EVERYDAY ENGINEERING MAGAZINE

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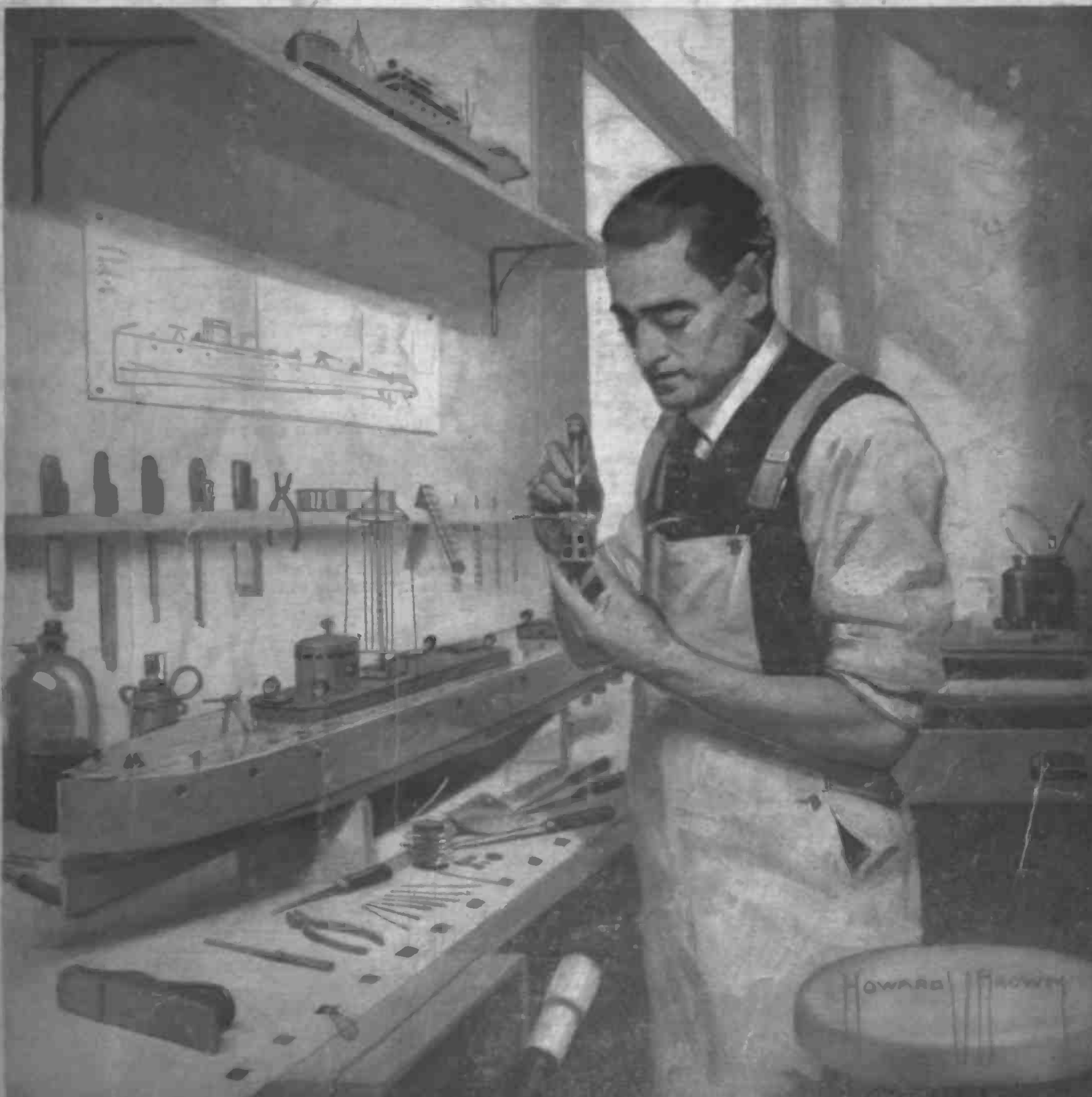

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CONTENTS

VOL. 8 OCTOBER, 1919 NO. 1

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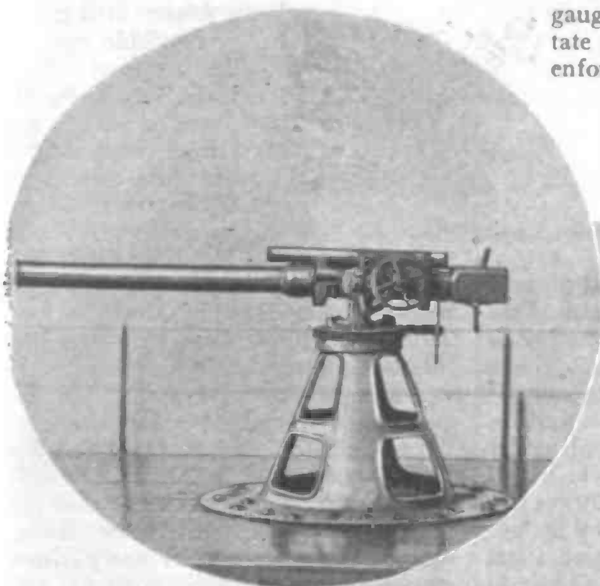
IT TELLS YOU HOW TO MAKE AND DO THINGS

VOLUME 8 OCTOBER, 1919 NUMBER 1

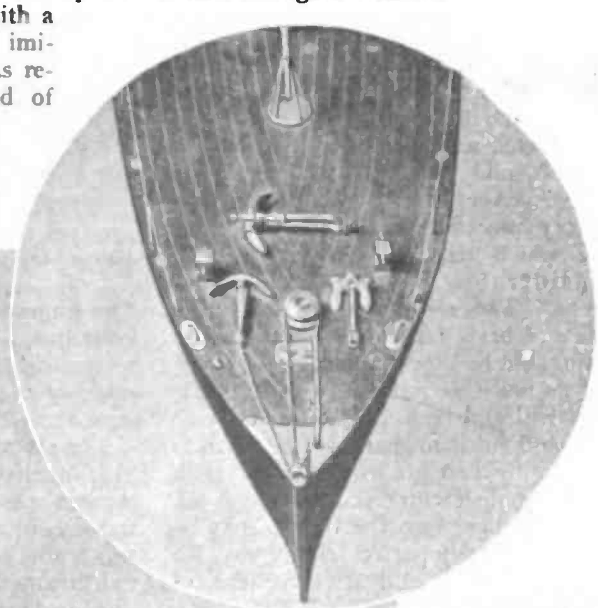
The Patrol Boat "Lucifer"

By Martyn Baker

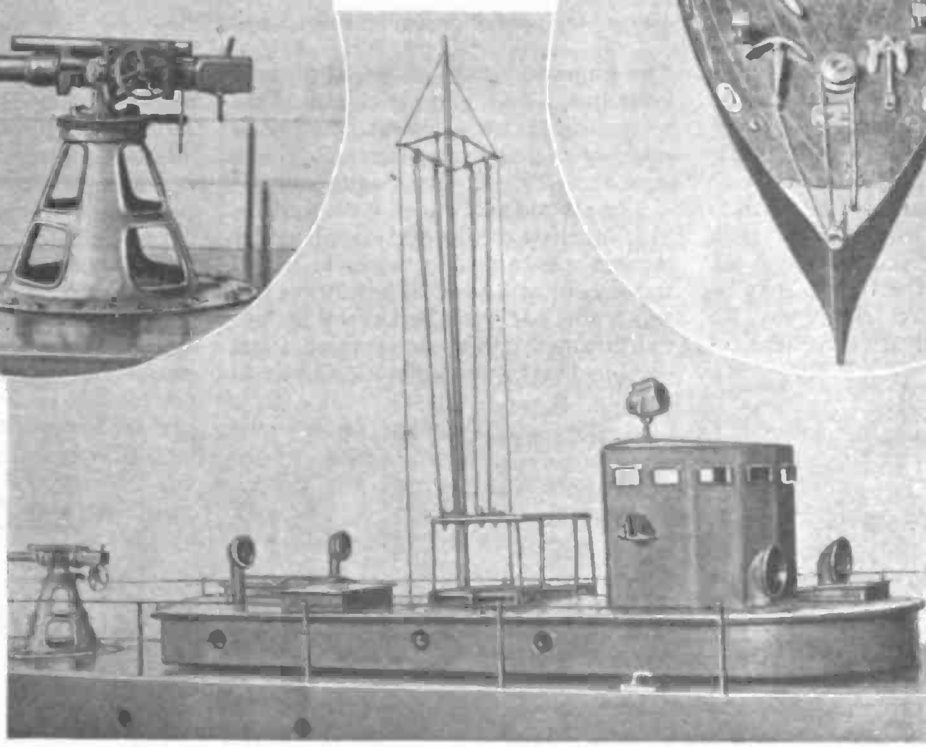
THE boat, *Lucifer*, is a scale model of the sixty-foot craft built in the early part of the war by the Greenport Basin and Construction Company for the Russian Government. Some of these boats were refused by Russia for financial reasons and were sold in this country.



The model gun which is mounted between the cabins



The bow of the boat showing fittings



A close view of the cabin showing the details of the deck fittings

The dimensions of the model are roughly as follows: Length, 36 inches; beam, 6 inches; draft of hull, 1½ inches. Other dimensions may be taken from the drawings. With the exception of the heavy work of digging out the hull, *Lucifer* was built entirely in a study with the necessary tools kept in a desk drawer.

The hull was gouged out of a solid piece of sugar pine in the conventional way, using templates to insure the two sides being the same. By cutting out the stern and putting in a transom piece afterward, much labor is saved in hollowing out the hull. It was made so thin that a seventy-five watt nitrogen bulb just showed light through the sides. The deck is an eight-inch piece of mahogany lined with a gauge and pencil to imitate planking. It was reenforced at each end of the openings for the deck houses by pieces of soft wood glued and screwed on athwart ship. A short section in the stern is easily removable to give access to the steering gear. The two deck houses are made of mahogany. The rounding front to the forward house was jig-sawed out of a two-ply piece and finished with file and sandpaper.

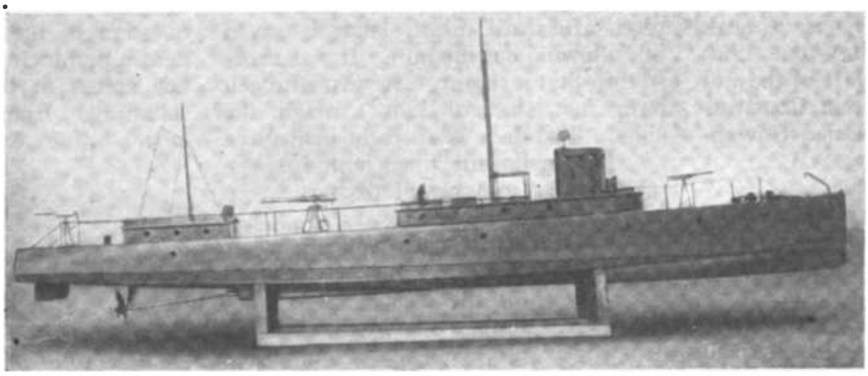
To the average model maker, the hull and upperworks so far explained present no unusual difficulties, but the question of presentable fittings is indeed a perplexing one to those who have not access to the little castings and stampings from which professional model fittings are made.

It is here that the experince gained in making *Lucifer* may be of help to many, for, with one exception, all the fittings were made from stock easily obtainable at the corner hardware store.

The instruments used were the ordinary assortment of light metal working tools, and included in particular a set of the little assorted shapes of files knows as "Swiss" files, a good alcohol blow torch, and several small sharp punches and cold chisels. The stock comprised sheet brass in three thicknesses, a little heavier plate brass, a half dozen sizes of brass wire with drills to fit each size, and brass rod and tubing bought as needed. In addition to this, was some assorted pieces of sawed brass in several thicknesses and widths. This was used only in making the little fittings that were cut from the solid.

For soldering, the combined solder and flux in paste form known as "No-korode" was found very convenient; in fact, some of the more delicate jobs would have been impossible without it. For holding work together, fine black iron wire was used as solder does not stick to it readily. In complicated places, wet rags kept one part of the work from unsoldering while the rest was being done. A surprisingly small quantity of solder is needed—the less used the better, for it only makes a messy job. These few hints contain the meat of a long and varied experience in building up fittings with solder.

Many smaller parts, such as cleats, chocks, hoisting hooks, etc., were cut out of solid metal. This is a very satisfactory process, but one which requires considerable patience. The method is to saw off a block of brass big enough to make the fitting, but no bigger, to rough the thing out as much as possible with hacksaw and drill and then to take the "Swiss" files and cut it to shape. The finish is put on by two grades of emery cloth and the polish with crocus cloth and oil. Little fittings, even the tiniest, may be made absolutely perfect in this way, for the blow holes and imperfections of castings are absent.

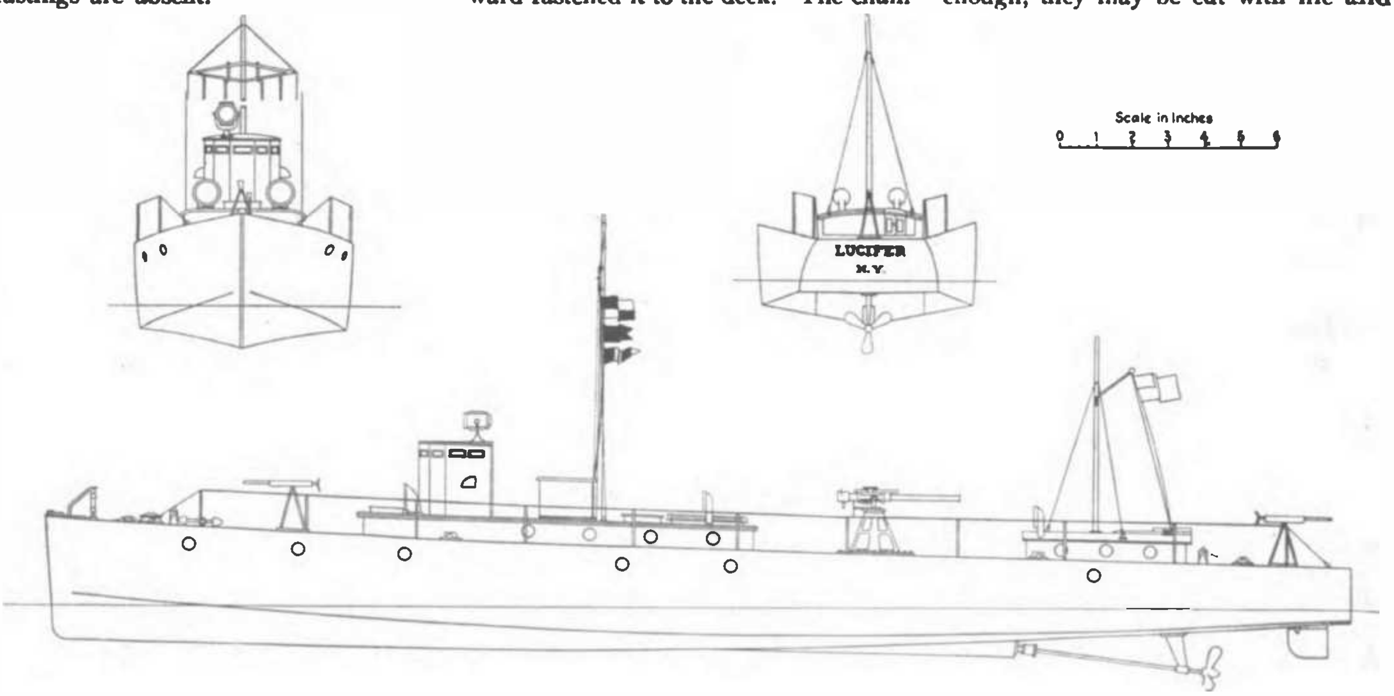


A view of the finished boat resting in its cradle

Starting from the bow of *Lucifer* and working aft, the fittings were made as follows: The bow plate and chain lead were made of sheet brass cut and bent to shape and soldered. The anchor davit was heavy wire with the end flattened to allow the tackle hook to pass through. The cleat was made of wire soldered into holes in the davit. In passing, I may say the spring wire is the kind to use, for its strength is sometimes needed and it may be easily annealed by heating it red hot and plunging it into cold water. The little eyebolt in the deck under the davit as well as the others holding the rigging were made of a loop of wire soldered into two holes in a tiny square of brass. The projecting ends are poked through holes in the deck and clinched. If the reverse side is not accessible, the bolt is made of a ring in the end of a single wire and is driven into a snug hole.

The ground tackle took quite a while, as it involved considerable detail. The capstan was turned by means of a drill frame held in a vise. The cutting tool was a file. It was chucked by a short rod threaded into the base which afterward fastened it to the deck. The chain plate was cut from sheet with little semi-circles of wire soldered around the forward side of the openings and filed smooth. The anchors themselves were made from castings and were the one fitting mentioned above not made from ordinary stock. However, the writer has since made several anchors from solid metal which were the equal in every way of those on *Lucifer*. The cross cars were made of wire with little wire rings soldered on and filed to shape for the balls. The shackles were made of fine wire. The chain cable was originally a piece of eyeglass chain which is obtainable in several sizes. The dead-men or snubbing posts were made of mahogany with brass pins, but could be easily made of square rod and polished. The shore line leads were made of sheet and wire, but cutting from solid would produce a neater fitting.

Port hole rims are best turned on a lathe, but in the absence of such a machine, short sections of brass tubing cut square and allowed to project very slightly from the side make excellent rims. The inside is painted black. Railing stanchions were a stumbling block for a long time, but the problem was finally solved by making them of heavy wire with just the end annealed and squeezed somewhat flat in the vise. The flattened end was then drilled with a fine drill and neatly rounded off. The slight taper that full size stanchions usually have is not missed, but if the builder has patience enough, they may be cut with file and



emery before the flattening process. The rail is unannealed wire stretched as tight as it could be pulled with pliers. Soft wire was first used, but it stretched so after being put on as to hang in loops between the stanchions.

The two machine guns fore and aft were made of wire and sheet soldered. The after one also controls the twin rudders by a simple system of arms and connecting rods. This does away with any fitting for steering that was not on the prototype. The hatches to the crew's quarters and to the engine room were made of sheet brass, the four sides in one piece and the top another. They are held on by pinning through the sides to a block of soft wood screwed to the deck.

The conning tower was made of fairly heavy sheet cut and bent to shape. Before bending, the ports were cut by drilling around them and then using a cold chisel and finishing with a file. The roof is soldered to the under side of the angle formed by bending over the top of the sides. A beading of wire was soldered to the after edge of the sides, and a rim of fine wire soldered around each port. This was a lengthy process, but well worth the trouble, for it gave a finished appearance that was otherwise lacking. The tower was pushed up through an opening in the deck house cut the exact shape and held by a flange on the under side. The searchlight was made from a 32 caliber pistol shell with the ventilation boxes, etc., soldered on. The base was made, after much deliberation, from an old collar button which had the proper shape.

The signal bridge was made almost entirely of wire soldered together. The three strips of sheet through which the grating bars run must be identical, and to secure this they were cut longer than necessary and the ends temporarily soldered together so that it was only necessary to file and drill one piece of metal instead of three. When they were ready for the bars, the surplus ends were cut off and the three pieces were absolutely alike. In soldering the bars, as little solder as possible was put on the under side, and the heat applied to a different bar and strip each time so as to avoid melting out the rest. The railing is obviously of wire.

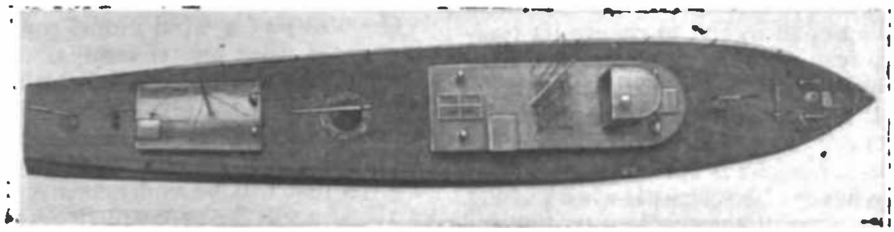
The mast is hard wood carefully tapered and smoothed. The tendency of most amateurs is to get all spars too thick, and the boat's appearance is thus greatly marred. The diamond yard arm was easily made of wire and fastened on by bindings of very fine wire.

The skylight over the engine room was made similar to the hatches, with the openings cut in by the cold chisel and file process. Celluloid makes excellent glass. The companionway slide on the after house was also made much the same way. It was first laid out flat on paper, then the brass was cut and bent to shape and ends soldered in.

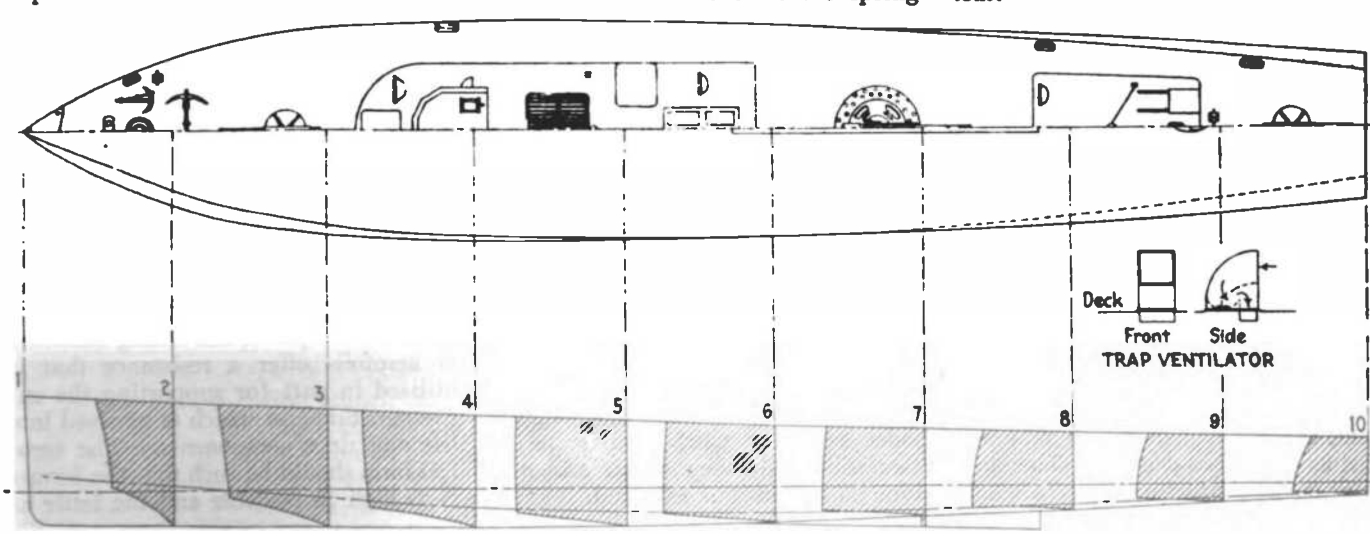
The three-pounder mounted amidships took time and patience, but the result was altogether satisfactory. The conical mount was made of sheet with the openings cut out and a fine wire rim soldered around each. Here again the time expended in this fussy job is amply repaid. It was topped by the little drum which contains the spring in a well known cheap watch. This drum has teeth in its periphery, and forms part of the pointing mechanism. The barrel was made of two sizes of tubing with a wire soldered around the muzzle to give the bell shape. The square breech was made of sheet and soldered on. The barrel is held in a carriage made of a large piece of tubing cut away except for a ring at each end, a lengthwise strip down each side and a half ring underneath where the trunnions come. The recoil cylinders were pieces of rod soldered to the top of this carriage. The carriage swung in a fork made of heavy sheet soldered to a disc which in turn is free to revolve on top of the conical mount. A pair of arms soldered on form the bearings of the worm gear which was made by soldering a few turns of fine wire properly spaced on a heavier wire and filing it to shape. The hand wheel was a gear from the same watch as the top of the cone, the teeth being removed. The elevating mechanism consists of a sector of another gear soldered to one arm of the fork and a gear with pinion combined engaging this, and turning in the carriage. The pointing and training action is rather delicate and will not stand rough handling.

The strut for the propeller shaft was cut out of solid metal, but could be easily built up from a short piece of tube and some heavy sheet. The stuffing box was made on a lathe at a later time, but a good one can be made from a piece of tubing larger than the shaft with a plug in each end drilled to fit the shaft. This is filled with grease. The propeller is best made as described in a recent issue of Everyday Engineering, by the built-up process.

I have left the description of the ventilators till the last, for they are perhaps the most perplexing problem of all parts. The smaller ones were cast of a zinc-tin alloy in a plaster of paris mold, and the two larger ones in front beaten from very soft thin copper over an iron form, but both these methods have their disadvantages for the amateur.



This view shows the deck plans of the Lucifer



Airplane Models and Wind Tunnel Tests

By Victor W. Pagé, M. S. A. E.

THERE seems to be an impression on the part of many uninformed people that model making is not serious work and that it is chiefly a hobby or pastime indulged in by men seeking mechanical recreation. In many lines of mechanical endeavor model making has an unquestioned practical value and is the means of carrying on experiments with new inventions at much less cost and with greater ease than would be possible if the experimental work was done with full-sized mechanism. Model making is serious work that calls for a high degree of mechanical skill when it is used as an adjunct to either scientific or mechanical development.

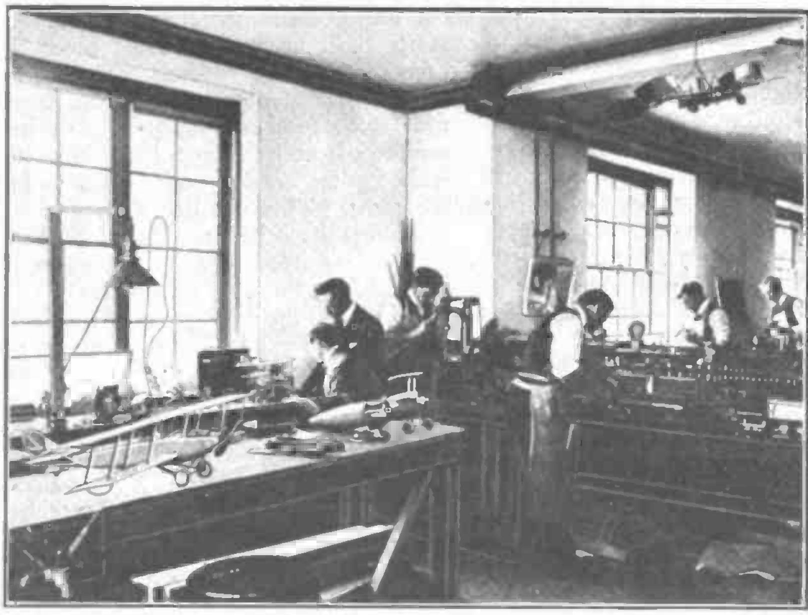
Scale Models Valuable

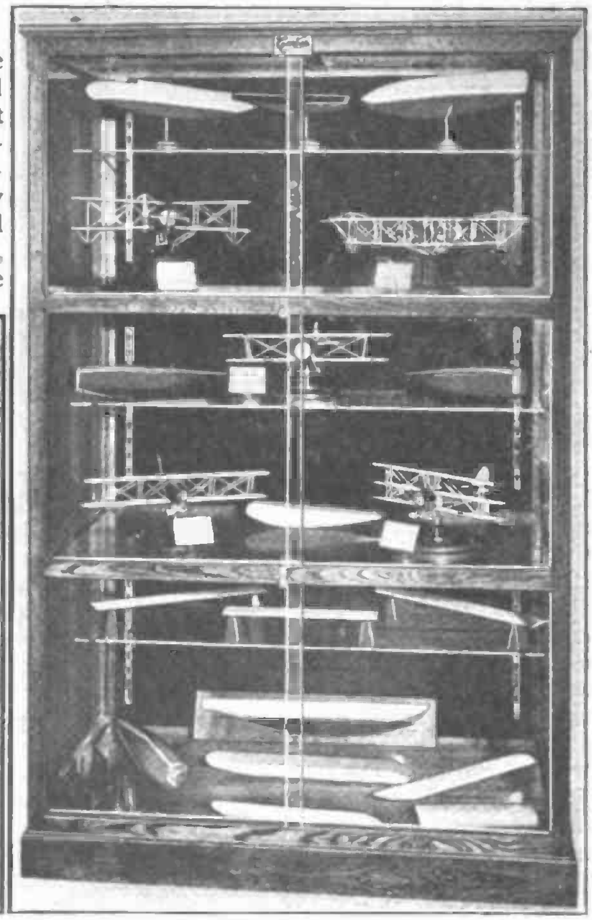
This is especially true of the small airplanes that are used in wind tunnel tests. It has been known for some time that experiments on scale models of both ships and aircraft afforded a means of obtaining valuable information on which the action of full size vessels and airplanes could be based. The problems studied with models relate chiefly to the performance of a movable body in a fluid, as in naval architecture where a small hull is towed at various speeds in a special tank of water, known as a "towing basin" or in the field of aeronautical engineering where a fixed model is tested in a moving air stream, the velocity of which may be varied as conditions demand. The stationary model method used in the wind tunnel offers the important advantage that it is easier to measure the forces acting upon it, and to change its position relative to the air stream flow lines at will.

It is not always easy to apply results obtained with models to full size machines, as there is apt to be an error in the change of co-efficients when passing from a small to a full scale, but experience is of value in this connection as in many others, and in the majority of cases the corrections necessary in applying with tunnel data are known with considerable accuracy.

Models Must Be Accurate

The models used must be made with great precision and of materials that are not apt to change their shape appreciably. For this reason, models of aerofoils are usually made of brass and machined with micrometrical exactness, most experiments being made with 18" by 3" wings. Seaplane hulls, fuselage shapes and other members of that class are made of wood, highly polished and as exactly as skilled workmen can produce them. A complete airplane for tests calls for extremely accurate location and assembly of the various parts, as well as precise reproduction of the members comprising the assembly. An error on a 1/12th scale model would be much greater in the calculations involving a full size machine so accuracy is essential.





View of the model making department of a prominent aircraft manufacturer shows the importance attached to production of accurate scale models of airplanes and their components for wind tunnel tests. Some of the Curtiss airplane and seaplane models produced and various parts used in trials are shown in cabinet at the right

Utility of Wind Tunnel

The utility of a wind tunnel can be appreciated when one is familiar with the mass of data that can be obtained by its use. It is not possible to go into this subject to any extent in an article of limited scope, but an example can be given that will be understood easily by all. As will be apparent in accompanying line drawing, an airplane may be divided into two main assemblies, one comprising the lifting surfaces; the other, the parts needed to carry the motor and passengers and to which the wings are attached. Obviously, each of these assemblies offers a definite resistance to forward movement of the plane through the air.

