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March, 1920
Vol. 8 No. 6

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BUILDING A SIXTEEN-FOOT SHALLOW DRAFT POWER BOAT (See page 361)

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THE VIBRATING WORLD

EVERYTHING vibrates; everything is eternally busy. The air vibrates, the ether vibrates, molecules and atoms vibrate. Nothing is still, nothing dead. True, many of the vibrations are quite beyond our senses, but science assures us that the whole world is a mass of vibrating particles.

SOUND waves, wireless waves, heat waves, light waves, visible and invisible, are made up of vibrations. Vibrations produced in air we call sound waves. In the ether the properties exhibited by waves depend upon their length. The real long waves are called Hertizan or wireless waves. The next shortest are heat waves, the next infra-red waves, and from this point they develop into visible red light with a frequency of vibration in the neighborhood of two billion per second. As the waves become shorter and shorter the sensations of orange, yellow, green, blue, etc., are produced until the zone of the invisible is approached. Beyond this point, our senses fail us, and we must rely upon instruments to tell us of the presence of such rapid etheral vibrations as those necessary for the production of ultra-violet and X-rays. There may be many other invisible rays in the "ultra" zone of the spectrum. Present-day scientists claim that but a small part of the invisible spectrum has been discovered. What the future holds for those working in this promising field of investigation no one knows. One thing remains certain: We must increase our knowledge of vibration before the great problems that confront us today will be solved. The problem of atomic energy, heat, electricity, mental telepathy—all are wrapped up in the Mystery of vibration.

RAYMOND FRANCIS YATES, Editor.

Price of Everyday Engineering Increased

BEGINNING with this number, the price of EVERYDAY ENGINEERING MAGAZINE will be increased to 20 cents per copy and to $2.00 for the yearly subscription. However regrettable this step is, it has become necessary through the increased cost to us of paper, engravings, press work, drawings, binding, etc., etc. During the last few months EVERYDAY has been increased greatly in volume. The space devoted to editorial matter has been increased through the well-deserved support the magazine has received from its readers and the publishers feel that the new price, which is strictly a matter of necessity, will not interfere with the development and progress of the only periodical in its field that closely adheres to a policy of practicability in the dissemination of information for those interested in mechanics, electricity, radio, aviation, automobiles and model engineering.

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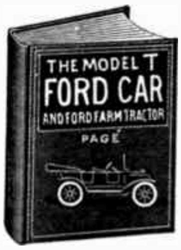

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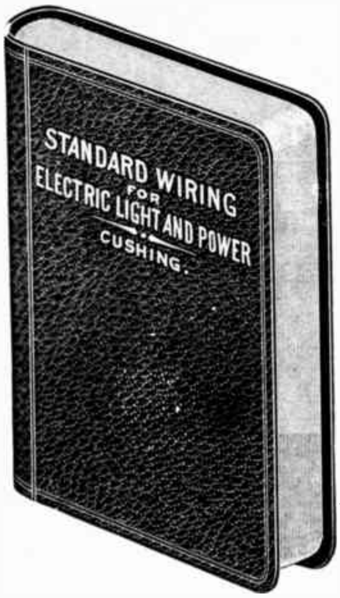

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PRACTICAL MECHANICS FOR EVERYDAY MEN

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IT TELLS YOU HOW TO MAKE AND DO THINGS

VOLUME 8 MARCH, 1920 NUMBER 6

A Sixteen-Foot Shallow Draft Power Boat

A Simple, Easily Built Craft That Can Be Constructed by the Handy Man at Relatively Small Cost and with Limited Tool Equipment

By A. C. Leitch, N. A.

IT seems to me most every healthy, red-blooded man or boy living near the water some day gets the "boat bug", and if this happy disease is allowed to develop sooner or later he invests. The purpose of this article is that he may invest wisely; by investing we mean building or buying. If he be enough of a mechanic to build for himself so much the better, he then knows exactly what is in the boat.

If you decide to build your own boat do not attempt to "design it" unless you have had training along the lines of technical or practical experience. Select a design that is suited for the waters in which you intend navigating, and for your own desires and pocketbook one that has actually been built if possible, and do not depart from the design in the least, for I am sure you will regret it if you do. Successful designers are not alone technical men but experienced yachtsmen, and a successful design seldom if ever represents one single masterpiece, but invariably a series of boats of that particular type, each one an improvement over the other.

A boat that is able to run in water not much deeper than that required for an ordinary row boat is given herewith. The advantages of this type of boat for shallow, somewhat protected waterways will be obvious to those living upon or near some beautiful stream wherein there is not sufficient depth to float an ordinary power boat. When this little craft is afloat and running over bars and other shallow points the reason for this paradox is not apparent, for in appearance I have purposely designed her to convey the effect of a classy little power boat, of possibly V-bottom construction, with an air of "go" to her, seldom seen in ordinary flat bottom boats, which in reality she is. I have given plans for a flat bottom boat capable of running in about six inches of water, but with the above water appearance of a graceful little speed boat, with the advantages of the simple and cheap construction of the former.

Tunnel for Propeller

The secret of this boat's success is in a tunnel housing for the propeller wheel, the said tunnel extending in a fore and aft direction, being shaped as shown on the plans forming a part of this description. This boat is not designed for rough water use, it is only suited for operation upon a somewhat protected stream, where due to bars and riffles the ordinary type of power boat is useless; and is designed for a moderate powered, light weight motor, say from three to six-hp., with the average revolutions per minute of an ordinary two-cycle motor, say about 800. With this power the boat will show a speed of from 6 to 9 actual miles per hour.

The tunnel housing as here shown is at its highest point 1 ft. 1⅝ in. above the bottom edge of planking. This is about the size that would be necessary for the propeller wheel of the largest size of motor to be used in the craft. I would suggest before laying the curve of "Bottom of tunnel planking" down, you decide upon the size of motor you are to use and ascertain from the builders of the same, what size and style of wheel they recommend using in combination with their motor.

By informing the engine people what type of boat you are building, giving them the principal dimensions, etc., you will have a much more satisfactory outfit than if anyone else attempted to give you theoretical data for the same. You will then know how high to hold your greatest height of tunnel; arrange this point so you will have about 1½ in. clear all around your propeller, that is sides and top. Hold the after point of height, viz. 7⅛ in. above base line and the point on section 2 of 2⅞ in. and gradually flatten the curve of "Bottom of tunnel planking" until your highest point intersects the point about 1½ in. clear of the wheel, not forgetting to change the half breadth of the 2 in. chafing strips down on plan to also be 7⅜ in. The reason for holding the tunnel only about 1½ in. larger all around than the wheel is not to drag any more water than necessary.

Boat Construction Simple

It will be seen by reference to the illustrations that the construction of this boat is extremely simple, the most difficult part being the tunnel or housing for the wheel, but which by the way enables the craft to lay upon the beach as well as upon the water without injury to any of the motor parts. You should be able to build and finish the entire boat exclusive of engine for forty dollars. I should suggest, if possible, to build the boat under cover and preferably in a shed or shop having as good and level a floor as possible, and that the boat be constructed upside down. See sketch marked "Setting up diagram", an explanation of which will be taken up later.

The first step is to mark out full size sections of your stations; transom to No. 5 inclusive, making use of the table marked "Molded figures". For this you should have large sheets of stiff paper and upon them erect vertical center lines and near the bottom draw at right angles a base line (using a large steel square, making your lines exactly at right angles and taking your dimensions accurately, because upon the accuracy of this laying out depends the success or failure of your boat). This base line will be the bottom edge of your planking from sections 1 to 4 inclusive. We will lay out, for instance, frame three. Having drawn center line and base line at right angles thereto, by the use of the steel square, we next draw a line parallel to the base line ¾ in. above the same, this being the moulded height of bottom. Out from the center line on the moulded bottom line lay off the half breadth of moulded chine at station No. 3 or 1 ft. 8¾ in. See table of moulded figures.

Next measure up from the base line (not the moulded line ¾ in. above the base line) the moulded height of deck at station No. 3 or 1 ft. 9½ in., then measure out from the center line the moulded half breadth of the deck at side or 2 ft. 4 in., and at the points of intersection of the two latter mentioned points erect a line from the spot on the moulded bottom line. This will form the moulded side of half of your boat, next measure up from the base line on the center line 6 in. and draw a line parallel to the said base line through the said point, this is your water line and will be used later on as a check. Follow this same operation for all of your sections transom to No. 5 inclusive, if your paper is not wide enough glue two sheets together, so you can lay the entire frame down (both sides). Mark each drawing clearly, giving the station numbers, the base line, the center line and the water line.

The lines you have now drawn will not be the exact width of both forward and after sides of the frames due to the bevel, but will in all cases except frame No. 3 where there is practically no bevel, be the largest side of the frame, except at the transom where the forward side will be about ¼ in. wider than the after side, due to the boat's beam increasing as we go forward up to frame No. 3, and from this point forward the forward side of the frames will be the smaller. When making the transom cut the same about ¼ in. larger all around on the forward section, the exact bevel may be determined when fitting the planking.

Be sure to have the exact finished line marked clearly and sharply on the *after* side of the transom. The transom may be made of oak ⅝ in. thick and in two pieces joined as shown in the drawing by a seam batten ⅝ in. x 1½ in. Mark out a deck beam mould for the data given on a thin piece of pine or template board. By the use of this template you can mark off the exact crown of the deck at the different points, always having the center lines of the template and your frame or mould in line and being sure to have the curve just pass through the two spots of your moulded deck at sides, draw this in on all sections. Assuming all sections are clearly marked on the stiff paper the next point is to assemble your frames or moulds. No. 1 can be built up of cypress or pine, the size of materials being shown in the drawings. Mould No. 1 being through the tunnel it would be wise to fasten a temporary connecting strip across the tunnel gap to hold the mould in proper shape, this strip may be removed when fitting the tunnel in place. In frame two, run the bottom members continuous and cut it out afterwards to receive the shaft log.

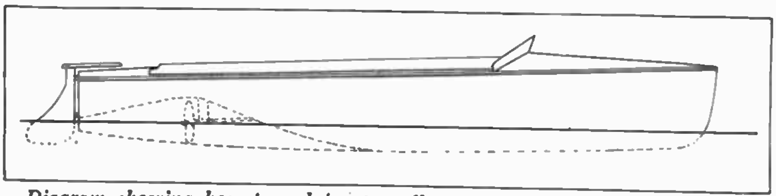


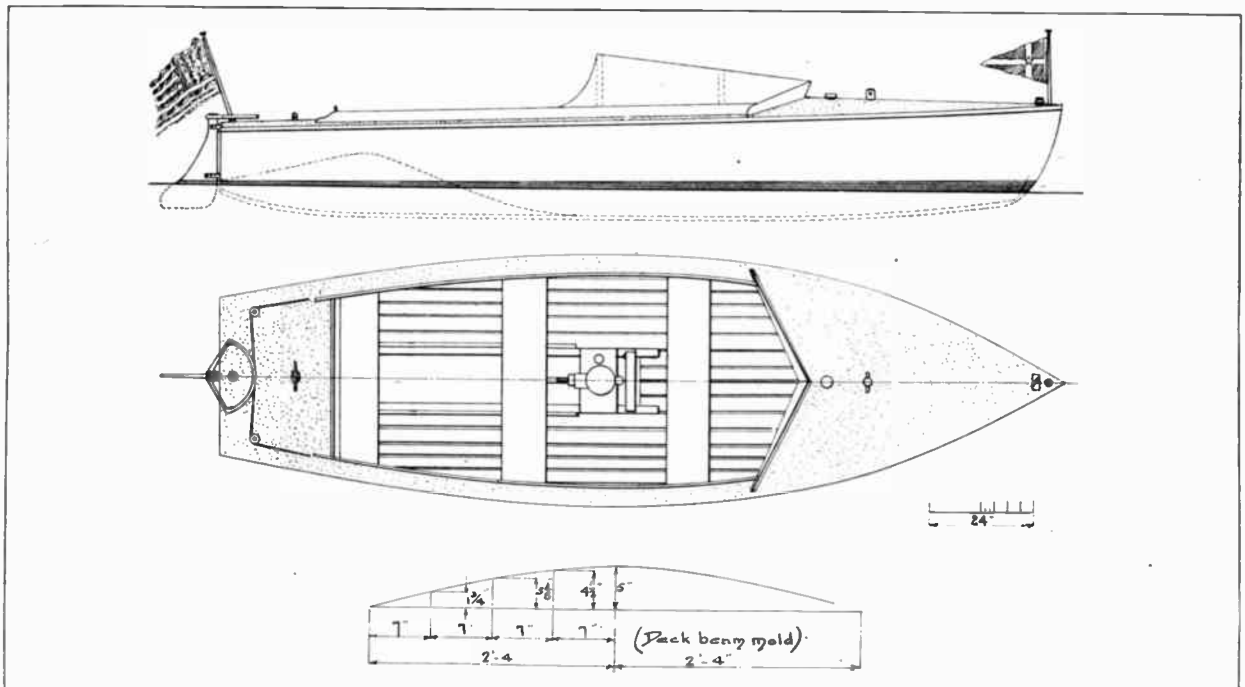
Diagram showing how tunnel for propeller makes a snappy shallow draft design possible

How to Construct Frames

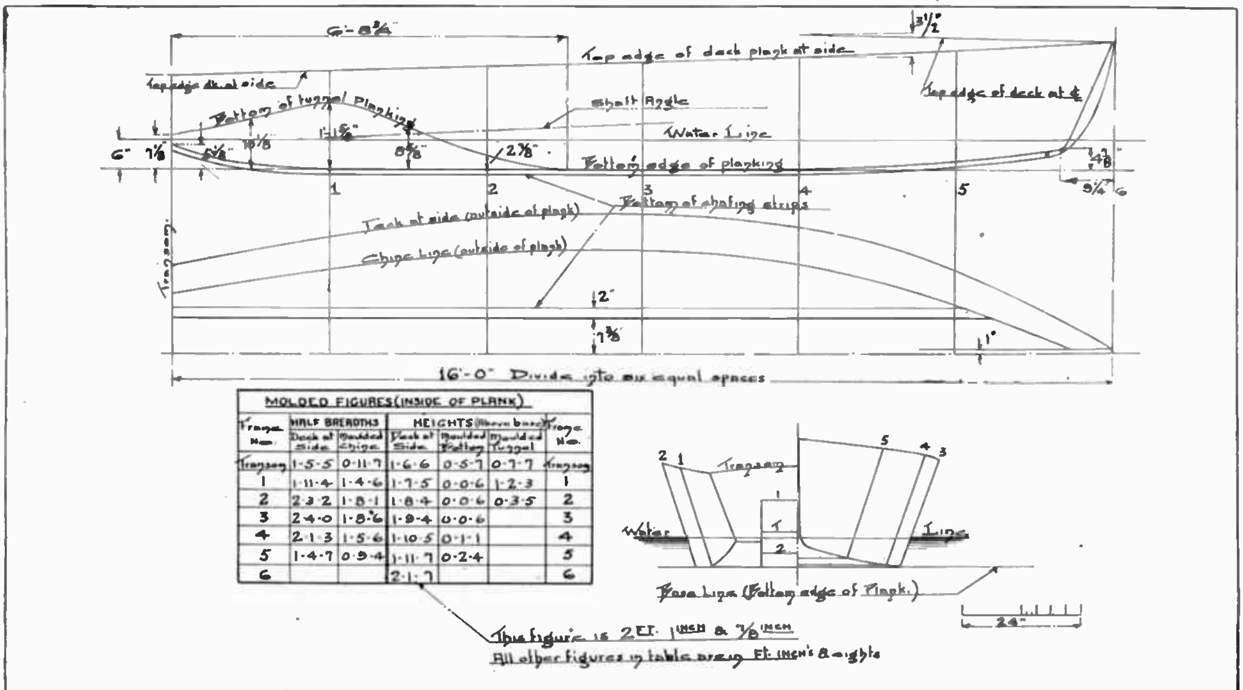
Frames 3, 4 and 5 should be made up as per drawing, omitting the deck beams, but in their place securely fasten a temporary cross piece to hold them in shape. The proper way to construct the frames is to place your paper template upon the floor, tacking the four corners, then finish your floor timber, which by the way are also cypress, and may be ordered from the mill the exact size, that is, width and thickness, 4 in. x ¾ in., saw off about the length required, then get out your uprights or sides which as seen are ⅞ in. thick and 3 in. at bottom tapering to 2 in. at top. When all forms are made up as shown in full lines on sketch "Setting up diagram cross section", secure the temporary bracing as shown in same diagram in dotted lines which is the specific construction for frame three. A center brace is tacked on with the exact center line marked thereon, the said brace in the case of frame 3 to extend below the line of moulded deck at side 1 ft. 4¼ in.; side and cross bracing also to be fitted as shown.

Boat Built Upside Down

The boat is to be built upside down so if on each frame the center and side braces are extended exactly the distance below the line of moulded deck at side as indicated on "Setting up diagram". Longitudinal section, the water line, check lines, placed on the frames, should all measure about 2 ft. 7¾ in.



OUTBOARD PROFILE & DECK PLAN – DECK BEAM MOLD–16 FT. SHALLOW DRAFT BOAT



MOLDED FIGURES (INSIDE OF PLANK)

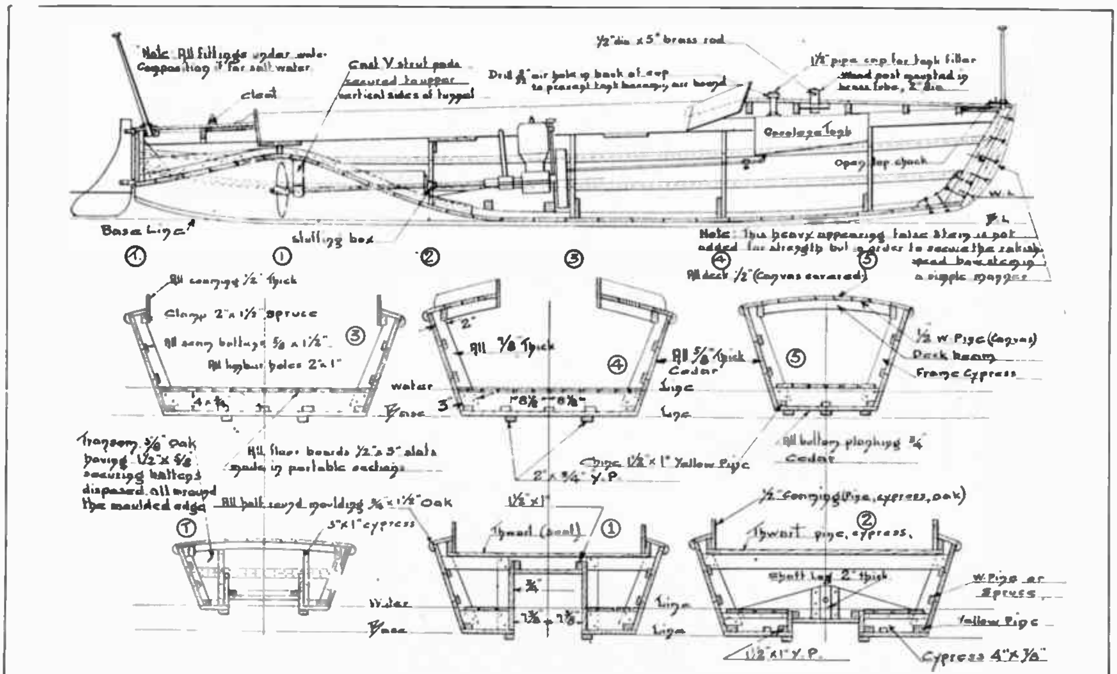
Frame No.	Half Breadths: Deck at Side	Half Breadths: Moulded Chine	Heights (above base): Deck at Side	Heights (above base): Moulded Bottom	Heights (above base): Moulded Tuggel	Frame No.
Transom	1-5-5	0-11-7	1-6-6	0-5-7	0-7-7	Transom
1	1-11-4	1-4-6	1-7-5	0-0-6	1-2-3	1
2	2-3-2	1-8-1	1-8-4	0-0-6	0-3-5	2
3	2-4-0	1-8-6	1-9-4	0-0-6		3
4	2-1-3	1-5-6	1-10-5	0-1-1		4
5	1-4-7	0-9-4	1-11-7	0-2-4		5
6			2-1-7			6

SHEER HALF BREADTH & BODY PLAN—MOLDED FIGURES

above your floor line. The temporary bracing may be of any material you have on hand, but the form should be followed substantially as shown, and be strongly fitted because there is a considerable tendency to rack and change the shape of the sections when bending on the sides. If any of the sections shift you will not have a fair boat. Before setting your frames up test them all over your full size drawings; the permanent fastenings in the frames should be either screws or rivets, well set up over washers, and I should mention the material used for frames should be straight grained material without any warp or other blemishes.

The stem may be made as shown, of oak having secured to its fore side after the planks are fitted the false stem, the seam having the outward curve as shown to give the boat a graceful appearance. You will notice by reference to the cross section of "Setting up diagram" that there are no notches shown to receive the chines, clamp or seam battens, so the next step is to divide the length of each side into three equal parts, and temporarily tack your seam battens to cover the spots, shifting them until they fair up nicely, the battens are to be 1½ in. x ⅝ in. white pine or spruce.

Having faired the battens, mark their top and bottom surfaces with a sharp instrument upon the frames and saw out the notches to receive them, being careful to cut them deep enough to allow their outer surface to come flush with the outer surface of the after part of frames 3, 4 and 5, and the fore part of Nos. 1 and 2; space the battens on both sides exactly alike, now by planing off the portion of the after side of frames 1 and 2 and the forward side of 3, 4 and 5, the amount that shows outside of the battens after they have been seated to their exact depth, all frames will have the exact bevel. The outside of the battens forward come flush with the outside of the stem proper and may be secured to the same by



INBOARD PROFILE & SECTIONS

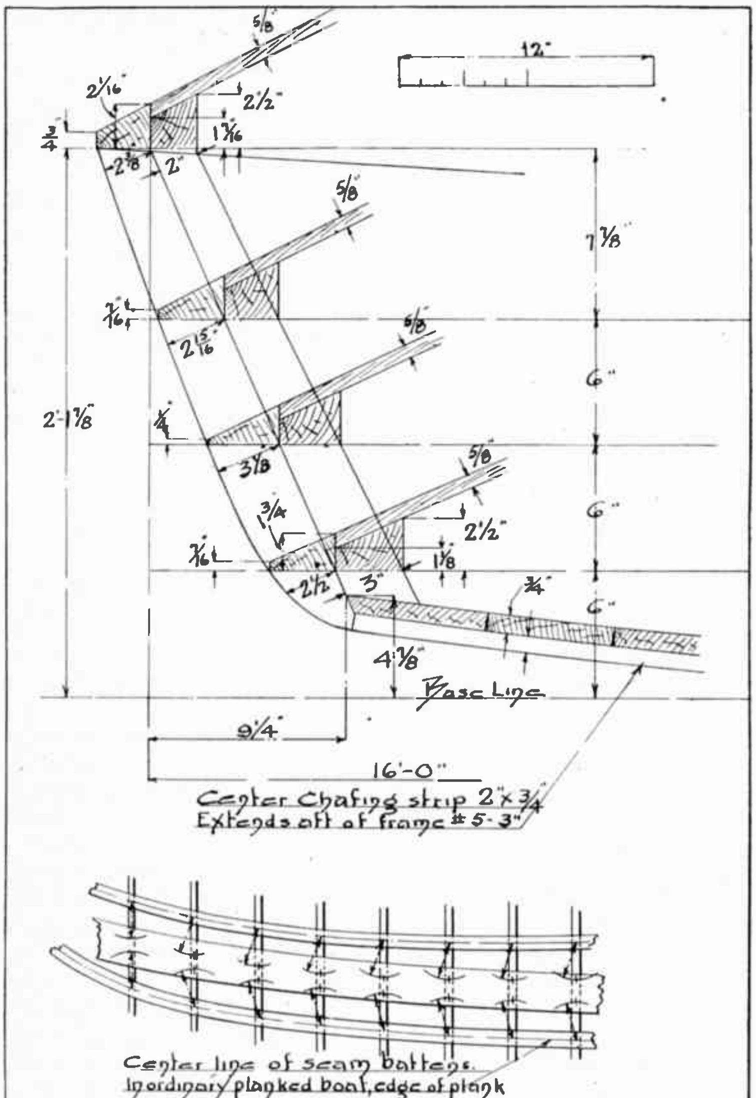
sufficiently long screws set at an angle.

At the transom the battens must come flush with the forward face of same, remembering the after side of transom is the true moulded side, the forward face may now be trimmed to the exact bevel by laying a straight edge on the battens, after the battens are all secured to the frames by either copper, brass or galvanized fastenings the planking may be gotten out and secured.

Taking a "Spiling"

As shown, there will be three planks to a side and the seams must come exactly on the fore and aft center line of each batten. In order to do this properly you must take a "spiling". This is done in the following manner: Mark clearly the fore and aft center line of the seam battens on each batten. Secure a thin piece of straight grained wood that will fit between the battens when bent on naturally, temporarily secure this to the frames, next secure a pair of pencil dividers and open them to a point just a little wider than the maximum space between the upper edge of your spiling batten and the center line marked on your seam batten. Say, for instance, this distance is 3 in., next place your center point of the dividers on the fore and aft center line of your seam batten and swing in a line with the pencil end of the said dividers on your spiling batten, repeat this at every frame, and say at one point midway between every frame.

Now repeat this operation on the batten edge and you will have a set of marks near the top edge and a set near the bottom edge of the spiling board, remove the board from the frames and lay it flat upon your planking for side of boat (better clamp it). Then with the same dividers set at the same spacing, use the lowest point of the curve for the center of your dividers and swing in a curve on your side plank. Repeat this for every spot, then unclamp your spiling board and with a stiff frame batten connect the spots with a fine line, and saw the plank out, leaving the line for trimming afterwards with a plane. If you do this work carefully you will find the plank when bent on naturally as was the spiling batten will come exactly to the fore and aft center line as marked upon the seam battens. A diagram of the spiling board arrangement will be found with the drawings.



STEM DETAIL & SPILING BOARD

Fastening Side Planks

Side planks are to be of cedar preferred—pine or cypress will do, and should be screwed to the transom, frames and stem. Use either galvanized or brass screws. The edges of the planks should be secured by screws or clinch nail fastenings, spaced about 4 in. centers, fastenings to be galvanized or copper. The bottom longitudinal and the chines may be fitted and secured in a similar manner to the seam battens, they are preferably of yellow pine but may be of white pine or spruce, spaced and fitted as shown on the cross sections.

The tunnel sides may be cut according to the data shown, not forgetting to cut them high enough to allow for the 3/4 in. top and the 1 1/2 in. fore and aft clamp, making a total extension of 2 1/4 in. above the moulded line shown on line drawing. From the highest point of the tunnel aft to the transom carry the sides about level so as to give ample fastening for the bracket piece shown; to make a good connection to the transom. The transom being made of two pieces joined by a seam batten as shown and further stiffened by vertical cypress strips 3 in. deep 1 in. wide, well screwed up and so disposed as to take the sides of the tunnel; all as shown.

Bottom Planking

The bottom planking 6 in. x 3/4 in. cedar is run crosswise and should be carefully fitted and held to the chine and longitudinal battens by screws (three to each end of plank), planks to run continuously from side to side of boat, the tunnel top should be carefully fitted and secured in the same manner. The outer longitudinal rubbing strip of 2 in. x 3/4 in. yellow pine may now be fitted, either riveted or screwed. Run an occasional rivet through inner and outer longitudinal to tie both well together. Now finish off the bottom and trim the overhanging edges of the bottom planking to follow the tumble of the sides. Cut away the temporary framing and turn the boat over. Set the 2 in. x 1 1/2 in. clamps as shown to the upper inboard edge of the frames, use spruce for the clamp, white pine or cypress; rivet through plank frame and clamp, set up on washers and between the clamp and the sides of the boat fit blocks every 6 or 8 in to fill up the space left there, use through rivets here also. The half round beading 3/4 in. x 1 1/2 in. of oak may be secured by screws. The deck beams cut to suit the curve of deck beam mould may now be fitted, they are notched into the clamp. The sides of the boat and the head of the frames and clamp may be cut to the proper level by use of the beam mould. The shaft log as shown is about from 2 in. to 3 in. thick oak fitted as shown, care being taken to have the bottom surface fit perfectly to the bottom curve of the tunnel screw thorugh the planking into the log, first smearing both surfaces well with white lead.

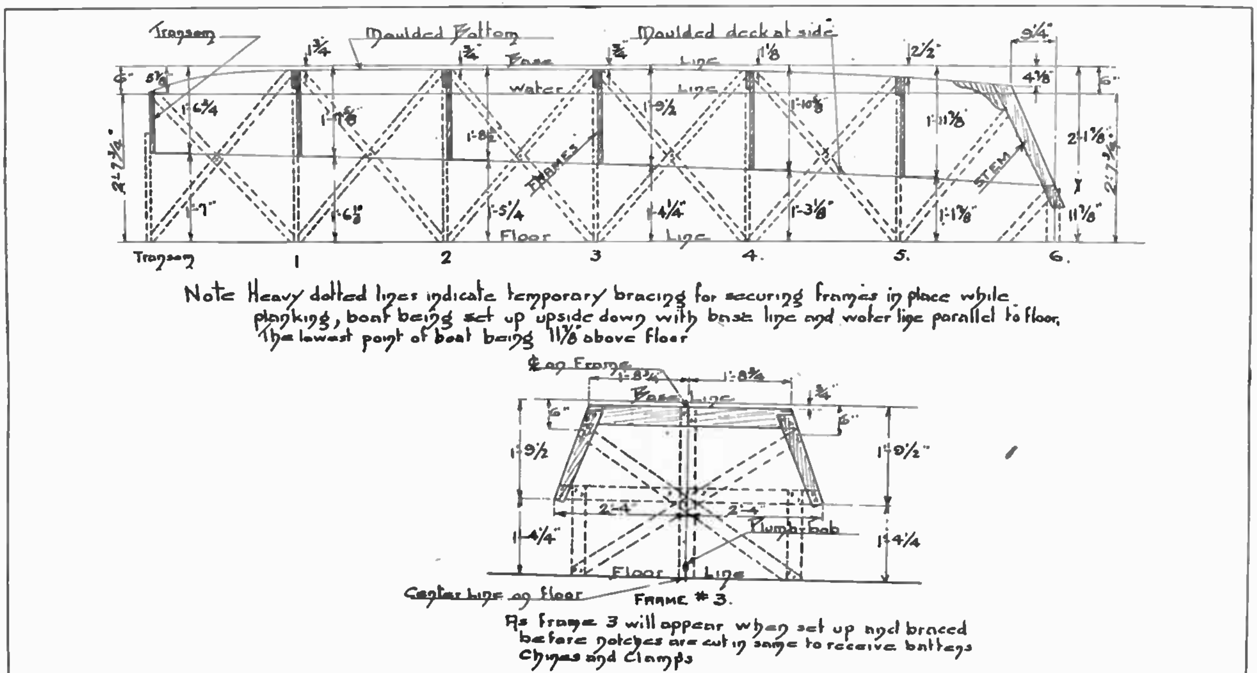
Simple Shaft Log Construction

I believe the simplest way to construct a shaft log is in two pieces, that is, with a vertical longitudinal seam, the inner surfaces being nicely dressed, batten, all as shown on the longitudinal inboard section, the bed may be entirely of yellow pine.

Fit a ½ in. round galvanized or brass bar around the forward edge of stem running same well down on center chafing strip. The rudder is oak 1 in. thick, shaped and hung as shown. The tiller should be substantially as shown in order to allow the ensign staff to be stepped as far aft as possible, the tiller may be made up or purchased. The strut is to be cast bronze V-shaped having either side pads for securing to the sides of the tunnel or top pads for securing to top of tunnel, in either case the fastenings must be through bolts well set up on a doubling strip, secured to the inside of the boat.

to cool and remove the clay. It may be necessary to use a Stilson wrench to start the shaft, work a little oil in with it and it should turn easily in a short while. The purpose of applying the lamp black to the shaft is to prevent the babbitt from adhering to the shaft.

The fine black dots on the deck plan indicate that the deck is to be canvas-covered. If you do cover with canvas you may use a poorer grade of decking, paint the deck with a priming coat, then thoroughly paint the bottom side of the canvas; stretch it in place while the paint is wet, bringing it down along the sheer and tacking same with copper or galvanized tacks, then put your half round beading over the portion extending down over the sides. The top may then be painted.



SETTING UP DIAGRAM

then bolted together, care being taken to keep the line of bolts clear of the line of shaft and also the base line to which the log is to be finished, then after finishing to curve of the boat as explained above, take out of boat and open up and after marking center line for angle of shaft, instead of boring hole gouge out half the diameter in each half of the log, smear the sides well with white lead and replace your bolts, galvanized iron or brass, and securely set up nuts on washers, or better still, rivet head over washers instead of using nuts. The location for the hole in the bottom of the boat may be readily found and bored with an auger.

The exact shape of motor foundation will depend upon the particular motor you select, but in general it should be two fore and aft members extending a little beyond frames 2 and 3 and notched into them and having two cross timbers joining them together at the

Strut Construction

In designing the strut make your pattern for the inside of the boss for receiving the shaft at least ¼ in. larger than the shaft, then after the strut is secured and the shaft placed into the shaft log and the inboard stuffing box, and the shaft nicely lined up, babbitt the bearing. This may be done by coating the shaft well with lamp black previously filing the inside of the boss fairly bright and cutting one or two good grooves into it, place a ball around the other end, leaving a good size opening at the top for pouring.

It is assumed you have some means for melting the babbitt metal (white brass), the metal should be heated until it will nearly char pine, but before pouring your hot babbitt, heat your bearing and clay with a gasoline torch and be sure there is no water in the boss, then pour your molten metal until it runs out of the vent at the top, allow

On the outboard profile of this little boat a canvas spray hood is indicated, this need not be fitted, it simply being indicated to show the boat, though flat-bottomed, to have the same classy appearance as the V-bottom boat design.

In a boat of some speed where now and then choppy water is encountered the spray hood keeps the engine dry and makes the boat more seaworthy, in as much as you are not at all apt to ship a head sea. It should not be necessary to caulk the boat. Run a little water into her before launching to swell the seams. If you find she makes too much water at any time it is an easy matter to "haul out on the beach" and drive the necessary cotton as caulking into the seams.

In Transylvania natural gas has been cracked by heat and a mixture of tar and soot obtained. This mixture was used as the basis for the manufacture of arc light carbons.

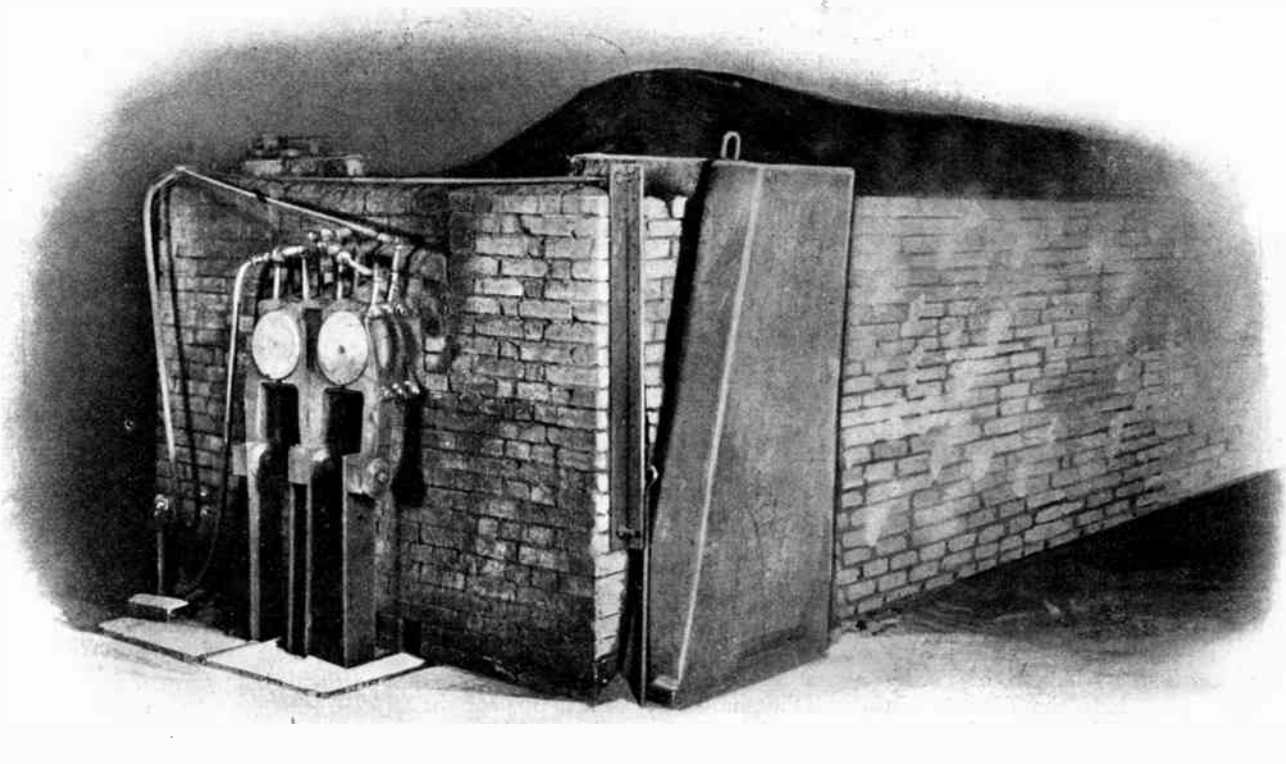
The Story of Artificial Abrasives*

By Raymond Francis Yates

An old bi-polar dynamo strained to the limit of capacity to maintain an arc in a furnace made up of an iron bowl and electric light carbon played a very large part in the industrial history of this country and gave to the world a substance so hard and sharp that it takes its place next to the diamond. The man who placed a little mud and coke in the bowl with the hope that a new substance would be formed was Dr. Edward Goodrich Acheson; the place, Monongahela City, Pa.; the time, in the late '80s. When Dr. Acheson removed the mass of heated material from his "furnace" nothing was present that would have received the attention of the average man. Dr. Acheson was an experimenter; he was not satisfied with a superficial examination of the material he had taken from his improvised furnace. He looked closely and found a few little crystals clinging to the carbon electrode. The crystals were taken off and rubbed across a piece of glass; they scratched. Further experiments showed that these tiny crystals were so hard that they could scratch the surface of a diamond. These crystals were carefully collected, and placed in a vial. The substance was called Carborundum and sold to a diamond polisher in New York at a price that would have brought a pound of it to the magnificent figure of $800. So runs the story of Carborundum. Today this substance is being produced by the ton—by the carload. It is made into grinding wheels, powders, coated papers, etc.

A few years ago the world sharpened its tools, ground its dies and polished its work by the aid of emery. The emery wheel could not cut fast, was unable to hold its shape and wore away rapidly, but it was the best article available at that time. The whole tool and machine industry of the world depended upon the emery wheel. With the discovery and cheap production of Carborundum, the machine industry was revolutionized. Carborundum bows only to the diamond in point of hardness. Its keen, brittle crystals cut fast and clean. The advent of Carborundum made possible many things that were theretofore unattainable.—Editor.

Carborundum is born within the blinding whiteness of the electric furnace. It is here where the elements silicon (in the form of sand) and carbon (in the form of coke) are caused to unite chemically, the resulting substance being Carborundum which is recognized by the expression SiC. Carborundum furnaces are long, trough-like structures with graphite electrodes arranged at each end. These electrodes carry the current to a central core made up of carbonaceous materials. During the operation of the device the temperature of this core reaches 4060 degrees Fahr. The raw materials (coke and sand) are placed about the core and the terrific heat of the core is communicated to them. Each furnace has a capacity of 2000 electrical horsepower and this amount of energy is expended for a period of 36 hours before the complete chemical transformation has taken place. The walls of a Carborundum furnace are of a collapsible nature and at the end of each run they are taken down to facilitate the removal of the Carborundum crystals which are present in great iridescent masses about the carbon core.

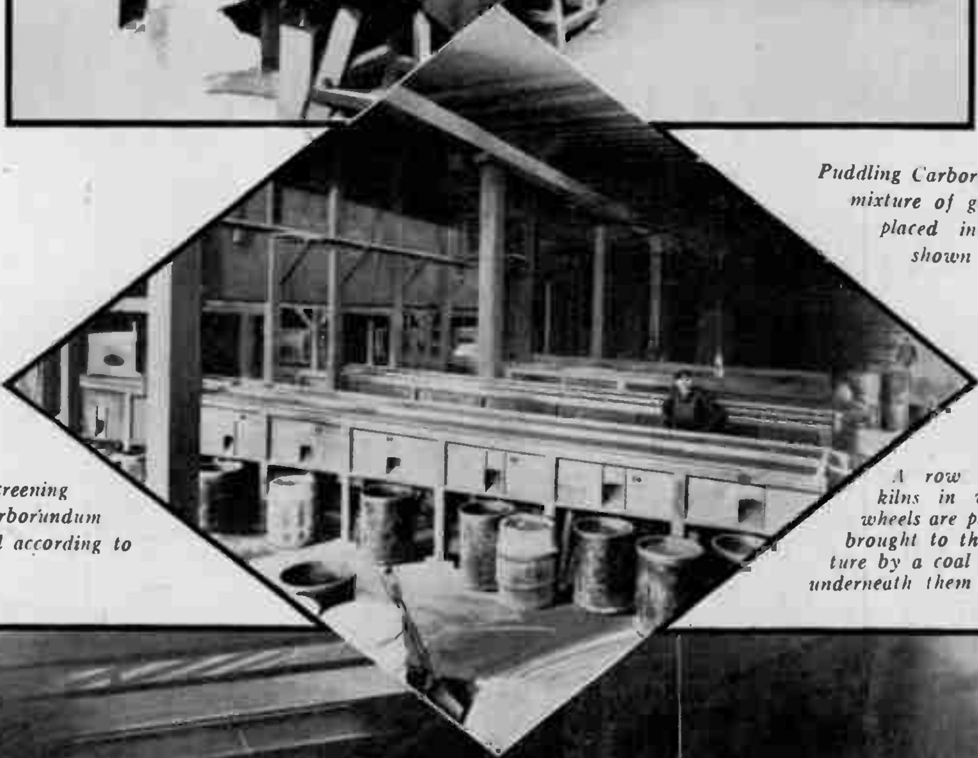


One of the great furnaces used in the production of Carborundum. The interior of this furnace reaches a temperature of over 4000° Fahr.

The Carborundum crystals taken from the furnace are crushed under great revolving stones after which the particles are thoroughly washed and graded. The grinding of the grains is brought about by a very ingenious device. A long incline is made up of screens with various meshes; starting with very fine screens at the top and ending with a very coarse screen at the bottom. The screens are oscillated and

*Photographs for this article were furnished through the courtesy of the Carborundum Co., Niagara Falls, N. Y.

Puddling Carborundum wheels. The mixture of grains and bond are placed in the large forms shown



The grading or screening room where the Carborundum grains are separated according to their size

A row of great vitrifying kilns in which the abrasive wheels are placed. The kilns are brought to the required temperature by a coal fire which is placed underneath them the grains starting at the top gradually bound down the incline until they reach the screen that permits their passage.

Abrasive wheels are made up of grains held together by means of what is known as a bond. The bond may be a vitrifying clay, sodium silicate, rubber or shellac. The vitrified process is the most widely used. The grains are first thoroughly mixed with the fusable clay in the proper proportions. The smaller wheels are pressed to shape under the ram of a hydraulic press while the larger wheels are formed by what is known as the "puddling" process. In this process the grain-clay mixture is puddled with water and cast into moulds where it is allowed to dry. After the mass has dried sufficiently, it is mounted and turned true on an especially designed lathe.

The puddling process produces a wheel with a greater porosity than those made by the pressed process. This is to be expected owing to the fact that pressure is not applied in the former case.

After the grinding wheels are formed by one of the two processes mentioned above they must be packed in sagers and placed in the vitrifying kiln which is then hermetically sealed and brought to the required temperature. Under this treatment the clay that forms a part of the wheel fuses or vitrifies and forms a hard matrix which incases the abrasive particles. After the baking process is over, the kiln is allowed to cool slowly and the wheels are removed to the lathe room, where they are again mounted on a lathe and trued up, this time with a diamond-pointed tool as the wheels are in a more finished condition and exhibit their abrasive properties more than before.

After being trued, the wheels are tested for speed. They are mounted upon a spindle and brought to a speed which is consistent with their size and weight. This speed is always considerably above that for which they are guaranteed. This is done to eliminate accidents due to bursting wheels when they are placed in use. During the speed tests the wheels are entirely covered so that should they burst no one will be injured by flying pieces.

Silicate wheels are made by mixing the silicate of soda with the proper amount of grain. This mixture is placed into moulds and put into a baking oven which brings about almost complete dehydration. After being trued and inspected the wheels are then ready for shipment.

The physical nature of abrasive wheels can be carefully regulated in the manufacturing process. The grit, grade and bond are under almost pe-fect control and wheels can be produced with properties that suit them to almost any task they may be called upon to do. In the case of vitrified wheels, ceramic experts are employed to keep watch over the clays used and to choose the proper clay for each different grade of wheels. The grade of a wheel is really determined by not only the nature of the clay but by the mixture of clay and grain. The larger the percentage of clay, the "harder" the wheel will be. The greater the mass of clay in a wheel, the more difficult it will be for the abrasive particles to break away from their seat after they have become dull. Thus, the wheel is said to be hard. "Soft" wheels are made by using a comparatively low percentage of clay so that the abrasive particles leave their setting when they become dull or partially so. In this way wheels can be made that are suitable for practically any kind of work. From the fore-running it will be seen that the grade of a wheel is important.

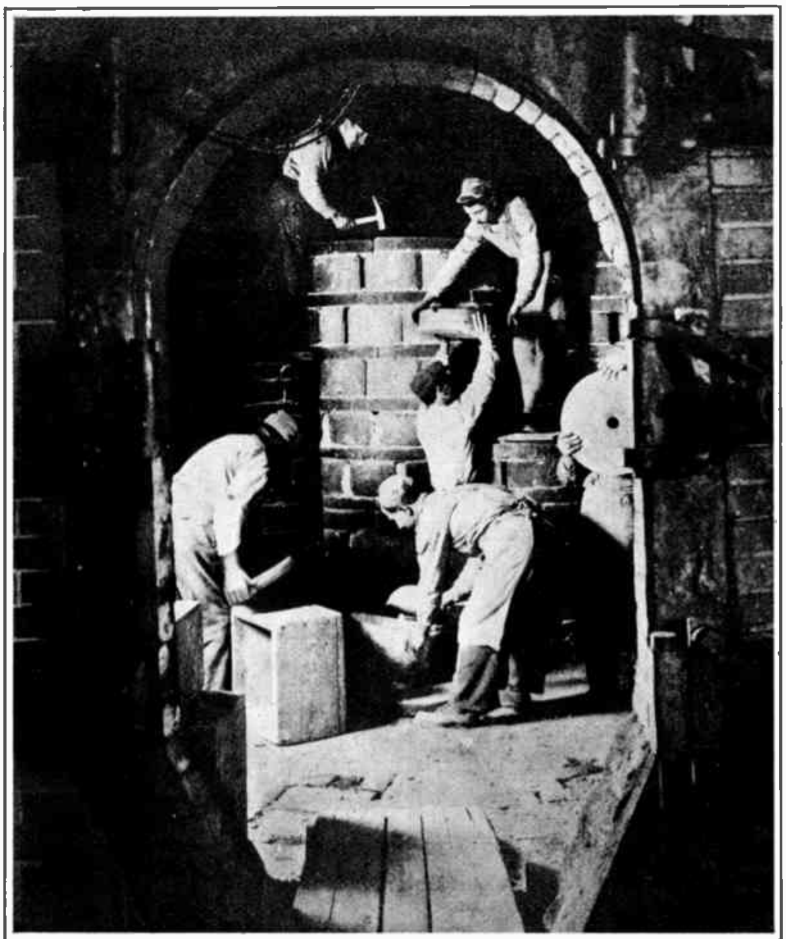
The grit of a wheel is the size of the particles that go to make it up. This is always designated by a number. If a wheel has a grit of 60, this means that its particles are capable of passing through a screen with 60 meshes to the square inch.

Shellac wheels are made by using shellac as the bonding material. After the grains are thoroughly mixed with the shellac in the proper proportions, the wheels are pressed to shape and placed in an electric oven and baked. These wheels are used for special operations.

Rubber wheels are made by pressing abrasive particles into rubber sheets as they pass under heated rollers. When heated, the rubber is capable of imbedding the grain in its fibre. When the rubber has been filled with the specified amount of grain, the wheels or discs are punched out. By means of this process wheels can be produced with remarkable thinness and owing to their elasticity they can be revolved at very high speeds.

Grinding stones are made in much the same manner as wheels. The grain, or powder, is thoroughly mixed with the bond, pressed to shape and baked. After the baking process is completed, the stones are squared by holding them against large discs revolving in a horizontal plane. A mixture of Carborundum powder and water is used upon the surface of the disc. The stones are manipulated by hand, several workmen being stationed at each disc.

Abrasive grains of all sizes are prepared for the market. They range in grit from 6 to 220. Beyond this the grains are sold in powder form. In place of being graded by screen, powders are graded by floating them on water. The powder that floats the longest is the finest. These powders are represented by the letters F, FF and FFF, which is the finest. Powders finer than those mentioned above are known as minute powders.



Loading a kiln with wheels. When the kiln is sealed and brought to the required temperature, the clay mixed with the abrasive particles fuses, forming a hard matrix

The Heat Treatment of Tool Steel

By Warren S. Dunlap

IN the average magazine article purporting to offer instruction to the experimenter, model maker and mechanic, in the art of treating the various tools he has to work with, we usually are able to sum the instructions up to the following: "Heat the tool to a cherry red and draw to a dark purple."

In times long since passed, such a rule may have answered most purposes for at that time only the ordinary straight carbon steels were used. Even then it must have been of a doubtful value to the mechanic as a reliable rule to follow; for what looks like a dull red to one man will appear to another as a dark yellow and so on. Another factor having much to do with proper heat to be applied is the percentage of carbon contained in the steel.

It will be patent then to anyone familiar with the action of heat on steel that if a piece containing 1.5 per cent carbon were heated to the same temperature that a piece containing .55 per cent would require, *the first piece would be burnt* and worthless as far as its cutting qualities were concerned. It necessarily follows that in order to get the best results and the longest service from a piece of tool steel it is of paramount importance that the carbon content be ascertained, and the proper heat be applied, most suitable to that content. Also, that the tool be quenched or plunged in the most suitable medium. This will also depend on the carbon content of the steel, and a suitable table is given elsewhere in this article, showing the proper heat and the proper quenching bath for different types of steel, including the chrome-nickel, chrome-vanadium, and the tungsten (or high speed) steels.

However, the purpose of this article is to offer some definite and reliable information for practical work and not to go into the intricate and technical principles involved. It is a matter of long and persistent study and research for those interested in the theory and metallurgy of steel.

