fact that the entire product for a varying term of years was brought up under contract and at prices that now seem ridiculously low. As the mine owners receive only the fixed price, they do not participate in any gain due to rise in value, and are therefore not desirous of a large production, but are husbanding the limited resources of their mines until such time as they can dispose of their produce to better advantage. Meanwhile the small mines, which, generally speaking, are not hampered by such agreements, are working to their full capacity, to take advantage of the stimulated prices; but their entire output is only a small percentage of what is usually produced. A greatly increased consumption of platinum in the electrical and chemical industries, together with this stringency of supply, accounts for the prevailing high prices.

The exhaustive tests and examinations of black sands commenced early in 1905 in connection with the Lewis & Clark exposition, and still being carried on at Portland, Oregon, by the United States Geological Survey, have done much toward placing platinum mining in this country upon a stable footing and developing it into a permanent and profitable industry. Not only have many discoveries of platinum in new localities been made, but the tests have revealed the fact that there are districts which contain surprising quantities of platinum, and they have also given much valuable data as to the best method of obtaining it.

The promising fields are in the counties of southern Oregon and northern California. Here the metal has been found in commercial quantities. With proper methods a considerable annual output should be obtained. The platinum metals are usually found in working gold placers, especially where the gravels are derived from peridotites. Many managers of placer mines have been convinced for a long time that it would pay to save the platinum in the gravels, if it could be done by some inexpensive method. The experiments of the United States Geological Survey which were conducted under the supervision of Dr. David T. Day have shown conclusively that 95 to 98 per cent. of the precious metals, both gold and platinum, contained in the sluice box sands can be saved on concentrating tables such as are used in everyday practice; and that in most cases the concentrates thus obtained will represent less than one per cent. of the total weight of sand fed to the table.

It should be noted that the imports of platinum during 1905 were valued at $2,173,263, as against $1,879,155 in 1904, an increase of $294,107. Considering the increased demand for platinum, the gain in importation is slight, but if the high price and scarcity of the metal be taken into account, the wonder is that there was not a large decrease in the quantity imported.—"The Mining World."

New Zealand has 2,374 miles of railroad in an area of 104,000 square miles.

TRANSFORMER FOR EXPERIMENTAL WORK.

PROF. W. G. CLARKE.

At the present day nearly every experimenter has the alternating electric current in h s laboratory or else has easy access to a reasonable amount of supply. The voltage is usually either 104 or 52, and the frequency is usually 60 cycles.

It frequently happens that in your work you will need voltages both away below and away above this fixed amount. You can easily get a lower voltage by inserting an adjustable rheostat in the circuit in series with your work. With this, however, you cannot get a higher voltage than the source of supply, and unless you have a voltmeter you can only guess at the amount of voltage that you are actually using.

By the use of an auto transformer you can get a range of voltage from 5 to 500 in steps of 5 volts and you know very close to the amount of voltage that you are using.

An auto transformer is not difficult to construct and the possessor of one will find no end of comfort and convenience in its use.

First procure a sheet of electrical steel 24x96 inches and .014 thick. Go to at tin shop and with the foot power squaring shears have them cut acrcss the sheet, 8 pieces each 7 1/8 inches long, and another 8 pieces each 3 5/8 inches long. Then cut across these 16 pieces making a large number of pieces each 1 1/8 inches wide, and you will find that you will have 168 pieces 1 1/8 by 7 1/8, and 168 pieces 1 1/8 by 3 5/8. This is somewhat more than you need but it is well to have a few over as some are almost sure to be bent out of shape so that they cannot be properly straightened without a great deal of trouble.

The greatest care must be taken in setting the guages on the shears so that all the pieces will be exactly the same width at each end and also that they are cut perfectly square. Otherwise your transformer core will look anything but symmetrical although it will perhaps do the work just as well.

If you cannot get the electrical steel in your town we can tell you where to get it and also where to get it cut up ready for assembling in case you cannot find a squaring shears handy, but this last is unlikely as nearly every small tinshop has to have a foot power squaring shears.

Sheet tin or any kind of very soft iron will answer the purpose only that you will require a much larger number of pieces in order to get the required thickness of core.

Make up 16 lots of each length of pieces, each lot to have an equal number of pieces and this number to be such that when 8 of the lots are clamped together tightly in a vise the whole will measure just 1 1/8 inches in thickness.

Build up your core by laying the several lots of pieces down on a board in the position shown in Fig. 1, and with the corners interlocked as the diagram clearly shows.

Now procure about a dozen small malleable iron clamps and clamp the whole core together tightly and evenly, tapping the corner edges with a hammer until all is square and symmetrical. If you have done your cutting and have used due care in assembling the pieces you should now have a very presentable core indeed, in fact some of these cores made up by amateurs are fully as god in every way as the cores made in the large factories with expensive automatic machinery.

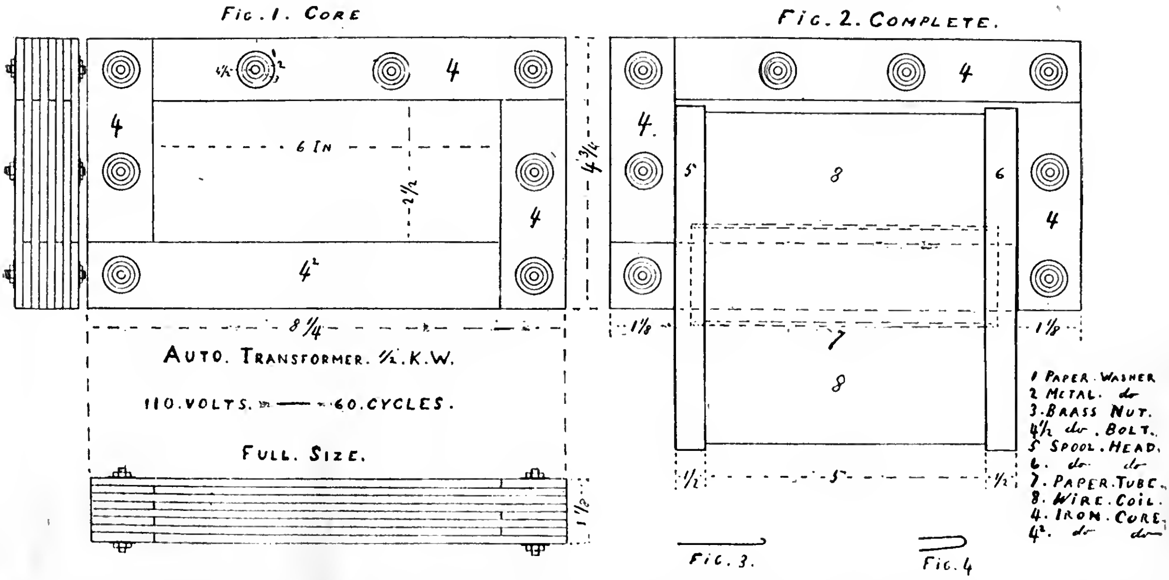
Take your core on the board to a machine shop where there is either a drill press or a good lathe and drill 8 holes through the core with a 3/16 inch twist drill at the points shown in the diagram. A piece of hard wood should be placed under the core at the point where the drilling is being done so that it will receive the point of the drill when it comes through and thus prevent the formation of much "burr" at this point. A clamp should also be on each side of drill and as close to the hole as possible, the clamps can of course be moved around, one at a time, as the drilling progresses, care being taken however. to at all times have enough clamps on the core so that the pieces are tightly clamped all around.

Cut off 8 pieces of brass rod 1 3/4 inches long and No. 8 screw size in diameter. On each end of these pieces cut a No. 8/32 thread for a distance of about half an inch. Now procure 16 hexagon brass nuts No. 8/32, 16 brass or copper washers that will just go over your bolts, and 16 fiber or paper washers that will also just go over the bolts, but about 1/4 inch diameter. You can cut these paper washers out of cardboard.

Cut some strips of typewriter paper 1 1/8 inch wide and paste one turn of this around each bolt so as to insulate the bolt from the iron core. Now place the bolts carefully in the holes in the core, put a paper washer on each end, then a metal washer, and then the nuts. After all the bolts are in place you can screw up carefully with small bicycle wrenches until the core is tight all over and then you can remove the clamps. You will see the position of the washers and nuts by referring to 1, 2 and) in Fig. 1.

Make a wooden roller carefully turned up to 1 3/4 inch diameter throughout its entire length of 8 inches. Cut a number of strips of cardboard 5 1/2 inches wide and the whole length of the sheet. Soak the cardboard in water and carefully remove one piece at a time and wind it on the wooden roller fastening it together with ordinary flour paste. Be careful, however, not to get any of the paste between the cardboard and the roller. Dry the tube out thoroughly either in the air or in a slow oven and then drive out the roller and you should have a very solid paper tube 1 3/4 inside and 1/16 of an inch thick. Trim off the ends with a sharp knife so that they are square with the sides of the tube and so that the tube will be not less than 5 3/8 and not more than 5 1/2 inches long.

Drill a hole in one of the heads close to the tube and pass the end of your wire through for about 6 inches. Cover the tube with one layer of the Grimshaw tape and wind on a layer of the wire allowing it to pass under a round brass bar placed close to the spool so that by holding the wire with the hand at the proper angle, it will wind on under great tension and consequently very tight. With care you should get about 90 turns of wire on each layer. Give each layer a good coat of thin shellac varnish as soon as wound and when this is good and hard put on a turn of cotton or linen cloth, fastening it at the edge with flour paste and seeing that it is pulled tightly in



place. Now wind another layer of wire and so on until you have wound just exactly 600 turns. Now bare your wire for a 1/2-inch and solder on a piece of thin brass or copper about 1/4 inch wide and about 2 1/2 inches long and bent to receive the wire as shown in Fig. 3. Take a piece of the tape about 2 inches long and place it under where this tap lies down on the coil, so that when the sides of the piece of tape are bent upwards and over they will cover the soldered joint and also the wire for about an inch on each side of it. Wind on another 600 turns and when you are pasing the first tap be sure and put a piece of tape on with its end under the turn of wire nearest to the piece of brass or copper. Do this on each side of the tap and leave the tape long enough so that each succesive layer of wire will have tape between the piece of brass and the turns of wire on each side of it. Put another tap on the end of the second 600 turns and wind on another 600, not forgeting to shellac each layer of the coil and to put the piece of cloth between the layers the same as you did at first.

Make two spool heads of perfectly dry hard wood as shown at 5 and 6, Fig. 2. Cut a square hole in the center of each of these so that they will fit tightly over side 4^2 of the core after it has been covered tightly with a layer of Grimshaw tape, which, by the way, should be put on this leg before the clamps are removed, the clamps can be removed one at a time as the taping progresses. The other three legs of the core are of course left untaped.

In each of the spool heads turn out a round recess 1/4 of an inch deep and of such a diameter that the paper tube 7 will just push tightly into the recess. Now put some thick shellac varnish on the tube ends and push the two heads on, see that they are square with the tube and allow the shellac to dry over night.

Procure about 25 pounds of number 16 B. & S. gauge single cotton covered magnet wire. Mount your spool on a square bar of wod in the lathe and arrange back gear so that the spool will turn very slowly. Wind a bunch of tape on the wooden ber and up against the outside of each spool head so that the heads will not be pushed off of the tube as the wire is wound on.

Solder a tap at the end of each 600 layers until you come to the fourth tap. You should now have 4 taps all in a row and in order that you may make no mistake you can now put a label on each tap and on the inner end of the wire that you passed through the hole in the spool head. Mark the inner end 400, the first tap 300, the second tap 200, the third tap 100, and the fourth tap 0. Now wind on 50 turns and solder on a tap marking it 5, another 50 turns and mark tap 10, and so on marking the tap at the end of each 50 turns 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85 90, 95 and 100. The taps from 0 to 100 should be placed in such a position that they will occupy another line a little separated from the line occupied by the first 4 taps. Finally wind a layer of tape over the outer layer of wire to keep everything in place. You will now find that if you have wound tightly and the pieces of cloth used between the layers have been no thicker than a thin handkerchief, that your spool will be just about full and it should be let stand for a few day to thoroughly dry in a dry place.

Remove the 2 bolts in leg 4^2 of the core, open the joint and slip the spool in place, close the joints and replace the bolts. You will find some considerable difficulty in putting the joints together and it will help you wonderfully to cut a number of pieces of thin iron or tin about 1 1/2 inches square and bend them to the shape shown in Fig. 4. Place one of these over each long section of the ends of the core and then you will have but little difficulty in putting the joints together and you can remove the pieces of tin with a pair of pliers after the joints are well entered into place.

We should have told you that in drilling the hole in the spool head for the inner end of the wire it should be drilled over the center of one of the sides of the square hole as if it is drilled over one of the corners of the square hole, it will come dangerously near to the iron core when the spool is put in place. Then another thing that you must be ecareful about is to so place the spool on the core that this same inside end of the wire will be as far away from the core as possible.

Your transformer is now complete and you can either mount it on a board or in a box and solder rubber covered No. 16 wires to the different taps and lead them to properly numbered binding posts either on the outside of the box or on the base board.

If your circuit is 52 volts or thereabouts you can now connect the circuit to numbers 0 and 55 or to any other two numbers that have 55 turn between them, or even 50 turns will not be too few. If your cicuit is 104 volts or thereabouts you should connect to numbers 100 or 10 or any other two numbers that have 100 or 110 turns between them.

After the transformer has been duly connected as above to either a switch or key socket you can turn on the current and if you have been careful with your work only a very small amount of current will flow through the coil and if you have a 5 ampere fuse in circuit it will not blow. If, however, you have failed to properly insulate the pieces of brass or copper from the adjacent turns of wire with carefully placed tape, or if you have been careless with your work in one of many other ways, you will perhaps have a short circuit and even a 25-ampere fuse will be instantly blown and you will have to unwind your coil and find the trouble.

Assuming that everything is all right you can connect a wire to number 0 and another to number 5, this will give you 5 volts for your work, 0 and 10 will give you 10 volts, 0 and 15, 15 volts, and so on until you get to 0 and 100 which will give you 100 volts. To go above this remove the one wire from 0 to 0100. This will mean that you must add 100 to the number to which the other wire is connected so that if it is at 15 you will have 115 volts and if it is at 95 you will have 195 volts. To go above 200 you must remove the one wire from 0100 to 200 and this will mean that if the other wire is at 35 you will have 235 volts. To go above 300 remove wire from 200 to 300 and to go above 400 remove it from 300 to 400 which will give you up to the limit of the transformer at about 500 volts.

You must be very careful not to allow bare wires to touch and thus short circuit a portion of the transformer and either overheat it and perhaps burn it out or blow the fuse. Then again don't forget that a voltage above 200 is dangerous and sometimes fatal so you must use the utmost care in handling your transformer and it is wise either to keep one hand behind your back or else use good rubber gloves.

One of the purposes that this transformer is very convenient for is to heat the wire used in the building of induction coils. When the sections of your coil are all stacked up and the connections made, whether the wire has been wound in wax or not, you should pass a current through the wire sufficient to warm it and thus drive out all moisture, and if the coils have been wound in wax this treatment will soften the wax and allow the sections to settle down upon each other and after cooling it will be found that the whole is one solid mass. Be sure, however, that you do not overheat for you must remember that the heat inside of the coil is much more than that which you feel on the outside and it is easy to char the insulation and thus ruin the coil. The way to do is to try a small voltage for a few moments and then gradually increase until you get enough voltage to drive sufficient current through to warm the coil. It may happen in very large coils that 500 volts will not be enough and in such a case warm up half of the coil at a time.

While this transformer is designed for a frequency of 60 cycles it will work equally well on a higher frequency.—"The American Inventor."

Approximately 30 per cent. of the cost of producing iron ore in the Lake Superior region constitutes mining supplies.

DECORATIVE ENAMELLING.

II. Two Brooches in Cloisonne Enamel.

Both the jewellery worker and the silversmith find the use of enamel of great value in forming a suitable decoration for their work, and in this article are given two designs of easy construction, useful to enamellers for this purpose.

The design illustrated in Figs, 1 and 2 is a suggestion for a plain leaf arrangement springing from the outside border of the panel. The colors to be used will, of course, depend on the individual taste of the worker, but it would be as well to make the leaves a shade of green, and contrast them with a groundwork, say, of brown or purple-brown, or even another shade of green. Suitable combinations of greens and other colors may easily be seen by studying the foliage in the garden, and choosing some colors that harmonise in their natural forms. In this way it is possible to get some beautiful combinations of colors, which are much better than any haphazard selection from the stock of enamel in hand. As explained in the previous article, the word cloisonne is given to that form of enamelling where cloisons, or thin strips of wire, are soldered on to a base to make a cell which contains enamel. To fully illustrate this, the side view of Fig.

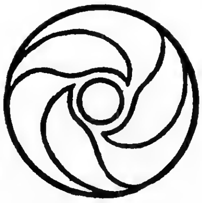


Fig. 1.

Fig. 2.

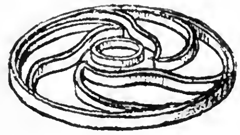


Fig. 3.

2 shows the cloisons fixed in their positions, and the section is taken through the diameter of the panel; in Fig. 3 is given a sketch showing the panel, with cloisons soldered down, quite ready for the reception of the enamel. In case the worker may think this design too dificult for a commencement, another is given in Fig. 4 and this is composed of a round panel, with a rim and containing four circles, each made of a strip of metal and soldered up and then soldered to the base.

To make a commencement with the work, we will take the design for Fig. 1, and fixing on a size, say, of 1 1/4 diameter of panel, as shown, we must take a piece of copper, or silver, about 22 S. W. G. and cut it to the shape. It must be domed to the shape shown in Fig. 2 and then placed in the hydrochloric acid pickling solution to be thoroughly cleansed, and next it should be planished on a stake and again pickled. The next step is to prepare the strips for the cloisons. The silver may be bought in lengths, ready rolled to a ribbon and of a suitable size, but the strips may be made by either cutting them carefully from a thin sheet of silver or hammering out a length of wire on a flat stake. With care the latter method is as good as any, although the metal rolls would ensure perfect evenness. Having provided sufficient, make an outside rim and solder it together, by tying a length of binding wire around it, touching the joint with borax and then placing a snippet of solder on and holding in the spirit flame. Next clean the rim in a sulphuric pickle and solder on to the base.

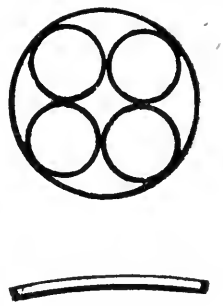


Fig. 4 & 5.

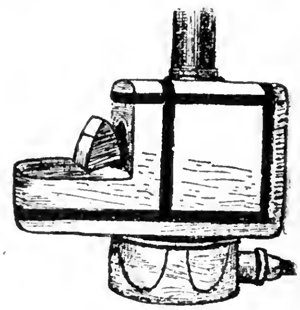


Fig. 6.

The worker may have found some considerable difficulty in keeping the small bits of solder in place during the bubbling up of the borax on first heating, and it will be found very helpful if some borax is thoroughly fused and then ground down to a powder in petroleum. The borax solution thus obtained may be kept in a wide neck glass stoppered bottle and taken out with a dipper made from a bit of copper wire, melted at the end and flattened out as a kind of spoon. The borax may now be placed where required and will not bubble up at all and the petroleum will not affect the solder in the slightest degree.

We will now bend one of the leaf shapes. see that the ends fit neatly against the inner edge of the rim, and the lower edge flat on the base, and then cover the lower edge with borax and place in position, put a few small bits of solder in position and flush them, pressing down the cloison to ensure it being flat. It is not necessary to solder them completely to the base, just sufficient to keep them in position, for a good many workers do not solder their cloisons at all, but this is not a satisfactory method for the beginner, because of the risk of the cloisons moving while the enamel is being fused. When the three leaves and the center ring have been soldered down, we must prepare a bed for it, for, being domed, the work will twist under the great heat required unless supported. The best support to use is a mixture of plaster of Paris and pipeclay, mixed together to a paste with a little water. This paste is moulded to the shape of the underneath of the pearl and is placed on a small bit of iron, pierced with a few holes, also covered with the paste, to prevent any oxidation of the iron. The iron is to form a cradle to hold the article whilst in the furnace and may be domed to fit underneath the panel if desired.

The work should now be thoroughly well boiled in a sulphuric acid solution and any projections of solder along the edges of the cloisons or on the base must be scraped off. Before the spaces are filled with enamel, the back of the panel must be painted with enamel, Any suitable colour may be used and should be mixed with a little gum tragacanth. The gum is necessary to make the enamel adhere, or else being underneath, would fall off while being fired. The enamel for the front should now be placed in, and the best method of doing it is to use a perfectly clean penknife and pick some up and press into place, taking care that the colors do not get mixed up. Next the surplus water must be taken up with blotting paper, using

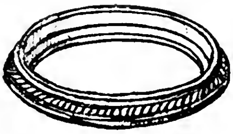


FIG. 7.

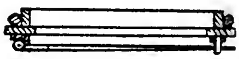


FIG. 8.

the very best quality. Clean linen, or cambric rag may be used, but the greatest care must be taken to prevent fluff from getting on the enamel. The enamel should now be dried on top of the furnace and then is ready for firing. We now come to one of the difficulties of enamelling, for a question of expense comes to the front.. The only method of doing the best work is to use a muffle furnace (Fig. 6), a small one with gas burner costing about $10. The time necessary for successful fusing if the enamel depends on the kind used, and if a thoroughly permanent effect is required, then the hardest enamels should be used on a small piece of work, about 1 1/2 minutes in a well-heated muffle furnace will generally be sufficient.

If, after the firing, it is found that the enamel has not filled up the spaces completely, the plate should be placed in a sulphuric acid pickle and any uneven parts rubbed down with a corundum file, and then the bare spots covered with enamel and refired, but it is advisable to anneal the plate before the second coat of enamel is applied. It is quite possible to place a different transparent enamel on another; for instance, a yellow on a deep blue, giving a shade of green, and if the plate is frequently annealed, it is surprising what may be done with it. The amateur may desire a quicker and cheaper method of enamelling, and if the work is small, say about 3/4 in. to 1 in., it may be treated in a spirit flame. The enamel should rest on a thin plate of iron, perforated with small holes and the underneath of the enamel place resting on a bed of clay and supported on an iron wire frame. A very suitable flame to use is that obtained from the lamp usually supplied to boil kettles.

Another way of firing small pieces of enamel is to get a crucible, place it on a firebrick on its side, place the enamel inside, properly supported, cover up the end of crucible and then build up a few pieces of firebrick around it to retain the heat. The heat should be directed on to the crucible with a large blowpipe, such as those used for brazing, and it is quite possible to do good work in this way. When the enamel is successfully fired, polish up the surface with putty powder, first filing down the projections, if any and then the work is ready to mount in a suitable frame.

A sketch is given in Fig. 7 of a very suitable form of mount for an enamel brooch. It is a thin band of silver about the same width as the outside thickness of the enamel, and of the same diameter, so that it is just the right size for the enamel to fit in. Next solder underneath a flat ring of silver, which should project inside and outside the band, sufficient inside to support the enamel and outside to hold a ring of twisted wire. Underneath this flat ring are soldered on the pin and catch, as will be seen in Fig. 8. Boil out the work, polish up with pumice and then with rouge and place in the panel, burnishing over the top to hold the enamel in place.

ALUMINUM CASTINGS.

Aluminum castings can e made in any ordinary foundry fitted for making brass castings, says the "American achinist." A graphite crucible should be used, and the metal is melted preferably over a coke fire. If this is not convenient, a fire of charcoal, oil or gas can be used, and they are desirable in about the order named. The great object is to use a fuel which is free from nitrogen and phosphorus. It is not advisable to use either hard or soft coal, because these fuels produce more or less of the above gases, which to a certain extent will be absorbed by the metal and occasion blow holes.

If it is desired to obtain an aluminum casting with a fine surface, the best results can be secured by first facing the mold with a fine sand, which has been thoroughly dried. Then, after the mold has been faced with the sand, it should be baked with the smoke of a gasoline torch. If these precautions are followed, the ordinary brass founder will have no difficulty in making successful aluminum castings.

Alloys of bismuth have been employed for fusible plugs for steam boilers and in fire extinguishing apparatus; but lately it has been found that these plugs alter peculiarly when exposed to heat for any length of time, and often will not melt at the proper temperature.

THE STORAGE BATTERY.

H. L. STRONG.

The history of the storage battery is older than that of the modern steam turbine, and its application is broader; but in either case there seems to be little reliable data or information obtainable which will throw much light on their economic operation or reliability. The reasons for this seem to be that they are comparatively new and the manufacturers are "saying little and sawing wood," hoping, in time, to improve and perfect their product to the end that they may be more efficient, longer lived and better fulfill the requirements and expectations of those who may invest their money in such apparatus. In many instances, both in large and small installation , storage batteries are proving very satisfactory in operation, and are good investments. One company, at least, in the United States is installing them in many large plants and taking their pay on a profit-sharing plan.

This seems to prove that, where conditions are favorable, a battery will reduce operating expenses. There are other cases where a battery is a great convenience, or where desirable results can be obtained with it which are difficult or impracticable without it. Most of the failures and consequent disappointments in battery installations are due to lack of knowledge of their limitations and requqirements. By this I mean that batteries are sometimes installed and operated under adverse conditions, and then storage batteries in general are condemned as being expensive, troublesome and unreliable. The conditions and requirements are so varied that it is not practicable to attempt to cover the ground thoroughly, especially in a short article, but a few lines in this connection may not be amiss.

As a few of the puropese for which storage batteries are used may be mentioned: Telephones, wireless telegraph installations, experimental work, driving automobiles and electric launches, firing submarine mines, lighting cars, yachts and other small vessels, lighting private residences, etc. The principal purpose for which they are used in electric light and power plants, and that for which they are best adapted in this line of work, is for helping the generators on peak loads and acting as a reserve for emergencies. In direct current systems, where the load is continually fluctuating, as in railway work, storage batteries give good results, for they are not only availible for peak load periods and emergencies, but also keep the voltage steadier and the load on the generators more uniform. When used in this way they are connected to the line in parallel with the generators, usually at some distance from the generating station, and are said to "float on the line." When the line voltage is normal the battery is idle, but should the line voltage drop a little the battery will feed into the line. If the voltage rises above normal, current will flow to the battery and charge it. A booster is used to run the voltage up high enough to give the battery a full charge once per week and a normal charge oftener if necessary.

One of the arguments in favor of storage batteries in electric plants is that by their use less generating capacity is required in providing for peak load periods, and, therefore, it is possible to operate the plant with more uniform loads and consequently with better efficiency. Just how this pans out in practice is not easy to determine, and I have never seen any data or figures in this connection. Under laboratory conditions, the efficiency of a storage battery is said to be not over 85 per cent., and from my own observation and what I have been told by those who should know, the efficiency under working conditions probably averages about 75 per cent. However, there are practically no stand-by losses, and a battery is ready to take a load instantly. It is also capable of taking heavy overloads of short duration, although heavy discharges of any considerable duration are neither economical nor desirable. A further advantage is the slight voltage variation on variable loads as compared with a generator operating unaided under similar conditions. It is a mistake, except in special cases, to install a battery with the idea of letting it carry heavy loads, especially of long duration. When fully charge a battery will supply its normal rated capacity for about eight hours, but a battery that is worked to the extent of a normal charge and discharge every twenty-four hours will only have a life, at best, of from three to four years. This statement is based on recent information and the most reliable that I have been able to obtain. With proper care and an average daily discharge of 40 to 50 per cent., a good battery will probably last about eight years.

It has been estimated that on an allowance of 10 per cent. per annum for depreciation and repairs, a good battery will last indefinitely. This estimate may strike an average, but I am inclined to think that it is none too liberal. It all depends on how hard the battery is worked and how well it is cared for. Ordinarily a battery requires no more care than a generator, and may safely be left alone for hours, or, in many places, for days at a time. Most of us know how electric elevators or even motors for other purposes will play the mischief with the lights in a place where both are operated from a small generating plant. A storage battery, properly installed, in such a place will greatly improve the lighting service and cause the generating machinery to operate much more smoothly. As to whether a battery will prove a money-saving investment in such a place is another question. However, the improvement in the service, and the greater security aga'nst total interruption of the service may be worth some extra expense.

In hotels and many other places there are periods during which but little current is used, and if a battery is installed the generating machinery need not be run for the light loads. If in addition to this, it is also practicable to reduce the labor expenses, there is little doubt but what a battery will give a good account of itself. As an example of this we have the following instance which is from actual practice:: A small electric plant is operated where there is a demand for current twenty-four hours per day, although the maximum load period is between sunset and 11 P. M. After 11 P. M. the load does not exceed 75 amperes, at 115 volts, and after 8 A. M. very little current is used, even during the short days. There are but two ways to handle this proposition. One is to run a generator continuously, and the other is to install a storage battery, and let one crew operate the plant by running the generators during the heavy load period and putting the light load onto the battery. In this particular case a $5,000 battery installation will save money in competition with any practicable scheme of operating a generator alone, because no attendant is required at the plant when the battery is discharging. If it was necessary to have some one at the plant all the time there would not be much to say in favor of the battery, although I believe it would be advisable to install a small battery to supply what little current is used during the daytime.

For private residence lighting, the storage battery is being extensively and satisfactorily employed. Some form of internal combustion motor is generally used to drive the generator for charging the battery. Some people even install a battery in their residence to guard against being left in the dark by failure or interruption of the commercial supply of current. The battery is kept charged and is provided with an automatic switch, which will instantly throw the lights on to the battery, should the commercial supply be interrupted. The action of the switch is reversed when the commercial supply is restored. This is getting it down finer than most people consider necessary or are willing to pay for, but a battery in such service should last indefinitely, with but little expense and care.—"The National Engineer."

A British naturalist recently recovered two live toads which had been buried in solid rock for unknown periods. One of the toads had been dug out of clay six feet below the surface, and the other was found embedded in a quarry. The only infirmity noticed that both had their mouths tightly closed; otherwise they were active.

STANDARDIZING BARONETERS.

We are indebted to Mr. Max Kuner, nautical optician, 94 Columbia street, Colman building, Seattle, for the following interesting description of the standardizing of the Aneroid barometer as daily practised by him:

"The apparatus used by us consists of two mercurial column barometers, and an air pump with mercury column attached. The two mercury barometers were first standardized in this manner:—They were carefully corrected for capillary attraction by moving the scale to the proper point. Then as a constant error there was an error for height above sea level to be subtracted. An error for local gravity to be added. These are constant error. There remains the temperature error; this is a variable one. (All barometers in the U. S. are reduced, for purposes of comparison, to 32 degrees Fahrenheit, sea level, local gravity, as at Washington, D. C.). Our two barometers are compared each day at 5 p. m., and after subtracting the algebraic sum of the errors are compared with the Weather Bureau reading, thus preventing all chance of error. (We have never got a variation, both barometers reading alike in every case).

"The method of testing is as follows: the correct height of the mercury column is read off both barometers, and the correction for temperature subtracted. If the aneroid is compensated it corrects for temperature and so reads different from our standard. The mercury column on the machine is set to read this height by shifting the scale. The aneroid to be tested is set to the same reading and placed under the bell glass and the air exhausted. Every half-inch the column and the aneroid are compared and the aneroid's error, if any, noted. When the limit of the aneroid's scale is reached the air is allowed to enter slowly and the reading and error noted going up the scale. The aneroid then goes out with our written certificate and its character and faults are known to the user, thus making it a dependable instrument. Without this precaution the aneroid is a mere guessing machine, but when properly corrected is an instrument of the utmost delicacy and accuracy, ranking above the sympiesometer and the mercury column. This is especially true of the modern holosteric compensated aneroid (Holosteric means flat spring, and is used in contradistinction to the older spiral spring aneroid). If there are errors of adjustment, we carefully correct these, in order that navigators may have a dependable instrument. This method of standardizing is identical with that practised in the observatory of the National Physical Laboratory, Kew observatory, England."

In the last 500 years more than $12,000,000,000 worth of gold is estimated to have been dug from the earth. Not much more than one-half of this is definitely known to be in existence in the monetary stocks of the globe.

ENLARGING FOR BEGINNERS.

"ALAR."

Amateurs usually find or imagine enlarging very difficult or costly, and it is for them that I feel inspired to write a few practical hints on the subject from my own experience.

The very words "bromide enlarging" had something mysterious in sound to me, indeed I know nothing about bromide papers yet, but I have spent my spare time for several days experimenting with a home-made enlarging apparatus until I have mastered it for enlarging on rapid developing paper, such as Velox or Yunox.

I did not succeed with papers requiring a longer exposure.

In the first place, I wanted to take pictures somewhat larger than 4x5, so purchased a long focus camera taking a 5x7 plate. If I had it to do over again, I would be satisfied with a 4x5 camera with long bellows, as it would be far more convenient for ordinary work, less bungling to carry or handle, and if I wished a larger picture, all I need is to have an apparatus ready to enlarge it at home. The results would be far cheaper than the results from 5x7 plates, etc., and, rightly done, as good.