The non-lifting parts offer a parasitic resistance that should be reduced to the lowest point, the lifting members or aerofoils offer a resistance that is utilized in part for supporting the entire structure and which is resolved into lift and drag components. The aerofoil form should be such that the former is as high as possible and the latter as low as can be obtained. The resistance of an airplane varies with the design. The proportionate parasitic resistance is about as follows: Fuselage and wings 62 per cent., landing gear 16 per cent., tail plane, fin, rudder and elevator 7 per cent., and wires struts and fittings of the wing structure 15 per cent. The reduction of any of these items will increase the efficiency of the airplane, i. e., it will fly faster with less power without decreasing the weight carried.

Expert model maker at work on miniature reproduction of nine cylinder rotary airplane motor mounted at front end of nacelle for twin-motored biplane

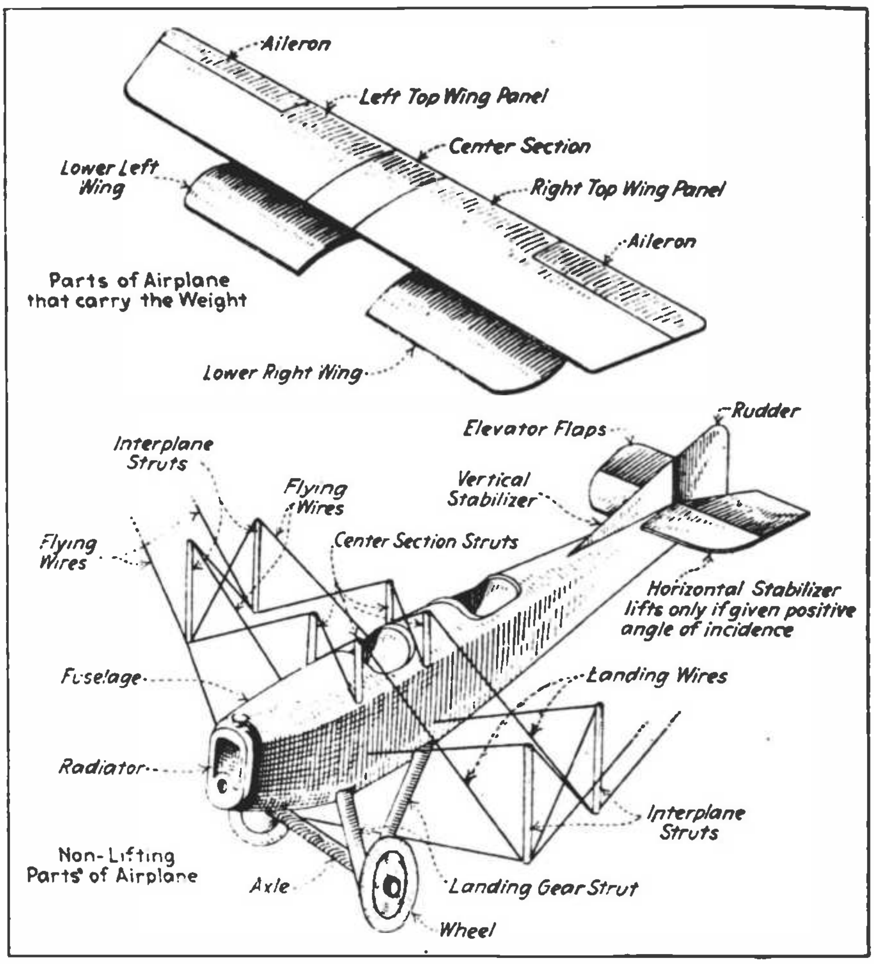
By the aid of the wind tunnel weighing mechanism these percentages can be determined in pounds or fractions thereof, this enabling the designer to figure the horsepower required to attain a certain speed and numerous other points in design. The complete airplane may be tested and its resistance measured or any of the parts may be tried out distinct from the assembly and the influence of change of form, location or size determined. Loening states that 10 pounds of air resistance saved by the better shaping of a part or placing it so it will present its best angle to the air will result in a saving in power that will permit of carrying 70 or 80 pounds more weight on the machine. Air resistances are measured by supporting the body in the air stream and weighing its reaction to the moving air, the velocity of the air being changed to simulate high and low speed flight conditions.

As an example of the development work possible with the wind tunnel, the first trials of a model seaplane hull showed that it would offer considerable resistance without contributing any useful lift in the air. Its shape was changed several times and finally a form was evolved that not only had less resistance but that contributed a certain direct lift to help carry its weight while it was in flight. The form that had the least air resistance was also found to be the most efficient when planing on the water in starting a flight and more effective in landing.

Typical Wind Tunnel

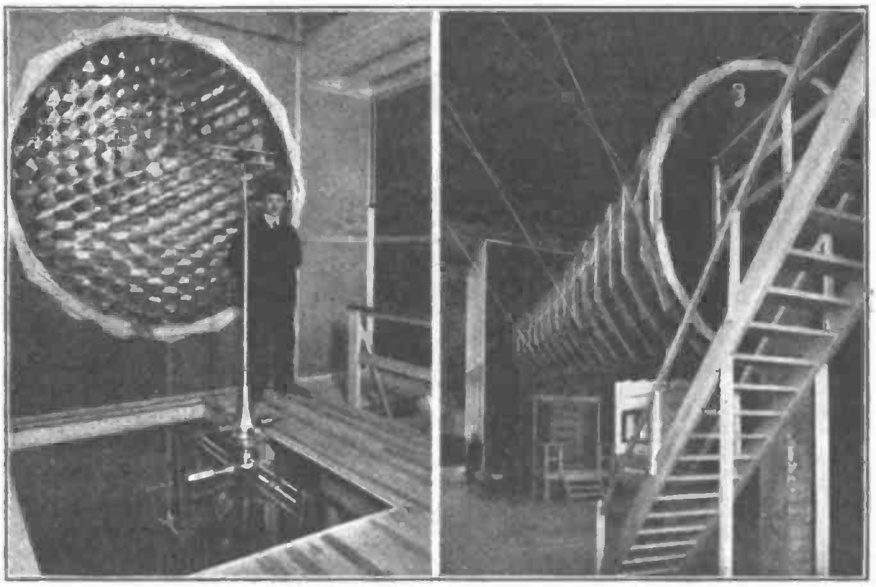
The sectional view of the wind tunnel installed in the laboratory of the Curtiss Engineering Corporation at Garden City, L. I., outlines a typical apparatus of this nature. It consists of three main parts, the central one of two rooms incorporating the two experimental chambers. The model is placed in the upper one through which the air stream passes, the measurements are recorded in the lower one which is below the air current. A large horn-shaped collector is placed at one side, this carrying a cellular or honeycomb partition to straighten out the air stream before it passes around the model. The diffuser is a long discharge conduit extending from the experimental chamber. The air flow is induced by an aerial propeller 12 feet in diameter, driven by a 400 horsepower Curtiss airplane engine. The speed of the air stream may be varied from 50 to over 100 miles per hour. The aerodynamic balance is so sensitive that it will measure forces acting on the model to 1/10,000 part of a pound. The collector and diffuser conduits are built of wood with external framing, the experimental chamber follows the usual light wood building construction. The size of the tunnel can be readily estimated from the illustrations.

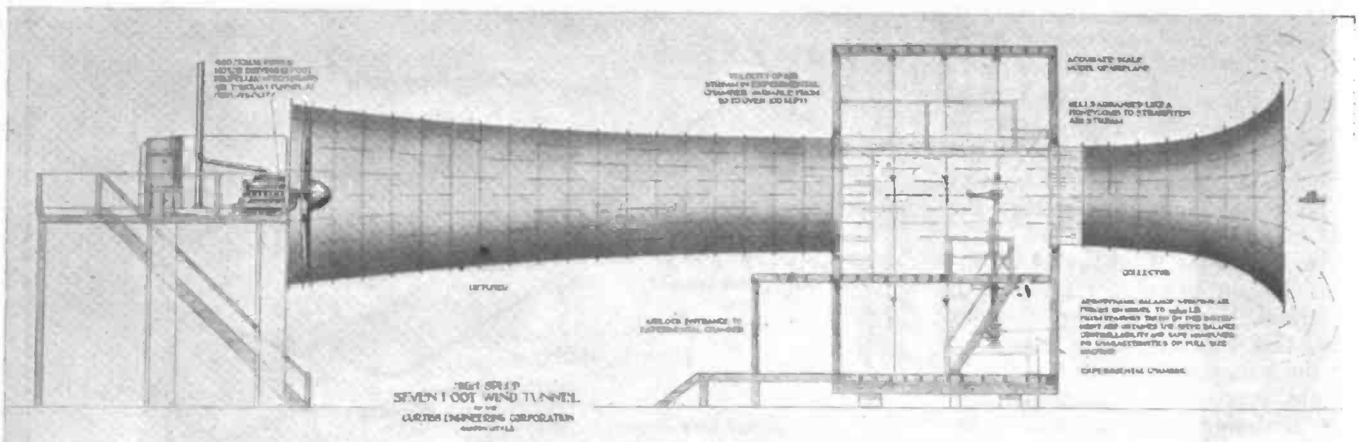
The modern airplane consists of two main assemblies as depicted below and resistance of each must be known in computing characteristics of the design and power needed for flight



Mounting Models for Test

There is no more difficult part of an investigation into the forces acting on a model than the increase of resistance due to the supports. The difficulty depends on the kind of model tested. If the resistance of a sphere, or a square plate in normal presentation, was being investigated, it is unlikely that any appreciable error would be introduced by the assumption that the correction to be applied is a given measurement of the resistance of the supports in the absence of the model. In the measurement of the resistance of a "streamline" body, however, an entirely different state of affairs exists. The resistance of an airship model 6 ft. long and 0.5 ft. in diameter is in some cases only about 1/100th of that of a square plate whose area is equal to that of the maximum cross-section of the airship model. Even though such a model is supported on a spindle about 0.3 in. in diameter, an error amounting in some cases to as much as 20 per cent. of the model resistance would be introduced if this method of measuring spindle resistance were adopted. In the test of some models, several alternative methods of test are available. Thus in experiments with aerofoils the method which is sometimes adopted is to mount the model with its span vertical on a spindle screwed into its end.





The wind tunnel of the Curtiss Engineering Corporation is a good example of this important apparatus for studying aerodynamics in the laboratory. The views at the top show how the model is supported by the weighing mechanism in front of the honeycomb arrangement used to straighten out the air stream. The other view gives a good idea of the size of the discharge opening of the diffuser

Weighing Mechanism

The weighing mechanism is very substantial in construction and on first thought would appear too heavy to permit accurate measurements, but it is extremely sensitive. The balance consists of two main parts, the lower of which carries the weighing arms and moment apparatus, and the upper which projects upward through the floor of the experimental chamber and carries the model under test. The upper part of the balance can be turned upon the lower one, and the model thus rotated through any desired angle about the vertical axis from outside the channel, and without stopping the wind.

The balance is supported on a single point resting in a hollow cone. This cone is rigidly fixed to a heavy casting, which is firmly bolted to a bed and is perfectly free from contact with the channel itself. The support is at the intersection of the center lines of the two weighing arms, which are set along and normal to the wind direction. The balance has three degrees of freedom, and is arranged in such a manner that moments can be measured about the center line of each arm and about the vertical axis of the balance. A jockey weight is provided on each beam for the adjustment, and the weighing arms are accurately counterbalanced to secure maximum sensitiveness of measurements.

The wind tunnel is not only valuable in measuring resistance to flight but it also gives valuable information relative to balance and stability, location and angle of incidence of aerofoils, streamline fuselage forms and effect of controls. Much of the development noted in modern aeronautical engineering can be attributed to wind tunnel experimentation.

By testing models, the great expense entailed in constructing full size machines that might not be successful after completion and the waste of time incidental to this method is eliminated. The expense involved is but a fraction of that called for by the old "rule of thumb" system and lives of valuable test pilots are saved.

A curious application of the Wheatstone bridge to giving the depth of water or fuel in airplane tanks has been proposed. Two wires are inclosed in a tube immersed in the tank. The liquid in the tank has access to one of them only. Each wire is in circuit in its own arm of the bridge. The liquid operates to cool the wire to which it has access, thus keeping down its resistance, and as this cooling action is greater or less as the wire is more or less immersed in the liquid the galvanometer and connections are calibrated to give the depth of fluid in the tank. The higher the level of the liquid the greater will the cooling effect be and lower the resistance.

Mechanical and Optical Pyrometers

By Joseph Stanley

PYROMETERS used for measuring temperatures up to 1,500 deg. F. may be of the expanding element type, the actuating or heat-recording element being a rod of graphite or copper contained in a steel tube. The lower end of this member is securely held while the upper end can move as the rod lengthens out under the influence of the heat. The degree of expansion varies directly as the increase in temperature and the greater the heat the more the rod lengthens out. This movement is transmitted to a pointer by suitable mechanism and the scale calibrated in degrees centigrade or Fahrenheit or both, as desired.

While both the metal case and copper rod expand from the heat, the copper has a much greater co-efficient of expansion than the case so its lengthening will produce a movement of the needle through suitable multiplying gear, as shown in accompanying illustration. Other types depend upon the expansion of mercury, still others on the principle of the Bourdon spring tube used in measuring air, steam and other fluid pressures.

Expanding Rod Type

If one refers to the illustration, Fig. 1, the interior construction of an expanding rod type will be easily understood. The relatively slight movement of the rod will be multiplied by the segment and pinion gearing actuating the pointer shaft. The end of the expanding copper rod is cupped out and a short toggle rod pointed at both ends is used to join the cupped lever on the toothed segment to the rod end. The parts are held in contact by a coil spring so there will be no lost motion and all rod movement, either on expansion or contraction will be transmitted to the segment, from there to the pinion and then to the pointer. The gearing is such that the oscillating motion of the segment imparts almost a complete rotation to the pointer shaft.

The Pyroscope and Its Use

Certain drawbacks had been enough to prevent the optical pyrometer from coming into practical use until the pyroscope was introduced in 1910. This instrument does not employ prisms made of rare and costly minerals, or electric apparatus of great delicacy. A plain oil lamp is used, which gives the desired constancy in a much better way. The optical arrangement shown at Fig. 3 is of admirable simplicity and so designed as to endure rough usage under the conditions which these instruments have to be applied, as in foundries, steel mills, forge shops and heat-treating departments specially in the presence of corrosive atmosphere.

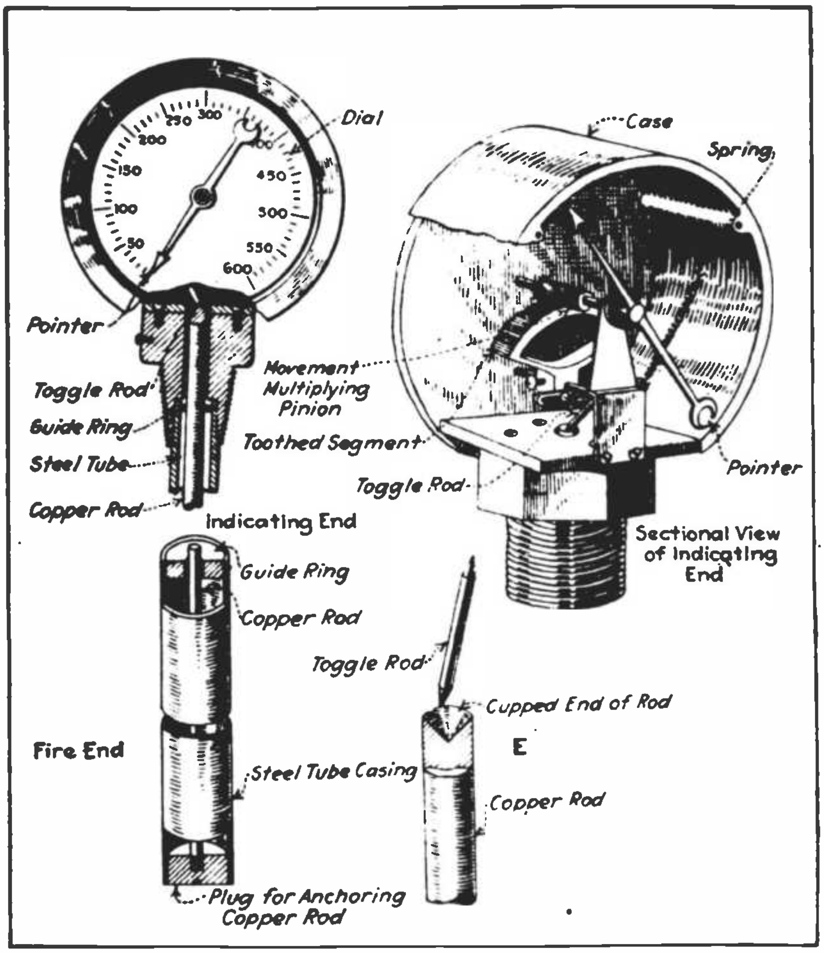


Fig. 1—Diagrams showing details of mechanical pyrometer outlines important parts and their relation to each other

The personal element often thought to be a serious objection in the use of optical pyrometers, is of little or no importance. The principle used is one to compare light intensities. Although in the type A pyroscope the natural heat colors are shown, which is an advantage in general practice, the color is not a factor upon which successful reading depends. A color-blind person, therefore, can read temperatures as well as one having normal eyesight, likewise if a green or blue glass be interposed between the eye, the pyroscope and the heated metal, faithful temperature readings can still be obtained. This is because, as before stated, readings ultimately depend upon comparison of light intensity.

The use of such an instrument is a great advantage and its low price makes it possible for small shops that could not profitably install an electric pyrometer outfit to carry on heat-treatments with much greater accuracy than possible when colors are gauged with the unaided eye. Two scales are provided, one reading from 1,200 deg. F. to 2,100 degrees, the other reading from 2,000 deg. F. to 3,000 degrees.

Optical Pyrometer Easily Read

The method of operation is very simple and easily grasped by the practical mechanic. Ordinary kerosene oil is put in the container of the lamp. Open glass door B, Fig. 2, and light the wick as in any ordinary lamp and adjust flame to normal height (about ¼ inch) by the knob K. Have flame low until wick is warmed up, then set as above. The variations of the flame cannot affect the readings unless entirely too low to cover reflector R or high enough to smoke. The instrument is now ready for work. By looking at the hot metals, etc., through eye-piece C, one will clearly see the object the same as through a telescope.

Focus by turning knurled ring E. Next turn knob F, which works the colored diaphragm and controls the light intensity of the comparison reflector R until practically no difference can be seen between redness of said reflector and the work. You can best tell this by going a shade higher or lower until balanced. Now look at indicator H on graduated drum G and take the temperature reading. If it is desired to set the instrument at a given temperature, figure so that the work can be all heated up to a certain degree, then lock by the set screw M.

The telescope can be used in any desired position on its pivot. All fine lenses are protected by glass shields, which, when broken, can be replaced at trifling cost. To clean the glass facing the lamp, which through carelessness may take on dust or soot, release set screw I, and pull out by drum G, and wipe with a clean rag or chamois skin. Any soot accumulating in chimney can be removed by turning cap J and at the same time pulling up and removing it.

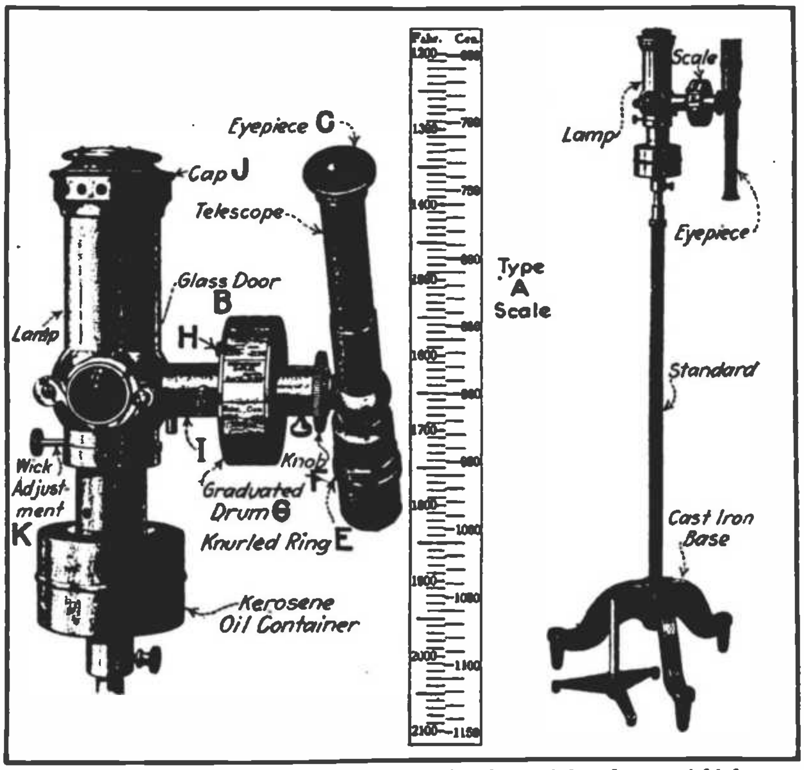


Fig. 2—The Shore pyroscope, an instrument for determining degree of high temperatures by optical means

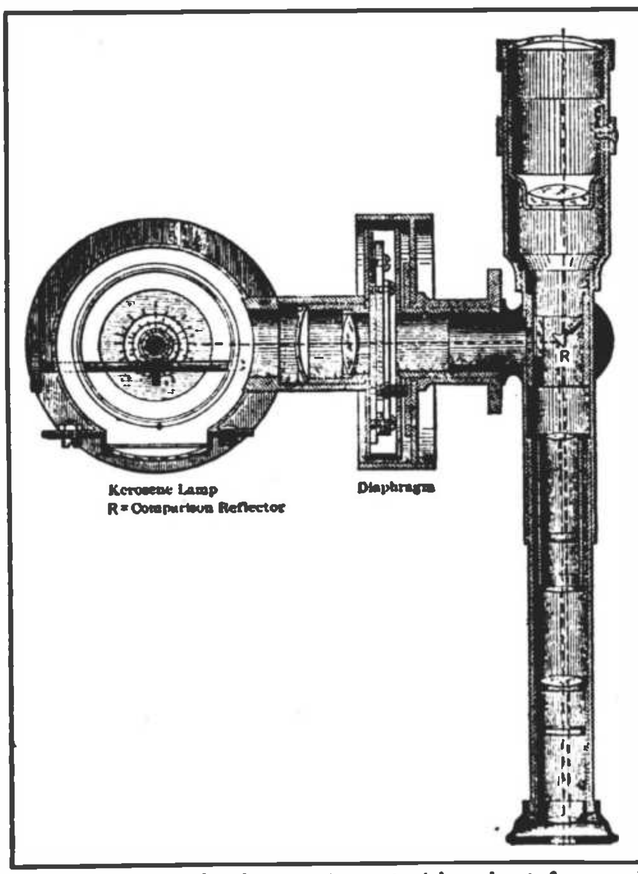


Fig. 3—Diagram showing arrangement of lens, lamp flame and comparison reflector in Shore pyroscope

Locotractors in South Africa

A CONTEMPORARY states that owing to the high cost of operating the usual forms of motor truck in South Africa, a modification of the truck tractor is being used in a way that promises both cheap and efficient transport. Roads are very poor and during the rainy season are often impassable. The light railway is advocated as the solution and suitable motive power is believed to have been definitely discovered in a gasoline locotractor, a special form of machine intended to take the place of the locomotive on pioneer light railways. When the usual railroad system is followed, a ballasted bed and heavy rails are needed to carry a locomotive of usual construction and the railroad cost per mile is very high. The locotraction system uses load-carrying cars running wholly upon rails. The guiding portion of the locotractor also runs on the rails, but the driving wheels, shod with solid rubber tires, run on prepared strips of road metal on each side of the railway track and have greater traction, thus for a given horsepower and weight the hauling power is stated to be four times as great as with ordinary locomotives having driving wheels running on tracks.

High Candlepower Projectors

PREVIOUS attempts to improve the efficiency of projectors have been in the direction of optical effect. A German experimenter has augmented the specific surface luminosity of the searchlight arc-lamp and has been able to attain a searchlight efficiency of five times that formerly obtained with the same current consumption and optical arrangements.

Instead of using the ordinary 38-mm. diameter pure carbons, he employed high-efficiency carbons 16 mm. in diameter. The negative carbon is placed obliquely upward opposite the horizontal positive, which is 11 mm. in diameter. The carbon ends are played upon by a flat spirit flame which cools the incandescent ends of the carbon, as the passage of the current is no longer limited to the ends but reaches the inner parts of the carbons. This causes a considerable increase in the temperature of the carbon crater, and the latter burns very deeply into the thin carbon rod, giving a small, round, and intensely bright crater opening which, when projected, appears as a circular luminous disk and has a much higher specific luminous intensity than the usual large but flat crater in the ordinary type of searchlight.

The energy consumption is much better, as the voltage with a current of 150 amp. is not 60 volts as ordinarily but reaches 75 to 80 volts. The carbons are kept in constant rotation by a small electric motor to ensure even burning. To keep the crater of the positive carbon in the focus of the parabolic mirror the carbon is displaced by an electromagnetic device with the aid of a selenium cell. Experiments show the light intensity of such searchlights to attain 500,000,000 candlepower. The new system makes it possible to construct very compact projectors of high power.

SHEET COPPER was first made in America at Canton, Mass., in 1801, by Colonel Revere. The first founder who worked in brass in America was Joseph Jenks, who made brass and iron at Lynn, Mass., in 1646. In 1653 silver coins were cast in Massachusetts.

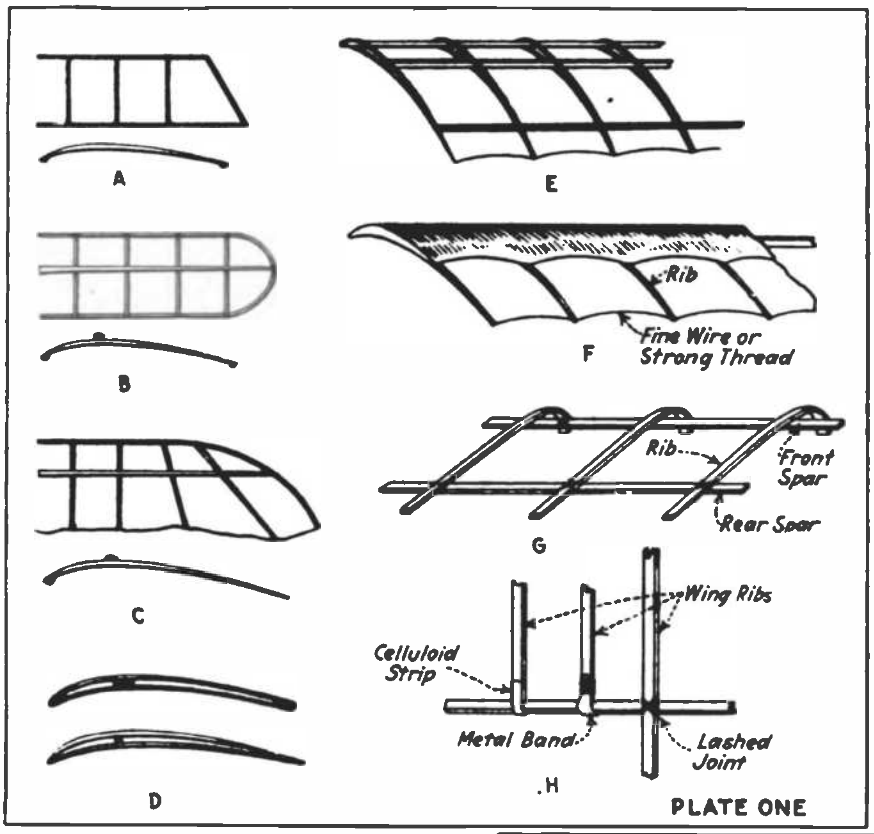


PLATE ONE

Notes on Model Airplane Construction

By H. C. Ellis

THE flying qualities of any model, particularly a racer, depend on the methods and thoroughness in design and construction as well as the workmanship. The model must be able to withstand very hard knocks and yet be light. The only way such a model can be turned out is by a good knowledge of the materials used and how to fasten them strongly together.

All wood must be straight grained and light, the frames, fuselages and spars being of spruce or cypress. All parts possible should be made from split bamboo, which is the best material for ribs, skids, braces, etc. It is easily split with a knife and should always be joined together by binding with strong fine linen thread and covering with glue. Nails should never be used on bamboo. Bending is always accomplished by steaming the material while working it. Reed and rattan are worked the same as bamboo and used for skids, planes, rudders, etc.

All metal parts should be small and light as possible, yet strong. Steel is considered the best and strongest by many for any metal part of a model, but brass and aluminum have their respective uses also. Small flat or round nose pliers are very useful in handling sheet metal and wires. In joining parts of the same material, the metals must be soldered wherever possible. When joined to wood or bamboo, strong thread and glue are the proper materials to use to make a satisfactory joint.

In covering a plane or tail the quickest and best way in my experience is to glue the cloth or bamboo fibre paper to the frame and allow to dry. Then give the covering one or two coats of Aero Varnish or "dope," which strengthens the surface and makes it taut and smooth. The fuselages, elevators, rudders, etc., are covered in the same manner. The dope is easily applied in thin coats with an ordinary brush.

The propellers in all cases must be as near perfect as possible as regards balance, and should turn in their bearings with minimum friction. Bearings must be accurately made, strong and light, also well oiled when model is in use. Wherever possible the propellers are protected by skids, which also enable the model to raise from the ground when wheels are attached.