It must not be forgotten that if the steel to be treated contains other hardening agents such as chrome, silicon or tungsten, we are obliged to look at the work from a slightly different angle and this will be the subject of a future article.

In treating steel there is no set of hard and fast rules by which to be governed, as the character of work to be performed, the temper of the steel, the kind of service to be used in, will all necessitate different processes in treating the tool. But, in all cases it must be remembered that the steel should be brought up to the proper heat, and should be the same temperature clear through, and not have any dark spots. Plenty of time should be consumed in heating, and the instant it reaches the proper temperature it should be withdrawn from the fire and plunged in the bath and left there until cold. If the proper heat has been applied there is little or no danger of cracking except in very high carbon steel and these should be quenched in oil which will not cause breakage.

In treating long reamers or other tools, never lay them in the water or oil length-wise, but end-wise and as quickly as possible, otherwise it will warp and distort the tool so that it will be worthless. In fact, all tools should be dipped in the bath end-wise whether long or short.

If a tool to be treated has any holes in it for bolts or screws, always fill these holes with fire clay or asbestos before treating as breakage is almost sure to follow if this is not done, especially in the case of the very high carbon steels (most drill rod is in this class).

Some shops use tools made of machinery steel (.25 to .40 C.) and put them through a case-hardening process, but this is a doubtful procedure and the tools are not as strong or reliable as those made from the correct steel. However, case-hardened steel has its field of usefulness elsewhere, aside from the fine tool field, and it justifies itself there.

Last, but not least, never place a piece of fine steel in a coal or coke fire so that it comes in contact with the fuel. If you do, it will be ruined as the thin edges will be blistered and burnt and there will, in all probability, be a soft skin of de-carbonized steel formed on the surface. Always lay a piece of pipe in the fire and the tool in the pipe. This gives the effect of the muffle furnace and protects the tool from harm. In addition it enables you to see the correct color of the steel.

If a nice finish is desired on the hardened tool, dip it in water when cold, and roll in powdered boracic acid. Then place in the fire until it has been heated to about 400° Fahr., take out of fire and again dip in the acid, making sure every part is covered by the glass-like film. Replace in the fire and treat in the regular manner. The acid will fall off in the quenching bath. The tool should be of a frosted silver color and very nice looking when this is done properly.

Below is given the most suitable steels to be used for the different classes of tools and they may be obtained from any reliable steel manufacturer:

Name of Tool	*Temper**	*Color of Hardening Heat*	*Quenching Bath*	*Draw to (Color)*
Chisels	.60— .75	Bright Cherry Red (1400 F.)	Water	D rk Straw (480 F.)
Drills	.85—1.5	Dull Cherry Red (1350 F.)	Water** Oil	Pale Yellow (460 F.)
Reamers, Taps....	.75— .90	Medium Cherry Red (1375 F.)	Water**	Straw Yellow (470 F.)
Springs	.50— .65	Red (1425 F.)	Oil	Dark Straw (480 F.)

*Carbon. **Water for low carbon. Oil for high carbon.

If the steel contains chrome or silicon, it will need a somewhat lower hardening heat than those given above, about 2 per cent, but the draw will be the same. If it is a vanadium or nickel steel the heat should be raised about 3 per cent, and draw the same.

If it is desired to treat tungsten or high speed steel, the proper method is to pre-heat the tool to a bright red (1500 Fahr.) then bring to a white heat quickly (1975 - 2100 Fahr.) quenching in oil until cold; next replace in the fire and bring up to a very dull red (900 Fahr.) and allow tool to cool off in the open air. This makes a very hard, tough tool with unexcelled cutting qualities, and while the better grades of high speed steel cost from five to ten times more than carbon steel it is more economic l for some classes of work, as a properly treated tool made of it will hold an edge when smoking hot and is capable of doing a tremendous amount of work.

In the case of a tap or hand reamer it would be folly to make them of this material as one could not commence to operate the mat anywhere near an efficient speed by hand. But where a

(*Continued on page* 421)

Makeshift Crankshaft Repairs for Obsolete Engines

WHEN the crankshaft of an automobile engine breaks, the best method of repair is to replace the injured member with a new one, as most repairs are very costly and not at all certain. Sometimes the car is an old model no longer manufactured or it may be a foreign car for which repairs would be difficult to obtain. The oxy-acetylene or thermit welding methods may be used for repairing, or the crankshaft may be made to serve for a time by a mechanical repair.

The four throw crankshaft is shown at *A*, Fig 1, has broken in one of the main journals. The first step is to turn off the broken parts flush to the crank webs in a lathe. To prevent springing of the shaft under the tool cut, blocking may be clamped between the webs as shown at *A*, Fig. 2. The end of the shaft is gripped in a chuck, or centers are used and the shaft steady rested and turned by a dog, whichever method is considered preferable by the mechanic doing the work. Holes are then drilled in the webs as shown at *B*, Fig. 1, and two keyways are cut in, 90 degrees apart. The hole should be about ¾ the diameter of the new journal piece which is turned from a piece of 50 carbon steel or special chrome-vanadium alloy steel if available. The piece is shown at *C*, Fig. 1. The dimension *E* conforms to the length of the bearing; the turned down portions *G* are as long as the web is thick. The diameter *F* should be about .002 in. larger than the hole in the web so it will be a force fit. Keyways are cut in the ends of the pin to correspond to those cut in the crank webs and keys are carefully fitted.

Before assembling the crank webs are heated to enlarge the holes somewhat and the cool pin is drawn in place by the special fixture shown at *D*, Fig. 1. The construction of the fixture is clearly outlined at *E*, Fig. 1. It consists of two forcing plates drawn together by substantial bolts. After the crank webs are forced in place against the shouldered portions of the new crank journal and allowed to cool, as a further precaution; holes can be drilled through the web and pin-reamed for taper pins, which are driven in and headed over. The keys insure that the webs will not turn relative to the journal, the taper pins insure against spreading, though if the force fit is properly made, this is a remote contingency.

The built-up crankshafts of some engines, notably those used on motorcycles employ the method of crankpin retention shown at *B*, Fig. 2. The holes in the webs may be reamed tapering and the replacement pin machined to fit. In this case, nuts on the pin itself may be used to keep the crankshaft parts in place. The nuts must be thin enough so as not to interfere with any parts as the crankshaft revolves. If the break comes in the rear main journal, as at *C*, Fig. 2, the repair is made in a similar manner. In this case the part for replacement may be shouldered or tapered and drawn firmly into the hole in the crank web by a clamp nut, care being taken to key it in a positive manner. If autogenous welding apparatus is available, the most satisfactory and really permanent repairs may be made by this method.

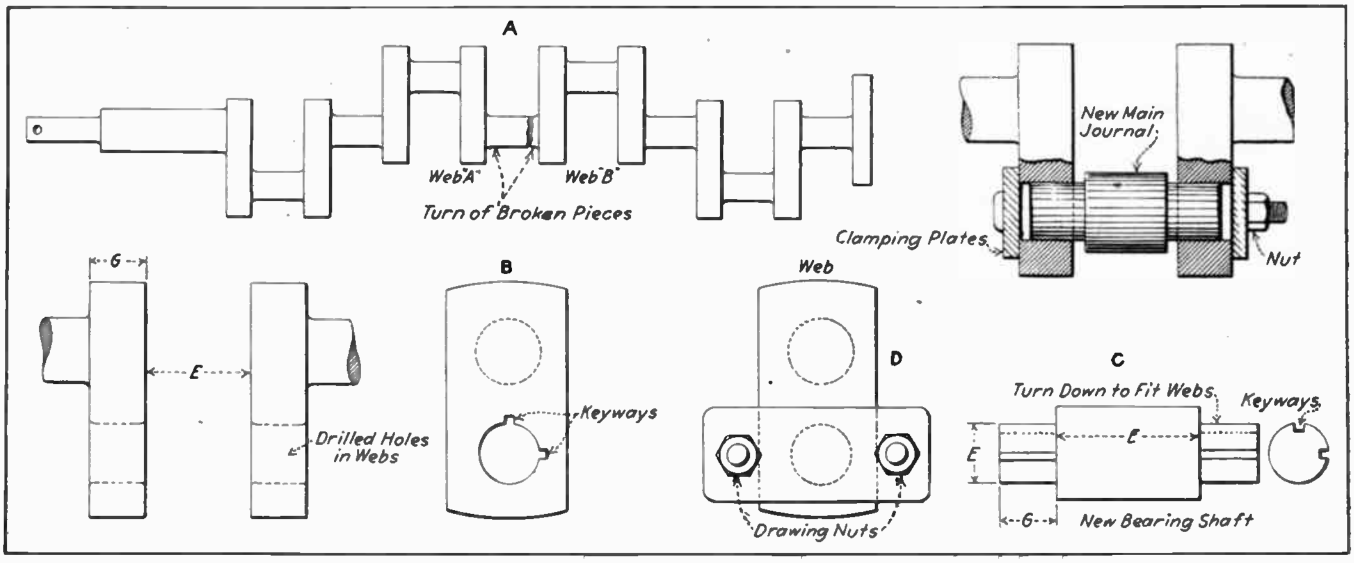


Fig. 1. Showing steps in turning off broken main journal pin and replacing with new main journal shaft

SQUARING THE CIRCLE

By Prof. T. O'Connor Sloane

THERE are certain problems which in past ages have occupied a peculiar position in science. For many generations finding the longitude at sea was an unsolved problem. The sextant, or rather its predecessors, the old wooden and ivory quadrant, the astrolabe and other crude instruments enabled the approximation of the latitude to be obtained, but not the longitude. At last the problem was solved by no new scientific discovery or mathematical calculation, but simply by the production of a clock which would either keep time, which it rarely does, or which would run day in and day out with a uniform rate of error.

Lunars, as observations of the moon for longitude are termed, had a certain vogue, but their complication and the fact that small instrumental or observational errors were greatly magnified in the final result, have caused their general abandonment.

What the future of wireless telegraphy has in store for the navigation of ships is open to conjecture. There is every reason to believe that it may take the problem of the longitude to a great extent out of the clockmaker's hands and give it to the electrician. It is fascinating to think of what radio-telegraphy may have in store for the sea navigator as well as for the aeroplane pilot.

One of the most famous of the unsolved problems of the world is the squaring of the circle. This means a method of finding the side of a square whose area will be equal to that of a circle of a given diameter. This resolves itself into finding the ratio between the diameter and circumference. One of the lessons of childhood touches on this ratio. How many of us have been taught that three times across the circle is once around it, which would be a very valuable and interesting figure except that it isn't so.

The factor by which the diameter is multiplied is symbolized or designated by the Greek letter κ, pronounced pi; it is supposed to be the initial of "periphery." The efforts to find it go back thousands of years. Archimedes, before the Christian era, put it between 3 1/7 and 3 10/71. The first of these is a little over the mark about 13/30,000 too big. The second one is too small by about half the same error, so by averaging them a reasonably close approximation would have resulted.

Another of the old-time factors was the square root of 10 $\sqrt{10}$, which is worse. The Arabians attribute this approximation to the Hindus, so it is fair to say that it goes back into remote antiquity. If you want a square root for a factor try $\sqrt{9.87}$—this is quite close. The Chinese κ is 3 7/50, about as bad as the Hindu factor. Copernicus, a few hundred years ago, put it at 3 17/120, which is a very good approximation, whose error is about 17/300,000.

It was at the end of the 16th century that a Netherland mathematician, Peter Metius, evolved the fraction 355/113, which is extremely close to the mark—so close that its use is to be highly recommended for those who prefer vulgar fractions to decimals. It is computed that the error for a circle of 100 feet diameter would be less than 1/12 inch of the circumference; the error by Archimedes figures would be between one and two inches. A later mathematician, Ludolf Van Ceulen, calculated the value of κ to 35 places of decimals and in his honor the Germans call κ the "Ludolfian number." The error with 35 places of decimals is inconceivably small. The reader can cipher it out, if he is so disposed.

It is said that Metius distinguished himself by evolving his fraction 355/113 to surpass a rival, Simon Van Eyck. The error comes in the 7th decimal place; the comparison below shows the astonishing approximation by so simple a fraction:

Metius's factor 355/113	3.1415928
True value of κ	3.141592+

The value of κ can never be fully determined as it involves an endless decimal which can be extended as far as desired without ever reaching an end. For practical use 3 1/7 or 22/7 is frequently close enough—355/113 is close enough for anything short of astronomical dimensions. It would give the moon's orbit within about 200 yards if it were a circle. A very usual decimal is 3.1416. This is less than 1/30,000 wrong and is applicable to about all mechanical calculations of the more exact kind. Never use the factor 3—it is too far off the mark.

If you like to use percentages multiply the diameter by 3 and add to the result 4.7%. This is fairly close. A circle 1 foot in diameter would measure approximately 3 feet + 3 × 4.7% or 3.141 feet in circumference by this method. This is closer to the truth than the 22/7 factor would give it.

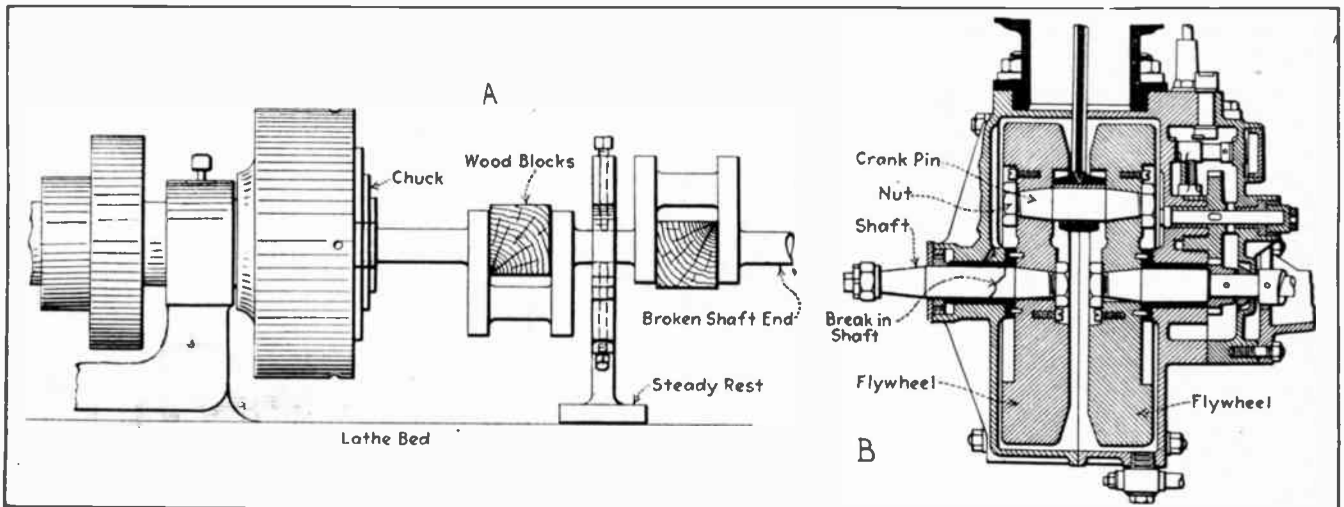


Fig. 2. Method of supporting damaged crankshaft in lathe for turning off broken main bearing shaft shown at A. Built-up crankshaft construction at B

MOTOR CARS FOR RAILROADS

THE use of motor cars in connection with railway transporation has developed very slowly. Of the various disadvantages which kept the internal combustion engine off the railways, the chief were the limited efficient speed range of the engine itself, the absence of a satisfactory means of building up a train speed from a dead stop, and the high cost of operation and maintenance.

During recent years, however, war conditions have greatly improved the standard and efficiency of motor vehicles of the motor omnibus and truck type, and the alternations in railway and motor costs have greatly improved the relative position of the automobile. The author of an article in *Canadian Machinery* describes a standard omnibus for twenty passengers set on a flanged wheel chassis. Two of these motor-buses are running on a standard gauge railway 15 miles long. A three-times-a-day service used to be maintained with a steam propelled mixed train, now the service has been increased with a greatly reduced staff.

On another system two cars have been coupled together at the back to obviate the necessity of turning round at the end of the journey. In this way one car is alternately the engine car and the trailer, and the speed between stations is 40 miles per hour. A very slow and inefficient service has thus been converted into an excellent one.

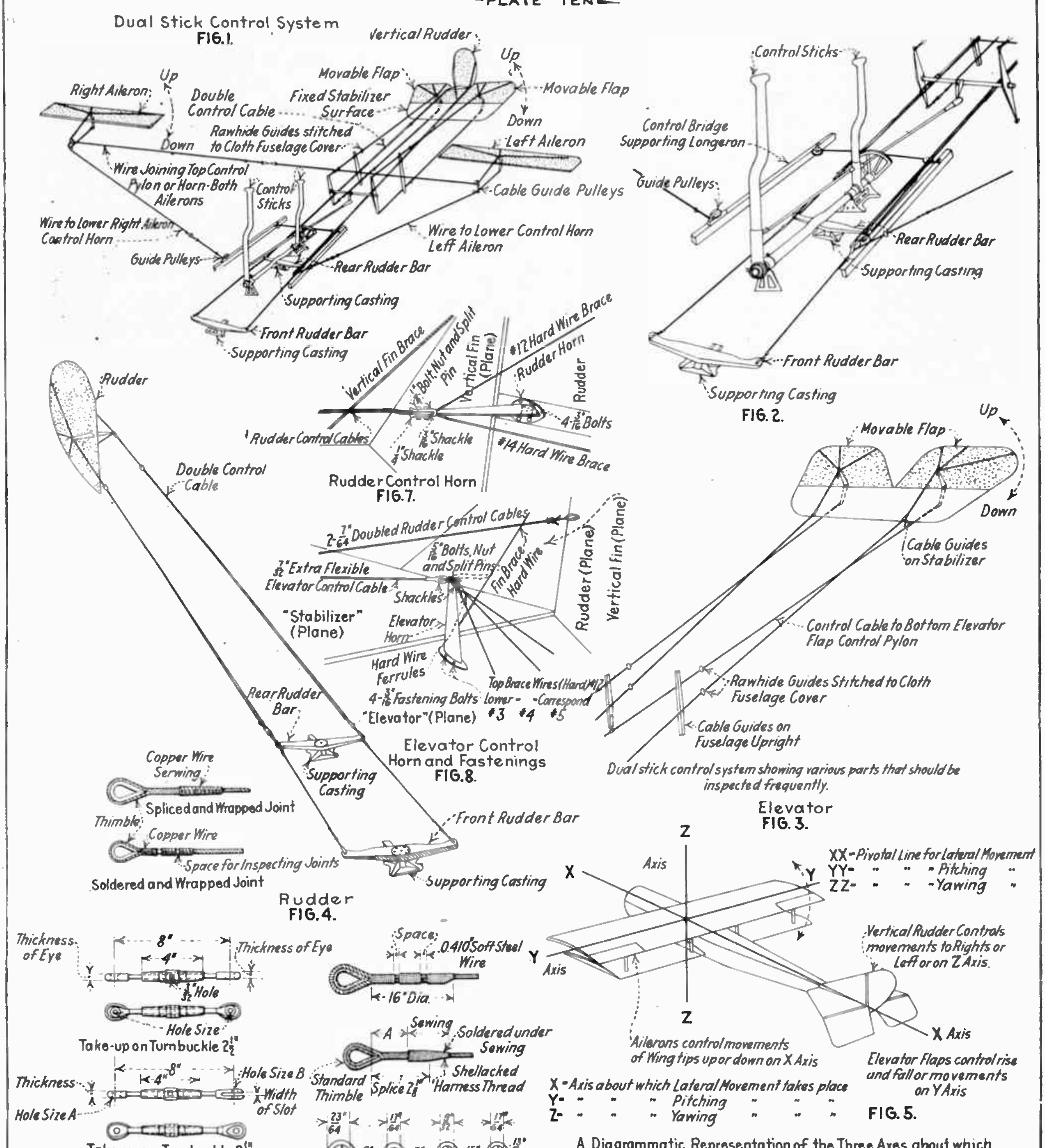
A third type of rail motor-car is driven off the track at the terminus and turned like an ordinary motor-bus, this being preferably on a square paved with stone, to prevent damage to the road from the wheels. The rail car is then driven on to the rails again. These methods of eliminating the expense of turntables or similar devices have proved expeditious and satisfactory.

The scarcity of tin during the war has had the effect of drawing attention to cadmium as a substitute in the making of solder. 20,000 tons of tin are needed annually for this purpose in the United States. It is believed that 600 tons of cadmium could be recovered from the dust of zinc smelters alone, instead of the trivial amount, 100 tons, now recovered annually. Germany is supposed to have used the comparatively rare metal for this purpose during her blockade early in the war. One pound of cadmium goes as far as three to five pounds of tin in the manufacture of solder.

Another odd instance of the killing of germs is to the effect that lemon juice, vinegar, white wine or alcohol have the power of killing in five seconds the coli bacilli in the oyster to the extent of 40% to 80% of the organisms present. The epicure in flavoring his oysters kills the germs.

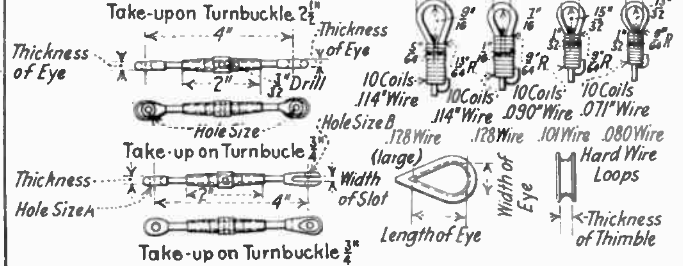
CONTROL (STABILITY)
LATERAL, LONGITUDINAL, DIRECTIONAL
TWO SEATER SEA-PLANE
DESIGNED BY C.E. MULLER M.A.E.

—PLATE TEN—



A Diagrammatic Representation of the Three Axes about which Movement of an Airplane in Flight May Take Place.

DIAMETER OF CABLE	LENGTH OF SPLICE	NUMBER OF TUCKS	LENGTH OF SERVING	FULL STRENGTH OF CABLE
3/32 7x14	1¼	3 over core buried 4 under	1	½ 800
1/8 7x19	1½	"	1	½ 2000
5/32 7x19	1¾	"	1¼	½ 2800
3/16 7x19	1⅞	"	1¼	¾ 4200
7/32 7x19	2⅝	"	1¼	¾ 5600



Details of Standardized Thimbles and Turnbuckles
FIG. 6.

Building A Two-Passenger Seaplane

By Charles E. Muller

Consulting Aeronautical Engineer

Control Elements
Part 7

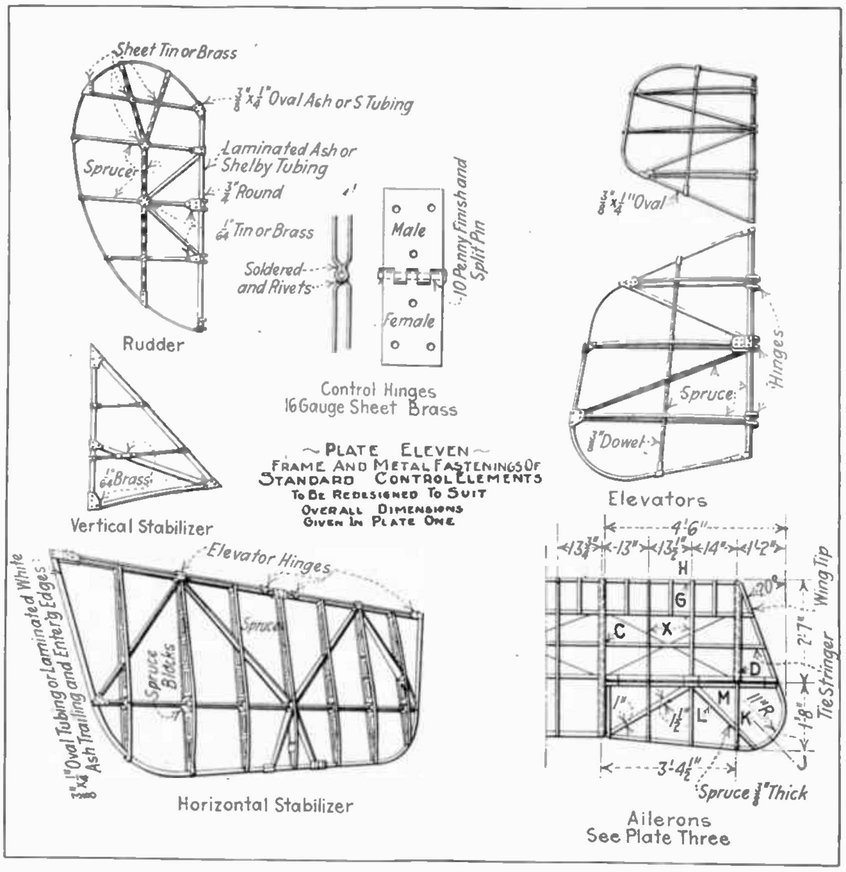
THERE are three kinds of stability necessary to consider in the design of an airplane. Dynamic stability, that which maintains the equilibrium of the airplane in flight. Static balance which is necessary to manipulate the machine from its position at rest to its flying speed and vice versa. To the layman this is perhaps overlooked but to the pilot it is an essential that constitutes the greatest flying problem. Its influence is decidedly felt when adverse conditions arise, that is, in maneuvering over the ground and when accelerating to take off and in landing, especially in forced landings. Aside of the very rare accidents in the air such as fire, failure of over-stressed parts and those due to combat, the only real problem is that of landing. This will be explained in the last article of the series.

The static balance has been carefully considered in the design of this airplane in that the pontoons have been lengthened and are more than 100 per cent. over capacity for flotation. The wheel landing gear has been strengthened and placed well forward of the center of gravity to prevent nosing over. Inherent stability is that which tends to balance the machine automatically as is to be explained in a later article. Of course inherent, static, and dynamic balance operates on the X-Y- and Z axis as depicted graphically in the fuselage diagram in the January edition of this magazine and in figure 5 of this issue. A study of the diagram in figure 5 will show that these, singly or some combination of them, constitute all the movements of any body in the three dimensions. It is a movement on one axis, more often a combination of two and frequently on all three axis that requires immediate adjustment or manipulation of controls when doing the so-called "stunts."

The movement on the X axis is called Rolling and is similar to a ship in a side sea. This is known as Lateral Stability. On the X axis it is called "Pitching" as it nautically and aeronautically is known as Longitudinal or Fore and Aft Stability, controlled by the elevators. The motion about the Z axis is called Yawing and is known as the Directional Stability attended to by the rudder. The Lateral Stability is controlled by the ailerons, as shown in Fig. 1, which are actuated by a 5/32nds of an inch cable easily traced and clearly defined in illustration. All control cables are usually in duplicate for a very high safety factor which is required by the government. However, it is not considered necessary in this machine as the single cables are sufficiently over-size. All control wires are always kept taut, i.e., one wire takes up the stresses applied while the compensating wire is played out in such a manner that as little slack as possible is permitted.

Caution must be observed that no control wires are ever tensioned highly enough to cause a binding tendency, especially of the ailerons. In the early days, the Farman type had large ailerons on top and lower wings connected together only on the respective sides. They were held horizontally by air pressure during flight, actuated by units independent of the opposite side acting as lifting surfaces only. In modern practice they are compensating while one side lifts the opposite side is depressed. Tracing the aileron cable from the Joy Stick quadrant Fig. 2, on through the pulleys on the seat sills, thence to the under pulley attached to the main wing bar in the outer wing section on to the lower aileron pylon shown at Fig. 8, plate 10. (The details of this horn appear in plate 4, Fig. 21.) A turn-buckle is placed in this cable between the pulley on seat sills and the outer wing section approximately a foot from fuselage covering.

The upper and lower horns are bolted through blocking attached to the framework supported by brass or tin strap bindings well braded with escutcheon pins by 4 3/16" steel bolts as shown in Figs. 7 and 8, plate 10. They are braced by 3 No. 12 hard-drawn wires, as shown. These are anchored to the trailing edges where they are braced by ribs that act as compression members. A study of the components in plate 11 with instructions for making wire terminals should suffice for all wire work required. You will observe that all control cable terminals are attached to shackles. All other wires are attached to small anchorage plates, shackles and fitting lugs. The wire connecting the overhead aileron pylons is called the compensating wire. It should have a turnbuckle near its center for adjustment and for convenience in disassembling the machine.



~ PLATE ELEVEN ~ FRAME AND METAL FASTENINGS OF STANDARD CONTROL ELEMENTS TO BE REDESIGNED TO SUIT OVERALL DIMENSIONS GIVEN IN PLATE ONE

The Joy Stick actuates the ailerons by a side-wise motion and the elevators by a fore and aft motion. If the Joy

Stick be considered as rigidly fixed, one may liken the stick as an integral bar, pushing it in the direction in which he wishes the machine to go. Pushing forward to descend, pulling backward to ascend, to the right to lower the wing on that side, etc., remembering the machine normally pivots on the axis as shown in Fig. 5, plate 10.

The rudder, however, is directly opposite in its movement; you push the bar on the side to which you wish to turn. This is just opposite to the bobsled, as you may readily see in Fig. 4. The reason this is done is to obviate the need of crossing the wires. However, it is optional, one may cross the wires and the same relative motion may be applied to the rudder that applies to the Stick. The mastering of these movements are absolutely necessary before flight is attempted. It is usually acquired by the student holding the Joy Stick lightly while the pilot manoeuvers the machine in dual control types.

Later the rudder bar is likewise learned, then combinations are tried as frequently and instinctively, some combination of all three are required to be executed almost instantaneously, especially during gusty weather when near the ground. This will be explained thoroughly in the last article of this series. I shall try to convince the readers that there is absolutely nothing in flying that a normal man or woman with steady nerves, machine and weather right, may not acquire.

The Joy Stick may be made of a straight grained piece of reliable hickory, white oak or ash, 1¼" at the butt, which must be bolted in the socket, tapering to about 1 inch with a knob at the top or rubber taped. A piece of 1⅛" tubing with a hardwood core may be used. The fittings shown in Fig. 2, plate 10, quadrant bearings, yoke sockets, etc., may be aluminum castings or built-up steel fittings, as the builder wishes.

Wiring

Aviation cable is used where there is excessive vibration or wear over the pulleys, principally because of the warning it gives by broken strands if over-stressed. Vigilant inspection should be given as instructed later. Hard drawn wire may be cracked or badly stretched without detection, so therefore are not used for the more important wires such as lift wires. It is recommended that the four main wing lift wires be 3/16" cable, approximately 4,200 pounds tensile strength, for a safety factor of 10 or on double wires 20. The landing cables will be ample if of ⅛" diameter, approximately 2,000 pounds. The landing gear cables should be 7/32" cables. The stagger wires may be of No. 12 hard-drawn wire Turn-buckles are recommended for all wire to make the necessary adjustment required after hard landings.

A close study of Fig. 6 will show how the wire and cable terminals are made. The cables are spliced and soldered as shown or turned back to at least 12 diameters of the cable over a thimble and wound with soft steel wire, then soldered. Sometimes the loop, which must be ample, is wound with a copper wire serving in lieu of the thimbles.

The hard wire is looped over a pin or bolt three or four times the wire diameter with a bend free from any kink with sufficient length to take hold of the end to bend back over the coil, Fig. 6. The surplus may be easily snapped off by filing a nick in it and then flexing it. The coil must be of hard drawn wire tightly and closely wound at least ten times. The loop is then dipped in soldering paste (acid is tabooed by experts), then in a pot of molten solder.

It is urgently recommended that several of these terminals be made for practice before attempting to cut the wires to length. A certain allowance must be known before it is safe to cut the wires to length. Make up the largest ones first, as, if there is any discrepancy or error, they will make the shorter ones by cutting to the required length.

A very easily and satisfactory made loop is accomplished by placing a ferrule sawed from a piece of copper tubing (16 gauge) whose diameter will permit its being flattened to an oval that will just admit the wire and the turned-back end. The same dimensions and method is shown in Fig. 6 (hard drawn loops) will suffice. This method is now nearly obsolete and not recommended. A cheap substitute for a turn-buckle will be diagrammatically explained next issue.

The framework of the control members, shown on plate 11, are of the general standard type and sufficiently clear to guide one in the designing of these components for the Seaplane. The rudder of the Seaplane is a balanced one. The general construction is the same as shown with the exception that the top trailing edge does not stop at the rudder post, but continues to form the section that is usually occupied by the vertical stabilizer or fin. This fin is located underneath the fuselage and is rigidly braced to form a solid anchorage for the lower rudder hinge. These hinges may be made of 16-gauge sheet brass similar to that shown on plate 11, and the same construction may be used for elevators and ailerons.

At Fort Worth, Texas, there is being established a new helium plant to extract the gas from natural gas. The latter is to be piped ninety-six miles, and the pipe-line is to have a capacity of forty to fifty thousand cubic feet a day.

INFLUENCE OF AVIATION ON ENGINE DESIGN

Experience gained in connection with aircraft engines will have an important influence on future automobile engine design, writes Charles Faroux in *La Vie Automobile.* "I am convinced," he says, "that we shall see the overhead camshaft type of engine become popular on the regular touring car, as well as on the speedster. This arrangement of the valves is the most rational from every point of view, and the objections which could be raised against it at the start are no longer valid. There are some very nice constructions, and some of these have already been described. Hemispherical combustion chambers also have a great future before them, and are destined to become the standard construction.

"The remarkable increase in mean effective pressure will also become evident in touring vehicle motors, and the specific output will increase proportionally. In the approaching races, we will see the output of 30 h.p. per liter (61 cu. in.), where we left off in 1914, improved upon, as well as speeds of 3,000 r.p.m. Touring vehicle motors will follow the same ascending path, and will exceed 20 h.p. per liter."

SIMPLE COPPERING METHOD

When clean iron or steel is dipped into any copper solution that is neutral or acid, the copper is deposited upon the surface by simple substitution. The iron dissolves and the copper takes its place. This fact has long been known and this method preceded that of electro-deposition by many years. Use is made of this property to coat small iron and steel goods with copper and it is still employed for the cheapest classes of hardware which will not admit, because of cost considerations, of electroplating with copper in the usual manner. Large amounts of iron and steel wire are coppered in this way and nearly everyone is familiar with the well-known coppered steel rods and wire so extensively used. While the amount of copper on the surface is very small, it acts beneficially in protecting the steel against rust, and for this purpose it is the cheapest process that can be used. A very general use is in machine shops where steel and iron surfaces are coppered with a simple "bluestone" solution to provide a surface on which dimension lines, circles, etc., as a guide for machining are easily scribed.

A receipt for liquid glue gives 500 parts of glue, 400 parts of water, and 100 parts of resorcine or though not so good of phenol, if the former is not to be had. The usual system of making liquid glue by the use of strong acids is in many cases objectionable.

INSTRUMENT TO AID IN AIRPLANE CONTROL

A COMBINATION recording instrument to aid the pilot in navigating aircraft under conditions that are not favorable to ordinary observations owing to lack of a horizon such as in clouds and darkness or when caught in a fog, has been developed in Germany. All three motions, climbing, turning and banking may be indicated simultaneously on a single dial. To ascertain if the airplane is banking or climbing when it is difficult to see the earth, a pendulum and a level are used. A miniature reproduction of the airplane is rigidly connected to the fuselage and is visible in the dial of the indicator, the amount of climb or bank being easily seen at a glance. For determining whether or not the machine is turning the use of the gyroscope is introduced.

A level, designed to show very small inclinations of the axis of the machine to the horizontal, consists of a fluid in an endless tube. The pendulum oscillations are damped in glycerine. , The gyroscope frame is restrained so it moves about one axis only, at right angles to the axis (horizontal in normal flight) of the gyroscope, and parallel to the direction of the motion of the machine. Even this freedom is restricted, the motion being controlled by springs. A pointer attached to the frame passes over a scale to the "picture" of the airplane on the dial, and shows at a glance the angle of bank. The instrument is staed to be reliable in action.

SMALL FARMAN MONOPLANE

THE Farman "Mosquito"—a diminutive single-seater monoplane, equipped with a two-cylinder engine of about 20 horse-power is announced by that prominent French maker as a type of single seat sport machine that will supply a popular demand. It is small enough to be stored in the average garage and its upkeep should be a simple matter, because of the simplicity of its construction. It is said to make a speed of about 65 miles an hour and land to at a speed of about 25 to 30, so that it can start or land on an ordinary road, if necessary. In flight, however, such small planes do not possess the stability of the larger machines. It pitches and swerves from side to side, which would seem to indicate that the pilot must be constantly on the alert to avoid accidents.

The sinking of a well, twelve miles deep, for purposes of scientific investigations and for determining the constitution of the earth's crust, was advocated at the last meeting of the British Association for the Advancement of Science. A period of eighty-five years and the expenditure of five million pounds was estimated for the carrying out of the investigation.

Making Cable and Hard Wire Terminals By Machinery

ONE of the most difficult obstacles to overcome in aeronautics has been the making of secure terminals on cables. A plane up in the air with the engine gone dead is in danger only to the extent of choice of landing. To be in the air with broken cable terminals is fatal, as control of the plane is impossible under such condition.

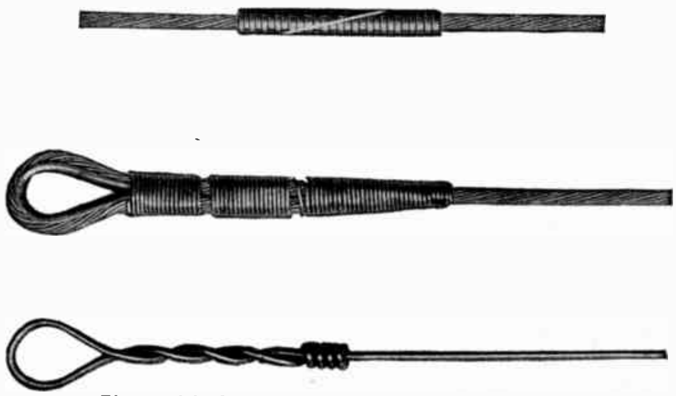


Fig. 1. Work turned out by the Edstrom machine

To serve terminals by hand, a very soft wire, of low tensile strength, must be used—copper wire is used in most cases—to enable the wrapping to be done by hand. This wire, when used under full tensile strength, falls short of a strong terminal, as is clearly illustrated by test, Serial No. 646, taken at McCook Field, Dayton, where it was shown that cables served with copper wire stood 71 per cent, against 100 per cent when served by special strength wire, both samples being made on the Edstrom machine. This, again, comparing with 32 per cent, being the best test on hand-served terminals, clearly shows the difference between hand work and machine, soft wire and a strong, springy wire that cannot be handled by hand.

The illustration at Fig. 2 clearly shows how tension is obtained by the Edstrom machine. First the spool is tensioned with lock-nut and spring, the wire then is dragged around the stationary drum, giving it the most uniform tension possible. By tightening the lock-nut, tension can be had that will break the strongest wire made, and what makes it possible to drag the wire to this high degree is, as will also be noticed in illustration Fig. 2, the continual wrapping up against the right-hand chuck, which is geared to work back just fast enough to permit the new turn room between the chuck and the last turn.

To save time, as well as improve the work, the company also has a machine to automatically clamp a metal flange on the cable, to keep it from flaring when cut; also a machine for cutting the cable, shown at the top, in Illustration No. 1. To do away with the expense of ferrule and soldering for hard wire, also greatly reducing the weight and cost, a machine has been built to turn out work, as shown at the bottom, in Fig. 1. Added to these, a test machine makes it a full and complete set of wire serving machine.

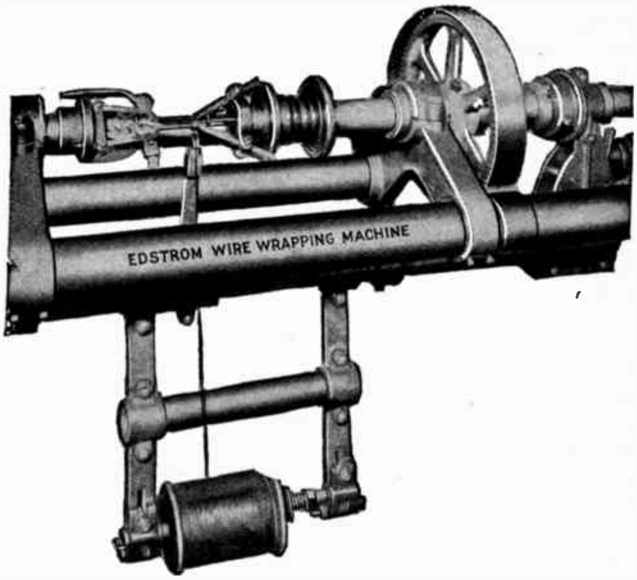


Fig. 2. How cable wrapping machine serves cable ends with wire under tension

The value of machine-made wraps to the aircraft is the fact that safer and better looking work is turned out, at a much lower cost of production, and, as the machine work will have a large influence in standardizing of cables, this will make still lower cost of production

The Kitchen Reversing Rudder

THE Kitchen rudder is fairly entitled to be called a curiosity in motor boat appliances. It is a double rudder, whose blades can be moved simultaneously to right or left, and which blades can also be brought close together at their rear ends. In one position they act exactly like an ordinary everyday rudder. But by bringing their ends together the boat can be brought to a slower rate of speed or to a dead stop or can be made to go backwards and all this without touching the engine, which continues to go in the one direction. No reversing gear or feathering blade propellor is required; the rudder does everything.

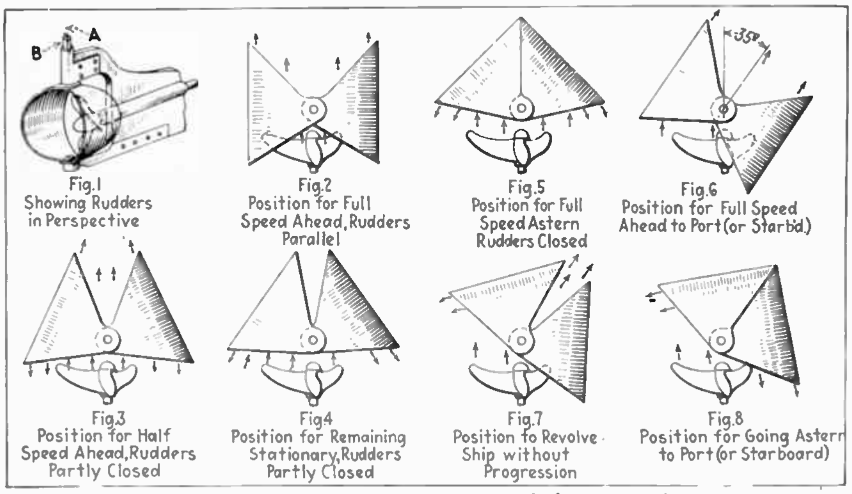


Fig. 1 Showing Rudders in Perspective. Fig. 2 Position for Full Speed Ahead, Rudders Parallel. Fig. 5 Position for Full Speed Astern Rudders Closed. Fig. 6 Position for Full Speed Ahead to Port (or Starb'd). Fig. 3 Position for Half Speed Ahead, Rudders Partly Closed. Fig. 4 Position for Remaining Stationary, Rudders Partly Closed. Fig. 7 Position to Revolve Ship without Progression. Fig. 8 Position for Going Astern to Port (or Starboard).

Figs. 1 to 8. Showing various positions of Kitchen Reversing Rudder

The first series of eight illustrations, Figs. 1 to 8 inclusive, explain the construction and operation of the rudder, and gives the various positions used for the different operations of the boat. The arrows indicate the water currents. The only thing to bear in mind in the cuts is that the rudder is astern of the screw. Thus in Fig. 5 the rudder forms a closed chamber astern of the screw, into which the latter drives a stream of water whose reaction forces the boat backwards. In all the cuts of this group except Fig. 1 the hull of the boat is supposed to lie below the screw and rudder as they are placed on the page.

The next cut, Fig. 9, gives a rear view or view from astern of the screw and the rudder blades, the line of the boat's counter showing above.

The manipulation of the rudder is simplicity itself. It is effected in different ways. In the illustration, Fig. 10, is shown an arrangement by which turning the hand wheel will rotate the two blades on their common axis so as to be parallel as for forward work, or can have their aft ends brought to any degree of closeness. There are two concentric shafts. The outer one is fixed as regards longitudinal motion; the inner one can be moved back and forwards by the screw mechanism in the forward end of the tiller. It will be understood that this double or telescopic shaft is the tiller of the boat. As the inner shaft is forced aft by the screw it forces aft the two oblique pivoted arms whose inner ends are connected to its aft end. Diverging therefore like a letter V, each has its other end pivoted to one of the rudder blades by an arc and sleeve. Going towards the stern these arms force together the after ends of the blades. When moved in the forward direction they separate the ends.

Each blade has its own stock or rudder-post concentrically arranged, and the whole can be turned together in one piece, as it may be expressed, by swinging the forward end of the tiller to right or left, exactly as in the ordinary hand tiller in use on smaller boats.

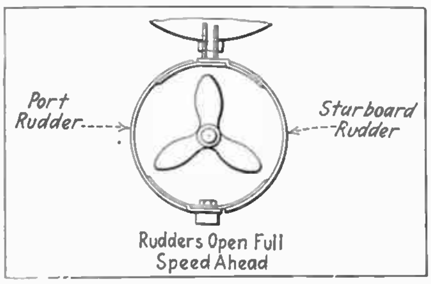


Fig. 9. Rudders open for full speed ahead

There are a number of ways of working the rudders; what we have described is one of several that have been in actual use. In one mechanism the blade manipulation is effected by raising and lowering the tiller's forward end, steering with it in the regular way. In another arrangement a smaller wheel to one side manipulates the blades, while the steering is done by a regular pilot wheel. This disposition is shown in the next cut, which is supposed to show the bridge of a power boat or the helmsman's place. Here the steering apparatus perhaps nearly the boat's length distant is operated by chain and wire gear.

Records of various official trials of boats fitted with a Kitchen rudder are given below:

Pinnace, 20 *ft.*, 7 *brake horsepower* (*Admiralty*, 1919).

Ahead speed: 6.2 knots (same as with ordinary rudder).

Astern speed: 2.02 knots (propeller full speed ahead).

Full speed ahead to moving astern: 7 sec.

Full speed ahead to dead stop: 4 sec. (in less than half boat's length).

Full speed astern to moving ahead: 4 sec.

Diameter of turning circle at full speed ahead (helm hard over): About one length of boat.

Launch, 25 *ft.*, 16 *brake horsepower* (*Air Ministry*, 1918).

Ahead speed: 9.80 knots.

Astern speed: 3.5 knots.

Full speed ahead to dead stop: Boat pulled up in 23 ft. (four men aboard).

Full speed ahead to dead stop: Boat pulled up in 16 ft. (one man aboard).

Time taken turning complete circle on own axis without progression in any direction: To starboard, 33 sec.; to port, 26 sec.

SCHOOP METAL SPRAYING PROCESS

A PROCESS for covering articles with a metal spray has been invented by M. U. Schoop. In this, the ends of two wires are brought to the melting point by passing a heavy amperage current through them, the current density being from 40,000 to 50,000 amperes per sq. in. The liquid metal globules thus formed are carried off by a jet of air or gas and deposited on the article to be coated. If continuous current is used the wire connected with the negative pole melts more rapidly and must be fed forward 1.6 times as fast as the other one. In the case of alternating current the fusing of both wires is at the same rate. A careful study has shown the melting and spraying phenomenon to consist of a quick succession of uninterrupted spark discharges which are accompanied by a special arc. The current density during the rapid succession of short circuits is so great that the particles of fluid metal would be thrown explosively in all directions, if they were not carried in a definite path by the air jet.

In order that no excess of metal vapor be present, the potential difference between the wires must not be too high. With the special metal spraying pistol a pressure of 30 volts is used. To lower it still further is inadvisable as the wires then melt away too slowly With a wire diameter of 0.032 in. this voltage gives a current flow of 35 amperes. The rate of feed of the wires is two to three yards per minute.

The air pressure of 50 lb. per sq. in. is generally used, but is not closely limited as in the case where the wires are melted by a gas flame. This permits of more finely spraying the metal and insuring a better bond between the object and its coating. Aluminum or copper sprayed on glass under an air pressure of 80 lb. per sq. in. cannot be removed without detaching smaller or larger glass splinters. Microscopic examination has shown that the glass at the points of contact is raised to the melting temperature and intimately unites with the coating. It is essential in this connection that the metal particles be absolutely pure and the temperature at contact high. It is said to be possible to coat readily inflammable materials such as wood, paper and even celluloid with metal by this process, without it catching fire.

FUELS FOR HIGH COMPRESSION ENGINES

In a recent paper by E. W. Dean and Clarence Netzer, publicity has been given to an important series of trials by various government agencies and the Delco Laboratories to determine the relation between the nature of the fuel employed in an internal combustion engine and the maximum compression ratio that can be used without interfering with smooth operation. The Delco Laboratories carried on their first experiments with an air-cooled engine adapted for operation on kerosene, and found that the use of compression ratios above a certain value caused what was described as "the kerosene knock" or "pinking." With proper selection of fuel this "knock" could be avoided. It was this "knock" which at the time caused the general conviction that the compression ratios of airplane engine should be limited to the proportions of 5.4 times atmospheric pressure.

A similar process of selection was applied to aviation engine fuels. The chemical properties of the fuels were obviously more important than the physical properties of the fluid. Accordingly, samples of gasoline were obtained from different varieties of crude petroleum; various types of synthetic gasolines were obtained. Benzol, alcohol, and cyclohexane were other fuels employed. Tests were conducted in a single cylinder Liberty engine, in which compression ratios could be varied from 5.3 to 1 up to 8.2 to 1. The final result of the investigation was that "hecter" benzol, alcohol and a special alcohol-benzol-gasoline mixture showed only a slight tendency to knock under any 8.2 to 1 compression ratio.

On a Liberty 12 a mixture of 70% of cyclohexane and 30% of benzene, give with a compression ratio of 7.2 favorable results both on the block and in the air, with perfectly smooth runs. Altitude laboratory tests showed a decided increase in power at all levels. Since one of the main points in aviation engine design is the employment of high compression ratios to keep down engine weight, the above results are very valuable and the chemist has shown the engineer a way out of some difficulties, which has much promise.

Much attention has been excited in recent years by calcium cyanimide, the basis for the fixation of atmospheric nitrogen. Now comes the statement that it can be used in case hardening steel and iron. The Shimer process uses melted alkali and alkaline earth chlorides, to which are added 5% of the calcium cyanimide. The cyanimide is at once acted on and a sort of effervescence takes place, which is advantageous in securing a good mixing of the fused material, although there is involved a loss of the cyanimide. The iron to be case hardened is immersed in the bath. The bath is cheaper than corresponding cyanide baths, and is free from the intensely poisonous effects of the same.

The preservation of chloride of lime, calcium hypochlorite, is greatly improved by drying it. Various agents have been tried, among the best were dry sodium hydrate and basic calcium chloride. Phosphoric anhydride and sulphuric acid were not so good. Only a little of the chlorine of the calcium hypochlorite was lost in the drying. The trade name of the compound is bleaching powder, and its value lies in its content of chlorine available for bleaching so that its preservation from losing this haloid is all important.