Of course one should first master ordinary printing with developing paper.

For my enlarging apparatus I found a light packing box somewhat over 3 feet long. The length needed would depend on the sized picture one might wish and the focus of the lens. My box was about 13 in. wide by 10 in. deep, my lens of 8 1/4 in. focus; so I could make a picture 10x12 in., about as large as I cared to attempt without spending too much for trays, etc., and I doubted my ability to handle larger prints. With a lens of the same focus, if one wanted larger pictures, a large and longer box would be needed.

I removed the reversible-back from my camera, and made a holder to fit the back with pasteboard and glue, to hold a 4x5 plate. Other holders could be made for any sized plate. One would require very stiff pasteboard, I used the backing on kokoid plates, which I happened to have.

Having made the holder and put a negative in position bottom up, in the back of the camera, I placed the camera box with the back against a square hole, which I had cut in one end of the box. The hole should be nearly as large as the back of the camera, and just where the back comes against it. With some little cleats on the bottom of the box, I fastened the camera firmly in place, then raised a north window, put that end of the box under it and darkened the rest of the window and other windows in the room with curtains; so that the room was not light enough to fog developing papers while handling and developing, as I wished to do all the work as handily as possible.

Having placed a sheet of white card —10x12 in.— in the room end of the box I opened the camera shutter and drew out the bellows until I could see a fairly clear copy of the negative enlarged on the pasteboard slide. Now came the difficult part, possibly the fault of my eyes, but I found I could not focus it properly by sight. When thought Iit was perfectly focused, a print would show haze. By experimenting I found that the picture seemed focused to me anywhere within a two-inch draw of the bellows, but the print knew the difference.

I think I would have given up in despair if one of my first efforts at printing had not chanced to turn out sharp.

I had arranged the room-end of my box, so that the sheet of white cardboard—a very stiff, straight one, by the way—could slip between cleats on the sides of the box, and so be placed either nearer or farther from the lens, so that I could vary the size of the enlargement. The sheet of developing-paper was to be pinned to this cardboard slide. The slides between cleats were numbered according to the number of inches from the camera front-board; for instance, with my camera, 22, 23, 24, 25 and 26. Placing the slide at 23, I focused it by my eye, measured the exact distance from pasteboard slide to lens-board, placed a small piece of developing paper across some sharply defined part of the picture and exposed the right time, which must first be found for the negative one is working with. My negatives required from 1 to 8 minutes with the papers mentioned. If, upon developing the piece, I found the result hazy, with the lens-board 20 inches from paper, I drew out the bellows a quarter-inch more and tried again and yet again till I got the exact focus, then wrote the number of inches extension for that slide down in my notebook for future reference, and tried another, till I had them all properly focused, and could enlarge a 4x5 plate to any size from a 4 1/2 x 5 3/4 up to 10x12, or thereabouts. As long as I use this box, the focusing need never bother me again.

I had some smooth pieces of board to place across the top of the box while exposing, so that noextraneous light would fog the paper The window-end of box should be securely darkened so that no light will reach the paper from that direction except through the lens. A piece of dark cloth tucked in around the camera is sufficient. If there is shrubbery near the window, it is better to tilt the box so the clear light from the sky can shine through the negative.

When not in use, my box is stood on end in some out-of-the-way corner.

Possibly some beginners may not at once see the good to be gained by all this bother. However, they would see if they had uselessly carried a 5x7 or larger camera, for very long; but there are other advantages besides getting a larger picture with less expense and trouble. Sometimes part of the negative is spoiled or uninteresting, but one little part would make a picture if large enough. Get out your enlarging outfit, focus that part to the size wanted—a 4x5, if desired—and you have a picture you wanted, without taking another plate. Get a sharp negative and enlarge what you want to a 4x5 size and print it. The various surfaces of developing paper should give what is wanted, even for newspaper work.—Western Camera Notes.

CONSTRUCTION AND MANAGEMENT OF GASOLINE ENGINES.

CARL H. CLARK.

X. Reversing Gears.

The gasoline engine, unlike the steam engine, has no ready means of reversing. Although most two cycle and some four cycle engines will run in either direction, the means of accomplishing it are cumbersome and not always certain. Some few engines have permanent reversing gears which work fairly well, but the majority of engines must practically be stopped and started in the opposite direction. It is possible to reverse a two cycle engine by a proper manipulation of the timing of the spark, as will be explained under the handling of engines; it is, however, not to be relied upon. This fact and the fact that most four cycle engines run in one direction only, necessitates the adoption of some form of outside reversing device. Engines of small power fitted in light boats can be run without any reversing device, but engines of over four or five horse-power should always be so fitted.

The simplest form of reversing device is the reversing propeller, which is fitted with a device for twisting the blades, to the reverse angle, causing the propeller to act in the opposite direction with the shaft always turning one way. Fig. 68 shows a sketch of a two blade reversing propeller. The shaft is made hollow, with the rod R moving longitudinally inside of it. This rod is round inside of the shaft and square in the propeller hub. On one side of the square end of the rod is the groove a running diagonally across it. The

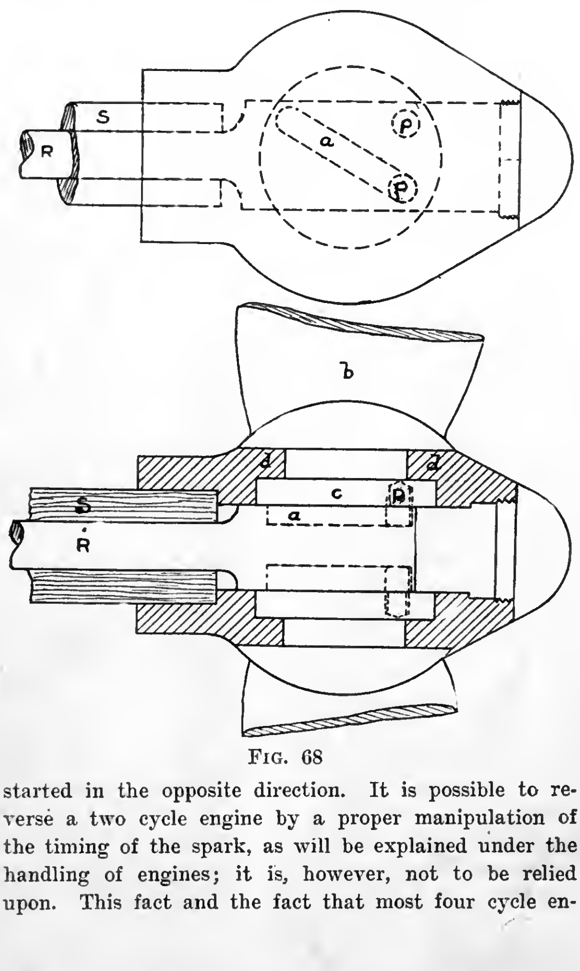


Fig. 68

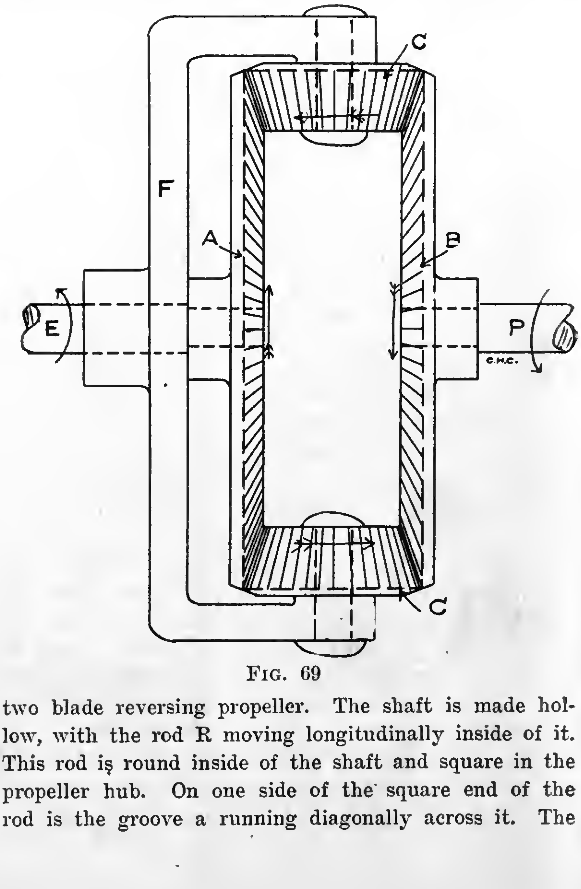


Fig. 69

blade b, is provided with the collar c, which fits under the projections d of the hub, holding the blade in place, while allowing it to turn. The face of the collar C bears snugly against the flat of the rod R. On the under face of the collar c is a pin P which projects down and fits into the slot a. It will thus be seen that if the rod R is moved along the shaft the pin P will slide in the slot A and thus turn the blade of the propeller. When the rod is in its extreme right hand position, the pin P will have moved to p, having swung across the center line into the opposite position and causing the blade to take an angle opposite to its former one and

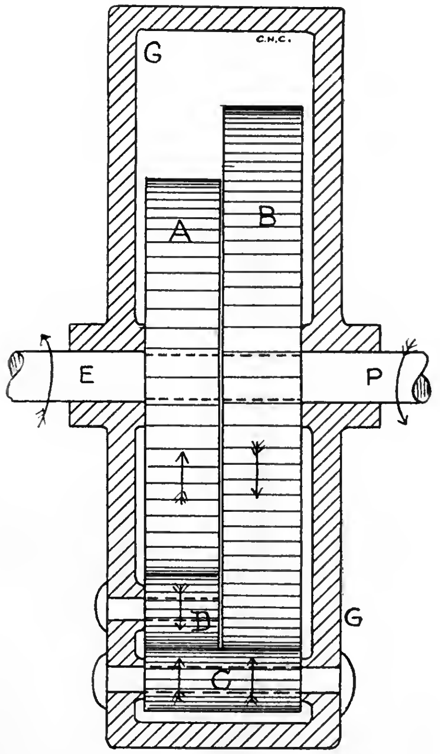


FIG. 70

to exert its force in the opposite direction. At some point about midway between tnese two, the blades will be practically at right angles to the shaft, and will turn without exerting any force. By turning the blades slightly either way a slight force will be exerted. Thus all speeds may be obtained, from full speed either way down to nothing. This allows the boat to be easily handled and even stopped entirely, without touching the engine.

The other blade is on the opposite side of the hub, and is operated by a pin in a slot on the opposite side of the flat end of the rod R and both blades turn together. The driving shaft S is hollow for the rod R and on its inboard end has an attachment to allow the rod R to be moved back and forth.

This form of propeller is a cheap and fairly satisfactory way of controlling the speed. If properly constructed it is nearly as strong as a solid wheel; the majority of reversible wheels on the market today are, however, poorly disigned and of flimsey construction and care must be taken in the selection of such a wheel. It should also be stated that the shape of the blade can be correct for one position only, and for all others it is more or less unsuited. For this reason, unless the correct position happens to be hit upon for the full speed, a certain loss of power is apt to follow. A reversible blade propeller is thus very likely to waste more power, and give less speed than a solid propeller.

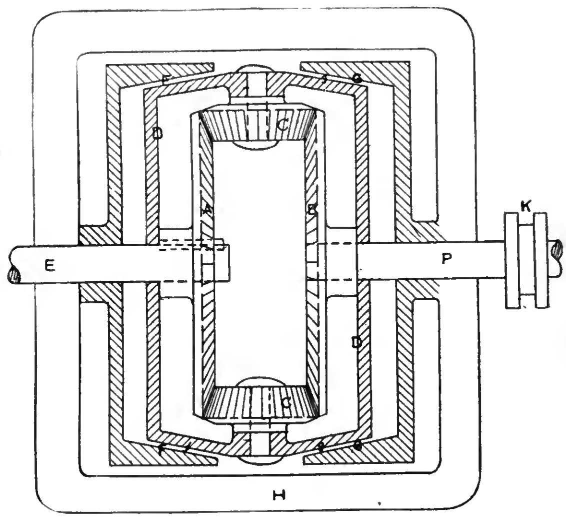


FIG. 71.

For engines of over six horse power a reversing device of the geared type must be used. These may for the present purpose be divided into two types, those using bevel gears and those using spun gears. Fig. 69 shows a diagram of the former type. The engine shaft E carries the large bevel gear A and the propeller shaft P carris a similar gear. The frame F encircles the shaft E and has bearing carrying the bevel pinnons C which mesh with the gears A and B. The frame F has two locking devices, one of which locks it to the shaft E and causes it to revolve with it. The other device locks it to the engine frame, holding it stationary and allowing the shaft E to revolve independently.

Suppose now that F is locked to the shaft E and turns with it, the gears C and A are thus locked together, and in consequence the entire gear revolves together and the shafts E and P turn in the same direction. This is the forward speed. If, now, the frame F is unlocked from the shaft E and locked to the engine bed so that it cannot turn, the gears C. C. will be brought into action. If the shaft E continues to revolve as shown by the arrow, th gears A-C-B will turn in the direction of the arrows and the shaft P will turn, as shown by its arrow, in the opposite direction to E. This is the reverse motion.

Suppose now that the frame F is left free, the shaft E may turn and the gears C will simply roll around on B without turning it, and the shaft P will remain stationary. This allows the boat to be stopped without stopping the engine and also permits the starting of the engine without the labor of turning the entire shafting and propeller.

Fig. 70 shows a diagram of the spur gear type of reversing gear. The engine shaft E carries the gear A while the propeller shaft P carries the gear B. These are enclosed in a case G. A bearing on the side of case G carries the pinion D which is in mesh with gear A. The pinion C also carried by a bearing in case G meshes with pinion D and also with gear B. There is thus formed a complete connection between gears A and B. As before, the case G is arranged to be either connected to revolve with shaft A or to remain stationary. Suppose now that case G is locked to the engine shaft A. This locks the gears inside of the case and drives A and B together thus driving the propeller shaft in the same direction as the engine shaft. Suppose now that the case G is released from the shaft E and prevented from turning by locking to the engine frame. The gear A causes the pinions D and C to revolve, thus revolving the gear B and shaft P, but in the opposite direction to that of shaft E. If the case G is left free, while the shaft E is turned it will simply revolve idly without moving the gear B thus allowing the engine to run idly as before.

It should be noted that the gear described in Fig. 69 reverses the propeller shaft at the same speed as the engine shaft while in that of Fig. 70 the reverse motion is slower than the forward motion in the proportion of the diameters of the gears A and B. The radius of A is reduced by the diameter of the idle gear D which gear is necessary to produce the reverse motion. This difference in speed is of little account, as a reverse at full speed is seldom necessary.

Fig. 71 represents the application of the bevel gear reverse. The bevel gears are contained in a sort of cast iron case or drum D which has bearings for the gears C-C. The outside of the drum D has the two conical friction surfaces f and g. The two pieces F and G have corresponding conical surfaces fitting f and g. The piece F is fastened to and revolves with, the shaft E while G is stationary and fastened to the base H. The gear A is not rigid on the shaft E but is fitted over a spline or key, which allows the gear to move along the shaft and still be driven. The drum D is a running fit on the shafts E and P allowing them to turn easily. A fork fitting into the grooved collar K, allows the shaft P and the drum D to be moved slightly. Suppose it to be moved to the left, bringing the conical friction surfaces F and f into contact. This locks the drum D to the shaft E thus locking the gears inside and driving the shaft P direct. When in the position shown the drum D is free to revolve either

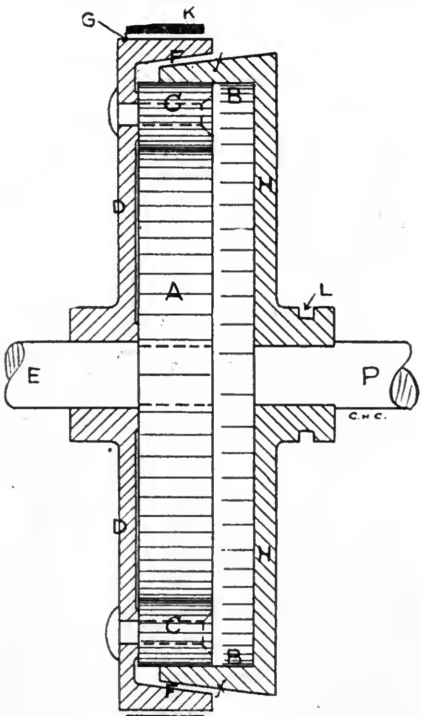


Fig. 72.

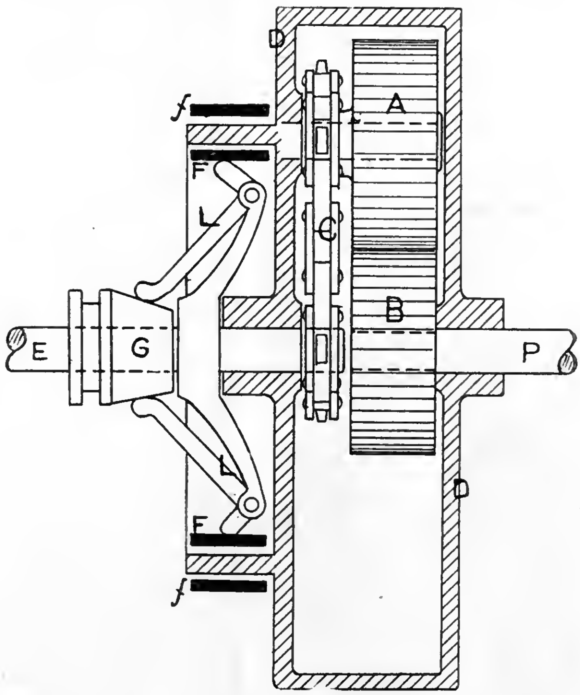


Fig. 73.

way, and whatever may be the motion of the engine shaft, no motion of shaft P will result, as the gears C.C. will simply roll around on gear B without causing any motion. Suppose again, that the shaft P and drum are moved to the right, bringing the friction surfaces G and g into contact. Since G is stationary the drum will become stationary and the gears will come into play, producing the reverse motion as before described. The slight fore and aft motion is allowed by the leather in gear A without drawing the gears out of mesh.

Fig. 72 shows a spur gear reversing clutch similar to that of Fig. 70 but using an internal gear. E is the engine shaft carrying the spur gear A. A shallow case D, which is loose on the shaft E, carries the pinions C. C. Two pinions are provided to distribute the wear. This case D is provided with the conical friction surface F on the inside of its rim, and the parallel friction surface G on the outside of the rim. The propeller shaft P also carries a shallow drum H, having on the outside of its rim a conical friction surface fitting into that on D and on the inside an annular gear B which meshes with the pinion C. A fork fitting into the grooved collar L allows the shaft and drum H to be moved fore and aft. A friction band K on the outside of drum D is tightened by a wedge and holds the drum stationary when desired. Suppose the shaft P and drum H to be moved to the left; this will bring the friction surfaces F and f into contact, locking the gears, and driving everything together in the same direction. As shown in the sketch the drum D is entirely free and the shaft E may turn without turning the engine shaft. If, however, the friction band K is tightened the drum D will remain stationary, the gears will come into action and the shaft P will reverse.

In another form of gear, the engine shaft carries a sprocket and chain C, the drum D carries a bearing for the gear A to which is fastened the other sprocket of the chain C. The propeller shaft carries spur gear B similar to A. At F is a friction surface for connecting with the shaft when the tapered collar G is moved to the right the levers L are pressed out and the friction band F is expanded, driving the whole with the shaft. As shown the gear is in the free position. The friction f is tightened by a wedge. When this done, the drum D remains stationary and the drive is through the chain and gears producing a reverse motion of shaft P.

The prime requisites of any reverse gear are that the gears should be in mesh at all times to avoid stripping, they should also run in oil, to reduce wear. It must be so arranged that the two frictions cannot be put in action together which would damage the gear. The gears should be in action only in reverse motion.

All reversing gears will be found to embody one or more of these principles and with this explanation no difficulty should be found in understanding the action of any type of reversing gear.

LONG DISTANCE TELEPHONING.

The use of the copper wire for the telephonic service was the beginning of its great extension. The New York Tribune says that the first copper telephone wire was about the size of tthe iron telegraph wire it replaced. With improved "long distance" instruments, such as are now in general use for all kinds of service, conversations can be conducted over wire of this size for about 350 miles with what the engineers call "standard transmission." By increasing the size of the copper strands on their long-distance lines they have more than doubled the early limits of successful transmission. The problem before the engineers has been to find a way to prevent the telephone current from "decaying" during the ourney of a message over the lines. That is, the engineers have sought means to counteract the inevitable loss of efficiency in the current and to keep it as near as possible at its original strength. Two methods of doing this have been tried. Separately they have worked out well; but as yet they have not been applied commercially to the same line. The two devices that promise so much for the extension of the range of londistance talking are the loading coil and the repeater. Though the ends they accomplish are, to a certain extent, the same, the principles on which they work are entirely different. When the electrical current from the transmitter of one telephone starts out on its journey to the receiver of another telephone a thousand miles away, say, it loses strength fast, sinking away by degrees until finally it becomes too weak to reproduce vibrations distinctly. The loading coil, which was invented by Professor Michael I. Pupin of Columbia University, acts as a sort of stimulant. It consists of an iron core upon which is windng upon winding of fine wire through which the talking current is passed in such a way that it is strengthened against the decaying processes and maintained at a level high enough to give satisfactory transmission. These coils are attached to a line two, four or maybe eight miles apart, and their use approximately doubles the range of the telephone. The repeater, which is a later invention, operates differently. As its name signifies, it actually repeats the message, which, coming through a receiver reproduces itself automatically on a transmitter. This allows of putting new current into he line, just as the original current is introduced at tthe transmitter of the subscriber's telephone. The result is practically to start the message all over again with a fresh lease of life, though naturally the force that carries it cannot be made quite as good as new. A repeater in the middle of a long-distance circuit extends the range of talking about fifty per cent.

Pennsylvania alone produced last year nearly three-quarters of a million tons pig iron more than the whole of Great Britain.

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.

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Single copies of back numbers, 10 cents each.

TO ADVERTISERS.

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

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MARCH, 1907.

HANDY HINTS PRIZE OFFER

Our recent prize offer for articles from readers produced a large number of contributions, but the limited number of prizes prevented all but a few from being accepted. Another prize offer is therefore announced, and this will be a regular standing monthly competition. It is especially designed to secure descriptions of tools and processes used in making machines and instruments, or in doing some special piece of work, likely to interest our readers. The amateur mechanic generally has but a limited tool equipment, and has many times to adapt or design a tool or instrument for the work in hand. Information along these lines is of the greatest practical value to other workers similarly situated, and to obtain it we offer a prize of $5.00 for the best, a prize of $3.00 for the second best article, and $2.00 each for every other accepted article received each month.

These competitions close at the end of the last office day of each month; any article received will enter the competition of the month during which it is received. All articles for these competitions should be labeled "Handy Hints Prize Offer." If not so labeled, they will be considered as being submitted at regular space rates. Drawings should be made in India ink on smooth white paper, and manuscript should have liberal margins and not be too closely written. The prizes will be awarded as nearly as possible upon the following scale of marking:—

Importance or usefulness of the tool or instrument described, 50 per cent.

Literary value of the description, 30 per cent.

Excellence of the drawings, 20 per cent.

It will be noted that half of the value is placed upon the thing described, this being done to secure contributions from those who have information of value, but are not so situated that they can conveniently write the description or make the drawings. This plan furthermore provides that every one who sends an acceptable contribution will receive payment for the same, and the combined efforts of all our readers should be productive of much valuable information.

The third prize in our recent prize offer was awarded to Edmund P. Smith, Niagara Falls, N. Y., and James H. Hunter, Hartford, Conn., the prize being divided between these two. Both contributions appear in this number. Other contributors in this competition will be advised regarding their articles as rapidly as possible.

The article "Attachments for Speed Lathe," by C. Tobyansen, in the February issue of this magazine should have been credited to "Carpentry and Building."

Enormous possibilities for power generation exist in the waste gasses discharged by blast furnaces, coke ovens and other metallurgical furnaces. Much greater progress has been made in utilizing these in Germany than in other countries. It is estimated that the so-called lean gases discharged from the blast furnaces of Germany are capable of developing 1,000,000 h. p. There are now built and under construction in Germany gas engines for this purpose aggregating 400,000 h. p. These are mostly in large units, one firm alone having constructed 140 engines, totaling 120,000 h. p. The utilization of coke oven gases has proceeded more slowly, although the gas discharged from such ovens is of a much higher caloific value than the lean blast furnace gas. The richer the gas enables a greater power to be obtained from an engine of a given size than is possible with the poorer furnace gas, but the lean gas permits a higher degree of compression to be used without danger of premature ignition, this giving the somewhat paradoxical result that the poorer gas enables the higher thermal efficiency to be attained.

The defects noticeable in precious stones are (1) feathers: like rents or fissures in the inside; (2) clouds: gray, brown, or white spots resembling clouds; (3) sands: small bodies like seeds or grains of sand of white, brown, or red color; (4) dust: fine sand disseminated in very fine paticles in a stone.

Lead wool, made in Germany, is used principally for caulking pipes, the joint being filled cold against a backing of hemp or tarred yarn. It is considered a good substitute for melted lead in making joints for hub and spigot cast iron mains. The "blei-wolle" is lead which has been shredded to about the size of heavy thread, collected into bundles of convenient length and of a size in proportion to the joint to be filled, twisted somewhat.

AN OLD ENGLISH BUREAU.

JOHN F. ADAMS.

The bureau here described is a companion piece to the bedstead shown in the priveions issue of this magazine. The peculiar feature of the bedstead, the spindles, cannot be embodied in the bureau to the same extent as in the bed, but is included to the extent that is necessary to make it harmonize with the bed. The making of a piece of furniture as difficult as this requires careful work in fitting all joints, and fastening all parts securely together.

The frame and drawers should first be made, the panelled ends being taken up first. The four posts are 2 1/4 x 2 in. and 33 in. long. Beginning 12 1/4 in. from the lower ends, the posts are bevelled off, as shown in the drawing, to 1 1/2 in. square. This dimension depends upon the size and the shape of the castors used, the preferable style having square ferules, to match those used on the bed, so the castors should be purchased before cutting the bevels. The posts are spaced 14 in. apart, making the crosspieces 15 in. long, which allows 1/2 in. at each end for the tenons fitting mortises cut in the center of the posts. The tenons should be 3/8 in. thick. The upper crosspiece is 4 in. wide and the lower on 5 in. wide. They are 15 in. apart, making the center piece between the panels 16 in. long; 1/2 in. on each end is allowed for the tenons. This center piece is 2 1/2 in. wide. The faces of the cross pieces are sunk 1/4 in. inward from the end faces of the posts.

Grooves must be cut in the posts, the grooves being 1/4 in. wide and deep. The panels are 16 in. long, 6 1/8 in. wide and 1/4 in. thick. The ends should be set up between clamps, using care to get the joints well glued, and that the work or glue are not chilled during the work.

The top of the frame is made of two thicknesses of wood, the under one measuring 38 x 17 1/2 in. and 3/4 in. thick. Ordinary stock is quite good enough for this, as it is covered by the second layer, which is 42 x 20 in. and 7/8 in. thick. The second top should be carefully selected to get a good match for the grain, as it will have to be glued up from two or three pieces. A 3/4 in. moulding is run around the edge of the under layer, the corners being mitred. This is not done, however, until after the frame is all assembled. The rear edge of the under top, when put finally in place, should be 1/2 in. from the rear face of the posts, to allow room for the sheathing as will be subsequently mentioned.

The ends are spaced 33 1/2 in. apart. Two pieces 35 1/2 in. long, 2 in. wide and 3/4 in. thick should have tenons cut on the ends, 1 in. long and 3/8 in thick; one pieces being put under the lower drawer and the other between the two back posts, the outer edge of the latter being sunk 1/2 in. inward from the lower ends of tne posts. They are not put in places until the frame is entirely finished and ready to assemble. Two pieces of the same dimensions are put between the drawers, these pieces having the edges at the front and the tenons are only 1 in. wide. The piece between the upper and middle between the middle and lower drawer 7 1/4 in. below the other.

We are now ready to assemble the frame, which we will do as follows:—The pieces between and under the drawers are put in place, first coating tenons and mortises with glue, and also the strip at the lower part of the back. The under top piece is then put on, remembering to leave 1/2 in. at the back for the sheathing, using both glue and screws, and making sure that the spacing is correct and that all angles are square. The pieces between the drawers and at the back should also be pined with 1/8 in dowels. On the inside of the ends are now fastened with screws pieces of 7/8 in. boards 22 in. long and 14 in. wide. As the inner faces of the pieces should be flush with the inner faces of the posts, it may be necessary to put thin pieces between them and the cross pieces of the ends. The runs for the drawers, 1 x 7/8 in. and about 15 in. long are now fastened with screws to the boards just put in place and the frame is then finished by putting on the backing of 1/2 in. sheathing. The sheathing is fastened with screws to the under top and the piece at the bottom. A division piece between the two upper drawers is made from a piece of board 16 1/2 in. long, 4 1/2 in. wide and 7/8 in. thick. On the front end of this piece glue a piece 7/8 in. square, the grain running vertical, and on the under edge fasten with screws a piece 16 in. long and 3 in. wide to make the runs for the top dawers. This piece is fastened to the under top with screws and glue. In place of gluing on the small piece at the front end of this piece, it can be cut an inch longer and 1/2 in tenons cut on the ends to fit mortises in the top and cross piece between the upper and middle drawers, which would be a preferable way to fit it. The upper top piece is now to be put on by first coating the surfaces of both tops with glue, and then screwing up about a dozen screws, holes for them having previously been bored and countersunk.

The drawers can now be made, and as previous articles have given the construction of drawers, and doubtful points can easily be solved by examining any similar piece of furniture about the house, only dimensions will be given. The upper drawers are 16 5/16 in. wide, 4 1/2 in. deep and 16 1/2 in. long, front to back. The two lower drawers are 33 1/2 in. wide, 7 1/4 in. deep and the same length. The pulls and other trimmings should be those most suitable to the wood and finish adopted by the maker.

The mirror frame can now be taken up and will require three pieces 34 1/2 in. long, two pieces 34 in. long of stock 2 in. wide and 1 1/2 in. thick and about 9 ft. of 3/4 in. square for spindles. The pieces above and below the mirror are 34 in. long, the sides and curved piece are 34 1/2 in. long. The joints at the lower corners are open mortised; those above the mirror and the curved piece are blind mortised; the tenons on the latter being about 1 1/2 in. long. The mirror is 30 x 26 in. and fits in a rabbet cut in the inner back edges of the pieces surrounding it. The curved piece is cut out and the spindles fitted in the same way as described for the bed in the previous issue of this magazine. The edges of the frame around the mirror may be chamfered or not as prefered.

The frame supporting the mirrer requires two posts 43 in. long, 2 in. wide and 1 1/2 in. thick. The upper 10 in. of these pieces are tapered off to 1 1/4 in. square, and 7 1/2 in. of the lower ends are cut out on the front faces to leave a thickness at the back of 5/8 in. A piece 41 in. long, 2 1/4 in. wide and 7/8 in. thick is beveled on the upper front edge and ends and another piece 36 in. long and 3 in. wide is fitted with tenons on the ends a little over 7/8 in. long which fit mortises cut in the posts located so that the piece just mentioned will lay flat under the ends of the posts where the full thickness begins, and the latter piece with mortised ends come down firmly against it, the two being firmly fastened together with glue and screws. Long screws of good size are also put up through the under piece into the ends of the posts. Pieces 1 in. wide and 3 in. long are also glued to the outside of the posts to represent continuations of the mortised pieces. Reference to the illustation will show what is required.

The mirror frame it attached to the bureau with three screws of good size in each part of the post extending below the top at the back. The mirror pins upon which the mirror frame swings may be purchased of about any hardware dealer, and an inspection will show the proper way to put them on. After the mirror is in place, a layer of thick manilla paper should cover the back before putting on the wood backing, to keep out both dust and moisture which are injurious to mirrors.

PERSPECTIVE VIEWS WITHOUT SKILL.

It sometimes happens that a perspective picture is wanted, either for an assembled view, accompanied by a mechanical drawing of the part, or for other reasons, where a skilled artist is not available (and if he was his time would cost too much to warrant its being used), says George F. Summers in the "American Machinist " It is here a camera comes into play as a drafting tool.

We will suppose, for illustration, that bids for a casting are required, where the patterns are furnished, and it is desired to mail the foundry people blue-prints showing the nature of the work.

A photograph can be taken of the pattern and from a negative a blue-print made, and outlined in pencil emphasizing any points to which especial attention is to be called. The print is then dipped in sodium hydrate, or common lye will do very well, when the blue at once turns into pale yellow, leaving the pencil outline standing out in bold relief, as in the sketch.

It is then a small matter to trace, free hand, the outline on tracing-cloth, making a neat, correct picture of the work at a small cost.