Various Methods of Wing Construction

Plate One shows construction of bamboo and wood planes, both single

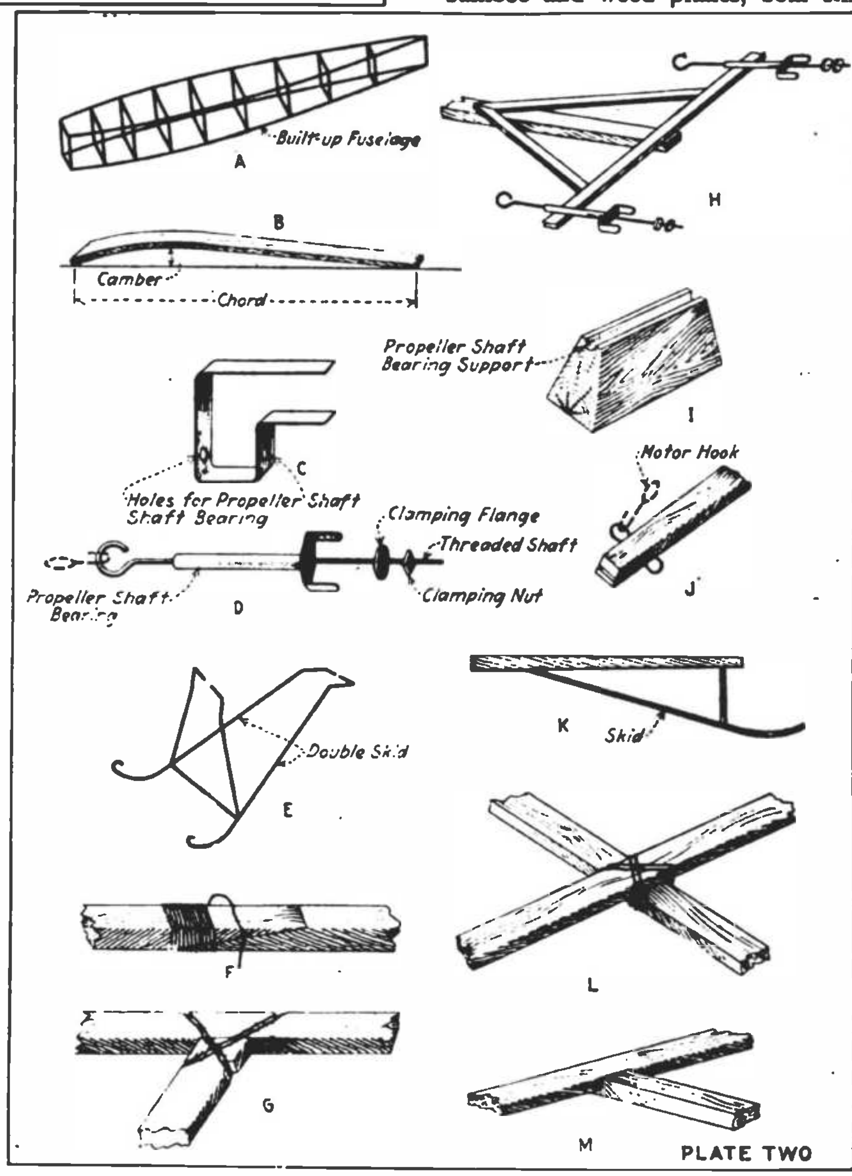


PLATE TWO

and double surfaced, showing methods of joining parts. The single surfaced wings, being lighter and much easier to assemble than other kinds, have found favor almost universally with the aero-

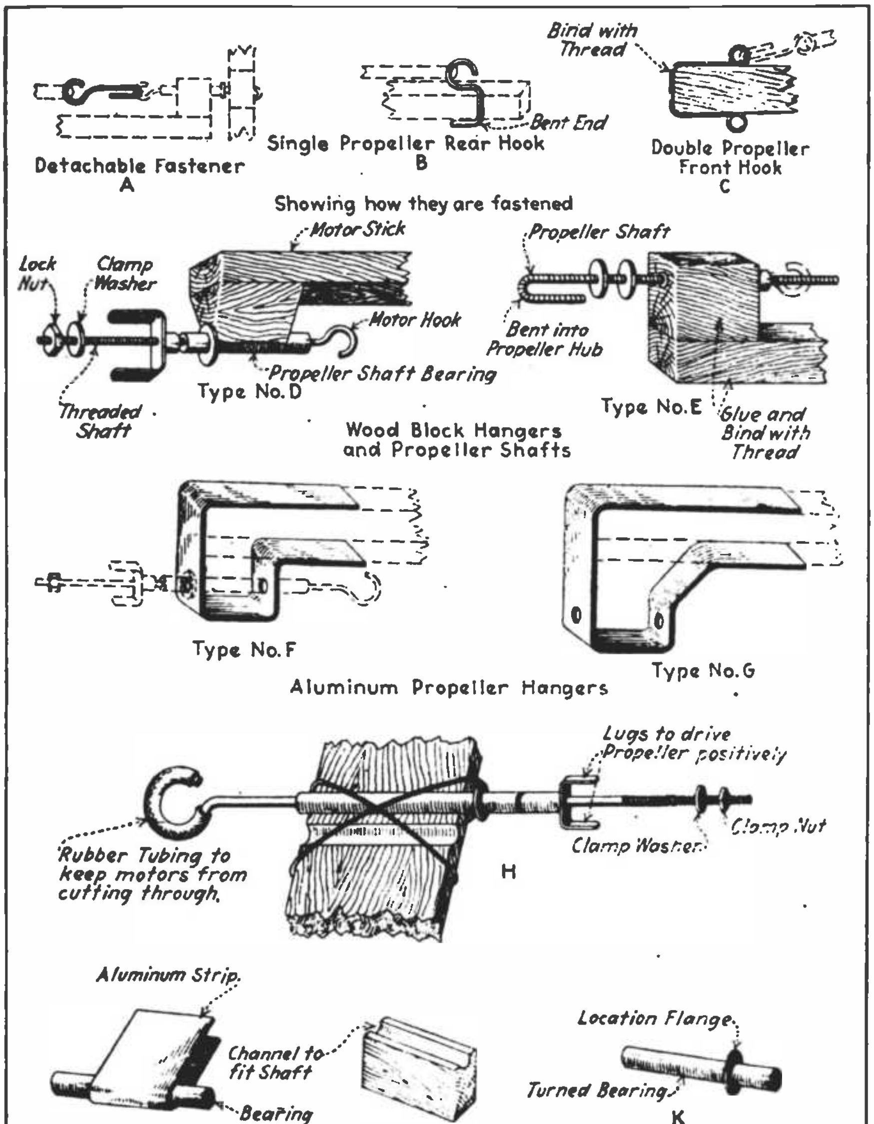


PLATE THREE

plane flyers. The simplest type of plane is shown at A; this consists of two strips of equal size for the edges of the frame, joined by the required number of ribs, usually equal distances apart. B illustrates a single-surfaced plane. The spar, as will be noticed, is placed above the ribs, the entering and trailing edge strips below. C gives a good idea of trailing knife edges which are always more or less flexible.

At D, the correct method of construction to secure light and strong double surface frames is compared with the old, heavy style which, generally speaking, caused that class of supporting surface to be labeled "too weighty." A two spar, double surfaced wing with a trailing knife edge as at E is the most satisfactory wing as regards efficiency. An alternative method of wing building is given at F, which is the semi-double surfaced plane.

The illustration at Fig. G, Plate One, shows method of joining ribs to entering and trailing edge strips, and is self-explanatory. Many different shapes and sizes of fittings, cut from the sheet aluminum or brass are used to a certain extent, being bound to the wood members and then glued as in H.

Plate Two clearly shows a variety of parts, at (A) built-up fuselage for scale model, (B) rib, (C) propeller hanger, (D) shaft and bearing, (E) wire skid for front of machine, (F) splice, (G) butt joint, lashed, (H) bearing spar and bearings attached in place on frame, (I) bearing block, (J) double frame hook, (K) bamboo skid for rear, (L) cross joint, (M) butt joint of frame and propeller spar. All these details can be easily understood by the reader interested in such matters.

Plate Three, Figs. A, B and C, show different types of motor hooks and how they are fastened to the motor stick. Sketches at D and E show types of wood block propeller shaft bearing hangers and propeller shafts. Figs. F and G show two types of aluminum propeller hangers, the forms being simple, light and practical and capable of easy duplication by the model maker. There is perhaps no other part that is so necessary to secure good success with a model as the bearings and shafts. All the strain or pull of the twisted strands of the rubber motor comes directly on the bearings, and they must be made strong and assembled to turn with as little friction as possible. Small ball-bearing shafts have been found of little value for flying models. The best all-round shaft and bearing is shown in Plate Three, Fig. H. The diagram at Fig. I shows bearing used for light racing models. That at Fig. J shows a wooden bearing block as used in the assembly at A. Fig. K shows a solid turned bearing that is used in type E propeller.

Plate Four shows sections that give sizes of wood, bamboo and rattan which have been found most satisfactory in the construction of model aeroplanes.

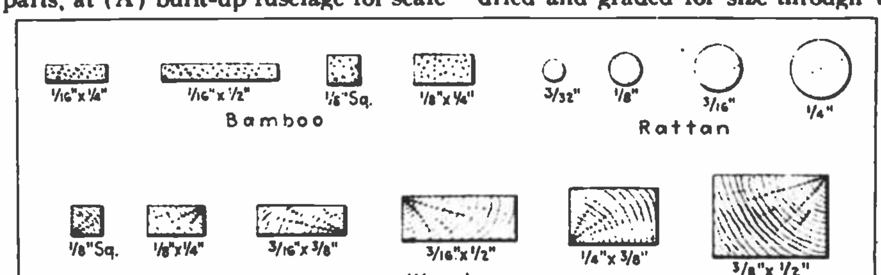


PLATE FOUR

Making Granulated Brazing Spelter

—There are two common methods of preparing brazing "spelter", one by pouring the molten alloy into a tank of water and the other by breaking up heated bars in a mortar. In either case the alloy is carefully made in graphite crucibles, there being no difference in this part of the work, while the dross is very carefully skimmed off the metal surface before pouring. In the "wet" process the molten metal is poured through a sieve of suitable mesh into a tank and when enough has been poured, the water is drained off and the metal dried and graded for size through wire sieves. In the dry process, the metal is formed into bars which are heated to the granulating temperature and then smashed up in an iron mortar with a heavy pestle of the same material, reheating being done as necessary. Grading is the same as in the first process.

A Sawing Attachment for a Bench Lathe

By Joseph Dante, Jr.

Member A. S. E. E.

THERE are many model makers who are making boats, railway cars, wooden models, etc., that have a bench lathe and use it for wood turning also. Herewith is a description of a small scroll saw which is intended for fine wood work and which will make a handy addition to the model engineer's shop. The design is simple and requires but a few patterns. The attachment is run from the spindle of a lathe using a plate to drive the machine, or, if the builder wishes, he can construct a small side bracket and make a pulley for the same. This will make the machine a unit by itself. Note that the assembled drawing has all the parts marked with letters. The same also applies to the details. Following is a description of the parts:

Part A. The base is cast iron. The first operation is to surface the bottom as per drawing. After this is done, drill a 5/8 in. hole, drill set screw hole and tap 3/8 in. A slot is then cut for the clamp bolt.

Parts B and C. The upper and lower brackets are cast iron. These two blocks should be drilled in pairs so as to insure perfect aligning of holes. In part B, drill a hole and tap 1/4 in. The set screw for this hole should have a tit on one end 3/16 in. in diameter so as to fit in the spline in the spindle rod and keep same in position. The set screw should have a very tight fit so that it will not work loose while running.

Part D. The driving block is cast iron. Mill 5/16 in. The slot is 5/16 in. deep. If a milling machine is not at hand, a 5/16 in. hole can be drilled and then broken open on the side. An operation of this kind may be recalled in an article published in this paper on Speedy, Jr. steam engine. Drill a 1/2 in. hole and tap 1/4 in. for set screw.

Part E. This is the driving plate and is cast in iron. A 3/4 in. hole is drilled in the center and at a 3/4 in. radius from the center plate. Another hole is drilled to accommodate a 5/16 in. pin. When the stud is put in place a 1/16 in. hole is drilled through the periphery of the disc through the stud. Into this 1/16 in. hole a pin is placed. The driving plate is 2 in. in diameter as noted on the drawing and it should also be case hardened to prevent wear. In the 3/4 in. center hole a No. 1 Morse taper shank is driven.

Part F. This is the table bracket and it should be cast in iron like the rest of the parts. A 5/8 in. hole is drilled in its center. A 1/4 in. hole is drilled into this and tapped to receive a set screw. Four holes are then drilled as shown at a 13/16 in. radius to receive wood screws. These four holes are countersunk.

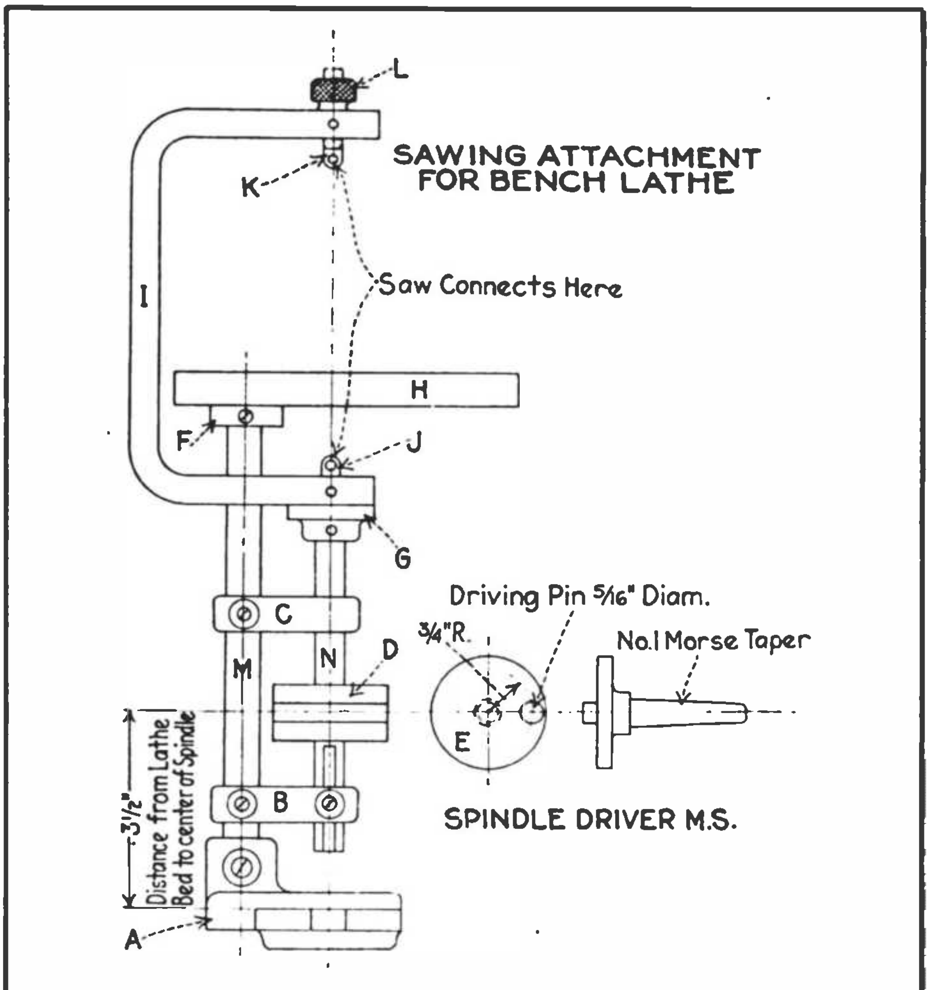
Part G. This is the saw bracket. A 1/2 in. hole is drilled .002 in. oversize so as to have a pressed fit on the end of the spindle. A 1/8 in. pin hole is also drilled in this member. The bracket is not pinned to the spindle until the saw frame is made. The screw holes should be transferred from the saw frame to the bracket. The assembled view shows to which side the saw frame is located.

Part H. The wood table used is 6 ins. in diameter, 5/8 in. thick with a 2 in. recess, 1/8 in. deep, to accommodate the bracket F. Drill a 1/2 in. hole for the saw through the table.

Part I. The saw frame is made of 1/2 in. square cold rolled steel bent as shown in the drawing. The two 1/4 in. holes are for screws and they should be transferred from this to the spindle bracket which has two 1/4 in. tapped holes on a 1/2 in. radius.

Part J. This is the lower saw stud and it should have a pressed fit in the saw frame, a 1/16 in. pin hole being drilled completely through as shown. A 1/8 in. pin is used for holding the saw in place.

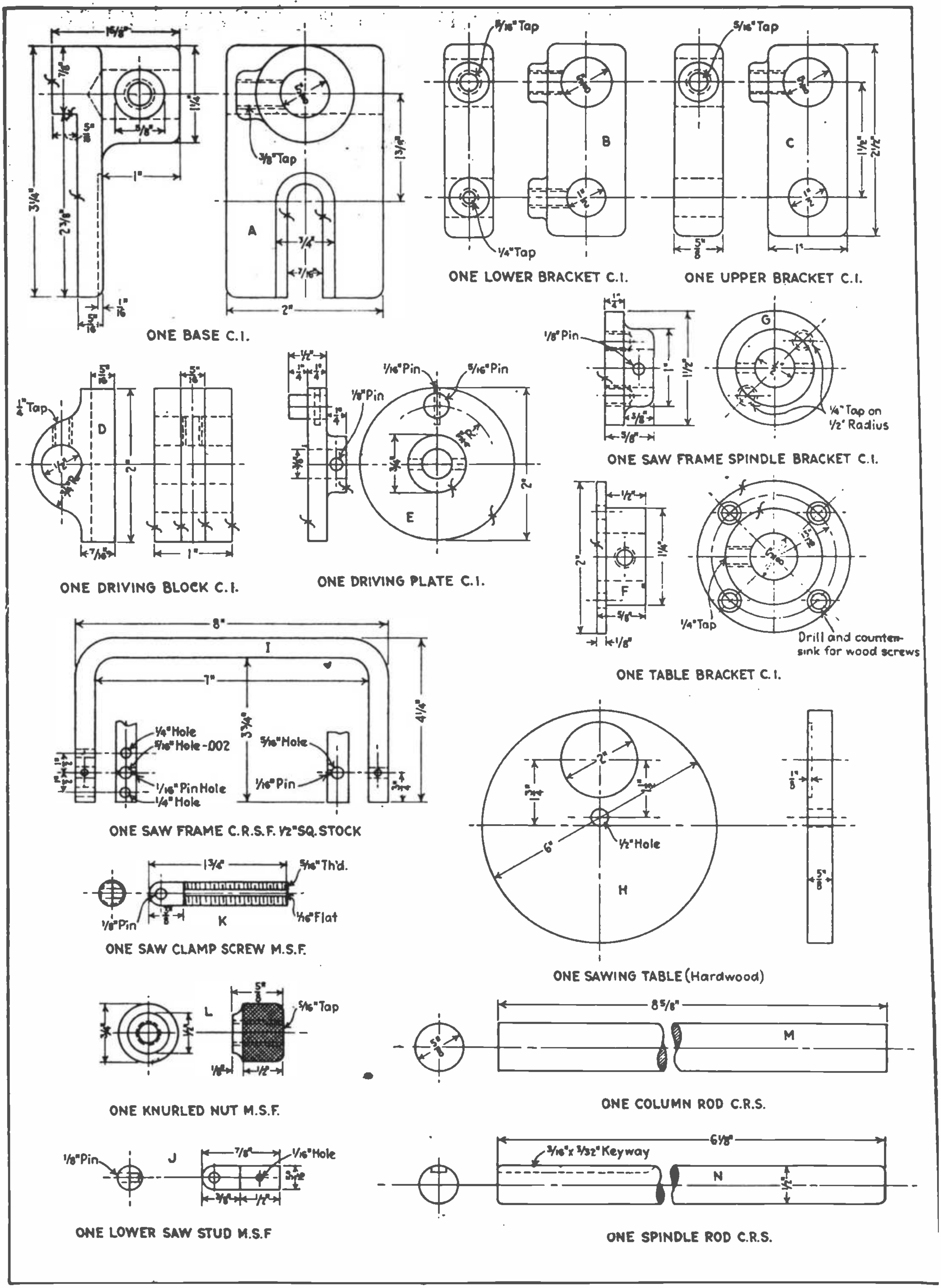
Part K. This is the upper stud and one end is filed half way as shown and a 1/8 in. pin is used for holding the saw. This also applies to Part J.



Parts M and N. M and N are the column and spindle rods and they are made from cold rolled steel stock with a bright finish.

The saws used on the small sawing attachment can be purchased at any hardware store and they are what is known as 6 in. coping saws. The saws have looped ends which are very convenient for holding them to the saw frame. The price for these saws range from 12 cents to 45 cents per dozen.

The capacity of the sawing attachment can be increased by making the Part I (shown in the drawing on this page) larger. Larger saw blades must then be used.


A
3/8" Tap
ONE BASE C.I.
B
5/16" Tap
1/4" Tap
ONE LOWER BRACKET C.I.
C
5/16" Tap
ONE UPPER BRACKET C.I.
G
1/8" Pin
1/4" Tap on 1/2" Radius
ONE SAW FRAME SPINDLE BRACKET C.I.
D
1/4" Tap
ONE DRIVING BLOCK C.I.
E
1/16" Pin
5/16" Pin
1/8" Pin
ONE DRIVING PLATE C.I.
F
1/4" Tap
Drill and countersink for wood screws
ONE TABLE BRACKET C.I.
I
1/4" Hole
5/16" Hole -.002
1/16" Pin Hole
1/4" Hole
5/16" Hole
1/16" Pin
ONE SAW FRAME C.R.S.F. 1/2" SQ. STOCK
H
1/2" Hole
ONE SAWING TABLE (Hardwood)
K
5/16" Th'd.
1/8" Pin
1/16" Flat
ONE SAW CLAMP SCREW M.S.F.
L
5/16" Tap
ONE KNURLED NUT M.S.F.
M
8 5/8"
ONE COLUMN ROD C.R.S.
J
1/8" Pin
1/16" Hole
ONE LOWER SAW STUD M.S.F
N
6 1/8"
3/16" x 3/32" Keyway
ONE SPINDLE ROD C.R.S.

Fitting Gas Engine Piston Rings

By Victor W. Pagé, M. S. A. E.

AS all gas engine pistons must be free to move up and down in the cylinder with minimum friction it is evident that to allow for heating and expansion they must be less in diameter than the bore of the cylinder. The amount of freedom or clearance provided varies with the construction of the engine, but it is usual to provide from .005 to .010 of an inch to compensate for the expansion of the piston, due to heat and also to leave sufficient clearance for the introduction of lubricant between the working surfaces in automobile motors. Obviously, if the piston were not provided with packing rings, this amount of clearance would enable a portion of the gases produced when the charge is exploded to escape by it into the engine crank case.

The packing members or piston rings, as they are called, are split rings of cast iron or steel which are sprung into suitable grooves machined on the exterior of the piston, three or four of these being the usual number supplied if they are the simple form, though three or four light steel rings may be used in each groove if multiple rings are employed. These have sufficient elasticity so that they bear tightly against the cylinder wall and thus make a gas-tight joint. Owing to the limited amount of surface in contact with the cylinder wall, the liberal use of lubricating oil, and the elasticity of the split rings the amount of friction resulting from the contact of properly fitted rings and the cylinder is not of enough moment to cause any damage and the piston is free to slide up and down in the cylinder bore.

These rings are made in two forms as outlined at Fig. 1. The design shown at A is termed a "concentric ring" because the inner circle is concentric with the outer one and the ring is of uniform thickness at all points. The ring shown at B is called an "eccentric ring," and it is thicker at one part than the other. It has theoretical advantages in that it is supposed to make a tighter joint than the other form, as it is claimed its expansion due to heat is more uniform. The piston rings must be split in order that they may be sprung in place in the piston grooves and also that they can expand to conform to the cylinder bore curvature, the types of split joints commonly used, being as outlined at C, D and E, Fig. 1. The butt joint at D is seldom used now.

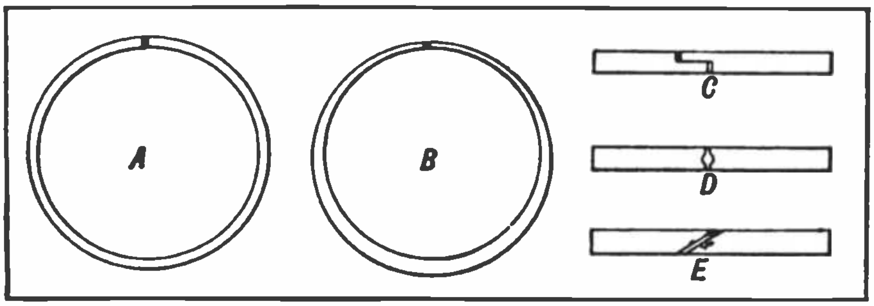


Fig. 1—Concentric ring at A, eccentric ring at B. The lap joint shown at C is widely used as is the diagonal cut at E. The straight butt joint at D should be utilized with pinned rings and is seldom employed at the present time

In order to avoid the leakage that is present with simple rings a number of compound rings of various types have been offered on the open market and some have been adopted by engine builders. Various designs of this nature are shown at Fig. 2. The construction of these rings is clearly shown in the illustrations. The simple ring still remains the most popular among engine builders as it is easiest to fit and is the most enduring.

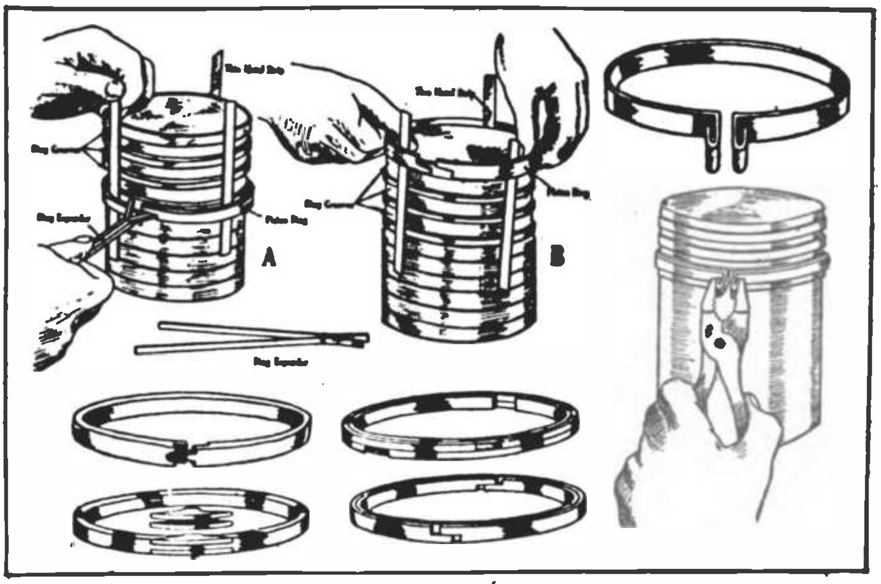


Fig. 2—The use of a ring expander and sheet metal strips to remove and replace rings in the piston grooves is clearly shown at A and B. Various types of compound and leak-proof rings are shown at left. At the right, a simple piston ring clamp to close rings so the cylinder can be slipped over the pistons and its use are outlined

If gas has been blowing by the ring or if these members have not been fitting the cylinder properly the points where the gas has passed will be evidenced by burnt, brown or roughened portions of the polished surface of the piston and rings. The point where this discoloration will be noticed more often is at the thin end of an eccentric ring, the discoloration being present for about ½ inch or ¾ inch each side of the slot. It may be possible that the rings were not true when put in. This made it possible for the gas to leak by in small amounts initially which increased due to continued pressure until quite a large area for gas escape had been created.

Piston Ring Manipulation

Removing piston rings is a difficult operation if the proper means are not taken, but is a comparatively simple one when the trick is known. The tools required are very simple, being three strips of thin steel about ¼ inch wide and 4 or 5 inches long and a pair of spreading tongs made up of ¼ inch diameter key-stock tied in the center with a copper wire to form a hinge. The construction is such that when the hand is closed and the handles brought together the other end of the expander spreads out, an action just opposite to that of the conventional pliers. The method of using the tongs and the metal strips is clearly indicated at Fig. 2.

At A the ring expander is shown spreading the ends of the rings sufficiently to insert the pieces of sheet metal between one of the rings and the piston. Grasp the ring as shown at B, pressing with the thumbs on the top of the piston and the ring will slide off easily, the thin metal strips acting as guide members to prevent the ring from catching in the other piston grooves. Usually no difficulty is experienced in removing the top or bottom rings, as these members may be easily expanded and worked off directly without the use of a metal strip. When removing the intermediate rings, however, the metal strips will be found very useful. These are easily made by grinding the teeth from old hacksaw blades and rounding the edges and corners in order to reduce the liability of cutting the fingers. By the use of the three metal strips a ring is removed without breaking or disturbing it and practically no time is consumed in the operation.

Fitting Rings to Grooves

Before installing new rings they should be carefully fitted to the grooves to which they are applied. The tools required are a large piece of fine emery cloth, a thin, flat file, a small vise with copper or leaden jaw clips, and a smooth hard surface such as that afforded by the top of a surface plate or a well planed piece of hard wood. After making sure that all deposits of burnt oil and carbon have been removed from the piston grooves, new rings are selected, one for each groove. The ring is turned all around its circumference into the groove it is to fit, which can be done without springing it over the piston as the outside edge of the ring may be used to test the width of the groove just as well as the inside edge. The ring should be a fair fit and while free to move circumferentially there should be

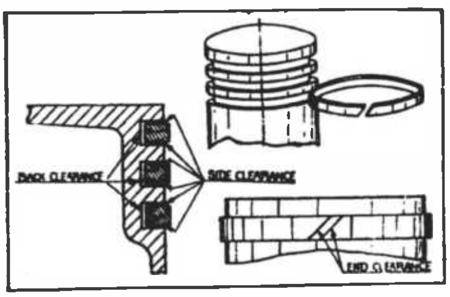


Fig. 4—Diagrams showing the various clearances that must be considered in fitting piston rings

no appreciable up and down motion. If the ring is a tight fit it should be laid edge down upon a piece of emery cloth which is placed on the surface plate and carefully rubbed down until it fits the groove it is to occupy. It is advisable to fit each piston ring individually and to mark them in some way to insure that they will be placed in the groove to which they are fitted. If the grooves in the piston are worn tapering or are much wider at the edge than at the bottom, the piston should be chucked in a lathe and the grooves machined out to uniform width the entire depth.

The Munger tool shown at Fig. 5 makes possible the easy truing of the grooves by hand. The device is wired to the piston and turned around so that the cutter removes the high spots, the depth of cut being easily adjusted by a set screw and the accuracy is insured by the guiding pads on each end of the cast metal yoke.

Fitting Rings to Cylinder

The repairman next turns his attention to fitting the ring in the cylinder itself. The ring should be pushed into the cylinder at least two inches up from the bottom and endeavor should be made to have the lower edge of the ring parallel with the bottom of the cylinder. If the ring is not of correct diameter, but is slightly larger than the cylinder bore, this condition will be evident by the angular slots of the rings being out of line or by difficulty in inserting the ring if it is a lap joint form. If such is the case, the ring is removed from the cylinder and placed in the vise between the soft metal jaw clips. Sufficient metal is removed with a fine file from the edges of the ring at the slot until the edges come into line and a slight space exists between them when the ring is placed into the cylinder. It is important that this space be left between the ends, for if this is not done when the ring becomes heated the expansion of metal may cause the ends to abut and the ring to jam in the cylinder.