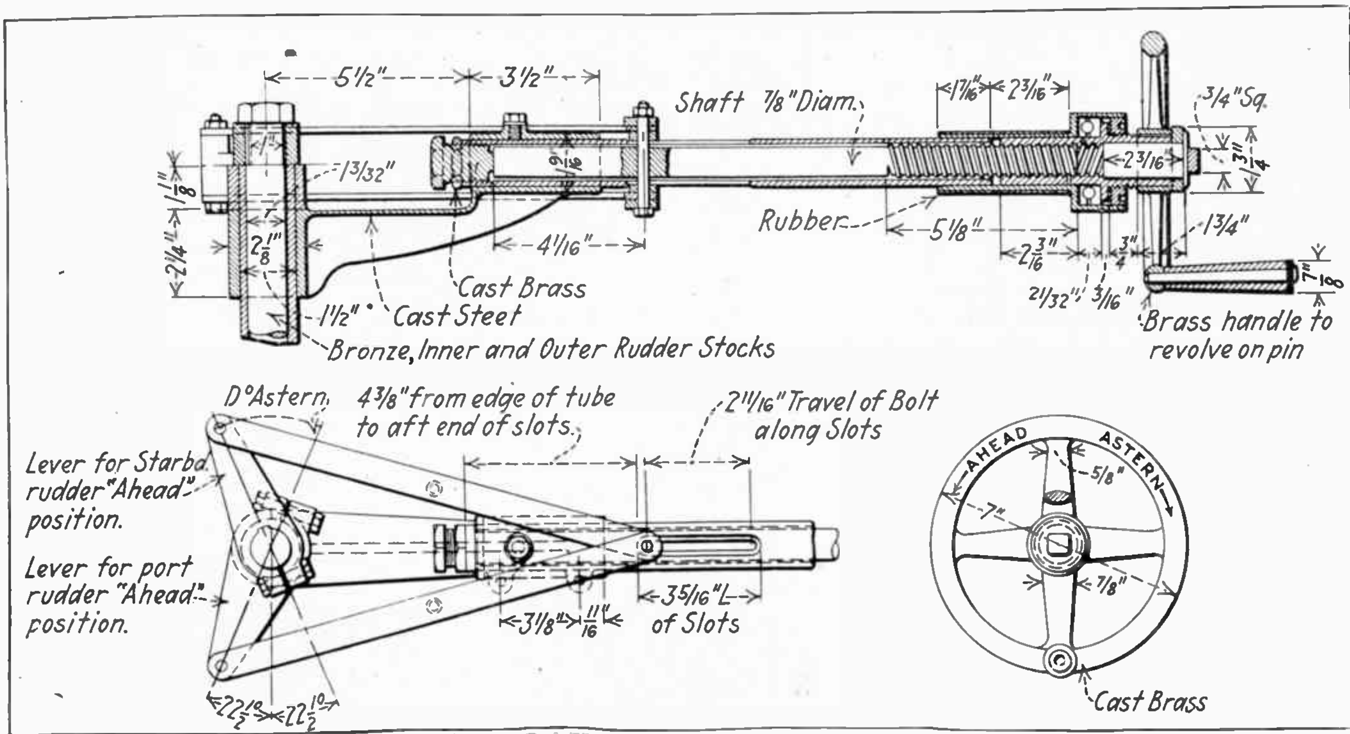


Fig. 10. Diagrams showing method of operating the Kitchen Reversing Rudder by screw and nut mechanism actuated by a handwheel

Adjusting Planetary Transmission

THE Planetary Transmission used on the Ford automobile is clearly outlined in part section at Fig. 1, the various adjustments and operating pedals are shown at Fig. 2, and a view showing its location relative to the fly-wheel of the engine is also shown at Fig. 2. The various adjustments are also clearly outlined. The operation is very simple and positive, there being three groups of planetary pinions P-1, P and

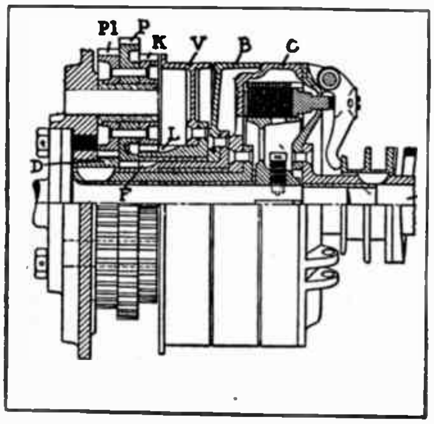


Fig. 1. Sectional view of Ford transmission

K. Gear P-1 meshes with gear D, which is keyed to a driven member attached to the drum C. The drive gear F is mounted on the end of a bushing which is riveted to the brake drum D. The gear L is attached to the brake drum B. The clutch is a multiple disc type normally held in engagement by a coil spring.

Three brake bands are used for this transmission, the one that constricts around the drum C is the foot brake and acts to retard movements of the car regardless of whether any of the other clutches are engaged. Tightening a band around drum B produces a slow speed. When the band is tightened around the drum V or that nearest the flywheel, a reverse motion is obtained. To apply either the slow speed or reverse band, it is necessary to break the direct driving connection by releasing the clutch spring tension and allowing one set of clutch discs to move independently of the other set. One set of the clutch plates is carried by the clutch case C which is keyed to gear D. The other set is carried by a clutch disc carrier which is supported by an extension of the engine crankshaft and prevented from turning by a set screw passing through the clutch disc carrier hub into the shaft. The adjustment of the Ford clutch is a very simple operation, this consisting of releasing the set screws in the clutch fingers by pulling out the split pin that acts as a lock and turning the adjusting screws. The slow speed adjustment is at the side of the gear case, and may be reached without removing the cover plate of the transmission which is necessary to adjust either the reverse clutch band or the foot brake band.

The chief trouble with a planetary transmission results from slipping clutch bands. In all cases these are provided with adjustments that can be tightened in event of wear of the friction linings up to a certain point. When the friction material wears thin, new brake lining must be riveted to the clutch bands. Care must be taken when making adjustments not to tighten any planetary transmission is usually caused by excessive wear in the gearing or in the bushings of the drums. Slipping of the high speed clutch may be easily remedied by making compensation for wear by the methods of adjustment previously described. When taking down a planetary transmission, it is important to note the condition of the bushings on which the planetary pinion groups rotate. If these are worn or if the pins supporting them become reduced in size, the gears will rattle when in use and the transmission will be noisy on low and reverse speeds and when in neutral position, though it will be silent in action on the high speed.

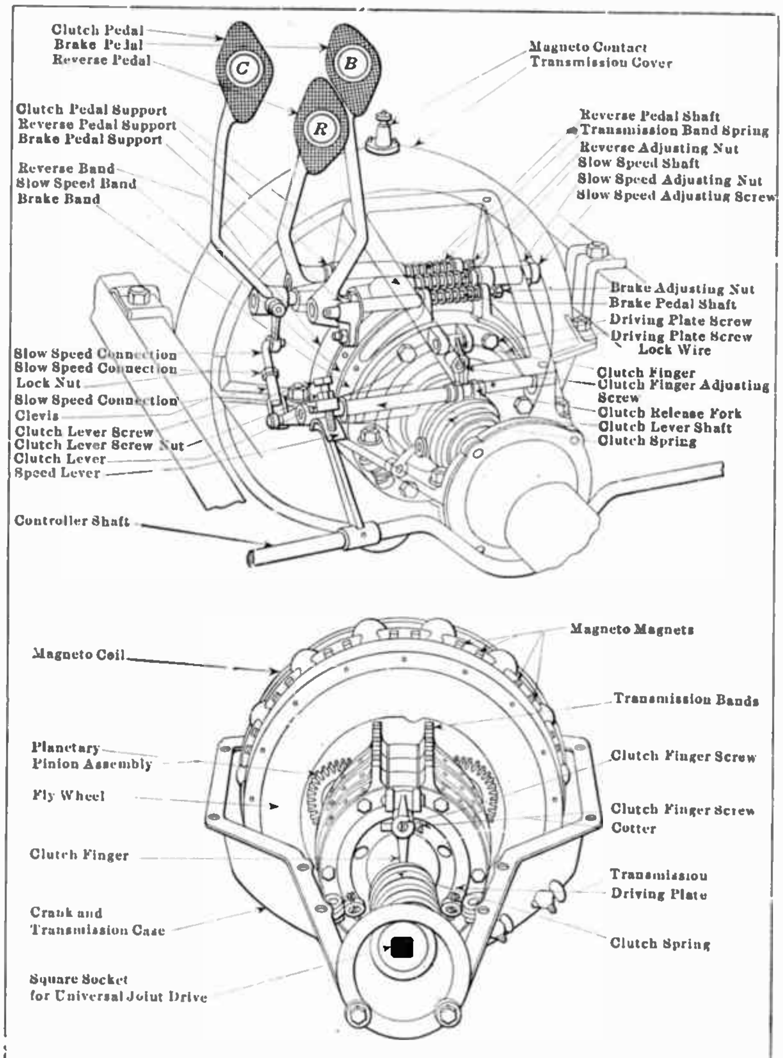


Fig. 2. Phantom view of Ford transmission at top shows operating pedals and leverage. The view below shows brakebands and high speed clutch adjustment

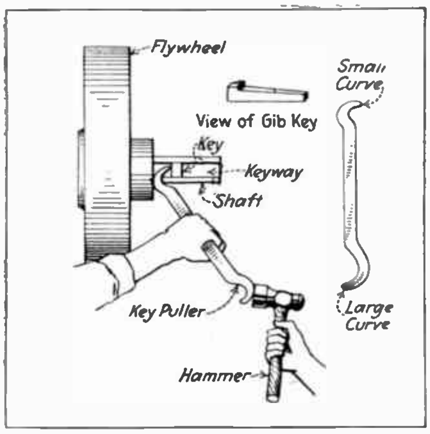
of the bands too much, as if these bind on the drum they encircle, it will produce friction which results in heating and wearing away of the brake lining and will also decrease the efficiency of power transmission. Noisy action of a

The brake drum surfaces often become grooved and these may be deep enough as to seriously reduce the strength of the brake drum. Where this condition is noted, new brake drums must be provided.

EVERYDAY MOTORIST

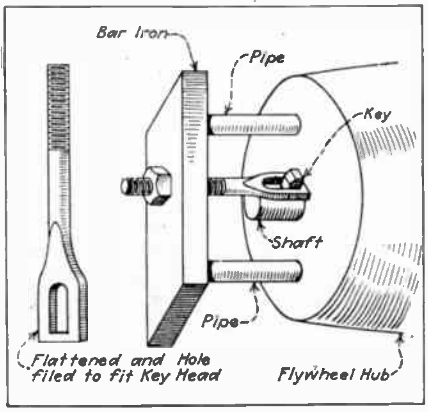
REMOVING KEYS

ON a number of cars of early vintage, such as the double-cylinder Maxwell and on many small marine engines, the flywheel is held on the crankshaft by means of jib-keys. When it is desired to remove the flywheel, as it is sometimes necessary to withdraw the crankshaft from the engine-base when rebushing the bearing, difficulty is sometimes experienced in removing the key. A very effective method of accomplishing this is shown in accompaning illustration. The key extractor or puller is forged of steel as indicated, having two hooks at the ends formed on curves of different radii. The one having the more gradual curve is used first to start the key while the one having more abrupt curve is employed for withdrawing it. When the key puller is placed between the head of the key and the hub of the flywheel a cam action is obtained by which the pressure of the hammer blows on the other end of the key puller is increased many times and the key started. If the key is rusted in place or if it has not been removed for a long time it may be found desirable to heat the end of the shaft with a blow torch or to soak the rusted parts with kerosene.



Special Forged Tool for driving out keys

Another simple and easily made appliance for removing keys that have rusted into place is also shown. This device consists of a large bolt the head end of which has been heated and flattened, a hole drilled through it and filed to receive the head of the key. A piece of bar iron is used to screw the nut against, this being held from the flywheel by spacers of pipe, steel shaft or metal blocks. Before using this puller, the key may be heated as recommended above and tapped on the head and sides sharply with a hammer for a time in an endeavor to break the rust bond. When the nut is screwed down so there is tension on the bolt, the end of the bolt can be given several sharp hammer blows which may expedite removal of the key.



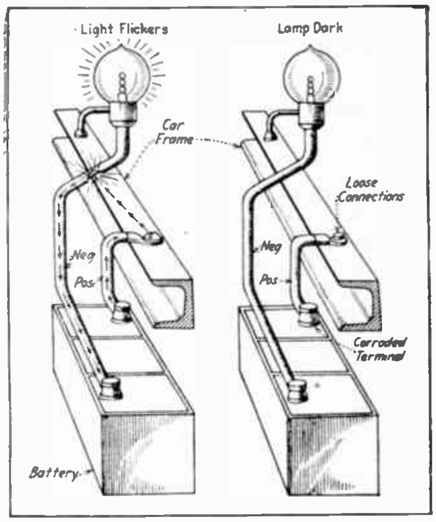
An easily made key puller

FAULTS IN WIRING

IN the two wire system every wire, connector and socket must be insulated from the car and should not be in metallic contact at any point except at the terminal. It is imperative that all wires be insulated from each other and the car frame except at points where permanent connections are made. All connections should be soldered to insure positive contact, held securely by means of cleats of insulating material and must be mounted in such a way that there is no possibility of sharp metal corners or edges wearing through the insulation and causing grounds or short circuits.

All wiring should be protected from the rotting action of grease, oil and water, and when the wiring is run where these substances are apt to accumulate the regular insulation should be supplemented by a conduit of insulating material such as circular loom or fiber tubing, or armored cable should be used. All wire should be so installed that there is no danger of interference between them and operating rods and levers. The abrasion of these members will wear through the insulation and result in short circuits. Brass or copper terminal connections should be used at all points and no connection should be made by winding as the strands may bridge across the terminal or to some metal part and cause a short circuit or ground. Special care should be taken with the connections in the lamps and other points. By the term "short circuit" electricians mean that two wires of opposite polarity are in metallic contact. Under such conditions the storage battery will be discharging and there will be no lights at the lamps. A short circuit may occur at any point in the wiring system, but is usually found at terminals that have been carelessly made or by worn insulation on wires.

A short circuit will be indicated by the position of the amperemeter pointer. Always note the position of the index hand of that instrument when the car is stopped. With the engine at a standstill and no lamps burning the hand should point to zero. If it does not the amperemeter is either out of calibration or there is a leak of current from the battery at some point in the wiring. To ascertain if the amperemeter is correct, uncouple one of the battery terminals of the lighting system. Obviously, if the hand swings to zero, the trouble is leakage of current, which should be immedaitely corrected after the trouble is located. If the index does not point to zero when the battery terminal is disconnected the instrument is out of calibration and while this does not affect the operation



Causes of flickering or inoperative lamp

of the system it should be taken into account when reading the amperemeter.

If the engine backfires when the ignition is interrupted and it makes one or two revolutions in the reverse direction, the amperemeter pointer may be found at the extreme of the scale on the discharge side. This is caused by the circuit breaker contact being held closed and means a short circuit of the battery through the generator winding. This must be corrected at once by momentarily disconnecting one of the generator wires or starting the engine. If the wires are removed from the generator for any reason, make sure that they are connected to the same terminals as they were originally.

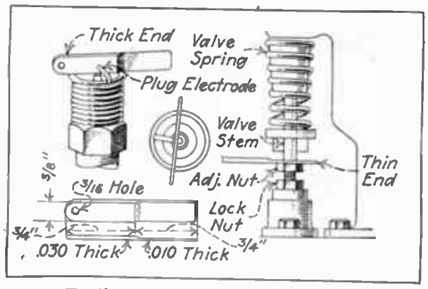
If the wires are reversed the amperemeter will indicate a dead short circuit by swinging to the extreme on the discharge side of the scale when the engine is started, and if this defective condition is not corrected the battery will be soon discharged. In case of a short circuit examine all of the wires connected to the battery terminals and to the lighting switch.

Make sure that the insulation is perfect and that it has not been cut through at any point. Whenever any wires are removed from any of the units always mark the terminals and the wire so that they will be replaced exactly as they were originally. If a short circuit exists when all the switches are opened, if one takes off a battery terminal and makes and breaks contact between the wire and that member a small spark will be in evidence. If no sparking occurs, connect up the terminal to the battery and then with the engine at a standstill close the switches to the lighting circuit one at a time and watch the amperemeter closely, as each switch makes contact. If the pointer does not move far from zero it shows that the current consumption is normal; if, however, the pointer swings to the extreme of the discharge scale it is evident that a short circuit exists somewhere in the circuit just brought into action. All the circuits can be tried in this manner one at a time.

If the amperemeter indicates only a normal amount of current consumption for the various lighting circuits it is apparent that no further search is necessary. If, however, the needle indicates a short circuit on one or more of the switch positions, examine the wires carefully for the circuits at fault, and if the trouble does not exist there it may be located in the lamp socket, the connector or the bulb itself. In case one or more lamps fail to burn the trouble is due to either a broken wire or a defective connection at the switch connectors, or lamp sockets or a bulb or fuse is burnt out.

SPARKPLUG GAUGE FOR MOTORISTS

A SIMPLE but useful attachment for the motorist's key-ring is shown in the accompanying illustration. It can be made of spring steel or hard brass, steel being preferred, however, since it can be hardened and tempered. It is made from a piece of stock about .050-in. thick, 1½-ins. long and ⅜-in. wide. Before hardening, a 3/16-inch hole is drilled in the end and the corners rounded off to make it easily inserted on a key-ring. The piece is then ground down to about .030 inch thick for about half its length and

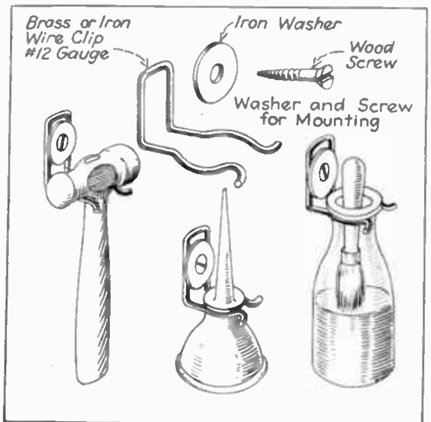


Easily made spark plug gauge

to about .010 inch thick for the remainder. The thick end is used for setting the gap between the electrodes of the ignition spark-plug; the thin portion will be found useful when adjusting the clearance between the valve stems and adjusting nuts on valve-lift plungers.

HOLDERS FOR TOOLS

SUBSTANTIAL clips for holding oil cans, hammers and other tools may be made as illustrated in the accompanying drawing. Pliers are used to bend lengths of suitable wire to a "U" shape and a bend is made in both prongs. The ends are shaped to conform to the neck of the container, or to



An easily made Wire Holder for tools

the handle of the tools to be placed in them. A washer and a screw are used to secure the clip to the dash of the car, or the wall of the garage. Such clips are easily made and installed and are very useful in keeping tools, oil cans, shellac bottles, etc., off of the bench top and keeping them out of the way until wanted.

OVERSIZE TIRE TABLES

OVERSIZE tires, designed primarily for exceptional and hard service, have come into favor among owners of medium and large capacity passenger cars, because of their extra strength, easier riding and longer mileage that may be expected from them. They are popular also because in the opinion of many owners they add to the appearance of the car.

Some users of oversize tires think that a tire with increased cross section diameter, but with no increase of diameter measured through the hub from outer edge to outer edge of tire, is an oversize. This is a mistake. In other words, if the regular size tire is 34x4, the oversize is not 34x4½ but 35x4½.

A tire manufacturer gives the following table to show the proper regular and oversize tire for a given rim which is the same as the regular tire:

Regular Tire	Oversize Tire
28x3	29x3½
30x3	31x3½
30x3½	31x4
32x3½	33x4
32x4	33x4½
34x4	35x4½
32x4½	33x5
34x4½	35x5
36x4½	37x5

Only the oversize tires in above list should be used to replace the regular size given because they have been designed to fit the same rim sizes as the regular tires and can be applied in their place without straining the beads. It will be noticed that not only the tire width but also its diameter is increased over the regular size.

CORRECTING FAULTY STEERING

AFTER driving a Saxon Six for some time I became annoyed with the abnormal amount of slack in the steering gear which developed slowly and without any apparent cause. Inspection showed that it was caused by a very little looseness in each joint, but there seemed to be no easy way to take it up. I finally decided to try a spring to pull on the wheels in one direction and this proved a complete success. The spring is a heavy coil 1" by 16" and is fastened under the front axle, one end on the steering rod and the other on the frame, so the wheels are pulled to the right. The tension must be adjusted for best operation. In driving, the wheel only needs to be kept steady, but in turning it will be found that the car responds quicker in either direction than without the spring.—LEO M. LAFARE.

MAGNET RECHARGING

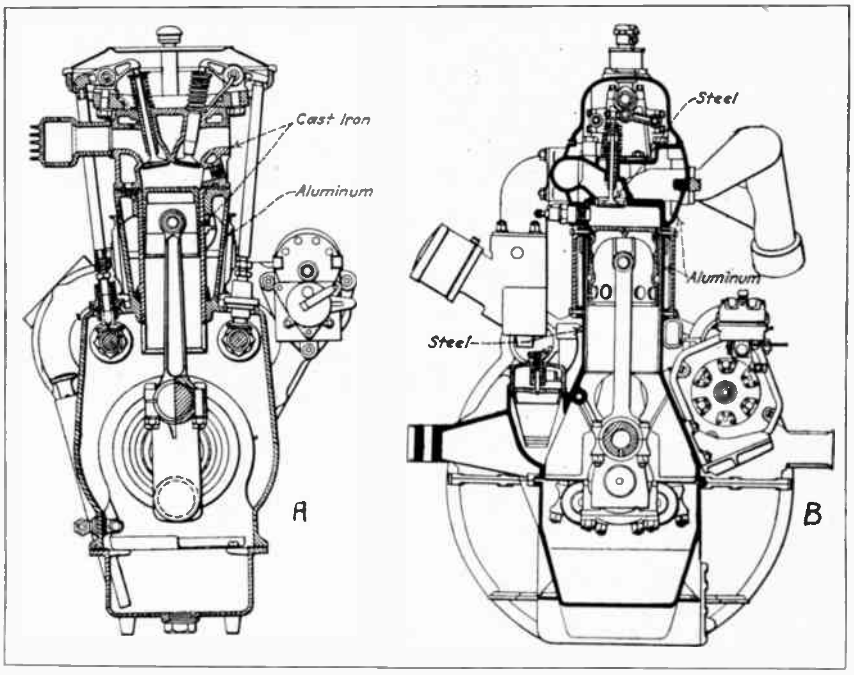
THE permanent field magnets used on magnetos are easily recharged by inserting them in solenoids wound for a current of 20 amperes at a potential of 6 volts so they can be coupled up to an automobile starting system battery of that voltage. The connection is made only for an instant as several contacts of a second's duration are all that is needed and this will not injure the battery. It is stated that a freshly charged tungsten steel magnet of a large magneto will lift in the neighborhood of 20 lbs. as ordinarily energized. This may be tested by a spring balance attached to a suitable armature member. In some cases where the magnets are large, the pull may be as high as 30 lbs.

TESTING MICA INSULATED SPARK PLUGS

PLUGS using mica insulation are very deceptive as in many cases short circuits exist that cannot be detected by the eye in daylight. A good way to test a suspected mica plug is to lay it on top of the cylinder after dark, taking care not to have the insulated terminal in contact with any metal parts except the high tension current lead. The engine is then run on the other cylinders and the inside of the spark plug watched to see if sparks jump between the insulator and the plug body, instead of between the points. If a short circuit exists, it will be easily detected by the minute sparks plainly evident in the darkness. It is sometimes possible to test a plug out in the daytime by shading it from the light in some manner, as with a black felt hat.

ALUMINUM CYLINDER BLOCK CONSTRUCTION

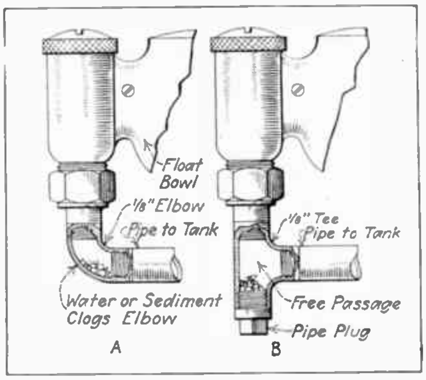
ONE of the contributions of aeronautical engineering to modern automobile engine construction is the use of aluminum for the cylinder blocks of automobile engines. There is also a growing realization of the advantages of the overhead valve placing, the actuation of these members being either by means of cam shafts carried in the engine base and depressing the valves through the medium of rocker arms actuated by tappet rods or mounting the cam shaft directly over the cylinders and driving that member by means of bevel gearing. The former type of engine is shown at A in the accompanying illustration, while the newer construction in which an overhead cam shaft is used is shown at B. When aluminum is used as a cylinder block it is not sufficiently hard material to stand the constant wear due to the reciprocation of the piston in the cylinder. For this reason a liner of harder metal such as steel or cast iron is interposed between the piston and the cylinder casting. There are two methods of using a liner of this type. The latest method developed, which is known as the "wet liner" type is shown at A. In this a cast iron member is machined in such a way that it has a flange at its upper end and is a close fit in the holes made to receive it at the upper and lower portions of the cylinder block. This cast iron liner is forced in place against a packing at the bottom and a water tight joint is formed at both top and bottom by the accurate fit of the liner. The reason that it is called a "wet" type liner is that the cooling water circulates directly around the cast iron walls. In the other construction, which is shown at B and which is known as the "dry liner" type, the sleeve is in the form of a thin steel tube which is pressed into the aluminum cylinder block and which is in contact with the aluminum casting its entire length. In this construction the water does not come into direct contact with the steel liner, which need not be very thick inasmuch as it is reinforced by the cylinder walls. Both of the engines shown are of recent English development.



Showing aluminum cylinder block construction methods

SEDIMENT IN CARBURETOR FEED LINE

REGARDLESS of how carefully fuel is strained when filling the automobile or motor-boat tank, a small amount of impurities will be introduced with the gasoline. The ordinary fuel filter using wire gauze screens does not prevent small particles from reaching the carburetor. While a screen will retard lint or scale, it will permit particles of rust or small drops of water to pass through. If the fuel supply pipe is joined to the carburetor with an elbow, as shown in accompanying illustration, the dirt or water is apt to accumulate at the bend, resulting in erratic engine operation because the flow of gasoline is impeded and sometimes stopped altogether.



Using a pipe tee as a sediment collector

The method shown at B is an improvement. A tee-fitting is used instead of an elbow and the open end is plugged with a standard pipe plug, or a 1/8" petcock to serve as a drain. Impurities then collect in the bottom of the tee instead of flowing into the carburetor and constricting the fine passage. A piece of pipe 1" or 2" long, capped at the end, may be substituted for the pipe plug. This gives a larger sediment chamber.

HIGH-SPEED SENSITIVE TAPPING DEVICES

AFTER pointing out the necessity of endeavoring to counterbalance the cost of labor by increasing the speed of production and aiming at standardization, a French writer describes a roller-bearing tapstock friction clutch, suitable for taking the usual taper shank sensitive chuck. A male cone comes in contact with a female cone under pressure of the tap, and forms the friction clutch to transmit the power of the latter. The female cone is also conical externally and carries on it five bearing rollers, which, when the hole is tapped, engage on an internal cone ring made all in one piece, with the first-mentioned male cone, thereby reversing the direction of rotation and releasing the tap. It is claimed that the use of this device will result in a great saving of operating time.

Design and Construction of Model Locomotives

By Henry Greenly

Member Institute of Locomotive Engineers, England

AFTER having settled the design of the cylinder for a model locomotive the most important item for consideration is the valve gear. The older American locomotive had its valves usually operated by a form of Stephenson link motion, the eccentrics for which were placed inside the frames. The expansion links were attached to a rocker and the motion thereby transmitted outside the frames to the slide valves on top of the cylinders. The more modern practice is to employ Walshacert's Bakers' or some other form of radial valve gear which is entirely outside the frames and wheels, and it is with a view to the use of such a gear that the cylinders already described were designed.

Walschaert's gear is by far the most widely used but in a small model it becomes rather complicated and requires quite a number of rather delicate parts. In a working model such are to be avoided and to provide ample wearing surfaces in all joints, the writer has devised a form of radial valve gear which has given excellent results in trials which have been made during the last ten years. The gear is one which employs Hackworth's tilting slide shaft, an arrangement invented in 1842, and subsequently adopted in Joy's, Bremmes' and many other forms of radial valve gear. A further advantage of the writers' motion in a model is that the provisions of "advance" (i. e. the lap and lead function of the slide valve) can be effected by a much smaller number of pieces than those required by Walschaert's gear and at the same time the external appearance of the model fitted with the gear is, to a casual observer, not radically different to Walschaert's as usually applied to examples of the latest American locomotive practice. The gear is similar in its action to the primitive radial gear illustrated in Figs. 1 and 2 herewith. The vertical component of the movement of the crank is converted into a horizontal motion by a tilting slide. The timing of the horizontal movement of the valve is therefore at 90° to the horizontal movement of the piston and in this way the gear reproduces the action of the eccentric, as employed in an ordinary stationary steam engine, but provides a simple means of reversing. The slide is tilted in an opposite direction to reverse the motion. The tilting slide shaft has a suitable die block which forms a common joint for both the vibrating link (VL) and the valve rod (VR). It is also obvious that by altering the angle of the slide the valve movement can be modified in respect to both tuning and amplitude. Although not shown in the diagrams, it will readily be seen that no horizontal movement to the valve will take place if the slide is placed in a truly vertical position. The diagrams Figs. 1 and 2 show the relative position of the valve with the big end of the connecting rod on top and bottom centres, in "forward" and "reverse" positions of the gear. While the arrangement shown in Figs. 1 and 2 explains the fundamental action of the gear, it does not represent a practical form. The point on the connecting rod from which the motion is derived (point A_1 or B_1 in Fig. 1) moves in an elliptical path and one would expect that by connecting this point to a slide block in a slide of the form shown that the four positions, mid-left, top-centre, mid-right, and bottom centre, would be reproduced in the position of the slide block in its slide, as shown in Fig. 3. Due to the effects of angularity in the vibrating link (VL) which connects the block to the connecting rod this is not so. If the mid-left and mid-right positions are arranged to come right, i. e. to coincide with a position of the slide block in the centre of the slide as shown in Fig. 4, then, due to the angularity of the vibrating link, the top and bottom position will be reproduced equally in the manner indicated by the respective dimensions of P and W in Fig. 4.

Especially where a valve with lap and lead functions is required some form of correcting gear is necessary to neutralize the disturbing effects of this angularity. There are many examples, the two best known being those of David Joy invented about 1884. Joy's gear had a considerable vogue some two or three decades ago but now only exists on various inside-connected engines such as built by the British model maker has been superseded by the writer's form of corrected gear. This gear can be applied to models of outside cylinder locomotives the drawings herewith (Figs. 5 and 6) showing its adaptation to a "half-inch" scale model such as outlined in the previous article on cylinders.

The gear looks like Walschaert's

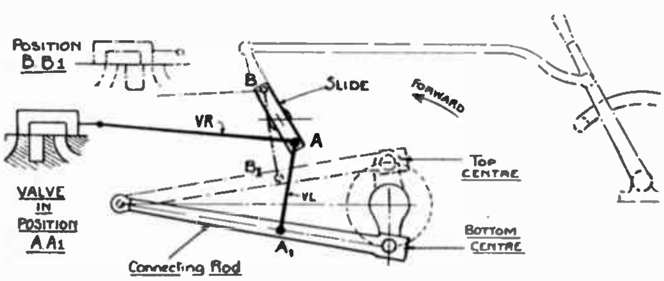


FIG. 1

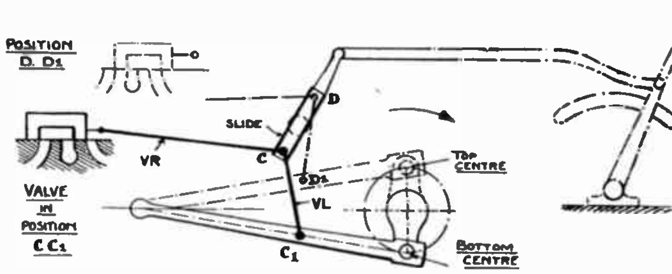


FIG. 2

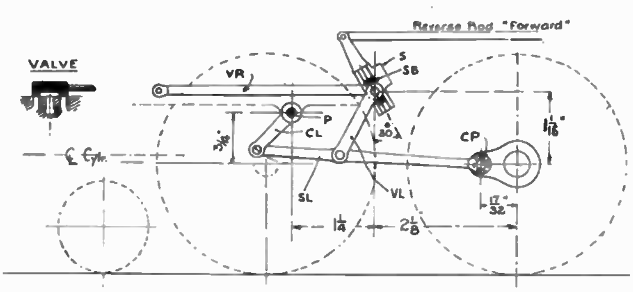


FIG. 5

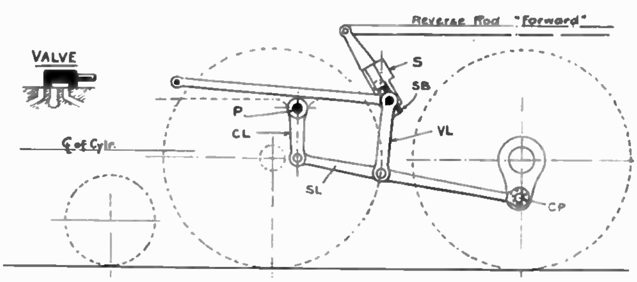


FIG. 6

Figs. 1 and 2. Diagram of primitive form of radial valve gear in forward and reverse positions. Fig. 5. Greenly's connected radial valve gear for 2½" gauge. It is shown on dead center position. Fig. 6. Greenly radial valve gear shown in bottom center position valve gear and makes use of the girder frame so common to modern American engines using the latter valve motion.

The valve gear provides for the correction of the angularity of the vibrating link (VL) by arranging the latter on a separate swing link (a miniature connecting rod), this link (SL) taking its motion from the crank pin (CP). Instead of being fixed to the crosshead the other end is supported by a link which swings from a fixed pivot (P) on the girder frame. This link is called the correcting link (CL in the drawings Figs. 5 and 6), and its function is to lift the swing link the exact amount required to neutralize the angularity of the vibrating link. This it does with mathematical accuracy and any reader can study its action quite easily by rigging up a few pieces of stiff paste board to act as links with some drawing pins as hinge joints. While such accuracy is necessary the proportions of the links are not absolutely fixed except in their relation to each other, and can be varied considerably to suit other considerations which may arise in the arrangement of the valve gear.

The lap and lead functions of a slide valve are absent in very small working models but independently of all ideas of the economy obtained by the expansion of the steam it will be found that engines with cylinders above half an inch in diameter work very much faster if the valve has a small amount of lap with, of course, an "advance" commensurate with this lap.

Lead is not necessary until cylinders approach 1½ ins. diameter and even then only in the case of high-revolution model steam engines such as used for the direct driving of dynamos. Lap and advance also reduce excessive cylinder condensation which is one of the characteristic failings of working models.

In a radial valve gear the horizontal component of the motion of the crank is employed to give advance to the valve. Lap is, of course, of no use without advance and in Walschaerts' motion the advance is obtained by a separate rigging, viz., a vibrating link operated from the crosshead.

The fundamentals of this motion is illustrated in the primitive form of gear shown in Fig. 7. The valve rod is not pivoted to the vibrating link at its joint with the slide in the slide block, but at a point above this joint. The selection of this point for a given stroke of piston will depend on the lap added to the valve. This lap is indicated by the blackened portion of the valve in the sketch and is approximately (not more than) half of the dimension A. This dimension is, of course, a function of the proportions of the vibrating link as exemplified by dimensions X and V. So much for the principles of the gear. In the next article the writer intends to show in detail the practical application and the dimensions of the parts standard valve gear, component, suitable for 2½ in. gauge models. Any difficulties he will be pleased to clear up if the perplexed reader will put them before the Editor in the ordinary way.

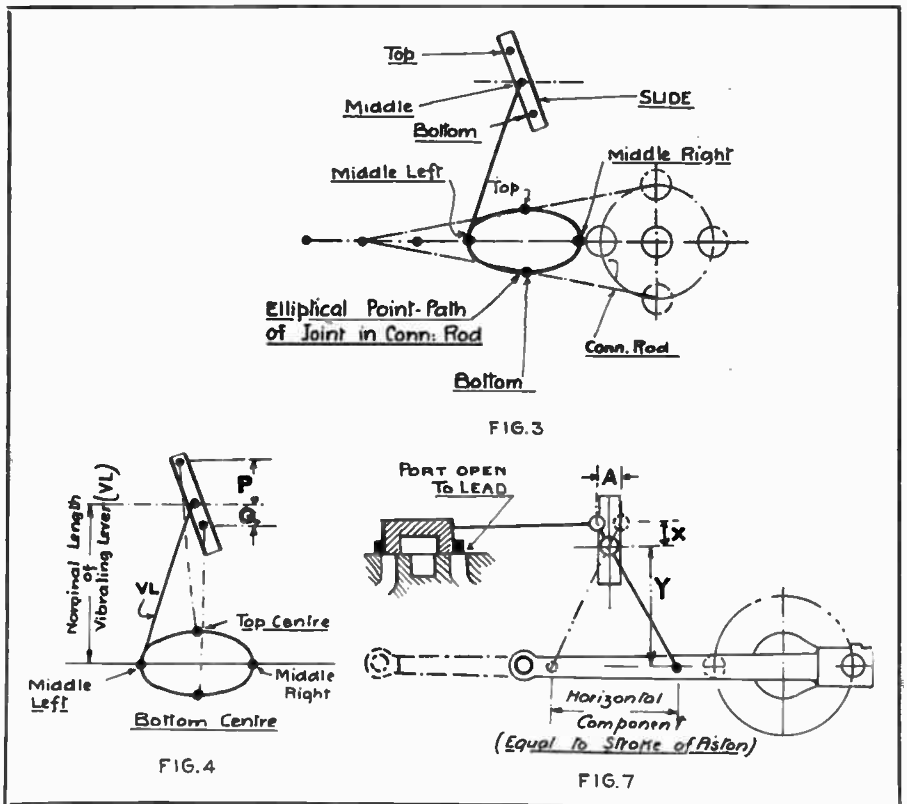


Fig. 3. Theoretical diagram of action of simple form of radial gear. Fig. 4. Showing the disturbing effects of angularity of rods on valve opening. Fig. 7. Diagram showing obtaining "advance" in a radial valve gear

PLATINOID

THIS alloy is a kind of German silver, with an addition of 1 to 2 per cent. of tungsten. The latter, in the form of phosphor-tungsten, is first melted together with a certain quantity of copper, the nickel is next added, then the zinc, and finally the remainder of copper. In order to remove the phosphorus and a potion of the tungsten, both of which separate dross, the resulting compound is several times remelted. Finally an alloy of a beautiful white color is obtained, which, when polished closely resembles silver, and retains its lustre for a long time. Platinoid has the properties of German silver in a pre-eminent degree. It shows great resistance, which remains quite constant at different temperatures, and is about 1½ times greater than that of German silver.

AMALGAM OF LIPOWITZ'S METAL

THIS amalgam is prepared as follows: Melt in a dish, cadmium, 3 parts; tin, 4; bismuth, 15, and lead, 8, and add to the melted alloy 2 parts of mercury previously heated to about 212° F. Amalgamation takes place readily and smoothly. After the introduction of the mercury immediately take the dish from the fire and stir the liquid mass until it solidifies. While Lipowitz's alloy becomes soft at 140° F. and melts at 150° F., the amalgam melts at about 143.5° F. This amalgam may be used for the manufacture of small, hollow statuettes and busts, which can be readily gilded or bronzed by the galvanic process.

Small statuettes are readily made by preparing a hollow mold of plaster of Paris and after uniformly heating it to about 140° F. pouring in the melted amalgam. The mold is then swung to and fro, this being continued until the amalgam is solidified. After cooling the mold is taken apart and the seams trimmed with a sharp knife. The operation may also be modified by placing the mold upon a rapidly revolving disk and pouring in the melted amalgam in a thin stream. By the centrifugal force developed the melted metal is hurled against the sides of the mold, and in this manner statuettes of considerable size can be cast.

NEW WAY OF ANNEALING STEEL

HEAT the piece as slowly as possible, and when at a low red heat put it between two pieces of dry board and screw them up tight in a vise. The steel burns its way into the boards, and, on coming together around it, they form a practically air-tight charcoal-bed. When it cools off the steel is apt to be found thoroughly annealed.

A 2500-Watt Step-down Transformer for Arc Welding

By E. F. Tuttle, Jr.

THIS transformer was built for a theatrical outfit and is capable of delivering a very high amperage at the secondary terminals. Numerous experiments can be performed with the use of this transformer which are very startling to the layman and the device will also prove useful in the laboratory as a source of low-potential, high-amperage current.

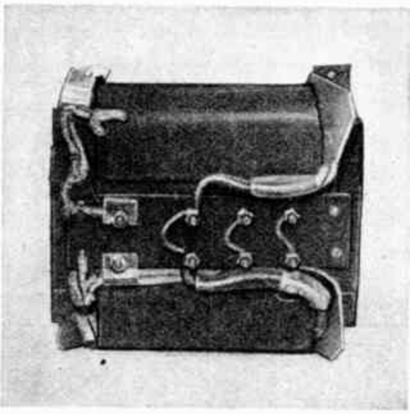
For the core of the transformer we will need about 140 strips of soft black iron (stovepipe iron) of about .017 inch thickness and 1⅛ inches wide and 5 inches long, and also about 140 pieces 1⅛ inches wide by 8 inches long. There should be enough of each size to make a stack of 2¼ inches high. They should be cut accurately to size and all rough edges removed. For the best results, each piece of iron should be given a coat of varnish or shellac as this will cut down losses through hysteresis and increase the general efficiency of the machine.

While the pieces for the core are drying, a form may be made for assembling the core by taking a board about 8 x 11 inches and nailing a block exactly 3⅞ x 6⅞ by about 1½ inches thick in the center of it. When the core is built up to 1⅛ in. in height and pressed tightly together, it can be drilled with 3/16 in. holes as shown for rivets. The rivets should be made of copper wire (No. 5 bare) and the holes should be countersunk at each end so the rivets will be flush with the surface. The four rivets marked AAAA should not be put in now as the end will have to be removed to put on the coils. The eight legs should be made and one put at each corner (top and bottom) as the corners are riveted together.

The end of the core may now be taken out and laid aside and the other two legs of the core should be well insulated with either oiled cambric (empire cloth) or friction tape to a thickness of ⅛ inch. It would be well to file off the rough edges of the core before applying the insulation to avoid cutting it.

A winding form for the coils should now be made of wood 1½ inches square with two end blocks on it as shown. If a lathe can be used it is much quicker than hand winding, but if a lathe is not available round ends must be made on the form so it can be run in wooden bearings of some sort. A block 7¼ inches long by 6 inches wide is nailed to the bench and two uprights with 1 inch holes 3 inches from the bottom are nailed to the ends of the 7¼ inch block. These serve as the bearings and a handle is fastened to the form to complete the job.

Both the primary and secondary are wound with No. 15 D.C.C. wire and about 15 pounds will be needed. A strip of cotton tape about ½ inch wide and 16 inches long is laid along each side of the form and tied with a string down into the corners at the ends and then a layer of rather heavy paper is put on and the winding placed over this. Start at the left hand end, leave about 8 inches at the end and wind 90 turns which should come to proper position at the other end. If it does not, the end block will have to be moved to the correct place. Then put on a layer of empire cloth and continue the winding back to the other end. This is continued until there are four layers in all wound on the leg of the transformer. This completes one of the primaries.



The completed welding transformer

Four layers of empire cloth should now be wound on after which the core is ready for part of the secondary winding. This consists of four layers of 90 turns each of number 15 D.C.C. wire, each layer starting at the left hand end of the form and being wound in the same direction as the primary. The winding is discontinued at the right hand end. Each end of the wire is left about 8 inches long and the four at each end of the form are connected together. There is no need of putting empire cloth between the different layers of the secondary, but two layers should be put over the outside and the ends of the four tapes brought together and tied. The coil may now be removed from the form by taking off one of the ends and well taped lengthwise through the hole with strips of empire cloth or bias oiled cambric. Do not use friction tape for this as it will not allow the coil to slip over the core without considerable trouble.

Wind another primary and secondary just the same as this one, being sure to start at the left hand end with both and to have just 90 turns of wire in each layer.

After these windings have been finished, one is slipped over each long leg of the core so the primary terminals will be at opposite ends. The top of the transformer should now be made from ¼ or 5/16 fiber, or, better still, Bakelite. The larger holes in it are ⅜ inch and the smaller ones 3/16 inch. The four ⅜ inch holes marked A are for fastening the top to the upper legs and holes BB and CC are for the secondary and primary terminals respectively. The D. P. D. T. switches will be needed and should be obtained before drilling the other holes, D and E. These holes are correct for a "Bryant 5190" switch. After putting in the end of the core and riveting on all the legs, and putting on our top we are ready for our connections. These are shown in the top view and allow us the following changes in voltage and amperage with the different positions of the switches.

Primary Switch	Secondary Switch	Ratio	Secondary Voltage	Secondary Amperes
Series	Series	720: 80	27½	45
Series	Parallel	720: 90	13½	180
Parallel	Series	360:180	55	90
Parallel	Parallel	360: 90	27½	180

These figures are for full load and on a dead short at the terminals. This condition should always be avoided, however, and the transformer used only with some sort of regulating device; a rheostat or impedance.

Mark one coil number one and the other number two and mark the inside and outside ends of all wires. Join the 4 secondary ends at each end of each secondary and connect them as follows:

Inside primary No. 1 to connection No. 3.
Outside primary No. 1 to connection No. 2.
Inside primary No. 2 to connection No. 1.
Outside primary No. 2 to connection No. 4.

Run a single No. 5 wire from No. 5 to No. 6. Now run a double No. 15 wire from terminal No. 13 to connection No. 1 and another double wire from terminal No. 14 to connection No. 2.

The terminals No. 13 and No. 14 are located at holes CC and should be capable of carrying 25 amperes. The terminals No. 15 and No. 16 are for the secondary circuit and should carry 180 to 200 amperes. They may be of any style desired but I find that the brass storage battery connections are very good and as cheap as any. If these terminals do not make a good contact or are too small they will cause trouble by heating.

The inside wires of secondary No. 1 go to switch connection No. 9.
The outside wires of secondary No. 1 go to switch connection No. 8.
The inside wires of secondary No. 2 go to switch connection No. 7.
The outside wires of secondary No. 2 go to switch connection No. 10.
Run 4 No. 15 wires from No. 7 to No. 16 and 4 No. 15 wires from No. 8 to No. 15 and 4 number 15 wires from No. 11 to No. 12.

The switches should be marked "Primary" and "Secondary" and on the fiber cross piece of the switch is stamped "Series" and "Parallel" as shown. These switches should not be opened while carrying current—especially the secondary switch as it carries such a heavy load that it will arc and burn the contacts.

A couple of flexible electric cords each about 6 or 8 feet long and about No. 6 or 8 gauge may be fitted with terminals to fit No. 15 and No. 16 on one end of each and on the other end soldered to a brass screw about 3.8 inch diameter by ¾ inch long to which may be fastened suitable clamps for holding carbons for an arc or even nails and iron rods up to 5/16 inch diameter to be welded. In welding, the pieces should be put together before the current is turned on and the current turned off before moving apart.

In using the connections for 13½ or 27½ the terminals may be held in the bare hands if they are not gripped too tightly and an arc 1 inch long between carbons ⅝ inch in diameter may be held between the hands. The 13½ volts is best for welding and 27½ best for the arc owing to the high resistance of the carbons. Copper and iron wires may be melted with this outfit but a pan should be placed under the wire to catch the molten metal.

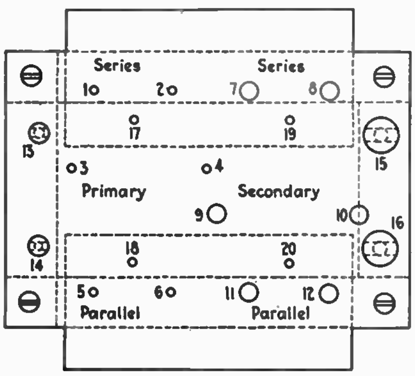
Also by sprinkling metal filings along in a ridge on a brick or other non-combustible article and connecting a wire to each end the filing may be welded together into one solid piece.

This transformer is designed for 110 volts and 60 cycle current such as is used for house lighting but heavier fuses should be put in than are ordinarily used as the transformer takes 23 amperes on full load.

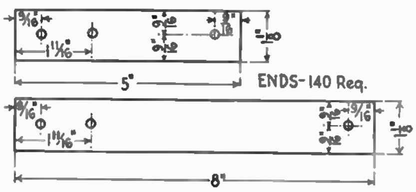
REMOTE CONTROL FOR LARGE SEARCHLIGHTS

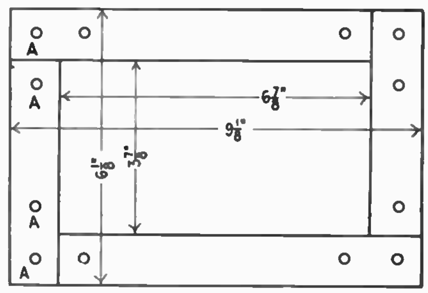
A RECENT copy of the *General Electric Review* contains a very interesting discussion concerning large searchlights and their use for military purposes. It has been found very difficult for the operator of a large light to train the light on the object to be illuminated owing to the dazzling effect the light has on his eyes. The only remedy for this condition is remote control and experiments are being conducted along this line. In the case of remote control the operator is stationed at least 500 feet from the searchlight and at this distance he is not affected by the beam. The control is brought about by placing the field of the operating motor across a certain portion of a rheostat. By means of a dial switch, the armature may be connected to the center point of the rheostat or to a point either to the right or left of it. This will depend entirely upon the direction of rotation.

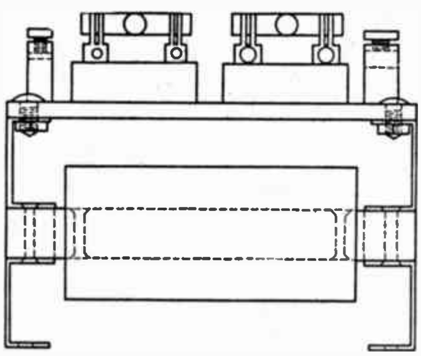
It is possible that such a plan could also be used on battleships as the same trouble is had in training the light on distant objects.

