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IT makes no difference whether a shop contains ten thousand or ten dollars' worth of tools. It is a shop just the same, and its owner will enjoy it regardless of its value. Probably the man who has just a few tools enjoys his shop more than the man who has every conceivable device to help him in his work. The chap with a few tools must use ingenuity; he must display resourcefulness to accomplish various difficult operations, and this he enjoys. True, his shop's capacity for work is not great, but he obtains just as much pleasure as the fellow with a complete outfit.

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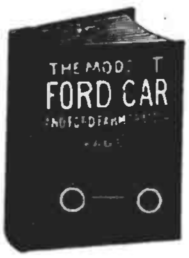

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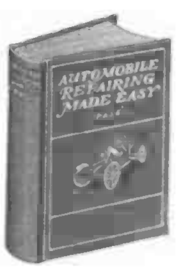

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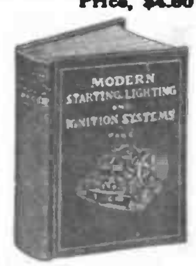

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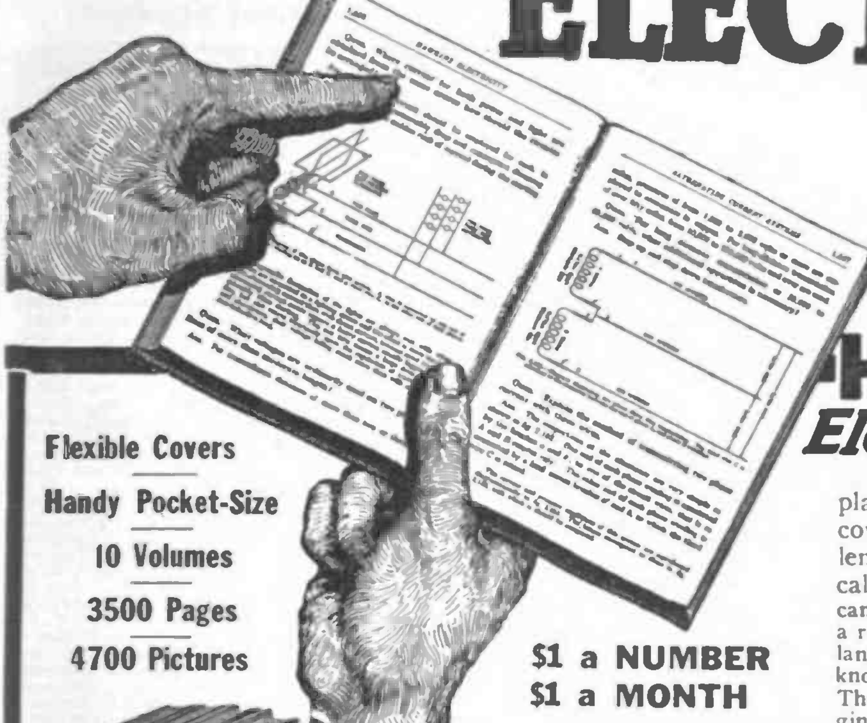

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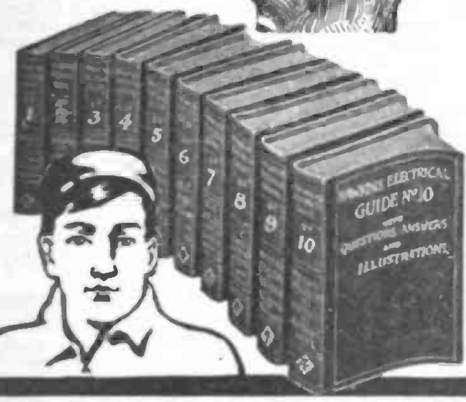

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Operating Principles of Rotary Engines

A Non-technical Description of the Gnome and Le Rhone Revolving Cylinder, Fixed Crankshaft Aviation Engines Detailing Principles of Operation and Features of Construction

By Victor W. Pagė, M. S. A. E.

THOUSANDS of rotary engines were used by the Allies during the past emergency on scout planes employed in active service both for operations against the enemy and for training pilots at the various aviation schools in this country and Europe. Some of the most successful airplanes devised have used rotary cylinder-fixed crank engines for power, and this interesting type has much to commend it for airplane use. The engines are easily installed and the design makes for a short, easily manoeuvered fuselage and a compact placing of power plant, controls and pilot that is so essential in the scout plane.

Rotary Engines Easy to Maintain

The revolving cylinder engine is a very easy type to overhaul and keep in condition because it is simple and compact in construction and practically all bearings are of the anti-friction type. These bearings do not require refitting every time the engine is overhauled, as is necessary with the plain bearing fixed cylinder, revolving crankshaft engines. Rotary engines are easily dismantled when repairs are necessary. The Le Rhone type has been found to be more enduring than the Gnome in the writer's experience, the former giving an average useful service of 75 flight hours between overhaulings, the latter seldom running more than 50 hours. It requires about 60 man-hours, or two men working 30 hours to overhaul a rotary engine if new rings must be fitted, all parts thoroughly cleaned, carbon removed and valves ground and have it ready for the test stand. With the conventional eight or twelve cylinder V-type it requires about twice as much time to do any kind of a job of overhauling, especially if crankshaft and connecting rod bearings must be fitted. As for ease of replacement, a crew of three men has taken a rotary engine out of fuselage and replaced it in eight minutes, a feat impossible of duplication with any conventional water cooled V-type or cylinders-in-line form. The fixed cylinder engines have a longer useful life, however, and it is not unusual to get 100 hours' flying time before cleaning is necessary. Some Curtiss OX5 engines have been run 120 flight hours without cleaning and Liberty engines have been operated for even longer periods without repairs being necessary.

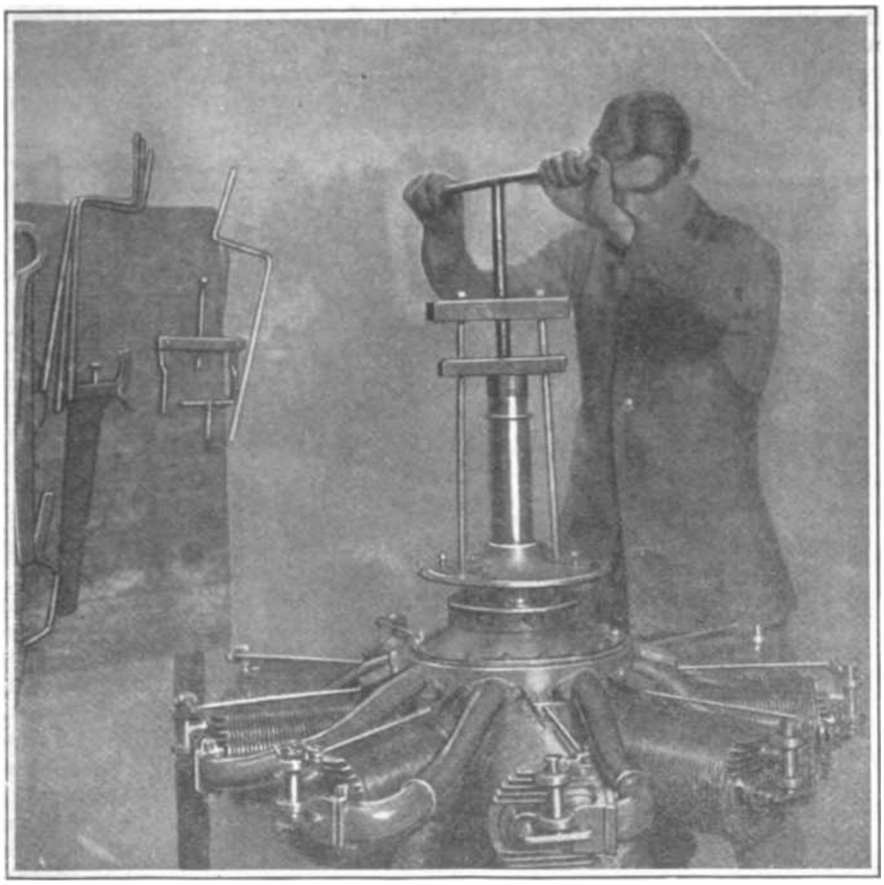


Fig. 1. American soldier-mechanic overhauling Le Rhone rotary motor. Special puller shown was developed for removing engine supporting plates

Design Permits Light Construction

Rotary engines are generally associated with the idea of light construction and it is rather an interesting point that the reason why rotary engines are popularly supposed to be lighter than the others is because they form their own fly-wheel, yet on aeroplanes engines are rarely fitted with a fly-wheel at all. As a matter of fact these engines are not light merely because they are rotary motors, but are rotary motors because that design has been adopted as that most conducive to lightness and is most suited to an engine working in this way. The cylinders of a Gnome could be fixed and crankshaft revolve without increasing the weight to any extent if the engine operated on a more conventional cycle. There are two prime factors governing the lightness of an engine, one being the initial design and the other the quality of the materials employed. The consideration of reducing weight by cutting away metal is a subsidiary method that ought not to play a part in standard practice, however useful it may be in special cases. In most rotary engines the lightness is entirely due to the initial design and to the materials employed in manufacture. Thus, in the first case the engine is a radial engine, and has its seven or nine cylinders spaced equally around a crank-chamber that is no wider, or rather, longer, than would be required for any one of the cylinders.

This shortening of the crank-chamber not only effects a considerable saving of weight on its own account, but there is a corresponding saving in the shafts and other members, the dimensions of which are governed by the size of the crank-chamber. With regards to materials, nothing but high-grade steel is used throughout, and most of the metal is forged chrome nickel steel. The steady running of these engines is largely due to the fact that there are literally no reciprocating parts in the absolute sense, the apparent reciprocation between the pistons and cylinders being solely a relative reciprocation, since both travel in circular paths, that of the pistons, however, being eccentric by one-half of the stroke length to that of the cylinder.

While the rotary engine has many advantages, on the other hand, the head resistance offered by a motor of this type is considerable; there is a large waste of lubricating oil, due to the centrifugal force which tends to throw the oil away from the cylinders; the gyroscopic effect of the rotary motor is said to be detrimental to the best working of the single engine aeroplane if of short span, and, moveover, it requires about 7 per cent of the total power developed by the motor to drive the revolving cylinders around the shaft and overcome the air resistance. Of necessity, the compression of this type of motor, which is always air cooled, is rather low, and an additional disadvantage manifests itself in the fact that there is as yet no satisfactory way of entirely muffling the rotary type of motor.

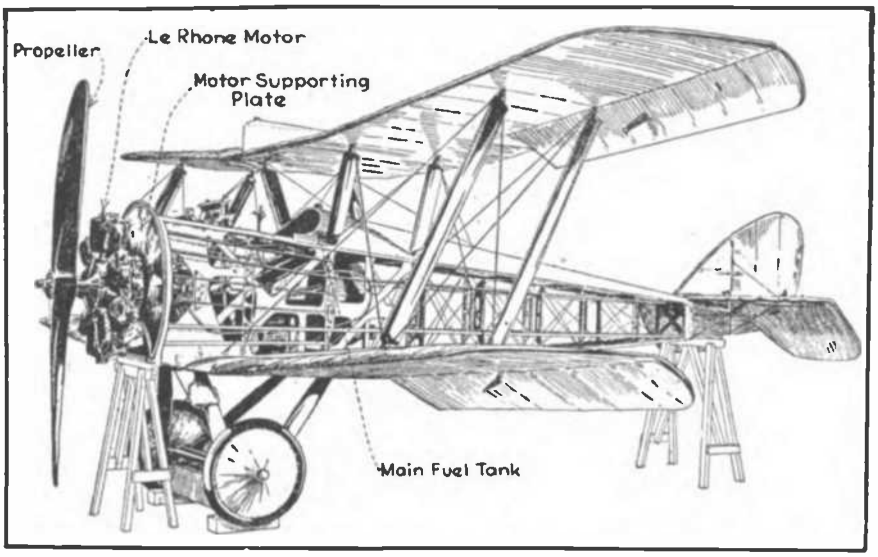


Fig. 2. View of DH-5 airplane, showing how easily rotary motor is installed

Rotary Cylinder Engine of American Origin

The modern Gnome engine has been widely copied in various European countries, but the form on which its design is based was originated in America, the early Adams-Farwell engine being the pioneer form. It has been made in three, five and nine-cylinder types and forms of double these numbers. The simple or one-crank engines have an odd number of cylinders in order to secure evenly spaced explosions. In the seven-cylinder the impulses come 102.8° apart. In the nine-cylinder form the power strokes are spaced 80° apart. The fourteen-cylinder engine is virtually two seven-cylinder types mounted together, the cranks being opposed just the same as in a double cylinder horizontal motor, the explosions coming 51.4° apart, while in the eighteen-cylinder model the power impulses come every 40° cylinder travel. Other rotary motors have been devised, such as the Le Rhone and the Clerget in France and copies of these types in other countries. The speed of a rotary cylinder engine is limited to a greater degree than any other form, and it is not safe to run them over 1200 r.p.m. owing to stresses produced by centrifugal force at higher speeds. The writer has seen an engine under test "throw a cylinder" when run at 1500 r.p.m. for trial purposes.

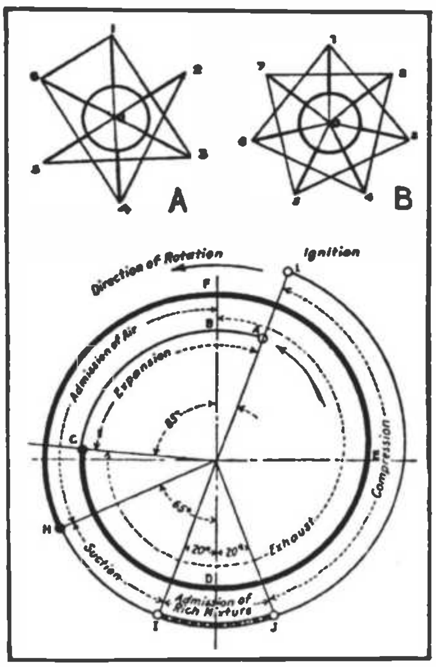


Fig. 3. Diagrams at A and B show why rotary cylinder engines operating on single crank should have odd number of cylinders. Gnome Monosoupape timing diagram shown below

Why an Odd Number of Cylinders Is Used

Many people doubtless wonder why single crank rotary engines are usually provided with an odd number of cylinders in perference to an even number. It is a matter of even torque, as can easily be understood from the accompanying diagram. Fig. 3A represents a six-cylinder rotary engine, the radial lines indicating the cylinders. It is possible to fire the charges in two ways if the engine is a four-cycle type, firstly in rotation, 1, 2, 3, 4, 5, 6, thus having six impulses in one revolution and none in the next; or alternately, 1, 3, 5, 2, 4, 6, in which case the engine will have turned through an equal number of degrees between impulses 1 and 3, and 3 and 5, but a greater number between 5 and 2, even again between 2 and 4, 4 and 6, and a less number between 6 and 1, as will be clearly seen by reference to the diagram. Referring to Fig. 3B, which represents a seven-cylinder engine, if the cylinders fire alternately it is obvious that the engine turns through an equal number of degrees between each impulse, thus, 1, 3, 5, 7, 2, 4, 6, 1, 3, etc. Thus, supposing the engine to be revolving, the explosion takes place as each alternate cylinder passes, for instance, the point 1 on the diagram, and the ignition is actually operated in this way by a single contact brush that ditsributes the current to contact segments on the distributor plate.

Rotary Engines Easily Installed

When rotary engines are installed, simple steel stampings or "spiders" are attached to the fuselage to hold the fixed crankshaft. Inasmuch as the motor projects clear of the fuselage proper there is plenty of room back of the front spider plate to install the auxiliary parts, such as the oil pump, air pump and ignition magneto, and also the fuel and oil containers. The diagram given at Fig. 4 shows how a Gnome "monosoupape" engine is installed on the anchorage plates, and it also outlines clearly the piping necessary to convey the oil and fuel and also the air-piping needed to put pressure on both fuel and oil tanks to insure positive supply of these liquids, which may be carried in tanks placed lower than the motor in some installations. The view of the DH5 biplane single-seater scout with rotary motor installed but motor cowling removed shows how simple this installation is, the engine in this case being a 110 h.p. Le Rhone.