Another method of fitting a piston ring is indicated at Fig. 3-B. A plug is made of soft wood, such as yellow pine, that will be an easy fit in the cylinder and one end is turned down enough so that a shoulder will be formed to back the ring. The turned down portion should be a little less than the width of the ring to be tested. The ring is pushed on this turned down end of the wooden plug and held by a small batten secured by a screw in the center. This does not hold the ring tightly enough to keep it from closing up. It is also important to turn the end of the wooden plug small enough so that its diameter will be less than the bore of the ring when that member is tightly closed. The cylinder bore is smeared with a little Prussian blue pigment which is spread evenly over the cylinder wall with a piece of waste and the ring is moved back and forth in the cylinder while it is held square by the shoulder on the plug. The high spots on the

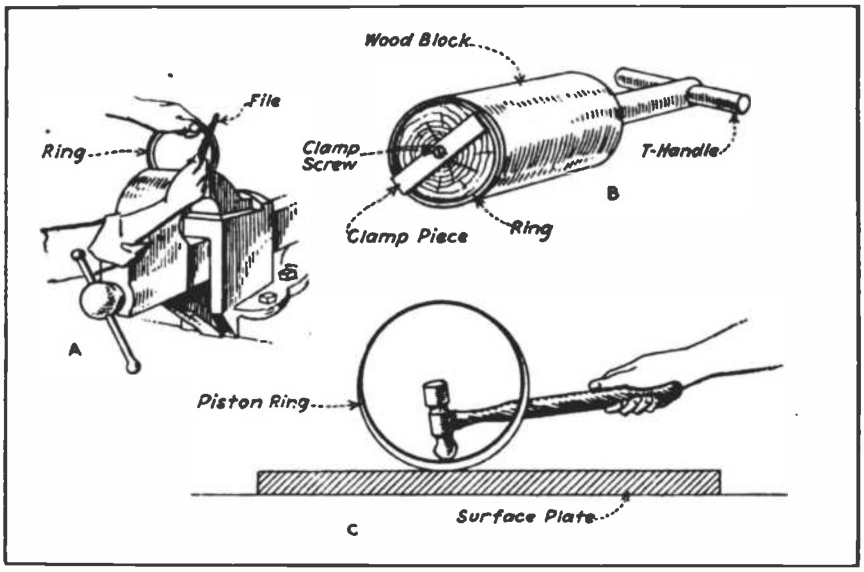


Fig. 3—How the proper clearance between ends of a diagonal cut ring is obtained is shown at A. The fixture at B shows a useful and easily made device for fitting large rings where great accuracy is necessary. Peening a used ring, as at C, sometimes imparts sufficient elasticity so it can be used again

ring will be shown by color. Usually the ring will be found to bear hardest at each side of the slot. These high spots are removed carefully with a very fine mill file or piece of emery cloth and the ring is again inserted in the cylinder bore to find other high spots which are removed in a similar manner. When the rings fit fairly well all around, the entire surface will have a uniform coating of blue. This method of fitting is usually necessary only in the case of large rings.

Peening Ring Sometimes Helps

If the old piston rings are bright all around but appear to have lost their elasticity, a new lease of life may sometimes be given by a process known as "peening," which is shown at Fig. 3-C. The ring is stood on a surface plate and is tapped inside with the peen end of a light hammer, using the harder blows at the thick section and gradually reducing the force of the blow as the slot is approached. If skillfully done a ring may be stretched to some extent and considerable elasticity imparted.

It is necessary to use more than ordinary caution in replacing the rings on the piston because they are usually made of cast iron, a metal that is very fragile and liable to break because of its brittleness. Special care should be taken in replacing new rings as these members are more apt to break than old ones. This is probably accounted for by the heating action on used rings which tends to anneal the metal, removing some of the brittle qualities as well as making it less springy. The bottom ring should be placed in position first, which is easily accomplished by springing the ring open enough to pass on the piston and then sliding it into place in the lower groove which on some types of engines is below the wrist pin, whereas in others all grooves are above that member.

Fig. 5—The Munger tool makes it possible to true out piston ring grooves accurately without special machinery

The other members are put in by a reversal of the process previously outlined for removing them. It is not always necessary to use the guiding strips of metal when replacing rings as it is often possible, by putting the rings on the piston a little askew and manœuvering them to pass the grooves without springing the ring into them. The top ring should be the last one placed in position.

Precautions in Replacing Rings

Before replacing pistons in the cylinder one should make sure that the slots in the piston rings are spaced equidistant on the piston and if pins are used to keep the ring from turning one should be careful to make sure that these pins fit into their holes in the ring and that they are not under the ring at any point. Practically all cylinders are chamfered at the lower end to make insertion of piston rings easier. The operation of putting on a cylinder casting over a piston really requires two pairs of hands, one to manipulate the cylinder and the other person to close the rings as they enter the cylinder. This may be done very easily by a simple clamp member made of sheet brass or iron and used to close the ring as shown in Fig. 2. It is apparent that the clamp must be adjusted to each individual ring and that the split portion of the clamp should coincide with the split portion of the ring.

The cylinder should be well oiled before attempt is made to install the pistons. The engine should be run with more than the ordinary amount of lubricant for several days after new piston rings have been inserted. On first starting the engine one may be disappointed in that the compression is even less than that obtained with the old rings. This condition will soon be remedied as the rings become polished and adapt themselves to the contour of the cylinder. It may take fully 100 miles of road work to bring the rings to a sufficiently good fit so that a marked improvement in the compression will be noticed.

Practice has taught us that the proper or at least a perfectly safe formula for end clearance is to allow .002 inch per inch of cylinder diameter for the average automobile or truck motor. This clearance can be measured by placing the rings in their respective cylinders and measuring the joint gap by a thickness gauge. Suitable allowances should be made for the angle of the cut when angle joints are used. Thus the actual clearance would be 1.41 times the measured space with a 45° cut, and twice the measured space with a 30° cut.

CARE OF CLOTH UPHOLSTERY

DO not use an acid solution in cleaning cloth upholstery. Cloth is not affected by climatic conditions and withstands both heat and cold, and having no oil in its make-up, does not pick up or hold dust readily. To remove ordinary dust, beat cushions and backs lightly with stick or carpet beater, then remove dust with whiskbroom or brush. Grease or oil may be removed by the application of a solution of luke warm water and Ivory soap applied with a woolen cloth. Any of the approved methods for cleaning woolen cloth may be used with success on this upholstery. Gasoline and benzine have a tendency to spread instead of removing the dirt. Their use is not recommended for this reason, although they work no injury to the fabric.

FORD TIMING CORRECTION

IN the drawing of the Ford ignition system, diagram Fig. 5, on page 280 of the August issue, the timer roller should be in the space between segments 2 and 4 and about to contact with the latter, which is the next cylinder to fire. With the roller in position shown the timing would be late.

TESTING STEEL FOR BEST HARDENING TEMPERATURE

A BAR of the steel to be treated is provided with about nine notches running around it, spaced in distances of about ⅝ of an inch. Next, the foremost notched piece is heated in a forge in such a manner that the remaining portion of the bar is heated less by the fire proper than by the transmitted heat. When the foremost piece is heated to burning, i. e., to combustion, and the color of succeeding pieces gradually passes to dark-brownish redness, the whole rod is hardened. A test with the file will now show that the foremost burned piece possessed the greatest hardness, that several softer pieces will follow, and that again a piece ordinarily situated in the second third, whose temperature was the right one for hardening, is almost as hard as the first one. If the different pieces are knocked off, the fracture of the piece hardened at the correct temperature exhibits the finest grain. This will give one a rough-and-ready idea of the temperature to be employed for hardening the steel in question and its behavior in general. Very hard steel will readily crack at the notches in this process.

VARNISH AND PAINT REMOVER

DISSOLVE 20 parts of caustic soda (98 per cent) in 100 parts of water, mix the solution with 20 parts of light mineral oil, and stir in a kettle provided with a mechanical stirrer until the emulsion is complete. Now add, while stirring, 20 parts of sawdust and pass the whole through a paint mill to obtain a uniform intermixture. Apply the paste to the painted surface, allow it to remain in contact for a sufficient time to soften the paint and then rub off. Experimenting will be necessary to determine the length of time the paste should remain in contact with the surface to be cleaned, as this will depend upon the thickness, character and age of the covering.

MELTING SCRAP ALUMINUM

THERE are more ways than one of melting this metal correctly. The oxide is so nearly the same specific gravity as the metal that it does not allow the molten metal to clear itself when in small globules or grains. Because of this, mechanical aid has to be given. In practice, the scrap is heated in the crucible up to the point where it becomes a pasty mass, in which state it is pressed and kneaded for some time, preferably with an oak or other hardwood rod of fair cross-section and then the heat is raised and the molten metal is cleared of the dross and dirt with the same rod.

How to Make Forming Punches

By George F. Kuhne

THE making of forming dies by use of plaster of paris is a very economical as well as very rapid method of producing tools for the forming and bending of irregular shapes.

A little treatment concerning the subject with explanations as to the procedure in making such tool should interest all who may have occasion to do such work. Assuming that the brass shell in Figure 1 is required, let us proceed as follows: Procure two pieces of hard wood or brass of sufficient thickness so that when joined together by glue for wood (solder for brass) it will be more than twice the thickness of the model to be made. See Figure 2.

After this is done, chuck the piece in the lathe and finish as in Figure 1, representing a solid.

The next step is to make a box as shown in Figure 3, the size of which is governed by the dimensions of the product and its thickness.

Now separate the turned model, Figure 4, and mix some plaster of paris by adding some water and place into the box just made. Mix it to a paste, free from all lumpy matter. After the box has been filled, scrape off the top surface and place the one half of model now separated in the mould, as in Figure 5. Press it downward evenly, keeping it in position until the cast has hardened. The pattern should be pressed down a little below the surface, as shown. When the plaster has hardened, the pattern is removed, and the top surface of the mould can be cleaned up and, if desired, the shape as in Figure 6 may be given for clamping.

The mould is now ready for the foundry and a casting is made. There are two methods of obtaining the pattern or model for the punch; one is to pour some hot lead or Babbit metal into the die just made, and the other to use the one half of the turned model. It is now necessary to make the punch holder, Figure 7, which is made of wood, the shank being a separate part from the punch holder proper.

Then take the half model and fasten it to the holder as shown, placing a thin piece of cardboard of a thickness equal to that of the material to be formed under the model. This allows for shrinkage and the pattern for the punch is now complete. The two patterns are now sent to the foundry, and upon their return a little dressing or polishing will be necessary.

Unless a regular blanking die is made for the work, strips as in Figure 8 can be cut and laid in the nest B, as shown in Figure 6. The punch, in striking upon the strip, forms the piece as in Figure 9, and the surplus metal or webb must be trimmed off. This is done by means of a trimming punch and die, Figure 10. The work is laid into the die at C, and the punch D severs the webb from the form and is prevented from becoming attached to the punch D by the action of the pressure pad E.

The product from the die is now finished and if the halves are to be joined, a facing operation on an emery disc is resorted to, in order to remove all sharp edges.

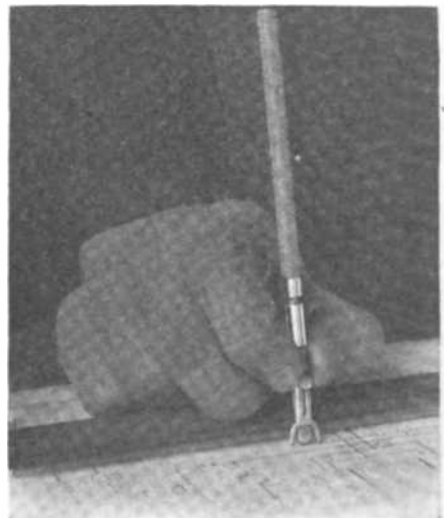
Should a model of the work be at hand, it is not necessary to make the half sections as described. The model can be used to make the impression into the plaster mould, and the pattern for the punch is made by pouring lead into the cast made as stated previously. The use of the box is merely to describe the method, although for numerous dies a standard form can be used.

Tools can be made in this manner for various classes of work. Bending and forming of irregular shapes can be done.

A Ruling Pen Which Makes Dotted Lines

WHILE some of us are thinking about new solutions for big problems, others are looking into ways of simplifying small ones. In the matter of financial success, small devices often bring as much or more profit than large and complicated machines.

The ruling pen illustrated here is an example. Those who have used dotted-line instruments will recognize the great improvements embodied in this device, and those who have not, will readily see the advantages in the use of this pen.



Essentially, it is like the ordinary ruling pen with the addition of a grooved, toothed wheel which extends just below the nibs. When ink is applied in the usual manner, it goes down upon the upper part of the wheel, filling the grooves of the teeth, but not the spaces between the teeth. Then, as the pen is moved over the paper, rotating the wheel, dotted lines are made.

By unscrewing the thumb nut, the nibs are separated and the wheel falls out. Different wheels can be inserted to give different lengths of dots and spaces, or dot and dash lines.

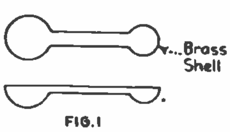


FIG. 1

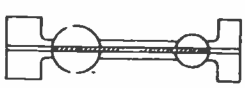


FIG. 4

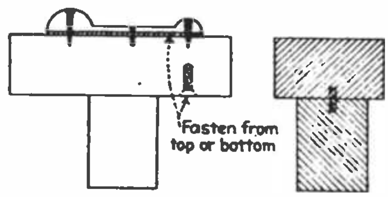
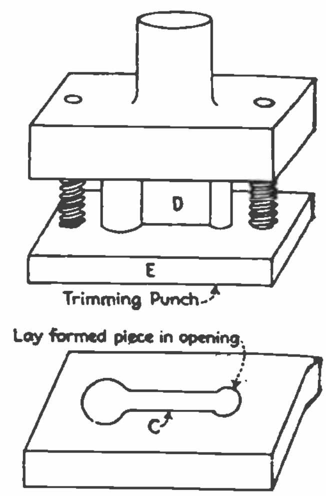


FIG. 7



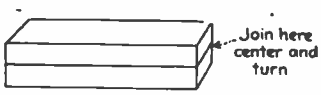


FIG. 2

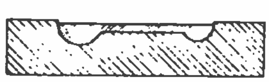


FIG. 5

FIG. 8

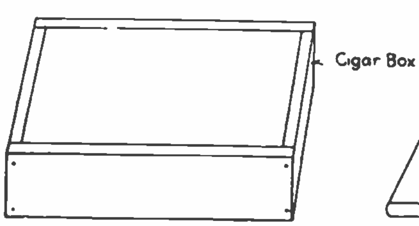


FIG. 3

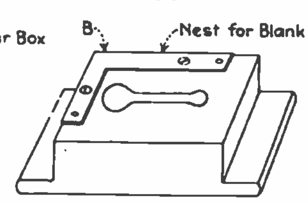


FIG. 6

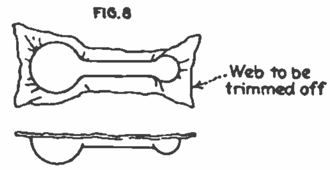


FIG. 9

FIG. 10

AMERICAN SOCIETY OF EXPERIMENTAL ENGINEERS

ACTIVE WINTER PERIOD FOR A. S. E. E.

WITH many new local chapters forming throughout the country and new members joining the Society at the rate of fifty a month, the future of the organization looks very bright. A large number of the members who served in the Army are again joining the ranks of the Society. Before another year passes, the membership of the Society should reach a number of at least two thousand.

Mr. William G. H. Finch, an active Buffalo member, recently visited the Society headquarters at New York and plans were laid for the establishment of an energetic chapter in Buffalo. The experimental engineers of Philadelphia, Boston and Chicago are starting to recognize the great value of the organization and work is being carried on in these various communities to form chapters and laboratories. Mr. Joseph B. Entner, of Boston, has started work on the formation of a chapter in Boston and vicinity. Walter B. Russell, director of the Franklin Union Institute, has pledged his support to the movement and has promised the use of the large lecture hall of the Institute and also the loan of any piece of apparatus in its large laboratories for lecture purposes. Mr. J. A. Wakefield Hastie is in charge of A. S. E. E. activities in Philadelphia, Pa. A preliminary meeting of members in and around Philadelphia was called some time ago and plans were formulated for further work. A very successful chapter has been formed in Mansfield, Ohio, under the direction of W. D. Starrett and Mr. Richard Hautzenroeder. A large room has been rented and enough funds are on hand to meet expenses for some time to come. Although the Mansfield Chapter is not very large, it is extremely active.

Many plans are under consideration to increase the activity of the organization. With the limited source of funds available in the treasury of the organization, it is a very difficult matter to broaden the scope of the Society's work at the present time. With the increasing membership, it will not be long before many new activites will be made possible.

The purpose of the Society is to extend experimental activities, and to promote this aim every effort is being made.

Who's Who in the A. S. E. E.

HAROLD BLAKE ROBERTSON, B.S.

Mr. Harold Blake Robertson, B.S., enjoys an associate membership in the American Society of Experimental Engineers. He started his mechanical training in the De Witt Clinton High School, New York City. While attending this institution he became an active member of the Mechanic's Club. After graduating from the De Witt Clinton High School, Mr. Robertson entered Wesleyan University and graduated

from this place in the year 1914 with the degree of B.S.

For some time Mr. Robertson's attention was engaged in the design and development of a small automobile with extremely advanced design. He is now commodore of the Irvington (N. J.) Model Yacht Club, which organization is now conducting a boat race every Saturday afternoon. Mr. Robertson says that half of the joy of living comes through his work as a model engineer and he believes that of all hobbies, it is the most instructive and interesting. He firmly believes that the public in this country should be educated to look upon model engineering as a science by itself rather than a work of toy construction. He thinks (and rightly so) that the model engineers of this country should win the same consideration and respect from the general public as the model engineers of England.

Mr. Robertson was born in New York in the year of 1891.

What Is the A. S. E. E.?

We receive a multitude of letters asking us what the A. S. E. E. is and what its purpose is.

First and foremost, it is the purpose of the American Society of Experimental Engineers to organize the mechanical, electrical, chemical and radio experimenters of the United States and Canada into a solid body and to gain recognition for these men. When united, the experimental engineers of North America will become a more potent factor than they are at the present time in a disorganized condition. There are many thousand men engaged in experimental engineering throughout the country and it was with the purpose of bringing these men together in a solid body that the A. S. E. E. was formed.

The experimenters of America should be recognized as a serious class of men engaged in an important field of endeavor, whether they work for pleasure or profit.

The second purpose of the American Society of Experimental Engineers is to promote experimental science among its membership in every way possible. This work of promotion will not only be carried on through the publications of the society, but also by the establishment of local experimental laboratories throughout the country in which the members in the various communities and cities will be able to carry on their work. The experiments carried on in the various laboratories of the Society will be described in the Official Bulletin, which is published bi-monthly at the present time and issued to members only.

The possibilities of the Society are practically limitless at the present time, it enjoys the reputation of being a serious scientific body of men organized for mutual help and benefit. Men of every phase of scientific endeavor are eligible for membership.

Increased membership will make it possible not only to help more experimenters, but to give more assistance to each one. Each member should bear in mind that, by securing more members, he helps himself as well as the Society.

THE EVERYDAY MOTORIST

CONSTRUCTION — REPAIRS DRIVING — OPERATION HINTS

Making Gas Engine Packings

By Arthur Alfred Alexander

BEFORE the cylinders are replaced on the engine base, heavy brown paper gaskets should be made to place between the cylinder base flange and top portion of the engine crank case. The best method of making these gaskets is to tamp them out by placing the sheet of brown paper over the mouth of the cylinder and directing a series of light blows with a machinist's ball peen hammer against the sharp edges of the casting. This will cut the paper exactly to the form of the base flange and cylinder bore. The holes in the flange may be indicated in the same manner or may be punched through with a steel drift. The same process may be used in making irregular shape gaskets of other materials such as asbestos or rubber packing.

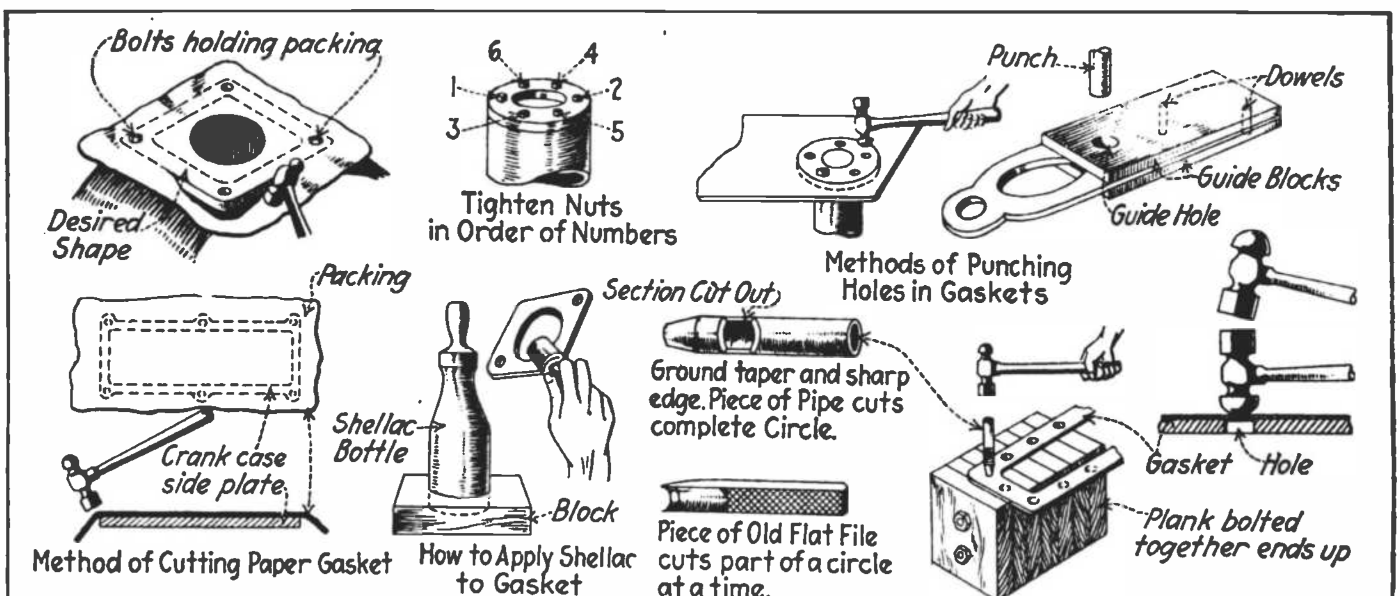
A number of cylinder designs, especially those in which two large or four small cylinders are cast in a block, have a large plate at the side which is used to close the water jacket, this forming a cover for an opening which had been left to facilitate foundry work when the cylinder was cast. This plate is either of sheet brass or aluminum; in some cases it may be an iron casting having a portion of the intake manifold cast with it. Leakage is prevented by a packing interposed between the plate and the cylinder, the plate being firmly secured to the water jacket by a number of closely spaced machine screws. This is a common method of construction and one often finds water leaks about the plate on inspection. The packing used is a rubber and fabric composition of the form known by the trade name "Rainbow" steam packing. This may be easily cut to proper size and holes punched in with a belt punch to allow the screws to pass through. In some instances simply removing the plate and smearing the gasket with shellac or red lead and then replacing the plate, taking care to screw down all the screws tightly, will cure the leak. One advantage of this plate is that it may be easily removed to permit of cleaning out the water jacket thoroughly of any accumulation of rust or sediment which may have become deposited there and which will interfere with proper cooling, this deposit being found in salt-water-engines more than in power plants operated on fresh water.

MOTOR FUEL FROM OIL-SHALE DEPOSITS

AS it is estimated that our present known natural liquid oil supply will be exhausted in about twenty years' time, the possibility of using fuels derived from oil-shale beds is now receiving some attention. These deposits are found in various parts of the country, but the most extensive are located in Utah and Colorado. In a recent article discussing the possibilities of exploiting these deposits and their value as a future source of internal combustion, motor fuels and other valuable by-products, the Engineering and Mining Journal states many interesting facts.

Oil-shale has no oily appearance indicating that it contains that material, but upon being subjected to heat its organic materials are broken up, and, among other things, oil and gas are yielded. The yield varies from 6 to 90 gallons of crude oil per ton of shale. The crude oil distilled may give 7 per cent to 12 per cent gasoline, 28 per cent to 49 per cent kerosene and 39 per cent to 62 per cent residium. Shale analysis indicated ½ per cent to 3 per cent moisture, 20 per cent to 52 per cent volatile matter and 45 per cent to 80 per cent ash. The asphalt varies from ½ per cent to 4 per cent and paraffin from 2 per cent to 9 per cent.

The by-products of shale are ex-



How accurately fitting gaskets and packings for automobile and marine engines may be made with simple tools tremely valuable and include, in addition to oil products, enamels, varnishes, paints, rubber substitutes, manufacturing products for glass, pottery and ornamental tiles, dyestuffs, ammonium sulphate, flotation oils and producer gas. The Colorado shale area covers more than 2,500 square miles and the Utah area over 3,000 square miles. The strata vary from a few inches to 80 feet thick. The yield is from 31½ to 80½ gallons per ton.

In Scotland over 3,000,000 tons of oil-bearing shale are profitably treated annually, but it is only the ammonium sulphate produced as a by-product which makes the business pay. On the other hand, the prospects of the American oil-shale industry should be good, as in Colorado and Utah the shale beds are relatively thick, suitably located at sufficient heights for gravity transportation, and give a yield of 40 to 50 gallons per ton.

Notes on Cleaning Files

FILES which have become clogged with tin or lead are cleansed by dipping for a few seconds into concentrated nitric acid. To remove iron fillings from the spaces between the file teeth, a bath of blue vitriol is employed. After the files have been rinsed in water they are likewise dipped in nitric acid for a few seconds. File-ridges closed up by zinc are cleansed by immersing the files in diluted sulphuric acid. Such as have become filled with copper or brass are also treated with nitric acid, but here the process has to be repeated several times. The files should always be rinsed in water after the treatment, brushed with a stiff brush, and dried in sawdust or by pouring alcohol over them, lighting it and letting it burn off on the file.

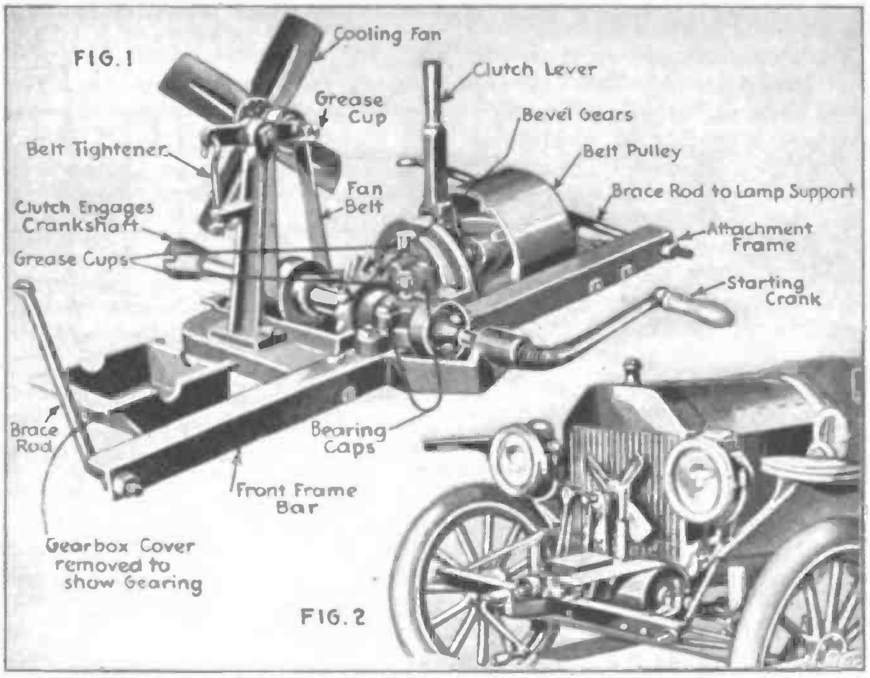
The uneven working of a file is usually due to the fact that filings clog the teeth. To obviate this evil, scratch brush the files before use and then grease them with olive oil. A file prepared in this manner lasts for a longer time, does not become so quickly filled with metal particles and can be conveniently cleaned with an ordinary rough brush when clogged.

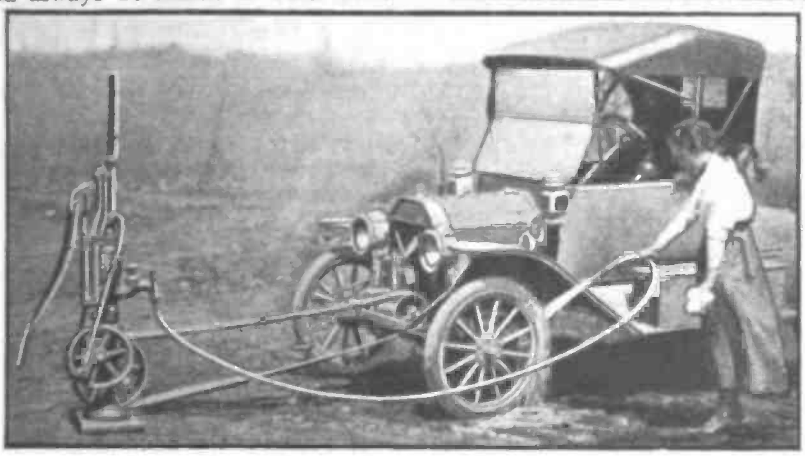
POWER TAKE-OFF FOR LIGHT AUTOMOBILE

By B. P. Fishbourne

VARIOUS attempts have been made to utilize the power from the engine of an automobile for driving different machinery. The simplest apparatus devised for this purpose ordinarily includes a drive pulley having its axis of rotation extending longitudinally of the automobile, the pulley being arranged at the front end of the automobile and connected with the crank shaft. The disadvantage of this arrangement is that the belt which receives the power from the drive pulley extends transversely of the automobile, and hence transmits strains in a direction transversely of the automobile. This action is found to be very detrimental to the automobile, and it is difficult to suitably brace the automobile against vibration and side play on account of the spring suspension.

The apparatus shown in the cuts successfully overcomes all of these objections, and may be easily attached to a Ford automobile to utilize the power due to the rotation of the crank shaft to the machinery to be driven. The apparatus in the cut (Figure 1) comprises a transverse frame to the ends of which are secured diagonal braces, apertured to receive the bolts which carry the lamp forks. The frame is also provided with apertured straps receiving the bolts which bind the front spring to the chassis. A shaft is arranged transversely of the frame and is journaled through bearings carried thereby. This shaft extends longitudinally of the automobile and its rear end is provided with a clutch element to engage with the transverse pin on the forward end of the crank shaft of the Ford automobile.





A power take-off for light automobiles is shown in detail at Fig. 1 and its attachment to the front end of a car at Fig. 2. The application to one of many possible tasks is shown at Fig. 3, where the car engine is pumping water

The opposite end of this shaft has a transverse pin to be engaged by the clutch element carried by the crank arranged forwardly thereof. This is the usual crank employed to start the engine. A second shaft is arranged at a right angle to the first shaft and is connected therewith by a pair of bevel gears. This second shaft carries the drive pulley which has its axis of rotation arranged transversely of the automobile.