Trial of motor 'buses in Nottingham, England, has shown that for cheapness of operat'on and maintenance the street car is far superior to the motor 'bus. The cost of rubber tires for the 'bus is 4 cents a mile, as against 2 1/2 cents per car-mile for rail, a difference which amounts to $500 a year for each vehicle. The cost of motive power is also less for the street car and is placed at 24 cents for a ton weight, while the cost for a petroleum motor vehicle is 80 cents.

JIG FOR SHARPENING TOOLS ON AN OIL STONE.

EDMUND S. SMITH.

For the benefit of amateur workers who have found difficulty in keeping a good sharp edge on plane irons, chisels, etc., a device is described below which, if properly made and used, will eliminate the main source of this trouble.

In sharpening a plane iron, for example, on an oil stone the chief difficulty lies in maintaining the tool at a constant angle with the stone on the forward and backward strokes. Any change in this angle of course produces a more or less rounded bevel on the iron as shown in exaggerated form in Fig. 1. When this rounding is at all marked it is next to impossible to secure a sharp working edge. As the degree of rounding of the bevel becomes less, the ease and rapidity with which a fine edge may be obtained materially increases.

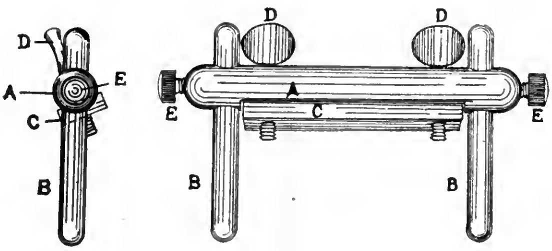


FIG. 2.

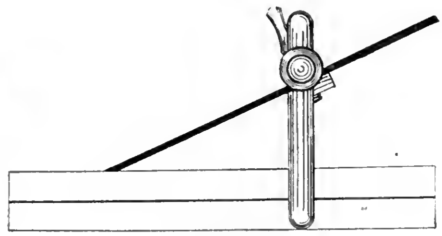


FIG. 3.

FIG. 1.

The desideratum, therefore, is to secure an absolutely flat bevel. To this end the writer devised the holder shown in the drawings, and found that it worked so satisfactorily that it is now offered to any one who may have encountered the difficulty he found in keeping the tool at a constant angle with the oil stone. By its use a tool may not only be ground more perfectly, but even with the extra time required in clamping the tool in the holder an actual saving of time is effected, especially if considerable stock is to be removed as in grinding out nicks, etc.

The device consists of the cylindrical steel bar A, recessed along its central portion to receive the flat piece of steel C, which is clamped to it by the thumbscrews D, D. The rounded rods B, B slide through the bar A near its ends at an angle of about 70 degrees with the flattened portion of the bar. Their position with regard to A is adjustable by means of the knurled screws E, E.

In use, the tool to be ground, a plane iron for example, is clamped between A and C and the legs B, B so adjusted that the iron meets the oil stone at the desired angle, as shown in Fig. 3. For the commoner angles the tool is clamped about four inches from its edge. The legs rest upon the bench (or other plane surface) straddling the stone. The tool and its holder are now moved back and forth over the stone as usual, the resulting bevel being of course perfectly flat.

By adjusting one of the legs so that it is longer than the other edge will be ground at an angle with the side of the tool instead of square with it. This same result is obtained by clamping the tool at any other than a right angle with the bar A. In this way the edge of the tool may be more or less rounded if so desired or it may be ground straight, but at an angle of as much as 45 degrees with the side of the tool. The degree of the bevel is determined by the length of the legs B B extending through A, ad also by the distance the tool is clamped from its edge in the holder. When the bevel is ground the tool and holder are turned over and the flat side of the tool rubbed on the stone to remove the burr, the holder in no way intrfering with its movment.

The most convenient oil stone to use is the so-called "combination stone" made of carborundum or other abrasive, consisting of a coarse and a fine stone cemented face to face. The coarse side is used on very dull tools where considerable stock has to be removed. When this is accomplished the stone is simply turned over and the fine side will soon put a keen edge on the tool.

The size of the holder depends partially upon the kind of tool to be used in it, but the dimensions of the parts given below will be found convenient for a holder to include chisels and plane irons up to 2 1/2 in. wide.

Bar A, 5 1/2 in. long, 3/4 in. diameter.
Rods BB, 3 1/2 in. long, 3/8 in. diameter.
Bar C, 3 1/2 in. long. 3/4 in. wide, 1/4 in. thick.
All four screws 1/4 in.

The transmutation of metals is still an enigma, and will doubtless remain so indefinitely. The galvanic battery has shown that alkalies have a metallic base, but it is a vexed question if a precious metal can be manufactured from substances which are believed to contain its ingredients.

A TWENTY FIVE FOOT AUXILIARY YAWL.

CARL H. CLARK.

V. Cabin Trunk and Rudder.

Before completing the cabin trunk construction it will be well to build the center-board trunk as it is much more convenient to work inside the boat before the cabin beams are put in. In Fig. 13 the outline of the centerboard logs is shown. These logs are the lower plank of the centerboard trunk and fit onto the bottom, being shaped to the proper curve. They are to be cut to the shape shown, cut of 2 in. oak plank. The upper edge is jointed straight and the lower edge is curved by trial to fit the curve of the bottom. The square notches are cut to allowit to fit over the bottom braces at the ends of the centerboard slot. The location of these centerboard logs is shown in Figs. 11 and 22. The construction of the centerboard trunk is shown in Fig. 19. A "head ledge" is fitted in between the center-board logs and extends high enough to take the ends of the side planks. 8he head edges are of oak 2 in. x 3 1/2 in. and about 2 1/2 ft. long. The one for the forward end is straight, while that for the after end is curved to a radius of about 4 ft.

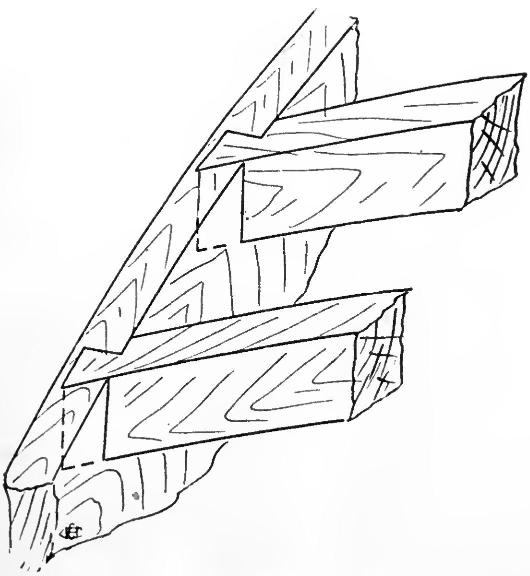


FIG. 23.

These head ledges are now et up at the ends of the slot, extending down flush with the under surface of the bottom. The centerboard logs are clamped along side of the ledges and carefully fitted. All surfaces are painted. A thread of cotton saturated with lead is laid along under each centerboard log, and also up on the side of each head ledge. The logs are now clamped tightly to the head ledges and may then be fastened down in place on the bottom. Heavy nails or screws are driven through the tapered ends of the logs into the bottom. Alongside the slot, howerer, 3/8 in. galvanized rivets should be used, headed over on both ends and spaced about 6 in. apart. A centerbore should be made for the heads of these rivets so that they will not protrude. The remainder of the side planking of the trunk may be of 7/8 in. pine, well jointed and fastened to the head ledgeswith galvanized nails, not forgetting the thread of cotton already mentioned. The top edge of the upper plank should be 2 ft. 3 in. above the bottom and should be finished level, or parallel with the water line.

Heavy nails are also driven through the logs into the ledges. Cotton calking must be driven around the sides and ends of the head ledges, working from the under side. The ends of the side plank are finished off even with the face of the ledges, and all nail heads should be 'set' down even with the surface. The top of the box is covered by a board, with rounded edges, and a slot to allow the rounded end of the centerboard to project through.

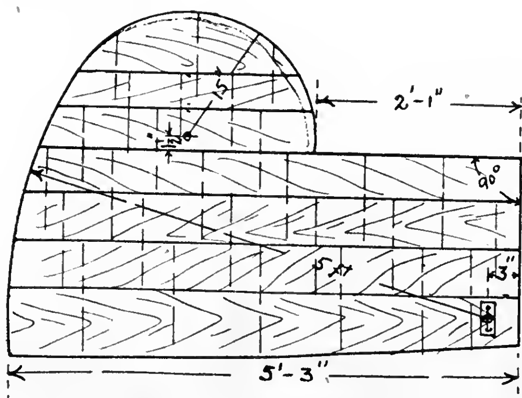


FIG. 24.

The house beams are now to be put into place. These are of oak, cut from a 3/4 in. plank, and are 1 1/2 in. deep with a crown of 6 in. in 6 1/2 feet. These beams should be neatly finished all over, and the under edges either bevelled or beaded. They are spaced 9 in. from center to center, beginning at the after end of the cabin, directly above the heavy deck beam already in place. The best way of fastening these cabin beams to the trunk is by a dovetail joint as shown in Fig. 23, not allowing them to go entirely through the trunk side, but leaving about 3/16 in. of stock at the end of the dovetail. In this way the ends do not show on the outside. In addition to the dovetail a long nail should be driven down through the end of the beam into the trunk. The upper edge of the trunk side must now be bevelled to the slope of the beams to allow the top planking to fit smoothly.

The top plank is of pine 1/2 in. thick, tongued and grooved. It is fastened in place with 1 1/4 in. galvanized nails. It is laid and trimmed off around the edges, and the opening for the sliding hatch cut out. This opening is 30 in. wide and extends to the fourth beam, as shown in Fig. 21, making it about 27 in. long. The beams, also, are cut off. The top is now to be covered with 8 oz. duck, laid in paint, stretched tightly and tacked around the edges. If possible, this should be obtained in one piece, but if not, it should be pieced down the middle. A piece of 3/4 oak half round moulding is now bent around the upper edge of the house to cover up the tacks, and the canvas is cut off even with its lower edge.

The bulkhead of the after end of the cabin is next to be built. It is of 5/8 in. tongued and groved pine; it is fastened on the after side of the heavy deck beam and the after cabin beam, and is carried down and fastened to short pieces bent in on the plank. This bulkhead should be well fitted and fastened both to the beams above and to the plank below, as it will form a very efficient brace to prevent the boat from twisting. An opening is, of course, left of the same width as that in the cabin top. A piece of 3/4 in. oak half round at the top will cover the joint. If the heavy deck beam has not already been cut off it may now be done, leaving it just even with the opening.

The lights in the cabin trunk are each 12 in. long, forward one being 3 1/2 in. wide and the after one 4 in. The glass is rabbeted in from the outside and set in putty, and the inside corners of the opening are bevelled off.

The skeg, or deadwood, is 3 in. thick, preferably of oak. At the after end it is 16 in. deep, and it is 7 ft. long. Its lower edge is straight, while its upper edge is curved to fit the bottom. The skeg is fastened with long spikes driven from the inside, except at the extreme point, where a heavy screw is used. In driving these spikes care must be taken to keep clear of the shaft hole, the center of which is 12 in. up on the after face of the skeg. The hole for the shaft should next be bored; the exact slope will depend upon the diameter of the fly wheel of the engine, but if a point is taken 10 in. above the bottom at mould No. 5, a line from this point to the point already mentioned on the back of the skeg will give a good line. The hole should be first bored by trial, using about 1/2 in. bit; it may then be tested by sighting, or by a line stretched between the two points. It may then be increased in size, using a large bit and taking out more on one side or the other to give it the proper direction. Its final size should be about 1 1/2 in. It is advised that this hole be lined with a piece of thin lead pipe to make the joints perfectly tight. Pipe about 3/32 in. thick should be used and it should be turned on both ends, bedded in lead and tacked with copper tacks. The inside shaft log, resting on the inside of the bottom need not be fitted unless an inside stuffing box is used, which is not common. In case it is fitted, it should be bored with the same size hole as the deadwood, and the lead pipe carried all the way through.

A piece of oak plank 2 1/2 in. thick 6 in. wide and 20 in. long is now securely fastened up and down the middle of the stern board, just above the stern knee. It forms the step for the mizzen mast and also holds rudder post tube.

The rudder post tube is a piece of 1 1/4 in. galvanized

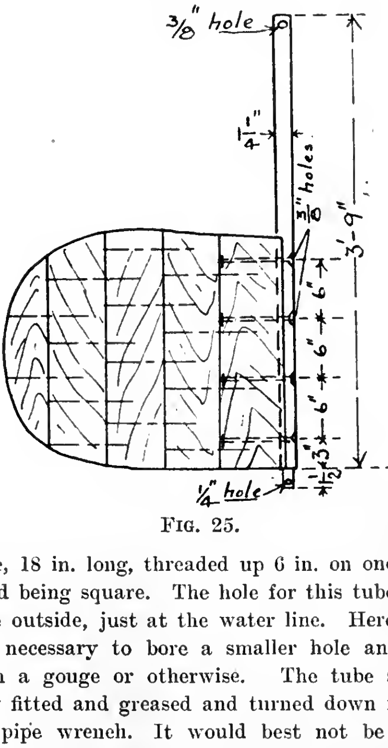


Fig. 25.

iron pipe, 18 in. long, threaded up 6 in. on one end, the other end being square. The hole for this tube is bored from the outside, just at the water line. Here again it may be necessary to bore a smaller hole and trim it out with a gouge or otherwise. The tube should be carefully fitted and greased and turned down into place with a pipe wrench. It would best not be put into place permanently until the step for the mizzen mast has been cut.

The step for the mizzen mast is a mortise about 5 in. long 1 1/2 in. wide and 2 in. deep, with its center about 6 in. aft of the center of the rudder hole. The mast hole in the deck should be directly above it and be about 3 in. diameter to be trimmed out exactly to fit the mast later.

The forward mast hole is 4 1/4 in diameter cut in the place already provided for it. The step formed of a piece of 2 1/2 in. oak plank as shown in Fig. 22 resting upon and fastened to the cross timbers of the bottom. The mortise is 4 in .wide and is located with the help of a plumb line dropped from the center of the mast hole above.

The bitt post is 3 in. square and extending down mortising into the stem as in Fig. 22. It should extend 6 in. above the deck and be provided with a piece of 5/8 in. brass rod 9 in. long passing through it crosswise to wind the lines about .

The cabin floor is 6 in. above the bottom amidships and is supported upon blocks resting upon tne bottom stiffeners. The floor itself is of 3/4 in. pine or spruce.

The standing room floor is about 12 in. above the bottom at its forward end and is level. It is supported upon spruce beams about 2 in. deep and 7/8 in. wide, spaced at each frame and supported by cleats nailed to frames or plank. The floor boards are 3/4 in. thick of pine. The outer boards must be neatly fitted around the frames and some form of finishing strip worked in.

The after bulkhead at the end of the standing room is of 1/2 in. matched pine. A door should be left in it for access to the space and also a slot for the tiller to pass through.

In Fig. 24 is shown the centerboard. It is of 1 1/4 in oak or hard pine fastened together with 1/2 in. iron rods. The boring of these holes for the rods is not as difficult as would appear. The pieces should be about 6 in. wide, and should be clamped together one after another, bored, and the rods driven. If plenty of lead

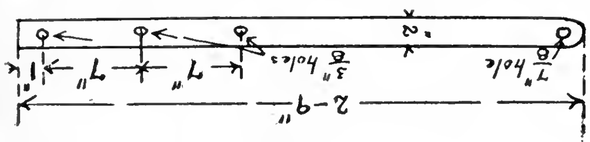


FIG. 26.

is smeared on the rods they will drive very easily. The lower and after sides should be shod with pieces of 1 in. half round iron, both to protect the board and to add to its weight so that it will sink into place. For a pivot, a rowlock socket should be fitted to take the wear. It must be put into the boat from below, the boat being heeled for that purpose. A 1/2 in. bolt is thus passed through holes in the centerboard logs to support it. If rubber washers are placed under the head and nut of this bolt no leakage can take place.

The rudder is shown in Fig. 25. It is 1 1/4 in. thick at the stock and tapers to 7/8 in. at the after edge. The first board should be of oak and be fastened to the stock by 3/8 in. rivets, headed on both ends. It should be rounded out to fit neatly around the stock. The remainder of the rudder may be of hard pine put together with 5/16 in. rod in the same manner as the centerboard. The stock is of 1 1/4 in. round rod, shouldered down to 3/4 in. at the lower end. The rudder is 2 ft. 3 in. long and 24 in. wide at the widest point.

The iron skeg is shown in Fig. 26; it is of 2 in x 1/2 in. flat bar, with holes drillled as shown. The iron work may be done at any blacksmith shop, the pipe may be gotten from a gas fitter and the whole sent away to be galvanized.

With the addition of a 1 1/2 in. oak half round moulding around the edge of the deck plank, the carpenter work on the boat is about complete, the only work remaing being the building of the engine bed and the fitting of seats, transoms and doors, which will be taken up next.

NEW BOOKS RECEIVED.

HENLEY'S ENCYCLOPEDIA OF PRACTICAL ENGINEERING AND ALLIED TRADES. Edited by Joseph G. Horner. 6 volumes of about 500 pages each, 99 3/4 x 7 1/2 inches. Copiously illustrated. Price, per set, $25; per volume, $6. Norman W. Henley Publishing Co., New York.

It is not an easy task to properly present the merits of such an extensive work as this, as its very character prevents other than a statement of the degree of skill and knowledge used in its compilation. The ability of the editor-in-chief is ample assurance that in these respects it would be entirely satisfactory, if we accept the method of classification, and even here preferences differ. In general, each topic and subdivision of a topic is presented under its separate heading, in preference to a single division with subheads. Exception are found to this however, as under "Drills," is found "Counterbores, " while "Twist Drills" are separately treated. This is a minor matter, however, and to others than the technical reader, will not be found detrimental to the best use of the work.

It is very comprehensive in its scope and quite up-todate, tools being mentioned which been but lately put upon the market. It is more especially devoted to mechanical subjects, althoug civil engineering subjects receive due consideration. Processes are given prominent treatment, whenever their impartance warrants it, giving the volumes a more practical character than ordinarily is the case. The illustrations are most excellent; the text and type are clear and easily readable. For public, school and shop libraries, as well as the mechanic whose means will permit of its purchase, this publication should be particularly valuable, and it deserves their extended patronage.

The sacred fires of India have not all been extinguished. The most ancient which still exists was consecrated twelve centuries ago, in commemoration of the voyage made by the Parsees when they emigrated from Persia to India. The fire is fed five times every twentyfour hours with sandal wood and other fragrant material, combined with very dry fuel.

The longest fence in theworld, it is thought, is one of wire netting in Australia, 1,236 miles long. Its object is to keep rabbits from the cultivated fields.

The world uses at least 170,000,000,000 matches yearly.

ELEMENTS OF DYNAMO DESIGN.

IRA M. CUSHING.

III. Equasion of the Dynamo—The Armature.

Before proceeding into the fundamental equation of the dynamo, the principle under which the current is generated must be studied. In 1831 Faraday discovered that if a closed conductor be moved across a field of magnetism an electric current would be generated in the conductor. By closed conductor is meant a loop or coil of wire with the ends fastened together to make a complete circuit. Faraday further discovered that an electric current so generated flowed in a direction at right angles to the direction of motion and at right angles to the lines of force.

Later Dr. Fleming worked out his graphic illustration of the rule, which is this:—Point the thumb, first, and second fingers of the right hand so that they will be approximately at right angles to each other. (See Fig. 9.) With the thumb representing the direction of motion of the conductor, the first finger representing the direction of the lines of force, the second finger will represent the conductor and will point in the direction in which the current will flow in it. In passing, it might be useful to note that the left hand will represent the motor. In this case there is given the direction of the current in the armature conductors and the direction of the lines of force, and then the thumb will give the direction of rotation of the armature. These two rules are very useful to remember and sometimes save much time.

Faraday proved, after many experiments, that the E. M. F. induced in this coil of conductors was directly proportional to the number of lines of force cut per second. From this it is readily seen, therefore, that the E. M. F. is proportional to the speed with which the conductor moves through the field of force, to the number of lines per square inch or magnetic density, and also to the length of the conductor in the magnetic field. Since the length of the conductor in the field and the magnetic density are both components of the total number of line of force, the latter term is used, which serves to simplify formulae and calculations.

The expression, "moving across a field of magnetism," has been used to explain the generation of current in a conductor. This implies cutting of lines of force. These expressions serve best in working out a formula for the result, but the following is probably a better explanation of the action. It is evident that if a piece of wire with its ends apart is passed through a field of force no current is generated, as there is no chance for it to flow although there may be what is called a "difference of potential" between the two ends; that is, there is a tendency for current to flow. If the ends are brought together to make a closed coil, and this coil be moved in a uniform field of force (where the density is everywhere the same) in a direction at right angles to the lines of force, its axis always parallel with the lines, no current will be generated in it. If, however, the coil be moved to a denser or less dense portion of the field, or into another adjoining field where the lines go in an opposite direction, an E. M. F. will be generated. Or if the coil be turned on an axis at right angles to the

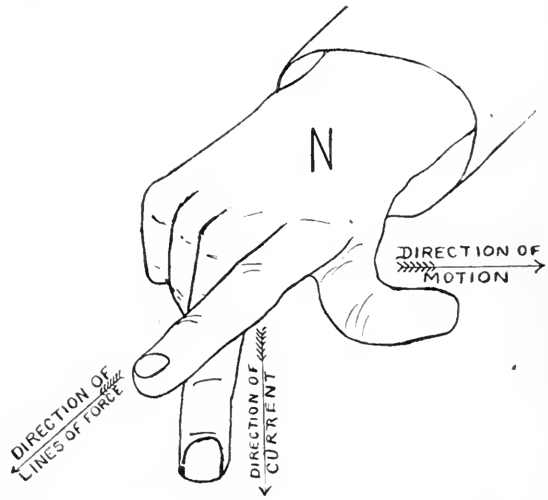


Fig. 9.

lines of force, then an E. M. F. will be induced. In the first instance the conductors of the coil were all cutting lines of force, but during all the motion the number of lines threading through the coil remained the same; for every line coming in at the front a line passed out at the back. In the other instances the number of lines threading through the coil changed as it moved, and experiment shows that the E. M. F. induced in the coil is directly proportional to the rate of change.

Fig. 10 represents a simple dynamo. W is a coil of wire centered on and rotated by shaft A-A, and placed in the field of force produced by the N and S poles. Each end of the coil is connected to a segment in the two-piece commutator C, and by means of the brushes B,B, and the external circuit D, the path for the E. M. F. generated in the coil is completed. When the coil is placed as shown with its plane at right angles to the lines of force, the maximum number of lines are threading through it.

If the coil be turned on its axis, or shaft A,-A, through an angle of 90 degrees, or until its plane is parallel with the field of force, the number of lines going through will become zero. Another turn of 90 degrees would bring the coil to the position of maximum lines again. During this half turn E. M. F. would be generated in the coil and this E. M. F. would be proportional to the rate of change of lines through the coil. This rate of change is equal to the total number of lines in the field, and the coil in turning cut the total number of lines. Therefore, when an armature is so placed in a field that the total lines can, during some portion of a revolution, thread through the coils the number of lines cut by a conductor are equal to the rate of change of lines threading through the coils. The next half turn of the coil completes one revolution and also repeats the process of generating E. M. F.

It is seen, therefore, that the E. M. F. generated is proportional to twice the total number of lines of force or 2N. If the armature is now wound with as many coils as can be put on, all coils being in series, it can be readily seen that the final E. M. F. will be proportional to the number of coils. It should also be noted that each coil has two conductors on the face of the armature. Therefore the E. M. F. is proportional to one-half the number of conductors on the face of the armature.

Further, if the armature is revolved at a greater or less speed than one revolution per second the E. M. F. will also be proportional to the speed in revolutions per second. All conditions governing the generation of a current in an armature coil have now been ascertained, and from this it is possible to make a general statement or formula. The absolute volts E (C. G. S. unit) is equal to $1/2Z \times n \times 2N$, where Z is the total number of conductors around the armature, n the revolutions per second and N the total lines of force. The 1/2 and the 2 cancel each other and the formula reads:

$$E(\text{C. G. S. units}) = nZN \qquad (11)$$

The volt of the C. G. S. system is entirely too small for practical use as it it takes 100,000,000, or 10^8 as it is designated, of them to make one practical volt as now used.

Formula 11 will therefore become

$$E(\text{practical volts}) = \frac{E(\text{C. G. S.})}{10^8} = \frac{nZN}{10^8} \qquad (12)$$

This, then, is the fundamental equation of the dynamo and is used, with a few modifications, for designing all machines. Formula 12 is correct for two pole dynamos. For more than two poles it becomes

$$E = \frac{p}{c} \times \frac{nZN}{10^8} \qquad (13)$$

in which p is the number of poles and c the number circuits in parallel in the armature from brush to brush.

Now that the equqation of the dynamo armature has been worked out, it would be well to study a little closer into what takes place in the coil as it turns in the field of force. Referring to Fig. 10, if the coil is turned 180 degrees to the right it will be found, accord-

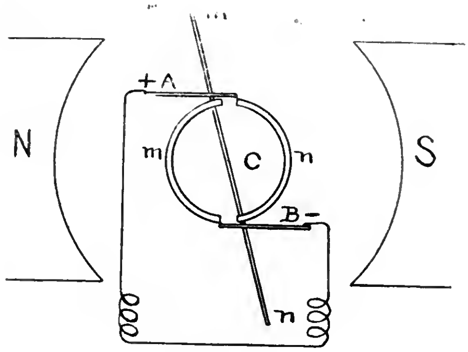


FIG. 10.

ing to Fleming's rule of thumb and fingers, that the E. M. F. will flow from n to m while that conductor is moving from top to bottom of the field. Turning the coil the rest of the way around to its original position, and applying Fleming's rule, shows that the E. M. F. flows from m to n, or just the reverse of the first half revolution. It will be readily seen from this that for the first half E. M. F. will flow out of the brush R, which is attached to the m end of the coil, and for the second half revolution will flow in at R coming out at brush T. Circuit F will then receive a pulsating or alternating E. M. F.

As alternating E. M. F. is not what is wanted, some scheme must be devised to change the direction of the E. M. F. at the same moment that it is changed in the coil. By making this double change it will be possible to obtain a continuous flow of E. M. F. The device used is a commutator, as shown at c, Fig. 10. This consists of two segments of metal, preferably copper, thoroughly insulated from each other, the entire surface being cylindrical. One end of the coil is attached to one segment and the other end of the coil to the other segment. Two brushes made of a spring metal bear on the commutator and are set so that they touch the commutator at diametrically opposite points. Now, if the brushes are set so that they slip from one segment to the other at just the time the E. M. F. changes direction in the coil, it will be found that the E. M. F. will always flow out of the top brush A in Fig. 11. It will be seen, from this figure, that the rate of change of lines in the coil will change from an increasing rate to a decreasing rate as the coil passes the vertical position. Or applying Fleming's rule, the direction of motion of the conductor changes from going up on the left to going down on the right and the change will take place as the coil passes the vertical position. The brushes A and B are, therefore, set to change from one segment to the other as the coil passes the perpendicular. As the conductor m passes down the south pole the E. M. F. generated will come towards the observer, and as brush A is in contact with segment m, the E. M. F. will flow out from that brush through the circuit back to brush B. As conductor m continues around and moves up the north pole, Fleming's rule, will show that the E. M. F. generated will flow away

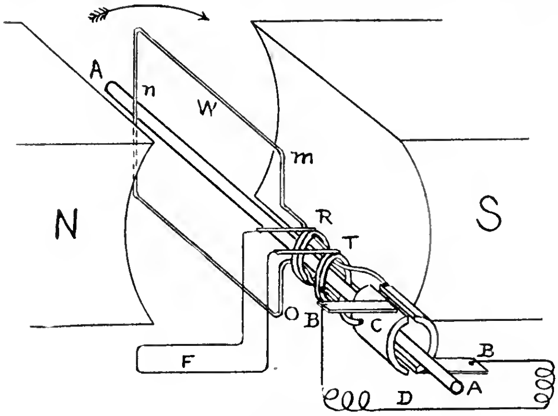


FIG. 11.

from the observer. But in the mean time A has slipped on to the segment n and B is in contact with m. Now by the same rule, n is delivering E. M. F. to brush A. It will be easily seen, therefore, that brush A will be in contact with the segment connected to the conductor moving down along the south pole and which is generating E. M. F. that flows towards the observer. Brush A is, therefore, always delivering E. M. F. to the circuit and is consequently called the positive, +, brush and B will be the negative, —, brush.

Electrical Methods of Measuring Temperatures

So much attention is now being paid to the determination of high temperatures in industrial processes where a rough guess was formerly considered good enough for practical purposes, that it is well to call attention to the two different methods of measuring temperature electrically, namely, the e.m.f. method and the resistance method. These are totally different and depend upon different properties of metallic substances. The e.m.f. method depends upon thermoelectric action. According to the electronic theory, if a certain metal, say copper, possesses a given average number of free negative corpuscles per cubic centimeter, while at the same temperature iron possesses a larger number of such free corpuscles, then, when these two metals are brought into contact the iron will tend by surplusage to diffuse free corpuscles across the mutual bounding surface at the junction, and the copper will be made negative by the reception of negative electricity, while the iron will correspondingly become positive. Since the rate of diffusion of free corpuscles increases in each metal with the temperature, so, also, will the e.m.f. of the junction. In order to have a resultant thermal e.m.f. in a closed metallic circuit, a difference of temperature is, of course, necessary between the two junctions. Conversely, by the measurement of this resultant e.m.f., the difference of temperature becomes known. The resistance method depends upon the fact that metals increase in resistivity with temperature. According to the electronic theory, the mean free path of the corpuscles in metal diminishes as the temperature rises. This has the same effect on the electric conductivity as though the length of path remain unchanged, but the number of free corpuscles diminished. But however we try to form a mental picture of the action, the fact is perfectly definite that at the standard temperature of melting ice, pure metals increase in resistivity about four-tenths of one per cent. per degree Centigrade. Moreover, the rate of increase follows a straight-line law with respect to temperature up to at least 100 degrees C. For high temperatures there appears to be a deviation from the straight-line law, in some metals at least.

An interesting paper on the measurement of temperature by electrical means was read at the Milwaukee Convention of the American Institute of Electrical Engineers by Edwin F. Northrup. The paper is addressed almost entirely to the resistance method, and suggests a number of important details in the technique of the manufacture, use and maintenance of resistance thermometers, such as go to make the difference between satisfaction and dissatisfaction in their application. In the first place, a special brand of nearly pure platinum is recommended for its uniformity and relatively high temperature coefficient. Then precautions have to be taken to prevent the platinum from dissolving or absorbing metallic vapors at high temperatures. Pure nickel wire is also recommended for moderate temperature thermometers. The beautiful principle of the Kelvin double Wheatstone bridge is also recommended for use with low-resistance thermometers. In such cases the resistance coils can be made very compact, and of dimensions comparable with those of a thermo-junction. For direct reading purposes a special form of D'Arsonval differential galvanometer, called a ratiometer, is described, in which the control is magnetic instead of elastic. That is, the coils lie flat in a dissimmetrical magnetic field, such that the differential magnetic actions cause the movable system to seek a definite magnetic displacement. The three leading-in wires are arranged to exert jointly a negligible torque about the axis of pivot rotation. Some of the results reported with the various types of instruments described constitute jointly a valuable research on temperature measurement and its automatic recording, and will prove directly useful to those responsible for the operation of plants in which it is desirable to maintain temeperatures of a uniformly high degree. The enormous waste of fuel caused by overheating, apart from defective characteristics of the products of high-temperature operations not under close thermometric control, make this subject one of much technical importance.—"The Engineering Record."