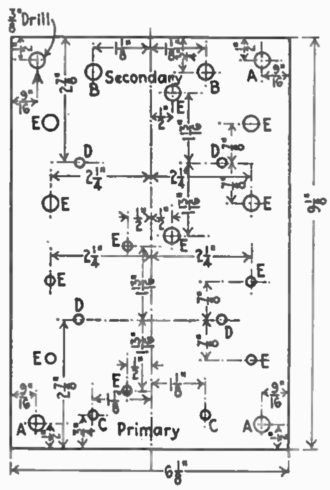


TOP VIEW

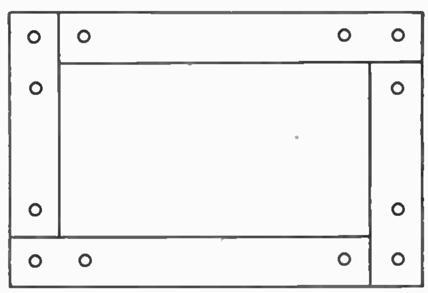

ENDS-140 Req.
SIDES-140 Req.

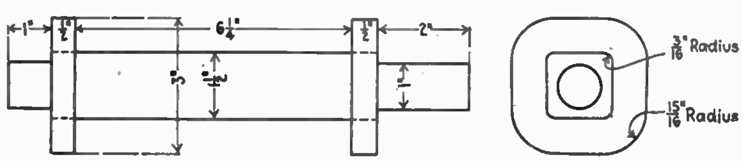

ALTERNATE LAYERS-1,3,5,7,9-Etc.

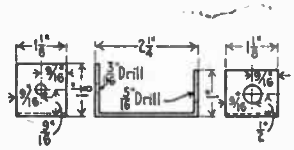

SIDE VIEW. WITH SWITCHES IN PLACE



TOP-1 Req.


ALTERNATE LAYERS-2,4,6,8,10-Etc.

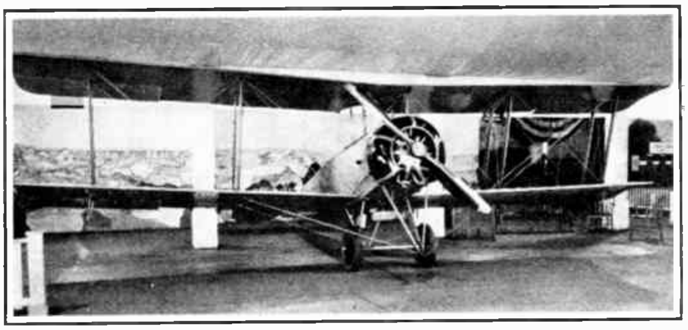

WINDING FORM

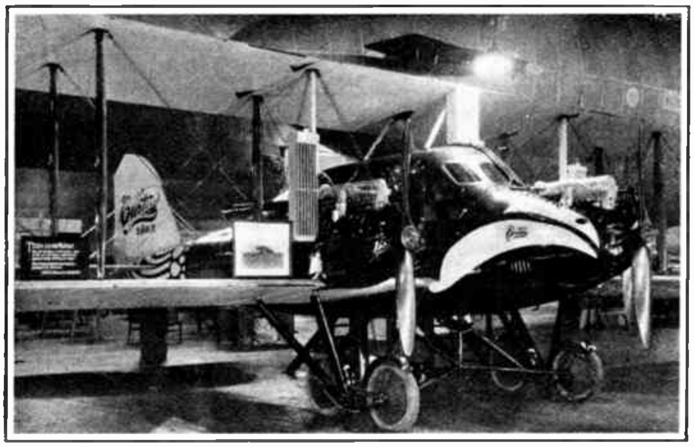

LEGS-8 Req.

Complete Enclosure for Passengers the Feature of New Airplanes

A MARKED feature of the recent Aeronautical Exhibits at Chicago and New York is the trend noted in airplane design away from the types intended for military use to those that have been designed recently with an appeal to those who can use airplanes for commercial requirements. One of the largest machines at the shows and one that attracted considerable attention is the Curtiss Eagle, which is provided with three engines, all of which drive tractor screws. The machine weighs about 7,500 pounds and has a useful load of over a ton. The engines are the six-cylinder type of 150 horsepower each. The feature that impresses the aviator is the large size of the machine and the relatively low capacity of the motor power provided, which means considerably higher transportation efficiency than is usually attained by aircraft. The completely enclosed and well arranged cockpit provides accommodations for pilots and passengers. The engine mountings are directly on the lower wing and special care is taken in stream-lining the outboard motors. The motor, mounted on front of the fuselage is, of course, very thoroughly stream-lined. The fuselage is a two-ply veneer construction.

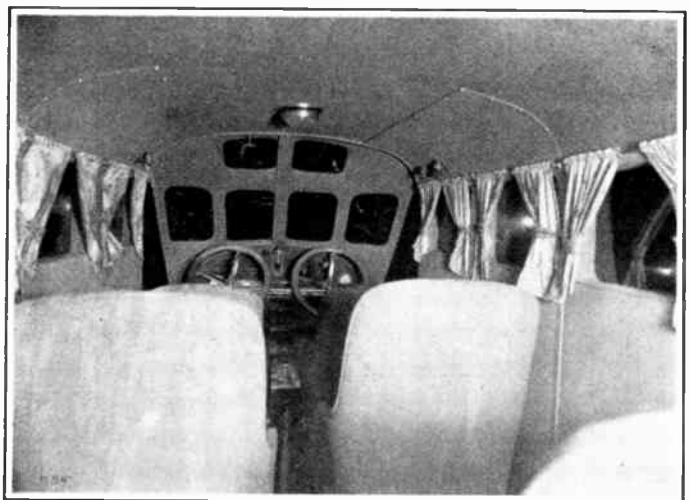
The Avro biplane, an English type that was widely used for training purposes in Europe





The Curtiss Eagle, a distinctive three-engine passenger carrier

Curtiss Oriole provides for two passengers in forward cockpit



Interior of Curtiss Eagle cabin, showing dual control and passenger accommodations

The landing chassis is exceptionally substantial and is original in design. There are two wheels used on either side, these being placed in tandem with axles supported by a strong, bridge-like truss. The chassis is composed of steel tubing which has been faired to reduce resistance. The span of the machine is sixty-one feet, length thirty-seven feet and the height twelve feet four inches. It provides accommodations for eight passengers and is equipped with a dual Dep control system. Another attractive Curtiss exhibit was the Oriole machine which provides accommodations for two passengers and a pilot.

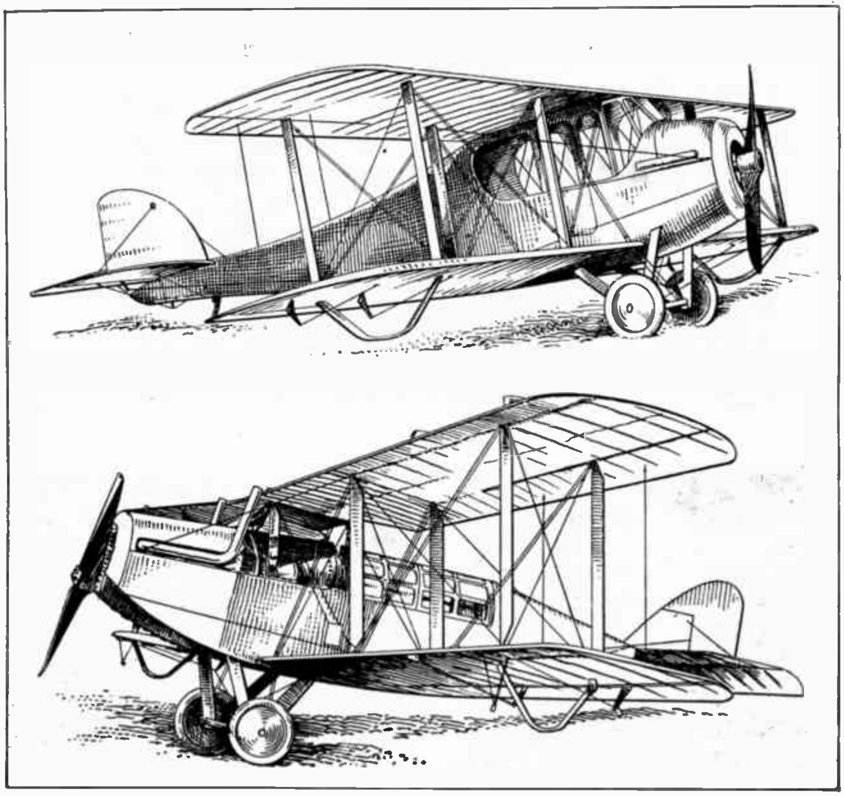
The passengers sit side by side in a roomy cockpit and are protected by well-designed wind shields. The pilot has his own cockpit placed back of the passenger compartment. The fuselage is built up of veneer and is an exceptionally well stream-lined monocoque form. The engine is a six-cylinder type and develops 150 horsepower.

The machines shown by the Dayton-Wright Company were very good examples of the modern method of enclosing the passengers in a light, but well-protected cabin. Two models were shown, one of which was known as the cabin cruiser, which is provided with a twelve-cylinder Liberty engine. The other model, which was of smaller capacity, is provided with the Hispano-Suiza motor and is known as the aerial limousine. The Avro three Place Biplane shown is a modified form of the type that was used in such large quantities for training pilots in Europe by both the American and English air forces. This machine was noted for its reliability, ease of control and strength. The engine is a one hundred and ten horsepower, Le Rohne rotary, readily accessible for inspection on account of its mountings. This was the only machine shown that had a combined skid and wheel landing gear. It is surprising that this construction is not built to a greater extent because a well-braced skid of this type acts to prevent nosing over on a rough landing and the rear end of the skid can be used to exert a powerful braking action on the ground to retard the speed of the machine when landing.

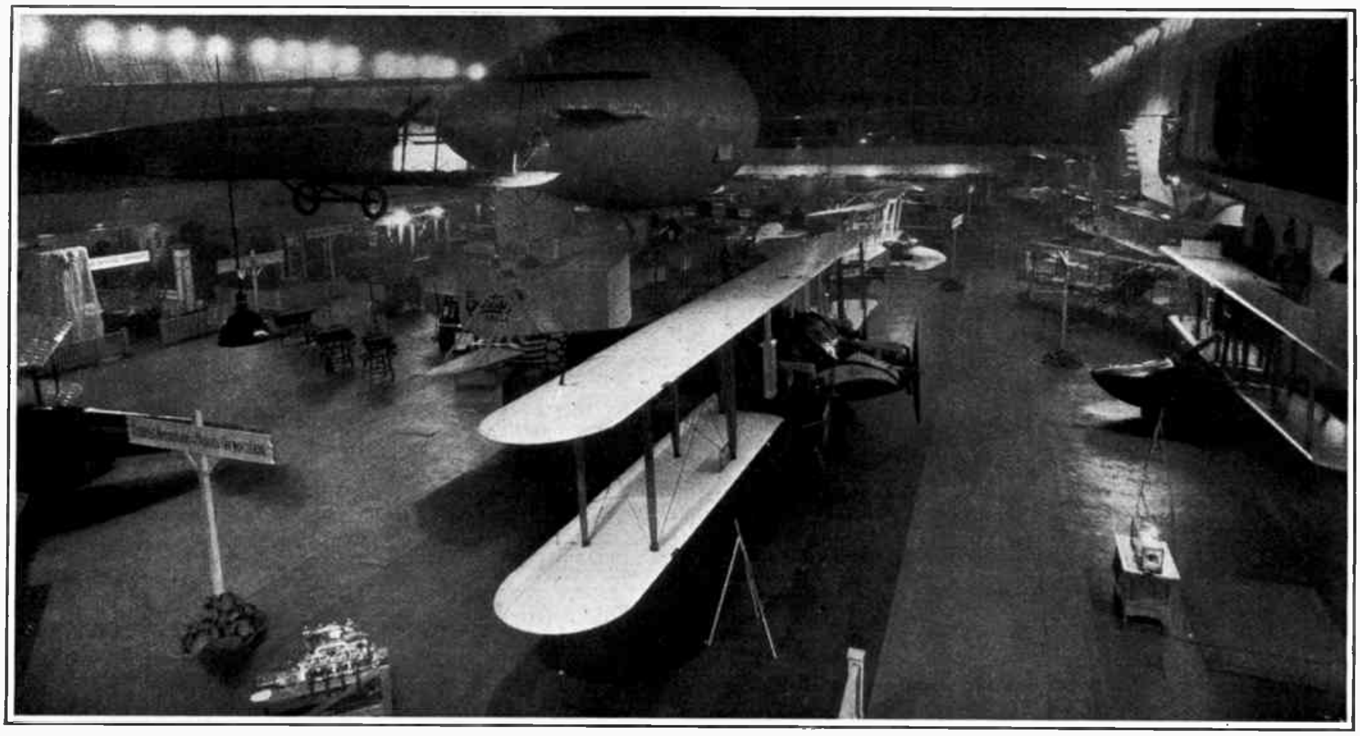
Among the other aircraft shown that created considerable interest were the Curtiss Sea Gull Flying Boat type, which was very similar to the M. F. boats used for training Navy aviators during the war. The Aeromarine Flying Yacht also received its share of attention, especially as the passengers and pilots are totally enclosed in a cabin provided with transparent pyralin windows. The pilot can open the windows in front of his seat if vision or control is impaired for any reason by their remaining closed. The engine is the Aeromarine, six-cylinder, vertical type, rated at one hundred and thirty horsepower.

The Goodyear Company had an interesting exhibit known as the "Pony Blimp," a small dirigible balloon providing accommodations for a pilot and passenger. This is a non-frigid airship of 35,000 cu. ft. capacity, 95 ft. long, 28 ft. diameter and 40 ft. overall height. It is the smallest craft of its kind in existence and is interesting because it seems to be the smallest size practicable for the carrying of two passengers. Fitted with an Ace 40 hp. engine, the craft has a high speed of 40 m.p.h. and a full speed endurance of 10 hrs. The disposable lift (crew, fuel and ballast) is 800 lbs. The envelope is notable for its blunt form, the streamline ratio, 3.5 to 1, marked a decided departure

(Cont. on page 421)



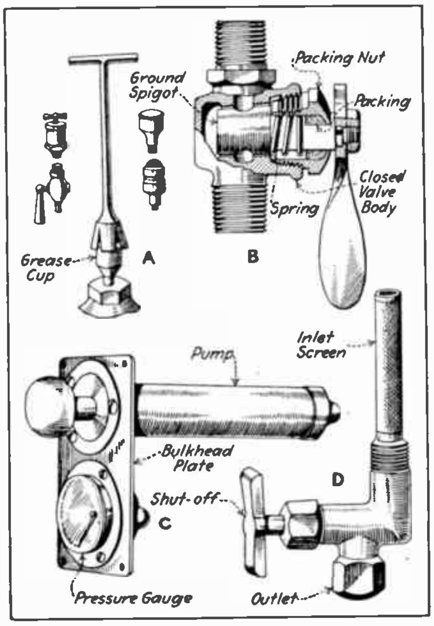
Two Dayton-Wright commercial models. Limousine model at top and cabin cruiser below. In these passengers and pilot are completely protected



General view of exhibits at Chicago Aero Show, with Curtiss Eagle in foreground and "Pony" Blimp in center of the hall

New Fittings For Motor Boats

THE accompanying illustration shows a number of new fittings that will be found of value by motor boat owners because they are simple in construction and serve a really useful purpose. The wrench shown at A is a simple device that will be found exceptionally useful for screwing up grease cups and for reaching into normally inaccessible places to open or close drain or relief cocks. It is of substantial construction and requires no adjustment. Because of its peculiar shape it will fit grease cups of any type as shown in illustration and either Tee or L handle pet cocks.



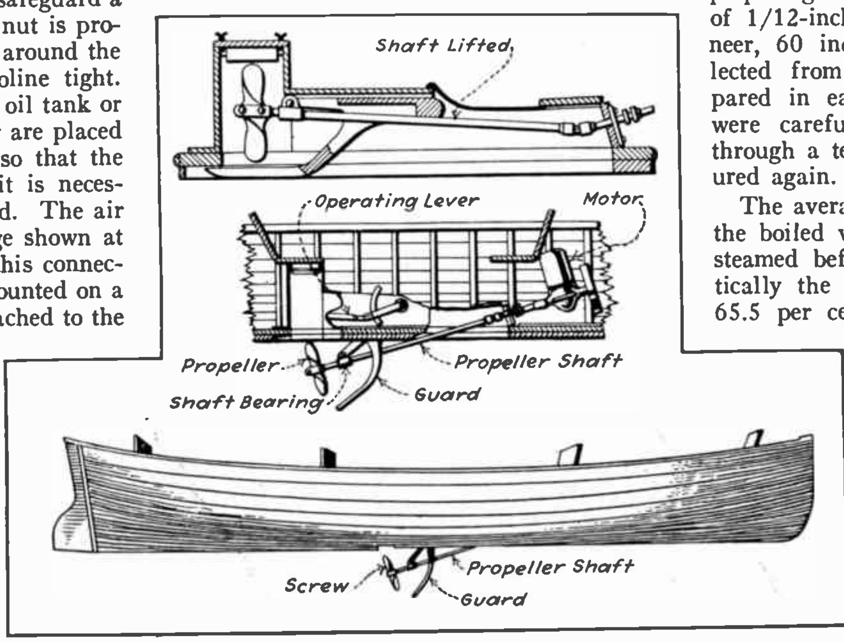
Some new fittings of value to motor boat owners

Leaky gasoline is a source of fire risk in a motor boat because it is apt to collect in the bilge and may become ignited from an electric spark or other causes. The gasoline cock shown at B is of very good construction and cannot leak on account of having a closed bottom and packed stem. The ordinary drain or shut-off cock construction is such that the spigot goes right through the body, and if it becomes loose, the gasoline may leak even if the valve is in a closed position. The construction shown has a ground spigot which is kept seated by a substantial spring and as a further safeguard a stuffing-box or packing nut is provided to close the space around the stem and make it gasoline tight.

When the gasoline or oil tank or water tanks of a cruiser are placed low down in the boat so that the liquids will not flow, it is necessary to use pressure feed. The air pump and pressure gage shown at C should be useful in this connection. Both units are mounted on a plate intended to be attached to the bulkhead. When sufficient pressure has been pumped up by the pump, a turn of the pump handle prevents the escape of air and the gage registers the pressure at all times. A vent, operative by turning the pump handle, is also provided. The tank shut-off valve shown at D includes a combination of a needle valve with a wire gauze strainer in one fitting. It is made throughout of bronze and can easily be installed in any gasoline tank.

POWER DRIVEN SKIFF WITH NOVEL PROPELLER ARRANGEMENT

THE suggestion given in accompanying diagram is a useful one for those who operate boats in shallow water, or who desire a light craft that could be hauled out on the beach when not in use. A light, double ended power-driven skiff that is reasonably seaworthy is depicted. The arrangement of the propulsive mechanism is such that the shaft and its propeller may raise up within the hull of the boat, leaving nothing projecting below the keel that may be damaged by contact with the beach or with obstructions in the water. The speed of the boat may be controlled to a reasonable degree by regulating the depth of immersion of the propeller. As will be seen, the propeller protecting shoe is an integral member with the supporting piece that carries the stern bearing. A double universally jointed driving shaft is used and the rear bearing for the propeller shaft is also hinged so that it can assume the required position due to the change of shaft angle when the mechanism is raised and when the propeller is pushed down into the water. The general construction of the mechanism is clearly shown in drawing, as is the location of the power plant and the operating lever.



Diagrams showing method of operating disappearing propeller so boat can be hauled out on the beach without damaging propulsive machinery

SHRINKAGE OF VENEER FROM BOILED AND STEAMED LOGS

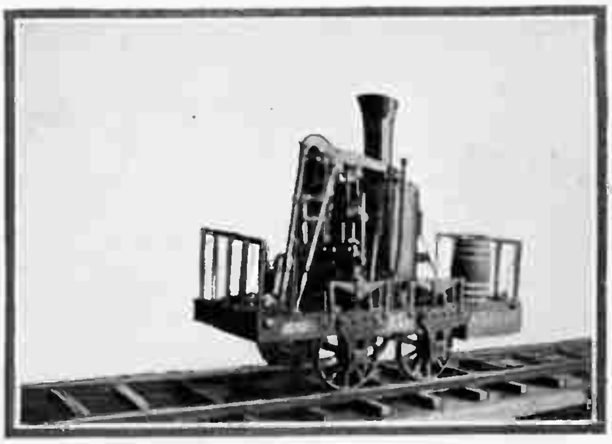
ACCORDING to present practice, logs which are to be cut into veneer are either steamed or soaked in hot or boiling water for several hours to soften the wood. The claim is sometimes made that the veneer from boiled logs is likely to shrink and swell less with changing moisture content than the veneer from steamed logs. This point was made the subject of investigation by the Forest Products Laboratory at a plant using both methods of preparing the logs. Thirty sheets of 1/12-inch rotary-cut birch veneer, 60 inches square, were selected from about six logs prepared in each way. The sheets were carefully measured, passed through a textile drier, and measured again.

The average moisture content of the boiled veneer and that of the steamed before drying were practically the same, being 64.8 and 65.5 per cent, respectively. The average moisture content for both kinds after passing through the drier was 10 per cent, and the moisture contents of all dried sheets were between 7 and 13 per cent. The shrinkage caused by drying was found to be the same for both kinds of veneer. When the dried sheets were resoaked, they expanded to their original dimensions, and when subjected to a second drying they shrank as uniformly as before.

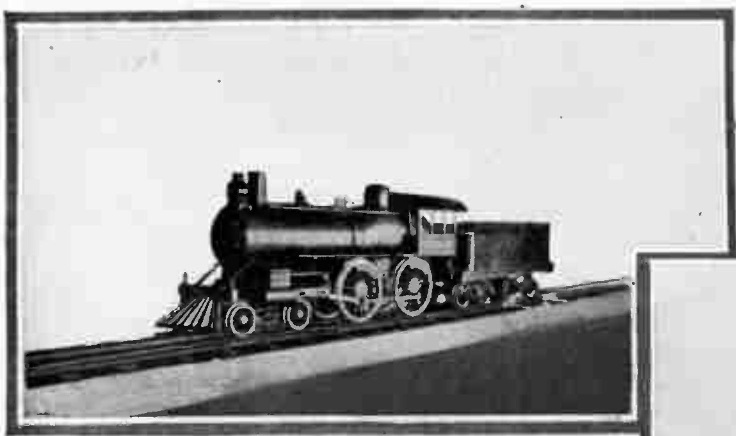
Although these tests were very crude, they indicate that the shrinkage of veneer from boiled and steamed logs is practically the same. The variation is no greater than is found between pieces from different logs which have undergone the same treatment.

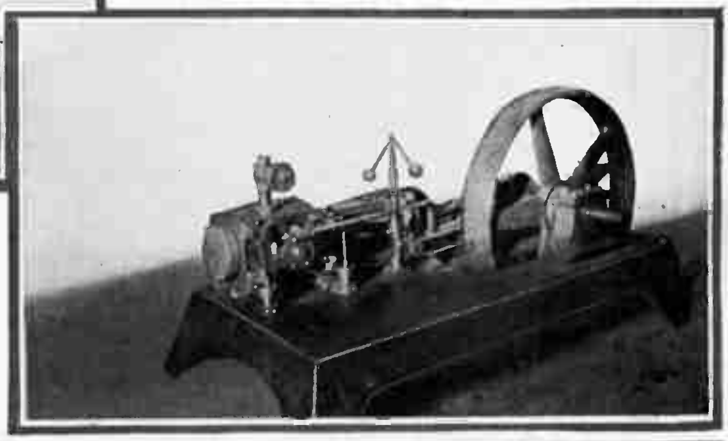
Models Made by a Reader

THE models pictured on this page are the work of Mr. George R. Aitken. Those interested in the construction of historical models will enjoy looking at the pictures of the Atlantic, "Puffing Billy," "The Rocket," and Robert Fulton's *Clermont*.

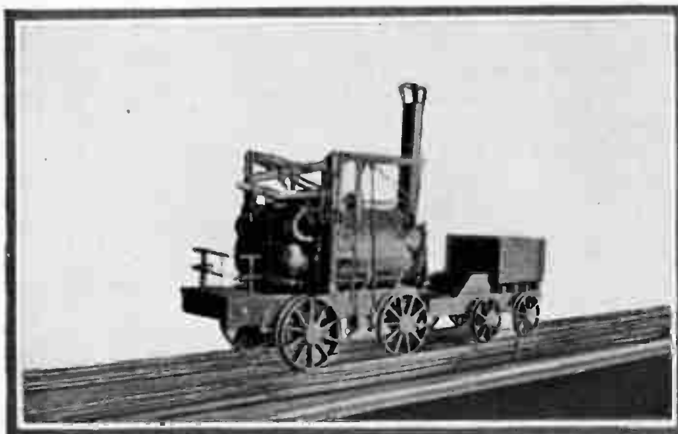


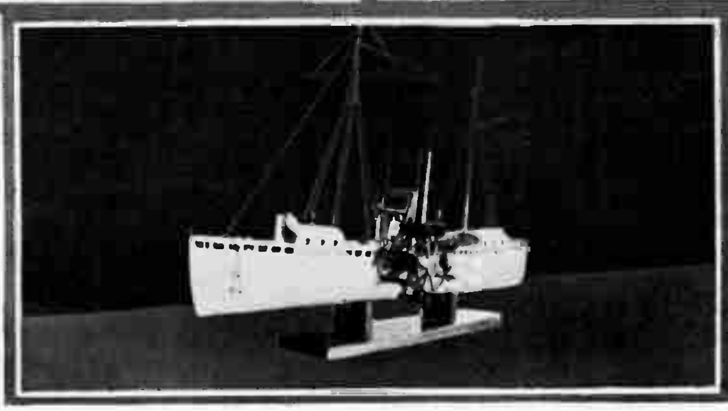
A well executed model of the Atlantic which was placed in service on the Baltimore & Ohio in the year 1832. The original of this now historical locomotive was built by Davis & Gartner of York, Pa.





A model of a modern passenger locomotive built by Mr. Aitken. This is a distinct contrast to the early types pictured on this page. The horizontal engine shown at the right is complete in every detail, including governor





Above is shown the famous old locomotive "Puffing Billy," which was built in 1813 by Timothy Hackworth, a blacksmith, for the Wylana Railway, England. The center bottom shows Robert Fulton's "Clermont," which made its famous trip up the Hudson in 1807

"The Rocket," which was put into operation in the year 1815 by George Stephenson. This was the first engine in which the power was given to the wheels by direct transmission

Standardization of Gauge Design

By Walter J. Oldroyd

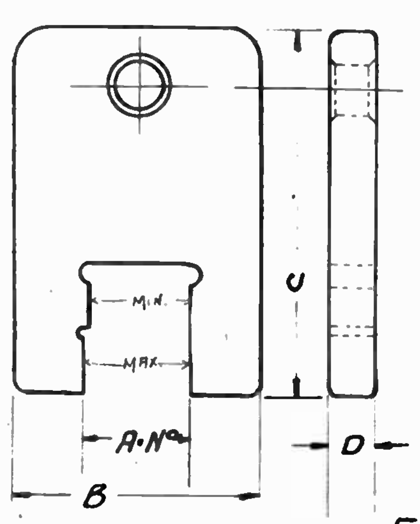
Supt. of Equipment, Springfield Armory

IN order to produce parts that are interchangeable in large quantities, the question of standardization of gauges has been found a very essential problem to contend with, a great many factories already having established their own standards for jig and fixture work, but the subject of gauging had not been given as much consideration. In order to show just what has been accomplished in standardization of gauges this manuscript has been compiled.

Snap Gauges

I will first consider the snap gauge, which is one of the simplest of gauges. Fig. 1 shows a set of standards for snap gauges which are very satisfactory for small work, gauging up to four inches in length. They are made of a good grade of carbon steel, carbonized, hardened and ground. They have been designed with the idea of departing from the old idea of putting many gauges onto one piece of steel, there being one gauge to a piece and this with a maximum and a minimum step.

When several gauges are to be used on one operation, several of these snaps are put onto a loose-leaf binder ring and a drop of solder on the joint will make the ring solid, and should it be required to correct the gauges, the ring is quickly opened. Each gauge on the ring should be given the same identification number with a letter following to indicate the order in which it is to be used in gauging the work. There is plenty of space on these gauges to mark the component name and the operation number as well as any other markings that the system might require.



Size	A	B	C	D
1/8 To 3/16	1	3/4	1 3/4	5/32
3/16 To 5/16	2	1 1/8	1 7/8	5/32
5/16 To 7/16	3	1 1/4	2 1/8	5/32
7/16 To 5/8	4	1 1/2	2 1/4	7/32
5/8 To 1	5	2 1/16	2 1/4	7/32
1 To 1 3/4	6	2 7/8	2	9/32
1 3/4 To 2 1/2	7	3 5/8	2	9/32
2 1/2 To 3 1/4	8	4 1/2	2 1/4	9/32
3 1/4 To 4	9	5 1/4	2 1/4	9/32

FIG. I

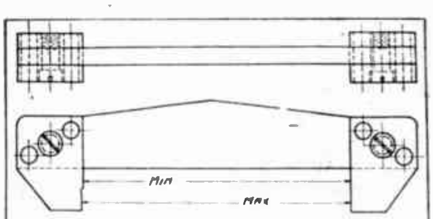
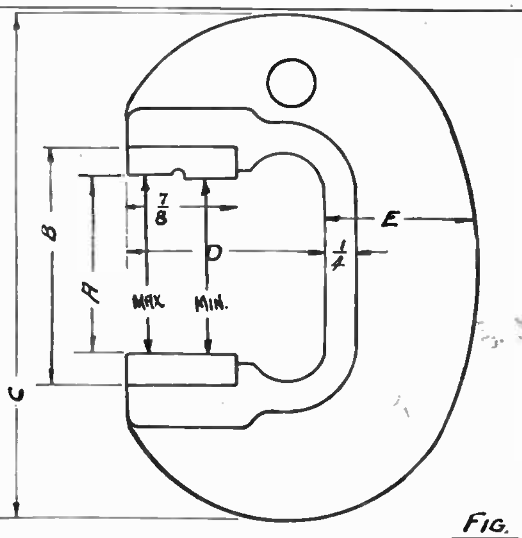


FIG. II

The illustration at Fig. II shows a form of built-up gauge for use in gauging work more than four inches long. The end blocks are the same for all lengths but the shape of the bar may be changed to suit conditions and the span of the gauge. The gauges in Fig. I are not suitable for gauging round work over one inch in diameter, but are satisfactory for the length of work up to four inches. To furnish a snap for diameters from one inch up to four inches the gauges shown in Fig. III are used. The capacity of each gauge varies by five-eighths inch and they are made of steel forgings with the blocks and plug set in.

A design of built-up gauge which has many advantages is illustrated in Fig. IV. As will be seen from the illustration it is made in two parts, the upper portion is a simple piece of carbon steel ground and the other portion of the gauge has the steps machined and ground one step on each end. The two parts of this gauge are held together by means of two filister head screws. While this gauge is often used up to two and a half inches, yet its greatest usefulness is on smaller openings, such as up to one-quarter inch, where grinding the opening in a gauge of the design shown in Fig. I is not practical. This type of gauge also has a distinct advantage over the ordinary snap gauge in that it may be taken down at any time when the steps become worn and by simply regrinding it can be put back in its original shape again and this process may be followed for an indefinite period of time or until the parts are too light to be of any practical use, which, of course, would be a very long time. It will be noted that these gauges are chamfered on the minimum side and provided with a radius on the



No	A	B	C	D	E
1	1	1 7/8	4	1 1/2	1/8
2	1 3/8	2 1/4	4 3/8	1 1/2	1/8
3	1 3/4	2 5/8	4 3/4	1 7/8	1/8
4	2 1/8	3	5 1/8	1 7/8	1/4
5	2 1/2	3 3/8	5 1/2	2 1/4	1/4
6	2 7/8	3 3/4	6	2 1/4	1 3/8
7	3 1/4	4	6 3/8	2 1/2	1 3/8
8	3 5/8	4 3/8	6 3/4	2 5/8	1/2
9	4	4 3/4	7	2 3/4	1 5/8

FIG. III

maximum side. In this way a man soon becomes used to the gauge and does not pay constant attention to the numerals identifying the size.

Plug gauges, while simple in construction, may be made to a variety of designs and constructions, but one that

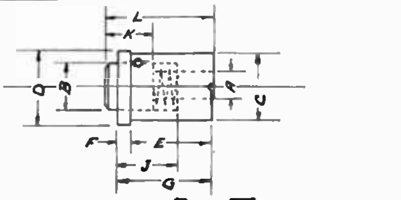


Fig. VI

No	A	B	C	D	E	F	G	J	K	L
1	1/8	1/4	7/16	1/2	5/8	1/8	3/4	7/16	3/8	7/8
2	1/4	7/16	5/8	11/16	3/4	1/8	7/8	5/8	1/2	1
3	3/8	9/16	3/4	13/16	7/8	1/8	1	3/4	5/8	1 1/8

seems to have met all the requirements of practicability, simplicity and neatness is shown in Fig. IV. The handle, which is knurled, is finished complete, except for the flat for marking, in an automatic screw machine and can be made of any cheap stock that works well at a rapid speed. The plugs likewise are made up in quantity lots and fitted to the handle and pinned to the handle by a straight pin as required.

Flush Pin Gauges

Flush pin gauges and bushings are made up and carried in stock with the upper end of the bushings left unground until assembled into the gauge. Flush pin gauges are built up to meet conditions of irregular shape, etc. These flush pin gauges have often been used

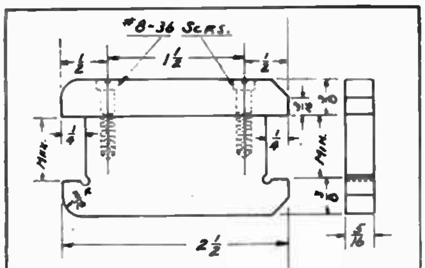
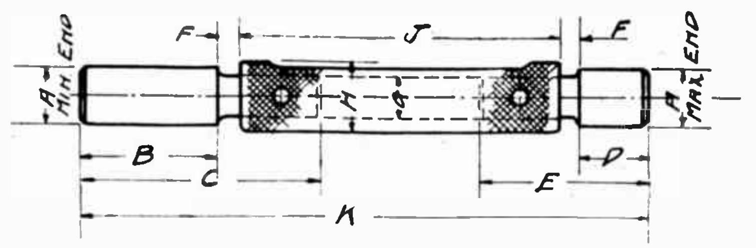


Fig. IV

in connection with snap-gauge frames, where for lack of space a two-step gauge could not be used, instead of making two single-step gauges. These flush pins are made in three sizes, one-eighth inch, one-quarter inch and three-eighths inch, and cover the requirements of nearly all cases where flush pin gauges are required. The two larger sizes, shown in Fig. VI, are the more often used.

Flush pin depth gauges for hand use in gauging the depth of holes, slots and the like is shown in Fig. VII. This gauge is made of four parts, the body is cold-rolled steel carbonized, hardened, and ground on the ends only. The bottom end is larger than the handle or knurled end in order to secure a substantial base while using the gauge. The plunger is of tool steel hardened and ground, the projecting end is made to whatever length is required and quite often has to be flattened on the sides to meet individual conditions. The plunger is held in place by means of a small drill rod pin. The plunger is flattened to allow about one-sixty-fourth



No	A MAX DIA.	B	C	D	E	F	G	H	J	K
1	1/8	7/16	15/16	3/16	11/16	1/8	1/8	1/4	1 7/8	2 3/4
2	1/4	1/2	1	1/4	3/4	1/8	3/16	5/16	2	3
3	3/8	7/8	1 1/2	7/16	1 1/16	1/8	1/4	7/16	2	3 9/16
4	1/2	1	1 13/16	1/2	1 5/16	3/16	5/16	9/16	2 1/8	4
5	5/8	1 1/4	2 1/16	1/2	1 5/16	3/16	7/16	5/8	2 3/8	4 1/2
6	1	1 1/2	2 7/16	1/2	1 7/16	3/16	1/2	3/4	2 7/8	5 1/4
7	1 1/4	1 3/4	2 13/16	1/2	1 7/16	3/16	5/8	15/16	3 1/8	5 3/4

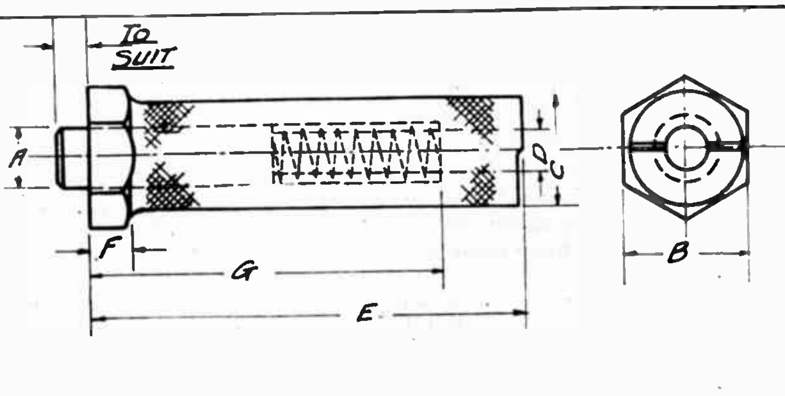
Fig. V

excess movement of the plunger each side of the two limits. A spring is provided inside the body to always force the plunger outward.

I do not consider flush pin gauges practical where the limits are very close unless a straight-edge is used in conjunction with them, about .004 inch is about as small as is practical for finger-nail feel.

Swing Finger Gauges

Flush pin gauges are not always satisfactory for certain cuts where the clearance has to be provided between the gauging points and the work while putting the work into and taking it out of the gauging fixture. Swing finger gauges are used in such cases, in fact I prefer them to the flush pin gauge. The standard for these swing finger gauges is shown in Fig. VIII. It will be noted that the length of the wearing surface of the "go" radius is greater than the "not go" radius. This greater wearing surface is to provide for the swing coming in contact with the work to be gauged, while the "not go" swing should never pass by anyway. The handle portion is reduced in thickness a little and knurled on both sides to provide a grip for the operator. These



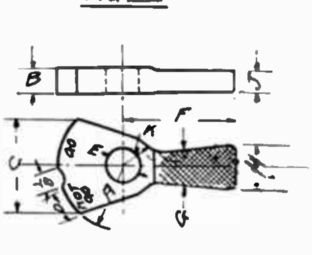
No	A	B	C	D	E	F	G
1	1/4	5/8	7/16	3/16	2 1/4	1/4	1 3/4
2	3/8	3/4	11/16	1/4	2 5/8	1/4	2 1/8
3	7/16	15/16	3/4	5/16	3	5/16	2 1/2

Fig VII

swings are made of a good grade of machine steel carbonized, hardened and ground.

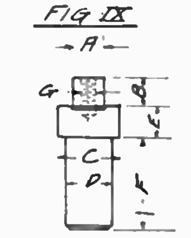
The studs upon which these swings are mounted are shown in Fig. IX. They are made of machined steel carbonized and the portion upon which the swing bears is hardened and ground. The swing fingers are held onto the studs by means of cold-rolled steel screws pack hardened and are shown in Fig. X.

FIG VIII



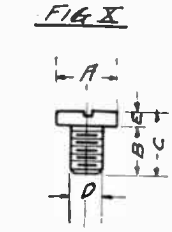
No	A	B	C	D	E	F	G	H	J	K
1	1/2	7/32	3/4	1/4	1/4	7/8	1/4	3/8	3/16	1/4
2	5/8	7/32	7/8	1/4	1/4	7/8	1/4	3/8	1/16	1/4
3	7/8	7/32	1	5/16	5/16	1 1/4	3/8	1/2	1/4	5/16
4	1	5/16	1	5/16	3/8	1 1/2	7/16	5/8	1/4	3/8

FIG IX



No	1	2	3	
A	1/4	5/16	3/8	
B	7/32	9/32	5/16	
C	1/4	3/8	1/4	
D	3/8	1/2	5/8	
E in	1/4	1/4	5/16	
E max	1	1 1/4	1 1/2	
F	3/8	3/4	7/8	
G	1/32	1/8	1/16	
TPI.	56	40	32	

FIG X



No	1	2	3	
A	3/8	7/16	1/2	
B	1/4	1/4	3/8	
C	3/8	3/8	1/2	
D	1/32	1/8	3/16	
E	1/8	1/8	1/8	
TPI	56	40	32	

Indicator Gauges

A very handy gauge for testing the alignment of one cut in relation to another cut already taken is the indicator gauge shown in Fig. XI. In this gauge "A" is the base, made of 40 per cent carbon steel carbonized, hardened and ground on the bottom and ends as indicated by the "f" marks. "B" is a tool-steel plunger hardened and ground and comes in contact with the surface to be gauged, while the ground surface on the front end of the base slides against a straight-edge which is in line with the surface on the part from which we wish to gauge the alignment of the surface upon which the plunger "B" makes a sliding contact.

The plunger "B" runs in hardened and ground bushings which are made of tool steel and held forward by means of a spring C attached to a pin D in the plunger. In the forward end of the plunger is a slot into which sets the arm E, which is pivoted on the stud F screwed into the base A. The other end of the arm E is forked. On the stud J is a pointer H, projecting from the bottom of which is a pin G and the other end, which is the pointer, projects through a slot in the cover. By this combination of levers the movement of the plunger is magnified forty times. A cover K is screwed to the base and has graduations for the indicator point, each graduation representing 1/1000 of an inch.

The only opening in the cover is the small slot for the pointer to pass through and over that is a small piece of glass which is held in place by means of a sheet steel cap riveted to the cover, this makes the mechanism entirely dustproof. Gauges of this design have a wide range of usefulness in connection with the gauging of gun work.

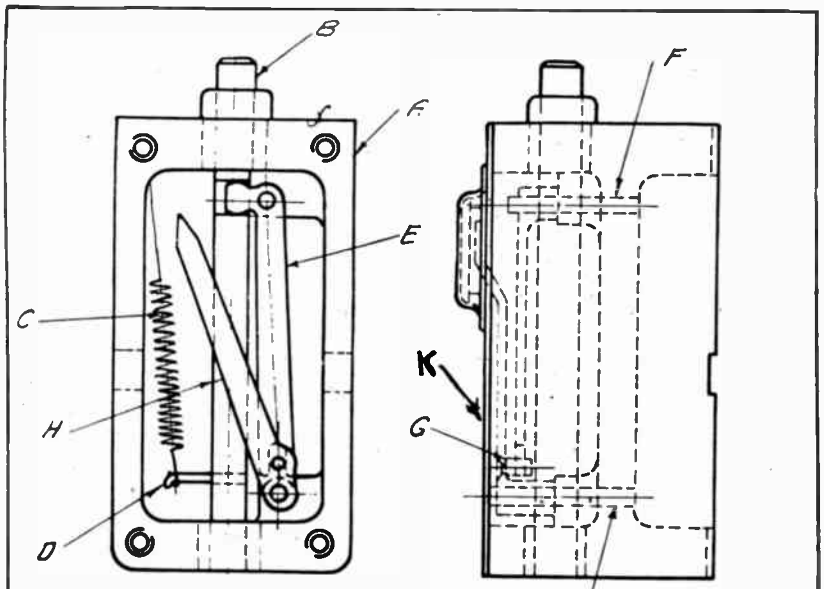


FIG. XI

SULZER DIESEL ENGINE

THE type of Diesel engine introduced by Messrs. Sulzer Bros. in Switzerland is now being manufactured in other European countries under license from the inventors. Units varying in size from 150 to 2,000 h.p. are being built on the single-acting, two-stroke cycle principle, as recently introduced, of which more than 270,000 h.p. have already been supplied. The advantages claimed are: (1) Reduction in the number of valves arranged in the combustion chamber and exposed to high pressure and temperature. (2) A simple and strong design of cylinder head. (3) A rapid and safe method of cooling the piston. (4) A simple form of reversing gear and (5) Safety appliances for preventing false manipulation.

The exhaust ports consist of openings in the lower end of the cylinder wall which, during the greater part of the stroke are kept closed by the piston, although partly controlled by an equilibrium lifting valve. The spent gases are first allowed to escape when the further travel of the piston connects the cylinder with the atmosphere and permits air to enter the scavenging. The exhaust ports are fully closed when the exhaust ports are fully closed when the crank is in its central position of the return stroke, compression commences and fuel oil is injected through a valve in the cylinder cover. Continued compression ignites the charge and the working stroke occupies a quarter of a revolution, after which the ports are again uncovered for the exhaust. The two cycles are thus completed in a single revolution, the four quarters forming respectively the working, scavenging, compression and ignition stroke. The cooling arrangement for the piston consists of a jet of water which impinges on the front end and escapes through a telescopic tube which keeps tight without stuffing boxes.

Persistent sulphation which is indicated by a greenish deposit on a battery terminal is due to a break in the sealing compound that allows the acid to climb the binding post and attack the terminal. This break can be sealed by softening the compound. A blow torch lamp is good for this, but care must be exercised not to melt the lead straps or terminal posts. The battery should be removed from the car to avoid the danger of fire.

ELECTRICAL PROGRESS DIGEST

LONG-DISTANCE TRANSMISSION LINES

WHAT will be one of the longest transmission lines is now in the course of construction. This will extend from the city of Winnipeg to Portage la Prairie, Canada. The line is to extend a distance of 60 miles and will have towers made of steel. Aluminum wire of No. 0 gauge is being used on the first circuit which is to carry 5,000 kilowatts at 66,000 volts with a 3 per cent drop in voltage at the destination. Plans are now being laid for the installation of a second circuit.

DETECTING UNDER-WATER SOUNDS ELECTRICALLY

A METHOD of detecting sound in water has been perfected. This is one of many different systems that have been proposed during the past five years. The present system seems to possess more than usual merit. The present method, which was developed during the last days of the war, makes it possible to fix the source of disturbance with great accuracy.

A number of submerged "hydrophones" are laid a few miles apart at the proper distance from the shore. These are all connected to a central station which is provided with a very sensitive galvanometer that records the slightest disturbance. The galvanometers are made to record the disturbances upon a moving photographic film. Normally, the record on the photographic film is in a perfectly straight line. When a sound wave strikes one of the submerged phones, a variation of the galvanometer current takes place and a record of the sound is produced upon the moving film. By the proper measuring of the difference in time between the arrival of the various signals on the galvanometers, the almost exact location of the disturbance can be calculated.

ELECTRIC TREATMENT OF SEEDS

A VERY novel method of treating seeds has been perfected recently. An electrolyte of sodium nitrate is placed in a vat or cell equipped with iron electrodes. The orignators of this system claim that the yield is considerably increased when wheat, barley or oats are subjected to this treatment. It is said that 500 farmers have become interested in this method and that the work is being carried on to some extent. After the seeds are treated in the way described above, they are placed in a kiln and dried. The entire treatment must be gone through about two months before the seeds are planted.

ELECTRICAL GAS MASK

THE electrical precipitation of gaseous substances has been applied to the gas mask in place of charcoal. In the new mask a small induction coil is used to condense the fumes or gases. The new electrical gas mask has been reduced in weight by two pounds and is said to be much more comfortable than the old type. The electrical mask has not been developed to a state of perfection, but it has shown very promising results.

A NATURAL INSULATING SUBSTANCE

KELP is now being used as a source of insulating compound in Australia. After the first treatment, the kelp is pressed into shape under hydraulic pressure and then treated with formalin. The finished product can be turned on a lathe and is capable of taking a very high finish. The kelp is available in tremendous quantities along the Australian and Tasmanian shores.

NEW METHOD OF MAKING IRON CORES TO CUT DOWN HYSTERSIS LOSSES

IRON cores used in radio apparatus are generally made with the greatest number of laminations possible. These laminations are always insulated from one another with a thin layer of shellac which further cuts down the losses.

A new method of making iron cores has recently been devised which is a distinct step forward. The iron used is produced electrolytically to insure great purity. The iron produced in this way is then pulverized to a fineness that will permit of its individual particles passing through a screen with two hundred meshes to the square inch. The iron powder is then thoroughly mixed with shellac and pressed into shape under a hydraulic press. In the case of small high-frequency coils four or five iron rings of this nature are used to build up the core. Engineers have found that this still further decreases the losses.

Each of the iron particles forming the core are insulated from one another by a very thin film of shellac. Thus each tiny particle acts a lamination.

A NEW TELEPHONE TRANSMITTER

THE present type of telephone transmitter has a number of disadvantages. One of the worst is its inability to accurately transmit certain parts of speech. The new transmitter is built on the principle of an electric condenser. The impinging sound waves of the voice changes the capacity of the circuit by causing one plate of the condenser to vibrate. This variation changes the current value of the circuit and causes speech to be transmitted to the distant receiver which is the same as that ordinarily used. The new transmitter has been found to transmit all parts of speech almost perfectly.

A further development along this line is the use of a carbon or microphonic attachment with the condenser-transmitter. This transmits all parts of speech with great perfection and gives a louder indication at the receiver.

Both of these transmitters are now in a state of development and as far as experimentation has gone very good results have been produced.

THE UNITED STATES TELEPHONE INDUSTRY

SOME figures recently issued by the Bureau of Census give some very interesting information concerning the extent of the telephone industry in the United States. According to the Bureau, there are over 53,000 separate systems and lines in the country. This also includes many private lines. These 53,000 lines involve nearly 29,000,000 miles of wire. This amount of wire is sufficient to reach around the earth at the Equator 1,150 times. About 11,700,000 telephones are connected together by this great network of copper wire. It is said that nearly twenty-two billion telephone messages were handled in the United States during the year 1917. This stupendous figure means that every man, woman and child in the country called on the telephone 220 times during the course of the year. About 262,000 were employed in the industry during 1917. About 65 per cent of these were women.

Year by year the telephone messages in the United States increase tremendously. Next year will exceed the figures given above.

TO MAKE STEEL SO SOFT THAT IT CAN BE WORKED LIKE COPPER

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

ANNEALING OF BRONZE

THIS process is especially employed in the preparation of alloys for cymbals, tam-tams, bells, etc. These alloys themselves are brittle, and the instruments cast from them become soft and sonorous only by immersing them while still hot, in cold water, then hammering and then finally again heating and slowly cooling. While steel requires hardness by quenching, a copper-tin alloy has the remarkable property of becoming sensibly softer and more ductile when quickly cooled, and this property is made use of by heating the alloy to a dark red, or, in case of thin objects, to the melting point of lead, and immersing in water. The alloy thus treated can be worked under the hammer and stretched without cracking or breaking.

TO HARDEN COPPER

AMONG the latest methods resorted to for hardening copper is that of melting together and stirring until thoroughly incorporated, copper from 1 to 6 per cent of manganese oxide. The other ingredients for bronze and other alloys may then be added. The copper thus becomes homogeneous, harder and tougher.

ZINC AMALGAM

ZINC amalgam is formed by mixing and triturating zinc filings with mercury at a heat somewhat below the boiling point of the latter. It is usually prepared by pouring mercury into zinc at the temperature at which the latter is just kept in a fused state. Care must be taken to keep the liquid stirred and to add the mercury slowly and in as fine a stream as possible.

The American Society of Experimental Engineers

WHO'S WHO IN THE A. S. E. E. DWIGHT SWAIN SIMPSON, M. M. E.—"By Himself"

THE gentleman so austerely pictured is not as old as he looks, having been born in the wilds of Michigan (Muskegon) in the Spring of 1883. The family silver spoon had been mislaid at the time, so he held a kit of tools in his hands.