An expansible clutch is arranged within the pulley and is operated by a lever, so that the pulley may be locked and unlocked from the transverse shaft. As the automobile is stationary, air is forced through the radiator by a fan arranged in front of the radiator and driven by the longitudinal shaft. Figure 2 shows the apparatus installed upon a Ford automobile, and Figure 3 shows the same operating a pump, suggesting one of the various uses to which the device may be applied.

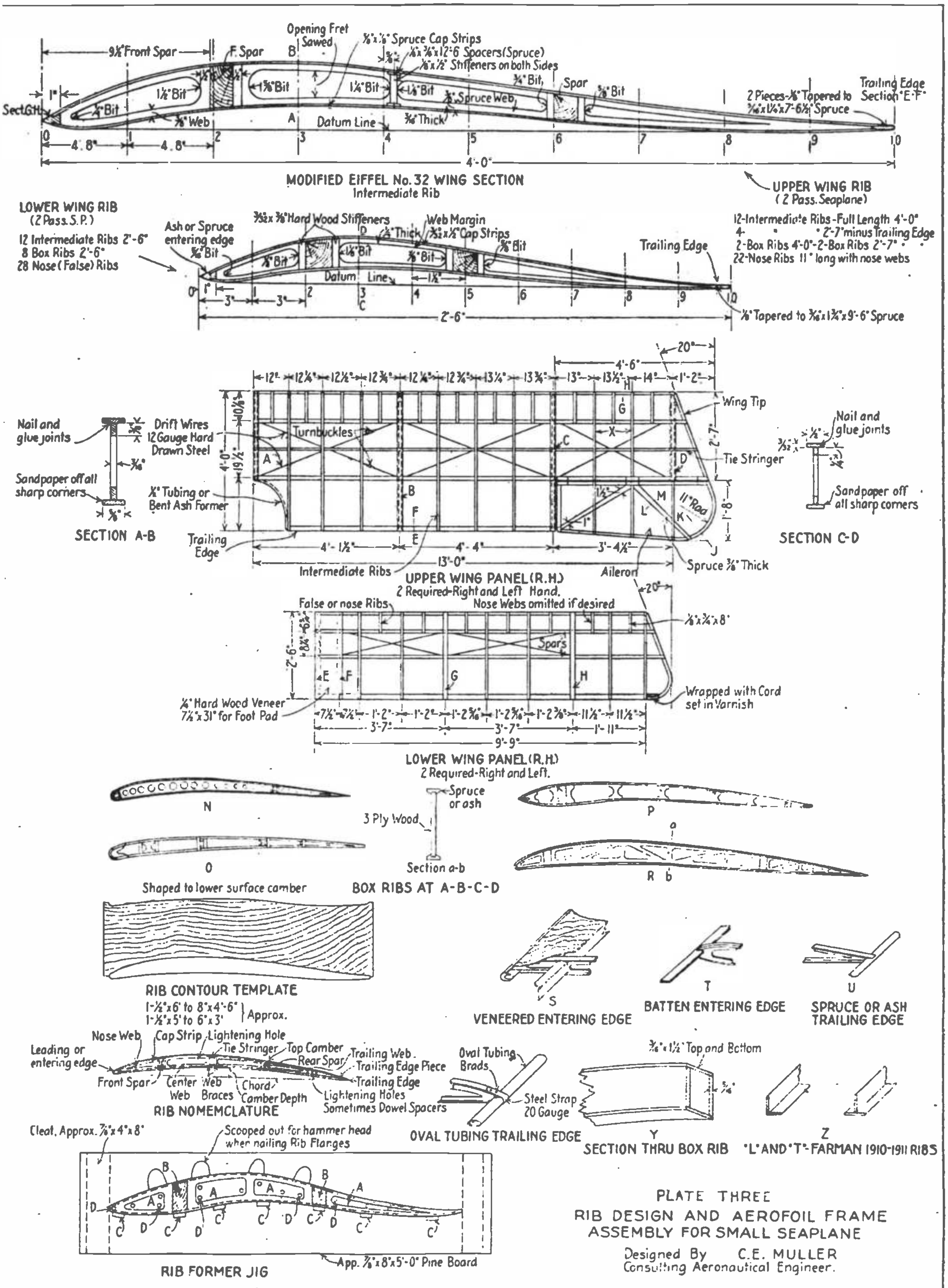


PLATE THREE
RIB DESIGN AND AEROFOIL FRAME ASSEMBLY FOR SMALL SEAPLANE
Designed By C.E. MULLER
Consulting Aeronautical Engineer.

Building A Two-Passenger Seaplane

By Charles E. Muller

Consulting Aeronautical Engineer

PART THREE

WING CONSTRUCTION

THE design and construction of the wings, aerofoils, planes or panels, as these components are variously named, unquestionably contribute the ultimate success or failure of the complete airplane. Due to considerable wind tunnel research by M. Eiffel at Paris, N. P. L. in England, and the Washington, D. C., laboratories, great progress has been made in plotting the aerodynamical characteristics of aerofoils. Up to and including 1911 Curtiss aerofoils were single surfaced, *i. e.*, the fabric only covering the top, the ribs and spars were exposed to view, The Farman, Graham-White and similar machines of that period had pockets for each rib and spar, but were single surfaced between ribs.

Designers no longer grope for aerofoil performances, but either select some tested wing section or submit a model for a test. There is no one best aerofoil curve. The selection of any particular wing curve depends on the performance desired. Speed and weight carrying have been the two greatest considerations. The future demand will be for a general all round machine with a very slow landing speed, as landing is, in the writer's opinion, the only real danger in flying. It is believed that any normal man or woman can fly an airplane after acquiring the manipulation of the controls, as the stability of the machine, if properly designed, is inherent. The writer's personal experience is that the lateral (sidewise balance) and longitudinal (fore and aft) stability control is perfectly natural in motion.

Many books have been and will be written on aerodynamics, and as the scope of this series of articles will not permit of this colossal mass of detail, it may be pertinent to recommend a most worthy book for reference. The A, B, C of Aviation by Pagé is an exceptionally fine treatise on the basic principles of airplane flight and aerofoil design and is recommended for the student either for home study or classroom instruction. Chapter IV very ably describes the aero-dynamics of aerofoils and design of these components in simple language that can readily be understood by the amateur builder of aircraft.

The upper intermediate wing rib illustrated by the accompanying cut in Plate 3 is practically the standard type of construction. It has been slightly modified from the Eiffel No. 32 wing section. The appended table gives its lift and drag co-efficients, lift-drag ratios, and the location of the centers of pressure at various angles of incidence.

AEROFOIL CHARACTERISTICS FOR A STAGGERED BIPLANE

Angle of incidence.	Drag.	Lift.	L/D Ratio.	Center of Pressure. Distance from leading edge. Ratio to chord.
0	.0000243	.00033	13.5	.220
3	.0000510	.000985	18.2	.235
6	.000127	.00161	12.6	.242
9	.000190	.00199	10.5	.269
12	.000273	.002175	9.5	.300
15	.000508	.002328	4.6	.319

The lower wing section is increased in depth because of structural necessity. This will increase the lift at low angles of incidence and slightly increase the drag at large angles of incidence. If a larger carrying capacity is desired the lower plane may be increased to 4'-0 chord, increasing the lift of the machine 20%, the center of pressure remaining as designed. This will not affect either the static or the dynamic balance of the airplane. The following table is given to show the extent of the modifications of the wing cambers:

COMPARATIVE CURVILINEAR ORDINATES

Eiffel No. 32 Aerofoil section 4'–0 chord in decimal fractions of an inch above datum line.

(See Plate 3.)

Station.	Bottom Camber. Eiffel.	Bottom Camber. Modified.	Top Camber. Eiffel.	Top Camber. Modified.
0	.48	.48	.48	.48
1	.336	.32	2.544	2.65
2	1.104	1.09	3.70	3.80
3	1.44	1.40	3.892	3.93
4	2.296	1.30	3.504	3.55
5	.96	.96	2.884	2.92
6	.576	.55	2.302	2.34
7	.240	.22	1.62	1.65
8	.096	.10	1.104	1.12
9	.00	.00	.76	.76
10	.144	.15	.406	.42

2'–6" CHORD LOWER WING

Station.	Bottom Camber. Eiffel.	Bottom Camber. Modified.	Top Camber. Eiffel.	Top Camber. Modified.
0	.30	.30	.30	.30
1	.210	.20	1.59	1.60
2	.69	.655	2.33	2.51
3	.90	.89	2.43	2.71
4	.81	.81	2.19	2.48
5	.60	.60	1.80	2.10
6	.360	.34	1.38	1.65
7	.150	.125	.99	1.20
8	.060	.07	.69	.73
9	.00	.00	.48	.465
10	.09	.095	.21	.25

The Eiffel No. 32 section was chosen as an excellent all around wing curve. Its maximum L/D corrected for scale is 18.2 at 3° incidence. It has reasonably fair values of L/D for high lift co-efficients. A most valuable consideration for the amateur flyer is the fact that its center of pressure movement is practically nil. The central parts or webs of the ribs are usually made of silver spruce, but may be made of whitewood, cotton wood, or white pine. Three-ply mahogany or birch are being used in increasing quantities, but are not recommended for seaplanes.

The lightening of the webs may be readily done by tacking a number together and fret or gig sawing to the holes bored to the sizes of the wood bits given in sketch to form the corners. Tightly clamp the webs together and bore until the spur of the bit protrudes through the last piece, then reverse the boring, thus obviating the splitting or slivering of the wood.

The nose webs, the center webs and the trailing webs are separate pieces until fastened together by the cap strips and should be held in a "former gig" when assembling these pieces as a rib unit. The cap strips are sawed with a fine tooth saw, from a five-eighth board of spruce or ash, but the same woods mentioned for webs may be used, but are to be avoided if possible. Elm is a good substitute if dry and straight grained. It is not generally used because of its tendency to warp and go out of shape. The writer used a considerable quantity of elm for ribs, as shown at Z, which proved fairly satisfactory, as early as the spring of 1911, at Waltham, Mass.

The cap strips will bend to shape, except possibly the lower nose camber. If any difficulty is found, this part may be soaked in hot water for a few minutes, then glued and nailed to the nose web with three-quarter inch No. 18 or 20 flat head wire brads which should be used to supplement hot glue. Great care should be used when nailing into the ribs to avoid splitting or running the brad out one side or the other.

As it is essential to have all ribs uniform, a jig similar to the sketch shown at AA may be made. In lieu of a trued up table or bench top a cleated board may be used to glue and nail on pieces A 7/32 inches thick, the identical shape and size of the webs, also blocks B the same size and shape as the wing spars. This will suffice if the lower cap strip be nailed on first. Of course, the ends where the trailing and entering edge pieces are fastened are left sufficiently open to permit these members sliding through when assembling the wing structures. Blocks C may be fastened on permanently. Loose dowels may be inserted in holes at D to clamp rib against blocks C. If the cleats are screwed on, they may be reversed to other side, permitting the use of the other side for small rib jig.

The short ribs marked X are exactly the same as the other intermediate ribs minus the trailing web section. The nose ribs of the large wing are identical with that much of the intermediate ribs of the small plane or they may be steamed to shape and fastened on minus the nose web.

The box ribs indicated at A, B, C, D, E, F, G and H are doubly webbed, as shown at Y; the webs are sawed from 5/16" spruce, or may be made of a 1¼-inch thick solid sawed out section spindled or scooped out between spars to an I beam section. These are necessary to take the compressional stresses due to the drift wires in the wing and the cross bracing of the interplane flying and landing wires which will be described in the next issue.

In same cases the ribs are all like the intermediate members, a strut of either steel tubing or wood is installed to take care of the compression, but as it necessitates an addition to the interplane strut fitting or a separate fitting, it is advisable for the amateur to accept the first method and use box ribs. The rib contour templates are necessary to check up the ribs as they are assembled in the panel and may be easily made as shown in the sketch.

The wing tips are made stiff to resist the tension of the fabric when shrinking. The shape is largely a matter of taste and forms one of the distinctive features of the complete machine. It may be made of a piece of ash bent to the desired shape or sawed out of a spruce board joined together with long splices, or an oval tubing may be heated and bent to shape with the major axis horizontal. This is preferable for a seaplane. Also a laminated section may be used, using a number of ash or spruce strips ¼ x 1", with the joints vertically disposed in the machine. It is bent and glued over a form, then dressed to suit conditions.

Trailing edges and entering edges are made in a number of ways, as the sketches graphically indicate. Figures N, O, R, S represent the spindled out entering edge for blunt nosed sections such as the Eiffel 13 bis, 33; U. S. A. sections 1, 2, 3, 4 and 5, R. A. F. 4; sharp nosed sections as the Eiffel 32, 36, 37, R. A. F. 3, 5, 6 and U. S. A. 6 require the methods shown at figures T and section G. H.

Figures U and V indicate the general forms of trailing edges now in use. The wire trailing edge is still used, giving a scalloped appearance like the French Spad and the German Taube.

When assembling wing panels 2-30" high wood horses will be found convenient. Caution is required for spacing and preventing any distortion, due to shrinkage or swelling of components. Hot glue and brad all wood joints. Use 20 gauge sheet steel bands if steel tubing is used for trailing edges, and wing tips.

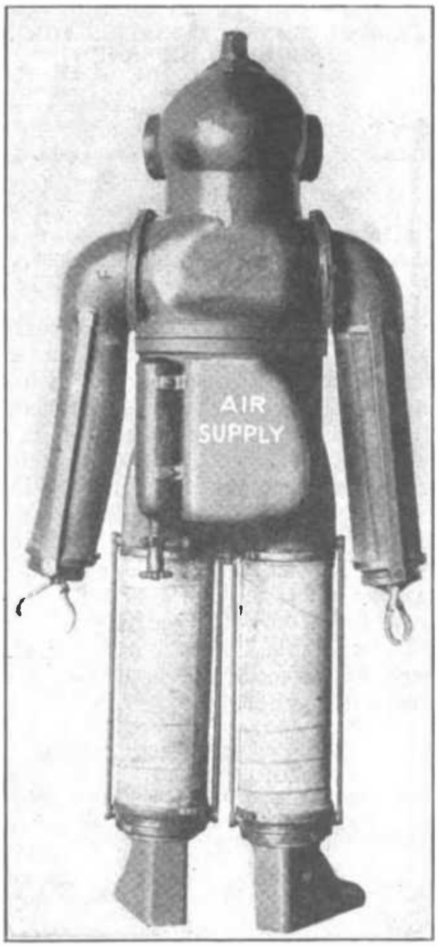
The top camber from the entering edge to front wing bar and sometimes to the stringer is covered with veneer as at figure S or covered with single ply or aluminum sheet, but may be omitted. The loss in efficiency is not great enough to compel this additional expense and the extra thickness of section will practically compensate for this deficiency. In high speed, high powered machines this part veneer, part cloth wing covering is desirable.

When assembled the steel tubing should be wrapped with tape; then the whole mass should be given a coat of orange shellac, followed by a coat of Valspar varnish. As these coats of varnish are to protect the material from the weather (dampness, etc.), and not for appearance, fairly thick coats are applied. Carefully hang up the wing frames by the use of slings suspended from the ceiling to prevent warping out of shape while waiting for the covering.

(Ed. Note.—Fabric and dope work will be described in Part 5.)

New Deep-Sea Diving Armor

THE opportunities for deep sea salvage were never so great at any time in history as at the present. One of the biggest problems receiving attention from the Nations of the World is the recovery of ships and cargoes sunk during the war, whose total value is counted at billions of dollars. In all operations under the water, whether recovering cargoes only or raising ships, it is essential that divers must be on the job. Mechanical means alone are inadequate, they must be supervised and aided by men who can work and see.



The improved Leavitt armor for deep-sea diving

The improved Leavitt diving armor shown herewith enables the diver to work in from one hundred to five hundred feet of water and allows all necessary movements, with no danger or inconvenience to the diver. He is encased in an all-metal suit that relieves him of all pressure, allows free movements of hands and arms, makes his air for breathing (sufficient for four hours' work at one time); has telephone connection with the ship above. He is unimpeded by air lines, signal cords and other objectionable features of the usual rubber diving suit.

The construction of the new Leavitt armor is different from any diving apparatus previously invented. The metal is manganese bronze, an alloy which will not rust, but which has the tensile strength of steel. Most joints would leak under water if made loose enough to allow motion, and if made tight enough to prevent leakage they would jam under the pressure. Mr. Leavitt therefore used ball-bearing joints at the shoulders, wrists and ankles, flexible hard-rolled interlocked copper tubing, wrapped with pure rubber, is used for arms and legs. The helmet has four windows of half-inch Triplex Safety Glass and a telephone with communicating wire built into the raising cable.

In addition to the diving armor Mr. Leavitt has perfected a system of electric lighting that will stand the pressure and illuminate a radius of twenty feet at depths to five hundred feet. By means of these inventions salvage work hitherto impossible is rendered comparatively easy.

The diving armor and lights have been thoroughly tested to a pressure of two hundred and twenty pounds per sq. in. equal to a depth of five hundred feet. Mr. Leavitt holds the world's record for depth of diving having walked on the bottom of Grand Traverse Bay for forty-five minutes at a depth of 376 ft. Also the armor has been successfully used in salvage operations, notably the recovery of the cargo of copper and valuables from the Steamer *Pewabic* sunk over fifty years in Thunder Bay in 176 feet of water.

THE JUNIOR EXPERIMENTER

How to Make a Simple Steam Turbine

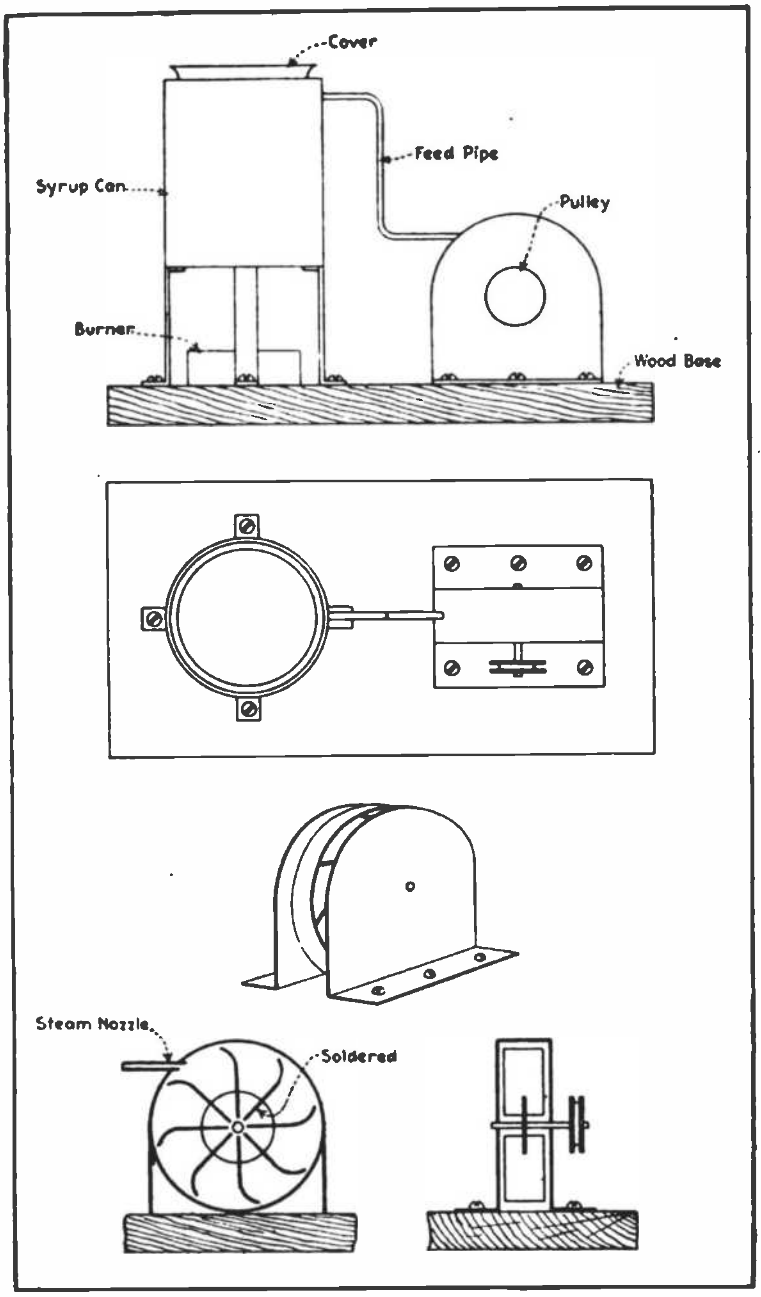
By George F. Carter

THE little steam turbine illustrated in the drawing is one with which a good many interesting hours can be passed, both in the construction of the device and in its operation. There is absolutely no danger of explosion with it and it possesses the advantage of easy construction with few tools.

The boiler will be considered first. A clean syrup can may be used for this. The paper covering, of course, should be removed and the can carefully examined for defects. Four strips of heavy gauge brass are bent as illustrated and soldered to the bottom of the boiler. These act as feet. They are drilled at one end so that small wood screws can be used in holding the boiler to the base board. Soft solder can be used to fasten the feet to the boiler, owing to the fact that the water in the boiler will prevent the solder from reaching the melting point. The top of the tin can is used both to fill the boiler and as a safety valve. If the supply pipe should become plugged, the steam pressure would blow the lid of the can off, thereby relieving the pressure immediately.

The burner is a small cover from a tin can filled with asbestos and covered with a small piece of copper or brass gauze. The alcohol which is used as the fuel is poured into the cover and it will burn for approximately fifteen minutes. It is advisable to make two of these burners, so that the turbine can be run continuously.

The turbine is very simple. A circular piece of sheet brass is cut out and eight slots are cut in it to accommodate the blades. The blades are also cut from sheet brass and their ends bent as shown. They are soldered into the slots of the circular piece. A small brass rod is placed in the center of the rotor for the shaft and this is also held with a drop of solder on each side. The sides of the turbine are cut and bent as illustrated. The circular covering between the sides of the turbine is formed by a strip of sheet brass with the ends soldered together. The sides are then soldered to this piece. The turbine is held to the base by means of six small wood screws, as shown. A small wooden pulley is placed on the protruding end of the rotor shaft. The steam feed pipe which connects the boiler to the rotor is copper or brass and it should be thoroughly heated before it is bent to the shape shown. This is to prevent it from kinking. In bending this pipe it is well to cut a little wooden form of the proper radius so that it can be bent around it. If the pipe is bent too sharply it will kink. A drop of solder on the point where the pipe enters the boiler and the steam turbine will render it steam tight. The position of the nozzle is shown in the cross section of the turbine.



With a very low pressure, this little turbine will develop considerable speed, but it delivers very little power.

In operating the little power plant, the boiler should never be permitted to become dry as this will melt the solder and probably cause leaks by undue expansion of the seams in the can. The water should not be permitted to stand in the boiler as it will cause rust. A little lubricating oil placed in the boiler will help to protect it from rust.

Those who wish to elaborate on this design can add more blades, or increase boiler capacity.

A Talk With Radio Beginners

The Boy Students or the Older Men Who Would Like to Work With Wireless Are Often Confronted With the Problems Which are Cleared Up in This Article

ALL kinds of interests are represented by the men who call at the offices of EVERYDAY ENGINEERING. Every one has, or is interested in, some particular hobby. Whatever the hobby, they are nearly all familiar to some extent with radio work, but, when the subject is brought up, so many say, "I'd like to have a wireless set, yet there are so many new and complicated instruments I haven't the time to get into it." Others, who had stations years ago, feel that they are too far behind the times, and some say the cost is prohibitive. There is also the difficulty of learning the code.

Not one of these objections, actually, is a reason for not having a radio station.

In the first place, the advances of the radio art has simplified, rather than complicated, the equipment required for a wireless station. The men who used to have sets, back in the dark ages, will find that receiving and transmitting with new apparatus is more reliable and can be carried on over greater distances than ever before. The cost of receiving instruments for a simple set is, in spite of general increased prices, lower than of equipment to do the same work five years ago. Finally, our Governments perhaps, to make up for its treatment of the experimenters, has established a broadcast schedule to give the beginners a code practice at slow speed.

And now, possibly, some of those same objectors are wondering, "What kind of a set can I have, how much will it cost, and how can I copy this code practice?"

Almost everyone can remember that, before the war, there appeared to be a high-mast competition. In fact, the antenna height was about the most important thing about the station. That is no longer the case. Sending antennas are limited in size by Government regulations. Aerials for receiving are almost entirely of the single wire type. They require no masts or spreaders, and can be put up on natural supports. Antennas are broadly classed as Short, Long and Super Range. The first class are 30 feet high and 100 feet long. They will receive the Arlington time signals, with a simple tuning coil or loose coupler, galena detector, and reliable 2,000-ohm phones, at a distance of 500 miles, under ordinary conditions. Second class antennas, 30 feet high and 200 feet long, with the instruments just mentioned, will receive Arlington up to 1,000 miles, while the third class, 30 feet high and 300 feet long, using a single Audion detector, will receive Lyons, France, up to 5,000 miles.

As for the apparatus required, this need be no more complicated than the knowledge of the operator is extensive. In the September issue of EVERYDAY ENGINEERING a simple receiving set was described. If the equipment is purchased, a tuning coil costs only four or five dollars, or a good loose coupler ten or twelve. Detectors are sold at prices ranging from one to five dollars, and telephones from four to sixteen. A one-dollar fixed condenser and a buzzer are also needed. Complete materials for a Long Range antenna cost about three dollars.

The price of the instruments for a complete receiving set, then, amounts to around fifteen dollars. This can be cut in half if the experimenter makes his own apparatus, and the instruments are so simple that no special skill is required.

The code requires a certain amount of application and practice. It will be found that, in many cases, commercial messages are not transmitted at as high a speed as was used before the war. Also, the Navy Department has inaugurated a nightly code practice which will be of great assistance to beginners. A further announcement is given on page 46 of this issue.

The plan is to use the usual Continental signals, but to arrange the letters of the words by a special code, furnished by the District Communication Superintendent. This method makes it impossible to guess at the letters; each one must be copied accurately to make possible an accurate decoding.

For the benefit of those not familiar with the Continental Code, now used entirely for radio communication, the characters are listed here.

A	. –
B	– . . .
C	– . – .
D	– . .
E	.
F	. . – .
G	– – .
H	. . . .
I	. .
J	. – – –
K	– . –
L	. – . .
M	– –
N	– .
O	– – –
P	. – – .
Q	– – . –
R	. – .
S	. . .
T	–
U	. . –
V	. . . –
W	. – –
X	– . . –
Y	– . – –
Z	– – . .
1	. – – – –
2	. . – – –
3	. . . – –
4	. . . . –
5	. . . . .
6	– . . . .
7	– – . . .
8	– – – . .
9	– – – – .
0	– – – – –
.	. . . . . .
,	. – . –

In memorizing the code, it is not advisable to think, for example, "dot dash, a, dash dot dot dot, b," but, "Dt da, a, da dt dt dt, b," and so on, as these sounds are more like the sounds of the signals. When possible, it is of great assistance to have some one send from a newspaper or book. This gives excellent practice to the beginner. Then, when the characters have been fairly well mastered, letters can be picked out, here and there, from commercial messages until, with a little more experience, all the letters are understood.

A copy of the Government Radio Regulations can be obtained from the Government Printing office for fifteen cents cash or money order. Stamps are not accepted. This gives all the details for obtaining a transmitting license—no license is required for a receiving station—and describes the methods used in radio communication. It also contains a list of abbreviations and special signals.

As soon as possible, the experimenter should apply for an amateur operating license. Altho this is not required, where a receiving station only is operated, it is essential for the owner of a transmitting set, and is always a valuable thing to have. The book of Government Regulations tells all about the different classes of licenses and the methods of application. Special arrangements are made for those who cannot go to the office of the Department for examination, and also for temporary licensing of isolated transmitters.

In the coming, as well as in the past, issues of EVERYDAY ENGINEERING there will be articles on the construction of simple apparatus for those who are just taking up radio work. Any inquiries for information on circuits or apparatus should be addressed to the Radio Department, EVERYDAY ENGINEERING.

A Three-Foot Flying Model Nieuport Speed Scout

By Elmer Ross

FIRST, we will make our full sized layout for forming and bending the longerons of our fuselage. Make the layout of one side and then form both sides in the same form. Place headless nails along the outside lines to hold the longerons in shape while drying. Then boil the longerons in water for ½ hour, after which they are placed in the form and permitted to stand until dry. While you are making the layouts, boiling and bending the wood, make the layouts for the two upper and two lower wings, the balanced rudder, elevators and stabilizer. The reed can be boiled along with the longerons. Returning to the fuselage: After you have the longerons bent, cut them to shape and fasten in place the fuselage struts, making up two complete sides. This done, cut and fasten in place the top and bottom fuselage struts. Fasten each strut in place by glueing and nailing with a small brad, and always be sure to drill a hole with a No. 61 drill before doing the nailing or the members will split.

Landing Chassis

When the fuselage is complete, cut it to size and fasten in place the landing chassis struts, which are made in one piece to the size shown. To facilitate construction, cut a small slot in the lower portion of the chassis members for the axle to slide in, pass the axle through and fasten it in place with the brace wires. The axle is 1/16 in. in diameter by 9 ins. long, and the wheels are 2½ ins. streamlined discs. Chassis struts are cut out of ⅛ in. wood, then given streamlined shape, and trued up to dimensions on the drawing.

Tail Skid

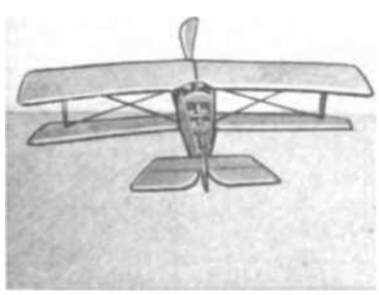
The tail skid is a piece of ⅛ in. x ⅛ in. bass wood 2½ ins. long and fastened to the lower longeron 1⅛ in. from the top end of the skid and 1⅝ ins. back from the tail post of the fuselage. Pivot on long brad passed through both lower longerons and then attach rubber bands, as shown, to take up some of the shock of landing.

Motor Stick

The motor stick consists of one piece of spruce 5/16 in. square by 15 ins. long, one aluminum propeller hanger, one ball bearing propeller shaft, one rear rubber hook, one 12 in. propeller and five doubled strands of 3/16 in. flat rubber. Connect them as shown in the April 1919 issue of EVERYDAY ENGINEERING in the writer's article on "A Model Curtiss JN4." Fasten in the fuselage at No. 2 and No. 3 top fuselage struts only and *exactly* in the center.