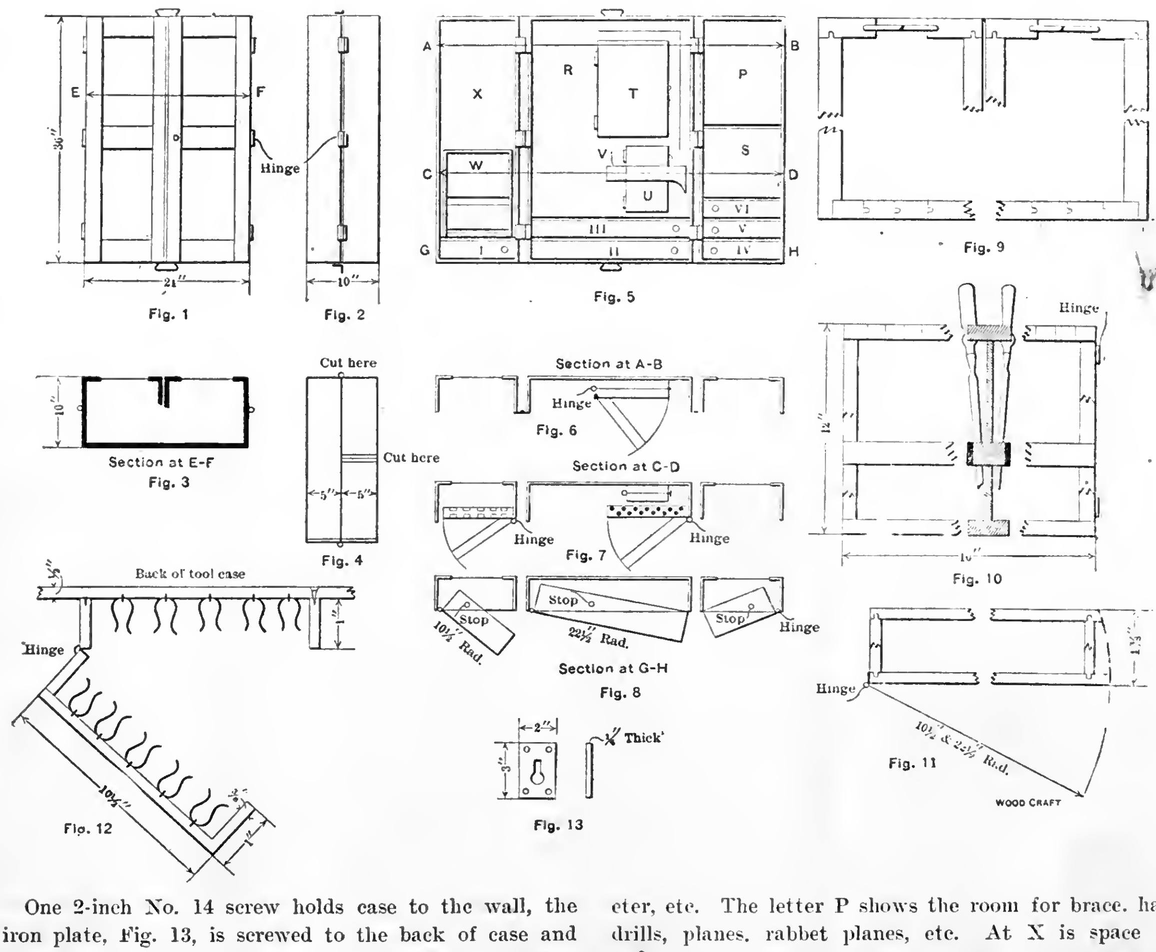
A TOOL CABINET FOR BENCH WORKERS.

WALTER SCOTT.

This tool cabinet I consider the most convenient for bench workers of any I have ever seen. It can be carried or shipped as easy as any tool chest and it is surprising the number of tools it will contain. The cabinet should be placed four or five inches above the centre of the bench and every tool will be within easy reach. It will only occupy about five inches of bench room when open.

Fig. 9 gives detail of construction. Fig. 1 is detail of chisel and straight-gouge rack. Fig. 11 detail of drawers, built of 1-4 inch stuff, and two inches deep.

The letter T designates the bent-gouge case (details are shown in Fig. 12), with springs to hold tools in place. At letter R is space for three planes placed in end, with suitable buttons to hold them. There is also room in this space for combination square, inclinometer, etc. The letter P shows the room for brace, hand drills, planes, rabbet planes, etc. At X is space for saws and long tools. The chisel rack is in place at W and is hinged to swing around so that one can get at both sides. At V is a rack for small bits, nail sets, plug cutter, and such small tools as are constantly in demand. This rack is a block of wood with holes bored part way through and is hinged to swing out of the way of the bit case at U which holds a complete set of bits. It is arranged same as the bent-gouge case, Fig. 13.



One 2-inch No. 14 screw holds case to the wall, the iron plate, Fig. 13, is screwed to the back of case and three inches down from the top; the screw enters lower part of slot, case drops down and is held firmly. Fig. 1 is a front elevation of the cabinet. The case is built solid, then cut as shown in Fig. 4. Fig. 5 shows case open. The section at G H shows the tills I, I, III, IV, V and VI open or partly open. The tills have flush draw pulls in one end. A 1/2 inch dowel, 1 inch long, set in the partition between the tills, forms a stop as shown in G H.

This tool cabinet should be built of hard wood, and if well made will last a lifetime. A continuous hinge, such as piano manufacturers use, would be better than the three hinges shown in Figs. 1, 2 and 5. The left-hand door fastens with an elbow catch and the right-hand door is secured to it with a spring lock. It may seem a good deal of work and expense to make a case like this, but the convenience will make up for that in a short time. Your tools are always in place, not scattered all over the bench and in the way. When it is time to leave the shop, there are very few tools to gather up; just swing the doors shut and that is all.—"Wood Craft."

STARTING A SHOP.

After reading the articles by Entropy, Dixie and others, I thought perhaps my experience in starting my shop would be of interest. I have always read with much interest all articles that applied to small shops, because my shop is small, and naturally I would be more interested in the small shop. I would like to hear from others who have a small shop and who started, so to speak, with nothing.

My start occurred about twelve years ago when I was 18, and living on a farm. I first started in with electricity, the same as a great many boys are doing today. I kept this work up a short time, all the time I could get when I did not have to work on the farm, and that was not much, as I preferred to work in the little shop than out in the field.

I made up my mind I must have a lathe, so I begged my grandfather for one. He bought me a No. 5 1/2 Barnes foot-power lathe. When it came, in five boxes, my grandfather bet me a dollar I could not put it together, but lost his bet as I soon had it assembled and a piece of iron in, doing my first lathe work.

There being no shop in town, I soon had a number of customers come to me to get work done. I picked up quite a few dollars, which I spent for small tools. I soon bought a set of 2 horse-power upright steam-engine castings, which I finished with the exception of boring the cylinder and turning the fly-wheel and crank-shaft. It was not long before I had to have a boiler, so I went to work and built a small porcupine type of boiler.

Things ran along in this way for a little over a year. Then I wanted to move to town and start a machine shop. So I had to ask my grandfather again for a little help to get started, as I had spent what little money I had made for small tools and engine. My grandfather rented a small piece of ground near the grist mill and put up a small building 18x24 feet, bought a 21-inch Snyder drill press, a piece of shafting, a few pulleys and what belting was needed. This was my shop as started in July, 1896.

I took steam from the mill boiler and did not use my boiler except when they were not fired up. In about a year I bought a 22x22x5-foot planer. I had previously bought castings for a small emery wheel, on which to do saw gumming and other grinding, which I finished up myself. I also bought a 10-horse-power upright boiler and steam pump.

Business was good. I had one man working with me, but got crowded for room, so in the spring of 1898 I started work on a larger shop. I bought a lot and put up a two story brick building 28x50 feet with three rooms; machine room, boiler room and blacksmith shop. I also bought a 24-inch New Haven lathe, a large emery grinder and a power saw. Such is my shop at the present time.

Two years ago I took up the manufacturing of gasolene engines to fill in my spare time. I am situated in a good farming country, with no competition, the nearest shop being ten miles distant.

In regard to money matters I have had no trouble to speak of in getting money due me and have not lost over $15, which I think is doing well. I have not over $75 book accounts that I cannot get any time I go for them. While this $75 is not really good, I have not given up hopes of getting it.

Dixie's method of "50 per cent. deposit required on all work" is a good thing, but I do not think I could ask it here with success, as a large amount of work is brought in by the hired men, who are not able to pay or who do not generally have any money with them and would have to go out and borrow it, in order to pay the 50 per cent. deposnt. To those not known or customers who are slow pay, I require cash when work goes out.

I heartily agree with Dixie about buying a small steam engine and boiler. They are more bother than they are worth, for a good gasolene engine is much better and takes much less looking after. It is started in a minute and all expense stops when the engine is stopped. In a small shop the engine is not needed all the time, but when steam is used, steam has to be kept up just the same. I use steam in the winter and a gasolene engine in summer when no heat is required.

I buy for cash only, and always take advantage of a 2 per cent. discount in 10 days where possible to do so, and pay all bills when due. H. C. Davenport in "American Machinist."

Chilled iron is whiter and has a harder surface than iron cast in any other way. It is cast in metal molds called chills, where by reason of the rapid conducting of the heat, the iron cools more quickly on the surface than it would had it been cast in sand.

When mercury is sub-divided minutely, as in stamp-milling, it is said to "floured"; when the globules become coated with grease, fine slime, manganese oxide, etc., so that they will not coalesce, the mercury is said to be "sickened."

ADJUSTABLE CONDENSER.

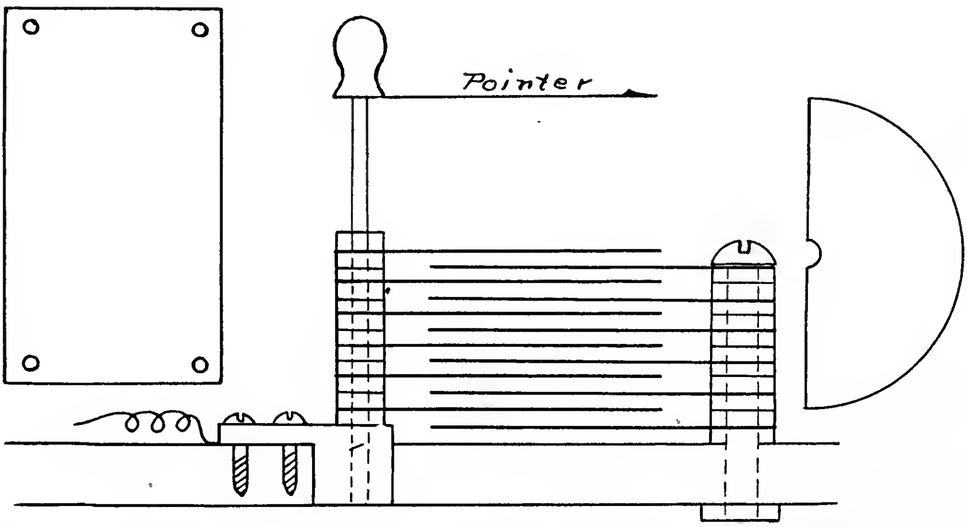
OSCAR F. DAME.

During a recent visit to a large wireless telegraph station, I observed in use a special type of condenser of very simple construction, and when immersed in insulating oil, so highly efficient that immediately on my return I set about making one for my own laboratory, where it now fills a long felt want.

In wireless work the services of an adjustable condenser are invaluable, but most adjustable condensers are simply banks or sets of small condensers which may be connected in series or multiple to give a few selected capacities. With an electrolytic receiver the condenser must be adjustable by every gradual and minute steps, otherwise the sounds heard in the head telephone will be faint and uncertain. At one time a bulky type of adjustable condenser was made from two telescopic tubes of glass lined with tin-foil, the inner tube being pushed more or less into the other tube to give desired capacity. Such a decice was bungling and very liable to breakage and finally gave way to the type here described.

In constructing the condenser, first purchase some extra heavy stove tin in perfectly flat sheets. From two of these cut four pieces 10 in. long by 5 1/2 in. wide. In the four corners of these pieces holes are punched to take four 8/32 machine screws. The four screws are thrust through the holes in one piece of plate, and then iron washers of a thickness of 1/8 in. slipped onto the screws. Then another plate is placed, and another set of washers, and so on until the four plates are in place, when the nuts are turned down securely onto the screws. By this arrangement we have four plates electrically connected, but 1/8th of an inch apart.

With a pair of dividers two circles are scribed on tin plate, 8 in. in diameter, and then each circle divided in two equal parts. With a pair of tinsmith's shears, the four half-discs are cut out evenly, care being taken to not bend or warp the discs, for each disc is to slip in between the square iron sheets previously mentioned, without touching at any part. At the point which was used as a center in outlining the circles, or exactly 4 in. in from the edge, it is advisable to punch or cut a 3/16 in. hole before cutting out the discs. Then, when the cutting is completed, we have a metal piece shaped as in Fig. 1.



A longer 8/32 machine screw than those previously used is next procured, also a supply of nuts to fit same. These nuts should be as near 1/8 in. thick as possible. The discs are next mounted on this machine screw, by screwing a nut securely against each disc until 4 discs are firmly fixed in place, one above the other, and 1/8 of an inch apart. The with soder the discs, nuts and screws are firmly affixed together.

A base-board of 1/2 in. pine or white-wood 12 ins. square is next procured and carefully shellaced on both sides and the edges. Holes are bored to take the four machine screws used in constructing the square plates, and the four screws slipped through and fastened with a final nut on each. This brings the bottom plate close to the wooden base. Calculations must now be made to find the proper position of the half circular pieces in their relation to the fixed plates, for as will probably be surmised by this time, the machine screw supporting them is to form a pivot or staff by which the half-discs are to revolve, thereby permitting the discs or vanes to intermesh as much or as little as desired, and without touching the permanent iron sheets at any point. This latter is imperative.

Having ascertained the exact position of this machine screw pivot, the head of the machine screw is cut off, and the exact diameter of the part un-cut with threads taken with calipers. With a drill of this size, a hole is bored in a block of brass or iron which is used to support the vanes erect. A hard-rubber knob is affixed to the other end by means of which the discs may be swung back and forth as desired without danger of discharging the electrcity through the body.

Having completed these metal parts, and connected two binding posts, one to the pivoting block, and the other to the fixed vanes, and having assured ourselves by actual test that the vanes swing clear of each other, we will now proceed to construct a wooden case for the condenser, which will contain parafine oil, when finished, as an insulator. This box will measure 12 in. square inside, and of a hight 1/2 in. above the highest vane. If the maker feels certain that he can construct a case with corners tight enough to hold parafine oil. a cover may also be built of proper size and a small indicating needle affixed to the pivot screw outside the cover, by which the exact location of the moving vanes may be ascertained without removing the cover. One may experience difficulty in constructing a case to hold oil, and I would advise that a second case 1 in. larger all around be built, and the first one sealed in place with plaster o fparis, which will furnish a positively secure container for the oil.

This condenser is by far the best I possess for universal use. I find it invaluable with an electrolytic receiver, and have also substituted it for Leyden jars in connection with the secondary discharge of an induction coil. The only chance for a break down is where, through over-sight, the moving discs are permitted to touch or come too close to the fixed plates.

Recent Wireless Achievements.

Some extremely successful results in the employment of wireless telegraphy have recently been recorded in the case of certain of the vessels of the North -German Lloyd Company provided with Marconi apparatus. Thus the Kaiser Wilhelm II., which has an equipment considered to be effective only for a relatively small radius, up to say two hundred miles, in order to communicate with passing ships, or with the coast, at the beginning or end of the voyage, has on several occasions lately received signals from very remote quarters. On her last voyage but one to New York, while the ship was off Texel, she was able to place herself in communication with Crookhaven, 600 miles away. She also on her homeward voyage to Bremen picked up the Nantucket Lightship at a distance of 600 miles, and later was able to speak Sable Island, distant about 800 miles. Subsequently she signalled the Cunarder Caronia, at distances of 1050 and 1200 miles, on the second occasion when that ship was off Cape Sperone, south of Corsica, with almost the whole of Europe intervening between them. It has been observed that these wide ranges are only possible when the vessel is at certain spots, either over the Newfoundland banks or off the Dutch coast, and it therefore seems to be probable that it is only in these places that atmospheric conditions highly favorable to the distant transmission of wireless signals are prevalent. A remarkable, if not an equally extreme variability in the apparent efficiency of Hertzwave apparatus has been repeatedly observed before. Rear Admiral Brownson's flagship, the West Virginia, furnished an illustration of the phenomenon when she was bringing President Roosevelt home from New Orleans a year ago last autumn. It is doubtful whether under ordinary circumstances the cruiser could send intelligible signals more than three hundred, or, at the utmost, five hundred miles. Yet while she was in the Gulf of Mexico despatches which were meant for Key West were picked up at Norfolk, Washington and even in Kansas! Though no harm resulted from the occurrence, they reached a number of ears for which they were not intended.

For some of the inequalities in the range of a particular transmitter adequate explanation have been found. One type of receiving instrument is more sensitive than another, and hence will respond at a greater distance from the source of the wave impulses. Again, the degree of resistance to the ether waves which is offered by the atmosphere varies. Sometimes an effect is produced like the obstruction to ordinary light that is presented by dust or thin fog. It appears to be independent, too, of the paralyzing influence of direct sunlight. Operators on other steamships than the Kaiser have had the opportunity to discover whether one part of the ocean is more favorable than another to wireless telegraphic communication, but they have apparently failed to observe anything of the kind. If a peculiarity like that under discussion really exists, it is queer that it was not detected years ago.

Theoretically, a miner working underground requires only 6 1/2 cubic feet of fresh air per minute for respiration, the absorption of moisture, and the dilution of carbonic aacid gas. This, however, assumes that all air after having been breathed is immediately removed, without mixing with the surrounding atmosphere, a condition impossible to fulfill.

A piece of granite measuring 60 by 30 by 14 feet has recently been quarried at South Ryegate, Vermont, establishing a record.

LOG HOLDER FOR FIREPLACE.

JAMES HUNTER.

In a residence having fireplaces in which wood is used as the fuel, the storing of a suitable supply of wood near the fireplace is attended with dirt and chips unless some receptacle is provided for the wood. An investigation at several stores of what the market afforded in the way of wood boxes did not disclose anything that met my wishes, and as the making of a simple rack did

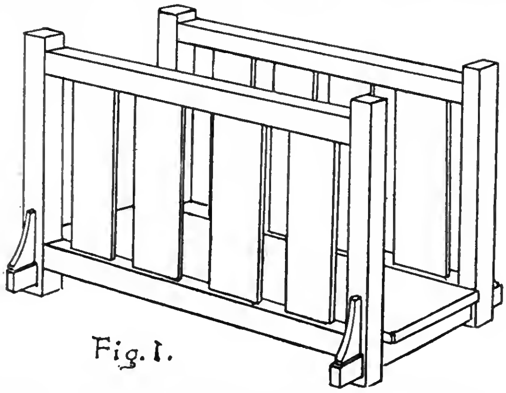


Fig. 1.

not seem a very difficult operation, I purchased the necessary wood and constructed the holder here described, which has proved entirely satisfactory for the purpose intended and has also been commended by indulgent friends. I therefore submit the following description, with the hope that the more critical audience it is now to meet will not find it unworthy of their approval.

The perspective illustration, Fig. 1, plainly shows the design, and Figs. 2 and 3 the dimensions of the several parts with a few exceptions, and these will be given in the text. Carefully selected oak was used throughout, the desire being to get pieces as finely figured as possible. The sides were made first. Eight pieces 15 in. long, and 1 3/4 in. square, and eight pieces 9 3/4 in. long, 2 in. wide and 1/2 in. thick are needed. Four of the square pieces form the corners and the other pieces run horizontally along the sides as shown in Fig. 2. Mortises are cut in these latter piecese 1/4 in. deep for the slats, and the ends are cut down to form tenons to fit in mortises cut in the corner pieces.

About the only thing to be noted in cutting the tenons and mortises in the sides and corners is the way the tenons on the lower sides and corners is the way pieces, Fig. 3, are carried by each other, those on the side pieces being cut on the upper part and on the end pieces on the lower part. The two end pieces are 16 in. long; the tenons on the ends are 4 in. long, 1 in. wide and 1 1/2 in. high. The board forming the bottom is 18 in. long, 2 in. wide and 7/8 in. thick. The corners are beveled off to avoid being marred by the logs. The inverted brackets on the tenons at the corners were cut out with a compass saw and smoothed with a spoke shave. It would save considerable work if these pieces could be cut on a band saw. They are held in place with glue. The board forming the bottom is fastened with three large screws at each end, the holes for them

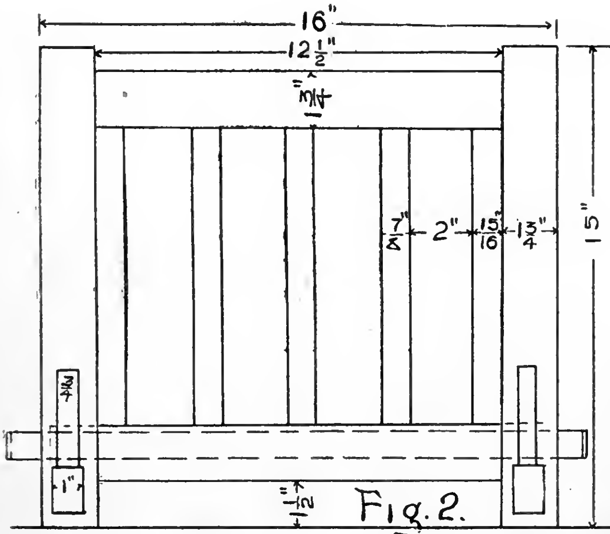


Fig. 2.

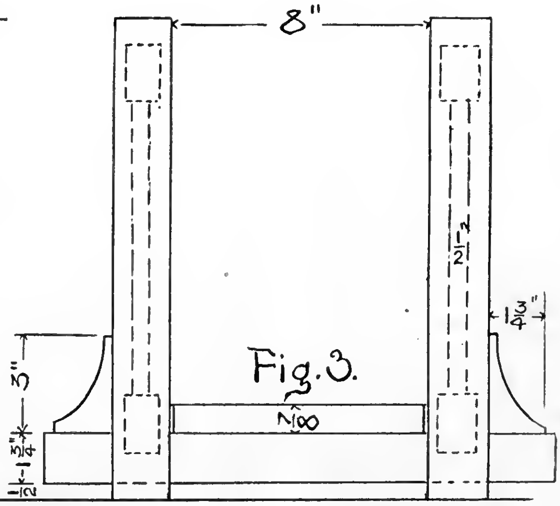


Fig. 3.

were cut with a 1/2 in. bit for about 1/4 in., then countersunk for the screw heads, and after the screws are in, covered with buttons cut out of waste pieces, with a knife and set in with glue. Any unevenness is then taken off with a sharp chisel and finished with sandpaper.

When completed, a coat of "fumed oak" stain was put on, and finished with a mixture of linseed oil, paraffine wax and turpentine, three coats of the latter being needed before the result was satisfactory. It is quite probable that many readers will see ways whereby this design and the method of construction can be much improved, but if what has here been said shall be found of any value, the writer will feel amply repaid for having submitted this too imperfect description.

VOLCANOES VENTS IN THE EARTH.

At the last meeting of the Boston Scientific Society, Professor George H. Barton spoke in a very interesting way on "Volcanoes," his paper having been called forth by the recent events in the way of eruptions and earthquakes. In outlining his subject Professor Barton called attention first to the changes which had taken place in the definition of volcano within the past wenty years and again to the latest conceptions of he sructure of the earth. "When I went to school," said the speaker, "we were taught that a volcano is a mountain that sends forth fire, smoke and lava. The latter day definition considers it not to be necessarily a mountain, nor does fire or smoke issue. A volcano, in our recent terminology is a vent in the earth's surface from which lava comes forth." The ashes which the volcano sends forth may fall about the lava and form a cone, or the lava itself may be heaped up in pyramidal form, but these mountain forms are incidents and not necessities.

Professor Barton gave in condensed form the nomenclature of the different layers of the earth, names which will be new to the generality of readers. The central portion of the earth is a hard mass about which practically nothing is known. It is believed to be firm and is of high specific gravity, higher, for example, than steel. This portion of the earth is denominated "centrosphere." Outside of the centrosphere lies the "lithosphere," the rocksphere, of which we know much and very little. The outer part of this, the ground we walk upon has been very closely studied and we know a great deal about it, and through it about the adjacent portions near the surface. But this knowledge is limited to portions of the earth at or near the surface. The "hydrosphere" is the mass of water covering a great portion of the earth's surface, the ocean, and the atmosphere is the medium in which we live. The "hydrosphere" and the atmosphere are important in geology from the effects which they have had in modifying the conditions of the surface, the water by direct erosion and the atmosphere by the more insidious processes of weathering, fracturing by heat and cold, separating by frost action, erosion by the running water and chemical actions of various kinds. For convenience the "lithosphere" is divided into two zones, the fracture zone, which is the outer part, and the flowage zone, which is the inner one. In the latter the rocks are under such enormous pressure that they become plastic and flow about into cavities as ice can be made to do at the surface. In the fracture zone the pressure is less and breaks and fissures in the rocks are important features in many of the phenomena.

Professor Barton then pictured the condition of the materials below the surface where under great heat and enormous masses of rock material exist. The igneous granites, for example, were such rock masses beneath the surface and wherever they are now found at the surface it presupposes that there formerly existed above these masses from five to ten thousand feet of earth or rock which has been removed.

Professor Barton then went on to the direct consideration of volcanoes, illustrating every point in their development and eruption by means of fine lantern views. The steam clouds of Vesuvius at its recent eruption, driven by the enormous force into the air for a hundred miles or more, and similar clouds on Pelee were particularly striking. The speaker's own experience with volcanoes had been in the Hawaiian Islands, which show different types, containing among others the largest crater on the earth, which while not comparable with those of the moon, still has a diameter of more than thirty miles and a depth of two thousand five hundred feet. All of the varied phenomena, the eruption, the flowing lava, the lava sprouts of fiery red, molten lava, of which he has seen at one time more than a score, the roughness of the lava bed, the smoothness of its satin-like finish, the cinder cone, all were noted and explained.

A POCKET WIRELESS OUTFIT.

An English electrical engineer, Mr. Ernest Oldenburg, has recently invented a new telegraphic receiver which, it is claimed, is sensitive enough to detect the most delicate impulses which a pocket battery, such as might be concealed about the person, could send out. This instrument, which is at present known as the "capilliform" receiver, is "more sensitive that the brain"; it is said to transcend previous inventions as far as Lord Kelvin's siphon recorder, which alone made submarine telegraphy practicable, surpassed its predecessors in delicacy. It depends on the fact that mercury in a vertical capillary tube—like that of a thermometer—rises and falls when an electric current is passed through it. This fact—which would be more accurately expressed by saying that the surface tension of the mercury, and therefore the shape of its meniscus, changes under the influence of an electric current—has long been known. Mr. Oldenbourg's invention consists in magnifying it and in utilizing it in a shape which enables it to be used practically as the receiving instrument of a telegraphic installation. Its peculiar value is, it is claimed, that it will respond to far smaller currents than those at present used; a mere fraction of a volt is sufficient to work it. Mr. Oldenbourg holds that it will be quite possible, with the aid of his new instrument, to make a telegraphic apparatus by which any one walking about the floor could send intelligible messages for instance to a confederate on the platform, where a "mind-reading" act is being performed, without any one else knowing about them.

SCIENCE AND INDUSTRY.

There are mining engineers who are paid $25,000 annual salary, and that is not considered the limit, as some distinguished members of the professions are credited with receiving more than that. Such a salary is by no means an unusual one among railway men, some of whom receive $50,000 a year. As to whether any man can make himself worth that amount of money to any concern per year, it may be said that while no one might "earn" that amount in the ordinary acceptation of the term, yet where a man by knowledge, experience and judgment can save or make, say a million a year, to the company he represents, 5 per cent of that would represent his salary, and there are many broad gauge engineers, miners and railway men capable of such showing.

For the purpose of obtaining a hard combustible, well adapted for use under boilers, an electric process recently adopted in Engand, says "The Iron Age," requires two and one-half hours and yields a material of high calorific value, almost smokeless, and less expensive than ordinary coal. The basis is peat, which is placed in revolving cylinders, and the water (originally 80 per cent.) is largely driven off. A set of electrodes in the cylinder uses the mass of peat as a part of the circuit. The passage of the current warms and dries the peat, but without carbonizinz it, and pulverizes it for the next stage in the process: The peat is then treated by a kneading roller and placed under an automatic press, which forms it into briquettes. It is then stored for final drying.

Green Lake, Col., is not only noted as the highest lake in the United tSates, being 10,252 feet above the level of the sea, but also for the fact that its water has a peculiar faculty for petrifying substances that are placed in it. The water of Medicine Lake, in the southern part of the tSate of Washington, on the Columbia plateau, possesses such unusual qualities that no vegetation ever grows on or near its banks. Owen's Lake in Owen County, Cal., is so rich in soda ash that 10,000 tons were taken out last year. The soda is taken fro mthe water by the process of evaporation. Tis lake, like the Great Salt Lake, is gradually disappearing.

The highest bridge in the world will be the trolley-bridge now under construction across the famous Royal Gorge, in Colorado, which will be 2,627 feet, half a mile, above the river below. As far as height goes, this little bridge—only 230 feet long—will be in a class by itself, its nearest competitor being the recently completed Zambesi bridge, in Africa, 450 feet in height.

In Arkansas there is a prehistoric quarry from which flint for making tools and weapons was produced on so large a scale that in certain places the hills and mountains have been practically remodeled by the pitings and trenchings. It is estimated that fully 150.000 cubic yards of flint have been removed from the hillside. Similar prehistoric quarries are known in other states and in the Indian Territory.

When a dynamo is to be operated by a separate engine not on the same bed-plate, the foundation should be made common to both, or if separate foundations are necessary, set the two machines on a frame made of substantial timbers, or steel I-beams which may rest on the double foundation. In this manner the engine and dynamo may be kept in perfect alignment.

The distillation of coal tar is ordinarily done by heating in steel vessels inclosed in brick work settings, provided with grates for burning coal. The vapors thrown off are condensed in coiled pipe or worm immersed in water. The distillates flow into a small receiving tank that empties into storage tanks, the oil being separated in accordance with its specific gravity. The remaining pitch is then transferred from still to cooler, then flows into barrels when cooled to proper temperature. Stills commonly used are horizontally placed cylinders of boiler plate. The large ones hold about 10,000 gallons.

In Birmingham, England, a device has been invented that will light street lamps by clockwork. The invention is so nicely adjusted that the gas will be lighted at a different moment each day in the year, according to the varying seasons. The machine turns on the gas at night and lights it, and turns it off in the morning. When once adjusted it will run for a whole year by simply winding the clockwork attachment once a week.

The density of the earth as a whole has been estimated, with close agreement among the several scientists who have made the determination by different methods, to be about five and one-half times as heavy as an equivalent sphere of water. On the other hand, the average density of the materials forming the accessible portions of the earth's crust is between 2.2 and 3, so that the mean density of the whole globe is about twice that of its outer part. This indicates that the central part of the earth is composed of heavier materials and may even be metallic, which would accord perfectly with the nebular hypothesis.

AMATEUR WORK

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WOOD AND METAL XYLAPHONES.

The xylophone and harmonica are musical instruments that have been in use, probably, for thousands of years. The xylophone, known also as the gigelire (pronounced je-je-le-ra, Italian for fiddle-lyre), sticcada, and straw-fiddle, is a wooden dulcimer, while the ordinary harmónica is a metal or glass dulcimer. A set of wine glasses played by rubbing the fingers round the rims, is also called the glass harmonica, musical glasses, or glass orchestra. The name "xylophone" is occasionally aplied to an arrangement of upright wooden resined sticks from which musical notes are produced by rubbing with a resined glove; a convenient name for this instrument is the "wood harp."

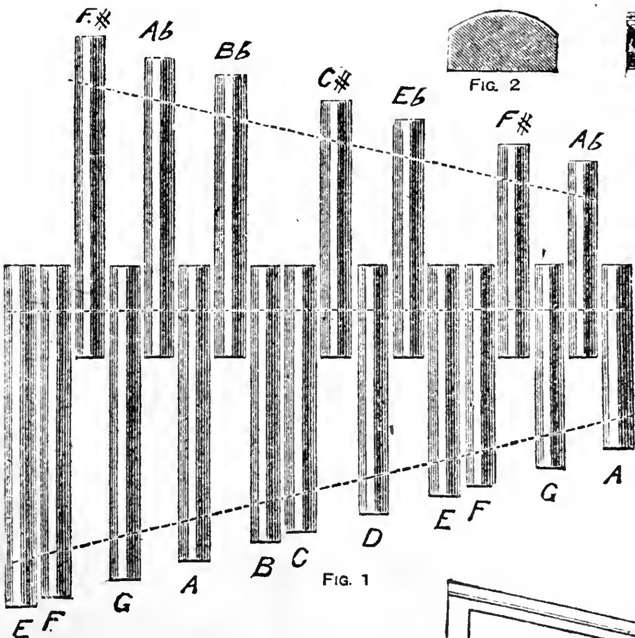


Fig. 1

Fig. 2

Fig. 3

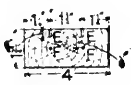


Fig. 8

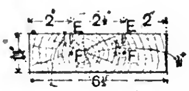


Fig. 9

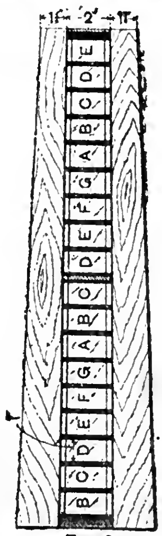


Fig. 6

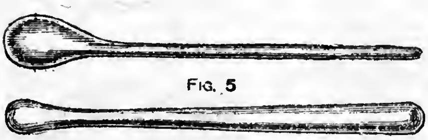


Fig. 5

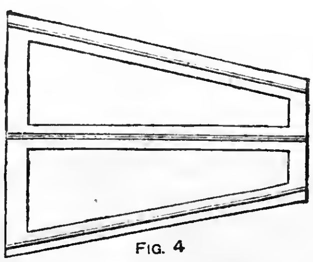


Fig. 4

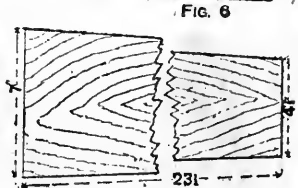


Fig. 7

The wood dulcimer xylophone consists of a number of pieces of rosewood, arranged in the manner shown in Fig. 1; these pieces form the notes, and are slung together with whipcord. They are laid on three straw ropes to insulate them, the straw ropes being fixed on a frame. The notes are played by two boxwood beaters, the player standing in front of the naturals, and playing the air with the right hand and the bass with the left hand. The xylophone may be played as a solo instrument, or with piano or other accompaniments; and in the hands of a skilful player some very good effects may be got from it. The rosewood notes are 1 1/8 in. wide and 5/8 in. thick, rounded on the top side as shown in section by Fig. 2. The middle C will be approximately 5 3/4 in. long. The addition of five notes at the lower or left-hand end down to C, and five at the top end up to D, is recommended. This will give it a compass of two and a quarter octaves, making the lower notes correspondingly longer and the top ones shorter. If rosewood cannot be procured, oak or pitch pine may be substituted, and to make the tone more even they should all be cut from the same plank; they should also be free from knots. A hollow 1/2 in. wide and 1/8 deep is cut across the under side of each note in the center. Bore holes 1 1/2 in. from the ends of the longest notes, and 1 in. from the ends of the shortest notes, for the cords to pass through, as shown by the doted lines in Fig. 1.