At an early age he was transplanted to Minnesota and succeeded in reaching the University. Education (so called) was completed at Cornell University, in Mechanical Engineering and the School of Naval Architecture.

During this time every moment that could be stolen from the halls of learning was spent on the lakes and rivers of the wildest parts of the continent. It is his boast that in all the hundreds of miles of wilderness traveled he never cut himself with an axe but once and was lost but once for three days. Not really

lost, you know—just didn't know where he was.

Some months in the general shops of a little logging railroad (pattern maker, foundryman, blacksmith, machinist, boiler maker and engineer—all in one for $20.00 per) gave valuable experience that is often called upon to-day.

After escaping from college with the degree of Master of Mechanical Engineering, numerous shipyards were graced by the presence of our hero, serving in any and many capacities from fitter's helper to chief draftsman. Then a year as consulting engineer and naval architect in Philadelphia drove him back to the quiet of riveting hammers and the shipyards saw him again.

In 1914, when general manager of the Essington Shipbuilding Co., he retired from active life because of ill health, and until cured by the great war spent a long time doing nothing.

Then, as head of the newly organized firm of Palmer-Simpson Corporation, he began a strenuous two years of struggle against the Huns, the U. S. Navy Department and its inspectors in a more or less successful attempt to build flying boats and seaplanes. "A mistake may cost a brave man's life" was the oft-repeated slogan in those days, and although it was necessary to train many green men in this new work, no coroner has yet indicted the Palmer-Simpson Corporation.

In a careless moment of his youth this prodigy had his "bumps" felt by a man calling himself a phrenologist, who allowed that the subject could write things. The bump that caused the decision had been made recently by a baseball, but that baseball is a great factor in American life is proved by the fact that some editors have for a long time been good enough to agree with that old fakir and the typewriter has been busy at odd times for many years. Camping, canoeing, woodcraft, yacht building and handling, engineering topics and shopwork have been the subjects that from time to time have engaged his literary talents.

In order to have something to write about it was occasionally necessary to do things, and a little shop grew up in the home. As no man is a prophet in his own country, however, the shop was confined to the vicinity of the coal bin or some equally useless place until recently it was moved to a little factory building with the dignity of an office all its own. In its new form "The Experimenter's Shop" is becoming so well known that we can close this history right here.

To conclude this laudatory sketch we can do no better than to make use of that form which has become so well and widely known during the war.

Nationality—American (four generations on this continent).

Father—Canadian, naturalized.

Mother—American.

Color—White.

Married—Once.

Dependents—Two (wife and small daughter).

Calls himself a naval architect and engineer.

Sings a sort of barytone.

Plays no musical instrument (used to, but hasn't the time). And, like the well-known Rajah of Bong, thinks "He can do almost any old thing."

Motor Sleds for Winter Sport

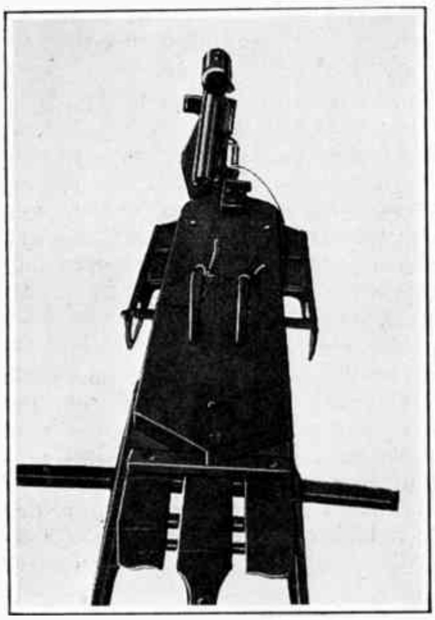
MOTORING enthusiasts cannot be prevented from enjoying themselves by inclement weather and a large number of interesting motor bobs have been built, using small gasoline engines for power. A number of designers utilize the propulsive thrust of air propellers and attain good speeds over ice or hard snow.

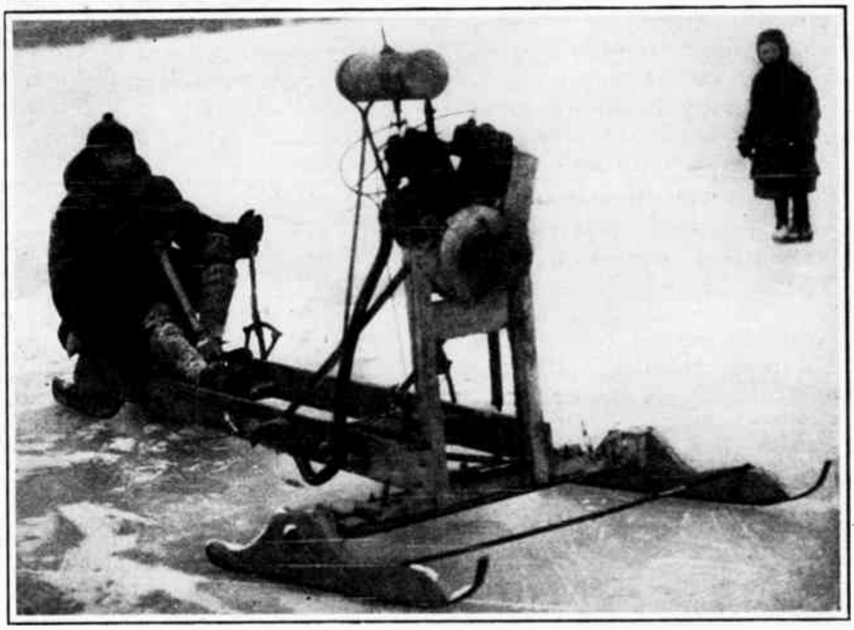
An interesting adaptation of a Smith motor wheel to a sled is shown in accompanying illustrations. Two flexible flyers are fastened together by a board about eight feet long, the first sled being held by a King bolt so that it may be used as a guide sled. A set of handle bars from an old bicycle were cut off and fastened to the plank so the operator could install the motor speed regulating levers. The speed of the engine is controlled by a throttle on one of the bars and there is also an exhaust valve lifter so the motor may be easily started. As shown in the side view, the motor wheel is attached to the rear sled by three one-half-inch bolts which firmly hold the wheel retaining bracket to the board fastened to the rear sled. As in bicycle practice, the wheel clamp is hinged to permit the wheel to play up and down and allow for road surface irregularities. Several men can be carried by this outfit. The steering is easily accomplished by means of a foot bar attached to the front sled. It is claimed that this outfit is capable of a speed of thirty miles per hour over hard snow or icy streets.

The general details of the construction of the types depicted should be clearly grasped by any one who might desire to duplicate any of the outfits shown.

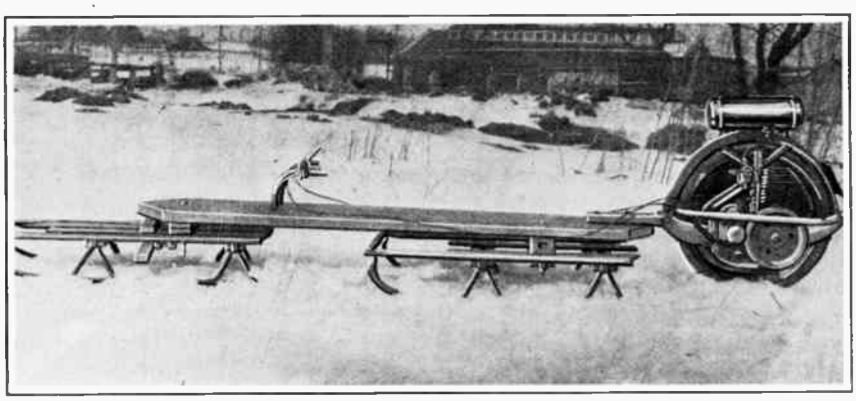
The Aero Sled depicted at the right uses a very compact power plant of double opposed form and a suitable aerial propeller, the entire outfit being suited for boat propulsion also

The craft shown below is capable of a speed of sixty miles per hour and is powered with a standard motorcycle engine driving an air propeller. The outfit is home-made





The motor bob shown above is made of a board, two sleds and a motor wheel for power

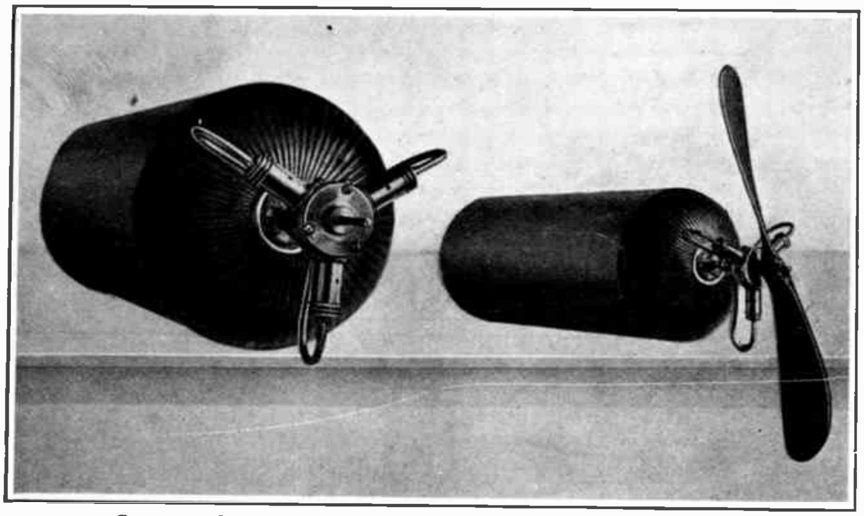


How the motor wheel and its control members are installed to push a bob sled at good speed

Compressed Air Motor for Model Airplane Propulsion

By H. C. Ellis

FOR the past few years builders of model airplanes (particularly scale models) have been looking forward to some source of power other than rubber band motors. The advantages of the compressed air engine are numerous. In doing away with the rubber motor it gives the model airplane a still higher position in aeronautical research. Scale models which hitherto could only fly about 100 feet, will now, equipped with an air motor, easily attain the 500 to 800 feet mark. The mass of the motor and tank is small and compact, so that models can be constructed after scale of man-carrying aeroplanes.



Compressed air operated power plant suitable for model airplanes

The motor shown in accompanying illustration is constructed as light as possible. Steel, bronze and aluminum are the only metals used. All necessary joints are screwed or silver soldered. The motor is what is known as the rotary type, that is the entire motor rotates around the crank shaft, which remains stationary. The cylinders of the motor are turned from a solid piece of steel. Pistons are of aluminum, lapped into the cylinders to insure a good fit. The connecting rods are of bronze and are carefully fitted to insure smooth running. The crankcase is of aluminum carefully machined to insure perfect alignment. The crankshaft is turned from a solid piece of steel rod. The complete engine, without tank and propeller, weighs but 2½ ounces. The piston stroke is ½" and the cylinder bore ½". The engine attains a speed of 1400 rev. per minute. The propeller used is 12" diameter and 21" pitch and gives a thrust of 1 lb.

The air tank shown in the illustration is 14" long and 5½" in diameter. It is constructed of sheet bronze, wound around a suitable mandrel, riveted and then soldered. The ends or caps are then put on, these being of the same material. They are riveted and soldered same as the seams in the tank. In the rear end there is a suitable tire valve for attaching the foot pump.

With a tire pump the air is compressed in the tank or container to a pressure of 150 lbs. Then the pump is removed and the model is made ready for flight. Through opening the throttle on the air container, the motor will start to run and turn the propeller for 30 to 60 seconds. Models that can be successfully flown by this motor can weigh empty up to 1½ lbs. and have a span of 4 to 6 feet. Many instructive and interesting models may be operated by the above motor. Some of these are to be described in coming issues of EVERYDAY ENGINEERING MAGAZINE.

A curious discussion has been going on in one of our contemporaries on the subject of the effect of motion east or west along the equator on the weight of a body so moving. If a body is motionless on the equator its weight is diminished by centrifugal force; if it were to move westward at the rate of the earth's rotation, it would be unaffected by that force and would lose weight. If it went eastward, it would add its motion to that of the earth and the centrifugal force would be increased and the weight correspondingly diminished. It is calculated that a motion of sixty miles an hour would change its weight one twenty-fifth of one per cent.

Housekeepers have long been familiar with glass baking dishes and cooking vessels which resist heat. Now the same kind of glass is being offered to chemists for use in the laboratory, as beakers, flasks and the like. Quartz ignition trays and capsules have been in use by chemists for some years, and the high price of platinum renders them particularly acceptable.

Totem poles can now be bought by the foot. In British Columbia the Haida Indians of Masset, sell them for $1.50 and $2.00 per foot. Considerable care must be exercised in packing them for transport. It is said that they are decaying and otherwise depreciating.

VARIATION OF HORSEPOWER WITH ALTITUDE AND COMPRESSION RATIO

THE results outlined below were obtained at the Altitude Laboratory of the Bureau of Standards. In this, the engine under test is installed in a concrete chamber, having insulated walls, and from which the air may be partially exhausted by means of a blower, thus reducing the barometric pressure within the chamber to a point corresponding to the pressure at any desired altitude. At the same time the temperature may be regulated during the test by passing the air, as it enters the chamber over a series of refrigerating coils. The power of the engine is absorbed by an electric dynamometer placed outside the chamber and connected to the engine by a shaft and coupling.

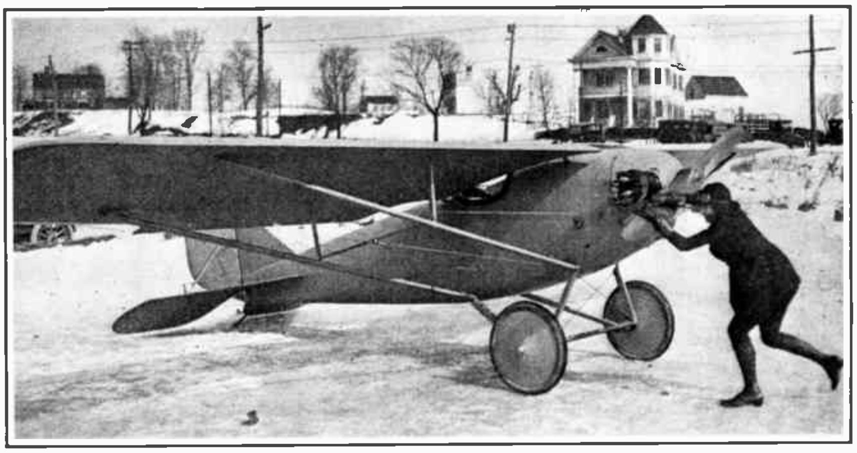
The engine used in the experiments was a 150 horsepower eight-cylinder Hispano-Suiza, furnished with three sets of pistons, giving compression ratios of 4.7, 5.3, 6.2. The Claudel Carburetor was adjusted by hand to give the maximum power for each run. The results are based on an engine speed of 1,500 r.p.m., and the horsepowers were corrected, in the earlier tests to 0°C., while in the latter ones they were corrected to standard temperatures, corresponding to the barometric pressures at which the tests were made. The actual temperatures at which the tests were made are not given. The tests were made at four barometric pressures, which were adopted as standards for comparing the results of different tests. These pressures corresponded to heights of approximately 5,500, 11,500, 19,200, and 29,600 ft., as calculated from the formula $h = 62900 \log_{10} 76/P$, obtained from the Smithsonian Tables for 1907.

The general conclusion drawn from the results is that the gain in power due to increase in compression does not bear a constant relation to the total power of the engine at different altitudes, but is greater at high than at low altitudes. The gain in horsepower due to a high compression ratio of 6.2 as against 5.3 amounts to 2.8 per cent at 5,000 feet, while it increases to nearly 5.8 per cent. at 30,000 feet. Likewise the decrease in horsepower due to the low compression ratio of 4.7, as against 5.3, while only 3.3 per cent. at 5,000 ft., amounts to about 7.3 per cent. at 30,000 ft.

It is pointed out that any comparison of absolute horsepowers for the different compression ratios may be misleading, as the engine conditions, such as fit of piston and rings, condition of valves, etc., were not the same in each case. This, however, should not affect the manner in which the power varies with barometric pressure for a given compression ratio.

A Practical Small Airplane

AMERICA'S smallest flying craft—the "Butterfly" monoplane of the L.W.F. Engineering Corporation, took the air in a successful trial flight at College Point, Long Island, the afternoon of February 18. It fulfilled all of the predictions made for it after wind tunnel tests of a model. The Butterfly, a veritable aerial flivver, will make its bow to the public at the Aeronautical Show of the Manufacturers Aircraft Association in the Seventy-first Regiment Armory, New York, March 6 to 13. It will be put on a quantity production basis and it is said it will sell for $2,500.



The Butterfly Monoplane. An L. W. F. type that has made successful flights

The two cylinder opposed motor with which it is engined, started on a half spin of the propeller and the plane rolled across the snow. It gathered speed rapidly and went into the air at about seventy-five feet from the starting point. Pilot Foote sailed off toward the sound made a wide turn, came back to the field and landed. The plane stopped within sixty feet of the point at which its wheels first touched the ground. Additional trial flights will be made for speed gasoline consumption, and climbing ability before the exposition. Laboratory tests give the plane a maximum speed of 72 miles per hour and a minimum without losing altitude of 22 miles.

The "Butterfly" weighs 595 pounds—two strong men can lift it from the ground. It is only twenty-nine feet and nine inches wide and nineteen feet long. The motor is smaller and weighs less than the motors in even the lowest powered automobiles, yet it develops 68 to 70 horsepower. The maximum carrying capacity is 383 pounds. The Butterfly was designed to satisfy the desires of sportsmen for a machine of low first cost, low operating expenses and low garage cost. Its wings ailerons and tail surfaces are detachable and many of the parts are interchangeable. The specifications of both motor and airplane are appended.

SPECIFICATIONS
L.W.F. Cato Motor
(Power Plant of the "Butterfly")

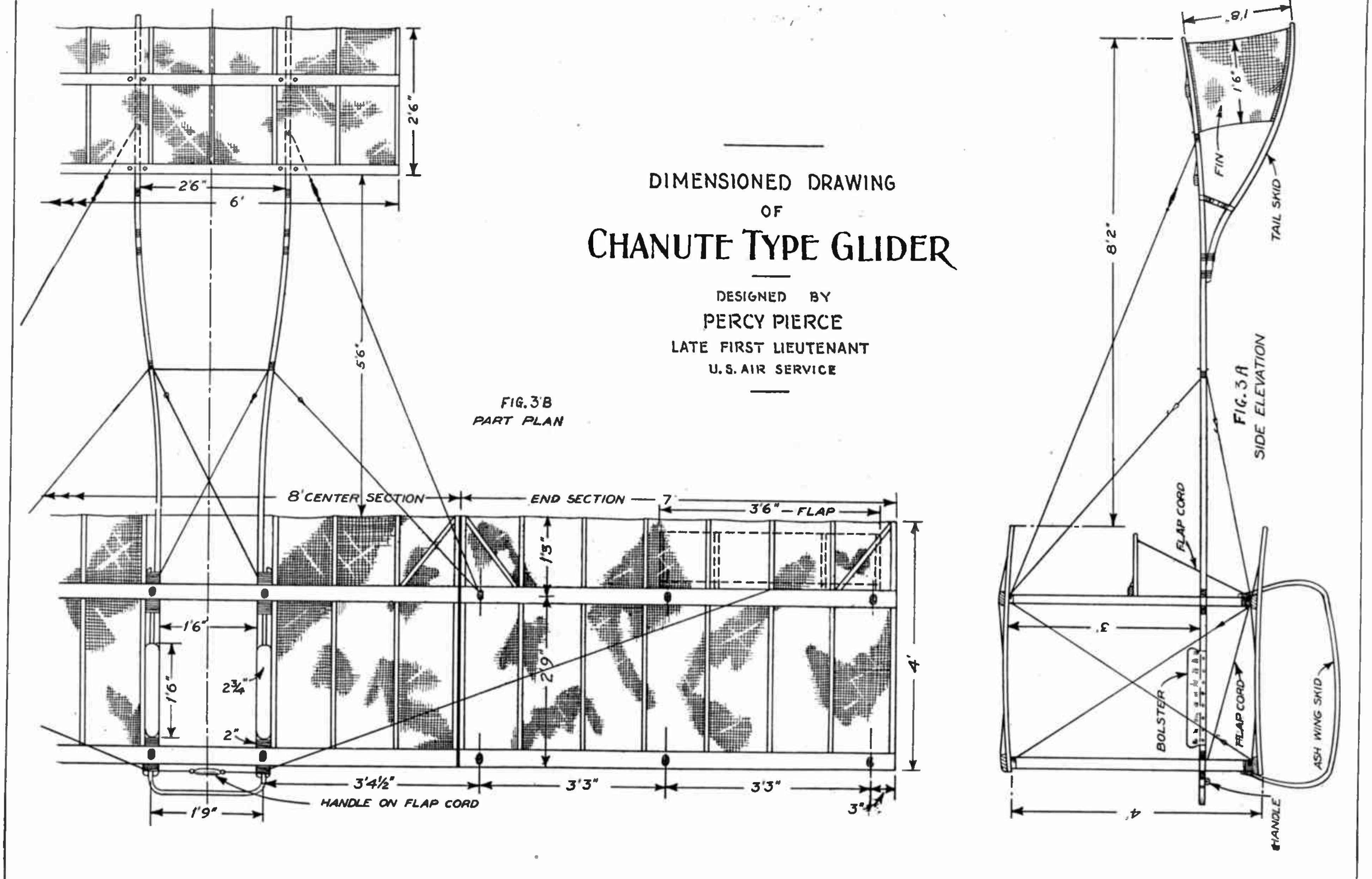
Type—2 cylinder horizontally opposed, 4-cycle, air cooled, valve in head.
Horse Power—72 at 1825 R.P.M.
Cooling—Air.
Bore—5 inches.
Stroke—6 inches.
Total Weight ready to run—154 pounds.
Area of Piston Head—19.635 sq. in.
Swept Volume—one cylinder 117.88 cu. in.
Total Volume Including Clearance Volume—152.97 cu. in.
Compression Ratio—4.33 to 1.
Piston Displacement—235.62 cu. in.

SPECIFICATIONS
MODEL "L"
"BUTTERFLY"

General Dimensions:	
Wing span	29′ 9″
Depth of wing chord	84″
Height overall	5′ 10″
Length overall	19′
Areas:	
Ailerons (each)	10.5 sq. ft.
Wings (without ailerons)	166.0 sq. ft.
Elevators (each)	6.5 sq. ft.
Rudder	6.5 sq. ft.
Stabilizer	6.0 sq. ft.
Fin	3.75 sq. ft.
Wing Curve	Cato No. 4
Weights and Loading:	
Net weight of machine (empty)	595 pounds
Gross weight	918 "
Useful load	383 "
Loading per sq. ft.	4.9 "
Weight per H.P.	13.5 "
Motor:	
Cato, air cooled	68-70 H. P.
Performance:	
Speed, maximum horizontal flight	72 M. P. H.
Speed, minimum horizontal flight	22 M. P. H.
Climbing speed	4,800 ft. in 10 min.
Radius of action (full throttle)	6 hours

FILL HOLES IN TIRE CASINGS PROMPTLY

THE motorist does not realize the great increase in tire mileage made possible by prompt attention to the many cuts and bruises to the tire tread which are apt to be neglected because they do not cause deflation. Water and sand works in between the plies through the cuts, causing sand blisters which in turn usually result in a "blowout." For general use of motorists and in small shops a combination vulcanizer which is composed of a large hollow cast-iron body filled with water and heated with a spirit lamp, is marketed. In this the curved face and the flat face may be used simultaneously and an inner tube patched at the same time that the outer casing is being treated. As very complete instructions are furnished with these small vulcanizers, any motorist may become familiar with their use without much difficulty. In some vulcanizers, the heat is furnished by electricity passing through resistance coils imbedded in the device and are similar to an electric flat iron in action. In vulcanizing, the most important precaution is to maintain a proper temperature. Too great a degree of heat will burn the rubber, while a proper cure cannot be effected if temperature is too low. The temperatures recommended for vulcanizing vary from 250 to 375 degree F. The lower degree of heat is used in working material previously cured, while the higher temperature is best for new rubber.



DIMENSIONED DRAWING OF

CHANUTE TYPE GLIDER

DESIGNED BY
PERCY PIERCE
LATE FIRST LIEUTENANT
U.S. AIR SERVICE

The Construction of a Chanute Glider

By Percy Pierce

Late First Lieutenant, U. S. Air Service

PART I.

THERE is perhaps little need for any lengthy description of the historical machines from which the glider shown in the accompanying illustrations has been evolved. By this, I do not mean to imply that the sketches show any great advancements of my own on the original machines of the apparatus designed years ago by the late Octave Chanute, that great and revered pioneer in the art of flying who carried the credit of devising the first powerless airplane of the biplane type —a machine with two superimposed planes or surfaces, one above the other.

Chanute's first glider or powerless airplane was a modified Lilienthal (Germany's Wright) type monoplane with a tail, later he built a quadruplane with tail, see Fig. 1, each deck divided at its center longitudinally both in main and tail planes. Later he abandoned this and came to the conclusion that two main surfaces superimposed were nearly all that was required and a biplane with cruciform tail, one vertical and one horizontal, was the result. The machine appears to have had but a single outrigger spar (the member connecting the tail surfaces with the main supporting surfaces) to carry the tail and here I think the machine could have been improved upon. No landing skids were provided, nor yet any sort of supports on which to rest the glider upon the ground. Such details as these I have introduced in the glider herein dealt with.

In Fig. 2 is illustrated the rear view of the glider in the air with the pilot "on board". It may appear from the drawing that he does not look real comfortable, but it may be taken for granted that he is, the bolsters by which he is supported under the arms, being nicely padded. The pilot is placed fairly close to the leading edge of the main planes, and with the center of gravity about on level with or a little below, the lower plane. Extending backward on a level with the center of gravity of the whole are two outriggers to carry the tail, and from beneath these, near their rear ends, are two skids curving downward and backward. Between these skids and the outriggers fabric is stretched to serve as vertical tail vanes, by means of which the head of the machine is kept well up to the wind.

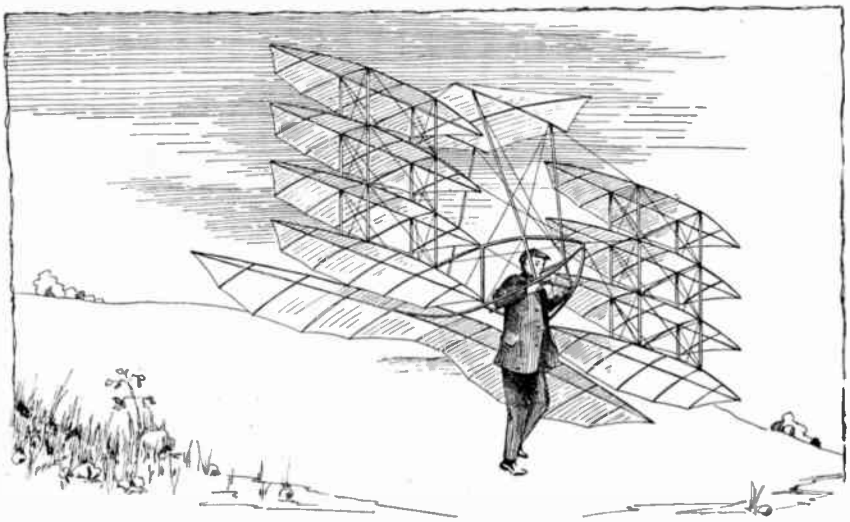


Fig. 1. Chanute's first glider was a multiplane form

No Elevator Needed

It will be noticed that no elevator (a movable surface to glide the machine upward or downward) is arranged for, but could easily be rigged up. However, I do not consider, and have never found it necessary, to use an elevator in this type of glider, since it is so easy to move the center of gravity of the machine by moving the body longitudinally, a small amount of swing to the pilot's legs either backward or forward being sufficient to control the machine. The correct angle of the tail plane—which, by the way, should be negative to the main planes—can be adjusted by means of the turnbuckles showing in the side elevation drawing, Fig. 3, the flexibility of the outriggers permitting this.

Stabilizing Flaps Provided

With regard to the lateral balance, this can either be accomplished by the movement of the pilot's legs from one side or to the other or by the movement of the center of pressure—caused by the actuation of the control cord to the ailerons shown in the plan and side elevations in Fig. 3. If ailerons are used they can be pivoted on the two outermost struts on the trailing edge of the planes at each end. These are merely flaps, and hang vertical when the machine is not in flight. When in use they make the same angle of incidence (the angle at which the planes advance through the air to give lift) as the main planes for normal flight, being restrained at that angle by the tension of the control cord. If they require to be operated for correcting an undesirable list or for the purpose of steering, their action is as follows:

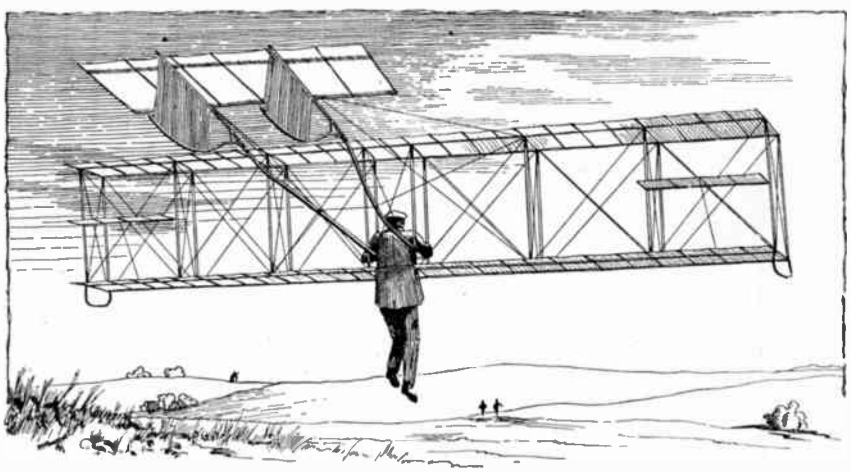


Fig. 2. Rear view of Pierce biplane glider in flight

Supposing the glider assumes a cant over to the left—that is, with the right-hand side higher than the other, the right-hand flap would be pulled down, thus disturbing the air currents between the right-hand ends of the planes and so rob them of their lift. At the same time the flap puts a brake on the rising side. The consequence is the left-hand side commences to travel faster relatively to the wind velocity, with the result that the left-hand side rises to the normal level. If flaps are not used the center of gravity is then moved by swinging the legs over toward the high side—which in this case is the right-hand side. Restoring the glider to its normal position as with the use of the flaps will be the result. If it is desired to steer the machine, say, to the right, the right-hand flap is pulled down; this produces a list to the right, the effort of which is to cause the left side to rise and the machine to swing round on the air banking.

The control cord is attached to the center ribs of the flaps and passes through eyes on the rear spar of the lower plane, meeting in the center of the machine in a handle placed immediately in front of the pilot, as shown in the plan view, Fig. 3.

Main Planes in Section

It will be seen from the drawing last mentioned that the ends of the main planes are arranged to be made in sections, a length of seven feet at each end being removable *en bloc*, complete with struts, flaps, bracing wires, etc. This will be found a very great advantage indeed when the question of storage for the glider comes up for consideration; it also means that the glider can be built in a much smaller workshop than would be the case were the planes each in one length of 22 feet.

The arrangement for coupling up the sections is shown in Fig. 4. It is simply a pair of hinged plates, the two halves of the hinge being united by a stout split-pin passing through the eyes in the plates. One of these hinges is screwed and bolted in the manner shown on each of the two main spars of the planes—one-half on the spar of the end section and the other on the center section; they should be put on the underneath side of the planes. Owing to the fact that the ribs are screwed to the underside of the spars, the hinges will have to pass over the two ribs at the ends of the two united sections; it two cases on full-sized power machines. will therefore be necessary to glue on to the spars some packing-up strips of equal thickness to the ribs.

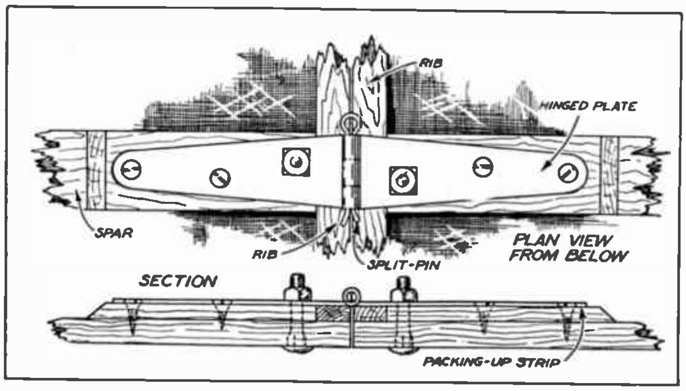


Fig. 4. The hinge coupling for the plane cellules

This method of attaching the sections has been found quite simple and perfectly efficient in practice; in fact, I have used it on much larger planes than those on the glider herein described—To detach an end section after using the machine, it is only necessary to undo the four bracing wires by means of the motorcycle spoke turnbuckles, draw the four split pins, and the end is off.

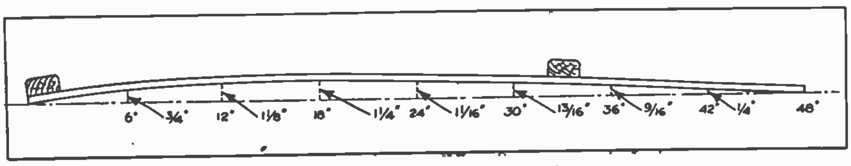


Fig. 5. Rib curve for main planes

Main Plane Curve and Construction

In Fig. 5, I have drawn the form of the main planes in section; the maximum versed sine is 1¼ in. at 18 in. from the leading edge. All the ribs, after cutting and planing to size—which, by the way, is ½ in. by ⅜ in. in section—should be steamed and bent over a templet, being afterward set carefully to a full size drawing copied from Fig. 5. The ribs and spars may all be of spruce or clean straight-grained pine. By spruce, I mean, of course, silver or Oregon spruce, not the common white variety. The trailing edge of the planes are wired as shown in Fig. 6. This should be No. 20 gauge music wire. Each rib is notched slightly across its end to receive the wire, which is then bound in place by a few turns of fine soft iron wire, passing it through a hole bored about half an inch from the end of the rib. Before finishing off the main wire on the rib ends, it will be necessary to introduce short struts as shown in Fig. 6; these serve to transfer the pull of the wire to the main spar and generally distribute the stresses through the structure of the planes. To terminate the wire, it should be bound into a notch in the rib in the same way as was done all along in the other ribs, and then bent sharply round the end of the plane and cut off about ¾ in. from the bend; this length is then bound into the end, or rather side, of the rib. When one end has been made off, the wire should be pulled fairly taut and the other end finished, then all the binding gone over with a soldering iron.

(To be continued)

MATERIAL IN AN AIRPLANE

THERE is a surprising amount of material of various kinds necessary to build an airplane of the conventional type. Materials involving metals of various kinds include the following:

Nails	4,326
Screws	3,377
Steel Stampings	921
Forgings	798
Turnbuckles	276
Wire	3,262 feet
Aluminum	65 pounds

The various kinds of wooden material mount up as follows:

Spruce	244 feet
Pine	58 feet
Ash	31 feet
Hickory	1½ feet

Other materials necessary for the finished plane are:

Veneer	57 sq. ft.
Varnish	11 gallons
Dope	59 gallons
Rubber shock absorber cords	34 feet
Linen	201 sq. yds.

This list of material is exclusive of everything necessary for the engine alone and is used in a well-known make of biplane tractor of about 40 feet spread built for training purposes during the war and now used in a modified form for many commercial purposes.

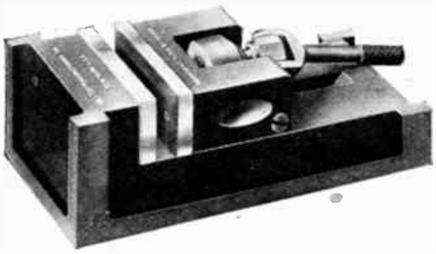
Two-thirds of the cobalt of the world is produced from the mines of Cobalt, Ontario, and at that it is only a by-product. One hundred and fifty-five tons of nickel, 337 tons of cobalt, 2,592 tons of arsenic are the annual production of the district along with over 19 millions ounces of silver.

In Shanghai, China, a trackless trolley is credited with the transportation of about 5¾ million passengers in the year 1918. It has been in operation for four years.

SHOP PRACTICE

A WELL-DESIGNED VISE

A NEW vise possessing many new features of a practical nature is shown in the photographs. This type of vise is made in several different sizes suitable for different classes of work.



Each vise is provided with a projected edge by means of which it can be clamped tightly to a drill press table, lathe face plate or milling machine. This is a feature that has not been included on ordinary vises. The edge also makes it possible to mount the vise on its side. The edges are milled perfectly accurate. By the use of an especially patented clamp, the moving jaw of the vise can be rapidly ad-

justed and finally tightened by a few turns of the screw at the back.

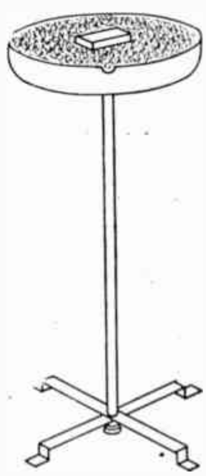
The vise is also manufactured on a swivel base accurately graduated from 1 to 360 degrees. This particular type has been developed entirely for machine use. It embodies the same adjusting clamp as the plain type.

The smaller sizes of these vises are admirably adapted to small shop use.

AN EASILY CONSTRUCTED SOLDERING STAND

A STAND like the one described, comes in very handy for hard soldering, annealing and similar operations in conjunction with a blow torch.

The pan is an old frying pan drilled through the center to accommodate a supporting rod. Instead of sawing off the handle it should be bent up, this making a convenient support for the blow torch when not in use. The rod is anywhere from 1/4 to 1/2 in. in diameter and is threaded at both ends. The feet or legs are bent as shown from some 1 in. width heavy gauge iron and drilled to hold the rod. Both pan and feet are fastened to the rod with nuts,



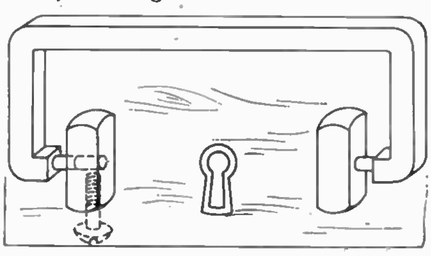
as per drawing. The completed stand should be about three feet high or adjusted to the height of the builder.

The pan should be filled with sand, gravel, etc. The brick, shown in the drawing, is used to support work while soldering.

The builder may easily fill in any other details to suit himself, bearing in mind, however, that rigidity is of prime importance.—W. G. Voss.

TOOL BOX OR DRAWER HANDLE

QUITE often the "handy-man" has occasion to use a hinged handle on a tool box or drawer, but in most cases, if he goes to the hardware or



furniture store, they will show him either the fancy stamped brass handles for dressers, or he will find heavy handles, such as used on trunks and heavy tool boxes or chests, and it then devolves upon him to make a handle of the proper shape and size to go with the thing that he is building. Below is given a sketch of a handle that is easily made, that is plain, and that will look well wherever used. The stock for making the handle should be square, the size depending on the size of handle wanted. The material should be able to stand a right angle bend without cracking. The two uprights are made of stock preferably slightly larger. A hole is drilled in the base. This hole is then tapped for a bolt to hold it to the box or drawer. A hole is drilled in the side of this upright, as indicated, and into this hole the rounded end of the handle proper is placed, so that the handle will lie down out of the way when not in use.

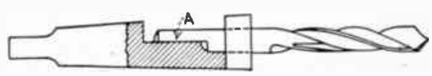
The above handle is very easily made, and if the work is carefully done, a very neat appearing handle will be the result.—Frank A. Sahbaum.

SAVING OLD DRILLS

NEVER throw away a drill, because of a broken tang. Remember a drill is valuable, for it can be easily fixed and used once more, although this is not generally known.

Like all real solutions, the idea is simple when once explained.

Simply grind the broken tang to the shape shown at A and make a socket

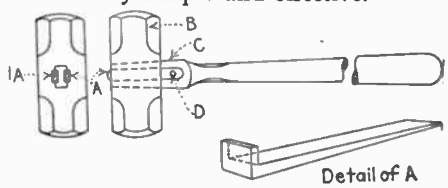


to suit drills of such nature. One socket will accommodate all sizes of drills, merely make the size of the next tang a standard size.

Considerable money can be saved by adopting this idea.—J. H. Moore.

SAFETY WEDGES FOR A SLEDGE

MANY an accident has been caused by the head of a sledge-hammer flying off, and any scheme to stop such a danger is worth adopting. The solution is very simple and effective.



Make two steel tapered wedges A (see detail view) and place on each side of C as shown on the sketch. These wedges should be slightly longer than the head of the hammer B. Now drill a hole through the shaft of the hammer and wedges, after which put the pin D in place.—J. H. Moore.

CARE OF A SLIDE RULE

A SLIDE rule, even though it will stand rough usage, requires intelligent care if reliable and consistent results are to be obtained. At frequent intervals the A, B, C and D scales should be checked against each other, and the sliding portion should fit snugly between the guides. The fit between slide and guides will vary with the weather, that is, whether it is dry or moist, since the wooden part of the rule absorbs moisture.

In case of a new rule, it will be found very easy to get it "broke in", if the guides of the rule are sprinkled with talcum powder and the slide worked back and forth several times.

If the glass runner is attached to metal blocks which serve as guides or slides, the glass is easily broken if the rule is dropped or severely jarred. To overcome this difficulty, place a piece of very thin paper between the metal blocks and the glass, and between screw-heads and glass. This makes a cushion between the glass and the metal, and it is surprising how much longer the glass will last when so protected. The paper should be trimmed off along the edges of the metal guides, and around the screw-heads. If so protected, the rule will need a new glass only at very infrequent intervals.—FRANK A. SAHBAUM.

BUFFING AND POLISHING WAX

OCCASION arose where some buffing and polishing was to be done on a polishing wheel, but no polishing wax or buffing wax, as ordinarily used, was at hand. The writer attempted to make a wax to meet the emergency by melting some paraffine, and then adding powdered pumice stone, till the paraffine was very thick and sluggish. The mass was then allowed to cool, after constant stirring. When quite hard, this was rubbed on the polishing wheel and very good results were obtained in the way of a finish. It takes more of this material to do a given amount of polishing than of the regular wax, but this was well suited in case of an emergency.

Several different qualities of this might be made, by making a mixture of fine emery dust and paraffine, and by mixing rotten-stone or some other polishing powder and paraffine. Which of these materials would be used would depend on the finish required and on the rate of polishing, for it is evident that the emery would do the work more rapidly, although it would not give the gloss that a finer grade abrasive would give.—FRANK A. SAHBAUM.

USE OF SOLDERING

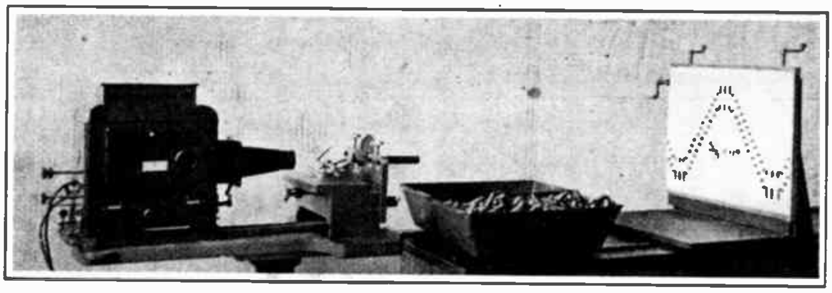
A DENT in a closed metal cylinder can be repaired by first soldering a small strip of metal to it. By this means the dent can be pulled out and the solder that holds the strip melted off.

OPTICAL APPARATUS FOR TESTING SCREW THREADS

OPTICAL methods are coming into use more and more in the field of mechanical measurement. By optical means an accuracy can be obtained that cannot be approached by any other method. The wonderful Johanssan blocks that are accurate to the hundred-thousandths part of an inch are produced by the aid of optical measuring instruments. In fact, this system is so perfectly accurate that precision blocks have been made with an accuracy of .000001 inch.

The optical method of testing screw threads rapidly has recently been introduced and is coming into wide use in all of the large manufacturing establishments in the country. Its advantages over the conventional gauge system are numerous. Great accuracy and greater speed are probably the most important factors.

In the case of testing screw threads, the profile shadow of the screw is thrown upon a small screen known as a tolerance chart by means of an especially constructed projector. The profile of one thread at a time is projected and the screw can be revolved so that its entire thread may be inspected. The screw is held in an especially designed holder as shown. This is so made that any inaccuracy in the lead of the screw will be evident upon the screen.



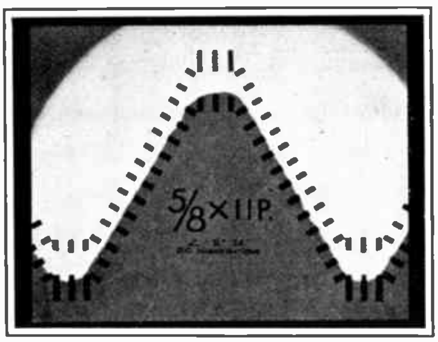
The complete projecting apparatus together with the tolerance chart

One of the photographs shows the projected profile of a screw with a correct lead. The zone between the dotted lines represents the limit of tolerance. The screw shown in the photograph is just at the limit of tolerance. If it was just a trifle smaller it would be necessary to reject it. Any profile that extends above the upper dotted lines represents a screw with too great a diameter. This system tells at a mere glance what is impossible to determine by the sense of feeling. The method is absolutely unfailing and unlike the gauge system it can be depended upon.

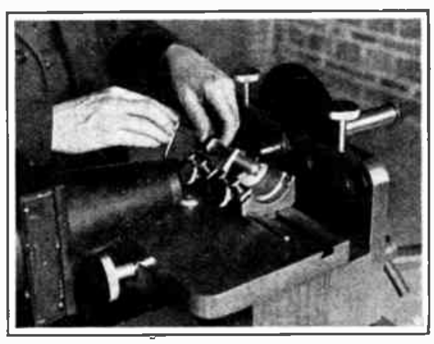
The projected screw is magnified 200 times and all of the irregularities of the surface are plainly visible. The tolerance zone is so measured off that it will indicate a tolerance of .004 inch at a magnification of 200 diameters.

When the apparatus is set up it is necessary to employ a standard gauge to set the screen the proper distance from the projector. Adjusting handles are provided on the screen so that it can be brought to the proper position.

A perfectly dark room is by no means necessary for the operation of the screw testing machine. A moderately lighted room does nicely.



The profile of a screw upon the tolerance chart is shown

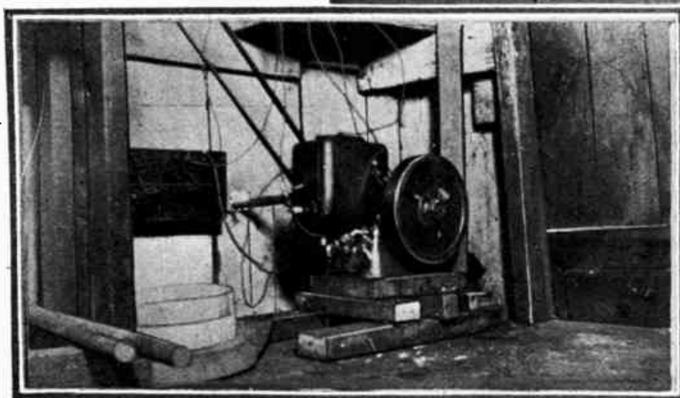


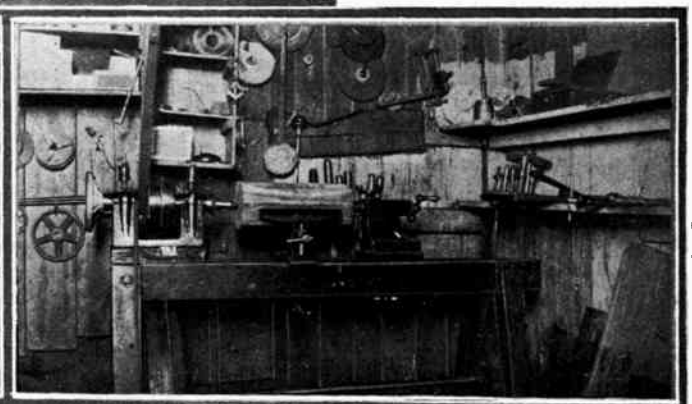
Placing a screw in holder for testing

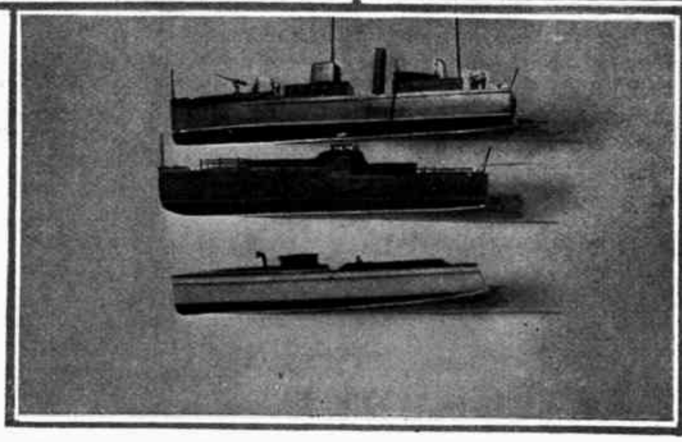
Mr. James Hartness, the inventor of the optical method of testing screw threads, claims that the present system of gauging, as outlined in the previous lines, will eventually reject all lead errors in screws of minimum diameter. The conventional system of gauging permits a larger lead error in the smaller screws than is tolerated in the larger screws.

Our Readers' Workshops Page

THE shop pictured on this page is owned and operated by Mr. H. Willhagen, who has derived no end of benefit and pleasure from his equipment. He had added to his shop from time to time until it is now very complete. Mr. Willhagen's description follows:







"I use my workshop as an aid to my hobby and incidentally I make quite a bit of money working in my spare time for my friends who see my work and who want something done which they are unable to do on account of lacking shop facilities. This work keeps me very busy at times, but on the other hand it adds considerably to my income. My bench, which is six feet long, has drawers in it and is provided with a quick-action vise at one end and a vise for metal work at the other end. One end of the bench is used for metal work and the other for wood work. From an old gas stove and bread toaster I made a very serviceable furnace which is used in heating soldering coppers and glue. Aside from this the shop is provided with fourteen planes of all shapes and sizes for matching boards, beading, etc. A multitude of dies and taps are on hand ranging from 2-52 to 9/16. Drills from the very smallest to ¾ in. are also provided. I have reamers from ¼ to 7/16; also two Morse taper reamers. I have a rip saw, cross cut, coping and back saw. I also have a key-hole saw, hack saw and a power driven rip saw. Some time ago I made a table out of 2 x 4's and an old saw spindle. I am able to cut grooves on this device and also use it largely for cross-cut work.