Engine Cowling

Make an aluminum cowling to the shape and size shown from 1/64 in.



thick aluminum. To fasten the cowling to the fuselage it will be necessary to cut off the first section of the fuselage and fasten it in place to the four longerons at section No. 2, after cutting off section No. 1. Drill a ⅞ in. hole in the cowling, as shown, for the propeller hub to project through. After putting the cowling in place, put the propeller on the hub and tighten up the nut.

Side and Turtle Deck Formers

Make the side and turtle deck formers to the sizes indicated and fasten in place to the fuselage in the position shown, by glueing and drill a hole and place a small brad in it for extra strength. The formers can be lightened if desired by drilling holes in them, or, if a scroll saw is at hand, by cutting out the centre portion.

Interplane and Cabane Struts

The interplane struts are cut 4⅝ ins. for the rear and 6½ ins. for the front and streamlined. Bass wood is used. The struts over the fuselage are made from 5/16 in. O.D. aluminum tubing flattened out to streamline shape and entirely flat at the top. The bottom end is left round to fit over a small strut socket. You will need four made to the dimensions shown. The special V-socket on the bottom plane can be bought ready made up. Other strut sockets are the ordinary upright kind.

Wing Construction

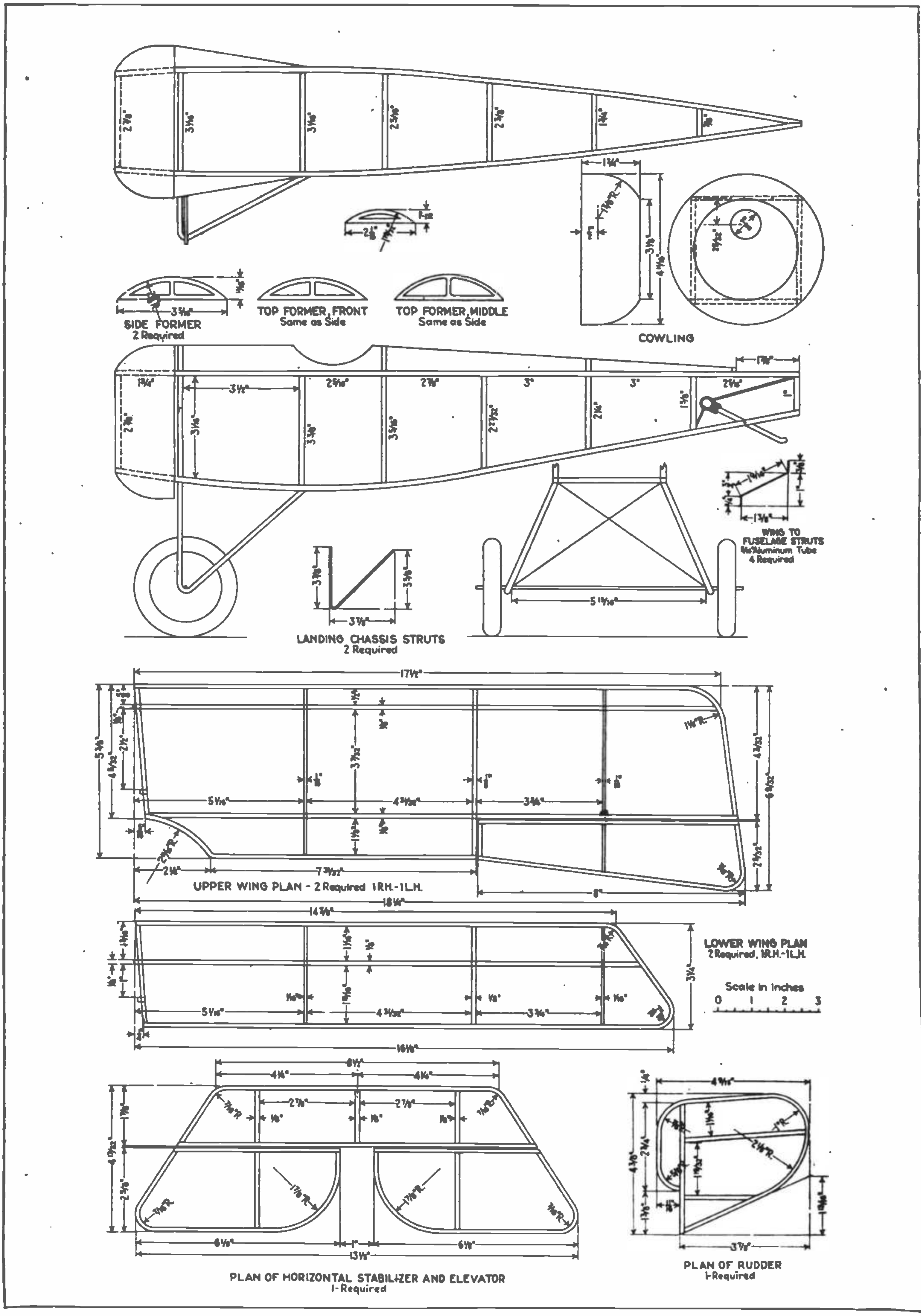
After the layouts are made and the wood boiled, place it in forms to dry. During this time the ribs can be cut out. Ribs will be needed for each top wing and each bottom wing, and they are made of 1/16 in. thick spruce to the size shown, with the exceptions of the ones which are ⅛ in. thick. The drawings of the wings only show the ribs altogether, but the writer used a 1/16 in. rib spaced in the middle of each rib shown on the drawing. If the wings are made as shown in the drawing, the model should only weigh 11¾ ozs., which will give a few feet more in the flight length. After the reed edging is dry and the ribs cut out and drilled, assemble as shown in the drawing. The writer has made the wings in one piece, but the drawings show the proper size of the ailerons; if you desire to use them on your model, place strut sockets on spars at points shown in rigging sketch.

Stabilizer, Elevator and Rudder

The stabilizer, elevator and rudder are made from ⅛ in. reed for the edging and ⅛ in. square bass wood for the filling in pieces. The stabilizer and elevators can be made in one piece if desired, but by making them separate and adjustable you can correct the tendency of your model to fly in anything but a straight course.

Covering and Doping

The wings, fuselage and controls are all covered with bamboo paper and doped with doping solution described in the April issue, or the builder can purchase bamboo varnish and use it. They both cost about the same. When covering the parts, be sure and remove all wrinkles out of the paper. It is


SIDE FORMER
2 Required
TOP FORMER, FRONT
Same as Side
TOP FORMER, MIDDLE
Same as Side
COWLING
LANDING CHASSIS STRUTS
2 Required
WING TO FUSELAGE STRUTS
4 Required
UPPER WING PLAN - 2 Required 1R.H.-1L.H.
LOWER WING PLAN
2 Required, 1R.H.-1L.H.
Scale in Inches
0 1 2 3
PLAN OF HORIZONTAL STABILIZER AND ELEVATOR
1-Required
PLAN OF RUDDER
1-Required

best to give the machine two coats of the doping solution.

Assembling

The model is assembled as shown in the sketch and should be perfectly square with the fuselage in every respect, with the exception of the arrow shape which the leading edges of the top and bottom wings will have and which is taken care of by the slant of the inner rib of each wing. Fasten the brace wires in place as shown and do not tighten securely until the wings are in the correct position. The writer used small turnbuckles on his machine, which still leaves the weight 13 ozs. The builder can use them, too, if desired, but by leaving them off a reduction in weight is effected.

To fly the model, choose a field in which the grass is a little bit long, and if the wind is blowing over 10 miles per hour, head your model with the wind. It is a good practice to get a good distance flight to head the model with the wind.

With the amount of rubber specified, give the propeller no more than 165 to 170 turns, but for the first flight give 150 and as the rubber gets older you can then work up to 170 turns. If the model is properly constructed, you should get at least 200 ft. from it, and if, while building it, you think you can cut down some weight, it will give proportionately longer flights. Also be careful to get the wings in the proper place or the model will not balance and consequently will not fly properly as its course will be erratic.

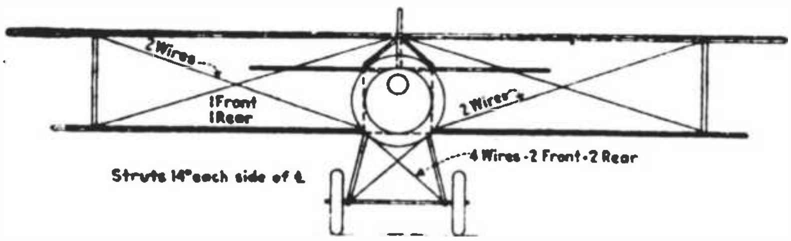
Remarks

The fuselage of the model Nieuport speed scout is 20⅛ ins. overall. The struts can be either made streamlined or ⅛ in. doweling can be used.

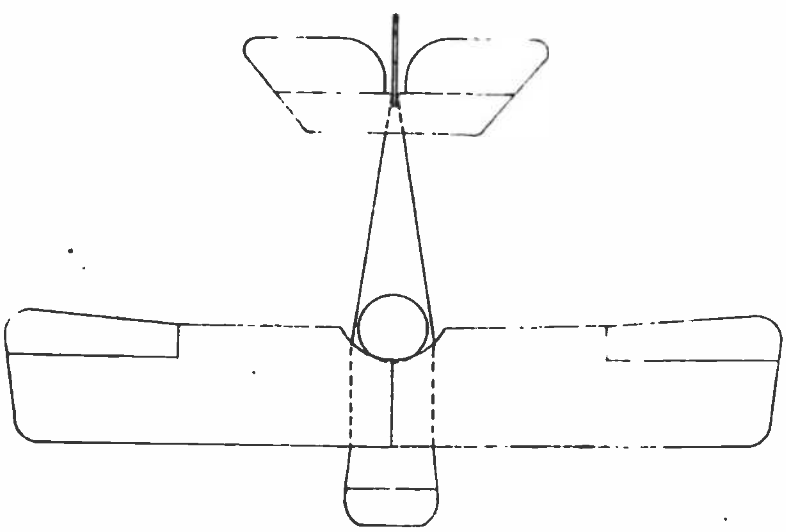
The landing chassis struts can be produced by either making them out of one piece of 3-ply ⅛ in. wood or it can be a piece of ⅛ in. round reed boiled and bent to shape as shown. To do away with the aluminum cowling, make a cowling out of split bamboo bent to the same size as the aluminum cowling. If you wish, you can take split bamboo for the turtle deck and side formers. Bend it to the proper shape, fasten to the fuselage with glue and thread, which will do away with the ⅛ in. thick pieces of wood for formers.

The motor stick could be made from a piece of 5/16 in. O. D. aluminum tube, and made 5/16 in. square at the propeller and with a 5/16 in. square piece of wood 1½ ins. long, in order to be able to fasten the hanger and the rear rubber hook could be inserted in a 1/16 in. hole drilled in the other end of the tube. This could be fastened with the small nuts that come with a rear rubber hook.

By using a 1/64 in. thick aluminum turtle deck made in one piece and fastened along the side of the top longeron, you can readily take it off to fix the motor any time you wish. A good idea is to have the engine cowling, side cowling and turtle deck all made of one piece of aluminum.



Leading edge upper plane at ℄ is 3¾" from front edge of cowling. Lower wing is placed so the rear strut is straight up and down.



Above all, be sure and have each part square with each other, and keep any extra added weight off the tail.

The complete fuselage is made out of ⅛ in. x ⅛ in. square basswood. The writer used 5/32 in. x 5/32 in. in order to have the machine stand more rough use during tryouts to find the proper position of the wings.

Carry an indelible pencil in your tire repair kit. When you find a leak in a tube you must mark it so as to find it again. A black lead pencil is useless, but indelible mark will remain.

PROPERTIES OF BALSA WOOD

A VERY light wood, known as balsa is now used widely in making life rafts, buoys and floats, airplane components and other uses where a wood of this nature is desirable. It also possesses valuable heat insulating properties. Prof. W. W. Rowlee, of Cornell University, who was sent to Central America last year by a New York company to study balsa in its native environment has just published an article in the *Journal* of the Washington Academy of Science on the botanical characteristics of the wood.

The balsa tree belongs to the genus "Ochroma." Formerly only two species were recognized, the one which was the source of the wood imported to this country being known as "Ochroma lagopus." Professor Rowlee's investigations increase the number of known species to nine. It grows with astonishing speed, often attaining a height of 60 feet or more in five or six years. In its natural state the wood is very perishable, decaying with about the same rapidity as a cotton fabric. The balsa wood of commerce is made durable and waterproof by a special treatment. In tropical America this tree bears many names besides "balsa," which is merely a Spanish word for "raft," in an allusion to the fact that rafts of this wood are used for transportation purposes on the South American rivers. In Nicaragua, the tree is called "gatillo", in Guatemala "cajeto," on the west coast "moho," in Jamaica "corkwood" and "down tree," because of its lightness.

Balsa proved its utility in the war when it was not only used extensively for life-rafts and life-boats but also in the construction of the 250-mile mine barrage across the North Sea, which included 80,000 floats made of this buoyant wood. In aeronautical work it has been used for seaplane floats and pontoons, for airplane wing rib webs and for streamlining and fairing steel struts, bracing wires and any tubular members of circular crosssection. Investigations are now in progress to determine and plot its strength—weight ratio and other physical characteristics.

No doubt many other uses will be found in the future for this remarkable wood despite its great cost.

EXPERIMENTAL CHEMISTRY

METALLURGY—ELECTROCHEMISTRY PHYSICAL CHEMISTRY

Metallurgy for Beginners

By E. Hurley

IT has been conceded that there is a lack of research and serious investigation in the laboratory of the amateur chemist.

In many localities there are valuable mineral deposits as yet not discovered and it is the object of this article to endeavor to give to the amateur chemist information that may aid him in his investigations for valuable ores, also furnishing an insight into the work involved in determining the metals in these ores.

The subject is not treated in a technical manner neither is it the purpose to describe all the processes that have been devised or even the modifications and adoptions of these processes that are now being used in the analysis of the principal ores.

The reagents and apparatus used are those generally found in the laboratory equipped for elementary qualitative analysis. The reagents for the work are prepared as follows:

Aluminum

Aluminum is of common occurrence and is one of the chief constitutents of the earth's crust. It is found in most rocks but there is but one ore, bauxite, that is of commercial value. This mineral contains approximately 74% aluminum oxide when pure. It has a dull lustre and is found in various colors, particularly red, brown, gray, etc. The electrical furnace is the only successful method of extracting the metal from its ores.

Test

Aluminum compounds, are, as a rule, insoluble in acids and to obtain the aluminum in solution, it is necessary to subject the ore to an alkali fusion. Dissolve the residue in hot water and add hydrochloric acid. Evaporate to complete dryness and when cooled, add 10 cc. hydrochloric acid. Then heat it three minutes over a bunsen burner and add 50 cc. water. Boil and filter, washing the filter with hot water. Dilute the solution to about 250 cc., heat it until it boils and then pass hydrogen sulphide gas through the hot solution. Filter and add a few drops of hydrochloric acid to the resulting filtrate and boil three minutes. Now add 15 cc. ammonium chloride and enough ammonium hydroxide to make the solution decidedly alkaline and if a precipitate is formed, filter it off. *No precipitate here indicates the absence of aluminum.* If a precipitate is formed, filter and wash it and then make a hole in the filter paper so that the precipitate can pass through to the test tube. To the solution in the test-tube add 20 cc. of concentrated potassium hydroxide, boil and filter, reserving the precipitate. To this filtrate, add 50 cc. of ammonium chloride and if aluminum is present a white precipitate will be formed which will not dissolve on the addition of ammonium carbonate solution.

Barium

The principal ores of barium are barite, a heavy whitish mineral. It is used in the manufacture of white lead and also in the paper and sugar industry. It occurs in Missouri, Tennessee, North Carolina, Kentucky and many other states.

Take a gram or a small quantity of the finely pulverized ore and add to it 15 cc. of moderately warm sulphuric acid. After heating, filter and discard the filtrate. Boil the residue for twenty-five minutes in a concentrated solution of potassium carbonate and filter, washing the precipitate well. To the precipitate add 10 cc. dilute hydrochloric acid by pouring it through the filter on which you have the precipitates, collecting the solution that passes through. Add three grams of ammonium chloride and then 5 cc. warm sulphuric acid. *No precipitate here indicates the absence of barium.* If one is obtained filter it off, boil again as before with a solution of concentrated carbonate solution, filter and wash thoroughly. Dissolve it in acetic acid and to the solution add a few drops of potassium dichromate and if barium is present a yellow precipitate will be thrown down.

Bismuth

The principal ore is bismuthinite with a lead-gray color. It contains 81% bismuth. Bismutite has a white and yellow color and contains approximately 88% bismuth. Tetradymite has a steel gray color and contains 69% bismuth. It has been found in several localities of the United States, an excellent grade coming from Arizona. Its principal use is in alloys, one of which is composed of lead, tin and bismuth with a very low point of fusibility.

Place a small quantity of the finely pulverized ore in a porcelain dish and add 10 cc. of hydrochloric acid and 10 cc. of nitric acid, and heat to boiling. Boil most of the solution off and then dilute with an equal amount of water and filter. Take a test tube, half full of water and add to it a little of the filtered solution. If bismuth is present a white precipitate is formed. Dissolve a small quantity of this precipitate by adding to it a few cubic centimeters of hydrochloric acid and add an excess solution of potassium stannite (made by adding to a little stannous chloride in a test tube enough potassium hydroxide to re-dissolve the first precipitate formed) and if bismuth is present a black precipitate will result.

Chromium

The principal ore is cromite. It is a brownish to black and slightly magnetic. This mineral is distributed widely over the United States. Its principal use is in the manufacture of chrome steel.

Fuse a small quantity of the pulverized ore in a small porcelain crucible with about four times as much sodium peroxide, using a blow pipe or blast burner. Dissolve the melt in hot water and filter. If chromium is present, the solution will be yellow. Make the solution acid with acetic acid and add a few drops of the lead acetate solution and if chromium is present it will be precipitated as yellow lead chromate which dissolves on the addition of sodium hydrate.

Copper

The principal ores are chalcopyrite and cuprite. There are many other copper ores. Copper is used extensively in the making of alloys, etc.

Place a small quantity of the finely pulverized ore in a test tube and add 5 cc. of nitric acid. When the solution is cold add enough ammonium hydroxide to make the solution decidedly alkaline. Filter off any precipitate. A blue color indicates the presence of copper. To a part of the filtered solution add enough acetic acid to neutralize the ammonia and into this solution put a bright piece of iron and the copper will appear as a metallic deposit on the iron.

Cobalt and Nickel

These ores are generally found together and will be treated accordingly. The principal ores of nickel are niccolite and millerite of cobalt-cobalite and smaltite.

Place a small quantity of the finely pulverized ore in a porcelain dish and add 30 cc. one-half strength nitric acid and heat. Apply heat until most of the acid is driven off and then add 40 cc. water to the residue and then heat to insure a good solution of cobalt and nickel. Filter and pass hydrogen sulphide gas through the solution for five minutes. Filter again and add to the solution filtered a few drops of nitric acid and boil one minute. Then add 10 cc. ammonium chloride and enough ammonium hydroxide to make the solution decidedly alkaline. Again filter and into the ammonical solution pass hydrogen sulphide gas and if cobalt and nickel are present they will be thrown down as a black precipitate, the absence of which is evidence no cobalt or nickel are present. If a precipitate is present wash and filter with a solution of one part hydrochloric acid to four parts water and dissolve the remaining precipitate in dilute nitric acid. Heat to expel the acid and then add 15 cc. ammonium chloride and then potassium ferrocyanide as long as a precipitate is formed and stir the solution rapidly, adding ammonia in excess. A dark precipitate will separate from the solution and shows that cobalt is present and ammonium sulphide added to the filtrate will show a black precipitate if nickel is present.

FROZEN SOAP BUBBLES

SOMETIME ago experimenters with low temperatures succeeded in freezing soap bubbles by the aid of liquid air. Considering the almost inconceivable thinness of a soap bubble, this was indeed a remarkable experiment. The actual thickness of a soap bubble has never been accurately determined but scientists claim that the amount of tangible matter contained in a bubble is almost unbelievable. The bubbles were frozen into a hard, fragile crystal. The life of a frozen bubble is extremely short unless it is maintained at low temperature.

TO CASE-HARDEN LOCALLY

IN case-hardening certain articles it is sometimes necessary, or desirable, to leave spots or sections in the original soft, uncarbonized condition while the remainder is carbonized and hardened. This may be effected by first covering the parts to be hardened with a protecting coat of japan and allowing it to dry. Then put the piece in an electroplating bath and deposit a heavy coat of nickel over the parts not protected by the japan. The piece thus prepared may be treated in the usual manner in case-hardening. The coat of nickel prevents the metal beneath being carbonized, so it does not harden when dipped in the bath.

A plating of copper answers the same purpose as nickel and is often used. A simple plan, where the shape of the piece permits, as when the outside or inside of a ring is to be treated, is to protect it from the action of the carbonizing material with an iron pipe or rod closely fitted or luted with clay. Another scheme is to machine the parts wanted soft after carbonizing but before hardening. By this procedure the carbonized material is removed where the metal is desired soft, and when heated and quenched these parts do not harden.

STRENGTHENED FILTER PAPER

WHEN ordinary filter paper is dipped into nitric acid (specific gravity 1.42), thoroughly washed and dried, it becomes a tissue of remarkable properties, and one that deserves to be better known by chemists and pharmacists. It shrinks somewhat in size and weight, and gives, on burning, a diminished ash. It yields no nitrogen, nor does it in the slightest manner affect liquids. It remains perfectly pervious to liquids, its filtering properties being in no wise affected, which, it is needless to say, is very different from the behavior of the same paper "parchmented" by sulphuric acid. It is as supple as a rag, yet may be very roughly handled, even when wet, without tearing or giving way. These qualities make it very valuable for use in filtration under pressure or exhaust. It fits closely to the funnel, upon which it may be used direct, without any supports, and it thus prevents undue access of air. As to strength, it is increased upward of ten times. A strip of ordinary white Swedish paper ⅛ of an inch wide will sustain a load of from ½ to ¾ of a pound avoirdupois, according to the quality of the paper. A similar strip of the toughened paper broke in 3 trials, with 5 pounds 7 ounces and 3 drachms; 5 pounds 4 ounces and 36 grains; and 5 pounds 10 ounces, respectively. These are facts that deserve to be better known than they seem to be to the profession at large.

SOLDERING PASTE

ONE of the semi-liquid masses ordinarily termed soldering paste is produced by mixing zinc chloride solution or that of ammonia zinc with starch paste. For preparing the composition, ordinary potato starch is made with water into a milky liquid, the latter is heated to a boil, with constant stirring, and enough of this mass, which becomes gelatinous after cooling, is added to the above mentioned solutions to cause a liquid resembling thick syrup to result. The use of all zinc preparations for soldering presents the drawback that vapors of a strongly acid odor are generated by the heat of the soldering iron, but this evil is offset by the extraordinary convenience afforded when working with these preparations. It is not necessary to subject the surfaces to be soldered to any special cleaning or preparation. All that is required is to coat them with the soldering medium, to apply the solder to the seam, etc., and to wipe the places with a sponge or moistened rag after the solder has cooled. Since the solder adheres readily with the use of these substances, a skillful workman can soon reach such perfection that he has no, or very little, subsequent polishing to do on the soldered seams.

SOLUTIONS FOR BATTERIES

THE almost exclusively employed solution of sal-ammoniac (Ammonium chloride) presents the drawback that the zinc rods, glasses, etc., after short use become covered with a fine, yellow, very hard to dissolve, basic zinc salt, whereby the generation of the electric current is impaired, and finally arrested altogether. This evil may be remedied by an admixture of cane sugar. For a battery of ordinary size about 20 to 25 grams of sugar, dissolved in warm water, is sufficient per 50 to 60 grams of sal-ammoniac. After prolonged use, it is stated, only large crystals (of a zinc saccharate) form, which, however, become attached only to the zinc rod in a few places, having very little disadvantageous effect upon the action of the batteries and being easy to remove, owing to their ready solubility.

RECUTTING OLD FILES

OLD files may be rendered useful again by the following process: Boil them in a potash bath, brush them with a hard brush and wipe off. Plunge for half a minute into nitric acid, and pass over a cloth stretched tightly on a flat piece of wood. The effect will be that the acid remains in the grooves, and will take away the steel without attacking the top, which has been wiped dry. The operation may be repeated according to the depth to be obtained. Before using the files thus treated they should be rinsed in water and dried.

RADIO
TELEPHONE AND TELEGRAPH APPARATUS

Construction of Apparatus on Standardized Panels

A Method by Which Radio Apparatus Can be Kept Up-to-Date Without Discarding Instruments

By M. B. Sleeper

WHEN radio experimenting first became popular, the different instruments were made separately, with no regard for co-ordination as to electrical or mechanical design. They were spread around over the operating table, arranged in a haphazard fashion.

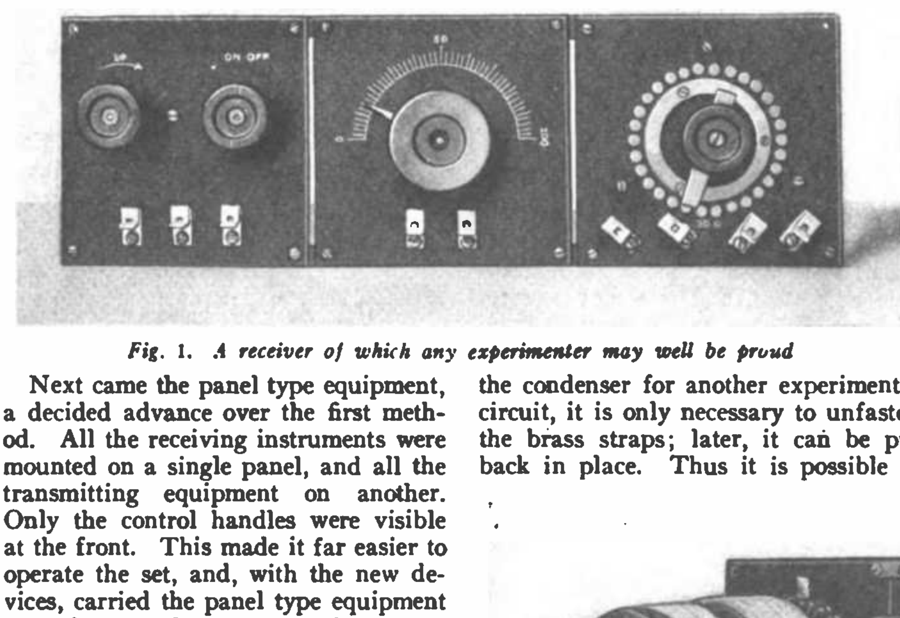


Fig. 1. A receiver of which any experimenter may well be proud

Next came the panel type equipment, a decided advance over the first method. All the receiving instruments were mounted on a single panel, and all the transmitting equipment on another. Only the control handles were visible at the front. This made it far easier to operate the set, and, with the new devices, carried the panel type equipment up to its marvelous present advance.

The great difficulty, however, has been that, to keep panel sets up with the latest developments, they must be discarded altogether or torn down frequently. Now, the standard panel method has come to the rescue with a combination of separate and panel mounting. In this system, each instrument or special combination of instruments, is mounted on an individual panel, of a size 5 x 5 ins., 5 x 10 ins., 10 x 10 ins., or 10 x 15 ins. By standardizing on these sizes, panels of different shapes can be grouped together, to form a rectangle. If they are put in a case, the only change necessary, if instruments are added or taken away, is a new cabinet. However, no case is needed when the panels are simply supported by angle brackets.

Figs. 1 and 2 illustrate a simple receiver made up on standardized panels. The instruments used are a loose coupler, secondary variable condenser, and buzzer test. A separate crystal detector completes the set. This can also be used with an audion cabinet.

If, for example, it is necessary to use the condenser for another experimental circuit, it is only necessary to unfasten the brass straps; later, it can be put back in place. Thus it is possible to use any instrument for temporary circuits without tearing up the receiver and it can be replaced in a minute. Additional apparatus can be put in, or the entire set rearranged.

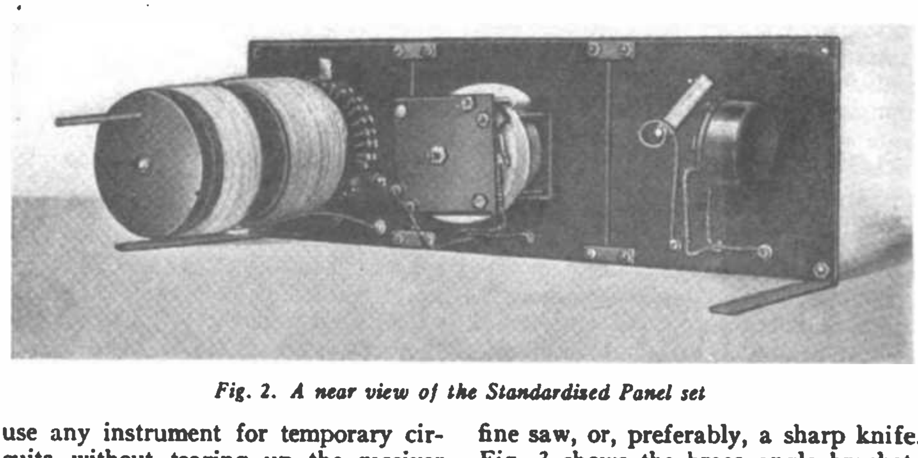


Fig. 2. A near view of the Standardized Panel set

A 200 to 1,000 Meter Receiver

Any type or kind of transmitting and receiving equipment can be made upon standardized panels, but to illustrate the method, a simple yet surprisingly efficient receiver is described here. It is intended for use on experimental and the ordinary commercial wavelengths up to 1,000 meters.

The primary of the loose coupler has 30 taps, while all the secondary tuning is done in the variable condenser. The buzzer test indicates, when its signals are heard in the telephones, that the detector is adjusted.

This is an easy set to operate, for all the tuning can be done with two knobs. When the primary handle is turned, it moves the switch arm; pulled out or pushed in, it varies the coupling. Sharp tuning is accomplished with the secondary condenser.

The Loose Coupler

Details of the loose coupler are given in Fig. 3. The primary coil is wound on a tube 3½ ins. long and 3 ins. in diameter. At the panel end, the tube is cut back so that there are three mounting legs ½ in. wide and ¾ in. long. This cutting must be done with a very fine saw, or, preferably, a sharp knife. Fig. 3 shows the brass angle brackets fastened to the legs by 8-32 machine screws and nuts.

The winding is composed of 100 turns of 3-16 No. 38 high frequency cable, wound in three banks, tapped every three turns, beginning with the thirteenth. At the end of each bank, when the wire is brought from the top turn down to the tube, two holes are made, one for the end of the section, and the other to take out the start of the next.