Three pieces of whipcord are passed through the holes, and the center one may have knots made between each note, to keep them apart. The ends of the cords are put through a small washer or button, and knotted.

The straw ropes are about 7/8 in. in diameter, and are made in the following manner. A quantity of good clean long straw is procured and the heads cut off; then draw it through the hands to straighten it, and take out the short straws. Then bore a 7/8-in. hole in a piece of wood, and fill it tightly with the drawn straw; push it through for 3 in. or 4 in., and wrap it with narrow red tape (as shown in Fig. 3), winding the tape on as the straw is drawn through the hole, and tie the ends as shown. If the straw cannot be got in long lengths, the ends may be cut angular and the pieces joined together.

The frame is made as shown in Fig. 4, the joints being mortised or half-lapped together; the wood may be 2 in. wide and 3/4 in. thick. The straw ropes are fixed on the top by small wire nails or staples, the heads of which should be below the top of the ropes. The frame is not absolutely necessary., as the straw ropes can be laid on a table or box; but it is better, especially if the straws are in two pieces, the instrument being then always ready for use.

A case may be made to hold the instrument. The case should be 3 in. deep inside, and the width of the lowest notes; it may be made narrower at the top end. Half-inch pine would do for the case, and it may be hinged on at side, and fastened by two hasps, or a lock. In playing, the frame may be laid on the case, which will improve the tone.

Two half-size views of the beater are shown by Fig. 5. They are made of boxwood, or, if this cannot be procured, lancewood may be used, which can be got from a broken gig-shaft. They are shaped as shown, with chisel and rasp, and smoothed with glasspaper.

The notes are tuned to a tuning fork or piano. They should be cut rather longer than they will untimately be, and raised in pitch by cutting a piece off the ends; but this must be carefully done, as if too much is cut off the note will be too high in pitch. It will be best to tune them before fastening them together, and, if one is made too high, it can be moved a note upward. The rounded tops of the notes are varnished, to improve their appearance.

The glass harmonica (Fig. 6) consists of strips of plain glass, which are played by being struck with a beater. Take a piece of 3/8in. pine of the shape and size shown in Fig. 7. Proceed to make a box of this by gluing to it on each side a piece 23 1/2 in. long by 1 3/4 in. wide and 1/4 in. thick. For the wide end a piece of 1/2 in. stuff, 1 3/4 in. wide by 6 1/2 in. long, will be required; and for the narrow end a piece 4 in. by 1 3/4 in. by 1/2 in. These must have two slots cut in them, as shown by Figs. 8 and 9. These slots are 3/8 in. deep, and are 2 in. from each side at the wide end and 1 1/4 in. at the narrow one. Glue across the center of the box a piece of wood to act as a bridge. The top of this must be 3/8 in. below the top of the sides, and must not touch the bottom of the box. In Figs. 8 and 9 E shows the slots, and F two small panel-pins, one of which is inserted at a distance of 1/2 in. below each slot. Take some trong fine silk or chochet cotten and tie one end securely to one of the pins. Bring the end through the slot immediately above the pin, carry it over the bridge and though the opposite slot, wind it around both panel-pins at that end, take it back again through the slots, and fasten it off securely. These strings must be stretched as tight as possible. Cut the glass into strips, 1 in. in width, and attach them to the strings by drops of sealing-wax. The box will hold eighteen strips, which should be in the key of C, and range from B to E.

Before fastening in the glasses, simply lay them on the strings and try them, changing them about until their proper places are found. To sharpen a note, cut the glass a trifle shorter.

For glass 1 in. wide and 1/16 in. thick the following will be about the correct lengths:—B, 5 1/2 in.; C, 5 1/4 in.; D, 5 in.; E, 4 7/8 in.; F, 4 5/8 in.; G, 4 1/2 in.; A, 4 3/8 in.; B, 4 1/4 in.; C, 4 1/8 in.; D, 3 3/4 in.; E, 3 5/8 in.; F, 3 1/2 in.; G, 3 3/8 in.; A, 3 1/4 in.; B, 3 1/8 in.; C, 3 1/16 in.; D, 3 in.; E, 2 3/4 in. When the glasses are turned and fastened to the strings, procure two pieces of 3/16-in. deal or pine, 23 1/2 in. long by 2 in. wide at one end and 1 1/4 at the other. Glue these on so as to hide the ends of the glass strips and form a top to the box.

For the beaters procure a piece of thin cane or whalebone about 8 in. long, and glue on one end a round knob of cork. The instrument is played by tapping the notes with the beaters, holding one in each hand, and grasping them about 1 in. from the end to let them have plenty of spring.

In arranging a set of musical glasses (see Fig. 10), one of the most important things to aim at is simplicity of construction, so that the notes may be brought well under the hand and can be reached without trouble. Fig. 10 shows a simple arrangement of the glasses, as it brings the semitone of each note next to the note itself. If of the plain dulcimer shape, the sides and ends of the case may be made to fold down and under, or the apparatus may be made as shown by the dotted lines. Note that the water glass for moistening the fingers is placed in the center; the water glass usually contains water that has been acidulated with lemon juice. The best kind of glass to use is the plain flint; and it is obvious that the glasses cannot be all of one size, as the necessary difference in pitch will not admit of it, but it will be well to get them all of the same height if possible. As they cannot be raised in pitch, any tuning necessary must be obtained by flattening. This is done by putting water into each glass till the desired note is attained. Do not flatten any glass any more than a whole tone, as it spoils the quality. The glasses are fastened to the baseboard b means of clips —three to each, as shown in Fig. 11.

The wood harp is shown by Fig. 12. In making this instrument, the wood must be carefully selected, because shakes or knots seriously impair the tone. Also the parts must be carefully fitted. For the foundation take a piece of well-seasoned deal, 6 ft. long and 6 in. wide, and about 4 in. in thickness. Plane this up to the size and shape down by FFig. 13. The rods are 1/2 in. in diameter when rounded up. The longest will need to be about 6 ft.;; all must be evenly planed and glasspapered. At 3 1/2 in. from one end of the foundation, bore a hole 1 in. deep with a centre-bit. This hole should be slightly less in diameter than the rods. Bore similar holes right along the centre of the foundation at distance of 3 1/2 in. apart. Slightly taper one end of the rods, and, after dipping them in good hot glue, drive them well home with a mallet. After putting in all the rods, leave them to dry for 24 hours. Proceed meanwhile to make the stand, which will require a board 6 ft. by 10 in. by 1 1/4 in. Plane this up to the section shown by Fig. 14. This is for the foundation to fit in at A. This stand is fastened to the foundation with 2-in. screws from the bottom. Fig. 15 shows the end in section, B being the rod, C the foundation, and D the stand. When thoroughly dry, rub down with glasspaper;; then take an old glove of wash-leather and dust it well with powdered resin. Take hold of the longest rod with a light but

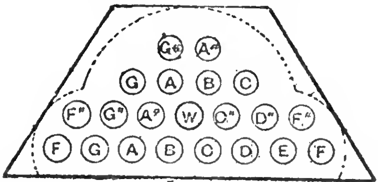


FIG. 10

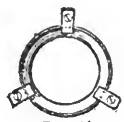


FIG. 11

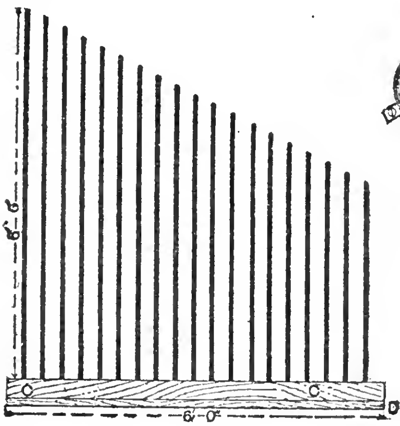


FIG. 12

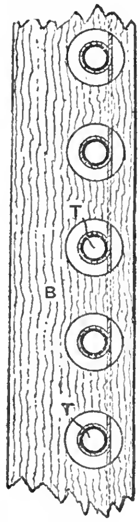


FIG. 17

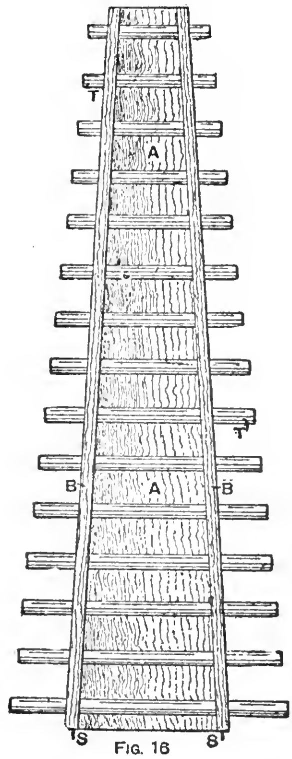


FIG. 16

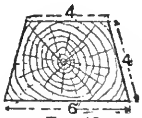


FIG. 13

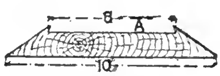


FIG. 14

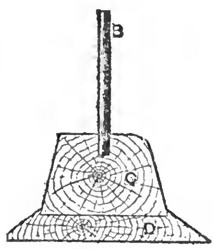


FIG. 15

firm grip, and draw the hand down. Try this until the best effect is obtained; then proceed to tune all the other rods from this one by cutting them down bit by bit until the desired notes are produced. Keep the wood harp very clean; do not stain, varnish or paint it. When the resin has worked into the rods a little, they will sound at the slightest touch. With a little practise a great many airs can be played. Never touch the rods except with the resined gloves.

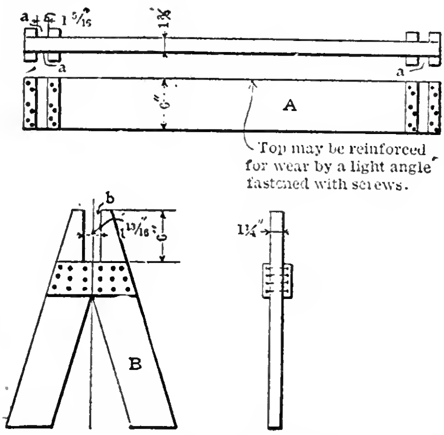
The tubephone, shown in plan by Fig. 16, is related to the harmonica. The following instructions apply to the making of a two-octave tubephone (fifteen notes) in the key of G. For the baseboard A, get a piece of 1/2-in. pine, free from knots and shakes, 23 in. long and 4 1/2 in. wide at the base end, tapering to 1 33/4 in. at the upper end. For the two sides B or bridges to carry the tubes, two pieces of pine, 23 in. long by 3/8 in. thick, will be required. The width of these depends upon the way they are joined to the base, whether fastened to the sides or tops. In either case they must stand 1 5/8 in. above the baseboard and 4 1/2 in., tapering to 1 3/4 in., apart, inside measurement. These bridges are bored with 7/8-in. holes on centres 1 1/2 in. apart, as shown in an enlarged portion of side (Fig. 17) for the tubes to be suspended in. The tops of these holes should be cut to a line gauged 3/16 in, from the top of the bridge. A stout saw kerf or narrow groove must be taken the whole length of the bridge along the top, to allow a soft cotton cord to lay in to support the tubes. This groove must be cut to a depth of 3/8 in., and will then support the tubes about the centre of 7/8-in. holes. The tubes T are made of thin brass 3/8-in. bore and 7/16-in. outside diameter, sound and free from cracks.

The lengths of tubes given below are approximately correct, but the slightest difference in thickness or weight of metal will cause veriations in pitch. As a tube cannot be flattened in pitch, cut them long enough in the first instance:—G, 9 3/4 in.; A, 9 1/4 in.; B, 8 3/4 in.; C, 8 1/2 in.; D, 8 in.; E, 7 1/2 in.; FS, 7 1/8 i n.; G, 6 7/8 in.; A, 6 1/2 in.; B, 6 1/8 in.; C, 5 7/8 in.; D, 5 5/8 in.; E, 5 1/4 in.; FS, 4 15/16 in.; G, 4 3/4 in.

To fasten the tubes in position, secure one end of the cotton cord to the base end of the bridge below the groove with a staple, screw, or nail at S, and lay it in the groove right along to the upper end; the cord will then show as a line cutting the 7/8-in. holes about 3/16 in. down. Draw the cord down in the hole, pass one part behind the other to make a bight, and insert the tube. When all the tubes are in, tighten the cord and fasten the end as before. The tubes can now be regulated to lie fairly in the centre of the holes without touching the sides. Finally, glue a thin strip of wood into the groove in the top of the bridge, and stain and varnish, or polish, as desired. The beaters are made of wooden balls about 1 in. in diameter, on thin flexible cane sticks 8 in. long. A good plan is to have the baseboard about 1 in. wider than the length of the tubes, and to make a wooden box or cover to fit over all; this will keep out dust and dirt and prevent damage to the tubes.—"Work," London.

A FOLDING TRESTLE.

Herewith is a sketch of a tressle which may be readily taken down and stored away in some small corner of the shop, writes W. E. Morey in the "American Machinist."



The top bar or rail A is provided with grooves near each end, formed by nailing strips of wood on each side as shown at a a a. The legs, one of which is shown at B, has a space b at the top which is a pretty close fit over the top bar, and the strips on each side of the top bar are a close fit on the upper end of the legs. This trestle is not so useful in the machine shop, possibly, as in some other lines, but its collapsible feature is perhaps worthy of your attention. It is certain that the old form of trestle is a very unhandy contrivance to store away when not in use.

The method of drilling holes in glass plates is to take an old twist drill, see that it is properly sharpened, and harden it by beating the point to a cherry red over a gas flame, and quench in ordinary soldering "acid," that is, chloride of zinc solution. Use this drill in the ordinary way in a bit brace or hand drill, lubricating the point with turpentine. A quarter-inch hole is very easily made in this way. Then take a medium coarse rat-tail file, moistened with turpentine, and the hole may be enlarge to required size in a few minutes. Care should be taken not to get the file stuck in the hole while it is still small.

Try this on a waste piece of glass first. If the drill gets dull it must be ground and then hardened again.

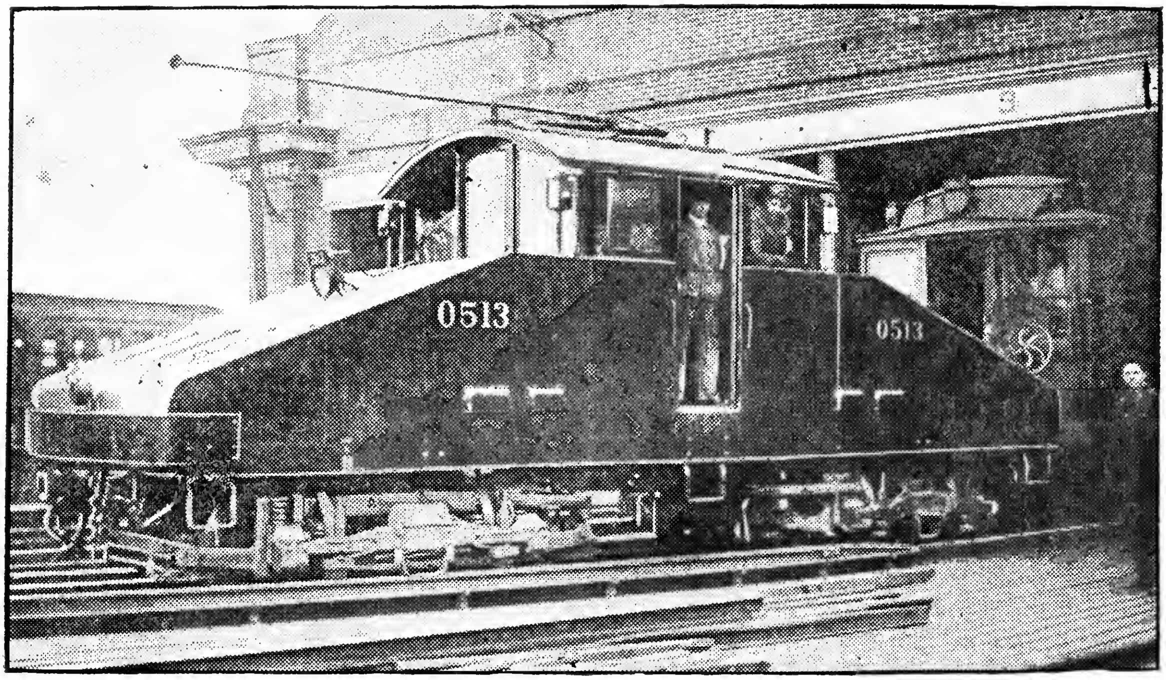
POWERFUL ELECTRIC LOCOMOTIVE.

One of the two powerful electric locomotives recently designed by the Boston Elevated Railway company for heavy yard and general haulage service on the elevated division has already been completed and is at work in the Sullivan-sq. terminal yard, Charlestown, and the second is in process of construction.

Both locomotives will have been manufactured in the company's own shops and are practically duplicates. One will probably be used more exclusively in yard work, while the other will be employed in the haulage of materials, flat cars, box cars or other rolling stock in connection with the work of the road department.

Each locomotive is 30 feet 7 1/4 inches over all and 8 feet 7 inches wide. The hight of the top of the cab from the rail is 11 feet 3 inches. They were designed to pass through the subway as readily as a standard elevated car and each weighs 77,000 lbs. The floor is a trifle above four feet above the rails.

In general design the locomotive conforms to the usual arrangement of a central cab and body with sloping ends on each side, supported on a heavy underframe, the latter being carried on two four-wheel trucks. These trucks are similar to the motor trucks used under the cars of the elevated division, having 24-inch steel tired wheels, a six-foot wheel base, and being 16 ft 3 1/2 inches apart on centers.



The contractors are mounted in a fireproof compartment in the centre of the cab, which is about eight feet long. The master controllers are mounted in diagonally opposite corners of the cab and are arranged for right hand operation of the locomotive, facing each end. The reverser, circuit breaker, fuse box and rheostats are installed under the sloping end at one side of the cab, and the main reservoir cylinders, air compressor and governor are installed under the opposite end. The wooden flooring is fireproofed by sheet tin in the compartment which holds the control apparatus.

Minor control switches and fuses are mounted in a special asbestos lined compartment at one end of the cab and a single-pole, double-throw switch is installed to connect the main motor circuit, either with the trolley pole, with which the locomotive is provided, or with the circuit of the third-rail shoes. The air brakes are of the new electro-pneumatic type with graduated release and quick recharge features,

Ark headlights and electrically lighted markers are provided, and part of the space at each end of the locomotive is given up for tool box purposes.

The locomotive already completed is used in shifting cars in and out of the northern division of the Sullivan-sq. shops for the purpose of wheel grinding or truck changing. About 48 pairs of wheels are ground daily, and the locomotive is constantly at work transferring cars to and from the special track in the shops.

Ever since electric train operation began in Boston it has been necessary to shift dead cars by a passenger car withdrawn from the service. On this car the facilities for looking back at the rear of the train were not good and safe movements could not be made without considerable delay in signaling. In the locomotive the driver can headily see all that is happening at the end of the train and the control is graduated so that the locomotive can be moved an inch at a time if desired. Eleven elevated cars, weighing about 33 tons each, have been hauled at one time by the new locovotive without the least difficulty.

"WIRELESS" WITHOUT AERIALS.

I have read with much interest in your first issue of March, an article describing the erection of poles, towers, etc., for the support of aerial wires in connection with radio-telegraphic apparatus, and in this connection I should like to say something concerning the transmission and reception of telegrams wirelessly, with and without the use of high aerial wires or conductors, writes Gorge S. Piggott in the "Electric World."

For some time past I have been engaged in experimental research with the object in view of ascer-AMATEUUR WORK.—19 hib mtn -avFgat FLEYYY taining, if possible, the kind of apparatus necessary for the accomplishment of continuous and perfect transmission of radio-telegaphic pulsations. In using the aerial I have found after numerous and exact experiments that the high wire is comparatively of no value for continuous and syntomic transmission, on account of the cumulative effect of atmospheric electricity on said wire, which effect is more than sufficient at times to operate the receiver, record false signals, and perhaps burn out the apparatus, thus endangering the life of the attendant or operator who might be near.

In consideration of the above I therefore set about to construct apparatus with which I could communicate continuously day or night during stormy or clear weather, without the use of the high aerial and I have succeeded to such an extent that I am perfectly satisfied with results gained.

I may say that I communicate, with great accuracy (as pefectly as by wire) over a distance of half a mile or more in the city of Chicago, with steel constructed and other large buildings intervening, these buildings entirely screening the instruments, which are situated each in its own respective room, on the ground floors, and having no wire or other artificial conductor whatever outside.

The instruments I have are quite crude, and are made up of anything suitable that came to hand; nevertheless they are very effective, when considering the power consumd in oprating the transmitter for the above distance, is not more than 22 watts, and the action of my detector at the receiver is so intense for the given distance, that the pulsations can be heard when the telephone is placed some 8 inches from the ear;; these results being gained with apparatus keighing in entirety not more than 60 lbs.

In conclusion I will state that I can carry my receiver to a building, set in down on a chair, throw a switch, and when a message is to come, a bell will ring, and communication has started; no aerial, or metal cylinders, or analogous conductors being necessary.

(At a demonstration with Mr. Piggott's apparatus in Chicago signals were transmitted at a distance of about 1/4 mile with numerous brick and some semi-steel frome buildings intervening. The receiver was in a small box which was set behind a piano with the idea of getting as much screening effect as possible. The only metallic connection to the receiver was a ground wire attached to a steam radiator. The sending station had no aerial conductor.—Eds.)

ELECTRIC PIPE THAWING.

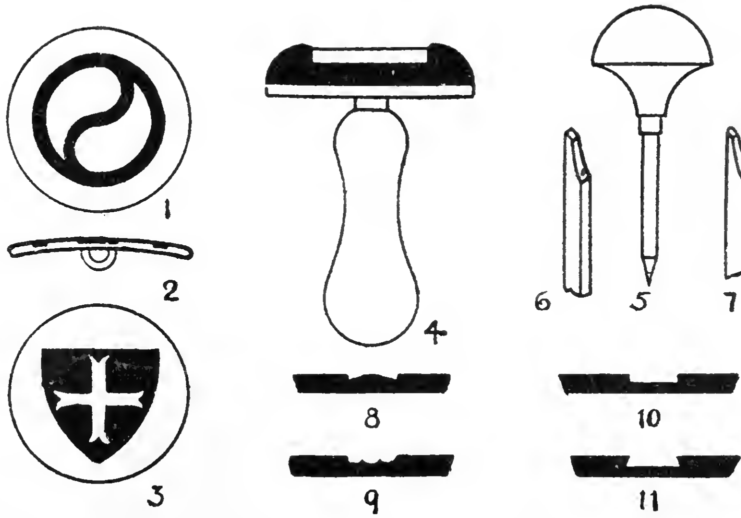
Electric Pipe Thawing has been successful in Ottawa, Can., according to City Engineer Newton J. Ker. Current is taken from the wires of the Ottawa Electric Light Co. and reduced by transformers to about 25 volts. The company charges $1.50 an hour for current and apparatus. One wire is connected to the service in the house and the other to the stopcock box in the street, an adjoining service or the nearest street hydrant, the object being to have a connection on either side of the frozen section and as close to it as possible. The electric curent sometimes cleared the pipe in thirty seconds, but if the service was long and frozen solid it varied from that to thirty minutes. Where couplings with a leather washer are used at the stopcock boxes the current will burn out the washer and cause a slight leak. Where the coupling used is of brass and lead the current causes no leak and no damage is occasioned the service, except in isolated and difficult cases where more than 25 volts are used.

The amount of steam that may be made with coal depends upon the coal itself, and also upon the conditions under which it is burned. Another important factor is the man who is doing the firing. An inexperienced man can easily waste coal by either too little or too much stoking. Overfeeding the fire results in intense heat, causing waste by blowing off of the safety valve. When fuel is again added to the fire in unnecessarily large amount it temporarily deadens the fire and the steam goes down, only to rise again when the fire burns brightly. Coal making a large percentage of ash is not so good as that making less.

DECORATIVE ENAMELLING.

III. Designs for Buttons in Champleve Enamel.

I enamelling on the method called champleve, the cells to receive the enamel are cut out of the metal by means of scorpers. The metal used should be fairly stout, at least 3/32 of an inch in thickness, and in view of the probability of the enamel being fired in a crucible, the work should be small. Buttons are very suitable for this method of work; although brooches, buckles and clasps may be made, they need more space and should be fired in a muffle furnace. Either copper or silver may be used, and both have a good appearance, especially the copper if it is burnished. The first thing the enameller has to consider is the design to be worked on the surface of the button and it may be either a conventional arrangement of leaves, a flower, or a geometrical form, as shown in Figs. 1 and 2. Another excellent method of ornamentating buttons is to utilize the arms and other portions of heraldry. Fig. 3 is a suggestion for the use of a shield in the centre of the button and ornamented with a cross.



This shield is attributed to the Saxon kings, and the cross is represented charged on a shield azure, the cross being gold. A study of heraldry will give the designer an unlimited store of suitable suggestions for design and so much of it extremely useful in enamelling.

We will take for a commencement the design shows in Fig. 1, and will presume we have a fairly stout piece of copper, cut to a circular shape with a diameter of 3/4 in. The design should be accurately drawn out on a piece of drawing paper, traced on ordinary tracing paper and then transferred with carbon paper to the metal. The metal should be thoroughly cleaned with fine emery cloth before the design is transferred on to it and also should be slightly domed to give a shape to the button. The transferred lines should be scratched with a fine scriber and then should be mounted on an engraver's block or a suitable stand, covered with cement. The cement should be the same used for repousse, and made up of Swedish pitch, plaster of paris, and a little tallow and resin. A very suitable form of stand is shown in Fig. 4, the stand being made out of a bradawl handle, with a square piece of hard wood 3/8 in. thick. The illustration shows a section through the holder showing the metal in position. To mount the button, warm the pitch and press the piece of metal, which should also be warmed, into the pitch and when quite hard is ready to use. The spaces are cut out with suitable scorpers, about half-a-dozen different shapes being useful, but a lot of work may be done with the three shown in Figs. 5, 6 and 7. Fig. 5 is a pointed scorper, Fig. 6 a square, and Fig. 7 a round, and as they need to be kept very sharp, an oilstone or slip should be kept at hand to keep them in good condition. It is better to get the scorpers fairly short, as they are usually too long when new, and it often pays to grind them down short enough to hold in the palm of the hand and reach to the end of the fingers. We will start by firmly holding the stand by the handle in the left hand and rest it against the bench or table. Next hold the scorper; for a start use the pointed one in the right hand, with the arm resting on the bench, the blade between the thumb and forefinger, and the handle in the hollow of the palm as near as possible to the joint of the little finger. The point of the tool is held at an oblique angle to the work and is guided by the thumb and pressed from the palm of the hand.

The use of the graver is not easy, and the worker will be well advised to practice on an odd piece of copper until he gets into the right way. Before cutting, wet the top of the tool and then make a sloping cut round the borders of the parts to be sunk. Fig. 8 shows the first stages of the cut, the deepest part being just inside the line. Next take the round pointed scorper and take out the middle of the spaces to a depth of 1/32 of an inch. This is done by taking small parings off until the bottom is reached and forms the second stage of the work, as shown in Fig. 9. To finish the bottom of the space, the square scorper should be used, leaving the space as shown in Fig. 10. If the enamel is to be opaque, the bottom of the spaces should be roughened, the edge of the flat scorper being pushed over the ground with a side to side rocking motion, making a zig-zag cut; it makes the enamel hold well, but should not be used with a transparent enamel as a rule, as it gives the ground a mechanical effect, which is unpleasant. The best way of thoroughly keying transparent enamels is to slightly undercut the edge, as shown in Fig. 11.

We will now suppose the cutting finished and ready for the enamel, which should be pulverised, as shown in a previous article. Place the enamel in the cells as suggested for cloisonne, dyry it over a spirit flame, and then make a cradle of sheet iron, pierced with some small holes, to fit underneath the button, and covered with loam or whiting and pipeclay. Place the work in a crucible with the lid on and fire it well, using a blow pipe and bellows, or if a muffle furnace may be used, fire it for preference in it. The cells will probably not be full after the first firing, although filled up with the enamel at first, so they should be refilled and refired until quite full. File up the surface quite smooth with a corundum file, wash the work in a solution of hydrofluoric acid and water, taking care to use rubber finger stalls when using the solution, and then finally refire the work. The finish should be given by means of rouge, thoroughly well polished. The ring underneathe may be soft soldered on, but may, if desired, be soldered on with hard solder before the enamelling is done; in this case the work should be covered with loam or the whiting and pipeclay mentioned above, or a mixture of plaster of paris and borax, otherwise the solder would run during the firing. In making the shield shown in Fig. 3, the cross should be left in the metal and being of a gold color, if made in copper and burnished, the effect will be nearly correct. Proceed in the same way as before, cutting out the whole of the shield with the exception of the cross, and then after roughing the ground, fill in with a deep blue and fire, refilling and refiring until the work is fished.

In working out other heraldic forms, a silver effect may be worked on copper by using a clear flux over a piece of silver foil and a brilliant gold by using gold foil on a layer of clear flux in the same way. When foil is used it should be pricked ful of fine holes, and the means of doing this is to set a bundle of the finest needles in a cork and use the points as a pricker. If great brilliancy of color is required, it may always be gained by first covering the gound with a layer of clear flux, firing it, and then adding the colors afterwards.

Antimony is a white metal which fuses at a low temperature and is readily vaporized, says the American Machinist. It is of a laminated or crystalline textile and is very brittle. It is used in several valuable alloys, but is not used in the pure state; its most important alloys are type-metal, britannia metal, pewter, and various anti-friction metals. Type metal consists essentially of lead and antimony, with, frequently, the addition of tin, nickel or copper in small quantities. Brittannia is a white-metal alloy much used for table-ware, and consists of antimony, with tin, copper and bismuth. A similar alloy, containing, however, a smaller percentage of antimony, is pewter. The antifriction alloys usually are known as babbitt metals. One of them consists of 30 parts of tin to 5 of antimony and 1 of bismuth, but, as is well known, various proportions are employed. Antimony has a hardening effect when added to lead; a small quantity of bismuth gives the alloy the property of expanding at the instant at which it solidifies, the result being a perfect cast from the mould.

The Use of Copper Sulphate as an algicide and disinfectant in water supplies has been tried practically under so many conditions that definite data regarding it are gradually becoming available. The conclusions drawn from the experience to date by Dr. George T. Moore, who first suggested this procedure, are as follows: Much less copper is required to eradicate algae from reservoirs than is necessary to destroy them under laboratory conditions. The effect of the sulphate on fish is of considerable importance and requires more study. The physical and chemical constitution of a water are factors to be considered in determining the quantity of sulphate to use. The elimination of organisms causing pollution sometimes makes possible the development of other species, but so far the latter have never been the cause of complaint. As a result of the sudden destruction of great numbers of algae, there is sometimes an increase in the odor and taste of the water for a few days immediately after its treatment with copper or sulphate. Under certain conditions the sulphate may be used to great adantage in connection with filtration.

The world uses at least 170,000,000,000 matches yearly.

FITTING OUT YACHTS.

GEORGE H. COLLYER.

Much preparatory work of fiting out can be accomplished early in the spring, long before it is practical to commence work upon the hull, unless the boat is under cover.

Hoops, blocks, oars and such movable fittings as cabin doors, tables, glass rack and tiller or wheel can be carried home and scraped, sand papered and varnished during leisure moments; then when spring fairly sets in and you are anxious to be afloat, you can devote your entire time upon spars and hull.