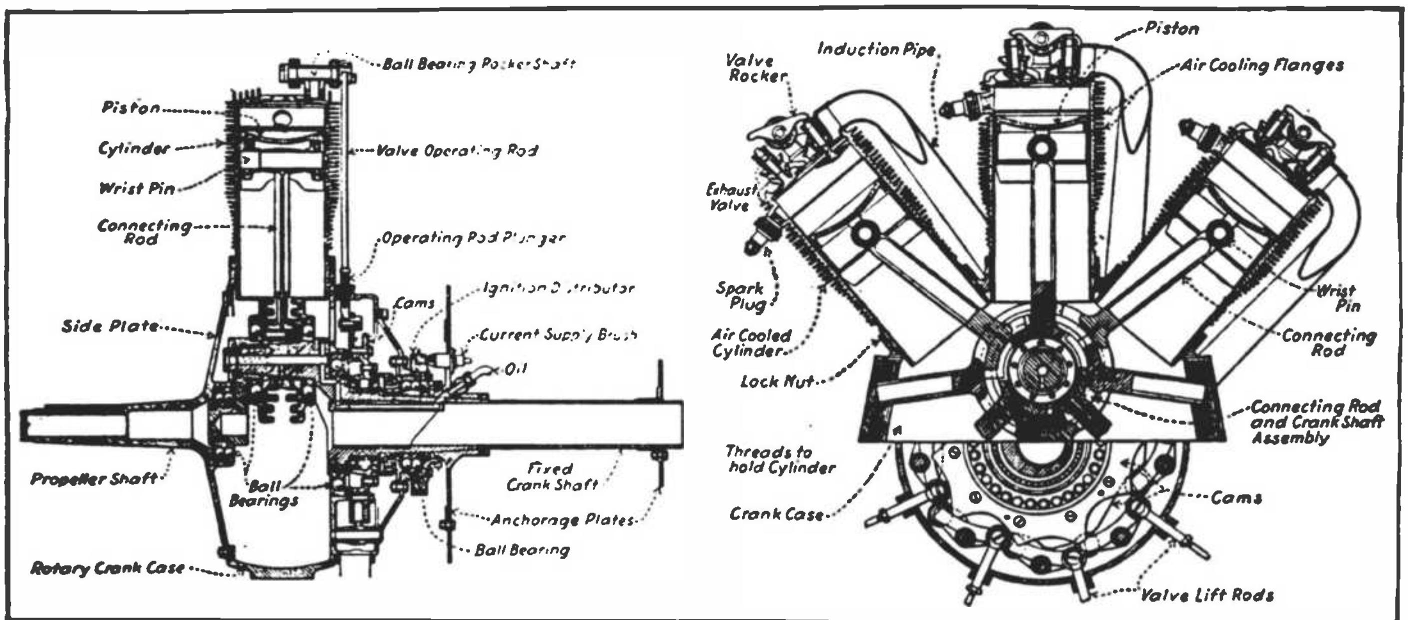


Fig. 6. Sectional view of Le Rhone rotary cylinder fixed crankshaft airplane engine, showing novel connecting rod arrangement and method of valve actuation

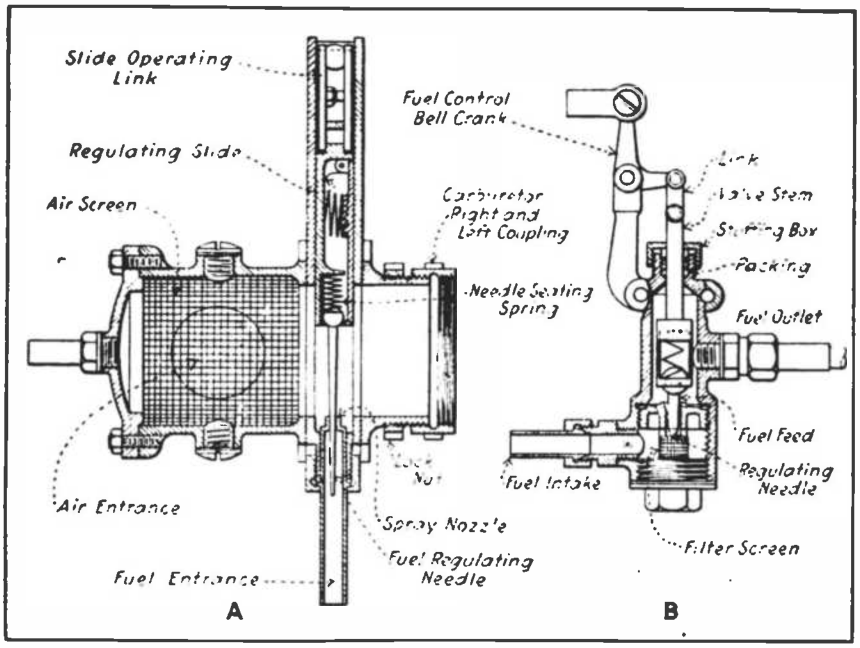


Fig. 7. The Le Rhone carburetor at A and Fuel supply regulating device at B

Gnome "Monosoupape" Type

The latest type of Gnome engine is known as the "monosoupape" type, because but one valve is used in the cylinder head, the inlet valve in the piston being dispensed with on account of the trouble caused by that member on earliest engines. The construction of this latest type follows the lines established in the earlier designs to some extent and it differs only in the method of charging. The very rich mixture of gas and air is forced into the crank-case through the crankshaft, and enters the cylinder when the piston is at its lowest position, through the half-round openings in the guiding flange and the small holes or ports machined in the cylinder and clearly shown at Fig. 5. The returning piston covers the port, and the gas is compressed and fired in the usual way. The exhaust is through a large single valve in the cylinder head, which gives rise to the name "monosoupape," or single-valve motor, and this valve also remains open a portion of the intake stroke to admit air into the cylinder and dilute the rich gas forced in from the carnk-case interior. Aviators who have used the early form of Gnome say that the inlet valve in the piston type was prone to catch on fire if any valve defect materialized, but the "monosoupape" pattern is said to be nearly free of this danger. The bore of the 100-horsepower nine-cylinder engine is 110 mm., the piston stroke 150 mm. Extremely careful machine work and fitting is necessary. In many parts tolerances of less than .0004" (four ten-thousandths of an inch) are all that are allowed. This is about one-sixth the thickness of the average human hair, and in other parts the size must be absolutely standard, no appreciable variation being allowable.

A still later development of the "monosoupape" is a 150-horsepower type with a special form of clack valve that has no valve spring. In other details, with the exception of the connecting rod arrangement, which is similar to that of the Le Rhone motor, it resembles the smaller model.

Gnome "Monosoupape" Valve Timing

In the present design of the Gnome motor, a cycle of operations somewhat different from that employed in the ordinary four-cycle engine is made use of. This cycle does away with the need for the usual inlet valve and makes the engine operatable with only a single valve, hence the name "monosoupape," or "single-valve." The cycle is as follows: A charge being compressed in the outer end of the cylinder, combustion chamber, it is ignited by a spark produced by the spark plug located in the side of this chamber, and the burning charge expands as the piston moves down in the cylinder while the latter revolves around the crankshaft. When the piston is about half way down on the power stroke, the exhaust valve, which is located in the center of the cylinder head, is mechanically opened, and during the following upstroke of the piston and burned gases are expelled from the cylinder through the exhaust valve directly into the atmosphere.

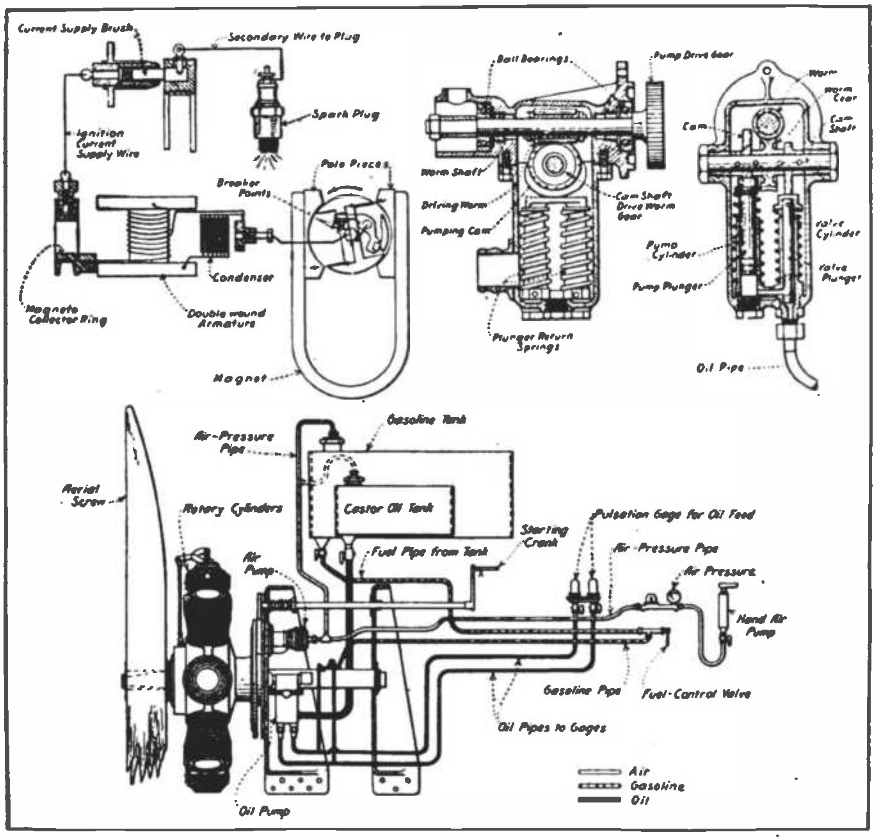


Fig. 4. Diagrams explaining action of Gnome ignition system, oil pump and showing complete power plant installation

Instead of closing at the end of the exhaust stroke, or a few degrees thereafter, the exhaust valve is held open for about two-thirds of the following inlet stroke of the piston, with the result that fresh air is drawn through the exhaust valve into the cylinder. When the cylinder is still 65° from the end of the inlet half-revolution, the exhaust valve closes. As no more air can get into the cylinder, and as the piston continues to move inwardly, it is obvious that a partial vacuum is formed.

When the cylinder approaches with 20° of the end of the inlet half-revolution a series of small inlet ports all around the circumference of the cylinder wall is uncovered by the top edge of the piston, whereby the combustion chamber is placed in communication with the crank chamber. As the pressure in the crank chamber is substantially atmospheric, and that in the combustion chamber is below atmospheric, there results a suction effect which causes the air from the crank chamber to flow into the combustion chamber. The air in the crank chamber is heavily charged with gasoline vapor, which is due to the fact that a spray nozzle connected with the gasoline supply tank is located inside the chamber. The proportion of gasoline vapor in the air in the crank chamber is several times as great as the ordinary combustible mixture drawn from a carburetor into the

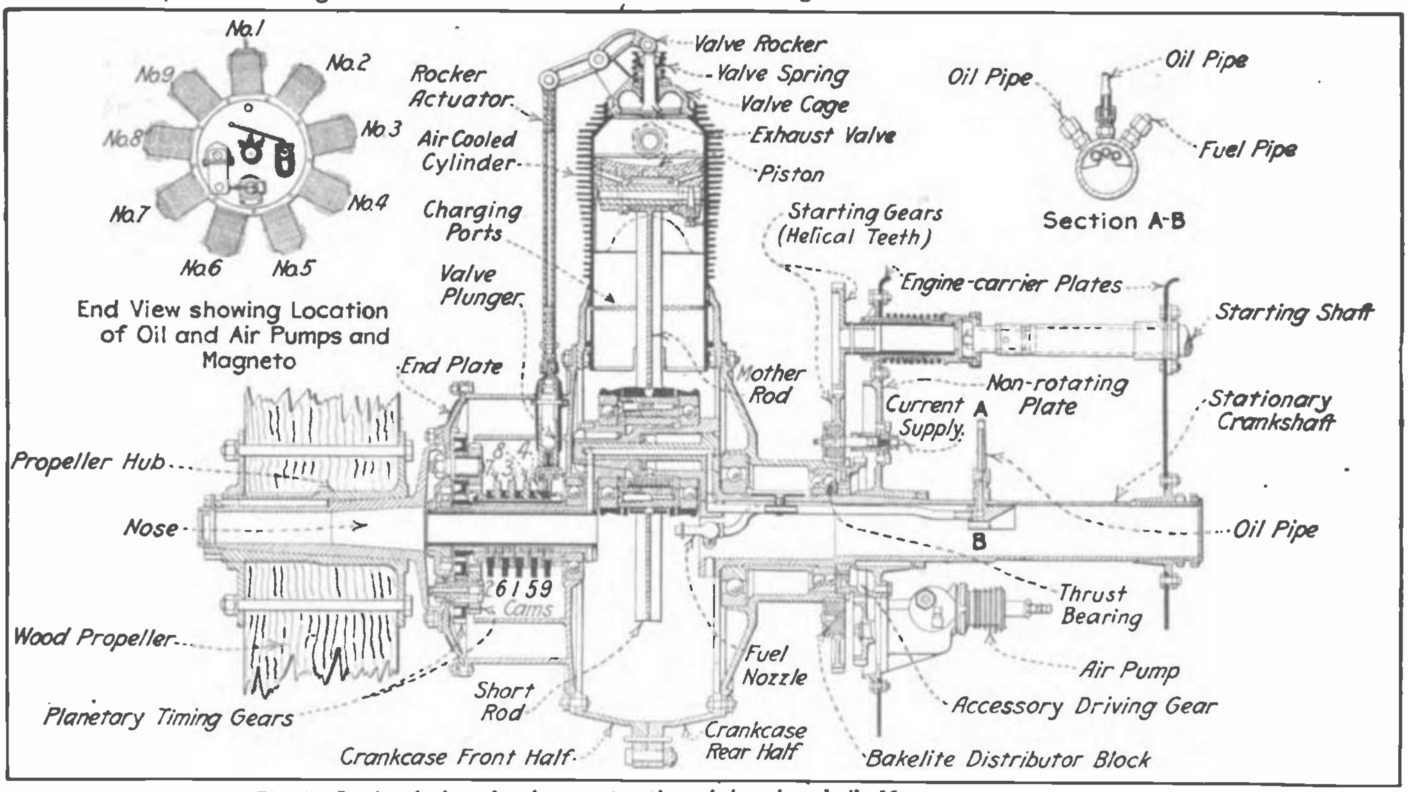


Fig. 5. Sectional view showing construction of American built Monosoupape Gnome engine

cylinder. This extra-rich mixture is diluted in the combustion chamber with the air which entered it through the exhaust valve during the first part of the inlet stroke, thus forming a mixture of the proper proportion for complete combustion.

The inlet ports in the cylinder wall remain open until 20° of the compression half-revolution has been completed, and from that moment to near the end of the compression stroke the gases are compressed in the cylinder. Near the end of the stroke ignition takes place and this completes the cycle.

The exact timing of the different phases of the cycle is shown in the diagram at the bottom of Fig. 3. It will be seen that ignition occurs substantially 20° ahead of the outer dead center, and expansion of the burning gases continues until 85° past the outer dead center, when the piston is a little past half-stroke. Then the exhaust valve opens and remains open for somewhat more than a complete revoultion of the cylinders, or, to be exact, for 390° of cylinder travel, until 115° past the top dead center on the second revolution. Then for 45° of travel the charge within the cylinder is expanded, whereupon the inlet ports are uncovered and remain open for 40° of cylinder travel, 20° on each side of the inward dead center position.

Gnome Fuel System, Ignition and Lubrication

Gasoline is fed to the engine by means of air pressure at five pounds per square inch, which is produced by the air pump on the engine clearly shown at Fig. 4. A pressure gauge convenient to the operator indicates this pressure, and a valve enables the operator to control it. No carburetor is used. The gasoline flows from the tank through a shut-off valve near the operator and through a tube leading through the hollow crankshaft to a spray nozzle located in the crankcase. There is no throttle valve, and as each cylinder always receives the same amount of air as long as the atmospheric pressure is the same, the output cannot be varied by reducing the fuel supply, except within narrow limits. A fuel capacity of 30 to 40 gallons is usually provided. The fuel consumption is at the rate of 12 U. S. gallons per hour.

The high-tension magnetos, with double cam or two break per revolution interrupter, is located on the thrust plate in an inverted position, and is driven at such a speed as to produce nine sparks for every two revolutions; that is, at 2¼ times engine speed. There is no distributor on the magneto. The high-tension collector brush of the magneto is connected to a distributor brush holder carried in the bearer plate of the engine. The brush in this brush holder is pressed against a distributor ring of insulating material molded in position in the web of a gear wheel keyed to the thrust plate, which gear serves also for starting the engine by hand. Molded in this ring of insulating material are nine brass contact sectors, connecting with contact screws at the back of the gear, from which bare wires connect to the spark-plugs. The distributor revolves at engine speed, instead of at half engine speed, as on ordinary engines, and the distributor brush is brought into electrical connection with each spark-plug every time the piston in the cylinder in which this spark-plug is located approaches the outer dead center. However, on the exhaust stroke no spark is being generated in the magneto, hence none is produced at the spark plug.