When the winding has been completed, the taps are cut to length, and each end heated red hot and dipped in alcohol twice. This removes the enamel insulation on the wires. An accident which occurred when this set was built will serve as a warning to others. In the first place, a small bowl of alcohol was used. During the work, a tap was put into the alcohol when the insulation was burning. This ignited the alcohol and, in some way, the bowl was tipped over. The result was a sheet of flame over the arms of the builder and on the floor and table of the shop. Then a small paint can cover was substituted for the bowl. If that had been tipped over, the small amount of alcohol would have done very little harm.

All the taps prepared, the two adjacent wires are twisted and soldered together, ready to be soldered to the switch points later.

The secondary coil is wound on a 3 in. tube 1¼ ins. long. This winding has 58 turns of 3-16 No. 38 cable, in four banks, with no taps. Fitted at the outer end is a flanged wooden disc ¾ in. thick, in the center of which is a ¼ in. brass rod, 2 ins. long, drilled out with a No. 16 drill. This, as will be seen later, acts as a bearing for the square main shaft.

Another hole is made in the wooden end piece, 1 in. from the center, with a No. 20 drill. It will take the guide rod which prevents the coil from turning, as shown in Fig. 3.

The next step in constructing the loose coupler, is to assemble the switch parts. A 5 x 5 in. panel is used, preferably ¼ in. thick. This set was made with ⅛ in. bakelite, but it was not quite rigid enough for the weight of the parts.

Thirty ¼ in. diameter switch points are set in a circle 3 ins. in diameter. In the center of the panel a ¼ in. hole is drilled to take the switch shaft. The 3-ply switch arm has a No. 16 hole for the square shaft and two No. 36 holes to slip the 2-56 machine screws which hold it to the bearing. This bearing is of brass, ¾ in. long, turned down for ½ in. to ¼ in. diameter, while the remaining ¼ in. is ½ in. in diameter. It is to this head that the switch arm is secured by the 2-56 screws.

Through the center of the bearings a No. 16-hole is drilled from the back almost to the front end. The hole is completed by a No. 30 drill. Next, the smaller hole at the front is carefully filed square, to take the ⅛ x ⅛ in. shaft. Finally, a collar ¼ in. thick and ½ in. in diameter, with a ¼ in. hole, is made to fit over the end of the shaft. Two 6-32 machine screws act as set screws.

When the parts are assembled, the bearing is put into the panel from the front and the collar fitted on from the rear. Thus, the shaft is free to turn, but cannot pull out, while the square shaft can move in and out, but, when rotated by the adjusting handle, it must turn the bearing and the switch arm attached.

The secondary coil must not turn with the main shaft. The shaft is threaded at the rear end with a 6-32 die, and two nuts are put on it at the outside and inside of the secondary end piece bearing. They are just loose enough to allow the shaft to turn in the brass insert, yet tight enough to prevent end play. Further provision against turning is made by a ⅛ in. brass rod which passes through the end piece. It is secured to a wooden strip glued inside the primary coil.

Fahnestock binding posts are provided at the front of the panel, though, in some cases, it is preferable to have only screws protruding at the rear, to which connections can be soldered.

Condenser Panel

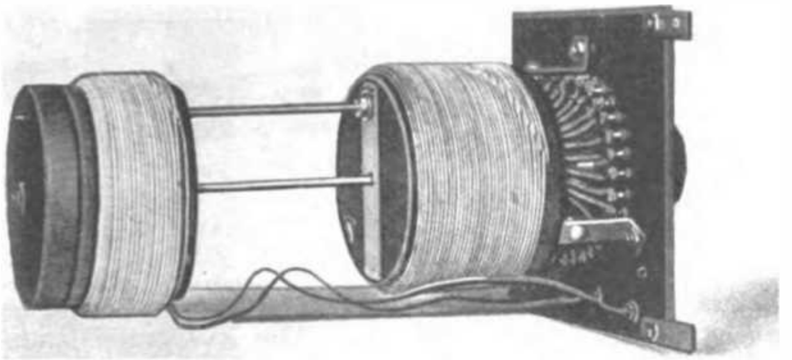
The condenser shown in Fig. 4 is of the Clapp-Eastham make. The maximum capacity is 0.0006 mfd. The wavelength range is smaller, however, than with a 0.001 mfd. type, so that, for the full range, the larger condenser should be used.

Although it was not necessary, it was thought advisable to put solid bakelite end pieces on the condenser. The metal pieces, with bakelite inserts, offered a possible leakage path across the plates which would result in broad tuning and loss of efficiency with an audion.

The construction of new end pieces should be attempted only by a skilled mechanic, for it is an easy matter to put the plates all out of alignment. Moreover, it will be found necessary, in all probability, to make a new upper bearing for the shaft. In drilling the holes in the bakelite pieces, the metal plates were used as templates.

If the construction of the condenser is not changed, it is an easy matter to secure the upper plate to the panel with small machine screws. Because there is no way to secure the handle to the shaft except by means of set screws, two 6-32 screws were put into the smaller part of the knob. The heads were cut off and slotted, so that they hardly protrude.

The pointer is simply a piece of ⅛ x ⅛ in. brass rod, filed down at one end, and threaded with a 6-32 die at the other. The condenser dial and figures on the panel were simply scratched with a compass and a sharp steel point, after which they were filled with whiting slightly moistened with linseed oil. When dry, this mixture becomes hard.



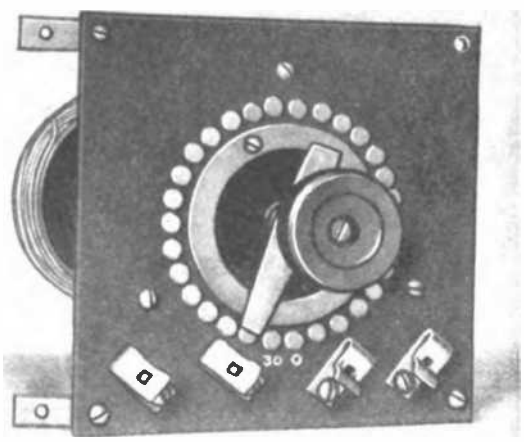


Fig. 3. Two views of the Standardized Panel type loose coupler. If a different coupler is made later, this can be removed and used for other purposes, and the new one set into place

Buzzer Test Panels

Fig. 4 shows the buzzer test. A new feature of construction is the vibrator screw control. A 2-56 thread is put in a hole in the thumbscrew. Then the shaft of the handle is soldered to the screws. To make it possible to put on the cover, a small slot is made in the side, to fit around the shaft. The 1/8 in. shaft was simply filed down at one end for the 2-56 thread.

The angle piece which holds the buzzer is joined to one of the buzzer connecting screws so that the switch clip can be held by the same screw which holds the angle piece. A brass strip, 1/16 x 3/8 in. acts as the contact arm.

Three binding posts are furnished, two for the battery, and another, wired to the vibrator screw, to connect to the ground. When the switch is closed and the buzzer operated, a sound is made in the receivers if the detector is in adjustment.

Arrangement of the Panels

Holes are made with a No. 18 drill in the corners of each panel, 1/4 in. from the edges. These are for the supporting strips. The strips are made of 1/16 x 3/8 in. brass, drilled with two No. 18 holes 5/8 in. apart. This allows 1/8 in. between the panels, and gives a slight leeway for discrepancies in drilling.

Additional panels can be arranged at the side or above those shown in this article, if the standard sizes of panels are used. Other apparatus, built by this method, will be described in the coming issues of Everyday Engineering.

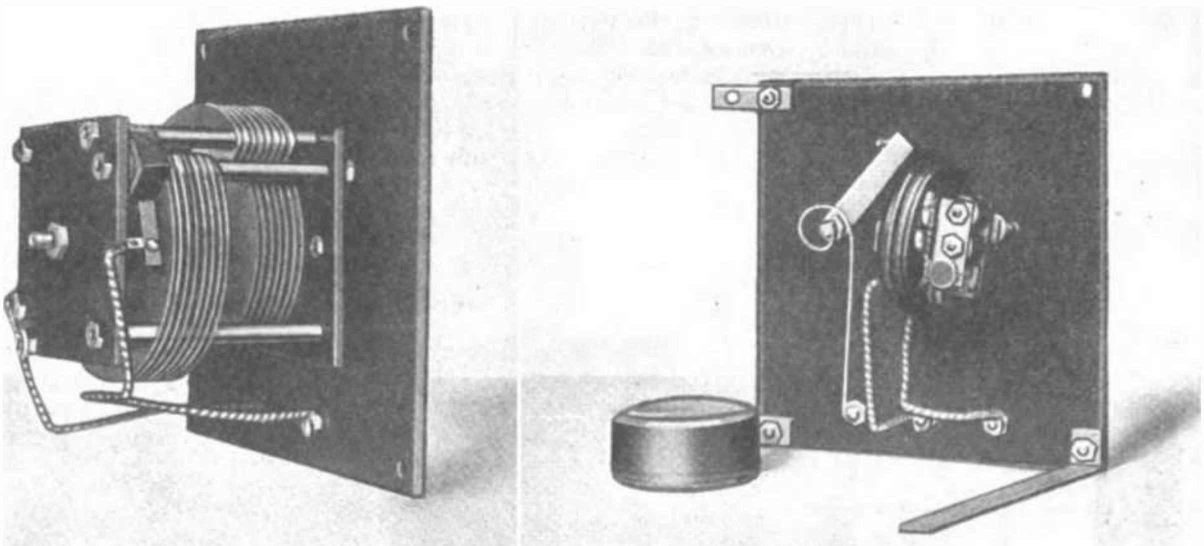


Fig. 4. Details of the condenser and buzzer test panels

Nycssa Radio Club

THE Nycssa Radio Club was organized this summer at Camp Nycssa where it built and successfully operated a station. The club will resume activities this winter under Mr. Filden at the West End Presbyterian Church, where we will install a station. The club has fifteen active members and expects to double that number before long. The Nycssa Radio Club would be pleased to hear from other radio clubs concerning their activities. All communications addressed to C. Stanley Johnson, Jr., Secretary, 160 Wadsworth Avenue, New York City.

Telephone Transformers

IT HAS been pointed out in the series of articles by Mr. Clement that the impedance of the telephone circuit of a detector or amplifier should be equal to the internal impedance of the last tube. Since the impedance of an ordinary telephone receiver is too low to meet this requirement, a transformer connected between the plate circuit and the telephones will improve the results.

The telephone transformer shown here is designed to give a combination of impedances of which the correct one can be determined by experiment. The plate is connected to the first primary terminal and the other side to any of the other primary binding posts. The

telephones are put across any of the secondary posts until by experiment the proper combination is found. The easiest way to carry out the test is to couple an inductance connected in the battery circuit of a buzzer to the secondary inductance of the receiving set. When the signals are heard with the greatest intensity the proper transformer connections have been found.

The Evergreen Radio Association

IN August, 1919, the Evergreen Radio Association of Long Island, N. Y., was organized. An invitation is extended to all experimenters in the vicinity to join this club. The primary purpose of the association is to promote good fellowship among all amateurs, to increase the knowledge of its members and the efficiency of their stations and to reduce QRM to a minimum. Those who are interested will kindly communicate with the secretary, George H. Roy, 681 Grandview Avenue, Evergreen, L. I., N. Y.

The Experimenters in France

IN the first issue of T. S. F., the French radio magazine, now resuming activities since the war, is a protest against the experimental radio situation in France. So far, no permission to send or receive has been granted. At the first of the war, privately owned apparatus was taken over, and has not yet been returned. We may wonder in what condition the instruments are now, if their construction was not far superior to the average homemade sets built by American experimenters four years ago.

The Radio Department

WHEN you look at a piece of radio apparatus and say it is a "nice piece of work" you make a strictly neutral statement. You have not criticised the faults or laid stress on the good points. The only thing accomplished is the saying of the expected.

Really, the man who did the work hoped you wouldn't see the imperfections and is satisfied that you are pleased, if non-committally.

When you look through the Radio Department of EVERYDAY ENGINEERING, you may say it is "good stuff." If you write and tell us that, we are pleased. We may put out our chests a bit.

Really, you have increased our lung capacity but you haven't added anything to the alleged store of gray matter on which we depend for judgment as to what should or should not go into these pages.

The success of EVERYDAY has made it possible to give its readers whatever they want. We have an idea that we are doing this now, but we want to make sure. But remember, we are after constructive criticism. If something about the department is good now, we want to know why it is good. If it is not, we want to know why it is not. There will be differences of opinion, and to create a discussion we shall publish letters which contain not words of praise but worth while comment on the Radio Department.

There are five dollars waiting for the man who gives us the best letter on What I Think of the Radio Department and Why. A maximum of five hundred words may be used.

TRANSMITTING is still a thing of the future, but the prospects deserve serious consideration. So many new men have taken up radio work, that, in the cities, difficulties from interference are imminent. Mention has been made of the possible use of short wave, undamped transmitters. Two hundred meters wavelength means a million and a half cycles. At this frequency, using heterodyne reception, a difference of less than one meter will bring the signals in or out. Obviously such sharp tuning will be of tremendous help in reducing interference.

High frequency alternators and frequency changers are beyond experimenters, but the versatile audion affects the rescue. Immediately the thought arises that audion transmitters are greatly limited in range. As a matter of fact, with a single tube receiver, telephone conversation has been carried on with one Marconi-De Forest bulb as a transmitter over a distance of forty-five miles. To be sure, four hundred volts were used on the plate, but the lack of plate voltage can be made up by an amplifier at the receiving station, or two or more tubes can be used in parallel for sending. However, for straight telegraph transmission, a much greater distance can be covered than by telephone.

The subject of transmitting has been rather neglected in EVERYDAY, but it is to be given its share of space in the coming numbers.

IN the April, 1919, issue there was an article on Standardized Design of apparatus. The ideas incorporated in it have been carried out in the article on receiving instruments in this number, and will be continued.

The advantage of using standardized panels, with separate or supplementary instruments on each panel, is a great advantage. It makes possible, in the first place, the panel mounting type of construction. It practically overcomes the problem of discarded sets, for while a complete outfit may become obsolete, there are always uses for the individual instruments if they can be retained in good condition, a thing almost impossible where they have all been mounted on and fitted to one panel. Ideas of radio sets change so rapidly that only a multi-adaptable system of construction will allow the experimenter to keep his equipment up to date without constantly discarding expensive instruments.

THE demand for radio operators shows no signs of abatement. Particularly on the Shipping Board vessels, a shortage has been caused by the demobilization of the Navy, and the withdrawal of Naval operators from those ships. In this service men are paid \$100 and \$125 per month in addition to all expenses.

In practically every Post Office of the country notices are posted which show the location of the nearest Sea Service Bureau where applications are received. Men employed as operators during the war are only required to pass the Department of Commerce examination.

Any further information will be given to those who address their inquiries to the Radio Department, EVERYDAY ENGINEERING MAGAZINE.

EXPERIMENTERS who are just starting in at radio work have some strange ideas. A month ago a New York manufacturer sold a simple crystal receiving set to a man in Michigan. It was a good set, too, one in which the company took considerable pride. However, all was not well. Two weeks after the set was shipped, a letter came, indicating that the purchaser was in no kindly frame of mind. He was plainly shocked at the deceitfulness of the manufacturer who took advantage of mail order customers.

"I am using a tree antenna with your crystal detector set and can't even hear Arlington time signals."

Can you blame the maker of the equipment for tearing his hair and feeling as exasperated as the customer? You won't if you have used a tree antenna. Which goes to show what comes of talking a lot about general applications of a thing intended for special use, and the harm from magazine articles written by ignorant men.

The work actually done with tree antennas by the Signal Corps is set forth in a paper given by Major General Squier at the Franklin Institute, June, 1919. Copies can be obtained from the Franklin Institute, Philadelphia, Pa. In this paper it is stated that seven stage amplifiers were used, and apparatus representing the highest developments of the art.

What chance was there, with a crystal detector, to repeat the results obtained by the Signal Corps?

NEXT month will have some rather pleasant surprises if the Navy Department does not withhold their approval. But perhaps we should wait and let the November issue speak for itself. One thing, however, will give you an idea of what is coming. Have you heard anyone speak of loop transmission? Probably, like the Englishman's, the comment was that it couldn't be done over any distance.

In France, an English loop transmitter accomplished the remarkable feat of sending three miles. The men at the American Signal Corps field laboratory just smiled at that report, rubbed their bumps of Yankee ingenuity and produced a loop transmitter that worked over forty-five miles. One of the men who did it is going to tell the readers of EVERYDAY about it.

Radio Engineering and Radio Experimenters

All kinds of opportunities are coming up in radio work, not only in the United States but in foreign countries as well. Men to fill these positions cannot be located readily, but they will be found through the Radio Register. Is your name among the others?

There are obvious uses of such a listing. The data required is:

Name.
Address.
Engineer or Experimenter.
Age.
Experience.
Special qualifications.
Radio station owned, if any.

Address your letters to the Radio Department, EVERYDAY ENGINEERING.

Audion-Crystal Receiver for Destroyers

A Highly Developed Receiver Manufactured by the Wireless Specialty Apparatus Company for Use on the U. S. Navy Destroyers

THE radio equipment designed by the Bureau of Steam Engineering of the U. S. Navy Department, and such designs as have been accepted by it, can be properly called the highest developments in efficient and substantial radio equipment. Dependability sums up, in a word, the construction and operation of Navy apparatus.

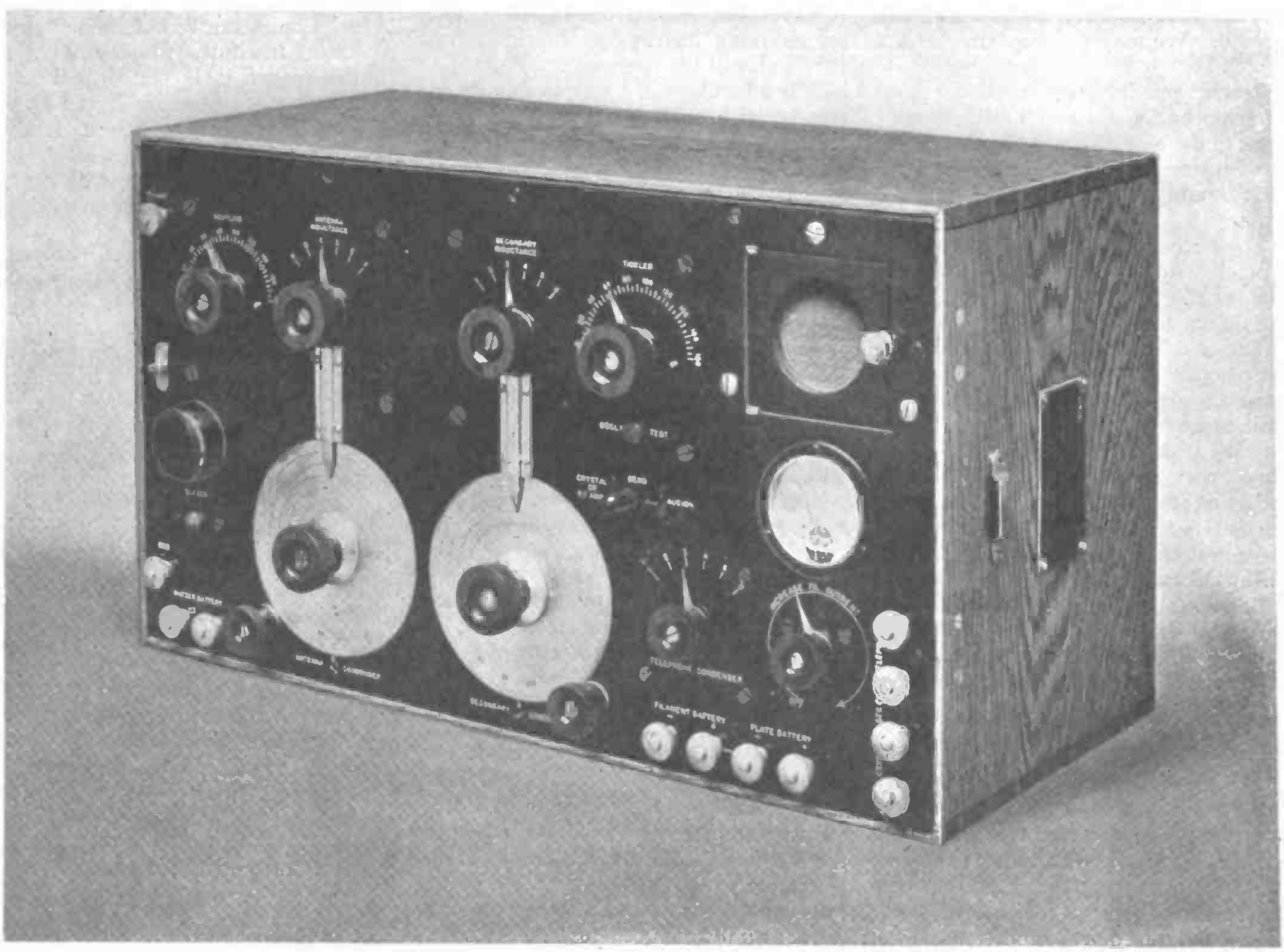


Fig. 1. Sturdy construction is an outstanding feature of this Navy set. Much of the Navy apparatus is designed by the Bureau of Steam Engineering instead of private concerns, as is largely the case with Signal Corps equipment

A typical example is the Destroyer type receiver described in this article. Fig. 1 shows the outward appearance of the set. It is intended to operate on 250 to 8,000 meters using a crystal or audion for damped wave reception, and a feed-back coupling with the audion for undamped waves.

The circuits are of the usual loosely coupled type, having a 6-step antenna inductance and series condenser for the primary, and a secondary coupling coil, 6-step inductance, and shunt tuning condenser in the secondary circuit. One-half of the condenser dials are divided into 180° scales, while the remainders are used for wavelength calibrations. As the inductance switch is turned, the pointer moves to a corresponding arc on the dial. Vernier adjustments of the condensers are provided by the handles which can be seen at the lower part of the panel near the dials.

At the left-hand side are the coupling control, safety spark gap, buzzer, and buzzer press button. On the right, the tickler coupling adjustment, oscillation test, crystal-audion switch, and telephone shunt condenser are mounted. There are also an audion mounting, filament current ammeter and rheostat.

The instruments themselves can be seen in Figs. 2 and 3. A metal shield covers the rear of the panel, to reduce interference from the body of the operator and to prevent any capacity coupling between the primary and secondary circuits.

The audion socket is of a design which absorbs vibrations, an important consideration, for vibration during operation causes a noise in the telephones and also reduces the life of the tube. Six sets of expansion-compression springs are fastened alternately to the three panel supports and the bakelite socket mounting disc, while a bakelite ring is held at the middle of all six springs. Cotton is packed lightly in the springs to prevent them from vibrating at their natural period.

Below the audion mounting is the filament rheostat. This is made up of resistance wire wound between brass pins set into the peripheries of two bakelite discs. A switch arm, passing over the set of pins next to the panel, gives the resistance regulation.

At the side of the rheostat, an adjustable mica condenser is secured to the panel. This condenser is shown in the circuit diagram between the filament side and the plate impedance. The impedance is of the closed core type; it can be seen in Fig. 2 just below the mica condenser.

The secondary inductance and tickler coil, as well as the primary and secondary coupling coil, with their 45° mounting, are illustrated in Fig. 2. Balanced condensers, with one-half of the plates at one side, and half at the other, are used in tuning the primary and secondary circuits.

Figs. 4 and 5 show the circuits employed in this set. Fig. 4 indicates the arrangement as viewed from the rear of the panel, while Fig. 5 gives the connections when the crystal-audion switch is at the audion position.

The antenna circuit is made up of a tuning condenser of 0.0015 mfd. and a six-step inductance. Instead of disconnecting the unused parts of the coil, they are simply shortcircuited by the four contact fingers. Connections are made to the first active section by the last contact and the metal segment to which the antenna is attached. Both primary and secondary switches are mounted on panels located behind the main instrument panel. A small coil, put around the antenna lead, is joined at one end to the armature of the buzzer. Excitation is obtained in this way for the buzzer test. The shield which covers the rear of the panel is wired to the ground, to prevent interference from the hands of the operator.

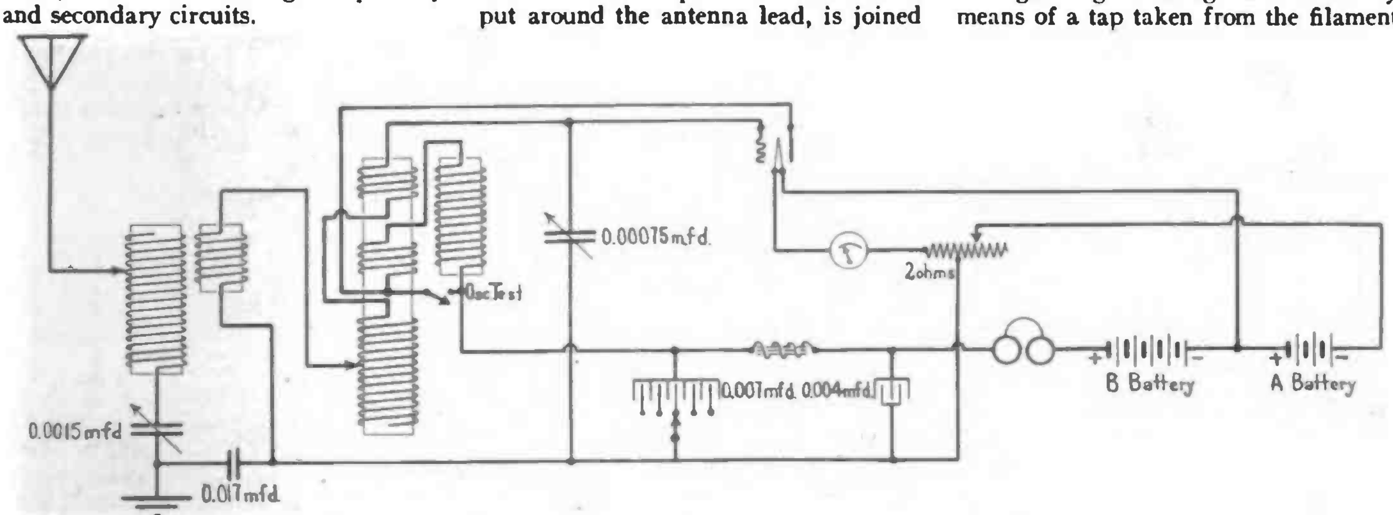


Fig. 5. An unusual arrangement is used for the secondary and tickler. The inductance of the tickler is varied by the variometer method as the coupling to the secondary is changed

Fig. 5 shows that there is a small coil, in series with the secondary tuning inductance, coupled to the primary. At the end of the secondary is a rather unusual arrangement for tickler coupling, in which a part of the tickler inductance is wound on the secondary tube, and the remainder on a separate form. A short-circuiting switch is provided around the tickler to test for oscillating.

Negative grid voltage is obtained by means of a tap taken from the filament rheostat so that 2 ohms resistance are always in the circuit to the grid. Since the positive terminal of the filament battery goes directly to the filament, the grid tap from the rheostat is more negative than the filament by an amount depending upon the current through the filament circuit. In other words, the difference in potential across the 2 ohms

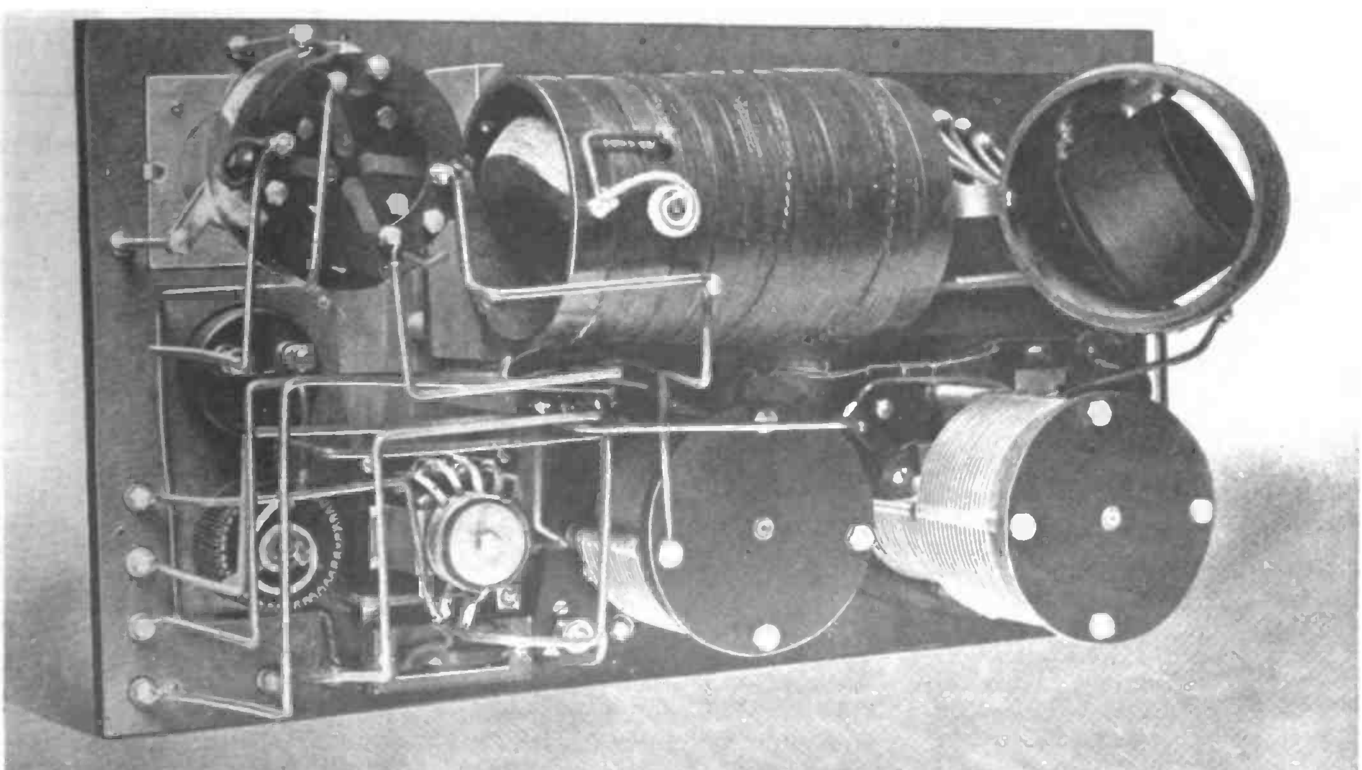


Fig. 2. A 45° mounting is used for the antenna inductance and secondary coupling coil, as will be seen in this rear view

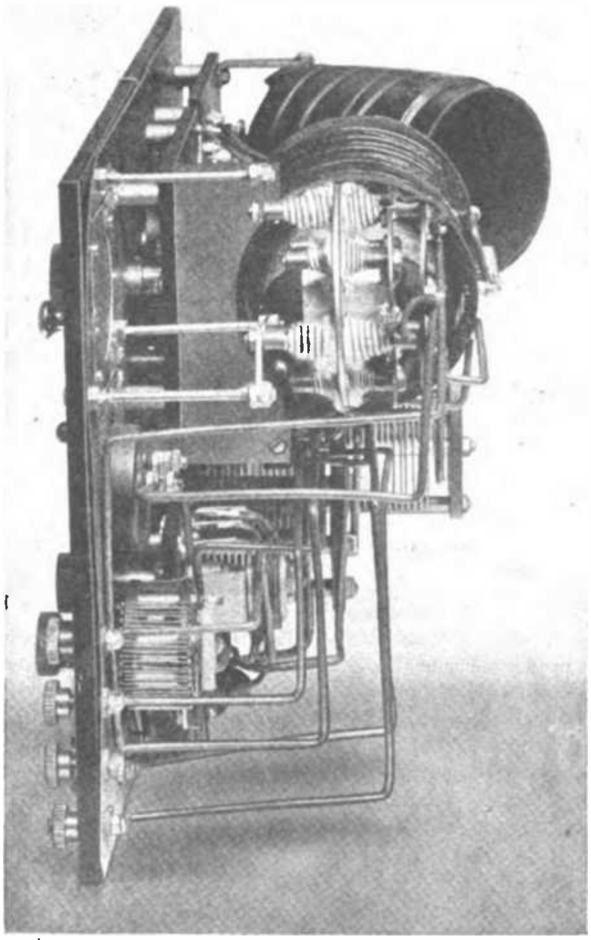
is where
E = I x R,
E = difference in potential,
I = current through resistance,
and R = resistance.