"Paints and varnishes of all shades, colors and hues are on hand and this is considered to be a very important part of the shop equipment. Carving chisels, gouges and clamps of all sizes make the wood working part of the shop very complete.

"Cigar boxes full of screws, nails, bolts, nuts, washers and 'junk' (as we call it) are stored under the benches where they are very accessible.

"Some of the work I have done in spare time has brought me good returns. In one instance I was paid $5.00 for a medicine cabinet. I have made a number of Kiddie Cars for my own little girls. A total of six lamps have been made in my little shop. I have recently added an old lathe which will be used especially for turning long lamp posts.

"The lathe shown in one of the photographs was made by me and it is very serviceable. I had a friend turn the spindle and all of the pattern work and assembly was done by myself. I have a face plate fixed up for a disc grinder and sander which is a very useful piece of equipment. The lathe parts include buffing wheels, grinding wheels, chucks, saws and centers. I also have a set of dogs and a cross feed for light metal work. It is my intention to install a good screw-cutting lathe before long. The lathe I have at the present time is run both by foot and gas engine power. The gas engine power plant, which is part of the shop, is illustrated in one of the photographs.

"I have made four boats, one of which was praised very highly by my friends who saw it. Two of these crafts were made from directions that appeared in Everyday Engineering Magazine. It was through the magazine that I turned my attention to model construction. Before long I intend to start building a small flash steamboat.

"I have obtained much pleasure from working in my small shop and I must say that it has put me where I am today. When I started to read your little five-cent magazine I was a 'sticker' machine hand working for 50 cents per hour. Today I am a pattern maker getting 85 cents per hour and was recently offered $1.20 per hour. I have had six wage increases during the last few years and this I attribute to my little shop."

THE JUNIOR EXPERIMENTER

B Range Loose Couplers

Beginners Will Have No Trouble in Building 200- to 600-meter Couplers if They Follow This Data

"CAN you suggest a type of loose coupler for 200-meter work?" This question is often asked in letters from the radio experimenters. Since the query requires an answer too long to put in a letter, it has been made the subject of this article, that the problem can be cleared up once for all. Specifications are given here for a B range type, that is, one which tunes from 200 to 600 meters.

The dimensions of the primary coil depend upon the antenna capacity, as it is not intended that a primary variable condenser be used, nor is it necessary. This capacity value will vary according to the dimensions of the antenna, but we will consider here the three standard types known as the Short, Long, and Super Range aerials, of 0.0002, 0.0004, and 0.0005 mfd. respectively. These were taken up at length in the November - December, 1919, issue.

While there are any number of ways to build loose couplers, we shall consider only those with single layer windings, having the secondary slide into the primary. Below is a table showing the dimensions of the primary for a loose coupler to give a B range, operating on any of the three standard antennas.

Primary Coil, B Range

	Diam.	Length	Wire	Turns per in.	Inductance
Short Range Antenna—	3½ ins.	2 ins.	No. 24S.S.C.	42	600,000 cms.
Long Range Antenna—	3½ ins.	1¼ ins.	No. 24S.S.C.	42	300,000 cms.
Super Range Antenna—	3½ ins.	1 in.	No. 24S.S.C.	42	250,000 cms.

Sliders or switches can be used to vary the inductance, according to the plans of the builder. If the slider is carefully made, it will be satisfactory. Taps should be taken off every second or third turn, if a switch is employed.

The size of the secondary coil depends upon the variable condenser connected across it. As can be seen from the table below, two variations of inductance are required with a 0.0005 mfd. maximum condenser. A two-point switch is all that is needed.

Secondary Coil, B Range

	Diam.	Length	Wire	Turns per in.	Inductance
0.0005 mfd. Condenser—	3 ins.	1⅜ ins. Tap ⅝ in.	No. 24S.S.C.	42	250,000 cms.
0.001 mfd. Condenser—	3 ins.	13/16 in.	No. 24S.S.C.	42	120,000 cms.

The advantage of the 0.001 mfd. condenser is that no adjustment of the secondary coil is needed, all the tuning being done with the variable condenser.

If the secondary is to slide in and out of the primary, wooden discs can be fastened inside the ends of the secondary tube, to take the supporting rods. It is advisable to use two ⅛ in. brass rods, mounting them on small wooden blocks secured to the base of the loose coupler.

The method of making connections to the secondary winding should be considered carefully, as high resistance in this circuit greatly reduces the strength of the signals. One way is to use the suporting rods for connections. If this is done, brass tubes, ⅛ in. inside diameter, should be put in the holes in the wooden coil discs, and the wires soldered to the tubes. Thus a sufficient area is in contact between the tubes and rods to give a good connection.

Another way is to bring out flexible leads from the coil. When this is not done correctly, the leads soon break off at the connections. If, however, at both ends, the wires are run from the joints through small screw eyes placed ½ in. away, the bending strain does not come directly at the joints, but is distributed.

Either a crystal detector or audion can be used with a loose coupler of this type, according to the range required.

Diagrams of various types are given in Radio Hook-ups, to which the reader is referred.

TESTING A. C. RECTIFICATION

A CLEVER method for testing the rectification of alternating current has been suggested by Mr. H. B. Trombly, of Pasadena, Cal.

When a horseshoe magnet is held near a lamp operating on alternating current, the filament vibrates rapidly. However, if a rectifier, of the type using only one-half of the cycle, is connected to the supply, the output of the rectifier will be in the form of a pulsating direct current, the other half of the cycle being cut out.

Consequently, a magnet held near a lamp carrying the rectified current should cause the filament to vibrate at one-half the speed first obtained.

CUTTING BAKELITE

OCCASIONALLY it is necessary in cutting out a piece of bakelite to remove quite a little of the material, but not enough that a saw can be used. A spoke shave, well sharpened, is an excellent tool for such work, as it makes a clean cut and removes the bakelite much faster than is possible with even a very coarse file. The latter is not good because it breaks the edges of the piece.

Don't try to polish bakelite—rub it down with a piece of No. 2 sandpaper, making the strokes all in the same direction and clear across the piece.

The Chemistry of the Common Metals

By Henry L. Havens

PART 1

Sodium

SIR HUMPHREY DAVY first prepared metallic sodium from sodium hydroxide in the year 1807. Previous to the date of its preparation by him, sodium hydroxide was regarded as a chemical element and the decomposition of the compound surprised the scientific world at the time. The chemical experimenter can very easily reproduce this classical experiment by carefully examining the diagram. The surface between the sodium hydroxide is kept well moistened with water and as the process continues the mercury will become thoroughly impregnated with metallic sodium. In this way the sodium is prevented from reacting with the water.

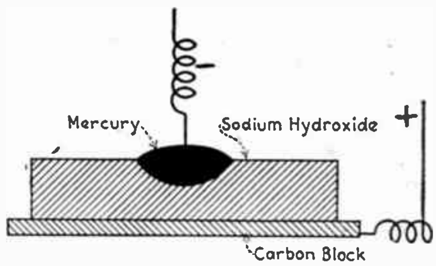
Sodium is one of the most abundant elements on the earth. It appears chiefly in the form of the chloride. It has been calculated that the ocean contains over 4,500,000 cubic miles of saline substances. A number of other sodium compounds also appear in nature, the more important being sodium carbonate (Na_2CO_3), sodium bicarbonate ($NaHCO_3$), sodium nitrate ($NaNO_3$), cryolite (Na_3AlF_6), and borax ($Na_2B_4O_7$). A number of silicates also appear in nature.

Sodium is a soft, pinkish-silver metal that tarnish or oxidizes immediately upon exposure to the air. It has a melting point of 97.6 deg. and boils at the temperature of 878 deg. The vapor passing off from boiling sodium is very active. Exhaustive experiments tend to prove that sodium has a molar weight of 23, which is exactly the same as its combining weight. The great activity of sodium vapor makes it extremely difficult to obtain the molar weight, but results tend to prove that it is very close to, if not, 23.

A very interesting experiment can be performed with sodium by dissolving a freshly cut piece of metal in amhydrous ammonia. The change is purely a physical one; a new compound is not formed. A solution of sodium is produced and this solution conducts electricity in much the same way as a metal. Upon the evaporation of the anhydrous ammonia pure metallic sodium is left as a residue. Sodium is also soluble in mercury as has been mentioned before. It was this fact that made Sir Humphrey Davy's experiment successful. Sodium-mercury amalagam is used largely in commerce in places where pure sodium would be objectionable owing to its extreme chemical activity.

When sodium is brought directly into contact with water a very vigorous chemical reaction takes place. The products of the action are sodium hydroxide and hydrogen as will be seen by the equation: $Na + H_2O = NaOH + H$. The escaping hydrogen from a small piece of sodium in contact with water will cause the sodium to skip about the surface rapidly. If a large piece of sodium is brought in contact with water the heat of the reaction is sufficient to ignite the hydrogen and a violent explosion will occur. Amateur chemists are cautioned not to try this experiment as sodium hydroxide is liable to be blown into the eyes which would in all probability destroy the sight. Upon the completion of the reaction of sodium with water, the sodium hydroxide can be obtained by evaporating the solution to dryness.

When sodium is heated in air it quietly burns with a yellow flame. The only way sodium can be preserved for a great length of time is by placing it in a perfectly air-tight receptacle such as a tin can with the cover soldered on.



It can also be preserved indefinitely by immersing it in petroleum which excludes the presence of air.

Sodium is so soft and pliable that it can be easily cut with a knife. When mixed with other metals that have a low melting point it assists in the formation of an alloy with a very low melting point.

Sodium Compounds

One of the most common compounds of sodium is its chloride ($NaCl$). This can be prepared by the interaction of moist chlorine and the element. It has been found that perfectly dry chlorine gas will not react with sodium at any temperature up to the melting point of the latter. The action of the water seems to be catalytic in every respect. By neutralizing sodium hydroxide with hydrochloric acid the chloride can be obtained by evaporating the solution to dryness.

Sodium chloride is nearly as soluable in cold water as in hot water. At 0° 100 parts of water is capable of dissolving 35.74 parts of sodium. At 107°, which is the point of saturation, the water is only capable of dissolving 39.65 parts of the chloride.

Sodium chloride crystals do not contain any water of crystallization in a true sense. They do, however, enclose a certain amount of water which causes the crystals to explode when heated.

Sodium monoxide (Na_2O) is prepared by adding metallic sodium to sodium nitrate according to the equation.

$$2\,NaNO_2 + 6Na = 4Na_2O + N_2$$

Sodium monoxide is a decidedly gray compound which reacts violently with water, causing the formation of the hydroxide ($NaOH$).

Sodium peroxide (Na_2O_2) is produced by heating metallic sodium in an excess of air freed from carbon dioxide. The resulting compound is a white powder about 93% pure. It reacts violently with water, forming sodium hydroxide and hydrogen peroxide (H_2O_2). Upon formation, the hydrogen peroxide breaks down rapidly into H_2O and free oxygen. The free oxygen is immediately available when the water comes in contact with the sodium peroxide. This makes sodium peroxide an abundant source of free oxygen and it is used largely in commerce as an oxidizing agent. In most cases a small quantity of some copper compound is placed in the commercial sodium peroxide which acts as a catalytic agent for the decomposition of the hydrogen peroxide. Sometimes sodium peroxide appears on the market in a fused condition under the name "oxone."

Pure metallic sodium can be produced in the laboratory by heating the peroxide with carbon. This results in the formation of sodium carbonate and metallic sodium. The temperature necessary for this reaction is between 350° and 400°.

Sodium carbonate (Na_2CO_3) is found in nature to a considerable extent. A number of lakes in the United States contain sodium carbonate which is obtained by solar evaporation. A double salt of the carbonate and the bicarbonate is produced ($Na_2CO_2NaHCO_3 2HO_2$). These salts can be very readily changed to the simple carbonate by heating. Previous to the recovery of sodium carbonate from natural lakes, it was obtained from the ash of sea plants.

The Solvay Process for the preparation of sodium bicarbonate consists of saturating a solution of ammonical brine with carbon dioxide (CO_2). As

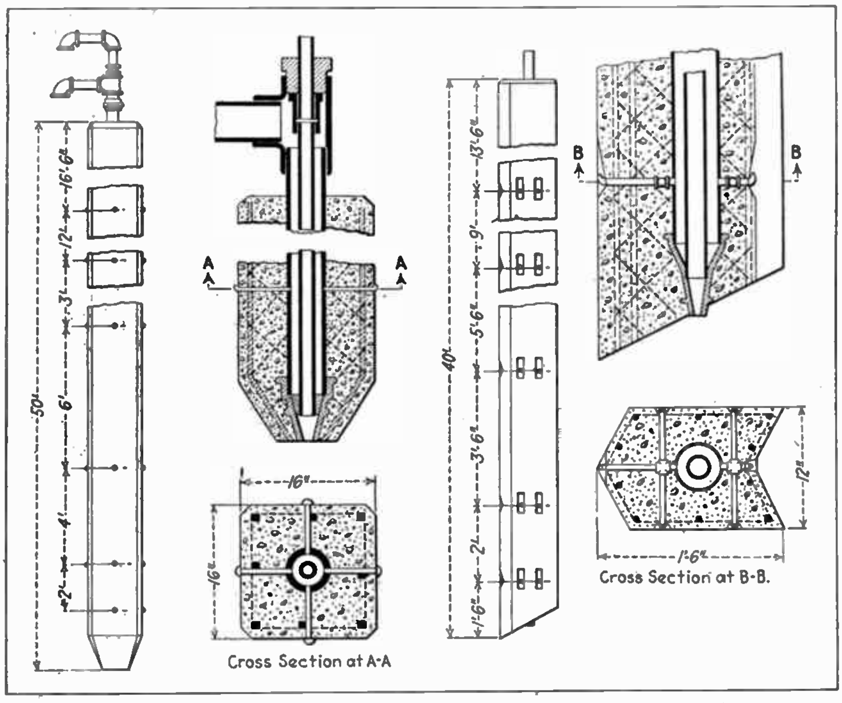
(*Continued on page* 427)

EVERYDAY SCIENCE NOTES

BY PROF. T. O'CONOR SLOANE

The Bignoll-Jones Concrete Pile

The pile, designated from the names of the originators, is made of reinforced concrete. The reinforcement is shown in dotted lines in the cut. The reinforcing can be distributed as desired; the feature of the structure to which attention is to be directed is the jetting arrangements for sinking it. At the partly pointed end of the pile is a funnel-shaped shoe, with a 1 1/16 inch nozzle. At its upper end the opening of the nozzle expands so as to be large enough to receive a 5-inch pipe. This pipe is fixed in the axis of the pile, and seats itself practically water-tight in the nozzle. Concentric with it there is a smaller pipe, 2 inches in diameter, which also seats itself water-tight in the nozzle. Thus the larger pipe is cut off from connection with the bottom opening of the nozzle.



The Bignoll-Jones Concrete Pile in Pillars for supports and sheet piling for caisson work

From the larger pipe small pipes are carried horizontally out to the surface of the pile; they are fitted with upwardly directed openings. Each pipe has its own independent water connection. The smaller pipe passes through a water-tight packing at the top of the 5-inch pipe.

To sink the pile water at a pressure of 150 lbs. to the square inch is forced into the larger pipe whence it escapes through the lateral jets, which may be from ⅜ to ¾ inch in diameter. Simultaneously a second stream of water at much higher pressure is forced into the central pipe; the pressure may be from 200 to 300 lbs. to the square inch. The pile sinks very rapidly, one case is cited where it sank at a rate just exceeding one foot per minute. The lateral streams of water are said to remove the spoil and to lubricate the passage through the soil.

The sheet piling is quite interesting. It is built on the same lines, is reinforced, and its cross-section is such that the piles interlock, somewhat like tongued and grooved planks. It will be noticed that in the sheet-piling the lateral jets are set in recesses so as to provide a smooth exterior surface, or better, one free from projections. In the elevation of the piling, the location of the lateral jets can be seen. The spacing is closer near the bottom, where there is the most work to be done.

This system of piling, sheet and plain piling has been extensively used on the Chicago, Burlington and Quincy R. R., under the direction of E. Bignoll, the superintendent of the road. It is in use by the dock department of this city also.

When the pile has sunk to the required depth, and this it does without any blow, as it is pure jet-sinking, the smaller pipe is removed. If thought desirable the larger pipe is filled with concrete. As it is held by the concrete it is quite impossible to successfully remove it. It may be taken as a contribution to the reinforcing. The fact that the lateral jets are turned upwards is an important feature as it makes them many times more efficient than if they were directed horizontally outward. The cuts show the various sections and elevations of the two kinds of piles described.

The heating phenomena of large steel ingots has been recently investigated. A 24-inch ingot it was determined may be at a temperature of 2370° at the surface and in the interior 2287°. After fifteen minutes' cooling the surface temperature was 2125° and the interior at the center 2280°. All temperatures were Fahrenheit. It shows how steel is strained in the heating and cooling phases. Chrome steel was noted as being particularly tender.

The combustion, spontaneous probably, of coal in bunkers, has given much trouble in the past. In Dortmund, Germany, to prevent it coal is stored in steel bunkers, which are kept filled with carbonic acid gas. The bottom doors and any openings below the top are closed gas- and air-tight. The upper openings do not need such careful sealing, on account of the high specific gravity of the gas. A certain amount of gas is lost when coal is withdrawn, but it is not expensive and is easily replaced. The particular bunkers are of 2,500 tons capacity.

A short note on the Pointolite lamp, an English product of the Ediswan Company has been published. The lamp was originally exhibited some years ago. It is a bulb lamp, with tungsten terminals within the bulb, between which an arc is maintained. A sort of deflector at the top and within the bulb acts to prevent blackening of the interior of the bulb. A lamp was shown at the November 25, 1919, seance of the British Illuminating Engineering Society of 4,000 candle-power. The efficiency is very high, 0.42 watts to the candle. Its life is short, only 250 hours, but it is hoped to increase this. The lamp has been made with a quartz bulb to give ultra-violet light.

Steam tenders are a well known feature of present day engineering practise. The Southern Railroad has utilized old engines for the purpose. The boilers are taken off so as to leave only the subframe or chassis, with the engine and connections. The steaming capacity of the regular engine is increased by the use of fire-brick arches and feed-water heater so that it can generate steam for its own engine and for that on the tender frame. The cylinders on the tender are bushed or lined so as to reduce their diameter by an inch. Steam tenders have been used on the compound Mallet engines on the Erie road and also in England.

The utilization of kelp, a kind of seaweed, for the production of potassium products and also for iodine and ammonia is being carried on on the coast of California. The kelp is cut about four feet under the surface of the sea, is retorted, incinerated and the ash, which is properly kelp, although the name is applied to the seaweed itself, is lixiviated and treated so as to give its products. The kelp industry in Europe is of very old origin and is one of the classic operations of industrial chemistry.

The discovery of pitchblende is reported from the Nipissing region in Canada. This is the second report of the finding of a radium ore in Canada, since the Ontario government offered a reward of $25,000 for the discovery of a source of radium in the Ontario province. It has recently been calculated that radium contains over two million times the energy in an equal weight of tri-nitro-toluol.

It has been estimated that an average American family spends $24 per annum on light. This is about the same that a similar family would spend a hundred years ago, but the family of to-day gets twenty times as much light for the same money.

M. Georges Charpy in a paper presented to the French Academy of Science developed the theory that the cause of the fracture of rails on railways was the production of minute surface cracks; these as they increased brought about the destruction of the rails. To overcome this he proposed to surface anneal the rails in situ. A welding acetylene flame is to be moved along the rail as it lies on the sleepers, and its rate of travel is to be such as to give just the requisite amount of heat to soften the surface and deprive it of its tendency to form these minute cracks. He thinks it possible that the life of rails might be doubled by this treatment.

In France a vast project has been outlined to utilize the water power of the Rhone, the Rhine and of the Pyrenees. Water from glaciers and snow-clad mountains, forming waterfalls and harnessed by engineers to servile power production has long been termed "white coal", and now that its black sister is failing, the government proposes to establish a great number of power stations and to distribute the power of waterfalls by electric lines to the smallest towns and even to farm-houses. Private enterprise in this direction is to be encouraged by subsidies, and anyone owning a water power site is to be required to utilize it. At the same time the use of heavy oil for fuel is being fostered by the French government.

To remove titanium compounds from the hearths of blast furnaces the injection of powdered iron oxide has been successfully tried. It is blown in through the tuyeres; it produces no chilling effect but on the contrary as it oxidizes the titanium compounds tend to increase the heat.

A method of obtaining day-light effects from incandescent lights has been introduced in which the lighting is done entirely by reflection from a surface covered with a mixture of colors in checker-board pattern. The lower part of the bulb is screened so that there is no direct light received from it. The modern high efficiency incandescent electric lamps enable reflection to be used advantageously; a few years ago it was quite out of the question to get economical results, or even satisfactory ones, by indirect lighting.

By the use of a thermopile in the focus of a fourteen-inch parabolic reflector, whose current was detected by a D'Arsonval galvanometer, it was found that the heat from a man at the distance of 600 feet could be detected. It was designed for use in war to detect the approach of the enemy in night operations. It is also suggested as being applicable to short-range signalling.

In the year 1819 the steamship Savannah crossed the Atlantic. This is credited as the first steam passage across the ocean, and a century later, in 1919, the passage was first made by the air route, by aeroplane and by dirigible.

In war the usefulness of heliographic signalling was impaired by its visibility. The same applies to the same method carried out with electric light. Messrs. Bell and Mercadier employing electric light screened the visible rays with a black screen and transmitted the messages with the invisible rays, which were received by a thermo-electric battery. Messages could be transmitted over twelve miles.

Considerable attention is now being given to the production of silk from spiders. The Paraguay Indians, it is said, made tissues from the spider's thread, and similar accounts are given of China and Africa. At the close of the nineteenth century an English investigator, Rolt, drew the thread or filament directly from the spider, winding it directly upon a reel. In twelve hours he got between three and four miles of thread from 22 spiders. The spider of Madagascar, the Halabe, is the only really available arachnid known at present. It is a huge creature, and active work is being done on the island at Tamarive, where it is very numerous, in the production of silk from the living spiders. An instance is cited of the reeling off from 10 living spiders of some 400 yards of thread at one operation. Twisted and doubled it gave a 24-fibre thread. In practise the spiders are subjected to the operation once in ten days, and they survive four or five operations. They need the tropical climate; there is no chance of naturalizing them in France.

The Laparmentier Ship

We illustrate a new type of ship, of French invention, due to the Laparmentier brothers. The ship is almost a twin-hull ship, but the hulls are so interconnected and built together that the result is a single hull. The original inspiration was due undoubtedly in great part to the submarine menace—the Laparmentier ship is supposed to be almost non-sinkable by a single torpedo.

The construction is perfectly clear from the cut. There are two parallel cylinders, which constitute the freight carrying part. These are connected by a curved bottom, extending from cylinder to cylinder, and by a corresponding deck. At the point of nearest approach the cylinders are several feet apart, the distance depending on the size of the ship. The central portion, between the two hulls, is used for water ballast. According to weather and load conditions the ship is ballasted, or the space between the hulls is left quite empty. The water-ballast space is fitted with bulkheads to restrain the motion of the water-ballast. At the same time every bulkhead may be taken as an element of additional safety, in the case of the central compartment, in case of striking a mine or even a rock.

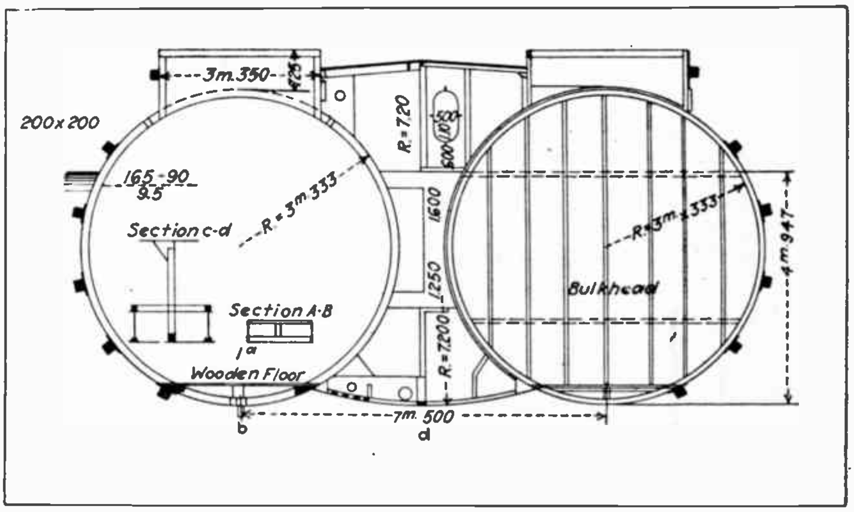
The cylindrical portions are the freight-carrying divisions. These also it was proposed to bulkhead, with complete divisions, without doors. If close enough a torpedo would do much damage, but there would always be an excellent chance of the ship surviving. A single torpedo could hardly damage both cylinders, especially as they are separated by a considerable space, the ballast compartment.

Bow and stern are worked to shape, as in the case of any ship; our section only shows the cross-section as it is amidships. The main feature of the larger 7300-ton type are:—Length overall, 393 ft. 8 in.; greatest beam, 55 ft. 9 in.; depth to deck in center, 28 ft.; draught in salt water, 19 ft. 6 in.; carrying capacity at this draught, including coal, oil, and provisions, 7300 tons; volume of holds, approximately 316,000 cubic feet. With 2500 horsepower a speed of 9 knots is obtained on 19 ft. 6 in. draught and 11 knots with a reduced cargo of only 2400 tons.

It is claimed that there is a saving of 30 per cent. of steel in these vessels, that the time of construction is much less than for the usual type of ocean carrier, and that the cost is much less. Owing to their light draught, reduced by pumping out any water from the central compartment, the ships can ascend rivers. It is calculated that the 7300-ton ship could go up the Seine as far as Rouen, and the 1200-ton ship could go up the Rhine to Strassburg.

Quite a strong point is made of the capacity of the ballast compartment between the two cylinders. In a sea-way heavy ballasting may be imperative, while the entering a harbor will be facilitated by reduction of draught. In the case of some harbors the harbor or pilotage dues are based on depth, so that in many cases there is an economy to be effected by reduction of depth of water required by the ship.

A ship built on this system is approaching completion at New Orleans. The cylinders are 20 feet in diameter, and as it is an oil-burning ship, the fuel oil is to be carried in the space between the hulls. There are eight transverse bulkheads, dividing cylinders and intervening compartment. The ship is 328 ft. 4 in. overall, 46 ft. 5 in. wide, and is to draw 16 ft. 2 in. It has a 700 h.p. triple expansion engine, with boilers in the cylindrical hulls.



The Laparmentier twin hull steel ship construction

In France there are four works making radium. Basing the production on the weight of the metal in the salts manufactured, they are credited with the production of 18 grams, about 275 grains, per annum. On the same basis the price just before the war was about $50,000 per grain. It is now about $60,000. One works making mesothorium, produces a little over 30 grains in a year. A radio-active gas is also produced and caught from springs. The United States is France's most serious rival; from the mineral, Carnotite, uranium vanadate, over 400 grains are produced annually. France is hoping to get radium ores from her colonies, especially from Madagascar. In 1918 Portugal produced 75 grains. England and Italy are all producers.

The Germans during the war planted quantities of barley in the vicinity of Verdun. On investigation it proved that the grain was of such superior quality that the French authorities proposed to keep the crop, or a part of it, for seed.

Recent investigations have shown that there are one million of acres of coal lands in British Columbia. They are situated in the southwest region.

RADIO
TELEPHONE AND TELEGRAPH APPARATUS

Construction of a Portable Receiver, B-C Wavelength Range
This 200- to 2,000-meter Portable Set Is Also Well Adapted to Stationary Use

By M. B. Sleeper

A PRACTICAL portable receiving set for field work or use in the country is not one that fits in the hip pocket, nor one which requires a small cart to trundle it along. In the first place, the electrical circuits must be designed; then they must be worked out in instruments which will withstand use; these instruments must be grouped properly in a small space; and, of course, the arrangement must provide an easy method of control.

Requirements of Electric Design

The Signal Corps of our Army used portable type apparatus almost exclusively during the war. One lesson that they must have learned is that one portable set cannot be designed for too broad a range of conditions if it is to operate at maximum efficiency under any one set of conditions. Signal Corps apparatus fell down alarmingly in the field because it was intended to do a little of everything and actually accomplished not much of anything.

In other words, the first thing to do as a preliminary to building a portable set, or any set, for that matter, is to decide exactly how few things it can do, yet meet the essential requirements. Ideas in this respect will vary widely. However, an average has been struck in the set described in this article.

Dependability is an important factor in any portable equipment, since in the field, laboratory facilities are lacking. Therefore, an audion detector was chosen for the foregoing reason and for its sensitivity.

Tuning circuits were the next consideration. Loose couplers meant extra coils, moving parts, additional space, and more difficult tuning than with a directly coupled circuit. These factors were responsible for the decision to use the latter. Moreover, sharp tuning was not of great importance.

The necessity for highest efficiency under the limitations called for high frequency cable on the inductance, with a banked winding to conserve space. To get the sharpest tuning, it was decided to use a variable condenser with a small number of taps on the coil. Experimenters who have used cable realize the difficulties of cleaning the separate wires to make soldered connections.

Before anything could be done on the coil or condenser, it was necessary to determine the size antenna to be used and its approximate capacity. This

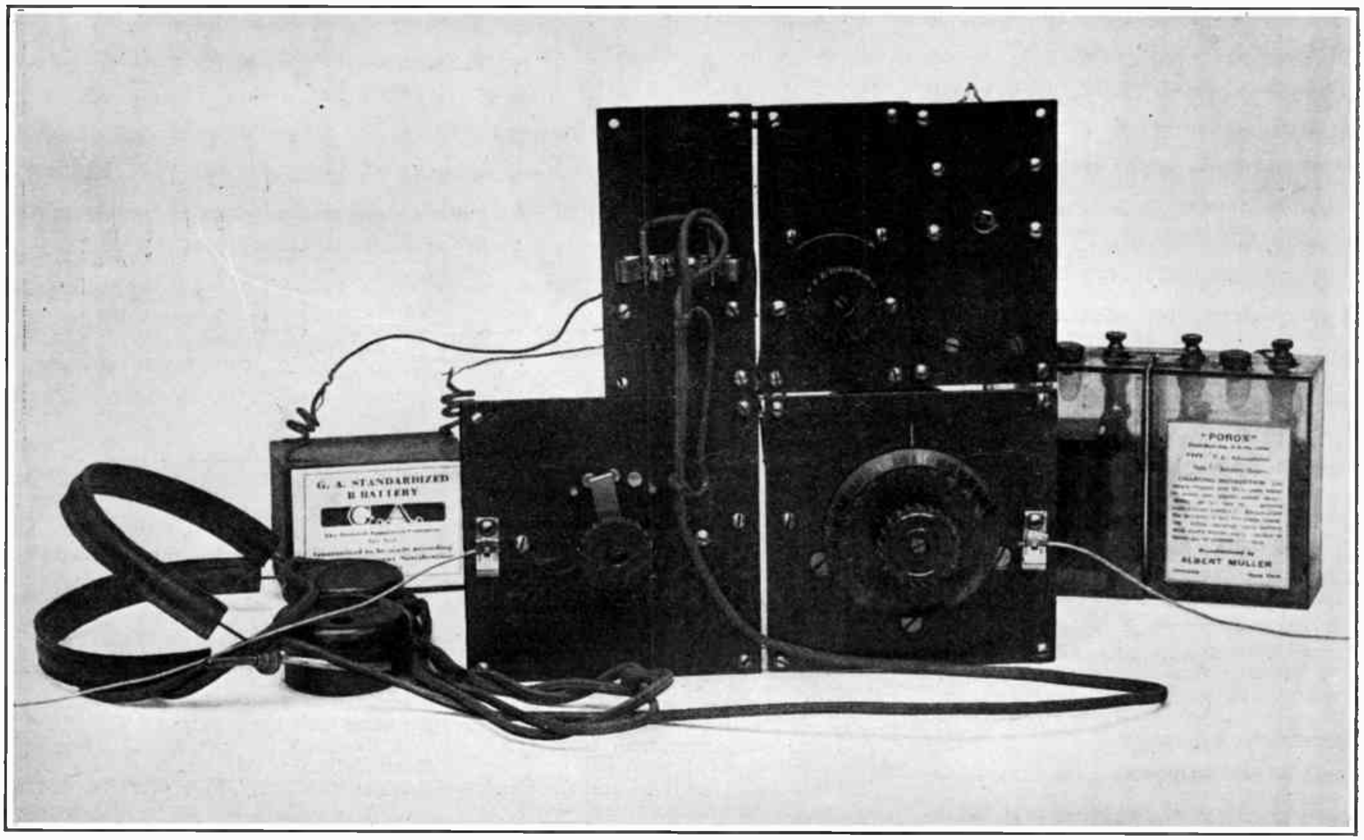


Fig. 1. The complete receiver, ready for use at the laboratory. For portable work, it is fitted into a carrying case

Fig. 3. Using the jig for laying out a panel

factor varies according to the situation in the field. For general work it seemed best to have a 75 ft. single wire 20 ft. high, with a 75 ft. length of annunciator wire laid on the ground under the antenna wire for the earth connection. This is better than metal rods driven into the ground, as the use of the latter means that a mallet must be included in the equipment, while the annunciator wire can be rolled off on a small spool.

The capacity of such an antenna was 0.0001 mfd. circuits.

While thinking of these points it was necessary to keep in mind the wave-length range. A B-C range, 200-600, 600-2,000 meters, covered experimental and the most important commercial stations.

Here, then, was the first data on which the electrical circuits were designed.

Mechanical Design

Weight and space had to be kept down to make the set light enough to be carried comfortably. The instruments outlined already were of such design and number that their weight was small. As a matter of fact, the weights were as follows:

Receiving instruments	3.25 lbs.
Carrying case	1.50
Telephone receivers	0.75
Storage batteries	4.00
B battery	1.00
Antenna and ground wires	2.25
Total weight	12.50 lbs.

To carry the instruments it was decided to have two 5 x 5 in. panels, and three 5 x 2½ in. panels, all ⅛ in. thick. It can be seen from the photographs that they were used in this way:

5 x 5 in. Panels—
- 1 inductance coil
- 1 variable condenser

5 x 2½ in. Panels—
- 1 audion and grid condenser
- 1 rheostat
- 1 telephone and B battery connection

This arrangement left an opening into which a box was built on the side of the carrying case, in which a screwdriver, pair of pliers, and short lengths of wire were kept. The case is not shown here, as brackets were fitted to the panels to support them vertically. The set, however, can be used as well in a horizontal position.

Since there were no amplifying circuits, the arrangement of the separate panels were not of great importance.

Inductance Panel

To minimize space and weight, it was decided to have a 0.0005 mfd. condenser in shunt with the tuning inductance. The G.A. Standardized type was chosen because the minimum capacity was practically zero, and the maximum 0.0006 mfd. (See Everyday Engineering, February, 1920, for calibration curve.)

This condenser, in shunt with the antenna of 0.0001 mfd., give a capacity range from 0.0001 to 0.0007 mfd. Then the inductance steps, to cover 200 to 2,000 meters, were:

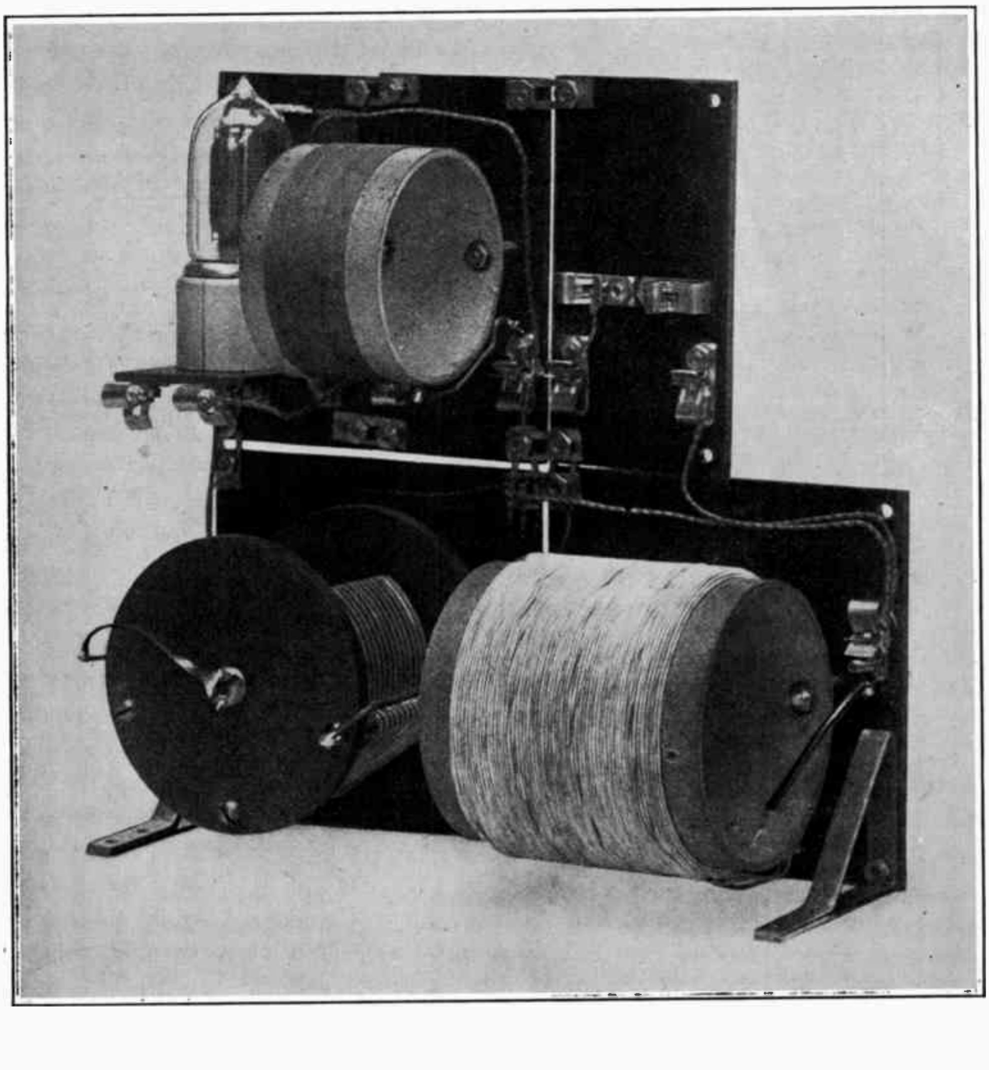
Capacity 0.0001 to 0.0007 mfd.
90,000 cms.—179 to 473 meters
400,000 cms.—377 to 997 meters
1,800,000 cms.—800 to 2,116 meters

Fig. 2. Showing some of the constructional details of the set, all wired except for the batteries. Note the slotted links which allow an adjustment of the spaces between the panels.

The flexible connection to the moving condenser plates permits a variation of the tension of the bearing screw, by means of which the plates are kept from turning, even tho they are not counterbalanced.

The simplicity of the circuits can be judged by the small amount of wiring required to connect the instruments.

When this photograph was taken, supporting brackets had been fitted to the panels so that the set could be used for work in the station. These are removed and the set fitted into a carrying case when it is taken out for experiments in the field.



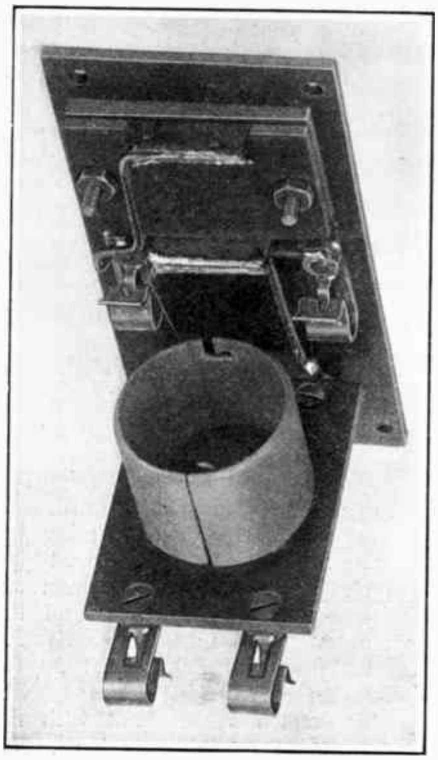


Fig. 6. The mounted socket and grid condenser

A little figuring showed that with a three-bank winding of 3 x 16 No. 38 D.S.C. high frequency cable, 18 turns per inch, on a tube 3½ ins. in diameter, the tapping points were:

90,000 cms., 22 turns
400,000 cms., 57 turns
1,800,000 cms., 157 turns

The length from the start of the winding to the taps were:

90,000 cms., 0.40 in.
400,000 cms., 1.05 in.
1,800,000 cms., 2.90 ins.

When the coil was mounted, the zero end was put at the left, looking at the front of the panel, so that, to increase the inductance, the switch was turned clockwise.

When the coil was wound, the panel was laid out and all holes drilled before anything was assembled. Fig. 3 shows a very useful fixture made to insure the accurate location of the holes at the corners. A sheet of No. 30 sheet brass was carefully marked with a 5 in. square, and punch marks made ¼ in. in from the sides at the corners. When the panels were laid out it was only necessary to clamp the brass sheet on a panel and punch the centers. This was important, for, otherwise, the panels would not have fitted together properly.

The coil mounting was very simple. Two lengths of brass tubing 3/16 in. inside diameter and ¾ in. long were cut up and placed on 8-32 machine screws which go from the front of the panel to the coil. Washers were put on the screws inside and outside the tube so that the brass tubing and the nuts would not cut in.

Other details can be seen from the illustrations.

Condenser Panel

Fig. 4 shows the condenser mounting. To secure the condenser to the panel, the screws were removed which originally held the upper end plates to the fixed plates, and longer ones substituted, so that they could be put in the front of the panel. Washers were used to separate the rear of the panel and the top of the end plate.

Connections were made to the movable plates by a thin brass strip soldered to the bearing set screw. The other side was soldered to one of the screws holding the fixed plates.

Fig. 5. A side view of the rheostat with the connection panel linked on

An A. H. Corwin dial, slightly modified, was put on the shaft. A hole 3/16 in. in diameter was drilled part way from the back toward the front, ⅝ in. deep. Then the hole was continued with a No. 26 drill, and countersunk at the front of the handle. The condenser is made with a hole in the end of the shaft threaded 6-32. When a 6-32 screw was put in the handle and turned into the shaft, it drew on the handle, clamping it securely. The depth of hole must be determined accurately so that the handle will not go on too far before it is stopped at the smaller hole.

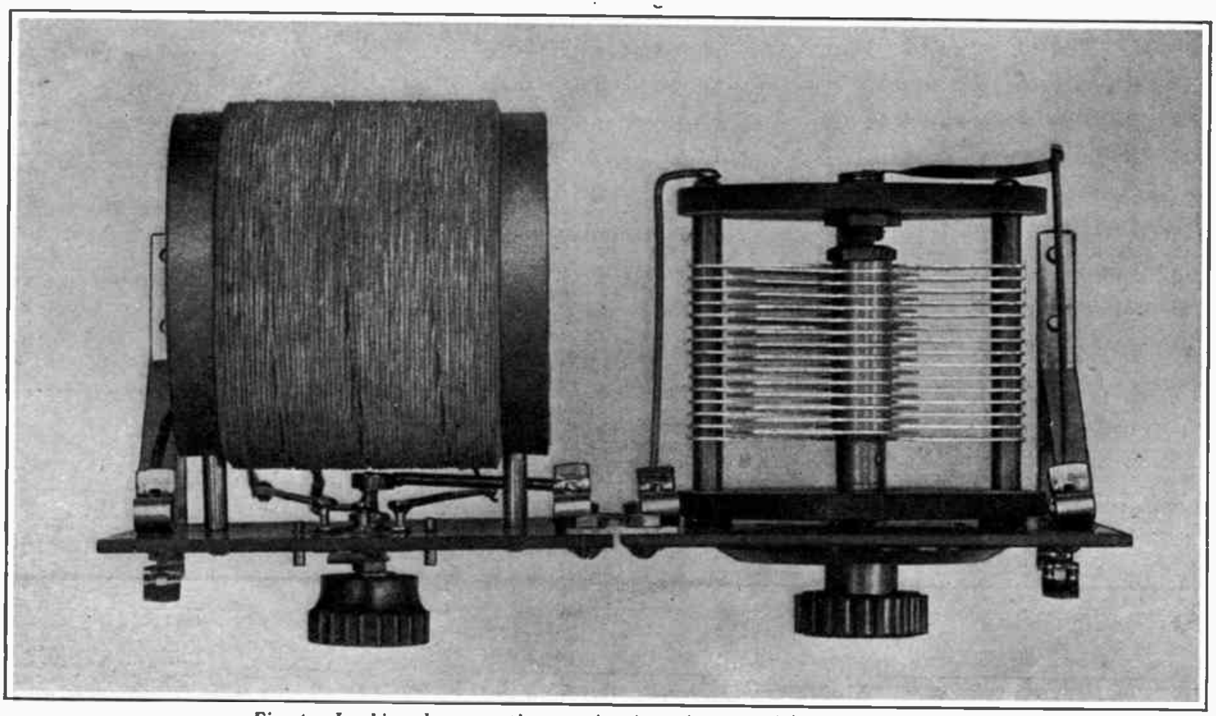


Fig. 4. Looking down on the completed condenser and inductance panels

The unusual strength and permanence of the design of this type makes it particularly well suited to portable work.

Rheostat Panel

A departure from the usual rheostat was employed in this set, principally because the porcelain base type was too large for a panel 2½ ins. wide. The resistance element was simply No. 24 s.s.c. copper wire wound on a tube 3 ins. in diameter. The coil was 1¼ ins. long. To make it non-inductive, the direction of winding was reversed every ¼ in.

A spring washer was put on the shaft of the adjusting handle, with a nut soldered to the shaft to keep a tension on the handle. Two more nuts held a brass contact which, at the maximum resistance end of the coil, slipped off the winding and opened the circuit.

Socket Panel

The audion mounting and grid condenser were put on a 5 x 2½ in. panel. Any type of socket could have been used, but the one shown was employed because it had been made up already. Two small angles of ⅜ x 1/16 in. brass strip held it to the panel.

Connections to the filament were made by Fahnestock clips put on the screws which held the tube contacts. The plate contact was wired to another clip, and the grid to one side of the condenser.

The condenser was made up of five sheets of No. 30 brass, 1½ ins. long and 1 in. wide, separated by paraffined paper. Two small bakelite plates secured the condenser in position.

Connection Panel

Fahnestock clips were mounted at the front of the connection panel to take the telephone cord tips. Another pair at the rear were for the B battery.

This section is shown clearly in Figs. 1 and 2.

Batteries

Obviously, it was not practical to use a 5-lb. Navy size B battery with this set. The small Signal Corps type gave results entirely satisfactory and saved 4 lbs. in weight.

Two 2-volt 10-ampere-hour Porox storage cells were decided upon, as their weight, filled, was only 2 lbs. each. The dimensions of the batteries shown in Fig. 1 were 3½ ins. long, 1½ ins. wide, and 4¾ ins. high over the binding posts. These cells operated the audion for 9 hours at a charge, and have stood up so that they promise to last indefinitely.

Connections

The wiring of the audion plate and filament circuits were of the usual sort. With a Marconi or VT1, no adjustment of the plate voltage was needed, operating the tube on a 22.5 volt battery.

Looking at the rear of the set, the antenna was connected to the right-hand post wired to the coil, the ground to the condenser post at the left; then a wire was run from the left condenser post to the left of the coil, and the right condenser post to the right of the coil. Finally, a wire from the grid was run to the antenna connection, and one from the filament to the ground post.

Any further information regarding this set will be supplied upon request.

Two New Instruments

A TEN-STEP inductance has been brought out particularly for experimenters who are working with new circuits. The advantage of this type of inductance shown in the accompanying illustration is that, while it is easy to couple it to any other coils by placing it in their proximity, it is portable and easy to set up for various purposes. The maximum inductance is 254 millihenrys.

The case is of oak, carrying an engraved bakelite panel. The dead end switch eliminates losses due to the connected unused turns. The panel measures 6 x 6 inches, a size sufficiently small to be readily used in many ways around the laboratory.

When this inductance is used with a variable condenser of 0.001 mfd. maximum capacity, the wave length is from 1,000 to 30,000 meters.

This inductance is the product of the Clapp Eastham Company.

Compactness of design is a feature of the Clapp Eastham two-step amplifier. Particular attention has been given to the location of the various instruments with the view of eliminating feed back effects.

An innovation is the provision for a C Battery by means of which the strength of amplification and the quality of reproduction can be greatly improved. Only 1½ volts are required. This set, however, operates very well without the C Battery.

Two rheostats are provided for the control of the filaments. A telephone type switch is also mounted on the panel to allow a change from one to two steps of amplification.

The oak case carries a panel 7 x 7 inches on which all the parts are mounted.

AN ADJUSTABLE PLATE BATTERY

THE Richter and Byrne Company has brought out an innovation in the plate battery design, in the form of a plug and socket adjustment incorporated in the block battery.

Tubular rivets are soldered to the negative or zinc sides of the individual cells, the tops of which are just flush with the sealing compound. Connection can be made to any cell by means of a plug which fits the rivets. If connections to the points of a battery switch are desired, several plugs can be inserted and soldered to the switch.

An advantage of this construction is that, if one cell gives out, it can be short circuited. In this way, the remaining cells can be used still. If voltages

greater than 22.5 are required, one of these batteries can be put in series with a non-adjustable type.

The Radio Department

AT a recent dinner where a number of radio men were present, there was a well-known financial expert from the Wall Street district of New York. The subject of conversation turned to radio magazines and the articles they contain. With the ponderous manner of one who attaches great weight to his own conclusions, the financier explained that in a short time the magazines would go out of business. "The reason is simple," he told us. "In a year or so, all the phases of radio will have been so exhaustively treated that there will be nothing more to write about."

You will not take this seriously, but the man spoke with great conviction. When the developments of the last year, the year of 1919, are considered, it is evident that the radio field is moving with an ever increasing speed that indicates no possibility of reduction. Commercial expansion has been held in check by the peculiar attitude of the Navy Department, but the experimental field has broadened beyond the expectations of the manufacturers and dealers in equipment.

ONE of the Government officials in New York recently stated that he estimates the number of radio experimenters owning sending and receiving, or only receiving stations in this country to be over 200,000. In no other pursuit is there one-half of this number actively engaged in experimenting on the development of a single art. To be sure, this figure includes men of all ages and degrees of proficiency, but the possible results from such concerted effort promise an unlimited expansion of the radio field. It seems very doubtful that, with any army of 200,000 men working on the development and extension of wireless, the magazines will run out of material for articles.

The estimate of the number of radio experimenters in the United States offers interesting contemplation to the manufacturers and dealers. Neglecting the expensive stations equipped with transmitting apparatus, and the many elaborate receivers with their amplifiers and other high priced instruments, let us put an average value of thirty dollars on each station. This shows an investment in experimental outfits of $6,000,000.

If 200,000 experimenters is a high figure—the origin was an authorative source—the valuation of thirty dollars is low, so that the investment estimate is not far wrong. The more important consideration, however, is the amount spent yearly.