In scraping the hoops and blocks first remove the accumulation of varnish by using some good varnish remover, allow the woodwork to dry thoroughly, then scrape with a steel scraper or broken bits of glass until the bright wood is exposed; sandpaper until a smooth surface is obtained, then shellac and varnish.

If an especially smooth surface is desired sandpaper with fine sandpaper after each coat of shellac until the pores of the wood are thoroughly filled, then apply two or three thin coats of varnish. Do not attempt to varnish if the temperature is less than 65 degrees, —and allow plenty of time for each coat to dry—and harden. The same directions also apply to all fittings which we have heretofore mentioned, although it is not advisable to use glass in scraping a flat surface, and its use should be confined exclusively to hoops and blocks. If the bright work is mahogany a little mahogany stain applied and thoroughly rubbed off with a soft cloth will improve the effect.

During spare moments overhaul the standing and running rigging; a new sheet or halliard may be needed. See that all rope ends are whipped and splices served; test all turn buckles and examine wire rigging, stay and shrouds. Don't be afraid to spend a cent for new rope, and never use running rigging for more than two seasons; you can never tell when you will get caught in a tight place, and when you do there is a certain sense of security if you know your gear is sound and will stand the strain. In buying rope be sure and get Plymouth, as it is softer, more pliable and free from the splinters which you will find in cheaper brands.

If time will permit, get to work on the tender, you will be surprised to see how long it will take to scrape, paint or varnish this necessary adjunct to a boat, and its "dollars to doughnuts" if you don't do the work before the season opens, it won't be done at all, or in such a slipshod manner that it might better be left undone.

Give your sails the same careful inspection that you give the rigging, and make all necessary repairs or have them made. Do not wait until you get ready to bend them on; then, finding it too late, take a chance with the result that it will cost you a new sail or a patched old one. During your leisure moments you can make a sail cover, a cover for skylight, or an awning, and if you are an expert in using the sewing machine a pennant, burgee or a string of code signals.

As soon as the shores are free from ice it is a good plan to put down your mooring for the season, and while you are about it make it of sufficient size to hold a boat twice the size you intend to moor to it; then you feel secure no matter how hard it may blow and no matter how rough the sea. Make it like the "Parson's one horse shay;" every part as strong as the other. How often do you see a mooring stone large enough to hold a "forty footer," a 7/8 inch mooring chain, and a cable as big round as your arm, while the shackle is not as large as a baby's teething ring.

If you moor in shallow water where your boat grounds at low tide, be sure your mooring is buried in the mud, that no projecting bolt may find its way through your boat's side when she settles at ebb tide. For a small boat a "sucker" mooring is the cheapest and will furnish a secure tie up. Take two planks from a foot to fifteen inches wide and from four to six feet in length, bolt them together at right angles, attach your mooring chain to the eye-bolt and bury in the mud. For a large boat a stone mooring is to be preferred.

If there is sufficient depth of water under your boat at all times and tides, the most satisfactory mooring is the "mushroom." It is easy to put down, easy to take up in the fall, and a mooring which can always be relied upon.

Mooring cans are preferable to kegs, spars or floats for pick-ups, as they will sustain a greater weight and can be more readily handled.

The length of the mooring chain and cable should equal four times the distance from the mooring to the surface at high water, or in other words, if it is 10 feet from the mooring to the surface the chain should be about 10 feet and cable about 30 feet in length. It is well to overhaul the cable occasionally to see if there are any chafed parts or parted strands.

De you moor your boat by a shackle slipped into an eye in the bow as the constant strain upon the stem is sure to loosen the planking, especially so if you are moored in an exposed place where there is a jump of a sea.

Lead your mooring line over the bow through a chock of sufficient size to prevent jamming, and make fast to bits, cleat or shackle to a bridle around the mast. Be sure that that portion of the cable which comes in contact with the bow or bobstay is protected by strips of canvas wound around it and served with stout marline.

If the spars need attention remove all old varnish, sandpaper thoroughly, apply two coats of shellac, rub down well, then varnish two or three coats. Do not varnish unless the day is fair and warm; if the sun is too hot protect the fresh varnish from the sun's rays or it will blister.

If the wood has become chafed or weather worn, or if you wish to do an "A1" job, go over spars with a spoke shave, then sandpaper, shellac and varnish. Paint all exposed metal parts, such as eye-bolts, gooseneck, withs, shackles, etc., with alluminum paint, if iron rust is showing through the galvanizing.

Now that you have made all preliminary preparations, as soon as the weather settles you may commence work on the hull in earnest. Give it a thorough washing and scrubbing, as the paint will look much cleaner and brighter if all traces of marine growth, mud, etc., are removed.

Scrape and sandpaper the bottom and top sides until a smooth surface if obtained. If the paint is so thick that good results cannot be obtained, it can be burned off by means of gasoline torch or removed with paint remover, but do not attempt it unless you have plenty of time at your disposal as it is a slow and tedious operation, and must be done well or the results will be most unsatisfactory. Fill the seams lightly with white lead putty, then sandpaper the whole surface.

Another bit of advice; don't attempt to paint the hull or draw the water line unless you are an expert with the brush; it is much better to hire some one to do this work for you and the improved appearance will justify the expense. For a bottom paint use a good anti-fouling paint and there are several good brands on the market. For a boat that is moored in deep water all the time "Marblehead Anti-Fouling Green" will give the best results, as it will keep cleaner and resist marine growth longer than almost any other kind of bottom paint upon the market.

In painting the top sides use for first coat white lead and boiled linseed oil well mixed and for a second coat add a little French zinc, as it will give a bluish white surface and counteract the effect of the linseed oil.

Do not buy ready mixed paints, unless you know the brand to be reliable, as many brands are adulterated with cheap mineral oils. If experienced in mixing paint buy your own ingredients, or have your paint mixed by some reliable painter who knows just what proportions to use.

Black paint is not recommended as it draws the heat, blisters, peels and soon looses its gloss.

If your deck, cockpit and cabin house are finished bright, scrape, wash with gasoline and a solution of oxalic acid to brighten the wood, then shelac one coat and varnish two coats, using the best spar composition. Avoid thick and gummy varnishes, as those which spread on thinner will prove more satisfactory.

If, however, your deck house and cockpit are painted, wash the surface carefully, sandpaper and give one or two thin coats of paint. Avoid the use of bright colors, and never use dark colors; a wood color or light drab is to be preferred. It is advisable to paint decks first, then give the hull its first coat just before launching.

Run your boat into the water until it is partially immersed but not water born and allow it to remain on the cradle until it is perfectly tight.

When leaking ceases, float off under the shears where the mast, which has already been rigged, can be stepped and wedged, rigging can now be set up, sails bent on, and you are ready for your summer's fun.

Should the craft continue to leak and you are convinced that it will not tighten up in the usual way, do not attempt to remedy the difficulty yourself, as in calking a small leak you are apt to create a larger one. If the seams are filled with soap before launching this can be scraped off as the planks come together, but if putty or lead are used in too great quantities, the surface will present a ribbed appearance, and occasion a great deal of hard work in removing it the next year.

Be sure that the hole in the garboard is plugged before launching; this oversight has caused many a tight craft to fill and sink in launching.

If iron is used for ballast, give it one or two coats of red lead before storing.

In rigging, whip all rope ends; nothing looks more slovenly aboard than "cows tails" on sheets or halliards.

For equipment, carry two good anchors and plenty of cable, also a good compass and charts; a coil of rope is also a necessary adjunct. Don't forget the lights, lead and fog horn. All of these are absolute necessities, and while many articles can be added to your inventory that will increase your comfort, they are largely a matter of taste and capacity of the pocketbook.

Crude Oil Fuel is being used in the boiler plant of the Eagle Flour Mills at Newton, Mass., at a cost comparing very favorably with that of coal. About 170 bbls. of oil are burned per week at a cost of from 3.99 to 4.69 cents per barrel of flour manufactured. The fuel cost when using coal averaged 4.6 cents per barrel of flour output, not taking account of the labor cost of handling the coal and stoking. The burner used is the Hammel crude oil burner, which uses steam for atomizing the liquid fuel, and no change was made in the furnace except to cover the grates tightly at the rear with bricks and sand, and at the front with half bricks laid loose with 1 in. air spaces; at the front close to the furnace doors an 8x12-in. air opening was left clear on either side. Combustion is absolutely smokeless when the burner is properly regulated.

A TWENTY FIVE FOOT AUXILIARY YAWL.

CARL H. CLARK.

VI. Cabin Fittings—Installing Engine.

A slide or hatch must now be fitted over the opening in the cabin roof. It is shown in detail in Fig. 27, and consists of two side pieces, with a groove about 1/2 in. square on the inside. The cover is built up on cross beams which have projections fitting into the groves in the side pieces. In this way the cover can slide forward and yet stay in place. Door jams and sill are next fitted. The sill should be raised about 6 in. above the standing room floor. Doors may be purchased quite cheaply, so that it will be better to do this than to attempt to make them.

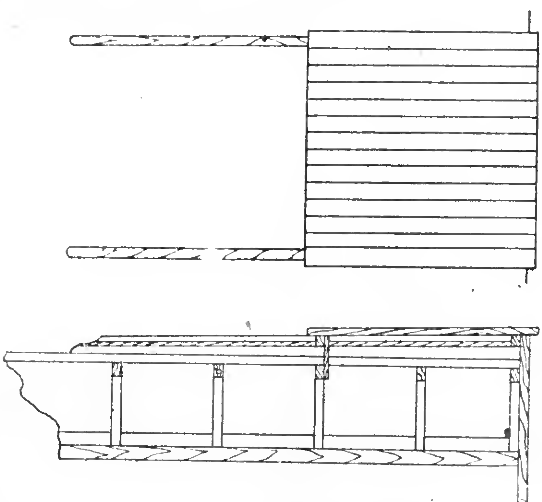


FIG. 27.

The inside of the cabin can be arranged to suit the individual ideas of the builder; as it is a rather simule mateer, but few directions will be given. A very convenient arrangement, however, is to have a transom, or berth, on each side about 10 in. above the floor and about 6 1/2 ft. long, adjusting the width so as to leave about 12 in. between it and the centerboard trunk. At the forward end of each transom a locker can be arranged for dishes, etc., and forward of this can be other lockers to suit the builder. Room should, however, be left for the storage of anchors and cables.

A folding table can be fitted to top of the centerboard trunk; and such other fittings as may be considered desirable.

The seats in the standing room are arranged to run all the way around except across the forward end. They should poject about 14 in. clear of the washboard, and are supported on stanchions and braces to the ribs.

If a tiller is fitted, it should project out above the seat and be curved upwards to be easily grasped. Some sailors prefer a wheel for steering; it is, howeer, a matter of fancy. If a wheel is fitted, a box is built above the seat to cover the gear. This work, with such additional small variations which may be worked in, should about complete the construction of the hull.

The installation of the engine is the next work on hand. The size may vary from 3 to 6 horse power, according to the amount the builder can afford to put into it. A 3-horse engine will make her easily controllable in calm weather and give a fair speed. A 6-horse power, on the other hand, will enable her to be run under the engine in any circumstances. If a single cylinder engine is selected, not over 3 1/2 h. p. should be used, on account of the weight. A double cylinder engine is by all means to be preferred, as it is lighter, smaller, and sits lower in the boat. An engine of this type of about 4 or 5 h. p. will be found to give excellent results. It should be of the medium weight, high speed type and be as light as possible.

The engine bed must be built from measurements taken from the engine. The bed is built as shown in Fig. 22, of two side pieces, resting either on the bottom or on heavy cross braces. The side pieces are of oak, about 2 1/2 in. thick and the same distance apart as the flanges of the engine. If the width outside of these side pieces is greater than the width of the bottom, three cross pieces can be fitted in across the bottom and the side pieces fitted on top of these, being notched down over them and nicely fitted. The upper edge of these side pieces must be in the same relation to the shaft center as the flanges on the bed. Between the side pieces, vertical cross pieces are fitted to hold the side pieces rigid. The whole is then firmly fastened together and to the bottom. A line or wire passed through the center of the shaft hole and drawn tight to a nail on the centerboard trunk will be of great help in locating the center.

When this is done the engine can be placed in position on the bed. The shaft and stuffing box should now be put into place, the stuffing box fitted nicely against the stern post, so that it will not bind the shaft when fastened in place. The under face of the stuffing box should be well smeared with lead before fastening. The propeller is now placed on the shaft and the latter inserted into the hole in the coupling on the engine. The exact amount to be cut off in order to bring the propeller to the proper position may then be measured. When this is done, the shaft is reinserted and the coupling set screws tightened up. If the engine is correctly set all will now be free and turn easily. If they do not, the alignment of the engine can be changed slightly by twisting it, or by placing thin strips of wood under the flanges. When this is correct the engine may be fastened down with lag screws. The rudder and iron skeg may now be put in place.

The first piping to be fitted in place should be the exhaust. If a muffler is used it may be placed under one seat with the outlet through the side of the boat, or it may be placed in the stern under the overhang, with the outlet through the sternboard. In either case the piping should run below the standing room floor.

For the engine in this position an under-water exhaust is a very good device, as it saves considerable piping. Great care must, however, be used in fitting the under water exhaust as otherwise considerable back pressure may be caused, which reduces the power. This back pressure may be reduced by having the exhaust as near the water-line as possible. A pet cock should be placed in the exhaust pipe near the engine, by opening it when the engine is stopped the water cannot be drawn up into the cylinder by the vacuum.

There is a make of under-water exhaust which contains a passage through which the water is forced by the motion of the boat, mingling with the exhaust and drawing it out. It is said to give very good results In many cases the exhaust may be arranged to pass out directly at the water-line. The method to be used will vary with the makes and style of engine used, so that more specific directions can hardly be given.

The cooling water may be piped next, using the same size pipe as the connections on the engine. The strainer for the inlet should be placed near the engine and yet for enough down on the bilge so not to be thrown out of water by the rolling of the boat. A short piece of rubber hose should be inserted on the line to give elasticity and prevent the vibration of the engine from starting the connection of the pipe with the hull and causing a leak. The discharge of the cooling water may either be carried out through the side well above water or into the exhaust. The latter is the preferable way.

The gasoline tank should hold about 10 gallons, and may be placed forward of the mast, or under the seats in the standing room. If the muffler is placed under one seat the tank may be placed opposite it to balance it. If the muffler is placed in the stern, or if no muffler is used, two gasoline tanks can be fitted, one under each seat, allowing them to me smaller, and so less conspicuous. The filling pipe should in any case run up through the deck outside the coaming, so that any overflow will drain overboard and not into the bilge. A stop cock should be fitted at the tank and also at the carburettor. The gasoline piping should be of 1/8 in. lead pipe, with all joints soldered.

Batteries and coils should be kept in the cabin where they will be dry, as moisture is detrimental to both.

After the engine is completely set up, the floor may be fitted around it. A portion around the engine should be easily removable, and a ledge about 1 1/2 in. high should be fitted around the edge of the opening.

If desired a box may be made to cover the engine when it is not in use; but as a box is a rather clumsey affair to stow when the engine is running, a cover of thick water proof canvas will do equally well and takes up less room.

There are many details both as to hull and engine fitting which can as well be left to the fancy of the builder. A little observation of existing boats will often give one many valuable points as to fitting and small details of equipment. It is advised that at about this stage of the work, the amateur builder take a few trips, if possible, among any boat shops or storage places which may be in his neighborhood.

With the finishing of the work as described the hull and engine should be about complete, leaving only the sails and rigging, which will be the subject of the next chapter.

The fact that a luminous emanation of variable shape will appear in the dark at such points on the surface of the earth below which there are extensive ore deposits at a more or less considerable depth was recorded in Germany as far back as 1747, says the "English Mechanic." Immediately before or during a thunder-storm these phenomena are said to be especially striking. Similar observations have more recently been made in North America in the neighbourhood of ore deposits. Though much should be ascribed to superstition and to errors of observation, the fact has nevertheless been confirmed by recent investigation. The electric emanation given off from the surafce of the earth has, in fact, been repeatedly ascertained photographically by Mr. K. Zenger. Plates coated with fluorescent substances were used. It may thus be taken for granted that the emanations in question occur with an especially high intensity at those points of the ground where good conductors of electricity are found in large amounts in the neighborhood of the surface of the earth; in other words, above ore deposits, which are very good conductors of the electric current. Lignite and coal, especially when containing pyrites, are fairly good conductors. The difference in the intensity of radiation as compared with points free from any ore would seem to be recognized by means of photography, thus affording to geologists a rather simple means of locating ore and even coal deposites.

USE OF ALCOHOL AND GASOLINE IN FARM ENGINES.

The United States Department of Agriculture has published in Farmers' Bulletin, No. 277, a very complete report, entitled "The Use of Acohol and Gasolene in Farm Engines," by Charles Edward Lucke, assistant professor of mechanical engineering, Columbia University, New York, and S. M. Woodward, irrigation engineer, office of experiment stations, Washington, D. C.

The following abstracts are of general interest:

The newest fuel for power purposes is alcohol. This is made from the yearly crop of plants. There is in existence no natural deposit of alcohol, but in a sense it may be said to be possible to produce inexhaustible supplies.

It is only within recent time that engineers have known how to build engines that would produce power from alcohol; and still more recent is the further discovery by engineers that this power can be produced at a cost which may permit its general introduction.

The cost of fuel per unit of power developed depends first, on the market where it is to be used, and next, but by no means least, on the ability of the machinery to transform the fuel energy into useful work. If all the different kinds of machinery used for power generation could turn into useful work the same proportion of the energy in the fuel, coal would be almost universally used, because of the present low cost of energy in this form.

Anthracite coal in the neighborhood of New York can be bought in small sizes in large quantities for power purposes at about $2.50 per ton. This coal will contain about 12,500 B. T. U. per pound. This is equivalent to about 10,000,000 heat units per dollar. Large sizes, such as egg coal, containing about 14,000 B. T. U. per pound, can be bought in large quantities for about $6.25 per ton, which is equivalent to 4,500,000 B. T. U. per dollar. Other grades of anthracite coal and the various grades and qualities of bituminous coal will lie beween these two limits of cost. Illuminating gas in New York costs $1 per 1,000 cubic feet, which is equivalent to about 500,000 heat units per dollar. Natural gas in the Middle States is sold for 10 cents per 1,000 cubic feet and upward. This fuel at the minimum price will furnish about 10,000,000 heat units for a dollar. Crude oil sells in the East at a minimum price of four cents per gallon, which is equivalent to about 4,000,000 heat units per dollar. Gasolene sells at a minimum price of ten cents per gallon, which is equivalent to about 1,200,000 heat units per dollar. Kerosene sells from ten to thirty cents per gallon, which is equivalent to 1,200,000 and 400,000 heat units per dollar, respectively. Grain alcohol, such as will be freed from tax under the recent legislation, will sell for an unknown price; but for the purpose of comparison, assuming thirty cents per gallon as a minimum, it will give 270,000 heat units per dollar. Gasolene, kerosene, crude oils, and, in fact, all of the distillates have about the same amount of heat per pound; therefore, at the same price per gallon, ignoring the slight difference in density they would deliver to the consumer about the same amount of heat per dollar, whereas the other liquid fuel, alcohol, if sold at an equal price, would give the consumer only about three-fifths the amount of heat for the same money. From the figures above given it apears that the cost of heat energy contained in the above fuels, at the fair market prices given, varies widely, lying between 200,000 heat units per dollar and 10,000,000 heat units per dollar. It is possible to buy eight times as much energy for a given amount of money in the form of cheap coal as in the form of low-priced gasolene, or twenty-five times as much as in the form of high-priced gasolene or kerosene. This being true, it might seem to a casual observer as rather strange that gasolene should be used at all, and the fact that it is used in competition with fuel of one-eighth to one-twenty-fifth its cost shows clearly that either the gasolene engine has some characteristics not possessed by an engine or plant using coal, which makes it able to do things the other can not do, or that more of the heat it contains can be transformed into energy for useful work. Both of these things are true.

Large steam plants in their daily work seldom use less than two pounds of poor coal per hour for each useful horse-power (known as a brake horse-power), which is equivalent to about 25,000 B. T. U. per hour, and which corresponds to about ten per cent thermal efficiency. Small steam plants working intermittently, such as hoisting engines, may use as high as seven pounds of coal per brake horse-power, or 2.5 per cent. thermal efficiency. Some plants will do better than the above with proper conditions, and some may do worse, but in general it may be said that the performances of steam plants lie between the limits of 2.5 and 10 per cent. thermal efficiency.

Plants consisting of gas-producers for transforming coal into gas for use in gass engines have in general a much higher thermal efficiency than steam plants doing the same work. They are, however, not built quite so small as steam plants, the smallest being about twenty-five horse power, and in general they have not been built so large, the largest being only a few thousand horse-power. Their efficiency, however, does not vary so much as is the case with steam plants. It may be fair to say that under the same conditions as above outlined these plants will use one and one-quarter to two pounds of coal of fair or poor quality per brake horse-power hour, which gives a thermal efficiency ranging from eighteen to ten per cent. These plants can be made to do much better than this, and perhaps may do worse, although the variation is not nearly so great as for steam plants.

Gas engines operating on natural gas or on illuminating gas from city mains will, on fluctuation of load with the regular work, average about 12,000 heat units per brake horse-power, or 20 per cent. thermal efficiency. Exploding engines operating on crude oil will average about 25,000 heat units per brake horse-power hour, which is equivalent to about 10 per cent. thermal efficiency. Exploding engines using gasolene should operate at a thermal efficiency of about 19 per cent. under similar operating conditions.

The efficiency of an alcohol engine may be assumed at this time to be unknown, but as alcohol can be burned in engines designed for gasolene, it may be assumed that such an engine will have with alcohol fuel the same thermal efficiency as with gasolene; 19 per cent. for fair working conditions.

From the above brief discussion of the efficiency of different methods of power generation from different fuels it appears that quite a range is possible, though not so great a range as exists in the case of cost of fuel energy. Efficiency is seen to lie somewhere between 2 1/2 and 20 per cent for all the fuels under working conditions. It is known that actual thermal efficiency under bad conditions may be less than 1 per cent. and under the best conditions as high as 40 per cent, but these are rare and unusual cases. The range given is sufficient to indicate that a highly efficient method may make the fuel cost per unit of power less with quite expensive fuel than it would be with cheaper fuel usel in a less efficient machine. It is also perfectly clear that without proper information on the efficiency of the machine or the efficiency of the plant it is impossible to tell what the cost of fuel per horse-power will be, even though the price of the fuel per ton or per gallon be known.

The following conclusions regarding the use of alcohol as fuel for engines as compared with gasolene are based on the preliminary results of the department's experiments, upon results of the European experiments and investigations which have been presented in the foregoing pages, and upon the general knowledge of the author:

(1) Any engine on the American market to-day, operating with gasolene or kerosene, can operate with alcohol fuel without any structural change whatever with proper manipulation.

(2) Alcohol contains approximately 0.6 of the heating value of gasolene, by weight, and in the department's experiments a small engine required 1.8 times as much alcohol as gasolene per horse-power hour. This corresponds very closely with the relatve heating value of the fuels, indicating practically the same thermal efficiency with the two when vaporization is complete.

(3) In some cases carburetors designed for gasolene do not vaporize all the alcohol suplied, and in such cases the excess of alcohol consumed is greater than indicated above.

(4) The absolute excess of alcohol consumed over gasolene or kerosene will be reduced by such changes as will increase the thermal efficiency of the engine.

(5) The thermal efficiency of these engines can be improved when they are to be operated by alcohol, first by altering the construction of the carbureter to accomplish complete vaporization, and second, by increasing the compression very materially.

(6) An engine designed for gasolene or kerosene can, without any material alterations to adapt it to alcohol, give slightly more power (about ten per cent.) than when operated with gasolene or kerosene, but this increase is at the expense of greater consumption of fuel. By alterations designed to adapt the engine to new fuel this excess of power may be increased to about twenty per cent.

(7) Because of the increased output without corresponding increase in size, alcohol engines should sell for less per horse-power than gasolene or kerosene engines of the same class.

(8) The different designs of gasolene or kerosene engines are not equally well adapted to the burning of alcohol, though all may burn it with a fair degree of success.

(9) Storage of alcohol and its use in engines is much less dangerous than that of gasolene, as well as being decidedly more pleasant.

(10 The exhaust from an alcohol engines is less likely to be offensive than the exhaust from a gasolene or kerosene engine, although there will be some odor due to lubricating oil and imperfect combustion, if the engine is not skilfully operated.

(11) It requires no more skill to operate an alcohol engine than one intended for gasolene or kerosene.

(12) There is no reason to suppose that the cost or repairs and lubrication will be any greater for an alcohol engine than for one built for gasolene or kerosene.

(13) There seems to be no tendency for the interior of an alcohol engine to become sooty, as is the case with gasolene and kerosene.

(14) With proper manipulation, there seems to be no undue corrosion of the interior due to the use of alcohol.

(15) The fact that the exhaust from the alcohol engine is not as hot as that from gasolene and kerosene engines seems to indicate that there will be less danger from fire, less offense in a rom traversed by the exhaust pipe, and less possibility of burning the lubricating oil. This later point is also borne out by the fact that the exhaust shows less smokiness.

(16) In localities where there is a supply of cheap raw material for the manufacture of denatured alcohol, and which are at the same time remote from the

source of supply of gasolene, alcohol may immediately compete with gasolene as a fuel for engines.

(17) If, as time goes on, kerosene and its distillates become scarcer and dearer by reason of exhaustion of natural deposits, the alcohol engine will become a stronger and stronger competitor, with a possibility that in time it may entirely suplant the kerosene and gasolene engines.

(18) By reason of its greater safety and its adaptability to the work, alcohol should immediately supplant gasolene for use in boats.

(19) By reason of cleanliness in handling the fuel, increased safety in fuel storage, and less offensiveness in the exhaust, alcohol engines will, in part, displace gasolene engines for automobile work, but only when cost of fuel for operation is a subordinate consideration. In this field it is impossible to conveniently increase the compression because of starting difficulties, so that the efficiency can not be improved as conveniently as in other types of engines.

(20) In most localities it is unlikely that alcohol power will be cheaper or as cheap as gasolene power for some time to come.

AREA OF THE UNITED STATES.

The question, "What coinstitutes the area of the United States?" would seem to the ordinary layman a simple one; but according to Bulletin 302 of theUnited States Geologial Survey, of which Henry Gannett is the author, it is quite the reverse. Jurisdiction extends to a line 3 nautical miles from the shore, but this strip of sea cannot properly be regarded as a part of the country. Supposing our country to be restricted to the sea and lake coast, there remains a question regarding the bays and estuaries. To what extent should the coast line be followed strictly, and where should we begin to jump across the indentations made by the sea? In this matter one can only follow his own judgment, making in each case as natural a decision as possible, as no definite criterion can be established.

The measurements and computations upon which these tables were based were made with great care and thoroughness in each case, and the results probably represented the areas as closely as they could be determined from the maps and charts in existence at both times. Most of the differences in these two sets of tables are trifling, amounting to only a few square miles or a small fraction of 1 per cent, being well within the limits of error of the planimeter and of the maps used. Some of them, however, are considerable, and a few are explained by the fact that more recent maps, which changed the position of boundaries between states, had been used by the Land Office, and its measurement was, therefore, more nearly correct. Other discrepancies arose from differences in determining the coast lines.

Realizing the desirability of but one government statement of areas of the states and terrotories, an attempt has been made by Frank Bond, chief draftsman of the General Land Office; C. S. Sloane, geographer of the Census Office, and Henry Gannett, geographer of the Geological Survey, to come to an agreement on these figures. The results of their conference and co-operation are set forth in the aforementioned bulletin.

By this adjustment the area of the United State proper, which is given as 3,026,789 square miles, is increased over the Census Office figures by 1,188 square miles.

The area given for Alaska is 590,884 square miles. It is subject to considerable modification in the future as the position of the coast line becomes better known. The area given for the Philippine islands is 115,026 square miles, and was determined by the Coast Survey of that archipelago, prepared at the instance of the Philippine Census. It also is subject to modification as accurate charts of the archipelago are made. The areas of Hawaii, 6,449 sqpuare miles, and Porto Rico, 3,435 square miles, are probably subject to only slight changes, as the charts from which they were measured are quite accurate. The areas given for the other small possessions of the United States, Gaum, 210 square miles; Samoa, 77 square miles, and the Panama canal strip, 474 square miles, will probably be changed in the future as their limits become more correctly defined.

Given two young men of equal ability, and let both of them go through good technical schools, both graduating as chemists, or as mining, mechanical, civil or electrical engineers. The one during the course of his study has covered much ground, has stored his mind with facts, has learned carefully and well the methods and manipulation required in the branch chosen. The other has not covered so much ground, but every bit of information that he has he thoroughly understands; he has acquired principles rather than a large array of facts, and he knows the reasons why. Let now these two begin work after graduation in the same place, and we are ready to confess that the former will make the best showing, and progress the more rapidly for the first year or two, but if our observation is worth anything, the latter will distance his competitor at the end of ten years.—Dr. Chas. B. Dudley.

The transporting power of a current of water, or the weight of the largest fragment it can carry, varies as the sixth power of the velocity. That is, if a current of certain velocity will move a cubic inch of stone, when the velocity of the current is doubled, it will move a stone sixty-four times as large, and if the velocity were increased ten times, the transferring power would be increased 1,000.000 times.

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.

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 advertisements 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.

APRIL, 1907.

Owing to a serious accident this issue is much delayed. We are making a big hustle and expect to issue the May number about on time.

The patterns for the 75-watt and 150-watt dynamos recently described in this magazine has been completed and premium offers of castings for same will be made in the May number.

We very much desire to know how many readers are interested in photography, and would request those who are to send us postal communications stating this and what additions to this department they would like.

Through an error an extra large supply of volume V have been bound. To quickly move a portion of this stock we will send a copy, postpaid for $1.00. This offer is limited to 200 copies, the first orders received up to this number to be filled.

For the information of readers interested in gas engines, we announce the publication in the May issue of a description of a 3 1-2 x 3 1-2 in. vertical two-cycle gas engine, this design being fully up-to-date in every particular. As soon as they can be prepared, castings will be offered as premiums and for sale, in both the rough and partly machined, thus enabling any one to finish an engine at small cost, and requiring but few tools for the work. The design is one which will also permit two cylinders being placed on one base, and also run as a two or three port engine as may be desired. If there should be a sufficient demand, castings will be gotten out for a 5x5 engine of the same design.

The first chapter of a very complete series of articles describing a model electric railway will be published in the June issue. The signals will be of the block signal type, and will be faithful representations of those in use on the railways about the country. Bridges, turntables, and other fixtures will be included in the several chapters, and arrangements are now being made to supply the parts ordinarily found difficult to obtain.

Sodium Transmission Lines.—The use of sodium for overhead transmission is attracting the attention of electricians. It is said to be cheap and a good conductor of electricity, but as its marked affinity with oxygen causes it to ignite when placed in contact with water, its employment in the form of a conductor would be limited, probably, to overhead transmission lines or feeders for railway work. The general process for constructing sodium conductors is to take standard wrought-iron pipes and heat them to a point well above the melting temperature of sodium. The sodium is then melted in special kettles and is run into the pipes, solidifying when cool. There is said to be no marked depreciation of either the sodium or the pipe if the latter be properly protected by a coat of weather-proof paint. For the same conductivity the price of the complete sodium conductor is much below that of copper cables, being in small sizes not more than 50 per cent. and in large sizes not more than 20 per cent. of the cost of copper. For instance, a half-inch wrought-iron pipe filled with sodium has a capacity of 19 amperes, and costs about 3 1/2 c. per ft., against 8 1/2 c. for a copper line of the same capacity. A 6-in. sodium conductor would carry 8,130 amperes, the cost of the line being about $1.40 per linear foot, as compared with $6.30 per foot for copper. These figures were estimated on the basis of 7 1/2 c. per lb, for sodium and 16c. per lb. for copper.

A piece of metal is not a homogeneous single thing. It is a collection of grains and granules that built it up just as the granules built up a glacier. The grains of metal are irregular in shape and unequal in size. Their existence is revealed by polishing and etching the surface of the metal and examining it under a microscope, when the grains can be readily distinguished by differences of texture and the boundaries between them can be clearly traced. Investigation shows that each grain is, in fact, a separate crystal, and the irregular boundaries are due to casual inequalities in the rates at which the various crystals have grown during their formation.

Detonators for exploding dynamite consist ordinarily of a mixture of mercury fulminate, and potassium nitrate or chlorate, placed in a copper capsule; when the cap is to be fird with a fuse, the fulminate is covered with shellac, collodion, thin copper foil, or paper, and the end of the capsule is left open ta receive the end of the fuse.

CONSTRUCTION AND MANAGEMENT OF GASOLINE ENGINES.

CARL H. CLARK.

XI. Installiing Engines—Under Water Exhaust.

The first question in the installation of the engine will be the bed, or foundation. Fig. 74 shows one of the most approved methods of construction, the bed. The two side pieces B, upon which the flanges of the engine bed rest, in turn rest upon the cross pieces A. These cross pieces A are built into the boat and distribute the strain. The side pieces B are notched down over the cross floors A and through fastened. A center piece C is worked in between the side pieces A whenever convenient to prevent their rocking sidewise. The whole is then firmly secured together and to the hull.