If, therefore, 1.3 amperes is flowing in the circuit, the negative grid potential will be

E = 1.3 x 2

or grid potential—2.6 volts.

impedance, and telephones are in series around the secondary tuning condenser, with the fixed condenser around the phones, and the adjustable condenser across detector and tuning condenser.



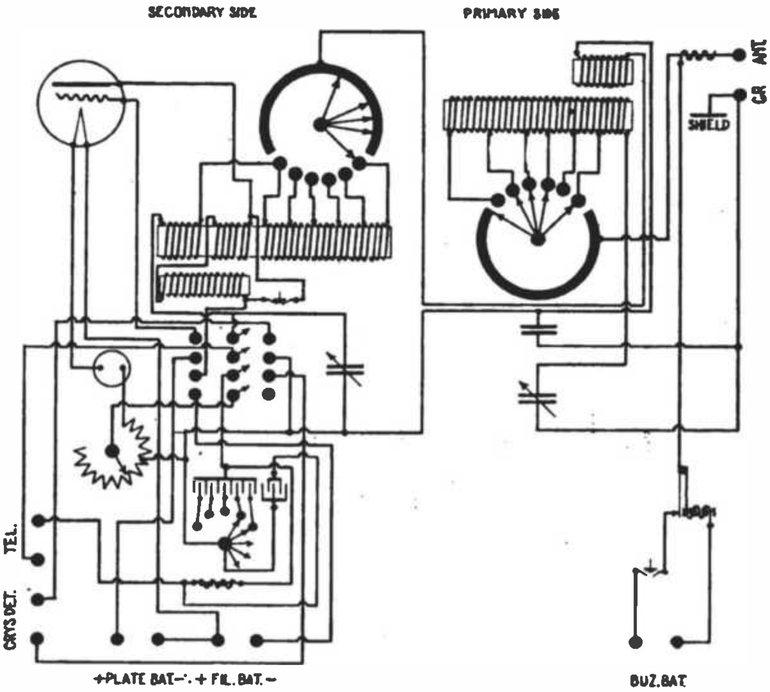


Fig. 3. Left, a side view of the set, showing particularly the audion, mounting. Fig. 4. Above, connections for the instruments as they appear from the back of the panel

In the plate circuit there is a small impedance and two condensers, one fixed, of 0.0004 mfd. and one variable in six-step up to 0.007 mfd. The latter is shunted across the battery and telephones.

When the set is connected for the use of a crystal detector, the detecor

At the detector adjustment, if no crytsal detector is used, a radio frequency amplifier and detector can be connected to the adjacent crystal and phone posts. These posts lead directly to the secondary condenser, so that the tickler and all the local audion circuits are not connected.

This set offers a number of features which should suggest new ideas to those who are building their own apparatus.

Coded Messages to be sent by the Navy for Code Practice

By authority of the Director Naval Communications, commencing October 5th, a code broadcast schedule, addressed to all amateurs, will be transmitted by the Naval Radio Station, 44 Whitehall Street, on 1500 meters. This broadcast will be transmitted immediately following the 9:00 P. M. press schedule.

Various items of interest to amateurs, such as the establishment of new stations and changes in wave lengths of high power stations, will be transmitted in this broadcast schedule.

Copies of the code to be used may be obtained by any amateur by sending a request to the District Communication Superintendent, 44 Whitehall Street, New York City. When writing this request an amateur should give the following information:

1. Name.
2. Address.
3. Age.
4. Date concerning any military service.
5. Commercial experience, if any performed.
6. Class of operator's license, if any.
7. Number of words per minute he can copy.
8. Education.
9. Size and power of transmitting set, if any erected.
10. Type of undamped wave receiver, if one installed.
11. Name of any radio organization or club to which he may belong.

The object of this radio broadcast is to maintain the interest of radio amateurs and to train them in receiving code.

It is expected that, later on, the signals will be undamped.

Book Review

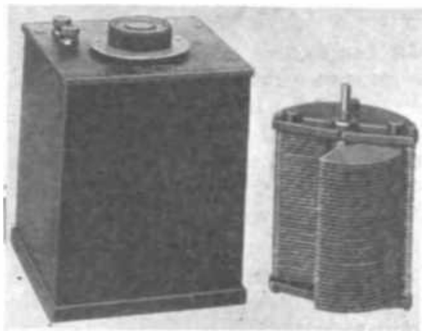
PRINCIPLES OF TRANSFORMER DESIGN, by Alfred Still. 216 pages; 5 x 7¼ inches; 67 illustrations; cloth binding; price $2.25. Published by John Wiley & Sons, Inc., New York City.

Experimenters during some phase of their work almost always run up against problems in building transformers for various purposes. Mr. Still in his new book does not go into complex formulas and difficult calculations, but presents, in a way that can be readily understood, the various problems of transformer design. The six chapters carry the reader through a discussion of various types and constructions; the insulation of high tension transformers; efficiency and heating; magnetic leakage; reactance and regulation; procedure in designing transformers and transformers for special purposes.

This book has much of interest to radio men, as well as general electrical experimenters, as it will serve as a complete guide for those who make their own transformers.

A Variable Air Condenser

THE variable air condenser shown in the accompanying illustration is designed not only for use in radio receiving sets, or vacuum tube transmitters, but as a laboratory standard as well. While this type of condenser does not incorporate the extreme refinements which have been advanced,

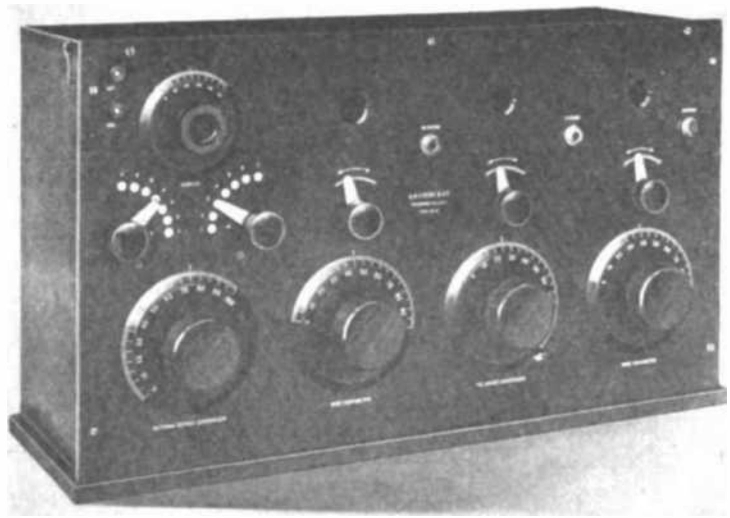


it is entirely suitable for work where a calibrated condenser of ordinary accuracy is required.

Considerable care in design and manufacture is used to give perfectly tight bearings to prevent variations in capacity from continued use. Cast bakelite and plates provide a maximum of insulation. The top plate also serves for mounting the condenser on a panel. Instruments of this type are made with capacities of 0.0015, 0.003 and 0.005 mfd.

A Short Wave Receiver and Two-Step Amplifier

ONE of the new receivers in the line brought out by the A. H. Grebe Company is made up of a short-wave regenerative set and a two-stage amplifier. Operators who are preparing for long distance relay work will find that this set covers all that they can require.



The wavelength controls, consisting of inductance, condenser, and coupling adjustments, are at the left of the panel. Looking toward the right, on the bottom row, are the grid variometer, telephone shunt condenser and wing variometer. Three rheostats are provided for the tubes, the brilliancy of which can be observed through the openings in the panel.

Connections for the telephones are made in any one of three plug switches, marked DETECTOR, 1ST STAGE and 2ND STAGE.

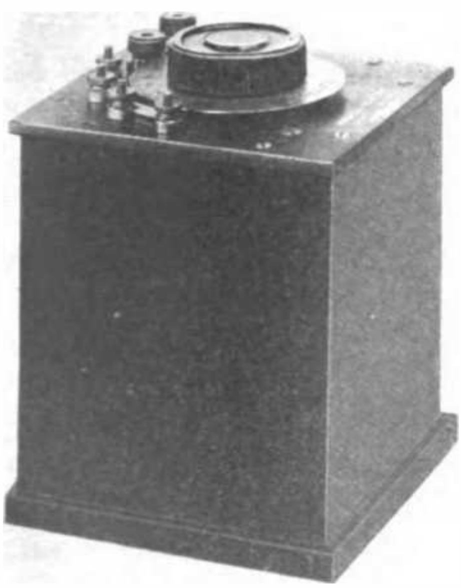
One feature of this set is the arrangement of the telephone switches. Inserting the phone plug at the first jack lights the detector filament and puts only that part in operation. The same is done at the two steps of amplification.

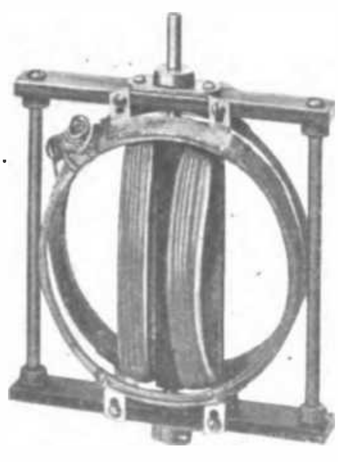
All the internal apparatus is mounted on the panel, so that the set can be removed as a unit from the case. A hinged top gives access to the vacuum tubes.

In a discussion of high powered transmitting vs. high powered receiving, this set presents strong argument for the latter case.

A Variometer with Self-Supporting Windings

A CHANGE in the usual methods of making variometers is incorporated in the type shown here. The method of winding possesses advantages which will appeal to those who





are interested in making their own equipment.

In the instrument shown, the windings are made of high frequency cable wound on spherical forms. Then they are impregnated so that the wires are held together firmly, making a solid unit. The coils have several layers wound by the banked method. The two inside coils are secured to a bakelite strip in the ends of which the shaft is held. The square frame carries, at the top and bottom, brass pieces to which the outer coils are bound. By using spherical forms, the coils can be made very close to each other, giving a maximum inductance range.

Connections on the panel make it possible to join the outer and inner coils in series or parallel. An inductance range of approximately one to fifty can be obtained. That is, a small size gives a variation of 0.008 to 0.4 mh., and the largest size 0.4 to 20.0 mh.

Audion Hints

When there is an unusual rumbling in the telephones, examine the contact points in the audion. Oftentimes they become slightly oxidized and form a microphonic contact.

Do not use sandpaper or a file on the points. Simply hold the tube firmly in an upright position and rub the points over a sheet of clean paper.

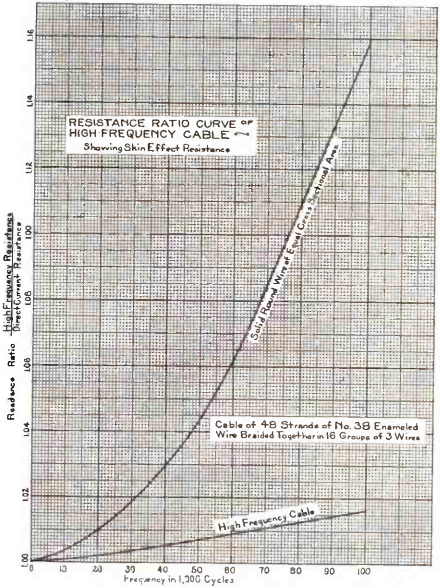
Another cause of noises is a poor grid or plate connection at the socket. Although sockets now supplied are fitted with screews, the wires should be soldered. There is such an infinitesimal amount of current at best that no precaution should be overlooked to prevent a loss of energy.

High Frequency Resistance

Showing the Results of Skin Effects at Radio Frequencies

HIGH frequency cable, or what was known before the war as Litzendraht, has come into wide use for radio equipment. The purpose of its use is to reduce resistance, desirable because energy is lost the frequency is increased this effect becomes more marked, and the resistance is increased very considerably.

The most useful way to express the increase is as a resistance ratio, or the number of times greater the resistance



in resistance, and because resistance makes the tuning of a receiver less sharp.

Various kinds of high frequency cables are made, some of which are advantageous, and some are not. This cable, strictly speaking, is made of a number of wires individually insulated from each other. Stranded bare wire should not come under this name.

It has been determined that, at high frequencies, electricity travels on the surface of conductors, instead of distributing itself through the wire. As is at high frequencies than with direct current. The ratio is

$$\text{Resistance Ratio} = \frac{R_1}{R}$$

where

R_1=High frequency resistance
R=Direct current resistance,

that is, if the resistance of a given straight length of wire is 100 ohms at 50,000 cycles, and the direct current resistance for this same wire is 50 ohms, the resistance ratio is 2. Therefore, any amount of this wire will have 2 times the resistance, at 50,000 cycles, that it has with direct current.

When bare wire strands are used, the outside and inside conducting areas are not much greater than solid wires of equivalent cross section. Also, there is a tendency for the current to flow from one wire to the next, and the imperfect contacts introduce resistance. Therefore, there is no advantage in its use.

In conductors of insulated strands, the resistance ratio falls as the strands are separated. It is essential, however, that the material used to space the wires shall be a good dielectric. This result is accompanied by using an enamel insulation on the wires.

Some cables are made with a slight twisting or spiralling of the wires, others have groups of twisted wires twisted together. Another method is to braid the wires in the form of a hollow tube. The first method increases the resistance ratio; the second effects a slight reduction, while the third is best of all.

The lower curve here shows the resistance ratio, at frequencies of 0 to 100,000 cycles, for standard Roebling cable made of 48 strands of No. 38 enameled wire. The strands are divided into 16 groups, which are braided together to form a hollow tube. Another curve is given to show the rapid increase in resistance of a solid wire equivalent in conducting area to the cable.

The advantage of the use of high frequency cable is clearly shown in the curve. At 0 cycles, or direct current, the resistance of both are the same. At 100,000 cycles, corresponding to a wavelength of 3,000 meters, the cable has a resistance only 1.016 times that with direct current, while the solid wire goes up to 1.16 times.

Winding wire into coils increases its resistance, and with multi-layer or pancake coils it is more than with a simple layer solenoid.

The standard cable sizes are 10-No. 38, 20-No. 38, and 3-16 No. 38. Large inductances are generally wound with 10-38 if the space is limited. This size is particularly easy to handle in making banked windings, as it is stiffer in proportion to its diameter than the larger cables.

20-38 should be used where space will permit. The diameter is not much greater than that of 10-38, and its resistance lower. 3-16-38 is used almost exclusively on U. S. Navy receivers and is also employed for audion transmitter inductances. The losses in transmitting circuits are of great importance, and it has been found that one of the first precautions to be taken is the use of heavily stranded cable.

Composition of Brazing Brass

THIS term is usually applied to yellow brasses, of composition ranging from 80 to 85 per cent copper and 20 to 15 per cent zinc, which will stand brazing with ordinary yellow brazing solder (50 copper, 50 zinc) without melting or cracking. These defects are liable with the brasses of low copper content, such as 60—40, on account of their lower melting points. If tin is present in the brazing brass cracking is liable to occur, while lead also should be absent. The 80 copper, 20 zinc mixture is yellow in color, but when the zinc is reduced to 15 per cent, with 85 per cent copper, the metal has an orange tint. The melting point of the lower zinc mixture is, of course, slightly the lighter of the two, and hence it is the more suitable, unless the color is a matter of importance.

Testing Plating Solutions

PLATING solutions evaporate much more rapidly than is usually imagined. In a warm plating room, with a large surface that is exposed to the air, evaporation is continually going on. The plating solution, therefore, is constantly becoming concentrated. At least once a week the plater should test the solution with a hydrometer, and add what water is necessary for bringing the bath up to the right degree. Many platers who usually neglect this operation will be surprised at the quantity of water which has evaporated prior to making their tests.

An Interesting Magnetic Alloy

AN interesting alloy with marked magnetic properties, known as Heussler alloy, can be produced by the experimenter. A mixture of powdered manganese and antimony in the proportion 1 : 3 is placed in a test tube and heated over a bunsen flame. The resulting alloy possesses remarkable magnetic characteristics. It is strongly magnetic and filings of the alloy may be used in place of iron filings used ordinarily.

Waterproofing Blue Prints

Immerse a number of pieces of an absorbent cloth about one foot square in melted paraffin until saturated. When withdrawn and cooled they are ready for use at any time. To treat a blue print, spread one of the waxed cloths on a smooth surface, place the dry print on it with a second cloth on top, and iron with a moderately hot flatiron. The paper absorbs paraffin from the cloth until saturated, and becomes translucent and completely waterproof.

Reciprocating Engines

The *Practical Engineer* states that the turbine has definitely become recognized as the most efficient type of engine for the propulsion of steam-driven ships. and many prophets go so far as to say that, in conjunction with double reduction gearing, it will very soon entirely displace the steam reciprocating engine. With this view we are not disposed to agree; both on account of its greater reliability and because it is far simpler to manage it will long be utilized for the propulsion of tramp steamers and cargo vessels of low power, where engineers of the highest skill are seldom employed; and for this reason attempts will continue to be made to improve the efficiency of the reciprocating set. It is hardly likely that any fundamental changes will occur, but attention to details is often instrumental in bringing about a considerable economy in operation. One of the most important details, and one which is worthy of the closest attention of designers, is the arrangement of steam ports. With a view to reducing the clearance volume to a minimum, short straight steam ports at the ends of the cylinder can be employed in conjunction with a long valve. this having the additional advantage of reducing the internal surface, which is cooled by the passage of the exhaust steam, and upon which the incoming steam will condense. Again, the cylinder covers should make joint with the possible; in this way, while the clearance volume may be unaffected, the internal surface upon which steam may condense is again reduced to a minimum.

To Loosen a Glass Stopper

Make a mixture of:

Alcohol ....2 drachms
Glycerine ....1 drachm
Sodium Chloride..1 drachm

Let a portion of this stand in the space above the stopper for a few hours, when a slight tap should loosen the stopper. A circular adjustable clamp, to which is attached a strip of asbestos in which coils of platinum wire are imbedded, is obtained. By placing this on the neck of the bottle, and passing a current of electricity through the coils of wire, sufficient heat will be generated to expand the neck and liberate the stopper. Heat may also be generated by passing a yard of cord once around the bottle neck and by taking one end of the cord in each hand, drawing it rapidly back and forth. Care should be taken that the contents of the bottle are not spilled on the hand or thrown into the face when the stopper does come out.

Cutting Lubricants

An authority claims that "sticky" water is the best cooling media for general purposes. Half a pound of soft soap to 1 gallon of soft water, with the possible addition of 3 per cent caustic soda, gives a very good general purpose emulsion for the usual machine shop. The amount of soap should be lessened in cold weather. Plain water splashes too much, the addition of the soft soap beside its lubricating qualities increased the skin tension of the fluid, and caused more intimate adhesion of the fluid to work, chip and tool. There is considerable choice in the matter of soft soap; some is perfectly bland, some has the vilest odor and color imaginable. After all, it depends upon the initial ingredients, and whatever these are in a cutting emulsion, the oil must first be saponified to emulsify. In the case of soft soap made from good vegetable oil the first stage on the road to emulsification has already been performed. Caustic soda, if added, tends to prevent rust. Submerged bath lubrication with a load not too severe (under 50 pounds per square inch) and without agitation, are conditions where a solution of soft soap and distilled water will give perfect results at a lower cost than oil. If a strong solution is first made, diluted to half strength for use, a daily addition of a small quantity of the strong liquor will rectify the fluid and prevent deterioration. For all practical purposes the fluid with the highest specific heat is the best cooler —in other words, water is better than oil in this connection. To get the best results from soft soap distilled or condensed steam water is far and away the best.

An interesting point in the operation of the gyroscopic stabilizer on vessels is its apparently insufficient size. It seems impossible that so small an apparatus should effect so fully the stabilizing of a ship of a size altogether disproportionate to the instrument restraining its motions in a seaway. The power of the instrument and its action without straining the ship is due to the fact that the motions of a ship are due to successive impulses from waves, one following the other, but neither having more than 4° effect on the vessel. Therefore, in a case where a ship might roll through 30° or more, such roll would be due to the actions of a number of waves. The gyroscope with only what may be called a 4° power will control a ship in such a case, taking care of each wave as it comes along, and never having more than a possible roll of 4° to take care of; hence its small size and power over a very large ship's motions.

Everyday Science Notes

By Prof. T. O'Connor Sloane

It is found that as illuminating and heating gas is now made, there is a considerable tendency for it to corrode the pipes, especially if there is any moisture present. The removal of water has become an object and in England the Helps system is under trial. To carry this out the gas is compressed and cooled so as to cause the water to precipitate. It is then released from pressure and admitted to the mains at greatly reduced pressure, practically free from water. As much as fifty pounds compression is cited as having been given in one case. Cyanogen acids are largely at the root of the trouble, and here a sort of paradox is encountered. If moist gas is exposed to the action of steam and incandescent coke the cyanogen radical gives ammoniacal gas. Here the presence of water is desirable, for if ammoniacal gas is exposed to incandescent coke in the absence of steam it gives the troublesome cyanogen compounds again.

The catalytic process of making sulphuric acid has to an extent revolutionized the old-time industry, the sulphurous acid gas being passed over finely divided platinum, to bring about its combination with oxygen. It has greatly cheapened the production of fuming sulphuric acid, now in extensive demand by manufacturing chemists, the acid costing only one-tenth the old price. At first, in the catalytic process gas made from pyrite gave trouble, but that has been overcome. The platinum is very expensive. The metal for a single plant may at present prices easily cost half a million of dollars.

The *London Engineer* describes and illustrates two Newcomen steam engines which have been running since the years 1787 and 1823 respectively, so it is supposed. This engine, it will be remembered, antedates Watts' invention of the condenser; the steam entered below the piston and forced it up. At the end of the stroke the steam was cut off and a jet of water was discharged into the steam-filled cylinder, condensing the steam so that the atmospheric pressure operated to force the piston down. The engine did its work on the down stroke only, the heavy pump rods worked the pump on the up stroke, for the engines are of the beam engine type. Originally a chain connected the outer end of the beam to the pump-rods. These, of course, in some cases were extremely long.

One of the curiosities in the history of the development of incandescent electric lighting relates to the metal osmium, which it was proposed to employ as the filament. The high conductivity of the metal and its fragility operated against its use. But the curious fact is, that although one pound of the metal will make 30,000 filaments, it is estimated that there is not in the whole world enough osmium available to provide a year's supply of filaments.

Heat detecting paints to be applied to shafts and bearings, and which paints change color if the bearings became heated and so call the attention of the operator to the fact that a little oil is needed, have long been known. Two formulas have recently been published of double iodides. The first one is cuprous mercuric iodide, Cu_2I_2, $2HgI_2$. This is a vivid vermillion when cold, but changes to chocolate well below the temperature of boiling water, at about 150° F. The other compound is silver mercuric iodide, $Ag\,I$, $Hg\,I_2$. This is lemon yellow at ordinary temperatures and changes to carmine red at a point just below the boiling point of water. A mixture of 85% of the first compound with 15% of the second is vermillion when cold and black when hot. They are readily made by triturating the two salts in proper proportions in a mortar together, or may be precipitated from solution, potassium iodide being employed to dissolve the mercury iodide. White shellac varnish or acetone varnish are recommended as mediums for their application. It is well to paint a band or other surface of white next to them on the shaft or bearing to act as a contrasting object.

A. N. Winchell and E. R. Miller have published an account of their observations on a dust fall, which extended over the states of Wisconsin and Michigan, on March 8th, 1918. Vast quantities of dust were transported by a wind storm probably from Arizona or the old Indian Territory region. The evidence gathered went to show that one million tons of rock were carried a distance of over one thousand miles, showing what profound geological changes may be brought about by the agency of the wind.

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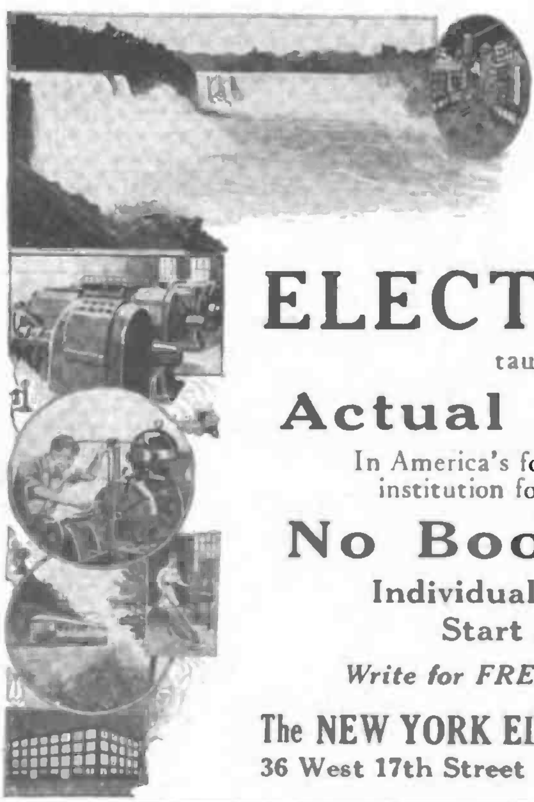

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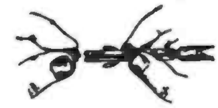

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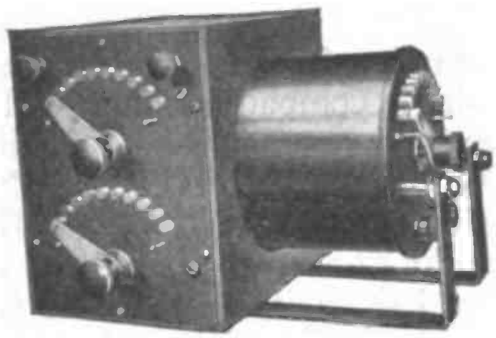

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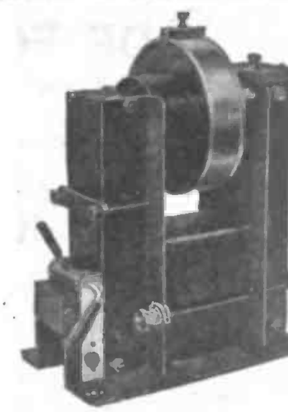

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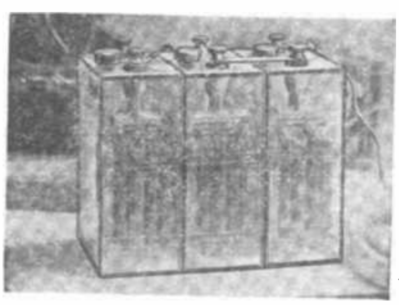

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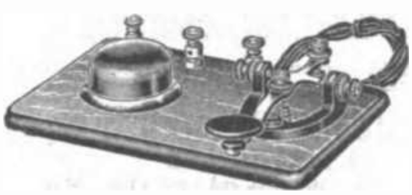

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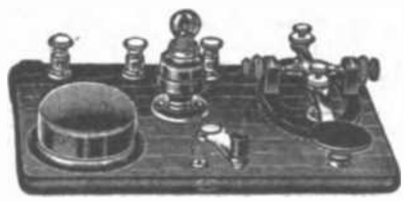

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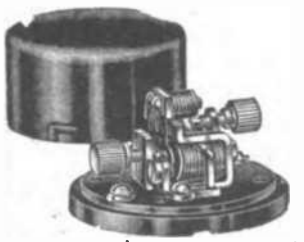

This buzzer maintains a constant note and is recommended as an exciter for checking wavemeters where pure note and ample energy are required.

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 Condensite base to insure constancy in operation.

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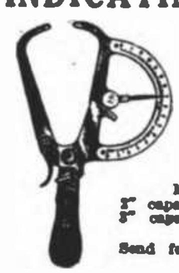

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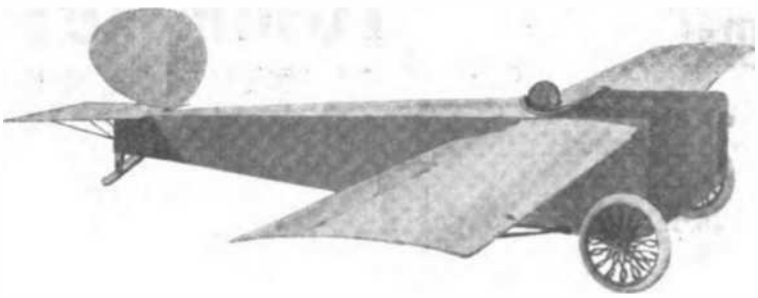

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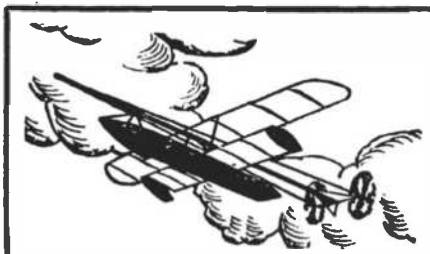

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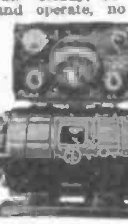

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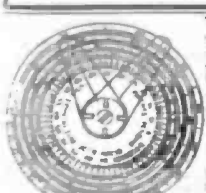

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