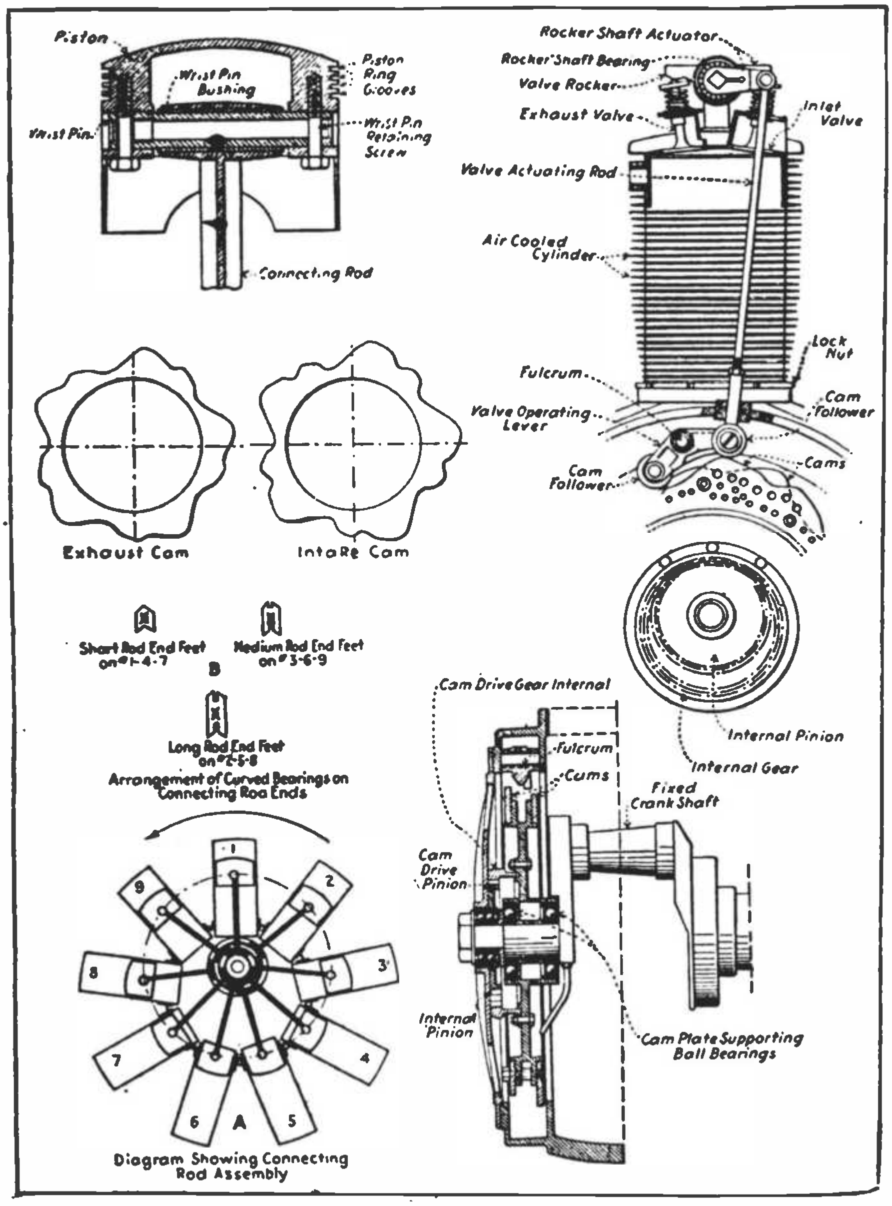


Fig. 8. Interesting mechanical details of the Le Rhone rotary cylinder motor

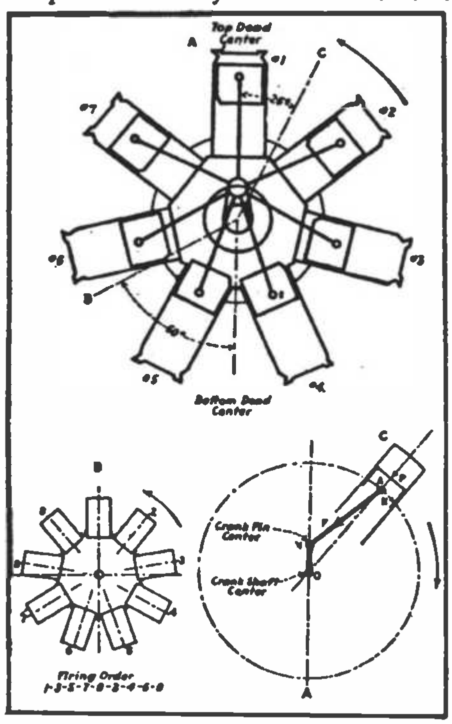


Fig. 9. Explaining Le Rhone motor action

Ordinarily the engine is started by swinging the propeller, but for emergency purposes, as in seaplanes or for a quick "get away," if a landing is made where it is not possible to start the motor by turning the propeller, a hand starting crank is sometimes provided. This is supported in bearings

(*Continued on page* 310)

A Model Steam Engine

Constructional Data for a Model With a Simple Walchert Valve Gear

By Oliver Savage

MODEL makers who have a desire to produce a workable steam engine, should not hesitate to set about the task of building one merely because they do not have the facilities for making castings or patterns. Very workable and practical little engines can be produced by using a few extremely simple castings and different odds and ends found about the workshop. It is true that perfect engines cannot be built by the use of such materials but working models can be made that will operate just as successfully as models that require a number of castings in their make-up. When engines are built with spare parts, the builder must use his own ingenuity in perfecting the design so that most of the available materials on hand can be used in the construction.

The little engine constructed by the writer evolves the use of only five castings and these are produced with very simple patterns that can be made by any experimental engineer no matter how inexperienced he may be in the art of pattern making. The patterns can be taken to the local foundry and the castings obtained for about one dollar. The castings should be made with hard brass.

The cylinder of the engine should be cast with a three-quarter hole and it will, of course, be necessary to employ a core box for this purpose. When the rough casting of the cylinder is received from the foundry, it is chucked in the lathe and the hole bored out to a diameter of one inch. After this is done, each end of the cylinder is faced off square. The flat portion of the cylinder upon which the steam chest rests must be filed square and finished as smoothly as possible, as much depends upon this particular operation. This operation can also be accomplished very nicely by the use of a small lapp grinder or disc grinder that can be mounted in the live spindle of the lathe. The flat surface should be tested for accuracy by the use of a machinist's square. By this the writer means that it should be squared up with the cylinder ends.

Few model makers or experimental engineers realize what neat and workable model steam engines can be made in a few hours' time and by the use of simple materials and tools. The little engine pictured on this page and described in the text is an example of the work that can be accomplished by the use of odd materials and a few simple castings of brass, the patterns for which can be made by every mechanic worthy of the name.—EDITOR.

The cylinder heads are now faced off carefully in the lathe and divided with a protractor into six equal parts. After being punched, these members are drilled with a ⅛-in. drill. When these holes have been drilled the cylinder heads can be used as a jig to drill the corresponding holes in the cylinder ends. The holes in the cylinder ends, however, should only be marked out by the aid of the cylinder ends. The holes should be drilled with a No. 36 drill. When this is done the holes in the cylinder are tapped out with a 6-32 tap to receive the small cap screws which hold the heads to the cylinder ends.

Now the holes in the top of the cylinder are laid out and a ⅛-in. drill run down about a quarter of an inch. Another drill is then run in from each end to meet. Care should be taken in this operation to see that the holes do not break through into the exhaust port, as this would render the cylinder useless. The exhaust port is drilled out by drilling about half way in with a ¼-in. drill. This hole is then tapped with a ¼-28 tap to receive the exhaust pipe which is held in this manner to avoid the use of solder. The hole for the exhaust port is continued beyond the one-quarter inch with a ⅛ inch drill One-quarter-inch copper tubing is used as the exhaust pipe.

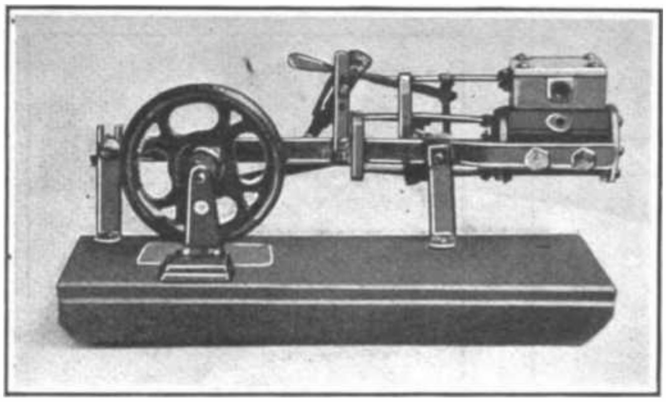
By referring to the drawing it will be seen that the cylinder is provided with two projections. These are used in fastening the cylinder to the engine frame and they should be drilled out and tapped with a ¼-28 tap.

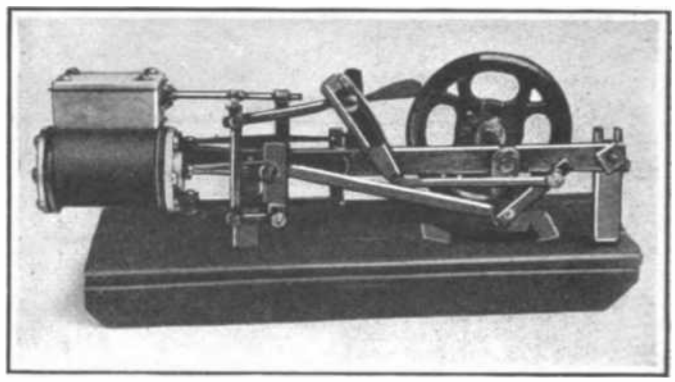
The engine valve is smoothed the same way as the top of the cylinder. The holes are then laid out on the steam chest cover and drilled and tapped to receive the cap screws. Where the valve rod enters the steam chest, a hole is made with a ⅛-in. drill one-half way through. The hole is then continued with a ¼-inch drill. In this way a place is made for the packing which obviates the necessity of making a union, which always requires a lot of time and patience. Very small unions are also impractical unless they are made with the greatest precision.

The cylinder head is drilled in the same manner as the steam chest. In the case of the cylinder head a 5/16-in. drill is used, first to drill the hole half way and this is followed with a 3/16-in. drill. A little packing plate is then cut to shape from thin sheet brass and placed over the hole in the cylinder end to hold the packing in place. The same thing is done with the hole in the steam chest through which the valve rod passes. The shape of these little pieces can be seen by referring to the drawing on the opposite page.

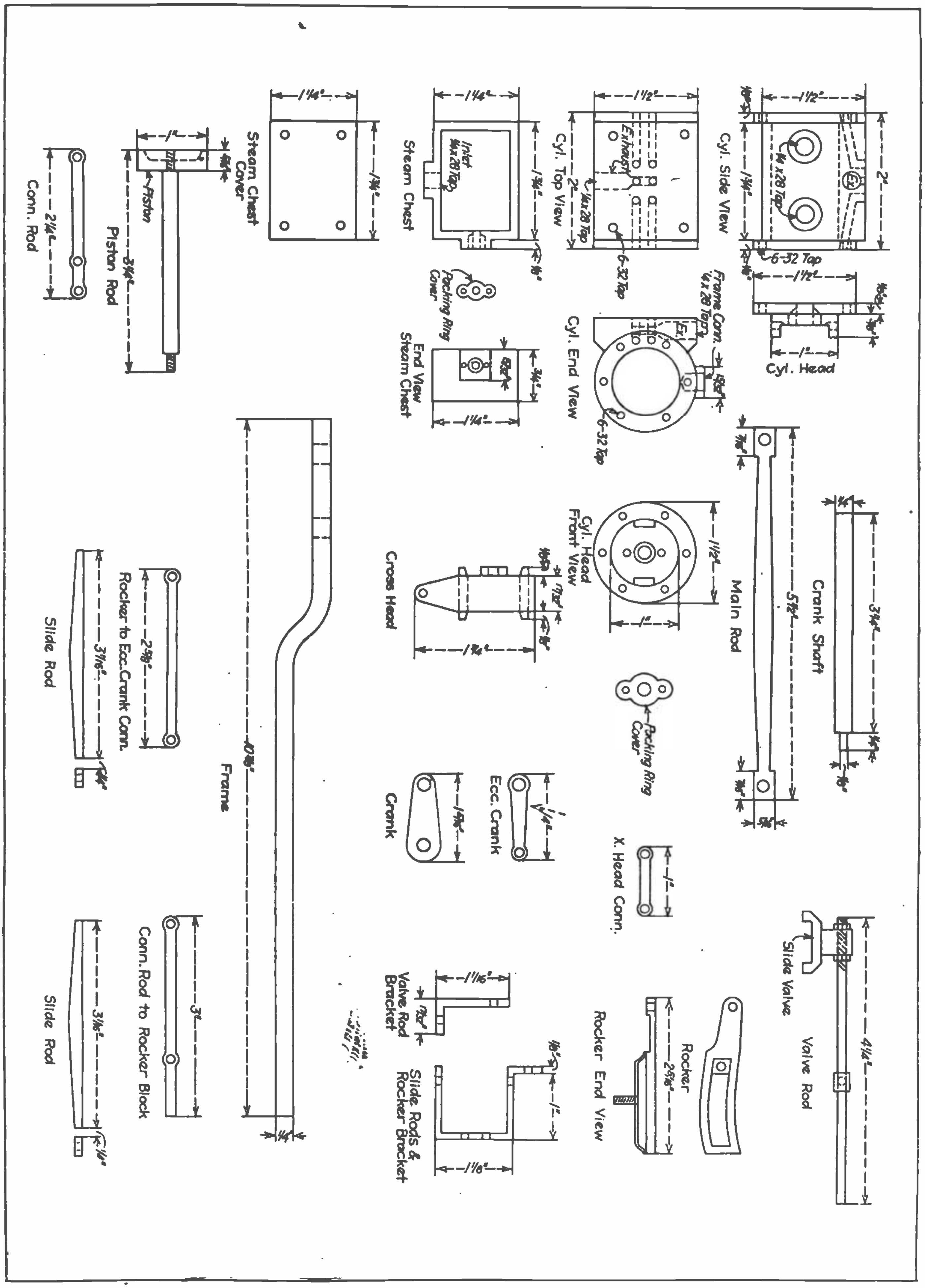
The valve rod is threaded on one end to fasten the valve to it. The stroke of the valve is regulated by means of two screws which are shown in place on the

(*Continued on page* 342)





Two views of the little steam engine described in this article. A careful study of the photographs will do much to assist the builder in the construction of the engine


Conn. Rod
Piston
Piston Rod
Steam Chest Cover
Steam Chest
Inlet 1/4 x 28 Tap
Cyl. Top View
Exhaust
6-32 Tap
Cyl. Side View
6-32 Tap
Cyl. Head
Frame Conn. 1/4 x 28 Tap
Cyl. End View
Packing Ring Cover
End View Steam Chest
Main Rod
Crank Shaft
Cyl. Head Front View
Cross Head
Packing Ring Cover
Frame
Rocker to Ecc. Crank Conn.
Slide Rod
Crank
Ecc. Crank
X. Head Conn.
Slide Valve
Valve Rod
Rocker
Rocker End View
Valve Rod Bracket
Slide Rods & Rocker Bracket
Conn. Rod to Rocker Block
Slide Rod

Grinding Convex Lenses

By Victor H. Todd

TO the average person, and to many mechanics accustomed to working in metal, the process of shaping and polishing a glass lens may seem quite beyond the powers of those who have not had some experience. As a matter of fact, the making of a lens is a simple process, and is done easily on an ordinary turning lathe and does not require more skill than is required for turning out a perfect metal article. The greatest asset required is patience and time, especially on the final polishing. Of course, special glasses with bifocal curved surfaces and the like are really the subject of the professional optician, but lenses such as those used for magnifying glasses are easily produced.

Assuming that a fairly high grade speed lathe is available, it is first necessary to make a few tools, which are easily produced by the ordinary mechanic; a gauge, a gouge and a polishing fixture.

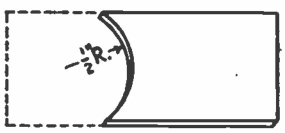


Fig. 1
Brass Gauge for testing the Convex surface of lens

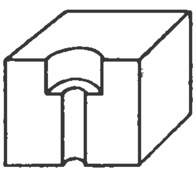


Fig. 4
Cross-section of mould

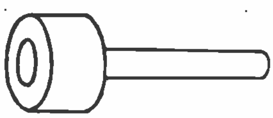


Fig. 5
Polishing Fixture Casted from Fig. 4

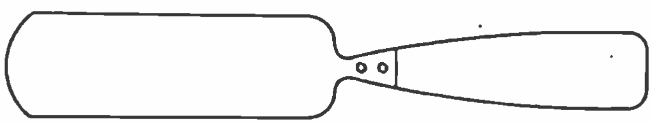


Fig. 2
Gouging Chisel, Front View.

Fig. 3
Gouging Chisel, Side View.

First determine the length of the desired lens; whether it is to be plano-convex (that is, flat on one side and convex on the other) or double-convex (convex on both sides) and the diameter.

Suppose we wish to make a plano-convex lens, with one inch focal length, which will magnify 10 diameters. Take a pair of dividers and set for ½ the focal length (½ in. in this case) and upon a thin sheet of brass strike a quarter or third of a circle. It may be advantageous to make a centre punch prick mark in the brass first, to get a true arc without the dividers slipping. If a double convex lens is desired, it would be necessary to set the dividers equal to the focal length and not one-half as in this case.

Now, with shears or narrow cold-chisel carefully cut the inner part of the circular segment out, and finish with a round fine file, exactly to the mark. Of course, if a cutter or other tool is available, or if proper appliances are had for cutting a circle in the lathe, it will undoubtedly make a truer and neater job. In any case, the finished gauge should look like Fig. 1 and the curved part should be part of a perfect circle.

The next tool, the gouge, is not used directly in making the lens, but is used in making the polishing fixture. It may be made of an old flat file, or a chisel, or even a wide saw blade.

The end should be carefully ground to a convex shape so that it exactly fits the concave gauge, and must be so exact that when the two are held together, toward the light, no light can be seen between them. It may be ground roughly on a coarse emery wheel and finished accurately on a finer one and at last by an oilstone. The cutting edge should not be flat like a chisel, but should be not less than 60 degrees, with the heel rounded off. The finished gouge should appear like Fig. 2 on a front view and an edge view like Fig. 3.

In order to make the polishing fixture, it is first necessary to make a wooden mould. Take a block of hardwood, about a 2-inch cube, plane one side smooth and with a sharp bit bore a hole, 1 inch in diameter, one-half inch deep, in the planed side. Then take a smaller bit and make the hole through the block. This last hole should be of a size most conveniently held in the lathe chuck. These two holes, of course, must be quite perpendicular, and if possible should be done in the lathe. A cross section of this wooden mould is shown in Fig. 4.

Next, melt some block tin or solder in a ladle, and, holding the block firmly on some firm smooth surface, pour it into the mould. On removing the casting it should present the appearance of Fig. 5. If the lathe is large enough to chuck the big end, the smaller part may be carefully trued up, so that it may be removed while shaping the lens, but we will assume it is not, so the first thing to do is to shape the lens, and then complete the polishing fixture, as will be described later.