Small engines may be supported upon a single cross piece at each end of the bed, but except for the smallest sizes the arrangement of Fig. 74 should be used. The engine is fastened down to the bed with lag screws.

The particular function of the muffler is to afford a comparatively large space into which the exhaust may pass and expand, greatly reducing the pressure. The gas, under the reduced pressure, then passes out with little disturbance. The muffler need be of no particular shape, as long as the volume is sufficient. Mufflers are usually made of cast iron in the smaller sizes and of sheet iron in the larger sizes. In many cases a long piece of rather large pipe will answer the same purpose.

The muffler may be dispensed with and much space saved by carrying the exhaust directly through the bottom of the boat and exhausting under water. Although this is a very convenient and many times satisfactory way of doing it, great care must be used or poor results will be obtained. When the exhaust leads directly out, a certain amount of pressure is used in displacing the water. This pressure is, of course, supplied by the piston and is a back pressure, as it is turned, retarding the piston and decreasing its power.

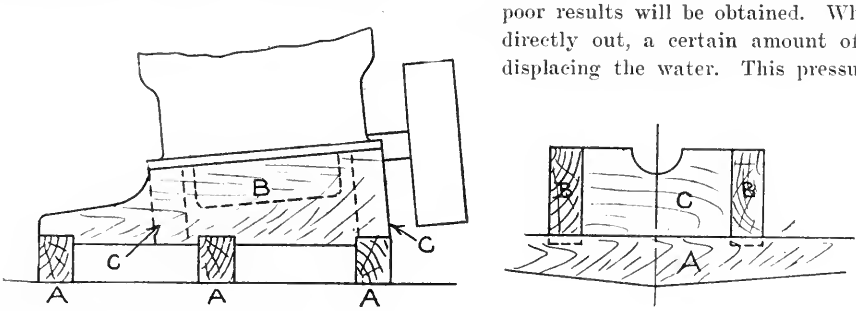


Fig. 74.

The heaviest, and in most cases the hardest, pipe to fit up is the exhaust pipe. It runs from the exhaust nozzle on the engine to the muffler and thence outboard. Fig. 75 shows a diagram of the piping as usually arranged. The muffler M is commonly placed in the stern with the outlet directly outboard It may, however, be placed in any convenient position as under the seats in the standing room, and the piping lead outboard. In any case, the piping for the exhaust should be as direct and as free from sharp bends as possible.

When the motor is near the middle of the boat, a good practice is to lead the exhaust pipe out through the bottom, along the bottom to a point near the stern, where it again enters the boat and connects with the muffler. The outlet from the muffler then leads directly outboard as before. This method, especially on a large cabin boat, avoids much loss of space and the disagreeable heat of the exhaust pipe. The surrounding water quickly cools the exhaust, reduces the pressure, and makes the exhaust almost noisless.

A small expansion chamber or muffler should be provided between the engine and the outlet in order to break up the violent pulsations and make the flow fairly constant. Some form of shield should be fitted over the outer end of the exhaust pipe to guide the stream of the exhaust aft and prevent the water being forced into it by the movement of the boat. Several forms of these are on the market in the form of a brass casting which bolts on to the outside of the hull and has a thread on the inside to take the exhaust pipe.

One of the best of those is on the principle shown in Fig. 76. The exhaust passes from the engine to e and out at E, the passage being curved in an easy bend. At a is a funnel shaped passage opening into the exhaust passage. The motion of the boat is assumed to be toward the right; the water will be forced into the opening a and out through its small end, at a considerable velocity, mingling with the stream of exhaust gases and tending to accelerate their flow. This principle tends to lessen the back pressure on the engine, and may, under some circumstances, entirely do away with it.

The under water exhaust is a very neat and simple method when corrently installed, as all noise and heat from the exhaust pipe are aoided. The exhaust may be considerably cooled and the noise reduced by discharging the cooling water from the cylinders directly into the exhaust pipe as shown in Fig. 75 and explained more in detail later. All sharp bends must be avoided in the exhaust pipe as the resistance offered by them is equivelent to back pressure and reduces the power of the engine.

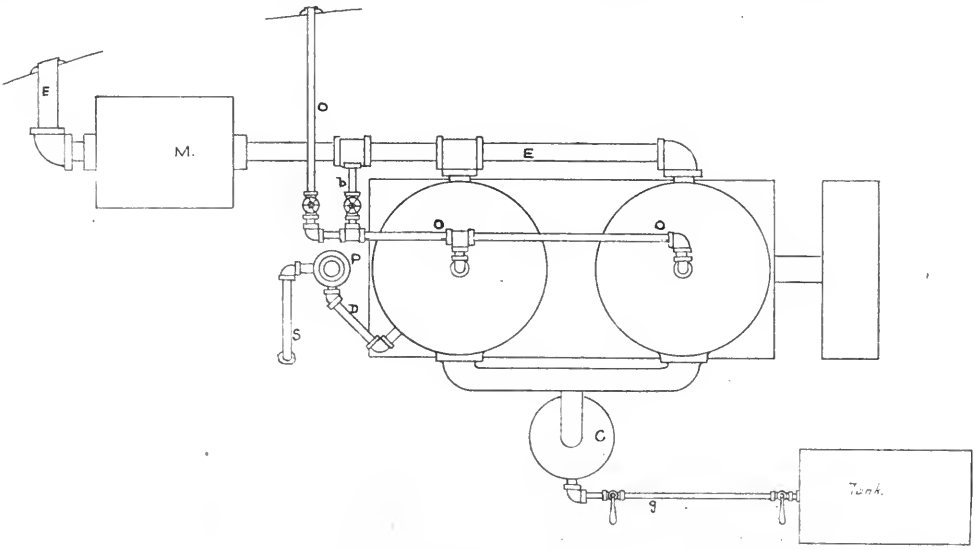


Fig. 75.

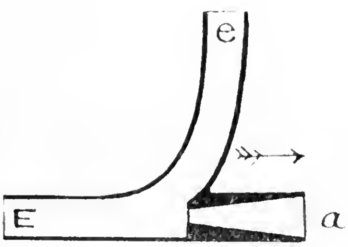


Fig. 76.

When the exhaust pipe is run under the floor a pet cock should be fitted at its lowest point, to drain off any condensation or collection of moisture. The discharge from the muffler should pass out through the side of the boat well above the water line, so that there will be little chance of its becoming submerged and flooding the muffler. When the engine is working there will, of course, be no chance for the water to pass in against the exhaust pressure, but if the boat were moored there might be a possibility of such an occurrence.

When the under water exhaust is fitted, a pet cock should be put in the exhaust pipe near the engine. This is opened when the engine is stopped, thus preventing the water from being drawn up into the cylinders by the vacuum caused by the cooling of the gasses in the pipe and cylinders.

The water piping of brass pipe is next to be fitted. The connection to the suction S of the pump P should be piped down through the bottom of the boat at some convenient point. This pipe may be made up solid, although many people fit a short length of rubber hose at a convenient point to take up the vibration of the engine and prevent the starting of the joints where the pipe passes through the hull. The outer end of this pipe is covered with some kind of strainer to filter out weeds, etc. A special casting is usually furnished including a clamp for both inside and outside of planking and a thread for the end of the connecting pipe. Care must be taken where this pipe passes through the planking, to get a good joint or leakage will ensue. In small engines the entire water piping may conveniently be of rubber hose. It is advisable to fit a valve on the pipe just inside the hull, by closing which, all possibllity of flooding the boat will be avoided.

If desired, a double suction may be fitteed to the pump, one branch leading as above and the other leading to the bilge inside. A valve in each branch will allow either to be used as desired. In this way the pump may be used to pump out the boat. As all of this water passes through the cylinder jackets this use of the pump is questioned by many. If, however, the bilges of the boat are kept fairly clean and the pump is used for this purpose only at the beginning of a run the effects cannot be very bad.

The connection from the pump discharge d to the cylinders should be found already piped; in fact, on small engines the pump is attached directly to the cylinder. The outlet O from the cylinders may either lead directly overboard through the side of the boat above water, or have a branch b leading into the exhaust pipe. In the latter case a valve should be fitted in each pipe so that the water may flow either overboard or into the exhaust, or both of these ways. The cooling water should not be put into the exhaust until the latter has become heated, and should be taken out from the exhaust a short time before the completion of the run, so that the moisture may all evaporate, leaving the pipe dry.

The piping g for the gasoline supply requires the greatest care as any leak may have fatal consequences. Too much stress cannot be laid on this point as nearly all accidents can be traced to this cause, combined with more or less carelessness. The gasoline tank should be of solid construction of either copper or galvanized iron. It should be well riveted and soldered, and thoroughly tested. The filling pipe should extend from the tank to above the deck, so that any overflow while filling the tank will run overboard instead of into the bottom of the boat.

Many people indorse the fitting of pans or other arrangements to catch and carry off any leakage, but it is, in the writer's opinion, best to make sure that all joints are absolutely tight, and assure that they stay so by occasional observation. The piping for the gasoline should be of either copper, brass or lead with as few joints as possible and those, except a union at end, soldered. A stopcock should be soldered to the tank and another fitted to the carburettor.

Some form of strainer had best be fitted in the gasoline pipe near the carburettor. Fig. 76 shows a good form of device for this purpose. It consists of a chamber containing a screen of wire gauze, through which the gasoline must pass. The bottom can be unscrewed and any collection removed. A device like this will remove any sediment or water which may be contained in the gasoline. If it is not possible or desirable to buy one, it is possible to make one out of pipe fittings which will answer the purpose. A fitting of this kind is likely to save a great deal of bother some time. The caution should again be repeated, to have all gasoline connections absolutely tight.

The gasoline tank may usually be placed wherever is most convenient. The most common place is perhaps in the bow, as the space there is of comparatively little value. When the engine is near amidships and a water tight standing room is fitted, a very good position is under the standing-room seats. Any possible leakage would then drain overboard. The tank should, of course, be kept as far away as possible from hot exhause pipe or muffler.

This completes the usual piping, and any additional piping would be simply an extension of the piping just described.

The batteries, coils and wiring should be kept in a dry place, as any moisture greatly interferes with their action or may even ruin them completely. If a magneto is us used it may be fastened to the floor or to a frame on the engine. The latter method is preferable when possible, as there is less likelihood of damage.

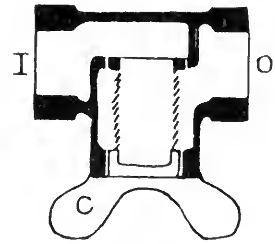


FIG. 77.

All wiring should be of the best grade of wire, and joints and connections should be carefully wound, or best, soldered, and taped. In the case of a jump spark engine the coil or coils should be placed as near the engine as is convenient, to reduce as much as possible, the length of the secondary wiring.

It is often advised to seal up the batteries in a tight box, or even bury them completely in tar or other material, with the object of keeping the moisture away from them. These methods are, however, hardly to be advised, as a single poor cell will spoil the action of a whole set, and it is better to have the cells accessible, so that in case of trouble they can be tested and the poor ones replaced. Two sets of batteries should always be used for general running with an occasional rest, and the other set retained in their full strength for starting or for emergencies.

In all the piping and wiring a great effort should be made to keep everything as simple and direct as possible, so that in the case of trouble or repairs, all parts may be quickly and easily gotten at.

It is also important that a convenient tool and supply locker should be provided. It is too often the case that small tools or parts which should be on hand are missing, causing much delay and inconvenience. This locker should be handy of access, and should be of such construction as to prevent the access of water to the tools, which quickly renders them useless. This is a point to which too little attention is usually given.

It is, of course, impossible to enumerate all of the small details of the work of instalation, but with the principles of the above in mind, no difficulty should be found in following out the work of almost any ordinary installation.

One of the causes of loss in the transmission of compressed air is pumping the air of the engine room rather than that drawn from a cooler place. The loss amounts to from 2 to 10 per cent.

BEST EDUCATION FOR MECHANICS.

The question as to the advisability of young men and boys in manufacturing establishments, such as that of the Crane Co., spending their time and money in taking up studies in technical schools, is one on which the president of this company had intended expressing his views at some future period; but as a number of Crane Co. employees have made a request for his advice on this subject, he has decided to publish his views now.

It seems to be a popular belief that technical education is indispensible in the production of good mechanics, foremen, etc., and I wish to say most emphatically that I do not agree with this theory in the slightest degree. I never received such education myself, nor have I ever had such men about me in my shops with the exception of a few in the drafting-room, and even in that case there is no advantage except in the carrying out of orders and in making drawings.

So far as manufacturing is concerned, I am most decidedly of the opinion that time spent in technical schools trying to produce mechanics is absolutely wasted. I maintain that what is necessary for men to have in order to be successful in manufacturing is a thorough knowledge of the art, and of the kind of machines best adapted for certain purposes, and how much the machines are capable of producing.

In addition to this, probably the most valuable qualification in such a man is tact in the handling and selecting of his men, and in this feature of the work kindness, consideration, appreciation, and fair treatment are the great essentials. He should also have a large amount of enthusiasm and activity in covering the ground thoroughly, and should know that all machines and men are turning out a day's work, that no unnecessary waste is allowed, and that the quality of the goods is strictly maintained.

I have never been able to see where technical education cuts the slightest figure in any of these things; but, on the contrary, I am quite strongly of the opinion that technical education is a positive drawback in such a business as ours.

The great trouble with technical schools appears to be that they make a boy feel that he is getting a knowledge of things there which are essential to his success, and that he is, therefore, superior to the boy who is brought up in the shop; and if he goes into a shop, he does so with his head swelled to such an extent that he is unable to grasp the sound practical things that are essential to success. If he is to succeed, he practically has to be knocked around until all those false notions are got rid of before he can begin to learn things that are of real material value.

The boy who is going to make progress in his mechanical education must be thoroughly wide-awake while working in the shop, to observe all the mechanical features by which he is surrounded and get a thorough understanding of them, studying over them and spending all his leisure time in seeking more information. In that way he can acquire a fund of knowledge which, if he advances into a higher position, will be valuable to him; but if he does not show any interest or energy in this direction, he, of course, will turn out to be but little different from the machine on which he has been working.

In my opinion, all that our workers need in the way of schooling is the following:

Drawing.—It is a good idea for them to know enough about drawing to be able to read drawings and make a reasonably good drawing.

Arithmetic.—They should have a reasonable knowledge of common arithmetic, and be able to do ordinary work in arithmetic correctly.

English.—They should have a reasonably good understanding of English.

Writing.—They should be able to write a plain hand.

Men or boys who are deficient in any of these respects may acquire such knowledge at the public night schools.

The solving of difficult problems by such methods as the differential calculus, etc., may be a very interesting and entertaining pastime, but as far as serving and other purpose is concerned, it is simply a waste of time to the general workman, for in a factory there are no problems of this nature that need to be worked out.

It is the exercise of pactical, sound common sense that makes manufacturing today a success.

Many people are deceived in regard to this matter of technical education by the fact that some of the graduates from these schools get into good positions. There is no doubt that this is true, but only to a very limited extent, and I maintain that where one of these boys obtains a good position, a dozen young men who have not had this education also get into good positions, and fill them equally as or better than the technically educated man. It seems to me that this is conclusive evidence that there is no special advantage in this education, and I very much doubt if any of such technically educated young men can be found in factories that have to meet with red-hot competition in business. I have heard of concerns that tried many of these boys and had to throw them all out.

Some years ago a man spoke to me about a relative or friend of his who had been through one of these schools, and, upon leaving, obtained a good position in a machine shop, where he was doing well, and he regarded this as quite a triumph for that class of schools.

In reply to this, I said to him that in my estimation if the same young man had gone into the shop in which he was then working, at the time he started in the school, he would have become very much more of a success, and, to my mind, there is not the slightest doubt as to the correctness of this position. In other words, I regard practically all of these schools as being gigantic humbugs.

I wish it to be clearly understood that in condemning technical education I have reference simply to such education in connection with the making of general mechanics. My criticism is not intended to apply to such lines as electricity, mining engineering, chemistry, etc.

A great deal has been said about the value of these technical schools in Germany, but notwithstanding all such statements as to the wonderful results that have been accomplished there by reason of this education, I maintain that these schools are a humbug in that country just as they are here; furthermore, that we have made decidedly greater advancement in a mechanical way than Germany, and that I have never heard of any firm in the United States seeking for help among the Germans who have attended the technical schools over three, for which so much is claimed.

In evidence that the contrary is the case, I would mention that a member of my family, when visiting a large electrical manufacturing concern in Nuremberg, Germany, found not only that it was full of American machinery, but that it was being run by Americans, which strikes me as rather a knockout for the great claims that are made in regard to the advancement of the Germans in work of this nature.—Valve World.

HISTORY OF THE GAS ENGINE.

Like almost all great inventions the gas engine is the product of many minds. It didn't suddenly happen, but has been gradually improved. In fact the modern motor is similar in many respects to some of the oldest types. It is an interesting fact that some of the engines made as far back as 1835 failed only because of the imperfect developments of some of the smaller details rather than the adoption of incorrect methods.

The exact date of the first gas motor is not definitely known. It is credited to Huyghens as far back as 1680. Huyghens proposed to use the explosive force of gunpowder as power. These experiments of Huyghens were without practical results. Papin in 1690 continued along this line; he proposed to explode a certain amount of powder in a closed cylinder. The explosion forced the air out of check valves, leaving in the cylinder a partial vacuum, that is, a pressure less than atmospheric.

The atmospheric pressure of the piston acted during the down stroke. The objections to this method were many. A pressure of 15 pounds was the maximum that could be reached. This necessitated a large and cumbersome cylinder. Secondly, it was impossible to produce in the working cylinder a perfect vacuum, hence the actual force available in doing work was the difference in pressure between 15 pounds and the partial vacuum in the cylinder. These objections were so great that the experiments of Papin were useless, as far as any real influence on the modern engine is concerned.

W. L. Wright in 1833 made a fairly practicable engine. It was double acting, that is, received an impulse per half revolution. The operation was similar to the steam engine. The mixture of air and gas was forced by separate jumps into the working cylinder, during only part of the power stroke. The charge was ignited by an open flame. This is the first engine on record where complete working drawings were made, though it is doubtful that the engine ever was actually made.

Up to 1837 no attempt was made to produce an engine of the compression type. William Barnet in 1835 describes an engine which comprest the charge prior to the firing. Here also the charge of gases was fired while the engine was crossing dead center, hence the force of explosion was utilized during the entire power stroke. This motor was not similar to the present gas engine, as the charge of gas and air was separately comprest, discharged into the working cylinder under pressure and ignited.

About this time the advantages of previous compression became prevalent. Lenoir in 1860 used an engine of the compression type, but he did not have a clear understanding of the nature of gaseous explosions. The supdden rise of pressure upon explosion and also almost equal drop, he tried to prevent by injecting steam to reduce, as he supposed, the too sudden pressure due to explosion and transform it into a more gradual impulse.

In 1867 Otto brought out a practical free piston engine and in 1876 he produced an engine of the compression type. This had the greatest efficiency of any engine yet made and had a sale of about 16,000.

tto produced an engine better than he knew, as he attributed the economy of his ignition to a slow ignition of the gases, whereas the real cause of efficiency was due to the compression used.

Up to 1885, the engines marketed were of the low speed type. The causes were several, but Daimler in his inventions struck at the root of the difficulty by using liquid fuel, introducing the now universally used poppet valves, and hot tube ignition is now supplanted by electric ignition. The increase of motor speed permitted much smaller designs for equal power.

Modern engines are built along the lines originally thought out by Daimler.—The Engineer.

In the middle ages the monks devoted themselves to alchemy, but, after failing repeatedly, were prohibited by the Pope from studying the art.

ELEMENTS OF DYNAMO DESIGN.

IRA M. CUSHING.

IV. Transforming Alternations to give Direct Current in Circuit.

The next step should be a consideration of the alternating E. M. F. impressed on circuit F from the rings and brushes, R and T in Fig. 10. A little though would clearly show that the rate of change of the lines going through the coil W vary much during a half revolution. With the coil at right angles to the lines of force, as shown in the figure, a turn of a number of degrees makes but the slightest change in the lines threading through the coil. The E. M. F. is, therefore, at zero, with the coil at 90 degrees to the lines, but begins building up as the coil progresses in the turn until it reaches the maximum when the coil is parallel to the lines of force, for at that point the rate of change is the greatest. As the coil continues its revolutions, the E. M. F. dies down again to zero, which is at the time the coil reaches the 180 degree mark. As the coil completes its turn the rise and fall of the E. M. F. is repeated, but in the opposite or negative direction.

The action can best be shown by diagrams. Let the line A-B, Fig. 12, represent zero potential. On this line are shown the degrees which the coil passes through in a complete turn; namely 360. Vertical lines, erected from the base line indicate the values of the E. M. F. found at each degree, those above the base line being considered as positive and those below as negative.

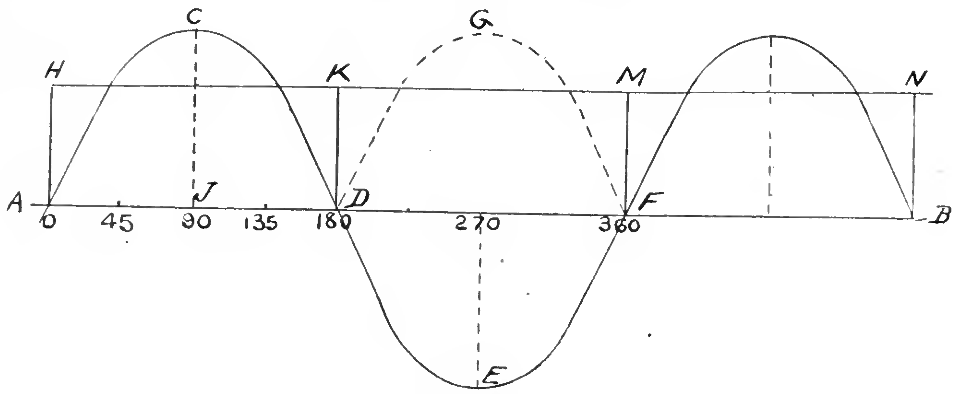


FIG. 12.

Through the points thus obtained draw a smooth curve, and the result will be the curve A C D E F. This shows, graphically, that the voltage is zero at 0, 180 and 360 degrees and maximum at 90 and 270 degrees. Since the coil has completed a revolution and is ready to start on another at the 360th degree, it can be readily seen that the curve repeats itself every 360 electrical degrees.

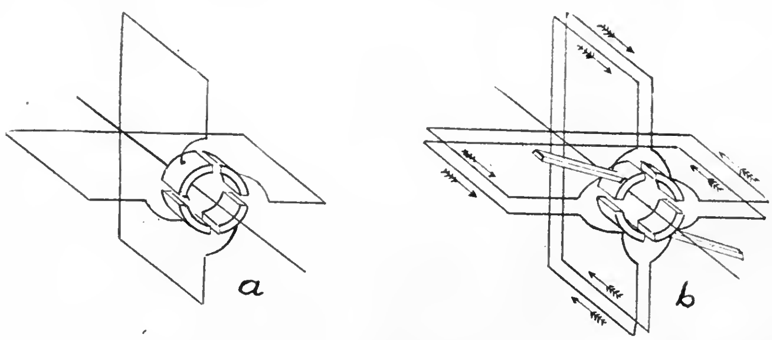


FIG. 13.

In the cycle described A C D is an alternator, and since D. E. F. is a duplicate of A C D, is except for the sign, it is seen that there are two alterations per cycle. The term electrical degrees is used because if the dynamo has more than two poles this cycle is repeated two or more times during a revolution; in fact, it is repeated as many times as there are pairs of poles, or in other words there are as many times 360 electrical degrees in an armature as there are pairs of poles.

As stated before, the object of the commutator was to reverse the E. M. F. delivered to the circuit at the same moment it was reversed in the armature. Its effect on the curve, or wave form as it is called, would be to reverse D E F, Fig. 12, into the dotted curve D G F. There will be then a series of positive impulses like A C D delivered to the circuit D. Fig. 10, producing a pulsating E. M. F. as distinguished from the alternating E. M. F. delivered to circuit F. These are called "sine waves" because they approach or approximate the curve called the "curve of sines."

The pulsating E. M. F. is not steady enough for our present electrical apparatus. A sensitive voltmeter would vibrate so much that it would be almost impossible to obtain a reading. A sluggish voltmeter or, if the frequency was high an ordinary voltmeter, would read an average value of voltage between zero and the maximum value represented by C J. This average would be the line H K M N. One great disadvantage of the single coil in the armature is that the receiving apparatus must be insulated for a voltage equal to C J, while the working voltage is only K D.

The method of duplicating coils on the armature, as shown in a, Fig. 13, also has many disadvantages. It is readily seen that as the second coil is set at 90 degrees to the first its rise and fall of E. M. F. will come 90 degrees behind that of the first and will therefore help fill up the gap between the pulsations in the first coil. The one great trouble with this method of winding is that it is impossible to set the brushes on the neutral point; that is, the point on the commutator which is at the moment connected to the coil in which the voltage is changing. For this reason a heavy, distructive spark occurs between the brushes and the commutator segments as the brushes leave them.

Another way of winding which gives much better results, is shown at v, Fig. 13. This method is as if the original coil had been divided into two equal parts and one half turned through an angle of 90 degrees. The commutator. is also cut into two more segments and the taps from the new coil brought down to them. This winding is quite different from the first in a number of ways. It will be noticed that there is a continuous path through the coil all around the armature. This shows that the winding is really one big coil with taps brought to the segments of the commutator from equidistant points in the coil. This is true of all simple wound armatures, no matter how many segments the commutator has, and it is also the principle upon which all armatures of the drum type are wound.

It would be well now to study the effect of splitting the coil on the E. M. F. generated. Fig. 12 gives the rectified E. M. F. for the one coil. By halving the coil it is evident that the E. M. F. will be one half. As the second coil is 90 degrees away, its E. M. F. will, therefore, be 90 degrees away, starting at D, Fig. 14. Now, although the maximum voltage B D would be only one half of C J, Fig. 12, the average voltage M N, and represented by the line H K, would be the same as the voltage K D and the line H N of Fig. 12.

From this can be deduced that the output of the armature would be the same whether it be wound in one big coil with a two segment commutator, or whether it is wound as many coils with as many segment commutator. The effect of increasing the coils is to reduce the voltage per coil (B D in Fig. 14) until it becomes approximately the same as M N, the average voltage of all the coils. It can be easily seen that multiplication of the wave curves A B C a few degrees apart would give nearly a straight line composed of just the wave tops.

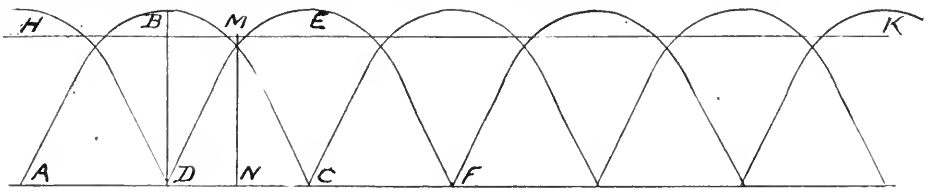


Fig. 14.

Mufflers to minimize the noise of the escape of exhaust steam from high-pressure steam engines are sometimes needed. A good muffler is made by inserting, near the engine, a chamber of 15 or 20 times the volume of the cylinder and continuing the exhaust pipe from this chamber. This will do away with the disturbance caused by steam passing through a tortuous exhaust pipe.

Mica is much used in electrical machinery, as an insulator beteween the segments of commutators. For this purpose the mica must be soft. Large sheets of mica are in demand for lamp chimneys and other novelties. Scrap mica is ground fine for fire-proofing material, as a lubricant, and for wall papers.

Comparatively little has been heard about radium this year, due to the fact that the cost of the salt is almost prohibitive, and that the experiments to date, while interesting, have proved little or nothing as to the actual value of the element.

TESTS OF INVENTION.

JOHN E. BRADY.

In a previous article it was stated that a patent cannot be properly be granted protecting the poduct of mere mechanical skill as distinguished from invention. Difficulty is frequently experienced in distinguishing between the two, and the supreme test for determining whether a particular device is the result of mechanical skill is not whether an ordinary mechanic could make the device if it were suggested to him,, but whether he would make it without suggestions save those which are prompted by his skill and knowledge of his art. For example, if a man constructs out of iron a machine which had previously been made out of wood, he does not thereby become an inventor in a legal sense, because everybody knows that any constructor can build a machine out of iron instead of wood. But, suppose that gunpowder had just recently been discovered and that the man who invented it had applied for and obtained a patent upon it. He might have claimed: "I combine saltpetre, sulphur and charcoal in a certain way, and produce a startling result," and it would be no answer, if an action for infringement were brought, for the infringer to say that every chemist could make gunpowder after he had been shown how. For. if every chemist did not have the knowledge as well as the skill, the originating of the powder constituted invention. Woodman vs. Stimpson, 3 Fisher's patent Rep. 98.

There seems to be no general affirmative rule by which to determine the presence or absence of invention in every case. In fact, the term "invention" cannot be defined in such manner as to afford any substantial aid in ascertaining whether a particular device discloses an exercise of the inventive faculty or not. But there are a number of negative rules declaring certain circumstances under which an invention cannot be claimed, which have been adopted as guides by the courts, and each of these rules applies to a large number of cases.

It is deducible from the authorities that it is not invention, the subject being the same, to find a new position for and old device, unless there is a substantial difference in the manner of its operation and some new and useful result is produced. The new machine may be an unquestioned improvement upon the prior art and may supersede the old machine in the market; it may work faster and better in the new position and yield a larger product;; nevertheless, if it be in fact the old machine, working substantially in the old way and producing substantially the same result, there is nothing upon which to predicate patentability. Thus, the placing of an electric burglar alarm on the outside of a safe instead of on the inside, as has been done long before the granting of the patent for the alleged invention, did not require invention, but disclosed mechanical skill merely and the device in the new position was not patentable. Holmes Electric Protection Company vs. Metropolitan Burglar Alarm Company, 33 Fed. Rep. 254.

It is no invention to use an old machine for a new process. The inventor of a machine is entitled to all the uses to which it can be put, including uses of which he had conceived no idea at the time of his invention. Robert vs. Ryer, 91 UU. S. 150. Parallel with this rule is the doctrine that the application of an old process to a new and analogous purpose does not involve invention, even though the new result had not before been contemplated. To illustrate: In 1883 a patent was issued to Alfred A. Cowles for an "insulated electric conductor" and a number of years later a subsequent owner of the right to use the patented insulator brought an action to restrain what was considered an infringement. Paraphrasing the language of the court, it seems that, although the art of insulating electric wires is almost as old as the art of conducting electricity for practical purposes by means of wires, it was not until electricity began to be used for lighting purposes that it became necessary that insulating material should be non-combustile. The result of the introductions of electricity for lighting purposes was that the insulating material then in use was frequently melted or set on fire and conflagrations from this cause became so common that insurance companies refused to issue policies on buildings in which the usual method of insulating wires was employed. Mr. Cowles was the first to discover that paint was the required insulator, it being practically non-combustile, and he accordingly applied for and obtained a patent upon his new process, which consisted of applying a coat of paint to a wire covered with cotton braid and then applying a second braiding directly upon the fresh paint so as to force the paint into the first braided covering and render it non-inflammable. It appeared at the trial that Edwin Holmes, referred to by the court as the "manufacturer of an electric burglar alarm," as early as 1860, had begun to cover his wires by a process similar to that of Cowles, the only difference lying in the fact that he allowed the paint to dry before putting on the second covering of braid. At that time there was no necessity for a non-combustile insulation and Holmes stated that it had not been his idea to produce such a one and that his method was no better adapted for electric light conduction than the paraffine coated-wire. It was held, however, that

Cowles had done nothing more than apply an old process to a new and analogous purpose and that, for that reason, the patent which he had been granted was void. Ansonia Brass & Copper Company vs. Electric Supply Company, 144 U. S. 11.

As a general rule, a change in the size of a machine or the parts thereof does not constitute invention, but is classed with the output of mechanical skill. It is a rule, however, which, like most other rules of law, has its exceptions. In the Edison Electric light patent, granted in 1880, the one difference between Edison's carbon filament and the earlier carbon burners of Sawyer and Man was that Edison had reduced the diameter of his filament to one-half the value of those previously made. But this reduction increased the resistance of the burner four-fold and reduced its radiating surface two-fold, thus increasing the ratio of resistance to radiating surface eight-fold. "That eight-fold increase of proportion," says Walker, in his work on the law of patents, p. 29, "enabled the resistance of the conductor of electricity from the generator to the burner, to be increased eight-fold, without any increase of percentage of loss of energy in the conductor, or decrease of percentage of development of heat in the burner; and thus enabled the area of the cress-section of that conductor to be reduced eight-fold, and thus to be made with one-eighth of the amount of copper or other metal which would be required" if the reduction of diameter of the burner had not been made. Former carbons had been found not to possess lasting qualities. While carbon burners continued to break down, even after Edison's invention, still the improvement which he made caused them to be more stable than they had ever been before. The device was held to have displayed inventiveness. the court remarking in the course of its opinion, that the difference between carbons that lasted one hour and carbons that lasted hundreds of hours was precisely the difference between failure and success. Edison Electric Light Company vs. U. S. Electric Light Company, 52 Fed. Rep. 300.