No one who owns a station is satisfied with it longer than it takes to plan something new. In the course of a year, the most restricted purchaser spends twenty-five dollars. At the lowest figure, this shows $5,000,000 worth of radio business a year.

WHILE we are on this subject, there are two other things which should be brought to the attention of radio experimenters. There was a company, back in the old days, whose slogan was, "An antenna on every housetop." That condition has never been reached, but it is a good ambition. Some of you Relay Leaguers may not enjoy the prospect, but, if necessity is still the mother of invention, it is not too much to expect that, when the time comes, or as it approaches, interference will be overcome.

What are you doing to increase the number of stations? Are you interesting your friends, helping them through the difficulties which are always encountered at the start? A true experimenter is also concerned with the expansion of the art, and not confined entirely to his own work.

Another thing: Radio Experimenters who have come here from the smaller cities say, "We have several excellent stations in our town, but the people who own them are so secretive about their apparatus and circuits. They get something good, and then won't let anyone know about it."

This is obviously the wrong attitude. If we are going to work for the good of the art, we must have a free exchange of ideas. The man who keeps his experiments secret is not doing his share. It sometimes happens, too, that the mystery is only for effect.

AN interesting controversy has been started in one of the contemporary magazines on the question of transmitter spark frequency for 200-meter work. Some operators of extensive experience claim that a set working on a low note can transmit farther than a 500-cycle outfit. The conclusions were based, however, on personal opinion which exact science has so often set aside. To say that high notes are not good for long distance because one has never heard strong, high pitched signals is like claiming that 500 meters is a poor operating wave-length because one has not heard anyone going on that wave.

With a given transformer operating on 60 cycles, the output is varied when adjustments are made to change the spark frequency. Because there are only two or three makes of transformers on which any sort of data can be obtained, exact information on this subject is not available. However, we expect to give next month some quantitative results obtained with the Acme transformer.

At the receiving end there is some indisputable evidence of the superiority of the high note. Measurements have been made of the audibility of signals of different frequencies, with a given input in watts. This test shows a maximum audibility at 800 cycles. In addition, high notes are easier to read through static and low pitched interference. Other opinions on this subject will be welcomed.

INQUIRIES have been coming in from experimenters who want to purchase Audiotrons and Western Electric VT 1's. The impression has been spread about that the only vacuum tube which has been purchased lawfully is the Marconi VT.

It appears impossible to make any statements regarding the vacuum tube situation in general which will hold good for more than a month or two at a time, but here are at least some established facts.

The Marconi Company, in attempting to obtain entire control over the manufacture and sale of tubes, found that, by any means they might employ, they could not convince the courts that a Fleming valve was an amplifier or oscillator. Judge Mayer of New York, well known for his opinions which so sharply conflict with those of radio experimenters and engineers, did go so far as to say:

"Stripped of technical phraseology, what Fleming did was to take the well-known hot and cold electrode incandescent electric lamp of Edison and use it as a detector of radio signals. No one had disclosed, nor even intimated, the possibility of this use of a device then long known in another art."

No one begrudges the Marconi Company their Fleming valve, for no experimenter would swap a good crystal for it. The claims involved in the suit, during the course of which the statement quoted above was made, were numbers 1 and 37, which read:

"1. The combination of a vacuous vessel; two conductors adjacent to, but not touching each other in the vessel; means for heating one of the conductors, and a circuit outside the vessel connecting the two conductors."

"37. At a receiving station in a system of wireless telegraphy employing electrical oscillations of high frequency a detector comprising a vacuous vessel, two conductors adjacent to, but not touching each other in the vessel; means for heating one of the conductors; a circuit outside of the vessel connecting the two conductors; means for detecting a continuous current in this circuit, and means for impressing upon the circuit the received oscillations."

Claim 1 describes the Edison device, and would be void if not limited in its use. Therefore, the following disclaimer was filed:

"To the combination of elements set forth in Claims 1 to 6, inclusive, and 10 to 15, inclusive, respectively, of said Letters Patent, except as the same are used in connection with high frequency alternating electric currents or oscillations of the order employed in Hertzian wave transmission, and to the words in the specification: 'Whether of low frequency or' at page 2, lines 32 and 33; 'either' at page 2, line 98; and 'or low frequency alternating currents of,' at page 2, lines 98 and 99."

This patent and disclaimer, No. 803,684, dated November 7, 1905, can be obtained from the Commissioner of Patents, Washington, D. C., for ten cents in cash.

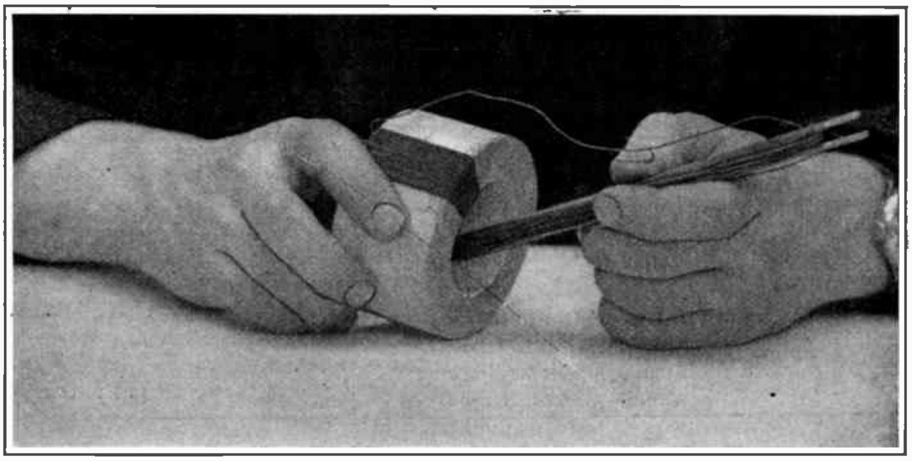
Claim 37 limits the Fleming valve use as a radio detector. It does not cover the amplifier or oscillion, nor can the Fleming valve operate as such.

All this means that three-element tubes, although they may be excellent detectors or oscillators, if licensed for use as audio frequency amplifiers, can be sold and bought when also licensed to use the third element, the grid.

Winding Toroidal Coils

EXPERIMENTERS are generally ready to try anything once. However, they have shown very little interest in the toroidal coil, possibly because of the difficulty in obtaining cores or the trouble of winding.

In the February 1919 issue, formulas for the inductance of a torus were given, although very little was said about this type of coil. In form, the core is in the shape of a doughnut or ring, the cross section of which may be round or rectangular. The wire, as shown in the illustration, is wound around the ring.



Using the needle to wind a torus

The particular advantage of the torus is that there is no external magnetic field. When two ordinary coils are connected in series and placed close together, the effective inductance also includes the mutual inductance, as shown by the familiar formula

$$L = L_1 + L_2 + 2M$$

or

$$L = L_1 + L_2 - 2M$$

To reduce the mutual inductance, M, to zero, the coils must be put at right angles to each other or widely separated. Toroidal coils, however, can be stacked up on top of each other, yet because the mutual inductance is zero, the effect inductance is simply the sum of the individual inductances.

In this way, individual tori can be made for the separate steps of the primary and secondary inductances of a receiver. Then, with dead end switches, there is no loss whatever due to currents set up in unused coils. A separate set of ordinary coupling coils can be made for the coupling between the two circuits.

Inductance of a torus of circular section; that is, of a doughnut shape, is given by the formula

$$L = 12.57\,n^2\,(2.54 - \sqrt{6.4SR^2 - 2.54\,a})$$

where L = inductance in cms.,
n = total number of turns,
R = the average radius of the torus, measured from the center of the ring, to the center of the cross section, in ins.,
and a = radius of the circular cross section, in ins.

A coil of rectangular cross section has an inductance

$$L = 11.7\,n^2 h \log 10 \frac{r_2}{r_1}$$

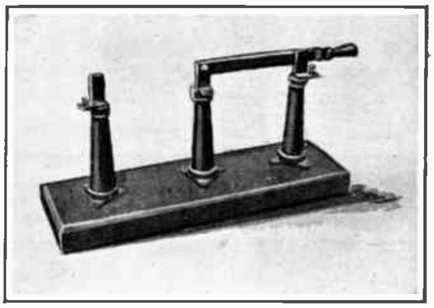
where L = inductance in cms.,
n = total number of turns,
h = height of cross section, measured at right angles to the plane of the torus, in ins.,
r_1 = inner radius of the torus, in ins.,
and r_2 = outer radius of the torus, in ins.

Maximum inductance is obtained by making the coil of large cross section and as small inside diameter as possible. More than one layer can be used, but the formulas given above become slightly inaccurate for such a winding.

The method employed in making these coils can be understood from the illustration. First, the wire is put on a needle, simply a wooden strip notched at the ends. This is passed through the center of the torus as the turns are put on. Care must be taken to keep the turns in the directions of radii, putting them close together on the inside, and spacing them slightly on the outside of the core.

A WELL MADE LIGHTNING SWITCH

IN response to a previous article pointing out the necessity of proper insulation for a lightning switch, Mr. W. A. Parks sent in the photograph reproduced here.



Instead of depending upon the inferior insulation of a slate base, he has mounted his switch on heavy pillars. These, in addition to being of electrose, providing a high grade of insulation, greatly reduce the leakage path from the antenna to the ground.

Experimenters should bear in mind that insulation at this point is as important as at the antenna or lead-in.

NOTICE

AN error was made in a formula on page 318 of the February issue, in the article on the measurement of the natural period of an antenna. The equation, at the bottom of the page, which read:

$$K = \frac{t_1 - t_2}{t_1 - t_2}$$

should have been

$$K = \frac{\lambda_2 - \lambda_1}{t_2 - t_1}$$

The effective range for a condenser with a 100 degree scale is usually taken as 5 to 95 degrees, or, with a 180 degree scale, ,10 to 170 degrees.

A Radio Frequency Amplifier Without Transformers

High Efficiency and Freedom From Limiting Resonance Effects are Characteristic of this Amplifier Which Also Cuts Down Interference

ALL things considered the tuned impedance coupling is the most satisfactory for experimental radio frequency amplifiers. The principle of this arrangement is illustrated in Fig. 1, and a complete circuit for the apparatus to be described is given in Fig. 2.

It can be seen that a condenser and inductance are connected in parallel across the plate and filament of the amplifier tube, and across the grid and filament of the detector tube. It is well known that, in a series circuit, the impedance is zero when the circuit is tuned to resonance with the alternating current flowing through it. In a parallel circuit, such as that in Fig. 1, the impedance at resonance is infinite.

At the same time, the direct current resistance through the inductance is only 3 or 4 ohms, so that the full voltage of the battery is applied to the plate.

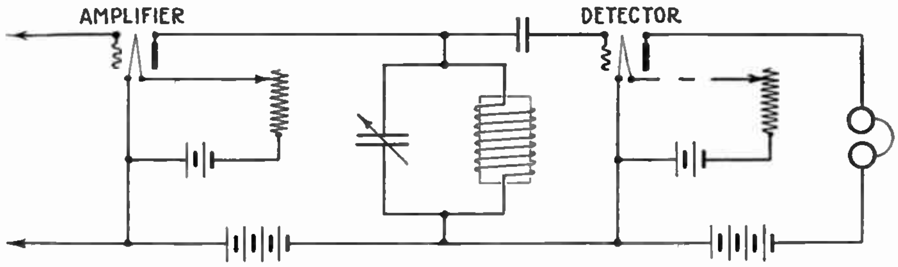


Fig. 1. A simplified circuit of the amplifier

The necessity for tuning the coupling circuit is an advantage in that interference is reduced, but, when several stages of radio frequency amplification are employed, the tuning of so many circuits makes it impractical.

However, this single step radio frequency amplifier has several distinct advantages. In the first place, it is cheaper than a single step audio frequency amplifier, containing only a coil and 0.0005 mfd. variable condenser, and particularly at long wave-lengths is easier to make function at maximum efficiency. If well made, this amplifier should produce nearly as loud signals as the usual audio frequency transformer coupled type.

Using only one step, this set is better than the resistance coupled type, which requires an extra potential battery, or the straight impedance and transformer coupled amplifiers which have such resonance effects that they must be de-

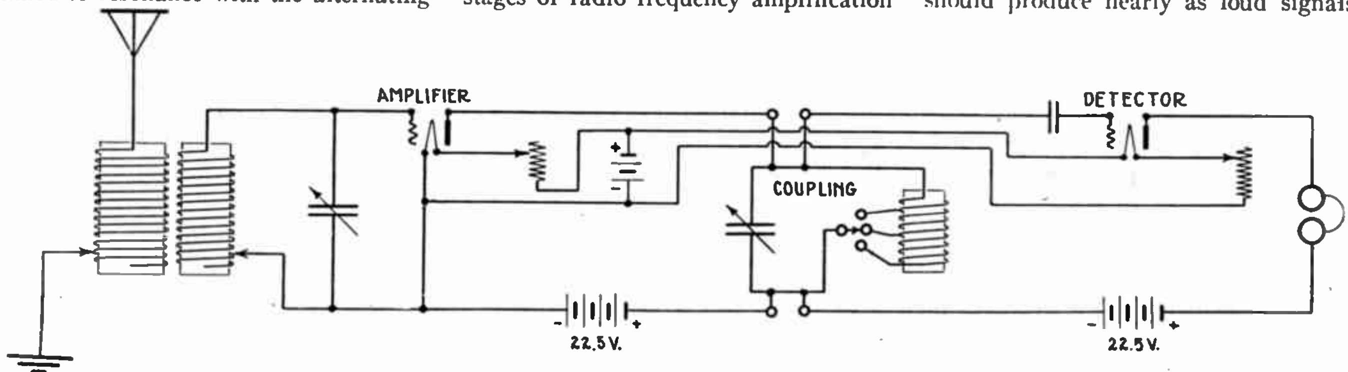


Fig. 2. Complete connections for the radio frequency amplifier

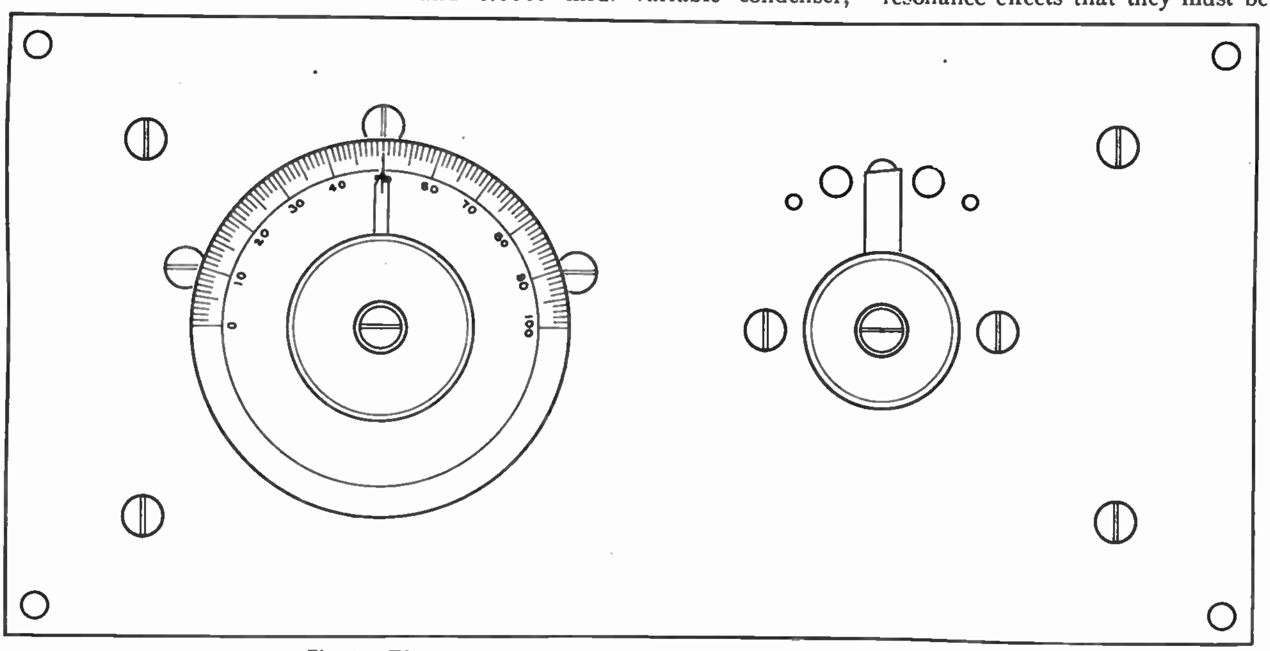


Fig. 3. There is nothing difficult about the construction of this set

signed for a limited range of wave-lengths, and cannot be made readily by experimenters.

Construction of the Amplifier

The set described in this article is for the B-C wave-length range, that is, from 200 to 2,000 meters. (See page 116, Everyday Engineering, November, 1919.) Fig. 3 shows the front of panel, with the inductance and condenser controls, and Figs. 4 and 5 the side and rear views.

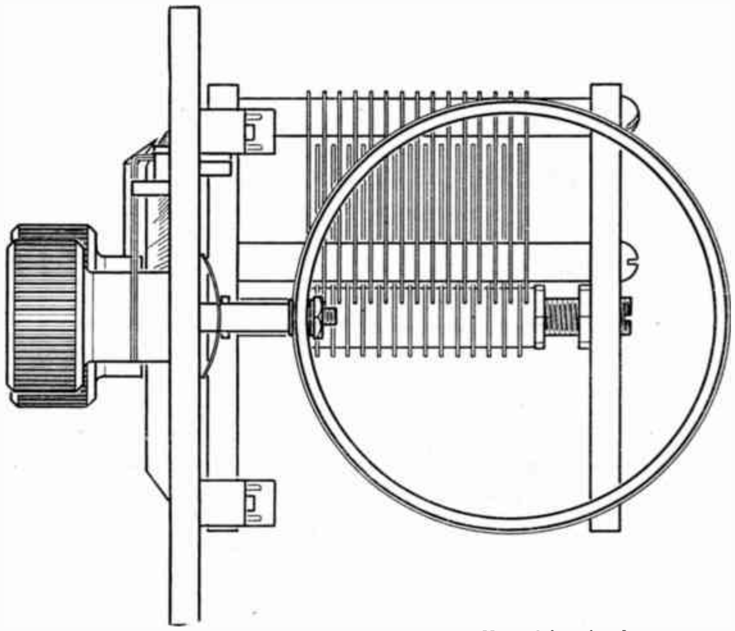


Fig. 4. A side view of the instruments. No wiring is shown

The Condenser

Any condenser of 0.0005 mfd. maximum capacity can be used, although one of the General Apparatus type is indicated here. A Corwin dial, fastened to the panel by means of two small machine screws is well suited as an indicator.

The pointer is simply a 1/8 in. brass rod, slotted at one end and threaded at the other. In the slot, a piece of No. 30 brass sheet is soldered and filed down at an angle corresponding to the bevelled edge of the dial.

For this particular condenser, the knob is made with a hole drilled part way through it of a diameter to take the shaft. Then a smaller hole is made the rest of the way to take a 6-32 screw which is threaded into the end of the shaft. In this way, the handle is held securely in place.

The Inductance

The inductance is clearly shown in the accompanying illustrations. It is made up of a two-bank winding of 10 in. No. 38 high frequency cable, on a tube 3½ in. in diameter, and 2¼ in. long. Looking at the panel from the rear the coil is started 3/8 in. from the right-hand end, and is tapped at the 27th and 58th turns, ending at 135 turns. This makes the coil 1.5 ins. long, with the taps 0.3 and 0.65 in. respectively from the start.

Care must be taken that the turns are wound closely enough to give the required number in the given space, as errors in this respect will change the inductance coil. Forty-five turns per inch were allowed for the 10 in. No. 38 double silk covered cable. Single silk covering is not good, for with such slight protection over the fine enameled wires, they are too liable to be damaged.

The inductance at the three steps, when the coil is carefully wound, is 120,000, 500,000, and 2,000,000 cms. This gives a wave-length range, with a condenser of 0.0001 to 0.0005 mfd. of

Tap 1. 200 to 460 meters
Tap 2. 420 to 940 meters
Tap 3. 840 to 1,885 meters

As a matter of fact, the G. A. Standardized condenser has a maximum capacity of 0.0006 mfd., bringing the maximum wave-length up to 2,000 meters. By adding another section on the coil, the wave-length with 0.0005 mfd. could have been brought up to 2,000 meters, but this shortcoming did not seem to warrant the additional wire required.

Connections

Four Fahnestock clips are provided for connection to the other circuits. As shown in Fig. 2, the condenser and coil are joined in parallel, and wires run from each side to two of the terminals. One set of binding posts go to the plate and filament of the amplifier tube, and the other set to the grid and filament of the detector tube.

Operation

There are two ways to use this amplifier. The first requires at least an

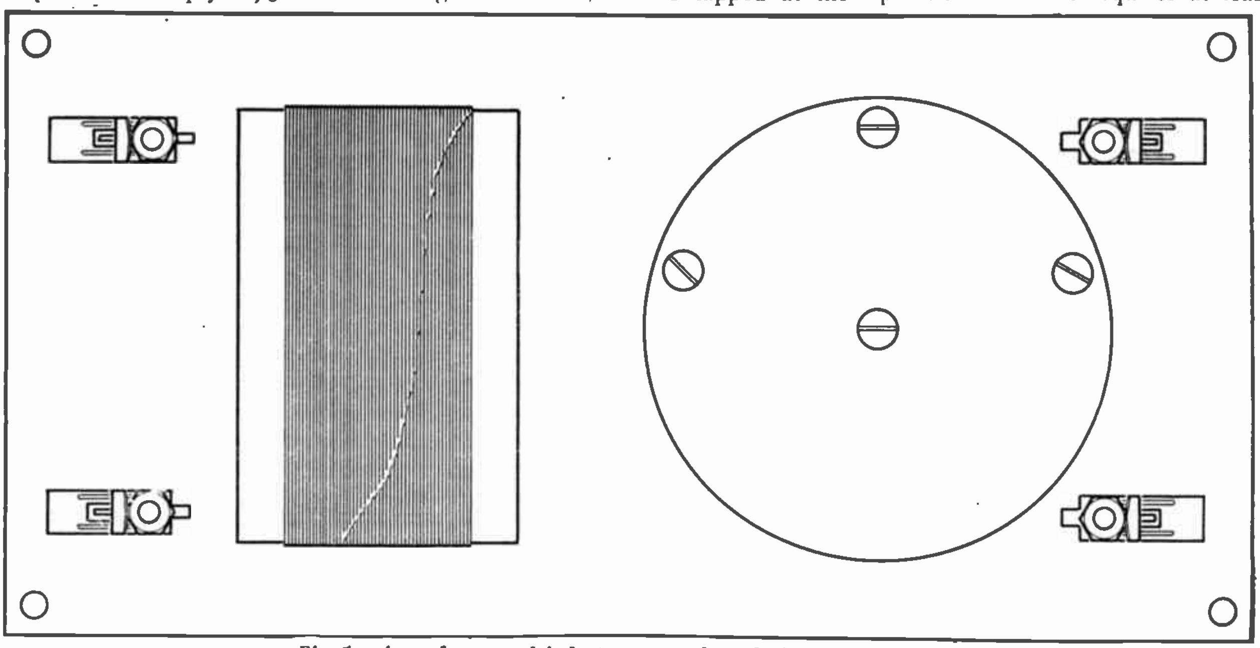


Fig. 5. A condenser and inductance are the only instruments needed

approximate idea of the wave-length adjustments of the primary and secondary tuning circuits. Then, at various settings of these circuits, the amplifier can be quickly tuned to the same wave-length.

This probably sounds worse than it really is, for, with only three taps on the inductance, the amplifier is easy to tune. If the amplifier is to be used for 200-meter traffic only, the inductance can be reduced to only 27 turns. In that case, only the variable condenser will need adjusting.

The other method, used only when signals with the detector alone can be heard but are too faint to read, is to have a switch by which the secondary circuit can be connected directly to the detector for standby work, or to the amplifier for copying. This simplifies the amplifier tuning, for with the primary and secondary already adjusted, it is an easy matter to tune the amplifier to the other circuits.

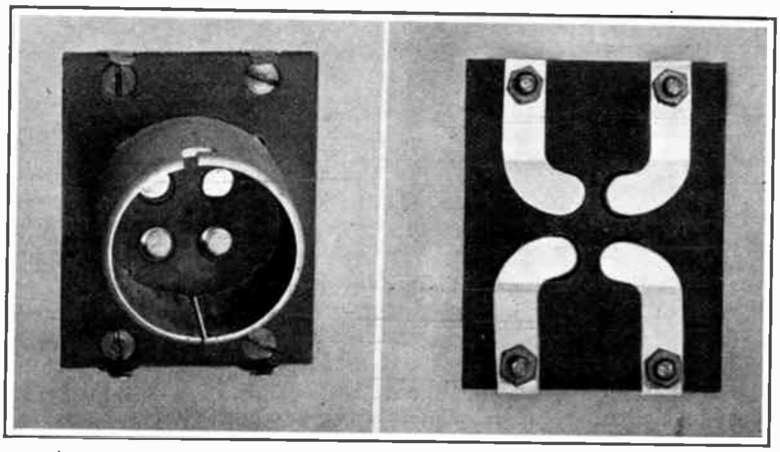
This is a most interesting equipment, as well as being equal to, or more efficient than a one-step audio frequency amplifier.

Making an Audion Socket

WHILE it is possible, of course, to buy as good an audion socket as can be made, the pleasure of experimenting is in doing the work yourself. This socket also possesses the advantage that it can be set up on a large panel with any other apparatus, depending upon the way it is to be used. For an amplifier, two or three sockets can be put on one plate as is done in the Western Electric set described in the June, 1919, issue.

ins. long, and 2 ins. wide. At the center of the piece a circle was described 5/16 in. in diameter and four holes 3/16 in. in diameter were drilled 90° apart, to allow the contact pins to pass through to the contacts on the underside of the base. Another set of holes 1/8 in. in diameter were drilled in the base to take the legs on the socket tube.

The shape of the contacts can be seen from the illustration of the underside. They were of No. 30 spring brass, all



This socket was made from a strip of aluminum 1-5/16 in. wide and 1/16 in. thick. A wooden rod, 1 3/8 in. in diameter, was turned up, and the aluminum strip bent around it to form the socket tube as shown in the illustration. An aluminum or brass tube 1 3/8 in. inside will do just as well, but when this socket was made only the sheet stock was available. The bending process took time and patience, because it had to be perfectly round. After shaping the tube around the wooden rod, it was cut off to the proper length. This made the sheet easier to handle than if it had been cut to length first.

With the tube completed, four legs were cut at one end, 1/8 in. wide and 5/32 in. long. These were to be used as mounting legs in fastening the tube to the base. If a solid tube is used, the legs can be cut in the same way.

The base shown in the illustrations was cut from bakelite 1/8 in. thick, 2 1/2

filed to shape at the same time. At the ends they were bent up so that connections could be soldered to them. Capacity and leakage was reduced by this method of shaping the contacts. When this socket was made the mounting legs came directly under the contacts. The result therefor would have been that the tube would have short circuited the contacts when the audion was removed. Accordingly, the contacts were bent so that, in the normal position, they could not touch the ends of the legs.

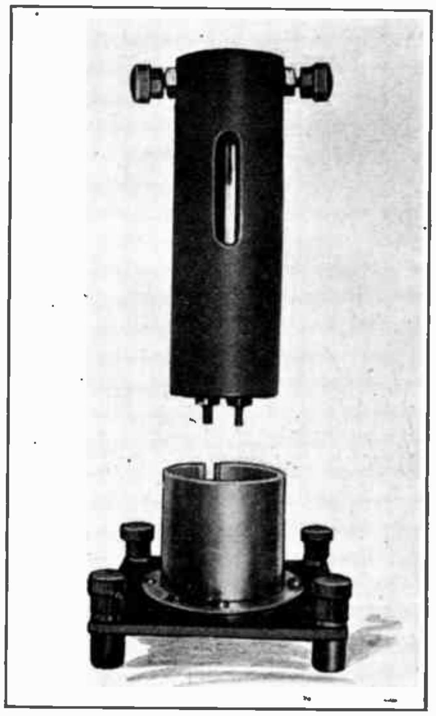
With the contacts ready to be put in place, the tube legs were put through the holes in the base and peined over. Fastening on the contacts completed the socket except for the slot to take the pin on the side of the audion base. This was filed down, between two of the contact holes, until the bottom of the slot was 7/8 in. above the top of the base, then over to the side for 1/8 in.

If the audion is to be mounted vertically on a vertical panel, two brass angle pieces can be made of brass strip 1/16 in. thick and 3/8 in. wide. The angles can be secured to the panel by machine screws, and to the socket by two of the screws which hold the contacts. For mounting to a horizontal panel, holes can be drilled through the base. In this case it is necessary to have the base held up at least 1/4 in. because the pins on the audion push the contacts downward.

AUDIOTRON SOCKET ADAPTER

THE wide use of the tubular audion has called for a socket adapter by which they can be used in the regular four-contact sockets. This need is supplied by the Radio Electric Company. The new adapter is shown here.

It is made up of a tube of insulating material, carrying at the bottom a disc in which four contact pins are set. The audion is set in the tube, and the upper



wires, from either filament and the plate, are fastened to the posts at the top. The other filament and the grid wires are put through a hole in the disc, and secured to nuts on the contact pins. A slot in the tube makes it possible to observe the brilliancy of the filament. At the side is a pin which engages in the slot of the socket.

This makes an excellent adapter, for the connections are easy to put on, and the audion is well protected by the upright tube. Sufficient ventilation is provided by the observation slot and the open upper end to take care of any tendency to overheat. Wires from the upper binding posts are soldered to the pins at the bottom, preventing any loss from loose joints.

Radio Buzzer Construction

A Development Which Combines Some Features of the Buzzer, Spark Coil and Transformer

BUZZER transmitters have been widely used in the American and foreign armies, demonstrating the practicability of this sort of equipment. There are many different kinds of buzzers, good, bad, and indifferent, with special limitations for the experimenter who builds his own equipment.

The type described in this article might be called a closed core spark coil, for, unlike the ordinary buzzer, it has a primary and secondary winding. It is intended that this buzzer will work on 6 volts, the current drawn varying with the adjustment of the vibrator.

For such an output, the transmitting range is much greater than that obtained from a spark coil, as the efficiency is much higher. The voltage is low, however, so that a very small oscillation transformer can be used, and less provision for insulating is required.

Illustrations of the buzzer and vibrator or condenser are given with this article, with a diagram of connections at Fig. 2. Essentially, the buzzer is made up of an almost closed core, carrying a primary and secondary winding. When the core is magnetized, it tends to draw in the armature of the vibrator to close the opening in the magnetic circuit.

An adjustable paper condenser is connected across the break. Experimenters do not always realize that the condenser exercises a control upon the output of the instrument. By making this feature adjustable the proper capacity can be selected for maximum radiation.

Other instruments to be used with the buzzer should be the same as used on other transmitters.

former laminations are used, about 0.010 to 0.015 in. thick.

When the core has been assembled, it should be clamped between two boards and the armature slot filed out. Three holes are shown for screws to secure the core to the panel. This helps to keep the laminations tight. They should be wrapped with tape also, to make the core solid.

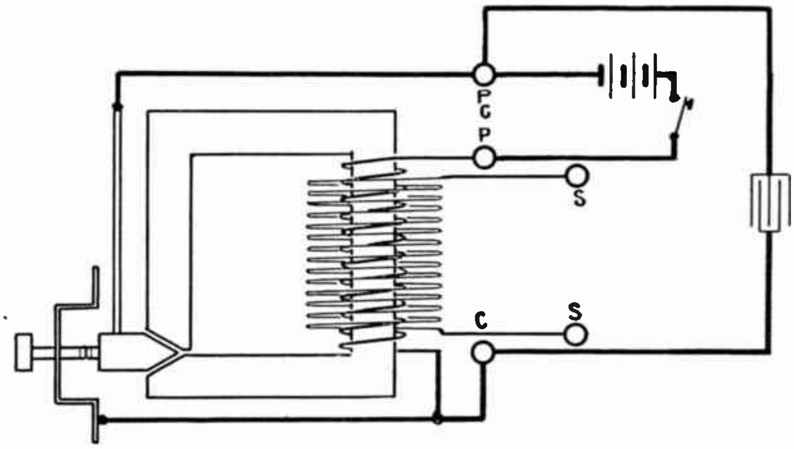


Fig. 2. Wiring of the buzzer and condenser

The Core

The dimensions of the core are 3¼ ins. long, 2¼ ins. wide, and ½ in. square in cross section. This core is made with built up strips in the manner of transformers. Regular trans-

An additional wrapping, 3/32 in. thick, preferably of Empire cloth, should be put around the leg which carries the winding.

Primary and Secondary Coils

Ninety turns of No. 24 S.S.C. wire

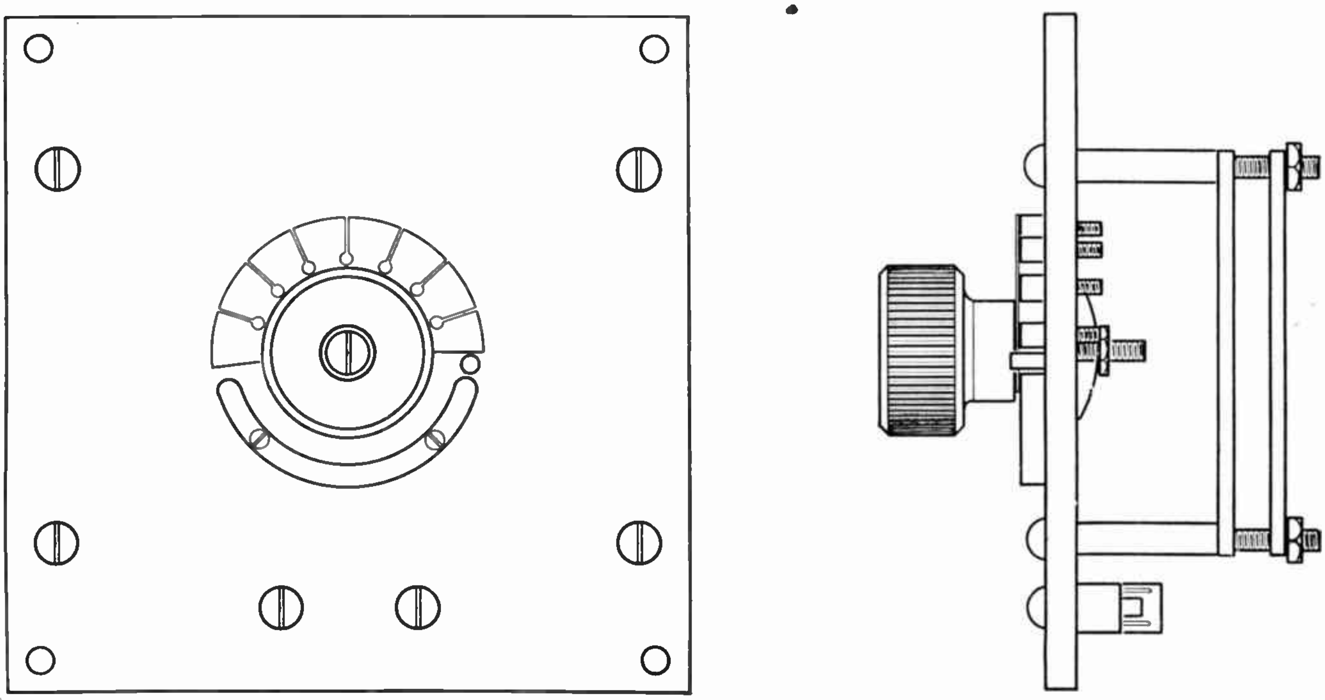


Fig. 3. Details of the adjustable condenser which reduces sparking at the contacts

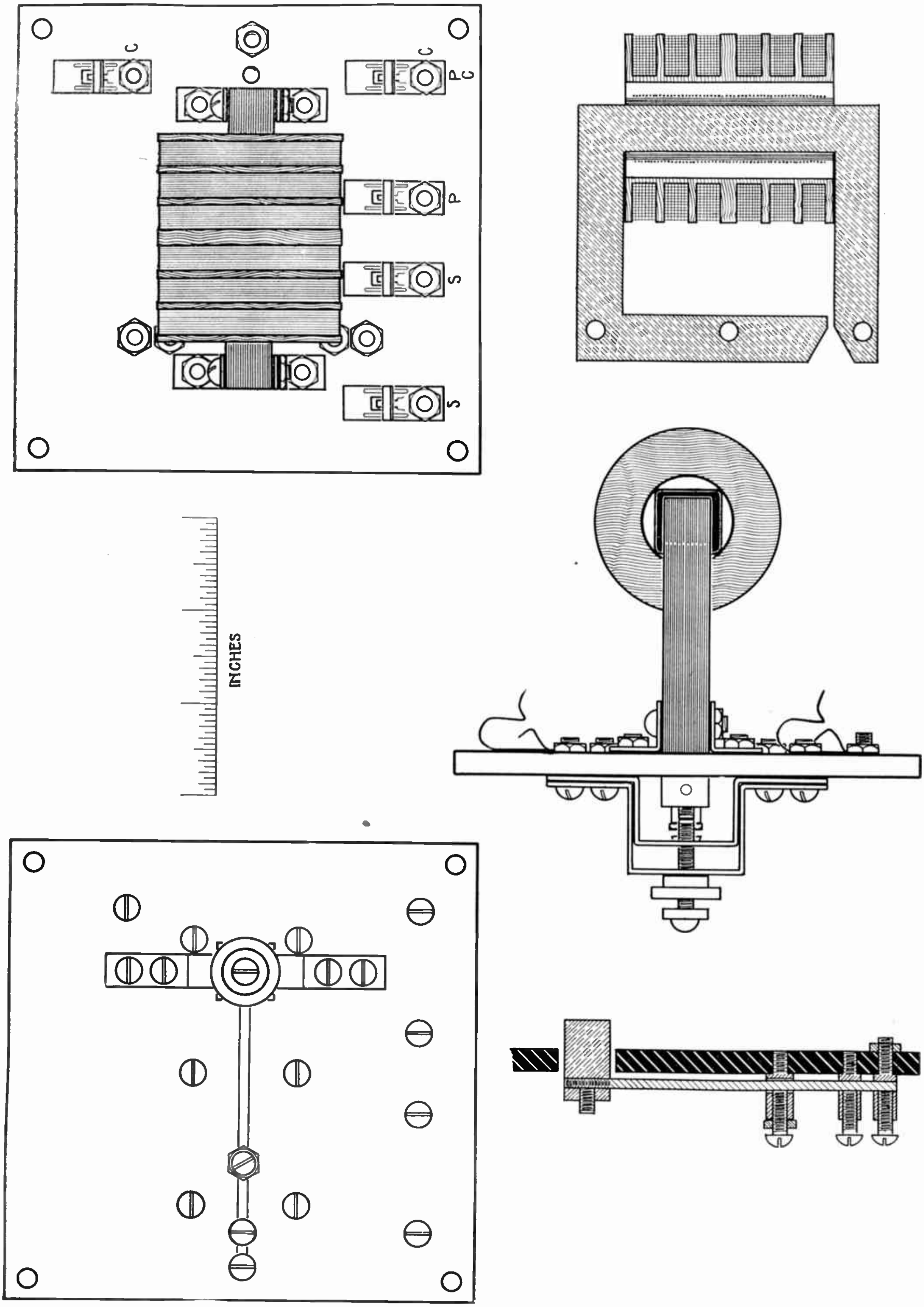


Fig. 1. *Front, rear, side, and sectional views of the transmitting buzzer*

are required for the primary coil. The secondary is wound in slots turned in a block of wood 2¼ ins. long and 2 ins. in diameter. Each slot is ¼ in. wide and 7/16 in. deep, allowing about 3,300 turns of No. 36 enameled wire per section.

The hole through the wooden support is 1 in. in diameter. This gives a clearance sufficient to allow it to slip over the primary coil.

When completed, the secondary should be put for one minute in boiling paraffin. If left too long, the wires will become expanded and loose.

The Vibrator

Because flat spring steel is so difficult to obtain, the armature is mounted on a short piece of drill rod, ⅛ in. in diameter. The rod is held by two posts with clamping screws. A third post, drilled out with a 3/16 in. hole, is fitted with a screw and locknut, by means of which the vibration of the rod can be adjusted.

The armature is a piece of annealed steel ⅞ in. long by ½ in. square filed down at the end to form a 60° point. The drill rod is threaded into it and headed over, to keep it tight.

As an added precaution, a screw is put from the top and turned tightly on the rod. Then it is cut off, and a small silver disc, cut from a ten-cent piece, soldered to the top for a contact.

The vibrator screw bridge is made of ⅜ by 1/16 in. brass strip, bent as shown. An 8-32 screw, also carrying a silver contact, completes the vibrator.

Adjustable Condenser

The condenser is made of 30 tinfoil or copperfoil sheets 4 ins. long and 2 ins. wide, separated by paraffined paper. One set of 15 plates are connected together to form one side of the condenser. Taps are run from the other side to the switch to give steps of 6, 8, 10, 12, and 15 plates.

The completed condenser is clamped between two bakelite plates 4½ ins. long, 3 ins. wide, and ⅛ in. thick, supported by four screws, and held from the panel by 1-in. lengths of brass tubing 3/16 in. inside diameter.

An easy way to make the connecting sector is to lay out the shape on a piece of No. 24 gauge brass. When the small holes have been drilled, the sheet should be clamped against a piece of wood, and, working against this wood, the slots can be sawed easily.

The sector on which the switch contacts work can be bent from a length of brass rod 3/16 in. square.

Fig. 2 gives a diagram of connections. Dimensions not given can be determined from the scale given in Fig. 1.

Commercial Stations Released by the Government

By Presidential Proclamation, commercial stations were returned, on March 1st, 1920, to their former owners, and the regulation of these stations was again put in the sands of the Department of Commerce. In other words, so far as commercial stations are concerned, the situation is the same as when the laws of 1912 were put into effect.

In the opinion of Government officials, however, matters are not the same, for, it is maintained, the Naval stations are not brought by the proclamation under the laws of 1912. If this is so —the point is not admitted by communication interests—the commercial stations are not on the old time basis, for the Naval stations can still handle private messages.

Interest in the circumstances was greatly enhanced by the March meeting of the Institute of Radio Engineers, directly following the effective date of the proclamation, at which Mr. Hogan, in his presidential address, took up the subject of radio legislation.

His paper was on the laws of 1912 as a basis of coming regulation, pointing out the defects and advantages of those laws and the need for new ones in keeping with the advance of the art. These points were also backed up by the majority of answers to a questionnaire sent out to members of the Institute.

Government control of radio was not dwelled upon at length because the opinions of radio engineers are overwhelmingly against it. Only the Navy Department is called upon to justify its attitude in this respect. Experimenters will be interested to know that Mr. Hogan advocated the extension of amateur wavelengths to 250 meters.

Dr. Goldsmith, discussing the paper, pointed out the difficulties under which the Radio Inspectors have been working. An appropriation of $45,000 previously supported the Inspection Offices which are charged not only with the regulation and licensing of stations, but the examination of operators. In 1919, the amount was increased to $65,000, yet it was specified that this increase should not be used to raise the salaries of the men. Unless steps are taken quickly to remedy conditions, the appropriation for the coming year will be only $60,000. Admiral Bullard stated during a discussion of this point, that the Navy has taken in approximately $800,000 for radio messages transmitted.

Before the meeting was called to order, the presence of Admiral Bullard caused much comment, for it was assumed that he would present the Government's side of the subjects brought up in the paper. Nor did he disappoint the members. It seemed, that when Admiral Bullard mounted the platform, that the representatives of commercial interests were to be given an oral thrashing, but it was immediately apparent that the heavy jaw and the positive manner were attributes of a man who could go more than half way to meet the criticism so steadily directed at the Navy Department. It was also significant to find that he did not concur with the views of Secretary Daniels, who has consistently advocated Government monopoly in this field.

At the same time he felt that the Navy had not been accorded fair credit for their accomplishments. Communication had been established with England, Norway, France, Germany, Italy, Russia, China, and Japan. Thousands of words of press news have been sent out that the foreign papers might obtain American news with the American viewpoint. Radio compass stations along the coast have been tremendous aids to shipping and in several instances averted what would have been inevitable disaster if the ships had not been informed of their bearings.

He seemed a little unfair in his criticisms of commercial companies which were not able to keep up the Navy's work when the stations were turned back, although the published propaganda from some directions did promise such improved results upon release of their stations that his stand may have been well taken.

Admiral Bullard did not neglect the interests of the experimenters, and seemed to think that the 250-meter limit may come as a result of furture legislation.

Above all, he was pleased to find that the Institute has taken an interest in radio regulation. He advocated the establishment of a Radio Commission as suggested by Mr. Hogan.

Mr. Simon, among other things, proposed the licensing of receiving stations to establish their location officially as a protection against the erection of transmitters, where a remote control system is used.

It seems, too, that the registration of experimental receiving stations should be required, to provide the Government, in time of need, with information as to the available radio men in the United States.

Copies of Mr. Hogan's paper and the discussion should be obtained by every radio experimenter, as this material, when published, will be found tremendously interesting and important to private individuals as well as the commercial companies.

Benzol-Alcohol Fuel Mixtures for Internal Combustion Engines

By Kenneth Alton

IN England, where gasoline sells for fifty cents a gallon in normal times, or one hundred per cent more than the average price in this country, engineers have sought to use benzol, which is said to be adaptable to the present type of motors without change, and in cases where it has been used as much power is obtained as with gasoline. This material is a by-product incidental to the manufacture of illuminating gas and coke, and while it was formerly distilled from coal-tar and obtained only in small quantities, improved methods make it possible to produce about three gallons from every ton of coal changed into coke or gas. The former material was at one time produced by a process which permitted the gas to escape, but at the present time this is retained and condensed to form benzol. The crude product is a foul-smelling liquid which has about the same consistency and color as heavy ale. When subjected to a refining process the dirty liquid is converted to one that is about the same color as water.

Benzol is not so volatile as gasoline, but it is claimed that a motor may be started without difficulty with this fuel supplied to a carburetor of ordinary construction. Owing to the greater number of heat units it contains, it is said it will develop more power than gasoline, and as it will not evaporate so readily it does not become stale or heavy by the vaporization of the lighter constituents. A disadvantage incidental to its use has been that owing to it being richer in carbon than gasoline it would deposit more of this substance on the piston head and interior of the combustion chamber. While this may be true of a poorly refined benzol and when mixture proportions are not correct, it applies equally well when low grades of gasoline are used and when the mixture of gasoline vapor and air supplied the cylinders is too rich.

Considerable experimenting with alcohol has been done by French and German engineers, and there are many points to be considered in its favor when discussing its value as a fuel. Alcohol, instead of being derived from natural mineral deposits, which become more and more depleted as the demands increase, is derived from various plants and vegetables and is the one fuel that can be produced in quantities that could be augmented as the demand for it increased. The vegetable substances which are distilled to make alcohol are reproduced each cycle of seasons, and in tropical countries there is no cessation to the growth of the vegetation. The raw materials from which alcohol may be manufactured are found in all parts of the earth. It is derived from any substance which contains either starch or sugar, and it can profitably be produced from fruits, grains, and vegetables. It may be made from beets, sugar-cane, rice, barley, rye, corn, wheat, or potatoes, and decaying fruit or other refuse, which could not be utilized otherwise, may be subjected to a process of distillation and alcohol derived therefrom.

Alcohol differs materially from gasoline, and as it is less volatile it requires more heat to vaporize it. Alcohol vapor can be compressed to a greater degree than the vapors of gasoline, and as the heat units liberated from a fuel vary with the degree of compression even though alcohol gives out less heat when burned under the same conditions, higher efficiency may be obtained by compressing the alcohol vapor to a higher degree. While this substance has been used for a decade or more abroad, in engines designed especially for its use, it is not been applied with any degree of economy in motors designed for use with gasoline.

A motor constructed for use with alcohol must use a higher degree of compression than a gasoline motor, and a form of carburetor which will heat the mixture before it is taken into the cylinder should be used. An engine designed for gasoline will use twice as much alcohol as it does gasoline to develop the same amount of energy, though in a special motor the same amount of power will be obtained as when equal quantities of gasoline are burned in the conventional engine. One of the disadvantages of alcohol that is shared in common with kerosene is that it is difficult to start an engine when cold, as alcohol is not very volatile unless heated.

The amount of air necessary for complete combustion is roughly estimated at one-third that needed with gasoline. Twice the amount of compression before ignition can be used with alcohol vapor. The range of explosive mixture proportions of alcohol and air is much greater than that possible with gasoline and air. Various authorities have stated that a compression of one hundred and fifty pounds per square inch is possible with alcohol, but it is doubtful if automobile engines will ever be built using such high degrees of compression unless remands for extremely economical operation will result in the development of Diesel engine types which use much higher compression pressure than this because only air is compressed by the main engine piston and there cannot be any danger of preignition as when a gaseous mixture is compressed too much.

Taylor-White Process.—A process has been developed with a view of permitting one to use alcohol in engines of present design with no change except a special form of vaporizer. In this the alcohol vapor is passed through calcium carbide before it enters the cylinder. The water which is present in commercial alcohol and which lowers its efficiency as a fuel is absorbed by the carbide and the resulting chemical action liberates acetylene gas. This is very inflammable and increases the explosive value of the alcohol vapor. When the alcohol-acetylene combination is used, to obtain the same thermal efficiency as with gasoline gas, it is necessary to add water to the alcohol until a solution containing seventeen per cent water and eighty-three per cent alcohol is obtained.

This is no great disadvantage, as water costs nothing to speak of, and the increase in the bulk of the fuel nearly pays for the carbide. It is estimated that one pound of carbide is used per gallon of liquid. As the market price of carbide in lots of one hundred pounds or more is but six to eight cents per pound, the only objection that can be advanced to the process is the increased complication of the vaporizing appliance. The combination of alcohol and acetylene has proved efficient on motors employing compressions as low as sixty pounds to the square inch and running as high as two thousand revolutions per minute, but when used alone the slow burning qualities of alcohol vapor have made it most efficient on slow-speed high-compression motors.

Alcohol used for fuel purposes must be rendered unfit for drinking by mixing substances with it which are not palatable, but which do not interfere with its use as a fuel. When so treated the substance is called denatured alcohol. Among the substances which may be mixed with the ethyl alcohol are wood alcohol, benzine, and benzol, and various distillates of crude petroleum. Chemists contend that it is better to use a hydrocarbon, such as benzol, than the wood alcohol, as a denaturizing sub-

(*Continued on page* 446)

COMPLETE ENCLOSURE FOR PASSENGERS THE FEATURE OF NEW AIRPLANES

(*Continued from page* 387)

from the usual design, but which is entirely justifiable where, as compactness, simplicity in rigging and the possibility of using the airship as a free balloon are desired.

The car, also well streamlined, is a mahogany veneer construction, semi-monocoque type, being built up of bulkheads and veneer planking, which insures strength and lightness combined. Single control is provided with a sliding wheel for altitude steering which permits the pilot to control with either right or left hand, or in the center, as he may desire. Directional control is by means of a foot bar. The car is thoroughly equipped with all necessary instruments for navigation.