Select a good piece of crown glass, as near as possible to the size of the lens, and cement it to a wooden center as follows: Turn a piece of wood similar to Fig. 5, except turn the front side perfectly plane, so it runs true. Now get some hard shellac (sometimes called stick shellac) and heating it in a fire, or flame, smear the end of the stick, smoothly and evenly, but very thin. Hold the glass cautiously in or near the flame until it is hot enough to make the shellac melt and stick. Smear the glass smoothly and thinly. Then, holding both the stick and glass in the flame quite close together until the shellac starts to run, press them firmly together, centering the glass as near as possible. When cold, if this cementing has been done properly, the glass will break before it will loosen from the stick.

Remove the slide rest and tail stock end chuck the stick with the glass on the end. It must be held very tightly so as not to work loose during the grinding process. Take a small emery wheel or piece of emery wheel and, setting the lathe in motion, hold the emery against the glass, first working it into a round shape and then grinding off the edges, gradually forming it into a convex shape. During the grinding the glass should be wet frequently. This can be readily done by using a sponge soaked in water and held in the left hand while the emery is held in the right hand for grinding.

The glass must not get hot enough to melt or loosen the shellac. After it has been worked into a smooth convex surface, stop the lathe and apply the brass gauge. This will immediately show where it must be ground in order to produce the right curvature. The gauge test must be made quite frequently when nearing the proper shape. Finally, it must fit the gauge so that when held up to the light no light can be seen between the gauge and glass.

When this is reached, go over it with fine emery paper to remove all scratches left by the coarser emery, being very careful not to distort the shape. Follow this with a piece of very fine whetstone until it is smooth, free from coarse scratches and still gauges up accurately. This leaves the surface ready for polishing.

Grinding a lens of this size need not

take very long unless a very thick piece of glass is used. It should not take over an hour or so. The hand very quickly acquires the knack of moving the stone around so as to give a smooth convex surface.

Remove the stick and glass and insert the moulded polishing tool in the chuck. Set the side rest squarely in front and proceed to turn the metal out of the center, using the gouge previously made.

Turn until there is a smooth concavity in the end, a little larger than the proposed lens, then dip a piece of slightly moistened flannel cloth into "putty powder" (tin oxide) and polish this concavity, being very careful not to polish it out of shape. This must also fit the gauge perfectly.

Now tie a piece of thin doeskin or other firm and thin woolen cloth over the concavity, fastening it around the sides with a piece of string. Slightly moisten the cloth and put a small quantity of putty powder over it. Start it revolving and press the glass (still held on the end of the stick) into the concavity, which it will fit perfectly. Keep up the application of moisture and powder frequently. Do not let the glass get hot enough to melt the shellac. Do not hold the glass in only one position, but rock it around in every position, taking care that it fits in accurately in any position in the polisher. If the cloth gets worn through, replace it with new. When the polishing has proceeded so far that the surface appears brilliant, and no scratches appear visible to the naked eye, the dampening and application of powder should be stopped, and polishing continued with what powder remains worked into the cloth, or, if desired, a finer polishing powder may be substituted. The polishing should not take long if the glass was finished carefully with a very fine stone as directed. It should be continued until a magnifying glass with a magnifying power of 10 diameters will not reveal the least scratch or roughness.

The lens may now be heated enough to melt the cement and removed. A little alcohol will remove all traces of shellac. If properly made, the lens will now give a clear, bright view of any object, and upon turning the glass in various positions no distortion will be noted.

It must be remembered that practice makes perfect and that this work requires a great deal of patience, as it is very tedious and the whole work may be spoiled in a few seconds by a little hurrying or impatience.

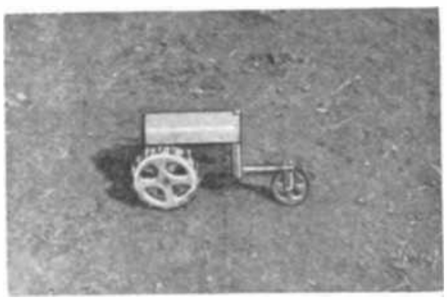
The average experimenter seems to have inherited fear of working with glass. If the directions outlined are followed, all will be well.

A Model Tractor

By Edward F. McCabe

THE making of a farm tractor may be something new in the line of models, yet there is no reason why any amateur handy with the scroll saw (which is used considerably in making the wheels) could not make this machine in a few hours.

A piece of hard wood 6 x ¼ x ⅜ in. is used in making the frame on which the clock-work, radiator and gears to the rear wheels are mounted. The clock-work from any clock will do, but try to get a clock as small as possible.



It need have no alarm, as this is not used.

The rear wheels, which are 2¾ in. in diameter, are cut from ⅜ in. hard wood, two pieces making one complete wheel. After sawing out the size of the wheel, the spokes must be cut out with a scroll saw, each piece having four spokes. Place the two pieces together so that the spokes in the first piece are just between those of the second and then glue. The small pieces of wood are glued in place. The front wheel is made of but one piece. Tin furnished the support from the frame to the front wheel.

The largest gear in the clock, which is connected with the spring, is used to drive the rear wheels, all other cogs being left in place except the balance wheel. Directly to the large gear is connected a small gear which can be taken from some other clock. This is soldered to the rear axle and fitted in the tin bearing, which is clearly shown in illustration No. 4.

The radiator is a ⅜ in. piece of hard wood with tin fastened to its center with small brads. The hood is simply a strip of tin 4¼ ins. long and 3¼ ins. wide, bent to the proper shape.

To stop and start the motor a wire is fastened as shown, so that when it is turned to the left it comes in contact with a small cog and brings it to a stop. To wind, a long key is necessary, as it must reach through the left wheel. This model will give much enjoyment and is able to pull small wagons three times its size.

The tractor can be improved by arranging a small steering wheel upon it together with a seat for the operator. The seat should be located at the back and the steering should be equipped with a long axle which will reach the front wheel.

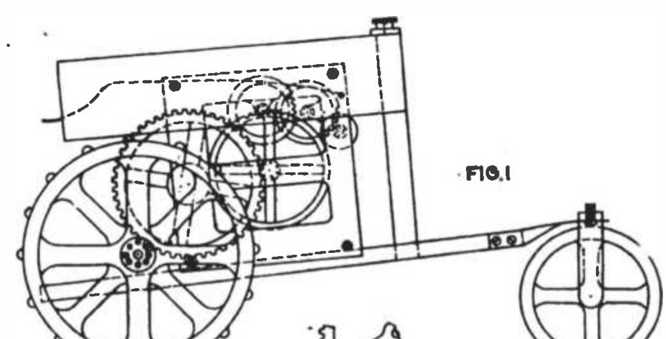


FIG. 1

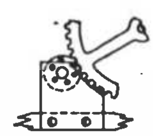


FIG. 4

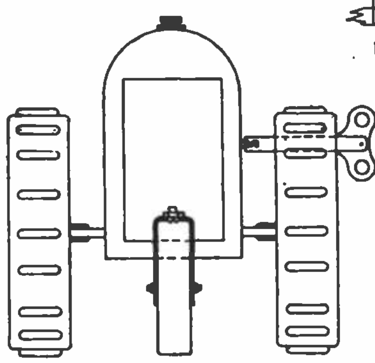


FIG. 2

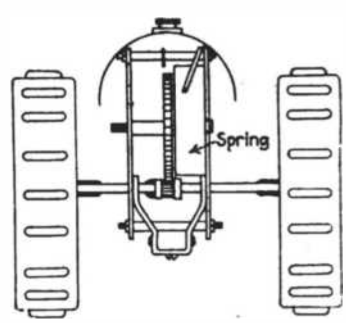


FIG. 3

Model Locomotive Design and Construction

By Henry Greenly, M. E.
Associate Member Institute Locomotive Engineers, England

IN the "old country" the standardization of model locomotive parts by the writer has been attended with a considerable degree of success and, as a result, many amateur model makers are now building satisfactory working models of their own general design where before they were limited to given types or held up by the fact that the supply of castings and accessories of interchangeable design was non-existent. Of course, the war has retarded progress in this work, but lost time is now being made up.

Mr. Henry Greenly

> *In this series of articles, Mr. Henry Greenly, who was introduced to our readers in the August number of "Everyday," will cover the standardization of model American locomotive parts. Mr. Greenly is consulting and designing engineer for a large English model manufacturer and his work can be relied upon as authoritative. The drawings are the work of Mr. Greenly.*—EDITOR.

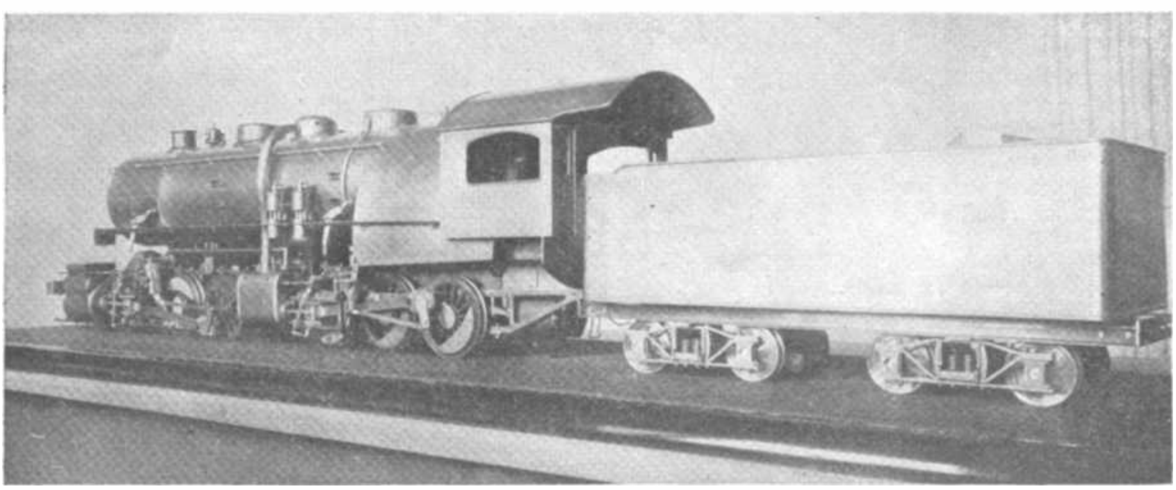
For the past twenty years the writer has been designing models of locomotives of all sizes as well as model rolling stock and railroad equipment. These models have comprised the toy engines and accessories for gauges 1¼ in., 1¾ in., and 2 ins., actuated by clockwork, steam and electricity such as were manufactured for the world's supply by the Germans in the Nuremberg district of Bavaria and, through all the intermediate gauges, model locomotives weighing anything from 5,000 to 6,500 lbs. capable of hauling 50 or 60 passengers, for 15 in. gauge public park and private garden railways. In numbers these models total some hundreds of different designs and naturally the result of this experience and from the data obtained from the many schemes tried out it has been possible to arrive at some measure of finality in the details of construction and to put forward a system of standardization.

The accompanying table will give the reader a little idea of the attributes of the various sizes which have had a vogue in the past. Several of them are so nearly alike—due to the parallel but in-co-ordinated efforts of British and German manufacturers, also amateur builders in pre-war days—that at this juncture the writer considers it wise to drop several of them. This advice has already been accepted and, in the small sizes especially, British model makers seem quite satisfied with the following:

- Toy Gauges—No. 0 (1¼ ins.) or 327 m. gauge; 77 m. scale. No. 1 (1¾ ins.) or 457 m. gauge; 107 m. scale.
- "Engineer Made" Models—2½ ins. Nominally half inch scale, actually 17/32 in. to 1 foot. Gauge 4¾ ins. Scale 1 in. to the foot.
- Passenger Carrying Locomotives—7¼ in. gauge and 15 in. gauge as already tabulated.

It is not intended in these articles to preach anything in the nature of standard locomotives. If, in America, the personal interest in the various types and design of locomotives approaches anything like the dimensions it does in Great Britain, then such a doctrine would soon prove impossible. Amateurs in the latter country have their particular "fancies." At the end of the last century the old Great Northern "single wheeler" with its 8 ft. driving wheel was the most popular engine, while the old Brunel broad gauge engines of the Great Western line had their devotees. The interest now is divided between the G.N.R. "Atlantic," a type of locomotive imported from the States and the Great Central Railway Company's 4-6-0 inside connected engine "Sir Sam Fay," a class which embodies most of the traditions of British locomotive practice. The writer's particular favorites in U. S. A. engines are those of the more recent machines built for the Pennsylvania Railroad, this preference being due to their excellent external proportions and to the scientific manner of their design.

Standard Cylinders for 2½ in. gauge models. With our Editor's permission it is the writer's intention to deal with "Character details" of various U. S. locomotives from a model maker's point of view and for the moment to give some attention to the design of what may be considered as the "heart of a working model," the cylinder—in the most popular and most suitable gauge of model locomotive for amateur building, viz., 2½ ins. Before doing so, readers may be referred to the diagrams, Figs. 1, 2 and 3, which give the leading dimensions in inches of a model 2½ ins. gauge, Atlantic 4-4-2 type engine. This locomotive can be fired with charcoal or alcohol (methylated spirit). It is also eminently suitable for amateur construction and for an outdoor model



A model American locomotive built by an English model enthusiast. The loco. is a Baltimore and Ohio "Mallet," articulated. It was constructed by Rene Bull railroad. The proportions, if adhered to more or less exactly, are bound to provide a successful model, given reasonably accurate workmanship with special attention to the cylinder details and to the steam tightness of the boiler.

The cylinder of a model locomotive must be made smaller than the scale equivalent. As working pressures cannot, from a practical point of view, be reduced to scale, in a 2½ in. gauge model which is roughly 1/24th full size, it would prove impossible to reduce 200 lbs. square inch to 1/24 of 200, owing to the increase in the proportion of condensation losses as an engine is reduced in size, a working pressure of from 50 to 60 lbs. is usually employed. The size of the cylinder and working pressure could be calculated from the point of view of tractive effort and adhesion weight, but such factors are governed by other considerations such as the reduction of working pressure due to the withdrawing of the steam. Readers will therefore welcome a simple rule based on actual model experience. With a normal boiler the size of the cylinder may be determined by the following formula:

Bore of cylinder in inches = 1.5 S —.125 where S is the scale of the model in inches to the foot.

For a 2½ in. gauge engine the scale may be taken as 17/32 in. or .531 in. and the result of the application of the formula gives .666 in., which is practically 11/16 in. The stroke of a model cylinder must as a rule, for spectacular reasons, be somewhere near the scale equivalent and therefore requires no special calculation. Should any model locomotive engineer wish to consider the size of the cylinder from the tractive effort point of view, he may take it that the steam pressure will be reduced at the cylinder to something like half of its nominal pressure, as he reads it at the boiler pressure gauge and that a tractive effort, on paper, of at least one-third of the adhesive weight may be provided for in a small model without risk of excessive slipping.

In making a model of any existing prototype, the dimensions and weight of which is known, the 2½ in gauge

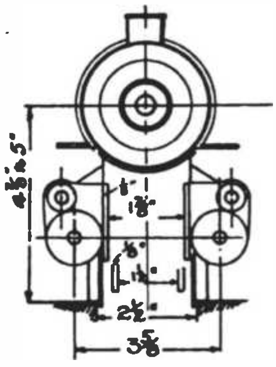


FIG.2

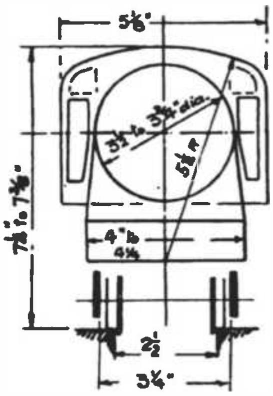


FIG. 3

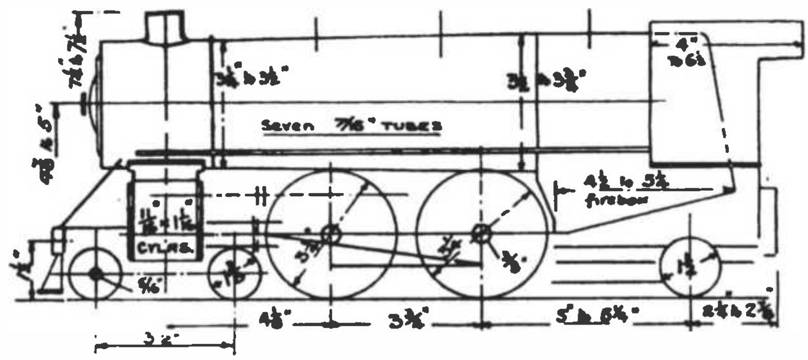


FIG.1

Fig. 1. Elevation giving leading standardized dimensions of a half-inch scale 2½ in. gauge loco., Atlantic tyype. Fig. 2. Front view showing frame width at cylinders. Fig. 3. Rear end giving cab and firebox dimensions.