In passing upon the question of the presence of invention, simplicity in the appearance of the device is immaterial. The proposition is illustrated in the case of Colgate vs. The Western Union Telegraph Company, 15 Black, 365, which was an action founded upon letters patent granted to George B. Simpson in May, 1867, as inventor of "an improvement in insulating submarine cables." In the opinion is an interesting outline of the efforts of the inventor to obtain a patent for his invention, which covered a period of nearly twenty years, the first application being made in January, 1848, and the letters being finally issued in May, 1867. The claim of the patent was "the combination of gutta percha and metallic wire, in such a form as to encase a wire or wires. or other conductors of electricity, within the non-conducting substance, gutta percha, making a submarine telegraph cable, at once flexible and convenient." It was admitted by the defendant company that it had used submarine cables, in the insulation of which gutta percha was employed, but it was contended as a defense that it had long been known that resins and gums, as a genus of articles, were electric insulators. and that, therefore, it did not require invention. when gutta percha became known, to cover wire with it for the purpose of insulating the wire. But it was held that there was invention in the discovery of the fact that gutta percha was non-conductor particularly suitable for submarine cables. It was very easy, after the discovery had been made, to say that it was a natural conclusion that gutta percha would be an insulator from the known insulating properties of gums and resins generally. But it was also a fact that experienced men had groped about, experimenting first with one device and then with another, in fruitless effort to secure a practical means of crossing watercourses with lines of telegraph wires, until it was at length found that gutta percha was the needed insulator.—"Electric World."

METHOD OF PLATING LARGE PIECES.

Occasionally it is desirable to protect metals by plating them with copper or other metal, but this can not be done conveniently because of the large size of vat which would be necessary in order to submerge the article to be coated. To overcome this difficulty R. Goldschmidt has tried the following method, and found that it gives excellent results. It consists simply in cleaning carefully the article which is to be protected, so as to remove all dirt and grease and leave a surface suitable for plating by the ordinary process. The article is then attached to the negative pole of the source of current and an ordinary paint brush, capable of containing a considerable amount of electrolyte. is attached to the positive pole. This brush is then passed over the part which is to be plated, carefully, and as the current passes through it, a smooth, adherent, strong coating of the metal may be built up to any desired thickness. The process is easily carried out and gives results of excellent character. The author, in his experiments, used a voltage of 110, but placed a number of incandescent lamps in series with the brush, so as to limit the current to about one-tenth of an ampere. He was able to plate successively in this way silver, gold, copper and nickel, and had no difficulty in coating different parts of the same object with different metals. Nickel was found preferable for a protective coating, because of the low voltage required in the process. Details of the solutions employed are given, cyanide solutions being used for gold and silver, and sulphate solutions for copper and nickel.--L'Industrie Electrique (Paris),

BORING CORE-BOX FOR GAS ENGINE.

Perhaps the way I bored out a core box for a small gas engine is not new to all of your readers, but at the same time it may interest others, writes Yrdnal, in "American Machinist."

A 3-horse-power gas engine came to us with the base broken, something as in Fig. 1. It was a 4-cycle type, open in the base on each side over bearings. The cylinder and base were cast in one piece and patching it was out of the question, as it was too badly broken. The only way out of it was to cast a new base, so we put the cylinder in the lathe and cut it off, as in dotted lines in Fig. 1, trued the end and cut a thread on it, as in Fig. 2. Then we screwed the new base on good and tight and put in a couple of set screws to make a surer job of it. The little engine has been running constantly ever since, with no signs of loosening up.

You know how it is in a repair shop where the lathe hands have to turn patterns for the patternmaker who has no wood lathe. Well, the pattern and core box were given me to be turned; the pattern, as in Fig. 3, was easy, but all the while I had the core box in mind; I schemed a way that turned out better than I expected.

The core box had to be 3/8 inch on a side smaller than the pattern, with the same curves, so as to have an even amount of metal all around. I got the patternmaker to make me a templet of the core box as it should be when finished, as shown at T, Fig. 4. I chucked and clamped the pattern in the lathe, as shown, and of course bolted weights on the chuck to counterbalance the pattern, I then made a long offset boring tool post with the cutting point in direct line with the centers of the lathe.

On the back end of the boring tool I clamped a piece of 3/8 round iron that had one end bent and pointed. The templet was then nailed to an upright piece that I had fastened to a board and clamped to the lathe bed. I tried the templet with the back and front of the core box: also had it at the same hight as the centers of the lathe. In the first and second cuts I had to let the pointer travel at a little distance away from the templet, but on the finishing cut I just kept the point from touching it. The finished job was barely 1/16 inch out and was very satisfactory in every way. I had done other jobs using the same kind of rig, and was always successful.

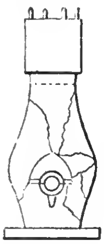


FIG. I

FIG. 2

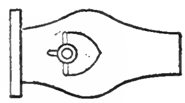
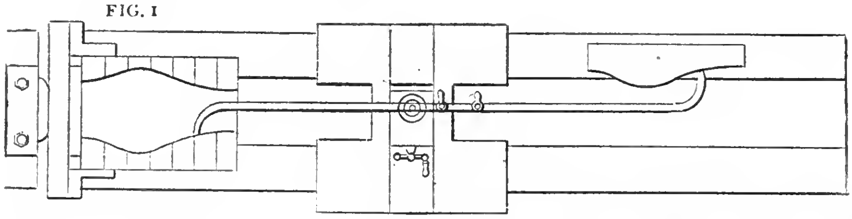


FIG. 3



VAPORIZING GOLD.

Professor Moissan, in vaporizing gold in the electric furnace, find that 100 to 150 gr. can be evaporated in two or three minutes. By condensing the gold vapor on a cool surface, either filiform masses or cubical srystals can be obtained. It is found that gold, like copper and iron, dissolves a certain amount of carbon when in the liquid state, but this separates out as graphite on cooling. Gold is to be found less volatile than copper. The properties of distilled gold are the same as those of hammered gold, or the melted metal reduced to a ne powder. When an alloy of copper and gold is distilled, the vapor of copper comes over first, showing that there is no definite compound. In case of alloys of gold and tin, the latter metal burns in contact with air. This tin oxide is found to be of a purple color, due to a deposit of fine gold on its surface.

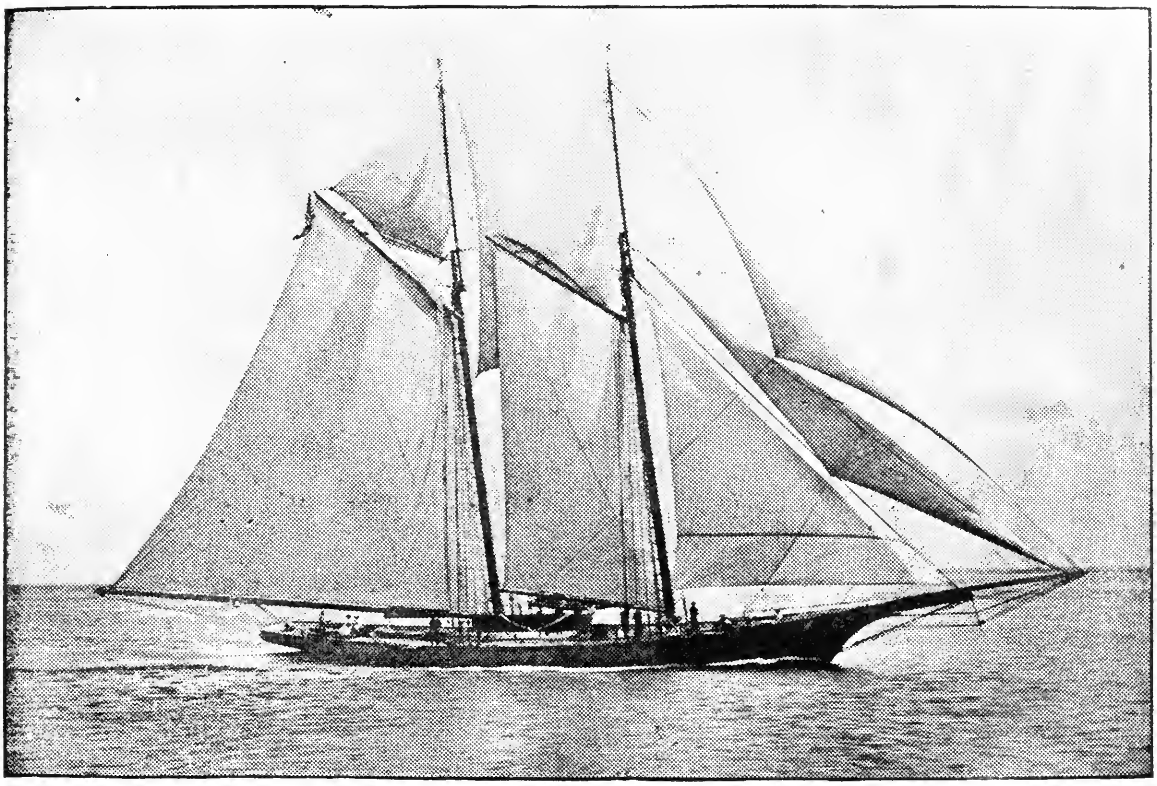
Many rivers- especially in broad valleys, are bordered by a terrace or plain, there being sometimes two or more, extending like a series of sheives, or steps, up the valleyside. The lowest of these is often covered by the river during periods of high water, and is consequently termed the flood-plain.

FIRST PHOTOGRAPH OF THE YACHT AMERICA UNDER SAIL.

Probably no American yacht has been oftener pictured than the famous schooner America, yet the negative of the rst photograph made of her while under way is preserved in Boston today.

It was made nearly 24 years ago, in 1883, when the photographing of moving objects was a novelty.

N. L. Stebbins, the veteran photographer of Boston, was a pioneer in photographing vessels under sail, making his rst pictures of that kind in the spring of 1883.



Gen. Butler then owned the America, which h had bought in 1873 at an auction sale at Annapolis, where, since the war, the celebrated yacht has been stationed. His sailing master was Capt. James H. Reid, a Boston branch pilot, who hearing that Mr. Stebbins could photograph a vessel in motion, called on him, and arranged to have a picture taken of the America.

Mr. Stebbins went down the harbor on a tug, and off Boston Light Capt. Reid put the America through her paces, in a moderate breeze, with all her light sails on.

"The picture was one of the wonders of the times," said Mr. Stebbins recently. "People had never seen anytning like it before. It had been customary up to that time to tie a vessel up fore and aft if she was to be photographed with her sails up. Of course the work could be done only in calm weather, and the picture didn't look very spirited. I was the first photographer to get results with photographs of vessels in motion."

The picture herewith was made from a print taken by Mr. Stebbins a few days ago from his original negative, which is still in good condition.

It is interesting to yachtsmen from a technical standpoint, as it shows the winner of the America cup in a rig which she no longer carries. This rig was given her in 1880, when she was rebuilt from plans by Edward Burgess, and was carried until 1885, when the headrig shown here was discarded and a pole bowsprit was put in.

When built, in 1851, the America was rigged with but one topmast. Her sail plan was considerably narrower on the base than the one shown here, though her masts were taller. When she left this country for Europe she carried no flying jibboom, and had but three sails, mainsail, foresail and jib.

For the great race at Cowes, Aug. 22, 1851, she was tted with a flying jibboom and flying jib, which were carried away i the race, to the satisfaction of "Old

Dick" Brown, her skipper, who said he didn't believe in flying jibs, anyway.

When Gen. Butler bought the America she had a rig given her by the government in 1870, when $20,000 was spent on her to t her for the first race in this country for the America cup, the challenger being the English starters.

The America now lies at Chelsea bridge. She has not been in commission since 1903. The last good photograph of her under sail was made in 1901, off Newport.

The famous old craft is now registered in the name of Paul Butler, having been in the Butler family since 1873. With an overhaul and slight repairs to her topsides, she would be good for several years more of service.

BOOKS RECEIVED.

PRACTICAL UP-TO-DATE PLUMBING. George B. Clow. 264 pp. 7 1/2x5 inches, 250 illustrations. Cloth. $1.50. Frederick J. Drake & Co., Chicago, Ill.

Plumbing is today a subject of much importance in every building, whether used as a residence, office or factory. It is essential that work of this kind be properly designed and installed; in fact, the regulations in many cities and towns are quite rigid in their requirements. In this book the subject is very completely presented, and the many kinds of fixtures and their uses are shown by means of numerous illustrations and suitable text. The apprentice who is learning the plumbing trade and the young journeyman, as well as the mechanic to whom such knowledge is desirable, will find this book very helpful.

MODERN AMERICAN LATHE PRACTICE. Oscar E. Perrigo, M. E. 444 pp. 9x6 inches, 314 illustrations. Cloth, $2.50. The Norman Henley Pub. Co., New York.

The variety of attachments and movements to be found on the modern lathe, and with which the mechanic and the engineer must of necessity be familiar, give to the book its special value, as the contents relate almost entirely to descriptions of the more prominent makes of lathes. Very complete and illustrated descriptions of the various parts of the lathe, attachments, rapid change gear and tools are given, as well as some excellent directions for testing a lathe. There are also chapters on high speed, special and turret lathes together with an interesting history of their development.

HENLEY'S RECEIPTS, FORMULAS AND PROCESSES. Edited by Gardner D. Hiscox, M. E., 787 pp. 9x6 inches. Cloth, $3.00. The Norman Henley Pub. Co., New York.

In compiling this book the editor has endeavored to meet the wants of the mechanic, manufacturer, artisan and the housewife. Much care has been taken in selecting the materials from reliable sources, and the editor has endeavored to discard anything of questionable merit. In connection with the matter, the particular application is given wherever possible, thus enabling the reader to select the formula best adapted to his needs. The matter is arranged alphabetically under general headings, under which are grouped all the information appertaining thereto. Numerous cross references are given to facilitate the finding of specific information, or that relating to any particular class. As a reference book for public libraries or for anyone engaged in general experimental work the book would be of much value.

MODERN HOT WATER HEATING STEAM AND GAS FITTING. William Donaldson. 244 pp. 7 1/2x5 inches. Cloth, $1.50. Frederick J. Drake & Co., Chicago, Ill.

The owner of a building, whether it be a esidence or one of larger size, may find it to his interest to know something of the subject treated by this book. Many a mechanic could make his home more comfortable during the winter months by installing a steam or hot water heating apparatus, and is only deterred from doing so by the lack of knowledge of details of the work. From this book can be obtained a working knowledge of modern systems and their proper installation, making it possible for an owner to determine whether work was being properly done, or for a mechanic to equip his own home at a very considerable saving in the cost. It is also a valuable bok for the apprentice or workman who desires a general knowledge o fthis branch of work.

BEGINNING WOODWORK. Clinton S. Van Deusen, M. E. 99 pp. 6x9 inches, oblong. 10 illustrations by E. V. Lawrence. Cloth, $1.00. The Manual Arts Press, Peoria, Ill.

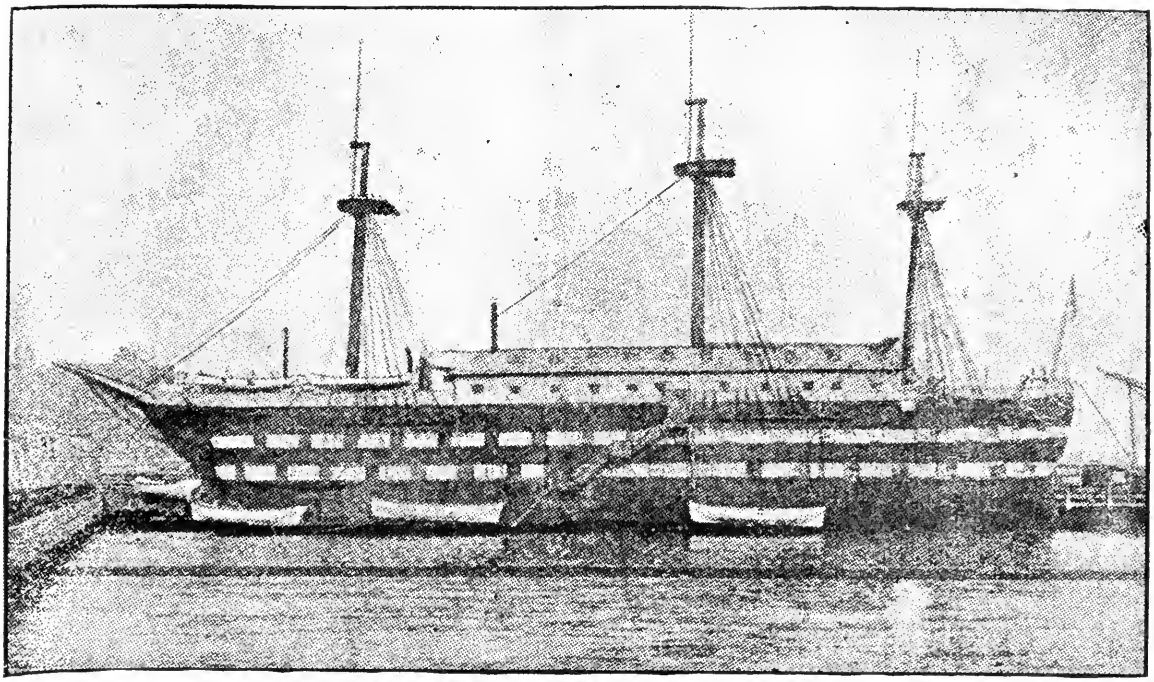
This book is intended as a definite statement of steps that may be followed by a beginner in learning the fundamental principals of woodworking. This is accomplished by a number of specific examples, and from the experience gained in doing these the pupil should be able to accomplish without difficulty other work of which the examples given stand as types. The number of examples given is so small, however, that the beginner must seek other sources of information before his appetite for designs is likely to be satisfied. As a suggestion for future editions, an appendix of about a dozen designs with dimensions would be recommended as rounding out the book. The information given is clearly expressed and the illustrations are well done.

In the early days of tunneling, machine drills were mounted on cars running on tracks, and this is still the practice in some parts of Europe.

A WARSHIP ON LAND 45 YEARS.

Next to the much-beloved frigate Constitution, the old ship of the line Granite State is the oldest vessel in the navy on the active list.

Quite singular and interesting are the facts in connection with the construction of this old craft. Like the Constitution, the Granite State is a New England product. The former was built at Boston and the latter at Portsmouth, N. H., by the government. Just after the Constitution made history by her famous engagement with the frigate Guerriche in the war of 1812, congress decided in favor of a bigger navy, expecting a prolonged war with Great Britain. Plans were made for the construction of a number of ships ready to meet the emergency. One of these was the Alabama, now the Granite State.



The war having ended in 1815, the rush was over. Plans for the contemplated ships were already made, however, and early in the year 1819 work was commenced on the Alabama. Just 45 years later the famous ship of the line was launched. This undoubtedly is a unique incident in the history of the United States navy.

Why was one-half of her career spent on dry land?

First, appropriations for the navy had become exhausted; second, there was no necessity for a big navy, the nation being at peace nearly 50 years, except for the Mexican war.

Care was taken of the old Alabama, while she remained in the stocks, but when she was launched on Jan. 23, 1864, she was of little use as a fighting ship.

Another notable circumstance connected with her was that on October 28, 1863, a few months before her launching her name was changed from Alabama to New Hampshire. This was due to the fact that the state of Alabama has seceded from the Union and had espoused the cause of the confederacy. Changing her name gave another New England state a proper representation in the navy.

A few months after the New Hampshire was launched she was fted out for a year's cruise and went to sea on June 15, 1864, four days before the famous fight between the Kearsarge and the confederate shop Alabama. From the latter part of 1864 up to 1866 the New Hampshire was used as a storeship, attached to the South Atlantic blockading squadron at Port Royal. From 1867 to 1875 she was used as receiving ship at the Norfolk navy yard. In 1877 she was again assigned to duty as a storeship at Port Royal and remained there until 1881.

In 1882 she went to Newport, R. I., and for the next eight years was used as a training and receiving ship for boys. For the next two years she was stationed at New London, Conn., as a receiving ship. Her final assignment was in 1893, when she was turned over to New York state for the use of the naval militia. There she remained until a few weeks ago, when se was succeeded by the cruiser Newark.

In 1903, when the 10,000-ton battleship New Hampshire was authorized by congress, naval officials deemed it unwise to have two ships in the navy bearing the same name. On Nov. 30, 1904, the name of the old New Hampshire was changed to Granite State, this being the third name given her.

The Granite State is 196 feet 3 inches in length, 53 feet in width, with a mean draft of 25 feet 6 inches. She was originally of 2600 tons displacement and carried 15 guns.

Today she is a fine old hulk of a type famous at the time of the beginning of her construction. She is still sound for inshore cruising. Since she was loaned by the government to the New York naval militia certain enlistd men have been attached to her as caretakers. As she stands today, without any assignment, she is in danger of being discarded from the active list of vessels and sold for junk. Interest, however, will be taken in her by Admiral Dewey and other leading naval officers, who believe in the preservation of these old hulks as naval museums. No craft ever built for the navy, it is believed, has ever had as odd a career in the navy as the Granite State.

NEW TELEGRAPH RAILWAY SIGNAL.

The attention of railroad men has been attracted to the telegraph railroad signal for the manufacture of which the Telegraph Signal Company has been organized at Rochester, N. Y. The signal is the invention of Selden R. Whight, a railroad telegrapher. It is essentially an emergency device, primarily for use on single track railroads, and is intended to place the control of semaphores at the several stations under the control of the dispatcher. By means of this signal the dispatcher may throw a semaphore to "stop position" at any desired point, regardless of the condition of the operator's instrument at that station, that is, whether or not the key of his instrument on the dispatcher's wire is open. The signal instruments form part of the operator's apparatus at each station, the relay being used to operate the semaphores and bell signal. The signal devices at all stations are identical. Each instrument is provided with an accurate and unfailing selector which enables the operator to select not only the required station but the particular semaphore which he wishes to operate. For each station there are three contacts on the selector drum—one for the first semaphore, one for the second and one for a bell signal.

Briefly, the signal operates in this way: If the dispatcher wishes to throw, say, the east bound semaphore at a station he would hold the key of his instrument open 50 sec. At the expiration of 40 sec. a contact would be made which would cut out the keys at every instrument on the circuit. At the end of 50 sec. contact would be made through another contact point, which would enable the dispatcher to operate the selector. By means of his key the dispatcher would step the selector to the number of the semaphore which he had selected to throw and wait 20 sec. At the end of that period the semaphore would be thrown to "stop position," and a messenger call signal would apprise him of the fact. Closing the key a few seconds later would restore all of the signal devices at all of the stations to normal, leaving the interlocking semaphore to be drawn to safety position when everything was clear. The other semaphore or bell signal would be operated in a similar way.

MALLEABLE CAST IRON.

When properly made malleable cast iron should have a tensile strength of 42,000 to 48,000 lb. per square inch, with an elongation of 5 per cent. in 2 in. Bars 1 in. square, and on supports 12 in. apart, should show a transverse strength og 2,500 to 3,500 lb., with a deflection of at least 1/2 in. The resilience should be at least eight times that of cast iron. Malleable cast iron can be bent, twisted, and abused very much before giving way, thus making ideal for service where a fair tensile strength is required, but especially where often repeated shocks are th rul.

Whil the strength of malleable cast iron should be as given above, much of it will fall as low as 35,000 lb. per square inch, and this will still be good for such work as pipe-fittings, hardware castings, and the like, where a certain amount of punishment can be expected, and cracking should not take place. On the other hand, this material can be made exceedingly strong, even 63,000 lb. per square inch having been reached, as well as a deflection of 2 1/2 in. on the transverse test, with oftentimes 5,000 lb. to cause rupture. This, however, is not desirable, as the softness of the casting is sacrificed in this way, and its resistance to continued shock lessened.

The process of making malleable cast iron may be briefly summarized as follows:—The proper irons are melted in eithe the crucible, the air-furnace, the open-hearth furnace, or the cupola. The metal when cast into the sand moulds must chill white or not more than just a little mottled. After rolling off the sand from the hard castings they go into the annealing department, where they are packed in puddle scale, or other materials containing iron oxide, and here subjected to a period of red heat (1,250° to 1,350° Fahr.), over 60 hours after reaching the proper temperature. They are then cooled gradually, rolled again to remove adhering scale, chipped or ground, straightened, and shipped away.

Pennsylvania alone produced last year nearly three-quarters of a million tons pig iron more than the whole of Great Britain.

THIN NEGATIVES IN THE ASCENDANT.

JAMES THOMSON.

That the ultimate purpose,—the end of all photographic endeavor insofar as the average amateur is concerned, is the pictorial expression,—the arrangement of lights and darks in what is commonly spoken of as "the print" would seem to be conceded. Furthermore, the negative that best serves our purpose is the one to use quite regardless of appearance or whether in technical excellence it is one to claim admiration. The clear, crisp, transparency-like qualities in a negative usually appeal to the beginner, nor are there wanting photographers who ought to know better who talk of such a result as one to emulate.

For many a long day was the novice misled in being taught to consider the negative the end rather than the means to an end. As for myself I remember more than one authority who constantly impressed upon the beginner the importance of developing the snapshot (as a rule notoriously undertimed) in solutions stronger than normal. Also to carry the process to the extent of entirely burying the image until all was an even blackness.

Starting with such wrongful instruction, and absorbing the idea that the negative of density, with clear glass shadows, alone constituted the "Ultima Thule" as regards plate deelopment in the realm of photogphy, it is small wonder it took the misdirected a considerable time to realize their mistake.

In my own case I soon discovered my error, but a friend of mine never did, and today continues to overdevelop his negatives and in the case of non-halation plates simply went to a ridiculous extreme. Many a good pyro developed negative he has thrown in the dump without ever printing a proof because thoroughly convinced from much reading of wrong instruction books that such a negative was too thin. Continually, and persistently, overdoing the business with ordinary plates, and reading that non-halation plates required to be carried further in development, he did so to the extent of burying the image completely, producing a negative, a time exposure so dense, it took a professional printer a full half a day to print from it. There are many like him so accustomed to the blackened, all-over, dense negative, they simply cannot believe a thin one though full of detail can possibly answer requirements. Most of these people have been alone familiar with the negatives developed through stock houses and the like who rarely use pyro.

Fortunately we have today got beyond the fallacy in question, and for much of our enlightenment we must thank present day pictorialists. We, most of us, concede now that the remedy for both over and under exposure is the same,—development in dilute solution as to preserve all possible detail which by the old time forcing system of the under-timed snapshot was a thing quite impossible.

Regardless of appearance the "perfect negative" for anyone is of necessity that which best carries out our pictorial purpose. Nor is it generally the one with the sharpest image and clearest shadows that will do so. While the backed plate is an advantage in a considerable, or many, subjects there are cases where it is clearly a detriment. For certain effects halation is to be sought rather than avoided, in fact a good many photographers would be the better for a reduction in sharpness. For white dresses, snow scenes, trees against the sky and such, the backed or non-halation plate is decidedly in order. In the case of many low-toned subjects where extremes of contrast are lacking, the unbacked plate will answer quite well.

In counter lighting, working into the sun, where the scheme calls for atmosphere in abundance, there is not the slightest necessity for the backed plate. The blackened tree trunks,—usually in such scenes too much in evidence,—will be none the worse for a little spreading of the light. Why, have all not heard how the old time photographers were accustomed to intentionally fog the shadows by exposing the plate either before or after taking the picture, to the light of a match. Such a scheme might do no harm at the present day in the case of some landscape pictures that come our way when all in the shadow is as black as night. While the exposure to a lighted match would not furnish lacking detail, were pictures from such negatives printed on rather rough paper the halation in the shadows might be made to answer for it.

The thin negative with all possible detail is without doubt in the ascendent and for some of the best papers on the market its use is imperative. Workers who are still wedded to contrast, or those who habitually overdevelop should mend their ways, for artistic work is not thus possible. Professionals we can plainly see as the overdeveloped negatives in the whitewashy appearing but the beautiful texture of human flesh is completely lost in density. It is quite easy to distinguish the oerdeeloped negatives in the whitewashy appearance of the resultant prints, more especially when in a black and white medium.

By thin negative one does not necessarily mean a flat one. In the pyro developed negative contrast is present though to those accustomed to the use of the modern reducers such as metol it might not seem to be the case. The property developed negative when our old friend pyro is the reducer will look rather thin but under the pinting light it will develop an astonishing amount of contrast and pluck.

Once all possible gradation has been secured we gain nothing by piling up density. We simply slow the printing and where there is a stain of a pronounced character we doubtless impair the quality of the image. Many a well blackened negative gives a surprisingly limited degree of contrast, the blue color permitting the light to pass without leaving the record of gne half tone in the image.

The forcing process in deevlopment in hope of gaining detail is foolish. Once the detail has ceased to grow in the shadows we may as well consider the job done, for no amount of forcing will then alter the steepness of gradation. No more can we force out detail in a plate than we can in a velox print and in the latter we but dirty the whites by prolonged development.

We cannot help but see the detrimental result where gaslight papers are involved, and it should carry a lesson to those who continually and persistently overdevelop plates and films.

In my own practice I have found Carbutt's Pyro-soda formula a good one because of its elasticity, and the getting of the full strength of the reducer by using the dry pyro, adding it just before starting to develop. The formula I employ is as follows:

CARBUTT'S PYRO-SODA DEVELOPER.

Sulphite of soda, dry ....3/4 oz.
Carbonate of soda, dry .... 1 oz.
Hot water .... 10 ozs.

Weak solution 1 to 10, medium solution 1 to 8, strong solution 1 to 5, and from 1 to 3 grains of the dry pyro to each ounce of solution used.

In my own practice with fully timed exposures I employ 1 to 8 and 2 grains of the dry pyro to the ounce.

Where there is a great deal of white in the composition, snow scenes, white dresses or white flowers, start in a dilute solution, 1 to 16 with 1 grain of pyro to the ounce, and when detail is well out if not sufficiently dense immerse in the full strength until opacity is obtained. Where more yellow stain is wanted, use but a half an ounce of the sulphate instead of three-quarters as stipulated. A slight yellowness of the film I hold is an advantage, the slightly stained negative making a much better printer.

Some who object to pyro for the reason that everything it touches is apt to get stained may find in ortol a satisfactory substitute, using the same quantity of the powder as recommended for pyro. A good metol-hydro developer is as follows, though with that a much more opaque negative will be required on account of the blue-black nature of the image which allows for the light filtering through much more than with some other reducers.

METOL-HYDRO DEVELOPER.

Solution A.

Metol, 32 grains.
Hydro-quinone, 32 grains.
Sulphite of soda (dry), 120 grains.
Water, 16 ounces.

SSolution B.

Carbonate of soda (dry), 120 grains.
Bromide of potass, 15 grains.

To develop take one part each of A and B and an equal quantity of water. When there is too much contrast simply dilute still further or use a less quantity of solution A.—"Western Camera Notes."

SCIENCE AND INDUSTRY.

Concrete is a troublesome material in which to drill deep holes; it is a good plan to use water under pressure, with a wide flare bit, permitting a small copper waterpipe to be inserted nearly to the bottom of the hole, so that chips and dust are carried off before they can wedge the bit.

Plasticity may be defined as the property which many bodies possess of changing form under pressure, without rupturing, which form they retain when the pre-out rupturing, which form the retain when the pressure ceases, it being understood that the amount of pressure required, and the degree of deformation possible, will vary with the material.

A stream of water can be thrown vertically 103 ft. and horizontally 9** ft., with a pressure of 100 lb. at the nozzle and 1 3-8 in. diam. The nozzle will discharge 674 gal. of water per minute. With a higher pressure, equivalent to a higher head, the amount discharged and the distance to which the water may be thrown will be increased.

Over 50,000,000 gal. of water are pumped out of the anthracite coal mines of Pennsylvania every day in the year. The exact average for 1905 was 633,000,000 gal. per day. Nearly 1,000 powerful engines, delivering from mine bottom to surface 500,000 gal. of water per minute, are required. Mines may be shut down and coal production suspended, but the water flows on forever. The cost of removing it is one of the important items of expense that make up the price of anthacite.

Whether a high-power or a low-power explosive is to be used in blasting, is dependent largely upon the use to which the rock is to be put, as well as upon the strength of the rock itself. Black powder, with its comparatively slow, heaving action, is used where the material is quite friable, as in mining coal or galena, or in excavating shale, hardpan, and similar material. A high-power explosive like dynamite is invariably used in tunnel-driving, shaft-sinking, and open-cut work in tough rock. It cannot be used for quarrying dimension stone, as it shatters the rock.