There has been no radical developments in the basic design of airplanes as the rules establishing design seem to be fairly well-established at the present time. The provisions made for the comfort and protection of the passengers in order to render flying more pleasurable than it is in the unprotected cockpits of the military type machines, show a disposition on the part of aircraft manufacturers to cater to the public and supply aircraft that can be used for passenger carrying aerial routes.

HEAT TREATMENT FOR STEEL

(*Continued from page* 369)

reamer or cutter is to be used in the lathe or drill press there is no more suitable or efficient steel for the purpose than tungsten.

In this connection, it will not be amiss to say that while some steel makers advise the use of water in grinding tools made of high speed steel, and others advise the use of a dry wheel, the writer has, in years of experience, noted that the best results are obtained by using a moderately coarse wheel *dry*. Never, when grinding, dip the tool in water, if it is purple with frictional heat it will not affect the tool at all, provided it is not dipped in water, but as soon as water touches a piece of tungsten steel when hot, checking or cracking will start rendering the tool unreliable. If you do use water, *flood* the wheel and do not permit the tool to get warmer than you can bear on your hand.

In conclusion, always remember that steel of any kind is at its best only when hardened clear through, and weakest when in the soft or annealed state. The drawback reduces strain and brittleness without materially weakening the steel, and is the safety valve of the treating process.

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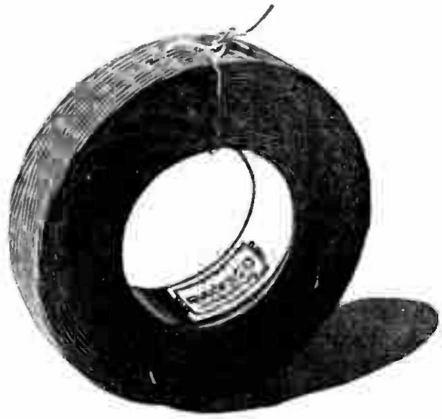

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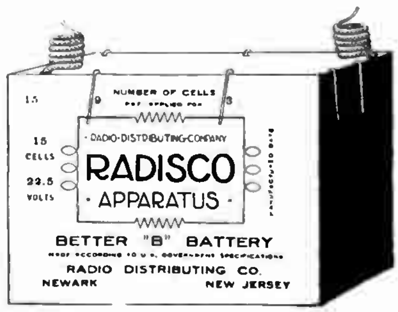

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CHEMISTRY OF THE COMMON METALS

(*Continued from page* 405)

the process of saturation continues sodium bicarbonate separates out until 2/3 of it has been transformed. The remaining compounds, carbon dioxide, ammonia and water, combine to form a solution of ammonium bicarbonate as is shown by the following equation:

$CO_2 + NH_3 + H_3O = NH_4\ HCO_3$.

This product reacts with the sodium chloride to produce the bicarbonate which precipitates. The ammonium chloride remains in solution. The action is very well illustrated by the following equation:

$$NH_4HCO_3 + NaCl \rightleftharpoons NaHCO_3 + NH_4Cl.$$

The bicarbonate is taken off, washed and heated to change it to the carbonate:

$$2HNaHCO_3 = Na_2CO_3 + CO_2 + H_2O$$

Sodium nitrate ($NaNO_3$) is found in great quantities in Chile. The natural product contains sodium chloride, and the nitrate and perchlorate of potassium are also present in considerable amounts.

Sodium nitrate is extremely soluble in water and is very deliquescent. Great quantities of it are used in the manufacture of nitric and sulphuric acids. Probably its chief use is as a fertilizer, imparting its life-giving nitrogen to the soil.

Sodium nitrate ($NaNO_2$) is produced by heating sodium nitrate with lead. The following equation fully describes the nature of the reaction which takes place:

$$NaNO_3 + Pb = NaNO_2 + PbO$$

The resulting compound ($NaNO_2$) is very soluble in pure water. It has found considerable use in the production of organic dyes.

Sodium sulphate occurs in nature in the anhydrous state. It has been known in the deca-hydrate form ($Na_3SO_4\ 10H_2O$) since the seventeenth century. Sodium sulphate is also known as a heptahydrate ($Na_2SO_47H_2O$).

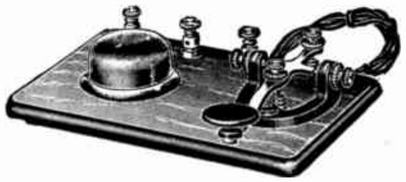
The preparation of sodium acid sulphate can be brought about by the action of sulphuric acid on the neutral sulphates. This substance, when heated loses its water and is converted into pyrosulphate ($Na_2\ S_2\ O_7$). If the temperature is carried beyond a certain point the pyrosulphate breaks up into sulphur trioxide and the normal sulphate. Solutions of sodium acid sulphate effect acid reactions. This is because of the dissociation of the HSO_4 + ion into H + and SO_4—

Sodium sulphite ($Na_2\ SO_3\ 7HO_2O$) can be prepared by dividing a solution of sodium bicarbonate into equal parts, saturating one with sulphur dioxide. This will result in the formation of carbon dioxide and acid sodium sulphate according to the following equation:

(*Continued on page* 429)

Wireless Receiving Ban Raised

MESCO WIRELESS PRACTICE SET



The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green covered flexible cord.

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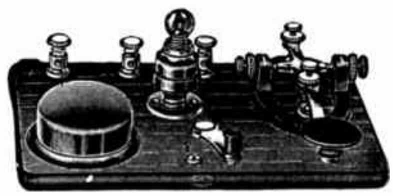
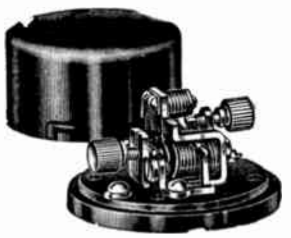


MESCO RADIO BUZZER



This buzzer maintains a constant note and is recommended as an exciter for checking wavemeters where pure note and ample energy are required.

It consists of practically a closed circuit field of low reluctance, having a steel armature to which is riveted a strap supporting a movable contact. The armature tension is adjustable by means of a screw with a milled head large enough to be easily and permanently adjusted with the fingers. The stationary contact is adjusted by means of a similar screw. The magnet coils are connected in series with a total D. C. resistance of 3.9 ohms. Shunted across these coils is a resistance having a D. C. value of 3 ohms. This shunt eliminates all sparking such as occurs at the break on ordinary radio buzzers and the energy saved thereby is transferred into any oscillating circuit connected to it, the result being that this buzzer as constructed radiates five times more energy than any other existing type All connecting wires liable to be broken are eliminated. Contacts are of genuine platinum, which is essential in order to maintain a constant note. The parts are mounted on a Condensate base to insure constancy in operation.

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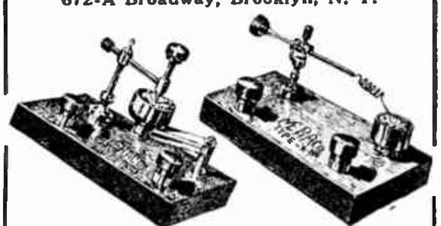

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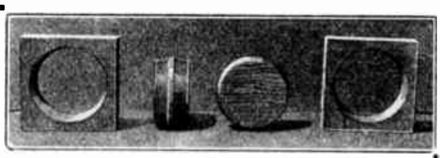

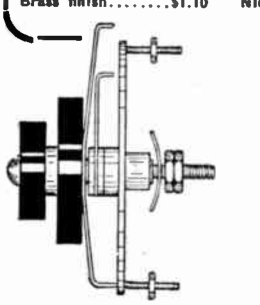

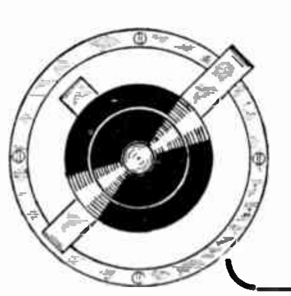

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CHEMISTRY OF THE COMMON METALS

(Continued from page 427)

$Na_2CO_3 + H_2O + 2SO_2 = 2NaHSO_3 + CO_2$.

When this reaction is completed the remaining part of the sodium bicarbonate solution is added, which results in the formation of carbon dioxide and the neutral sulphate.

$Na_2CO_3 + 2NaHSO_3 = 2Na_2SO_3 + H_2O + CO_2$.

Sodium sulphide (NaS_2) is usually prepared by the reduction of the sulphate with carbon. The reaction has to be carried out at high temperature. The compound, when dissolved in water, has a decidedly alkaline reaction.

The thiosulphate of sodium ($Na_2S_2O_3 5H_2O$) is produced by boiling a solution of the sulphate with sulphur. One of the most important uses of this salt is in the fixing of photograph plates and films. Since the development of the motion picture industry, the consumption of sodium thiosulphate has increased greatly.

Three sodium phosphates are known: monosodium phosphate (NaH_2PO_4), disodium phosphate (Na_2HPO_4), and trisodium phosphate (Na_3PO_4). The disodium phosphate is probably the most important salt. It can be prepared by neutralizing a solution of phosphoric acid with either sodium hydroxide or carbonate. This salt is extremely soluable and effervesces very easily.

Sodium silicate (Na_2SiO_3) is a compound well known under the name of "water glass." It is prepared by fusing together silicon dioxide and sodium carbonate. This compound is a thick, syrup like liquid.

Sodium cyanide is made by first passing ammonia over metallic sodium. This results in the formation of sodium amide:

$2Na + 2NH_3 = 2NaNH_2 + H_2$.

The product of this reaction is brought into contact with charcoal heated to dull redness. The following reaction takes place:

$NaNH_2 + C = NaCN + H_2$.

Like most of the cyanides, that of sodium is extremely poisonous.

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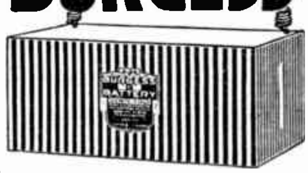

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EVERYDAY SCIENCE NOTES

Electrically welded joints in ships' plates have been recently tested in England with excellent results, as regards strength. They are from 90 to 95 per cent. as strong as the original plate, where rivetted joints are from 65 to 70 per cent. only. In elasticity they are so far inferior to rivetted joints, succumbing more quickly to bendings back and forth than do rivetted joints. A 5,000-ton ship has about 450,000 rivets, a 9,500-ton ship has about 650,000 rivets. In the displacing of these there would seem to be quite a field for electric welding, if it can be successfully done. Sometimes a badly driven rivet occasions a leak, and such a leak is regularly treated now by electric welding. The joints between ships' plates can be made quite flush by this process.

A recent paper on the Sperry stabilizer for ships brought out some of the interesting points of the apparatus. At one time there was apprehension that the stresses of the stabilizer might operate to strain the ship, but it has been determined that the strains incident to the rolling and pitching of a ship in a sea-way subjects it to four to six times the strains due to the stabilizer. It is possible to instantly throw the stabilizer in and out of action, as far as steadying the ship is concerned, and it is said that this gives a most impressive demonstration of the work done by it. When out of action in a heavy sea, it leaves the ship to roll and pitch with the waves and the effect of turning on the stabilizer operates to bring about an impressive silence, the creakings of the ship ceasing as the stabilizer comes into action. The ship, it is said, is steadied in her steering, and economizes on power, especially if she has bilge keels. Naturally there is not the same need of slowing down in bad weather, if a ship is well stabilized. There is less water on deck in a head sea.

It is calculated that the United States consumes nearly 75 per cent. of the petroleum used in the world. The demand for petroleum is increasing; the ship program calls for about half of the domestic supply. Internal combustion engines are said to furnish about two-thirds of the prime motive power of the world, and gasoline takes care of 95 per cent. of this.

A power line operating at a potential of 100,000 volts broke in Colorado, its loose ends separating some 200 yards or more. It was delivering 3,700 kilowatts at the time. The current found its way along and through the earth, and the irregularity in the action was only observed at the power house after seven hours had elapsed. It required three hours for the earth to cool off. The siliceous matter of the soil was melted in places into glass-like cones or fulgurites, similar to those produced by the lightning stroke. These were several inches deep, and were formed with their apexes down in the soil.

A system of secret communication by ultra-violet rays has been described, which was used during the war to communicate at sea, at distances of three or four miles. The ultra-violet rays of the Cooper-Hewitt lamp were employed, and were transmitted to a receiving fluorescent screen, coated with barium platinocyanide. A focussing system was a part of the apparatus.

Georges Claude, the eminent French authority on the liquefaction of gases and on low temperature work, has been working on the synthesis of ammonia from the atmospheric nitrogen as the source of the nitrogen of the compound. He has used pressures as high as one thousand pounds to the square inch, with results exceeding those attained in the famous Haber process of Germany.

NOTES ON ALUMINUM ALLOYS

Aluminum not alloyed with other metals is used for a great many machine parts and devices. The automobile industries are large users of aluminum castings, also the manufacturers of pneumatic vacuum cleaners. Commercially pure cast aluminum has a tensile strength of 14,000 pounds per square inch, which is too low for any parts subjected to great stress as it is less than that of cast iron. In order to increase the strength of aluminum, it is alloyed with stronger metals. Aluminum bronze is an alloy of copper with from 5 to 11 per cent of aluminum, which increase the tensile strength of the copper from 28,000 pounds per square inch to an average of 85,000 to 100,000 pounds per square inch. Aluminum bronze is of a light yellow color, and is not as heavy as any of the ordinary bronzes. It has been used for automobile engine crank case and gear cases.

In machining castings of aluminum and its alloys a difficulty is frequently encountered by reason of the chips becoming so firmly embedded between the teeth of milling cutters and tools that they cannot be removed with a stiff brush, and the machine has to be stopped for their removal. This necessitates the use of a lubricant. Oil does not prove suitable, but soapy water gives good results, although it leaves a dull surface. A good cutting lubricant is kerosene, which gives a bright finish when the cutting tools are properly ground and turpentine has been used to advantage also. The cutting edges of all tools should have sharp, square corners or edges, and there should be plenty of cutting relief or clearance.

COLOR INDICATIONS OF HEAT

To determine the color corresponding to various degrees of temperature in Fahrenheit degrees, the following table is given as being approximately accurate. It may be of use to the mechanic who desires to obtain a known degree of heat in any work, such as smithing, heat treating, etc.

	Deg. Fahr.
Lowest red, visible only in the dark	635
Faint red	960
Dull red	1290
Brilliant red	1470
Cherry red	1650
Orange	2010
Bright orange	2190
White heat	2370
Bright white heat	2550
Dazzling white heat	2730
Welding or scintillating heat	2800

For very accurate heat treating work, as in hardening or tempering modern alloy steels, more accurate control of the heat is necessary and even the best trained eye does not give satisfactory results so pyrometers are used.

Just Published

The Everyday Engineering Handbooks

The Experience and Knowledge of Experts Condensed and Simplified for the Handy Man—the Mechanic and the Radio Experimenter

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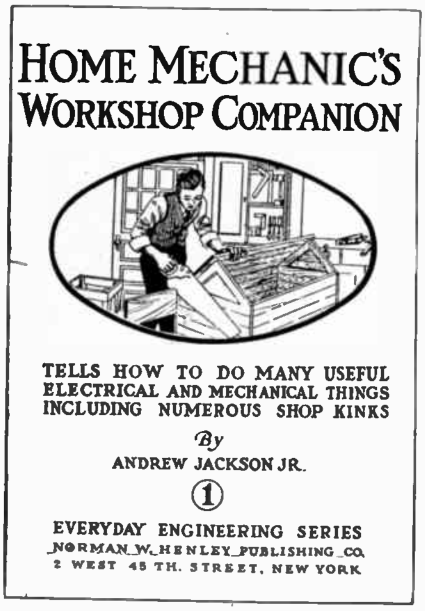

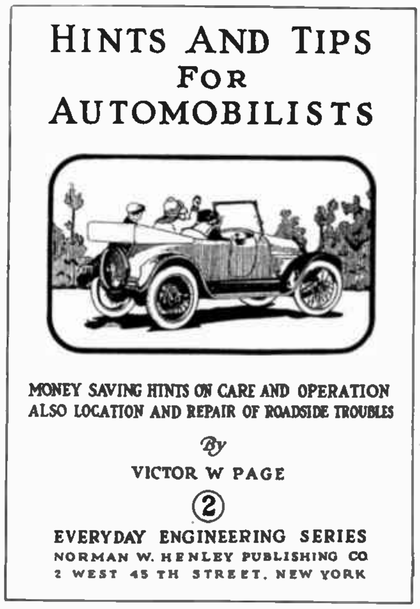

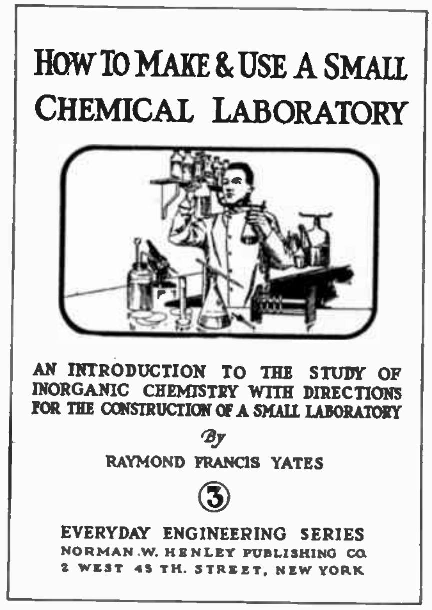

For the Handy Man in the Home or Shop

There has always been a demand for a hand book of mechanical instruction that would help the average everyday man to do the many small jobs of repair work that are found around the home and shop.

This treatise includes a compilation of useful suggestions that cannot fail to interest the handy man, and while it is not intended for mechanical experts or scientists, it will prove to be a veritable store of information for any one who desires to rig up a small shop where odd jobs can be carried on.

The subject matter is divided in five parts as follows:

Chapter 1—The Home Workshop and Its Equipment. Chapter 2—Special Tools and Shop Expedients. Chapter 3—Useful Home Appliances. Chapter 4—How to Do Things Electrical. Chapter 5—Helpful Recipes and Formulae. The illustrations are especially clear and all suggestions are further amplified or made more easy of comprehension by hundreds of thumb nail sketches made by the author.

For the Automobile Owner or Driver

This volume is replete with interesting facts compiled by an expert from a mass of information furnished by the Service Departments of leading automobile makers on operation, upkeep, lubrication, location of troubles and simple repairs of automobile parts. The instructions given are concise and to the point and no information that will help in the everyday operation of automobiles is omitted.

The book is ideal for the busy man or woman who wants to know about car operation and upkeep because of the economies possible when an automobile is intelligently operated. It contains many money saving hints and a brief simple exposition of location and remedy of roadside troubles apt to occur under ordinary operating conditions.

The permit of logical presentation, the subject matter is divided into four chapters. Chapter 1 deals with the Control and Operation; Chapter 2, Systematic Inspection and Lubrication; Chapter 3, Power Plant and Auxiliary Groups; Chapter 4, Automobile Care and Maintenance Suggestions.

For the Student Chemist and Experimenter

The treatise covers all of the essentials of elementary chemistry. The law of definite proportions, solutions, crystalloids, colloids, electrolysis, etc., are explained. The second part of the book is devoted to chemical and electro-chemical experiments. Only those experiments that will tend to broaden the readers' knowledge of chemistry in general have been chosen.

The third part of the book describes the construction and fitting out of the home chemical laboratory. Directions for the construction of the many simple pieces of chemical apparatus are given. A chemical balance, ring stand, electric furnace, etc., are described in detail, with working drawings. The manipulation of chemical glassware is also treated.

This book gives all the necessary information for a well-grounded understanding of chemistry. It will not only be a help, but an inspiration to study further into this fascinating realm of science.

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RADIO BOOKS CONTAIN MANY WIRING DIAGRAMS

SOLDERING & BRAZING

A USEFUL HANDBOOK FOR MECHANICS

By
RAYMOND FRANCIS YATES

④

EVERYDAY ENGINEERING SERIES
NORMAN W. HENLEY PUBLISHING CO.
2 WEST 45 TH. STREET, NEW YORK

For the Mechanic and Model Maker

This treatise gives all the necessary "kinks" that will enable one to accomplish successful soldering. If a mechanic has not succeeded in his soldering, this book may tell him just what he needs to produce good work—something that he may heretofore have forgotten.

Hard soldering, for some reason, is not generally known. Hard soldering, however, is very important and must be used in all cases where soft solder does not possess sufficient strength. Hard soldering and solders are thoroughly covered in the book. Nothing has been omitted that will enable the mechanic to apply hard solder successfully.

Brazing and all of its important ramifications are treated in detail. Brazing, like hard soldering, is a process little understood by many mechanics. The book "Soldering and Brazing" is divided in five parts as follows: Part I—Soft Soldering; Part II—Hard Soldering; Part III—Brazing; Part IV—Heating Devices; Part V—Soldering Notes.

RADIO HOOK-UPS

A BOOK OF THE MOST ADVANCED CIRCUITS OF RECEIVERS, AMPLIFIERS AND TRANSMITTERS FOR DAMPED AND UNDAMPED WAVE WORK:

By
M. B. SLEEPER

⑤

EVERYDAY ENGINEERING SERIES
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For the Radio Experimenter and Amateur

In this book, the best circuits for different instruments and various purposes have been carefully selected and grouped together. The result is a comprehensive summary of radio circuits for tuning coils, loose couplers, capacity coupling, variometers and other equipment for receiving long and short damped and undamped waves, damped, undamped and modulated wave transmitters using buzzers, spark coils, transformers, arcs and vacuum tubes, telephone transmitters, laboratory oscillators, vacuum tube characteristic measuring circuits, wave-meters, and audibility meters—in short, diagrams for every purpose.

A special feature of this book is the explanations which accompany each circuit, giving constructon or operating details. Spaces are also provided for notes on the results obtained with each diagram. This arrangement, coupled with the skillful selection of the circuits, makes Radio Hook-ups an essential to every radio experimenter or operator.

DESIGN DATA FOR RADIO TRANSMITTERS & RECEIVERS

SIMPLE METHODS FOR DESIGNING APPARATUS ACCORDING TO ADVANCED AND APPROVED PRACTICE

By
M B SLEEPER

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For the Radio Engineer and Student

Far from being a collection of formulas, Design Data takes up in proper sequence the problems encountered in planning all types of receiving sets for short, medium, and long wave work, and spark coil, transformer, and vacuum tube transmitters operating in 200 meters.

Where formulas are difficult, tables have been worked out so that values can be found without the use of mathematics. The few formulas given are so simple that any school boy can solve them. The subjects are so arranged that, having decided upon the type of receiver or transmitter to be built, the reader can locate immediately the problems and solutions required.

In Design Data, radio experimenters are given such information, readily accessible, as to make it possible for them to have modern and highly efficient equipment and to get the best possible results from the instruments they make or buy.

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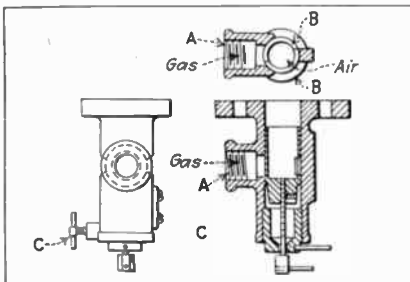
COAL GAS FOR TESTING ENGINES

A PROMINENT automobile maker uses city gas for testing and "running-in" engines in its testing department. The company had constructed a special mixer which fits the inlet manifold and takes the place of the carburetor. This is shown herewith and will prove of value to any of our readers who contemplate using an automobile type engine for stationary power-plant purposes. The housing is a cast iron cylinder having a threaded boss on one side for attaching to the gas supply at A. Level with the gas inlet are two air ports, BB. Threaded into the bottom of the housing is a plug, the object of which is to rotate a sleeve immediately above it around in one direction or the other as may be required for the adjustment; this sleeve is connected to the threaded plug by two sliding keys (not shown in drawing).



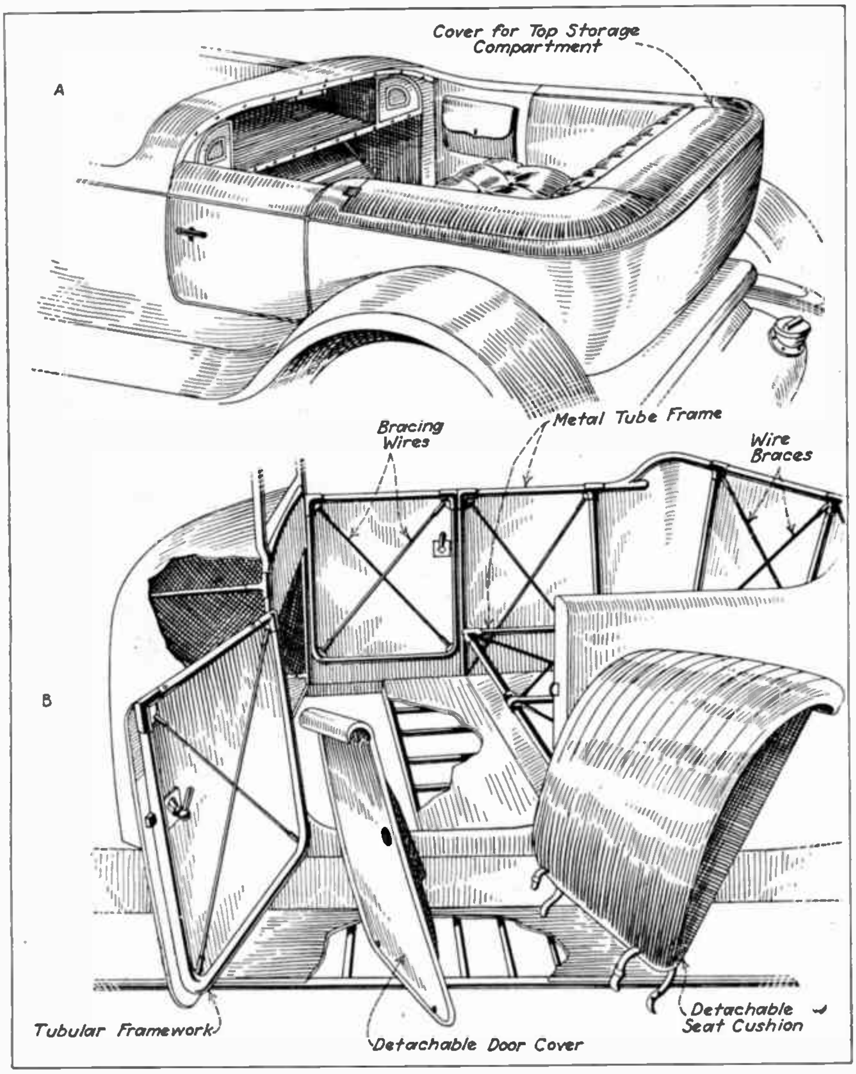
Device for using coal gas for running gasoline motor

Running through the plug is a rod threaded at the upper end which permits of the sleeve being raised and lowered as may be required but which will not rotate it on account of the sliding keys that move up and down in corresponding slots in the plug; the plug is locked in position by the screw C. When setting the mixer in testing an engine, the sleeve is first rotated by the plug to obtain the correct proportion of gas and air, usually to a position as shown in section AA. Note that the gas supply is considerably smaller than the amount of air allowed. When this adjustment is made the plug is locked by screw C. Then the speed of the motor can be regulated by raising or lowering the sleeve with the threaded rod running through the plug. This makes a very simple and inexpensive device which is entirely satisfactory. Besides saving on the cost of fuel, it does away with the fire-risk incidental to using gasoline in interior installations.

The gas supply can be regulated by any form of shut-off valve and a rubber gas bag can be used to equalize the pressure. These bags look like a hot-water bottle but have an inlet at one end and an outlet at the other.

New Foreign Auto Body Designs

TWO very interesting types of motor car bodies are shown herewith, that at A being a touring body having a special compartment built around the rear seat in which the top is stored when it is not in use. The covers provided are easily removed when it is desired to raise the top. A new light metal body is shown at B. In this, aircraft construction principles are incorporated, notably in the arrangement of the tubular metal framing and the use of tension brace wires fitted with spoke nipple ends to lend rigidity to the structure. The exterior panelling is of metal, as are the floor boards and running boards. The cushions and leather door covers are made up of separate units which can be easily attached to the framework and which can be removed very easily when it is desired to clean these members or the body interior. It is stated that this construction makes a very strong and light body for motor cars.



Interesting new foreign automobile body designs

COMPRESSED AIR AS A FIRE SCREEN

A German technical paper treats of methods employed for screening furnaces. Workers who have frequently examined what is going on in the intensely heated and glowing masses suffer much from the heat radiated and various devices have been tried for relief. Hollow, water cooled furnace doors afford protection only when closed. Devices have been installed for drawing off the hot air in front of furnaces by centrifugal exhausters, the objection to these being that the workers are subjected to too great and sudden changes of temperature. The most effective arrangement is to fix immediately behind the furnace door a narrow, oblong nozzle through which cold air is blown upward, thus interposing a screen of relatively cool air between door and furnace. This arrangement is to give adequate protection to the worker, and has the incidental advantage that when the doors of the furnace are opened the escape of flame is checked and the furnace interior temperature is maintained more constant.

COLLAPSIBLE FLOATS

A DESCRIPTION of collapsible floats has appeared in a recent issue of *L'Aerophile*, this detailing another interesting war development which the censor kept secret. Two or more floats of rubberized fabric are rolled up and stowed at any convenient place under the wings or fuselage, and these can be filled by means of a compressed air apparatus in thirty seconds. The number of compressed air containers required is reduced by the addition of an injector which draws in external air to assist in the inflation process.

The wheels of the chassis may be dropped off before alighting on the sea, but it would seem unnecessary to do this if the air bags were properly placed and proportioned. In addition a hydrovane is fitted to the chassis to prevent too great a shock to the inflated floats when they strike the water.

These air-bag floats may have considerable value for ship airplanes, allowing land machines to be used in lieu of seaplanes, which of course are much less speedy for the same power. They may also prove useful in commercial single-engine land machines flying over country with large stretches of water, as they will permit of emergency landings in case the motor fails without serious damage to either airplane or pilot.

VARIABLE PITCH PROPELLERS

LATE experiments with the variable pitch propeller indicate that it offers practical possibilities both in this country and Europe. Such mechanism will always be viewed with a justified prejudice by the aeronautical engineer as well as the flier, who dread the introduction of any additional mechanism to the airplane, no matter how simple it may appear to be.

It is interesting to note that French engineers are considering another solution of the variable pitch propeller. A foreign designer proposes to have two two-bladed airscrews, one for taking off and climbing to 5,000 yards and the other for use at higher altitudes. The altitude screw will be free during the first part of the climb and be brought into service only as needed by a special clutch, thus converting the two-bladed screw into a four-bladed one at will. What will be done with the idle screw while climbing or at low altitudes so it will not increase the parasitic resistance or complicate matters must be guessed at until more details are available.

Photographers use spring clothespins to suspend their films and prints with when drying. An ingenious proposal is to make a sort of replica of such clothespins out of a couple of pieces of cork and a rubber band, avoiding the use of any metal. Prints or films can be held by this and put into a rather deep bath for washing. The cork will keep them floating near the surface in the best possible position for quick washing, and the operation is considerably expedited.

Book Review

AIRPLANE DESIGN AND CONSTRUCTION, by Ottorino Pomilio. Published by the McGraw-Hill Book Co., New York. 400 pages, 6 x 9 in.; 248 illustrations.

Pomilio is a name well known in the aircraft industry, as the Pomilio Bros. developed an aircraft plant in Italy, which later was taken over by the Ansaldo interests after which they came to this country and organized the Pomilio Bros. Corporation. Previous to the signing of the Armistice, this firm completed a number of different aircraft models which were submitted to the Government for tests.

With a complete experience in the design and construction of airplanes, the author is well qualified to write on the subject. His book is a text of real engineering value dealing with the subject in an analytical way. The entire subject is treated in a complete and systematic manner. The author enumerates and defines the functions of each of the principal parts of an airplane, and considers the general laws of aerodynamics. In subsequent chapters, he gives a detailed treatment of the individual parts and a discussion of the laws of flying. The engine is dealt with only from the airplane designer's point of view, and its design is not discussed.

The text is divided into four parts, as follows: Part 1, Structure of the Airplane; Part 2, Elements of Aerodynamics; Part 3, Problems of Efficiency; and Part 4, Design of the Airplane. While considerable use is naturally made of mathematics, all of it is quite simple, and there seems to be no unnecessary mathematical treatment such as many engineering writers use for embellishment. There is much tabular material in the volume, relating to the properties of materials and other matters. The calculations are illustrated by examples of airplane design carefully worked out. English weights and measures are used instead of the usual metric system found in books of a foreign flavor. It is an authoritative and well written treatise that can be included in the library of anyone interested in the engineering side of aeronautics.

Radium gun sights for use in night work have been extensively made. They are so mounted on the gun that they can be pressed down out of the way in daytime. A glass tube one centimeter long and a little over a millimeter in diameter contains the luminous compound, a mixture of the radium salt with zinc sulphide. 0.4 milligram of radium bromide is used for a gram of the zinc salt. The latter, it is stated, must be impure, although the nature of the impurity is not known. For the tubes soda glass proved to be the best, as it turned only amethyst in time, while potash glass turned brownish.

A PRACTICAL BLUE-PRINT PROTECTOR

BLUE-PRINTS are always getting dirty, wet, greasy or torn while being handled by workmen using them. An inventive genius has designed a very practical blue-print protector of simple construction and low cost. A sheet of transparent sheeting—the same material used for lights in auto curtains—is cut to desired size. A piece of lightweight leather substitute is then cut about a half inch larger all around than the piece of sheeting. This extra half inch allows for a lap-over on all but the top side of the protector. A sewing machine stitches the lap down to the sheeting, forming a large flat pocket, open at the top for the insertion of the blue-prints. Both the transparent front and the coated fabric back are waterproof and grease-proof. Dirt or grease may easily be wiped or washed off either without injury to the material. Both materials are flexible and the holder may be rolled up if desired in the same way an unprotected blue-print is usually handled by a workman.

MAGNETIC METHOD OF TESTING HARDNESS

An engineering firm in England has developed a system for testing the physical qualities of steel after heat treatment by means of the magnetic method. The principle is that the magnetic retentivity of a steel is a function of its hardness. First a specimen (usually a turned piece 3 in. long by ½ in. diameter) is heat treated as desired. It is then tried for magnetic hardness by being placed inside a standard magnetizng coil, and a direct current from the mains connected to the coil for an instant which magnetizes the steel to saturation. The specimen is then removed from the coil and is placed in a small search coil, which is coupled to a Grassot fluxmeter. The specimen is then sharply removed from the ballistic coil and a reading is obtained on the fluxmeter, which represents the hardness of the specimen. The scale of the fluxmeter is divided in terms of Maxwell-turns. With the search coil of correct design, the reading is also given in terms of C. G. S. units. Soft steel has less retentivity than hardened material and the magnetic flux will vary with the hardness of the specimen, so by comparison with known standards, a suitable calibration permits of determining the efficiency of the heat treatment with considerable precision.

In a recent investigation it was found that 3,717 American locomotives had mechanical stokers. The engines burned 10 per cent. to 40 per cent. more coal than when hand-fed, but hauled more and developed a better engine performance.

SUBSTITUTE FOR PLATINUM CRUCIBLES

A gold Palladium alloy, under the name of "Palau," has been put on the market by a firm in California and is offered as a substitute for the more expensive platinum-iridium alloy generally used by chemists. A crucible of this ware has been tested at the United States Bureau of Standards. The loss in weight on heating to 1,200 deg. C. is intermediate between that suffered by crucibles of platinum containing 0.6 and 2.4 per cent iridium, respectively. The melting point of the alloy is 1,370 deg. C. which corresponds to that of on alloy of 80 per cent gold and 20 per cent platinum. In resistance to most of the chemical reagents to the action of which such is ordinarily exposed, "Palau" compares very favorably with ordinary platinum ware. The one noteworthy exception is fused alkali pyrosulphate, which attacks it much more than it does platinum. The ware is very promising as a substitute for platinum for many laboratory purposes.

ALLOY FOR FINE CASTINGS

For making the finest quality of fine sand castings, such as used for models, tablets and ornamental work, the following mixture cannot be surpassed, and probably is unequaled:

Copper	90 parts
Tin	7 parts
Zinc	2 parts
Lead	1 part

It is unnecessary to say that for such work it is unwise to use scrap metals, and only the best new metals should be employed.

It is said that artificial graphite has particular advantages as a facing in making fine alloy castings. Its purity prevents it from slagging when the hot metal strikes it and a smooth skin results on the casting.

NICKEL PLATING ALUMINUM BY A NEW PROCESS

A METHOD of nickel plating aluminum is given in a French journal. Remarkable results as regards adherence of the plating is claimed. The aluminum is cleaned by treatment with caustic soda solution, then with milk of lime brushed on; it is next immersed for a few minutes in a 0.2% solution of potassium cyanide and washed. A bath of 1,000 parts of an equal mixture of water and hydrochloric acid with 1 part of iron dissolved in it is next employed. In this the aluminum is immersed until it shows colors due to the precipitation of iron either metallic or as some compound upon its surface. It is then washed and nickelled. The salt recommended is nickel chloride, instead of the sulphate generally employed. There is a deposit containing 0.25 to 0.50 gram of metallic iron to the square meter—a very minute quantity, and whose action is a mystery, although efforts have been made to determine the exact role played by the iron salt in the process. The plated metal can be bent and heated without injury up to the point, as regards the heating, when the aluminum melts.

PUMPING WATER WITH A SPIRAL SPRING BELT

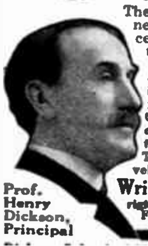
WHAT the eminent British scientists are pleased to call a "mechanical impertinence" has recently made its appearance in England, in the form of a unique pump which works by means of a spiral spring belt. The pump consists simply of a spiral spring belt, a grooved weight which turns with the bottom loop of the belt and holds the latter in place, and a driving crank and pulley for turning the belt. Despite this simple construction the pump is capable of lifting a thousand gallons of water per hour from a depth of 300 feet, even when worked only by hand, according to reports. The coil-like cable is sunk to any depth by a rotating weight Obeying the law of capillary attraction, the water lodges between the turns of the spiral spring and only falls out when it reaches the top of the pump.—*Scientific American.*

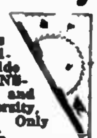
Burnt earth or burnt brick clay, which has passed through a one-inch sieve and been held by a one-quarter-inch sieve, has been found available in England for making concrete where broken stone was not to be had. In South America experiments have been carried out, in British Guiana, with ligno-concrete, which is concrete reinforced with wood strips in place of steel bars. A wood called green heart was used. It was employed in strips, two inches square and two by three inches. A twelve by twelve inch pile, reinforced by two of each size, a total of four strips, carried some two hundred pounds more than a similar pile with five steel reinforcements, round in section and ¼ inch in diameter. Neither was tested to destruction in this test. In another trial a beam with two by three inch reinforcement collapsed under a load only 10 per cent. less than that required to break down a similar beam reinforced with ⅝ inch steel bars. There were two of the steel bars of this size and only one of the green heart, the wooden one three by two inches. It was found that the wood should be soaked in water for at least twenty-four hours.

Explosives, no longer needed for the destructive operations of war, are being made into fertilizers. All explosives contain the essential fertilizing element, nitrogen, and this is put into assimiltable form for the nourishment of plants. Ammonia products and nitric acid salts are mixed with powdered peat, and the final product analyzes well. The Italian government has been conducting the experiments, which promise to yield good results.

An interesting method of determining the percentage of sulphur dioxide, which in solution forms sulphurous acid, has been published. The solution is treated with an excess of hydrogen dioxide; this converts the sulphurous acid into sulphuric acid. Dilute sulphuric acid is then added and the excess of undecomposed hydrogen dioxide is determined by titration with manganese permanganate.

The Illinois Central R. R. has tried a concrete gondola car, capable of carrying 50 tons or more of coal. Its somewhat excessive weight of 53,600 lbs. it is thought can in future constructions be reduced to 46,000 to 48,000 lbs. The Portland cement used was mixed with burnt shale.





Benzol-Alcohol Fuel Mixtures

(*Continued from page* 420)

stance, because wood alcohol tends to produce acetone and other compounds which are of corrosive nature and which might corrode the metal parts of the cylinder which were exposed to the effects of a by-product resulting from incomplete combustion of such a vapor.

Alcohol has the advantage in that the fire risk is less than with gasoline. The latter is a more volatile liquid than alcohol, and is more dangerous because it evaporates more readily. The flame of burning gasoline is one which radiates heat rapidly, whereas the alcohol flame does not radiate heat to such an extent. A mass of burning gasoline will generate sufficient heat to set objects at a considerable distance from it on fire. The heat from burning alcohol goes upward and exists mostly in the hot gases evolved by the flame. A gasoline fire is spread by water, whereas burning alcohol may be extinguished by it. Gasoline is much lighter than water and floats on its surface, but alcohol is so nearly the same density that it will mix with the water.

If one compares the chemical composition of alcohol and gasoline it will be found that it requires less air to burn a pint of alcohol than the same amount of gasoline. The oxygen contained in the alcohol tends to make combustion better, and there is practically no residue left in an engine burning alcohol gas. The exhaust from any of the petroleum distillates will smell strong and be smoky if an excess of fuel in proportion to air is in the mixture. The burned products of an alcohol mixture are not objectionable even if there is an excess of alcohol. These exhaust gases, besides being more agreeable to the senses, are cooler and cleaner, and as they contain a smaller proportion of free carbon less of this is deposited in the combustion chamber and muffler.

Among the conditions which are unfavorable to the use of alcohol and which militate against its use at the present time can be cited the present types of engines and carburetors, and the high price of denatured alcohol. While alcohol has not been extensively experimented with in this country, because the supply of gasoline at the present time seems adequate, it is expected that, should there be a shortage of this use of alcohol in connection with present-day forms of motors. Some authorities contend that alcohol will be the fuel of the future, while others believe that kerosene is more adaptable for use in the hydrocarbon motor.

Alcohol-Benzol Fuel.—According to reports, the Germany army automobiles were being run on a mixture of benzol and alcohol. As soon as Germany found herself cut off from outside supplies of gasoline a technical committee was appointed to find a substitute. Experiments were carried out with a 1914 Mercedes touring car equipped with an ordinary carburetor, when mixtures of alcohol and benzol were found to give satisfactory results. Summarized, the results obtained in these tests were as follows:

Benzol	Alcohol	Speed Obtained M. p. h.	Miles on 1 Liter of Fuel
1 part	1 part	42.2	4.66
1 part	2 parts	41	4.4
1 part	3 parts	39.1	4.3
1 part	4 parts	38.5	4.1
1 part	5 parts	36	3.7
Benzol only		41.6	3.79
Gasoline only		43.49	3.6

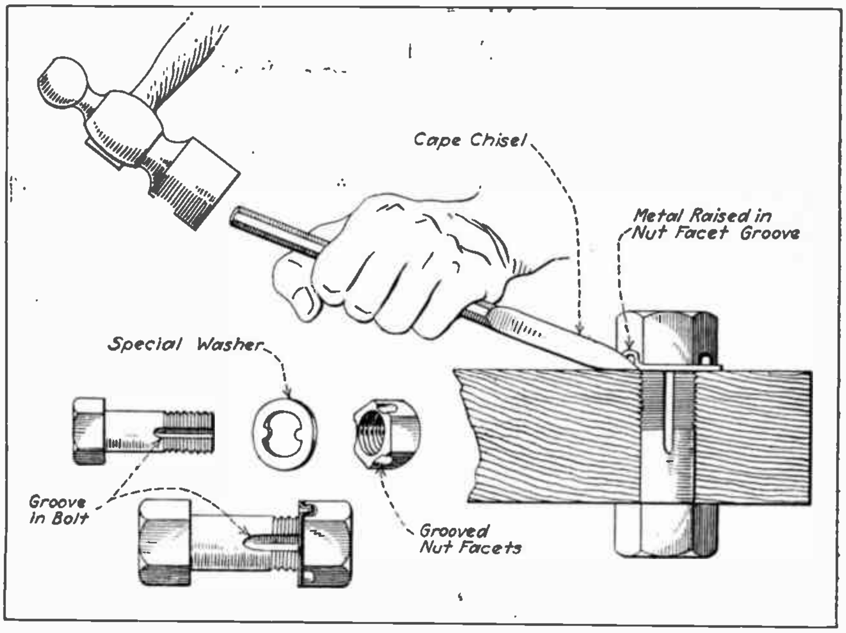
Calculating on the rates existing before the war, the benzol-alcohol mixture is the cheapest fuel obtainable. One liter of gasoline costs 9 cents, benzol 8.6 cents, and alcohol 8.2 cents. The cost per kilometer works out as follows:

	Cents
Gasoline	0.0157
Benzol	0.01362
Alcohol-benzol, 50%	0.0125
Pure alcohol	0.0167

This shows that a 50 per cent. mixture of alcohol and benzol is the most economical, and it is this fuel which has been used throughout the German motor transport service. The only inconvenience experienced is the necessity of a preliminary heating of the carburetor. Starting the motor is a difficult task, and on several occasions when the army has been retreating automobiles have been abandoned on this account. This difficulty has been overcome by fitting a secondary tank containing a small quantity of gasoline or ether. A three-way cock allows the supplementary tank to be put into connection with the carburetor for starting purposes. As soon as the motor is warm the reserve fuel is shut off and the alcohol-benzol mixture supplied to the motor. In case of a breakdown near the enemy's lines, or the loss of the main fuel through a bullet or piece of shell entering the tank, the reserve supply is used. This is able to take the vehicle ten or twelve miles, which is generally sufficient to remove it from the danger zone.

NEW NUT LOCK

THE safety interlocking nut and bolt shown herewith is said to prevent stripping or wearing of threads, owing to the fact that the threads in the nut are always in perfect contact with the threads on the bolt and as no movement of the nut is possible, the threads cannot wear. A permanent contact, irrespective of the thickness of the bolted elements, is obtained through a combination bolt, washer and nut. The washer has two inner extending lugs that fit into grooves in the bolt. It is locked to the nut by upsetting a portion of the washer into one of the grooves on the nut. The bolt, washer and nut remain locked in contact with the bolted elements, and the nut will not loosen after the metal of the washer has been forced into the groove with a cape chisel. The nut is unlocked by driving the metal down out of the nut groove with the same tools.

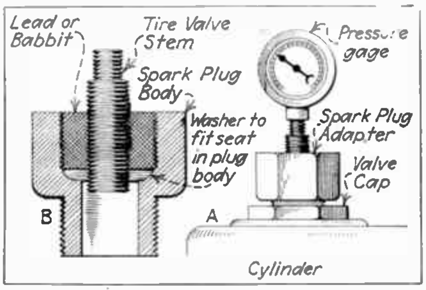


A positive method of locking nuts on mechanism subject to vibration

In Finland it is calculated that there is three million horsepower in its waterfalls, of which a little over one-third can be utilized. There are 79 waterfalls included in this calculation. At present only 150,000 horsepower are utilized.

SIMPLE GAUGE FOR MEASURING COMPRESSION

ONE of the most common causes of lost power in an automobile is that the force of the explosion pressure depends upon compression pressure before the gas is ignited. If the compression is 80 pounds, the explosive force acting against the piston top and imparting power to it will be about 400 pounds per square inch. If worn piston rings or leaky valves allow gas to escape when the piston is rising on its compression stroke, the resulting decrease to 50 or 60 pounds means a reduction of explosive pressure to about 300 pounds per square inch. Besides this diminution in pressure there is a



Simple compression gauge

loss due to further leakage through the faulty retaining members. A simple compression pressure indicating gauge may be made by taking an old spark plug body, from which the porcelain has been removed and fit in a valve from a discarded inner tube by pouring melted babbit or solder in to fill the space between the spark plug shell and the valve. When the metal has set, the valve is found to be firmly imbedded in the soft metal. The spark plug is removed from the cylinder to be tested and the combination plug body and valve stem put in its place. As the engine is turned over briskly by either the hand-crank or self-starter by an assistant, or the engine run slowly on the other cylinders, a tire pressure recording gauge held against the valve will record the compression pressure just as it does air pressure inside a tire. If the pressure is low on all cylinders it is a good indication that the entire engine needs attention.

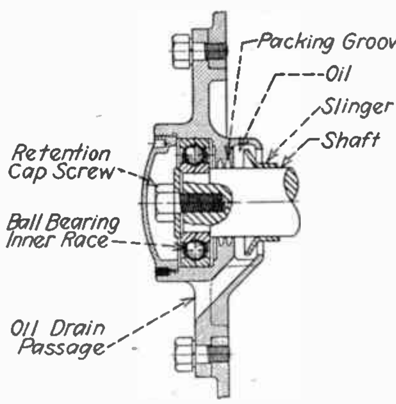
A new power development at Niagara is now in process of execution. A canal connects with the Welland River 4½ miles from its mouth. The flow of the river is to be reversed in direction so as to feed the water of the Niagara River into the upper end of the canal. This is located some distance above the falls. The canal, nine miles in length, runs to the lower end of the lower Niagara River, ending about a mile from Lake Ontario. Three hundred and five feet head are obtained, instead of from 136 to 165 feet as in the present installations. Each cubic foot of water per second gives 30 horsepower. The present rate is only 14 horsepower. The work is all on the Canadian side. At Niagara 605,000 horsepower are now used; it is claimed that 420,000 more can be taken without impairing the beauty of the falls.

NEW ALUMINUM ALLOY

A French engineer has patented an alloy of aluminum for which is claimed the possibilty of being cast as easily as the usual alloys and also worked, or tempered in the same way as steel. For the preparation of this metal, it is said a preliminary alloy is prepared containing cobalt, nickel, tungsten, silver, magnesium, and aluminum. About 10 per cent of this alloy is incorporated with 90 per cent of aluminum to make the new compound which is somewhat heavier than the simple metal and also stronger.

KEEPING OIL FROM MOTOR ARMATURE

THE use of ball bearings in electric motors and generators is a feature that has many advantages providing the installation is properly made. The accompanying illustration shows how the bearing housing may be made so the oil will not run out along the armature shaft and damage the windings or cause commutator trouble. The use of packing grooves will insure the retention of most of the lubricant in the bearing housing and any that does seep through will be thrown off centrifugally by the oil slinger and will run out of the housing through the drain passage cored in the end plate casting.



Oil slinger to keep oil from injuring windings

Concrete derrick cranes are reported from France. They weigh less than twice the weight of a corresponding steel crane. They are allowed 498 lbs. compression and owing to the reinforcement, 17,000 lbs. tensile strain. They are much cheaper than the steel structures. Another use of concrete is reported from Kingston, Jamaica. Mooring buoys have been successfully employed made of this material. They weigh five tons, are three inches thick, cylindrical in shape, with concave ends. A ton of ballast is needed to keep one upright. They cost £35 each, while steel buoys cost £75.

An alloy steel, termed "stainless steel", containing 12 per cent. of chromium, has been found of value for valves of aeroplane engines. At a red heat it does not scale.

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