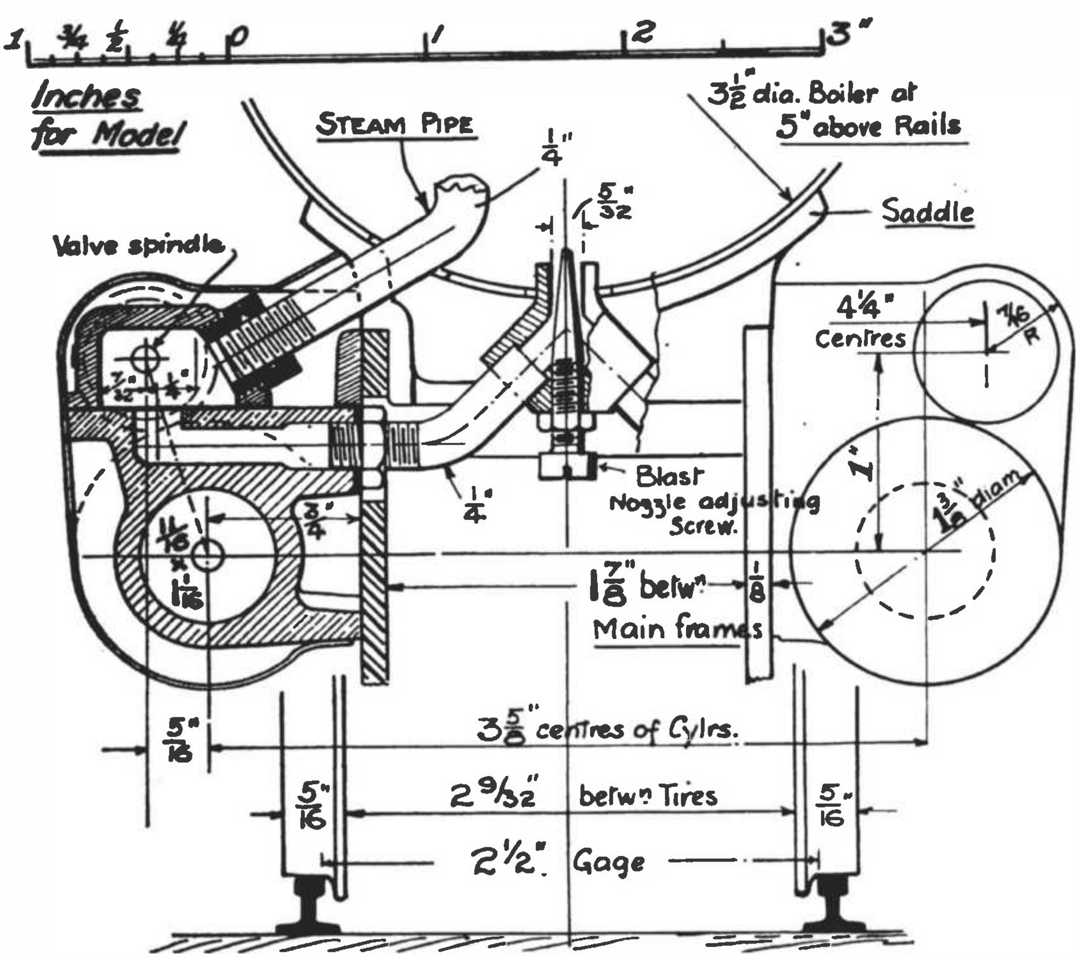


FIG.4

Standard "half-inch" scale locomotive cylinder (modern piston valve type) cross-section and end view model will weigh at least .165 lbs. for every ton (American, 2,000 lb. ton) of the original. A model varies roughly as the cube of the scale and the reciprocal of the above coefficient used in model work for 2½ in. gauge is

1 lb. of model = 6.06 American tons of prototype.

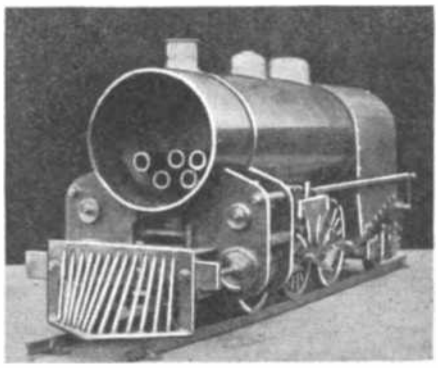
In figuring out the adhesive weight it should be noted that it is best practice in arranging the spring gear of a working model to crowd on to the driving and coupled wheels a little more weight than the equivalent at the expense of that carried by bogie and pony trucks.

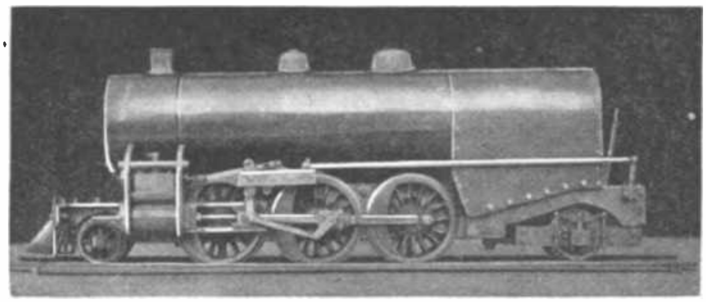
So much for what may be termed theoretical considerations. The cylinder of an American engine are usually outside the frames with the valves above the pistons. In most modern prototypes piston valves are employed, but in model practice such as not satisfactory under 1½ in. or 1¾ in. in diameter and therefore, for 2½ in. gauge engines may be entirely ruled out.

To preserve the external features of a piston valve cylinder a design similar to that shown in the accompanying full size drawings, Figs. 4 to 8, has been employed by the writer with success. The cylinder and steam chest is cast separately, gunmetal being usually employed. The end faces are machined true after the two parts have been fitted together, preferably from the bore of the cylinder, the casting being mounted on a mandrel for this purpose. The cylinder and steam chest are finished off to the correct profile by a lagging or cleaning strip of planished metal—blue or Russian iron, for example, looks very well. The valve is of the time honored "D" type and to provide for Walschaerts' or other type of radial valve gear the valve spindle is offset to the extent shown on the cross sectional drawings (see Figs. 4, 7 and 8).

The castings are arranged so that they may be moulded from metal patterns without coreboxes, the writer having found that for cylinders under ¾ in. bore no advantage accrues from the use of cores for cylinder bores. It is easier and cheaper in the long run, even for quantity production to rough drill the cylinders at the outset, and to complete all further machining operations from the bore.

All the steam passages are formed by drilling, the ports at the valve face being either chipped by hand or end-milled to the rectangular shape indicated in the plan view (Fig. 7). The steam passage should be two adjacent 3/32 in. holes, the





Semi-finished American type model locomotive

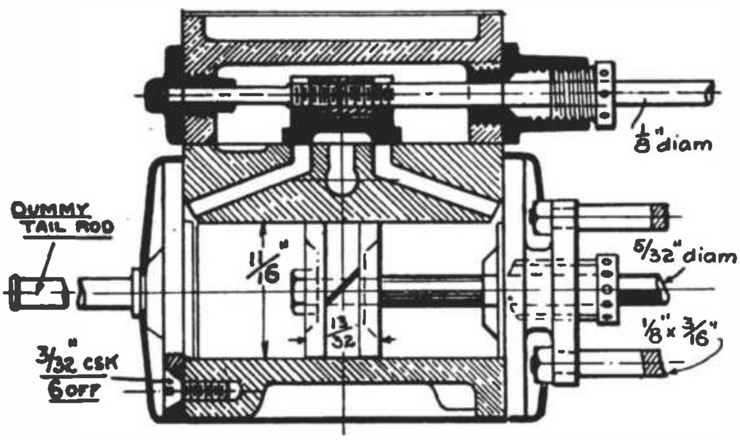


FIG. 5

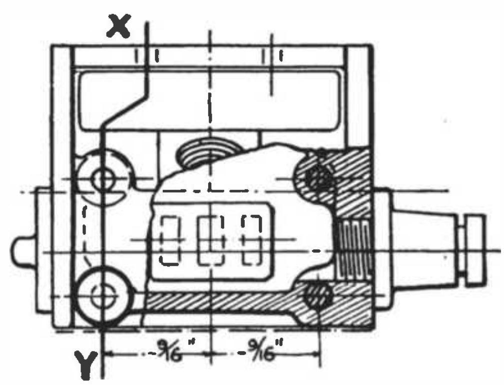


FIG. 7

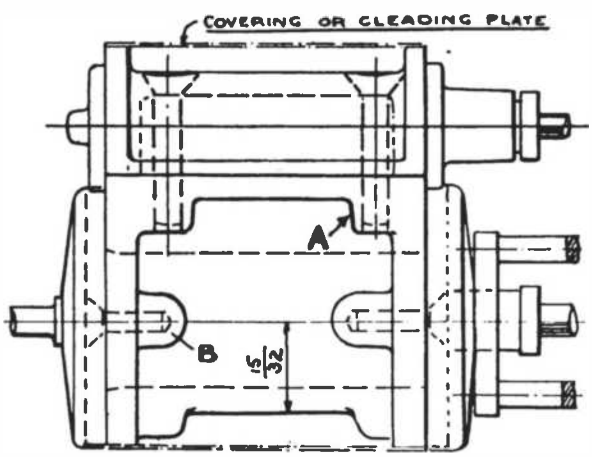


FIG. 6

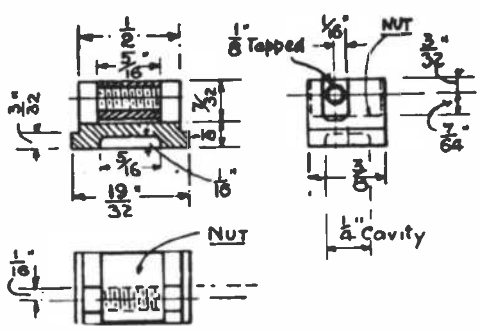


FIG. 9

Fig. 5. Longitudinal section of standard cylinders. Fig. 6. Elevation of standard cylinders. Fig. 7. Plan of steam chest. Fig. 9. Detail of slide valve and nut

exhaust being a tapping hole for ¼ in. copper pipe. The steam chest is held down to the cylinder castings by four ⅛ in. countersunk screws as shown in Figs. 6, 7 and 8, bosses being provided for these fastenings in the walls of the steam chest casting as indicated in the plan view, Fig. 7, and in cylinder casting as shown at A, Fig. 6.

The valve spindle is supported at both ends. This arrangement being more or less essential where a radial valve gear is employed and where the spindle is not provided with an outer guide. Both the packed and the

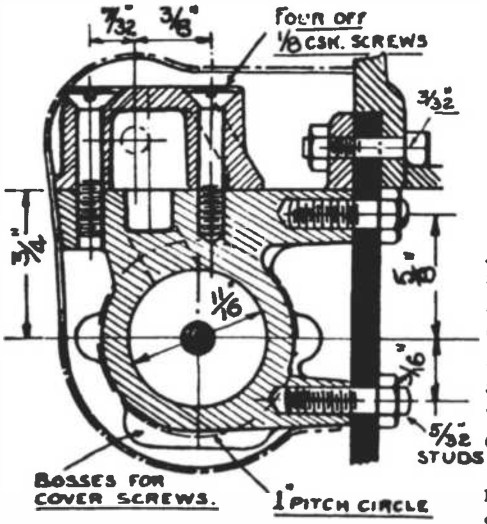


FIG. 8

Cross-section of cylinder on line XY

"dummy" glands are screwed into the steam chest. These glands may be made out of nickel bronze (German silver) polished bright or turned from brass bar and then nickel plated. The cylinder covers are capped with spun or pressed sheet metal caps which are a snap fit on the main covers and may also be nickeled. The back cover supports the slide bars, the stuffing box having an oval flange which is jig drilled at diametrically opposite centers, ⅜ in. radius, to receive the shouldered-down spigots of the rectangular steel slide bars. The slide bars are then secured by nuts as shown in Fig. 5. The pistons may be made in several styles and as the points involved in piston design and packing will be discussed at a later date, reference to their construction may be deferred. However, it is essential that the cylinder bore should be true to one-half a thousandth and the minimum and maximum clearances (including tolerance and allowance) between piston and cylinder should fall between ½ and 1 thousandth of an inch. The piston and piston rod should be true in alignment. This is very essential. The front end of the cylinder should be bell-mouthed but to assist in obtaining perfect alignment the spigot of the back cover should fit tightly in the parallel bore of the cylinder. Six countersunk screws are used to attach the cover bosses, being provided where required in the cylinder castings to accommodate these screws as shown at B, in Fig. 6.

The slide valve is driven by a rectangular nut fitting easily in a slot filed or machined in the back of the valves. The valve is set over, towards the inside, as shown in the detail drawing in Fig. 9, and the nut is therefore drilled and tapped accordingly. This nut provided for an adjustment of the valve on its valve spindle and as this can only be accomplished within the limits of half a turn of the spindle, the thread chosen should be the finest available.

The writer has given considerable attention to superheating in models and also to the effects produced by various arrangements of exhaust nozzles (blast pipes). In the standard arrangement shown herewith (Fig. 3), an adjustable nozzle is provided for. This adjustment can be effected from the outside and therefore experiments can be made with steam up. The blast pipe unit is a complete assembly and may be fitted on the running joint principle, sufficient length of thread being provided in one cylinder and on one arm of the blast pipe to make this possible. The unit is made steam-tight by lock nuts and a joint washer. The nozzle should be silver-soldered to the pipes.

Inside the smokebox the steam pipes (these are dual and joined to a common superheater) should be bent to clear the jet of exhaust steam. A system of running joint is also suggested for fixing the ends of the steam pipes to the valve chest casting. A flanged nipple is screwed inside and outside with a thread of the same or nearly the same pitch. The inside thread should, of course, suit the ¼ in. diameter steam pipe. A lock nut is also provided both the lock nut and the nipple being slightly countersunk on their adjacent faces to provide for a redlead grummet. To fix a steam pipe the nipple is screwed onto the pipe about double its normal or final distance. The pipe is then placed opposite the tapped hole in the valve chest casting and the nipple screwed in up to its flange, the joint being grummeted with some sewing cotton and red lead. The nipple, of course, screws off the pipe to its final position but the lock nut is run down to it and similarly grummeted to make the whole joint steam tight. This arrangement saves using a union and is more compact.

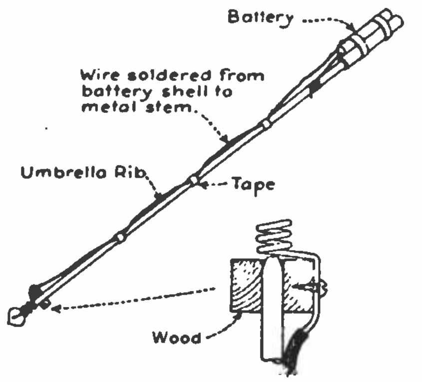
The cylinders are secured to the frames by four well fitting studs 5/32 in. in diameter. An additional support may also be provided by two bolts or studs fitting into a wall cast on the steam chest as shown in Fig. 4.

These studs or bolts also assist in securing the saddle casting to the main frames of the engine.

As the steam chest is none too roomy the corners of the slide valves may require to be removed to provide for sufficient travel. To give additional clearance the lower portions of the bosses round the fixing screws may be chipped away on the inside. The diagrams herewith among other things give the accepted standard dimensions of wheel tires for 2½ in. gauge engines.

Inspection Lamp on Umbrella Stem

In many places where an inspection must be made in dark locations, as, for instance, back of pipes, or boilers, where an ordinary flashlight cannot be used to advantage, the lamp may be placed on the end of an old, dismantled umbrella cane, with the battery strapped on the handle, as shown in the illustration. For the socket, take a piece of wood and drill a hole so that it will slip tightly over the end of the



cane. An empty thread spool will do nicely. Then wind several turns of No. 16 bare copper wire around the lamp base threads and tack it to the spool as shown in the insert. Connect a piece of lamp cord from this to the inner connection on the battery, and connect the shell to the metal umbrella stem. The push button controls the lamp in the regular way. If desired, a small mirror may be placed on the end, in addition to the lamp, and the two will reveal points which may be entirely inaccessible in any other way.

VICTOR H. TODD.

New Process for Aluminum

A new process has been perfected which will do much to broaden the application of metallic aluminum. It does not produce a new alloy but merely gives aluminum new properties. These new properties give aluminum greater tensile strength and increased electrical conductivity. It is claimed that within a short time aluminum will be replacing copper more than ever before as a conductor of electrical current. Aluminum is used to a great extent to-day in high voltage transmission where resistance is not a large factor.

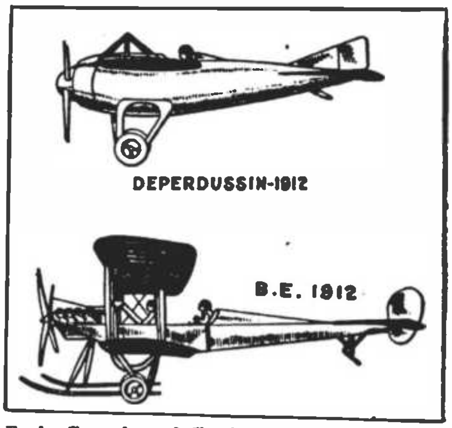
Fuselage Design to Reduce Resistance

THE problem of reducing resistance of an airplane in flight has received the attention of scientists for many years, even prior to the construction of airplanes that would fly. In a very complete paper head by N. Y. Lieberman, M. S. A. E., before the Buffalo section of the society, many interesting facts were brought out. A very interesting table showing the influence of streamline construction in reducing fuselage resistance is reproduced herewith from the S. A. E. Bulletin will show our readers interested in the construction of either full size or model airplanes why it is important to use a streamline construction for every part of an aircraft where it can be incorporated. The values given were determined by wind tunnel tests.

The general design of the fuselage is frequently fixed by considerations other than those of a purely aerodynamic nature. Mounting a flexible gun in the rear cockpit with the average type fuselage causes a break in the lines of air continuity. The outlines of the engine generally have a marked influence on the cross-sectional and fore and aft disposition of both space and lines. Fighting equipment, observation apparatus, the controls, the arrangement of the pilot and crew, all of these have their individual weight in deciding the shape best suited to the particular conditions.

In general discontinuity of outline is avoided as much as possible. The faster the design-speed of the machine, the greater must be the consideration given to the "wake" of the larger bodies. Many designs have consequently been developed, varying in their treatment of virtually the same problem, that of carrying the power plant and its fuel, the pilot and the crew and the accessory load.

The early forms with open framework are all now replaced with a continuously surfaced structure. Apertures are kept down to the minimum since theory indicates and experiments show that these add to the total resistance by disturbing the streamline flow. The main distinction in fuselages centers about the differences between the "short type plus tail booms," and the "long continuous type." The Farman and Voisin construction in French planes, the Vickers Gun-Bus and all the FE derivatives are of the first class. Most of the fuselage construction, however, is of the long continuous type, even when the extended construction merely serves as a boom to the tail as in the Caproni.



Early French and English airplanes showing first closed type fuselage designs

The resistance co-efficients now available on these various types are meager and disconnected. That is, knowing the co-efficient for one form of fuselage does not materially help in determining the resistance of another form. The forms and co-efficients in the table are the results of both early and recent tests. The co-efficients in the table are all for 1 sq. ft. of cross-section at a velocity of 100 M. P. H., the fuselage inclined 6 deg. to the direction of the wind. The fineness ratio or the maximum length divided by the maximum depth is also noted.

Fuselage	Length ÷ Depth	Resistance Lb. per Sq. Ft.	Fuselage	Length ÷ Depth	Resistance, Lb. per Sq. Ft.
FARMAN NO. 1. (NO RADIATOR)	3.2	6.53	F.E.2B.	4.8	13.88
FARMAN NO. 2 (NO RADIATOR)	3.2	8.56	F.E.2C	4.6	13.05
FARMAN NO. 3 (NO RADIATOR)	4.3	14.69	F.E.8	3.1	10.00
DEPERDUSSIN (OPEN MOTOR)	5.3	10.20	DEPERDUSSIN (COVERED MOTOR)	5.2	7.55
S.E.4 A	4.7	4.92	S.E.5.	5.6	12.85
B E 2 C	7.2	5.71	B.E 3	6.2	8.65
AVRO	6.8	11.10	F.E.7	7.6	5.91
STREAMLINE (ROUND SECTION)	6.4	3.80	STREAMLINE (ROUND SECTION)	6.4	4.98
STREAMLINE (SQUARE SECTION)	6.0	4.08	STREAMLINE (SQUARE SECTION)	6.0	5.35

Diagrams showing influence of fuselage design on resistance and how the streamline form is the most efficient

The advantages of streamline construction and the enclosure of the fuselage frame was apparent to experimenters as soon as the first crude wind tunnel tests were made and both the French and English contrived designs as early as 1912 that had enclosure of the fuselage as an object. The French Deperdussin design, illustrated above, may be considered the parent type of the present Spad and it was a product of the same designer. The streamline design resulted in a speed of 120 miles per hour, a remarkable speed for that time nearly a decade ago, as it was made with a 100 horsepower motor. The machine was a single seat monoplane. The English type, the B. E., was a passenger carrying biplane and naturally was not as efficient aerodynamically.

Large Monoplanes Practical

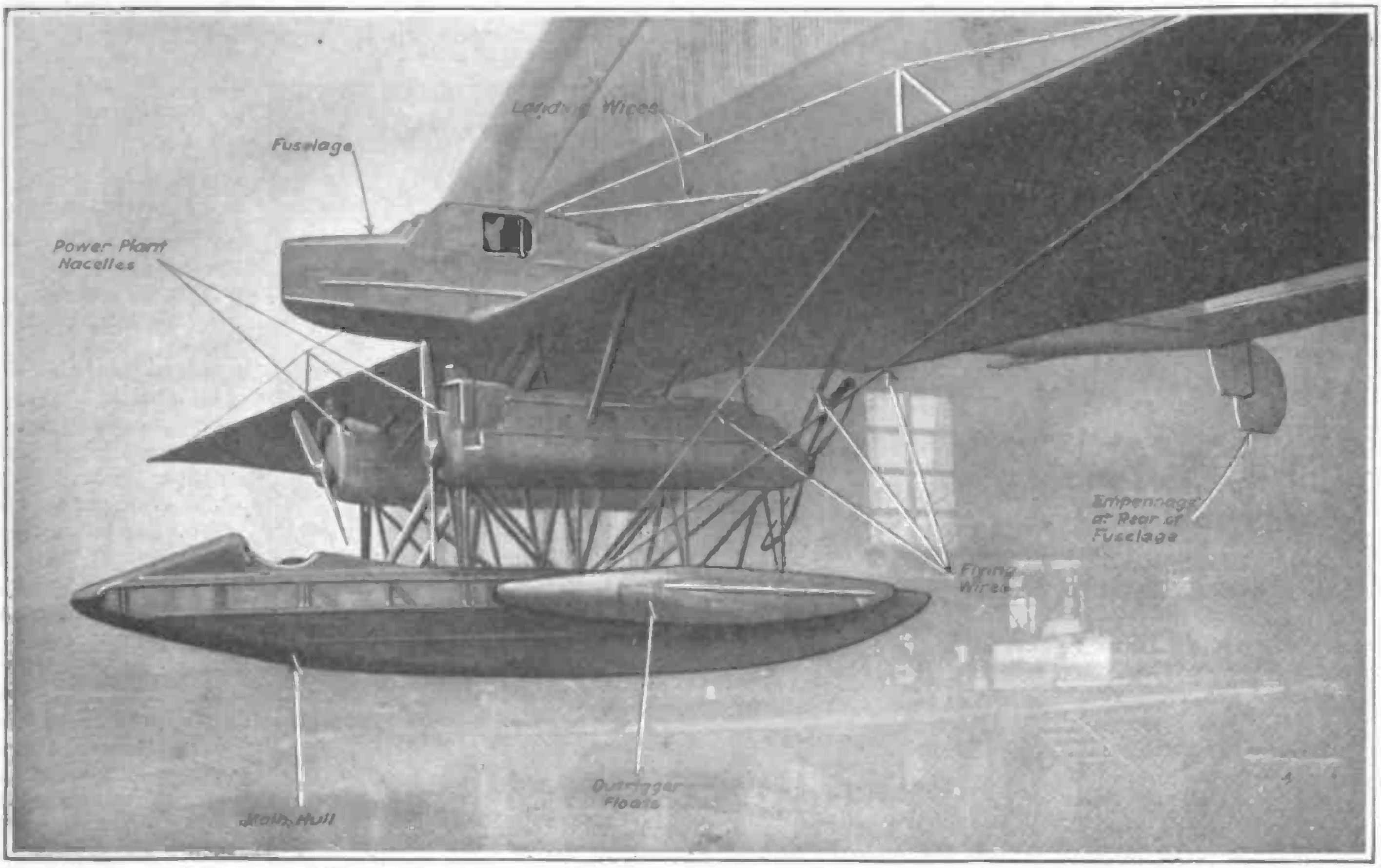
THE Zeppelin-Lindau flying boat may be considered a very interesting development of the monoplane. It is equipped with an aggregate of over 1,000 horsepower, divided into four 260 horsepower motors. The machine has a span of 120 feet, carries fuel for twenty hours and complete armament and instrument equipment, yet is a monoplane with wire trussing at top and bottom of wings. The single hull under the wing may be termed a flying boat rather than a float. The fuselage which supports the tail surfaces is placed above the wings and serves for attachment of the landing wire bracing. The total weight is twelve tons. This machine seems to discredit general belief in the aviation world that monoplanes can be built only in small sizes with any degree of success and therefore any future development along these lines will be watched closely.

The general details of construction can be clearly understood by inspecting the accompanying illustration which has just been received from Germany and which depicts the giant craft outside of its hangar. The power plant arrangement in two nacelles placed under the wings and over the hull, one at each side, is clearly shown. There is a pusher screw at the rear of each engine nacelle and the usual form of tractor screw at the front end. Outrigger floats of metal are placed at each side of the hull under the engine compartments in order to assist in carrying the heavy load when the machine is at rest on the water and the hull settles low in the water. When the machine attains a certain speed, the main hull is sufficient to carry the load and the outrigger floats are lifted clear of the water.

These floats are of aerofoil form at the top, having a cambered upper surface and probably contribute some useful lift when the machine is in flight. There seems to be ample accommodations on this craft, as mechanics can be carried in each engine nacelle, passengers or freight in the hull, and still more passengers and the navigators in the cabin on top of the planes which forms the front end of the fuselage. The machine probably has a useful load capacity, or at least six tons, and is a splendid example of pioneer work in aeronautical engineering because it is so unusual in design. It is evident that this machine was intended for long flights, as every provision seems to have been made for housing the pilots and the use of enclosed nacelles for the engines would permit mechanics to make minor power plant repairs while the airplane was in flight.

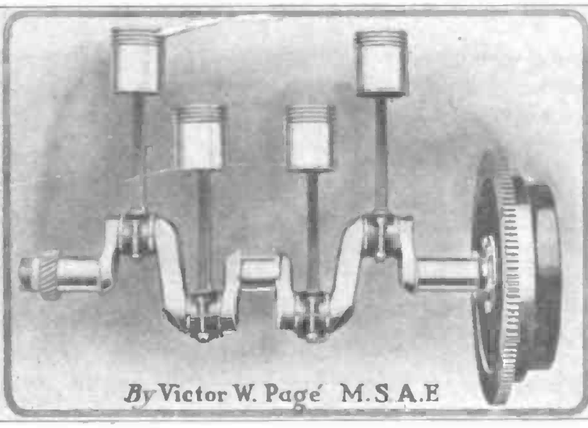
It is reasonable to assume that the four engines would be needed only when the machine was fully loaded and that after it had discharged its cargo or bombs and had used the greater part of its fuel that it would be sufficiently lightened to permit of flight with two of the motors. This craft was originally built for bombing purposes and was being tried out when the armistice was signed. It has now been turned over to the Allied Commission and several of the powers want the airship for experimental purposes. Latest reports indicate that the machine is an all metal construction, the wings being made of a metal frame and aluminum alloy sheet covering.

The Paris-London Air Express is now an established fact. The trip is made in from 2½ to 5 hours, depending on the type of airplane used, number of passengers carried and flying conditions. The planes are to leave Paris and London simultaneously at noon and the fare in one direction is $100 or about four times that if the trip is made by rail and boat. Freight is to be carried, the rate varying from $1.25 to $2.50 per pound. De Haviland planes are used by one company and Handley Page types by another. The smaller planes will carry two passengers. The larger has accommodations for ten passengers.



The Zeppelin-Lindau monoplane flying boat is claimed to be the largest craft of this type ever constructed

Fitting and Adjusting Connecting Rod Bearings



By Victor W. Pagé M.S.A.E

PART III.

Refitting Bearings by Scraping

WHEN the bearings are not worn enough to require refitting, the lost motion can often be eliminated by removing one or more of the thin shims or liners ordinarily used to separate the bearing caps from the seat. These are shown at Fig. 2 A. Care must be taken that an even number of shims of the same thickness are removed from each side of the journal. If there is considerable lost motion after one or two shims have been removed, it will be advisable to take out more shims and to scrape the bearing to a fit before the bearing cap is tightened up. It may be necessary to clean up the crankshaft journals as these may be scored, due to not having received clean oil or having had bearings seize upon them. It is not difficult to true up the crank-pins or main journals if the score marks are not deep. A fine file and emery cloth may be used, or a lapping tool such as depicted at Fig. 2 B. The latter is preferable because the file and emery cloth will only tend to smooth the surface and there is always the danger of having the crankpins or journals out of round unless the work is done by an expert, while the lap will have the effect of restoring the crank to proper contour.

A lapping tool may be easily made, as shown at B, the blocks being of lead or hard wood. As the width of these are about half that of the crank-pin, the tool may be worked from side to side as it is rotated. An abrasive paste composed of fine emery powder and oil is placed between the blocks, and the blocks are firmly clamped to the crank-pin. As the lead blocks bed down, the wing nut should be tightened to insure that the abrasive will be held with some degree of pressure against the shaft. A liberal supply of new abrading material is placed between the lapping blocks and crankshaft from time to time and the old mixture cleaned off with gasoline before new material is applied.

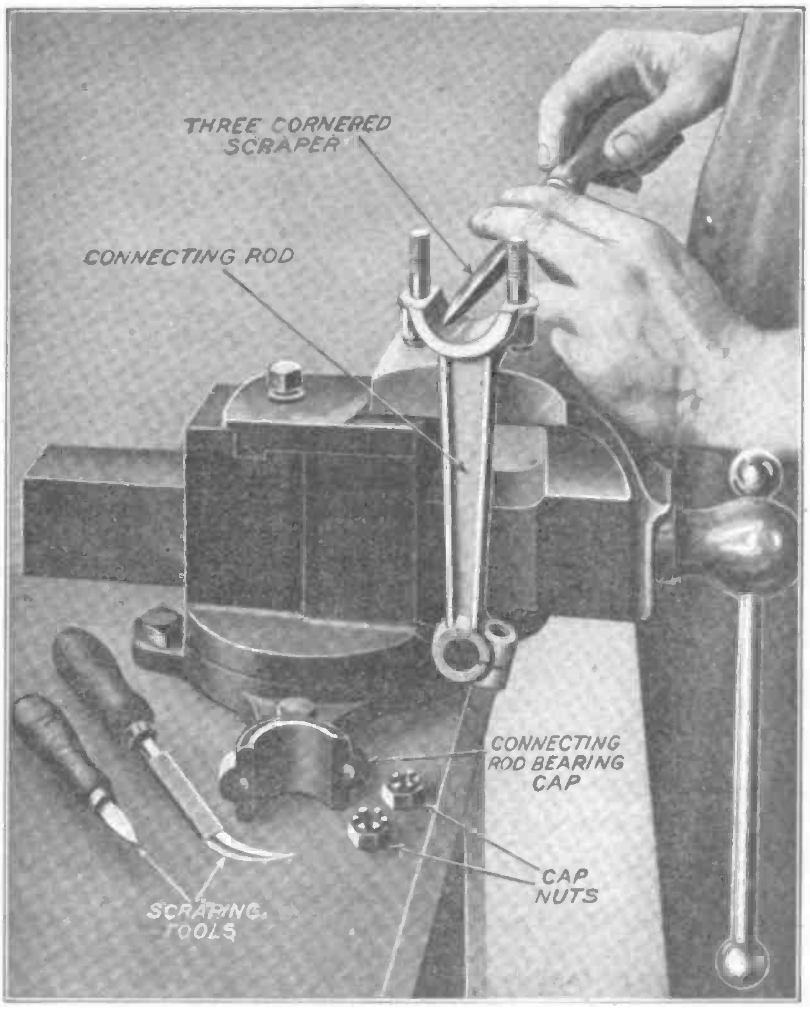


Fig. 1. Illustrating method of scraping in connecting rod bearings and tools used in this process

It is necessary to maintain a side-to-side movement of the lapping tool in order to have the process affect the whole width of the crank-pin equally. The lapping is continued until a smooth surface is obtained. If a crank-pin is worn out of true to any extent the sure method of restoring it is to have it ground down to proper circular form by a competent mechanic having the necessary machine tools to carry on the work accurately. A crank-pin truing tool that may be worked by hand is shown at Fig. 2 K, and if the automobile owner or repairman is possessed of the requisite mechanical skill, though he does not need to be an expert mechanic, it can be used to good advantage in truing roughened crank-pins and will do a good job.

This tool is of recent development, and is known as a "crankshaft equalizer." It is a hand-operated turning tool, carrying cutters which are intended to smooth down scored crank-pins without using a lathe. The feed may be adjusted by suitable screws and the device may be fitted to crank-pins and shaft journals of different diameters by other adjusting screws. This device is not hard to operate, being merely clamped around the crankshaft in the same manner as the lapping tool previously described, and after it has been properly adjusted it is turned around by levers provided for the purpose, the continuous rotary motion removing the metal just as a lathe tool would and with a perfectly smooth cut.

Automobile owners and repairmen who wish to save money during the overhauling period, may do so through the use of another recently devised hand tool for grinding crankshafts instead of doing that work on a lathe or other equipment required. This device, shown at Fig. 3, eliminates the lathe or grinder, the cost of experienced operators, and may be used upon a crankshaft without removing the latter from the engine. The working parts of the Atlas abrasive tool for grinding crankshafts are as follows: 1. A hardened steel cutter which cuts in one direction only. 2. A bronze track bearing, opposite the cutter. This bearing cannot cut a ring in a pin like hard steel nor freeze against a pin from excess friction like soft steel. 3. Adjustable abutment blocks which slip up easily against the face of the crankpin and hold the cutter and track in their proper working place.

Its work is claimed to be accurate to .001 in., fully as good as any machine shop will guarantee with a lathe. It works quickly, as an hour suffices to complete an entire crankshaft. It is adjustable to fit any crankshaft up to 2½ in. diameter. The price is reasonable. Extra cutters, one used at a time, are only a few cents each. Each cutter will true up from ten to twenty pins or bearings, according to their condition.

After the crankshaft is trued the next operation is to fit it to the main bearings or rather to scrape these members to fit the shaft journal. In order to bring the brasses closer together, it may be necessary to remove a little metal from the edges of the caps to compensate for the lost motion. A very simple way of doing this is shown at Fig. 2 D. A piece of medium emery cloth is rested on the surface plate and the box or brass is pushed back and forth over that member by hand, the amount of pressure and rapidity of movement being determined by the amount of metal it is necessary to remove. This is better than filing, because the edges will be flat and there will be no tendency for the bearing caps to rock when placed against the bearing seat. It is important to take enough off the edges of the boxes to insure that they will grip the crank tightly. The outer diameter must be checked with a pair of calipers during this operation to make sure that the surfaces remain parallel, otherwise the bearing brasses will only grip at one end and with such insufficient support they will quickly work loose, both in the bearing seat and bearing cap.

Scraping Brasses to Ft

To insure that the bearing brasses will be a good fit on the trued-up crank-pins or crankshaft journals, they must be scraped to fit the various crankshaft journals. The process of scraping, while a tedious one, is not difficult, requiring only patience and some degree of care to do a good job. The surface of the crank-pin is smeared with Prussian blue pigment which is spread evenly over the entire surface. The bearings are then clamped together in the usual manner with the proper bolts, and the crankshaft revolved several times to indicate the high spots on the bearing cap. At the start of the process of scraping in, the bearing may seat only at a few points, as shown at Fig. 2 G. Continued scraping will bring the bearing surface as indicated at H, which is a considerable improvement, while the process may be considered complete when the brass indicates a bearing all over, as at I. The high spots are indicated by blue, as where the shaft does not bear on the bearing there is no color. The high spots are removed by means of a scraping tool of the form shown at Fig. 2 F, which is easily made from a worn-out file. These are forged to shape and ground hollow as indicated in the section and are kept propely sharpened by frequent rubbing on an ordinary oil stone. To scrape properly, the edge of the scraper must be very keen. The straight and curved half-round scrapers, shown at M and N, are used for bearings. The three-cornered scraper, outlined at O, is also used on curved surfaces, and is of special value in rounding off sharp corners. The straight or curved half-round type works well on soft-bearing metals, such as babbitt or white brass, but on yellow brass or bronze it cuts very slowly, and as soon as the edge becomes dull considerable pressure is needed to remove any metal, this calling for frequent sharpening.

When correcting errors on flat or curved surfaces by hand-scraping, it is

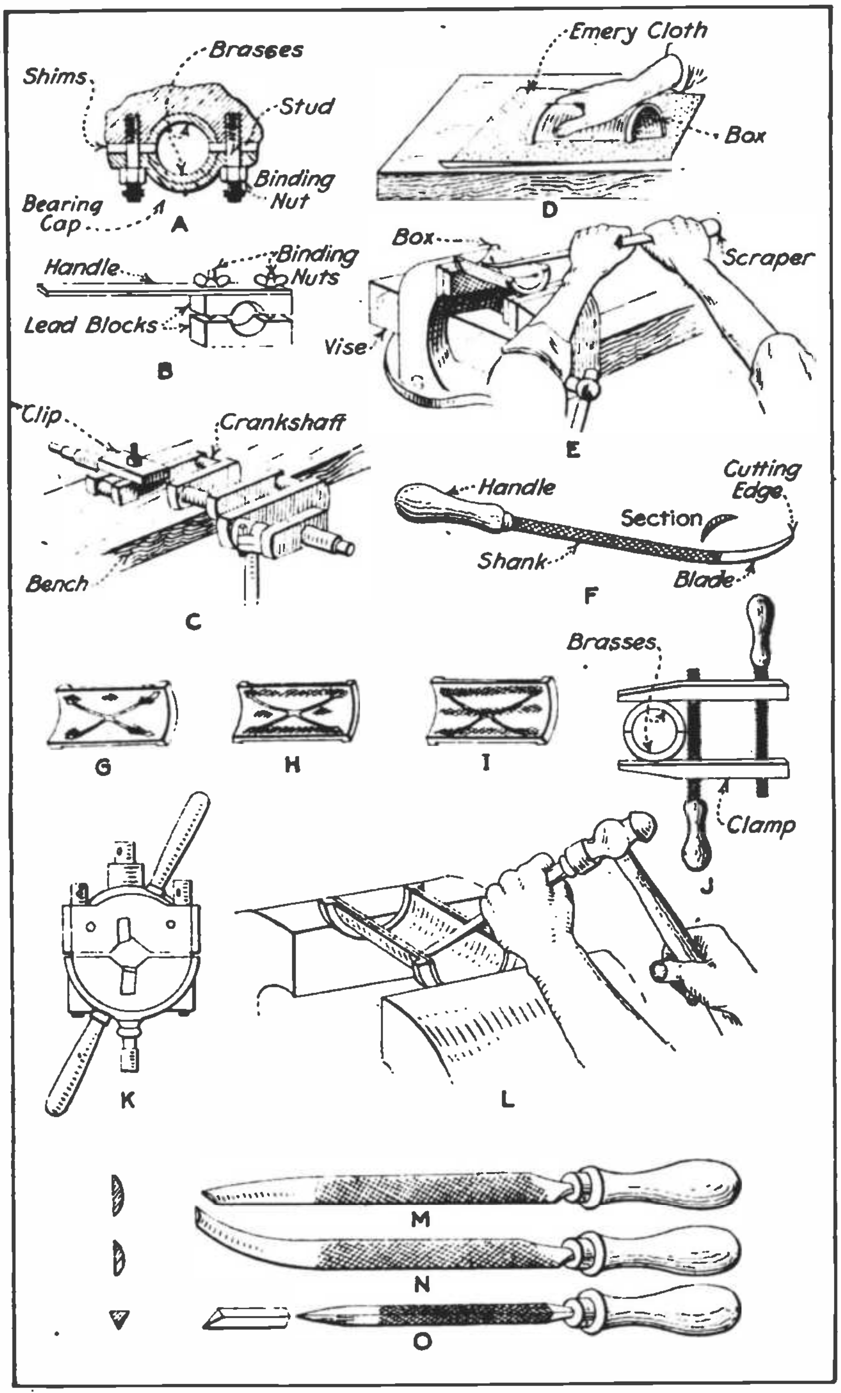


Fig. 2. Tools and processes used in refitting engine bearings

desirable, of course, to obtain an evenly spotted bearing with as little scraping as possible. When the part to be scraped is first applied to the surface-plate, or to a journal in the case of a bearing, three or four "high" spots may be indicated by the marking material. The time required to reduce these high spots and obtain a bearing that is distributed over the entire surface depends largely upon the way the scraping is started. If the first bearing marks indicate a decided rise in the surface, much time can be saved by scraping larger areas than are covered by the bearing marks; this is especially true of large shaft and engine bearings, etc. An experienced workman will not only remove the heavy marks, but also reduce a larger area; then, when the bearing is tested again, the marks will generally

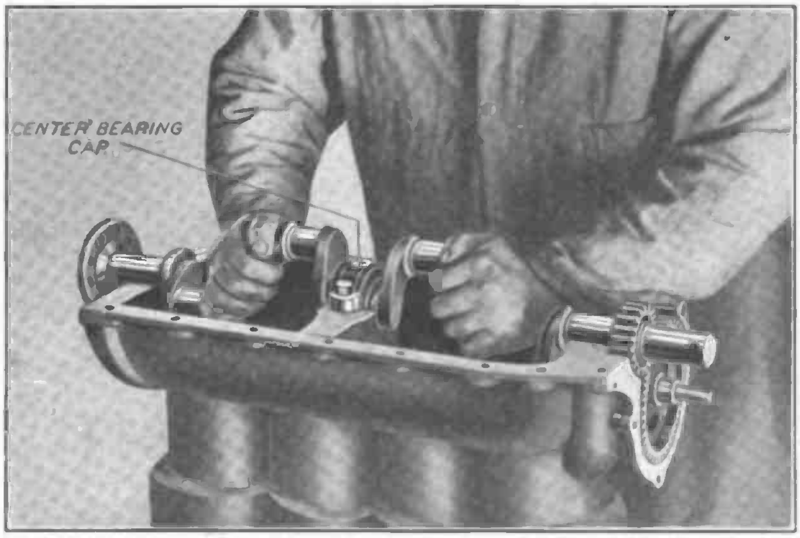


Fig. 4. Showing method of testing main bearings when refitting by rocking the crankshaft by hand

be distributed somewhat. If the heavy marks which usually appear at first are simply removed by light scraping, these "point bearings" are gradually enlarged, but a much longer time will be required to distribute them.

The number of times the bearings must be applied to the journal for testing is important, especially when the box or bearing is large and not easily handled. The time required to distribute the bearing marks evenly depends largely upon one's judgment in "reading" these marks. In the early stages of the scraping operation, the marks should be used partly as a guide for showing the high areas, and instead of merely scraping the marked spot the surface surrounding it should also be reduced, unless it is evident that the unevenness is local. The idea should be to obtain first a few large but generally distributed marks; then an evenly and finely spotted surface can be produced quite easily.

In fitting brasses, when these are of the removable type, two methods may be used. The upper half of the engine base may be inverted on a suitable bench or stand and the boxes fitted by

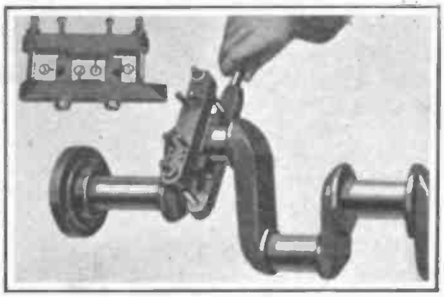


Fig. 3. Special tool for truing crankpins and shaft journals

placing the crankshaft in position, clamping down one bearing cap at a time and fitting each bearing in succession until they bed equally, as shown at

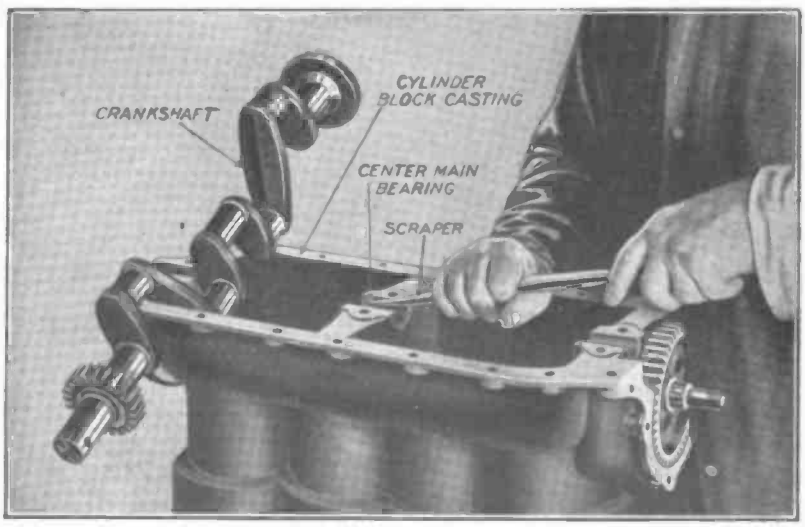


Fig. 5. Showing method of scraping in main bearings to fit crankshaft journals

Figs. 4 and 5. From that time on the bearings should be fitted at the same time so the shaft will be parallel with the bottom of the cylinders. Considerable time and handling of the heavy crankshaft may be saved if a preliminary fitting of the bearing brasses is made by clamping them together with a carpenter's wood clamp, as shown at Fig. 2 J, and leaving the crankshaft attached to the bench as shown at C. The brasses are revolved around the crankshaft journal and are scraped to fit wherever high spots are indicated until they begin to seat fairly. When the brasses assume a finished appearance the final scraping should be carried on with all bearings in place and revolving the crankshaft to determine the area of the seating. When the brasses are properly fitted they will not only show a full bearing surface, but the shaft will not turn unduly hard if revolved with a moderate amount of leverage.

Bearings of white metal or babbitt can be fitted tighter than those of bronze, and care must be observed in supplying lubricant, as considerably more than the usual amount is needed until the bearings are run in by several hours of test block work. Before the scraping process is started it is well to chisel an oil groove in the bearing as shown at Fig. 2 L. Grooves are very helpful in insuring uniform distribution of oil over the entire width of bearing and at the same time act as reservoirs to retain a supply of oil. The tool used is a round-nosed chisel, the effort being made to cut the grooves of uniform depth and having smooth sides. Care should be taken not to cut the grooves too deeply, as this will seriously reduce the strength of the bearing bushing. The shape of the groove ordinarily provided is clearly shown at Fig. 2 G, and it will be observed that the grooves do not extend clear to the edge of the bearing, but stop about a quarter of an inch from that point. The hole through which the oil is supplied to bearing should be drilled through in such a way that it will communicate with the groove to insure positive distribution.

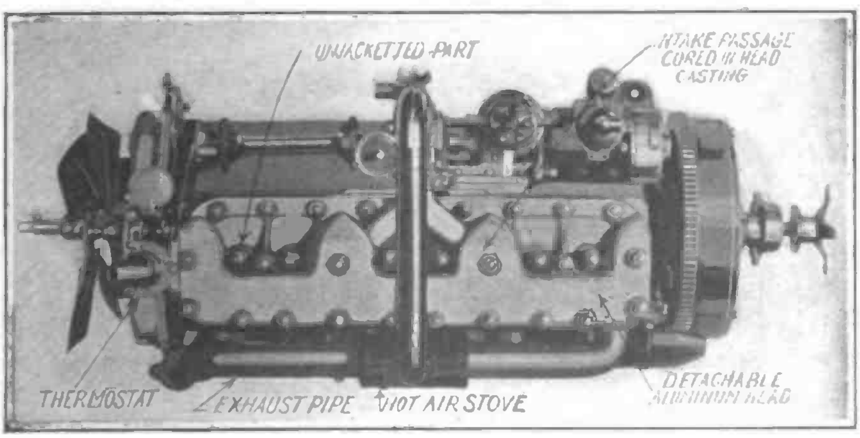
Vaporizing Low Grade Fuels

THE great demand existing for liquid fuels for use with internal combustion motors has resulted in the producers including some of the fractions of lower volatility in the gasoline used today to increase the volume of production to endeavor to cope with the demand. The new fuel is different from the gasoline sold in former years in that it does not vaporize as readily and engine designers have been forced to take this into consideration when new engines are designed. It is a reasonable assumption that the fuels sold for automobile use will not improve in quality as time goes on, so the new engines must be designed with heated manifolds or thermostatic cooling water control to insure sufficient heat as a guarantee of complete vaporization.

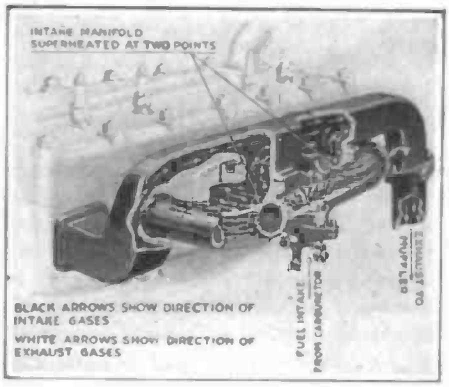
With a view to improving carburetion, the intake manifold of several power plants, in both overhead-valve and L-head types of engine, is cast entirely within the detachable cylinder head, connection with the carburetor being effected by an integral cross passage between the third and fourth cylinders, to the opening of which is bolted a short elbow supporting the carburetor. A small portion of this elbow is integral with the exhaust, forming a hot spot of limited proportions to assist in breaking up the fuel before it enters the manifold.

Care must be taken in designing the intake manifold system to secure the application of heat in just the correct proportion, i.e., to secure satisfactory performance on low grade fuels without undue thinning of the gases and consequent loss of power. That complete success has been attained in this respect is witnessed by the performance of one of these engines, 71 horsepower being developed on low grade fuels at 2600 engine revolutions, though the N. A. C. C. rating of the engine is only 29.4 horsepower.

Method of arranging gas passages in cast aluminum head of Studebaker engine

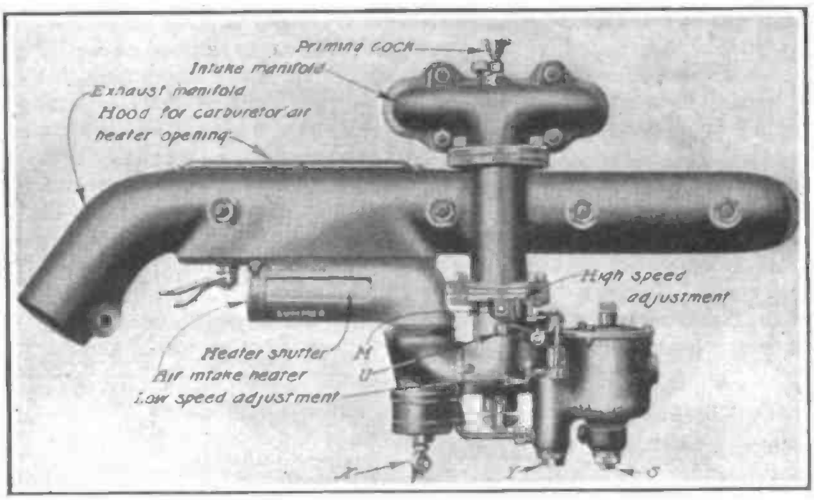


Another well developed motor in which a number of new and valuable features are incorporated is shown in view herewith, the attention of the reader being specially directed to the novel cylinder head construction.



Hot spot manifold of Allen car

The motor has a detachable aluminum head in which are cast not only the usual water jackets, but also all passages of the horizontal intake manifold. The horizontal feed Stromberg carburetor is bolted directly to this head. The combination of the intake manifold with the motor head not only shortens the distance from the carburetor to combustion chamber, but also allows intake passages to be heated directly from the combustion chamber itself. These intake passages are inclined downward from the point of contact with the carburetor, so that any unvaporized particles of gasoline leaving the carburetor will be forced to flow down hill and into a position directly in contact with the combustion chamber. The disadvantages of low grades of gasoline now in general use which prevent complete carburetion and result in the presence of a certain quantity of raw or unvaporized gasoline in the manifold are overcome by this type of construction. By the position of the valve openings, gases immediately upon passing through the valves are directed against an unjacketed and therefore superheated portion of the combustion chamber head. This insurance of complete vaporization and perfect combustion contributes greatly to fuel economy and likewise prevents the impairment of lubrication by the seepage of raw gasoline past the pistons into the oil reservoir.



How intake manifold is heated by having a portion cast with exhaust conduit on Reo cars

The problem is not simply met by heating the mixture as means must be provided to insure just the proper degree of increase in temperature to secure maximum efficiency at all times. For this reason, hot and cold air control is nearly always provided. This is done by altering the temperature of the primary air after it leaves the exhaust heated stove by manually regulated air intake shutters that permit cool air to enter and mix with the heated air in any desired proportions. In cold weather, it may be necessary to entirely close the cold air opening so only heated air will enter the carburetor, in hot weather the reverse procedure may be necessary.

SHOP PRACTICE

The Proper Use of Lathe Tools

By George Shipston

THE amateur lathe operator must thoroughly understand lathe tools before he can expect to accomplish successful metal turning. It is regrettable, but none the less true, that few mechanics understand their lathe tools as they should. This article has been prepared for those who desire further information along this line and the author hopes that it will be studied diligently by those who do not already fully understand the subject matter.

A complete set of lathe tools is shown in Fig. 1. The name of each tool suggests the nature of the work that it is to be used for. While few mechanics are in possession of the complete set of tools illustrated, as many as possible should be obtained as it is desirable to always use the right tool for the right job if good work is to be accomplished.

A few words about grinding tools may not come amiss, especially to those who now believe that it is only a matter of a few misdirected jabs against a grinding wheel. When a tool is being ground it should never be held against the grinding wheel until it becomes real hot. It should not be allowed to reach a temperature where it cannot be held comfortably in the hand. The point of the tool should be occasionally immersed in a convenient receptacle of cold water while it is being ground. If the tool is allowed to become too hot it will lose its hardness and become useless for further work.

The proper angles of the cutting edges of a tool should be maintained during the grinding process. If this is not done the tool cannot function properly. The original angles must be preserved throughout the entire life of the tool if good results are to be expected from its use. Figure 7 (A and B) illustrates two examples of badly ground tools. At A the angle is much too sharp and the point of the tool would be in constant danger of breaking off. The case shown at B is equally bad. It will be seen that the effective cutting edge at B is much greater than that at A. The tool at B will require much more driving power for the lathe it is used on than the tool shown at A. It must always be remembered that the more the cutting edges of a tool approach a line parallel with the axis of the work being turned, the greater the power necessary to run the lathe will be.

More experienced mechanics can preserve the original angles of a lathe tool after repeated grindings. However, this is merely a matter of extended experience and the beginner cannot expect to do this. A small tool gauge should be used by those who lack the necessary experience. Such a small gauge is shown in Fig. 5. Here it is being used to properly set a screw cutting tool at exact right angles to the work mounted between centers.

The matter of mounting a tool in the lathe is very important. If a properly ground tool is badly mounted good work cannot be accomplished. The height of a tool must first be determined. Experience has proven that for all ordinary turning the lathe tool should be mounted about five degrees above the center of the work it is expected to turn. This is shown graphically in Fig. 4. This does not hold true in the case of screw cutting, however. In screw cutting, the lathe tool must be mounted so that the top of its cutting

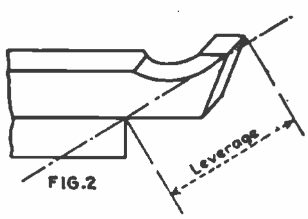


FIG. 2


FIG. 3

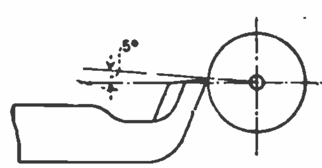


FIG. 4

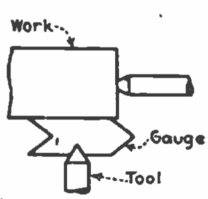
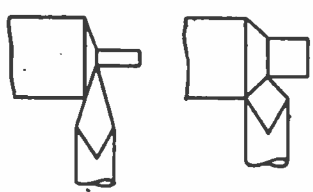


FIG. 5


A FIG. 7 B

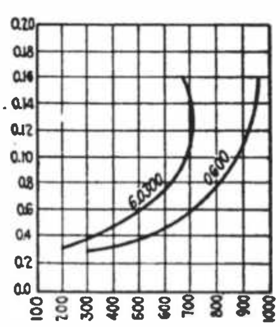


FIG. 9

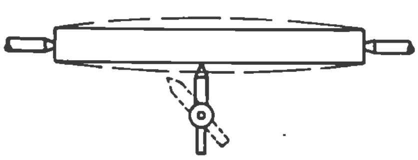


FIG. 6

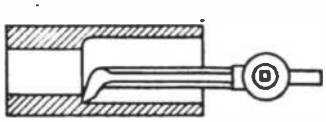


FIG. 8

edge will come at the exact center of the work. If this is not done accurate threads cannot be cut.

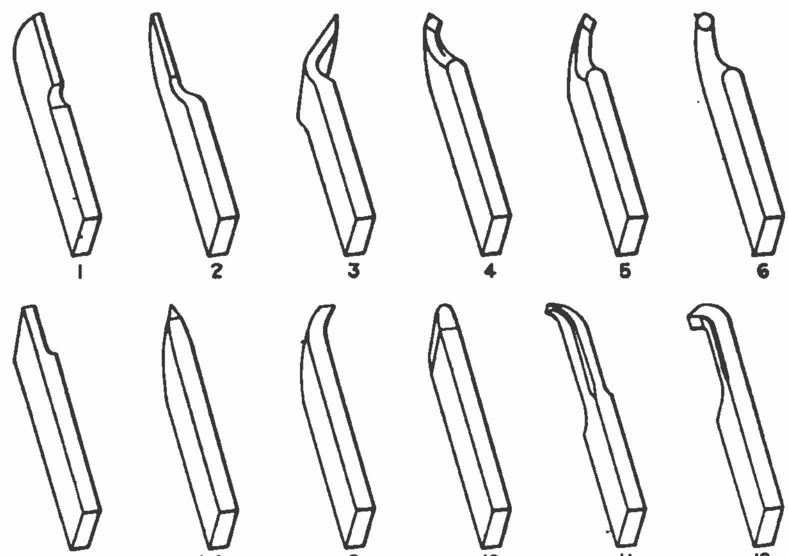
Another important consideration is the distance of the cutting edge of a tool from the supporting piece in the tool post. The greater this distance is the more tendency the tool will have to spring. This is depicted in Fig. 2. It is simply a matter of increasing the effective leverage. The tool should always be so mounted that its cutting edge will be as near to the supporting edge as practical. Care should also be taken to see that the tool is secured rigidly as possible to prevent chattering with its attending evils.

Some may think that the matter of mounting a cutting tool approximately at right angles to the work in the lathe is not important. This is by no means true, as the tool will have a tendency to cut in the manner shown if its angle is changed while the turning is being done. It will be seen that as the angle of the tool increases the distance of its cutting edges from the work also increases. This results in the effect illustrated in Fig. 6.

The matter of rake must be considered. Many probably already understand that a tool with a positive rake should not be used to turn brass. For the benefit of those who do not, this part of the subject will be given attention. A tool with a positive rake is one which has an angle that declines *from* the cutting edge and surface of the work being turned. A tool with a negative rake is one with a cutting edge that is at the lower end of an angle that inclines *to* the work. A tool with a positive rake must be used on steel and other metals of a similar nature. If such a tool is used on brass, however, it will have a tendency to "bite in." This is due to a property that is peculiar to the metal. A tool digging in in this manner will, in nine cases out of ten, either ruin the work being turned or the end of the tool will break off. In any event, something will happen which a real good mechanic would be thoroughly ashamed of.

Fig. 3 illustrates the methods used in England for mounting lathe tools. This was originated by Sir Joseph Whitworth. His object was to bring the cutting point of the tool on a level with its line of support. In this way any vertical pressure is sure to force the tool away from the work. This practice is not followed greatly in America, although the writer has seen a few mechanics that claim it to have many advantages.

Side angle on a lathe tool refers to the angle at which the top is ground either to the right or left side. A tool ground in this manner must have either a right-hand rake or a left-hand rake, depending upon the direction of the angle. The right-hand tool must always be used in cutting to the right and a left-hand tool for cutting to the left. Increasing the rake makes it possible to decrease the driving power, as the tool will then have more of a tendency to screw its way along.



1. *Left-hand side tool.* 2. *Right-hand side tool.* 3. *Right-hand bent tool.* 4. *Right-hand diamond point tool.* 5. *Left-hand diamond point tool.* 6. *Round nose tool.* 7. *Cutting off tool.* 8. *Threading tool.* 9. *Right-hand tool.* 10. *Roughing tool.* 11. *Boring tool.* 12. *Inside threading tool*

The chart shown in Fig. 9 is very interesting. It shows the power required for making cuts of various depths in a piece of steel. The vertical figures represent the depth of the cut while the horizontal figures represent the number of pounds force required to make the cut. It has been found that steel requires about two and one-half times the power for cutting as does cast iron. Wrought iron, which is used considerably, requires about one and one-half times the power. These calculations are based on experiments made with tools ground as correctly as possible. More power would be required if the tools were improperly ground.

An ordinary boring tool is sketched in Fig. 8. The same laws for outside turning do not hold true for inside turning. This is to be expected, as the contour of the cutting surface is entirely different. In one case the tool is cutting on the outside of a circle and in the other case it is cutting on the inside of a circle. If the tool is mounted about five degrees above center for outside turning, just the reverse condition would hold true for inside turning or boring as it is called. In boring, the tool is best mounted so that its cutting edge will come a few degrees below the exact center of the work. Greatest cutting efficiency is realized at this particular point. The clearance of the tool as regards brass and steel is the same in boring as in outside turning.

The cutting edge of a boring tool must not be mounted too far from the tool post or bottom support. If this is done the tool will spring and accurate work simply cannot be accomplished. The tool will have a tendency to spring in two directions. It will be pushed from the surface of the work and it will spring downward. The result of this will be a hole with a slight taper. The more the tool springs the greater the taper will be.

Forged lathe tools are either made of tool steel or crucible steel. These tools can be tempered by heating them slowly and evenly for a distance of about two inches from the cutting point. After the point becomes heated for the required distance to a cherry red, it is picked up with a pair of tongs and the point immersed in a bath of cold water. The entire tool should not be immersed; merely its entire cutting edge. About one and one-half inches of the tools should be exposed to the cooling action of the water. When the point of the tool has become cool it is removed from the bath and carefully cleaned with carborundum cloth. The surface is then wiped with an oily rag. The heat in the shank of the tool will now drive the temper toward the cutting edge. After this edge becomes a dull brown straw color it is completely immersed in water.

When cutting steel, the mechanic should always take the precaution of properly lubricating the point of the tool to assist in cutting. This also offers a certain amount of protection to the cutting edges of the tool and prevents them from becoming dull. A good lubricating substance for long cuts and continued work on steel can be made of very soapy water held in a receptacle above the tool, and allowed to drip on the point. For short cuts, a few drops of lubricating oil placed occasionally on the tool point will suffice.

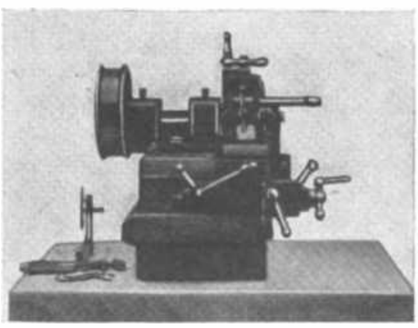
Building A Small Crank Shaper

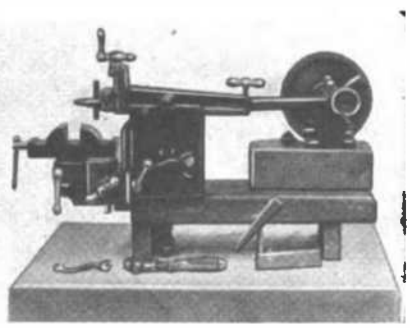
By Joseph Dante, Jr.

HOW many times has the editor told us to take a file and smooth the bottom of this piece or that? The author first constructed this machine with a friction drive. It did not prove successful and he had to resort to the crank drive as shown in the photographs. In the development of the machine many of the parts were made as many as four times. The vertical slide in use now is the fourth one that has been made and is a good one with a very neat appearance. The machine is well adapted to the construction of the many small parts which a model maker has to make. It will be noticed that the vertical slide is a plain one and does not swivel. The vise block is made so it can be turned or swiveled until the base of the vise strikes the cross rail, as it will not clear this rail. The machine is mounted on a suitable wood base and the driving mechanism is built up with a block so that the center line of the driving shaft will line up with the center line of the stroke adjusting rod. It will be seen in the photograph that the baseboard is cut away on the end so as to allow for the cross rail to drop down. In checking up the machine with an indicator, the results were as follows: The vertical slide travels for its full length within .0015 and the cross rail travels for its full length within .006, which the writer thinks is a very good job. The speed of the machine should be about forty strokes per minute.

The vise can be swivelled through an arc of 180°. The jaws of the vise are made of cast iron and should be lined up with steel plates in order to prevent them from getting nicked up when clamping the work. The vise will open about 2¾ in. and is about 2½ in. wide. In cutting metals, the writer made the following tests in steels and cast iron. The machine has been able to take a cut of about 1/16 in. deep with a .008 feed per stroke and for brass and bronze it takes cuts ⅛ in. deep with .005 feed per stroke. The reader will notice that next to the cross rail crank there is a ring which has fifty graduations and the screw has a 5/16 in. x 20 thread. A pattern is made for the bed and ram and should be finished as per drawing. The author worked his up with three good twelve-inch files and made a fairly good job out of it. The gibs are all plain stock and no description is needed for them here. The ram is shown with its dimen-

The little crank shaper described in this article will provide the mechanical readers of EVERYDAY *with a shop project of real value. When completed the machine will make a very useful addition to the small shop. The author and designer of the machine, Mr. Joseph Dante, Jr., does not need an introduction to our readers as his very practical articles that have appeared in past issues will be well remembered.*
—EDITOR.



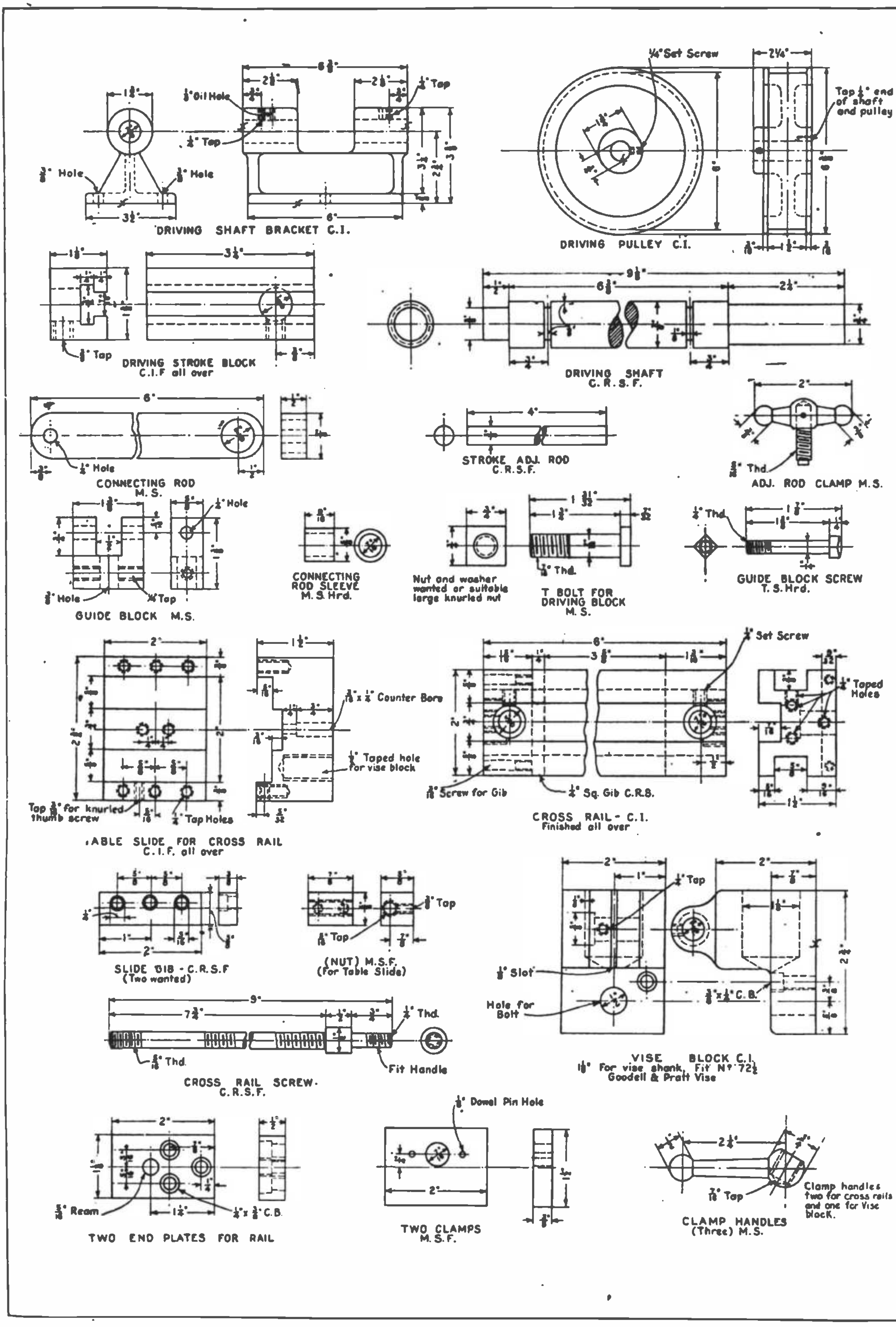


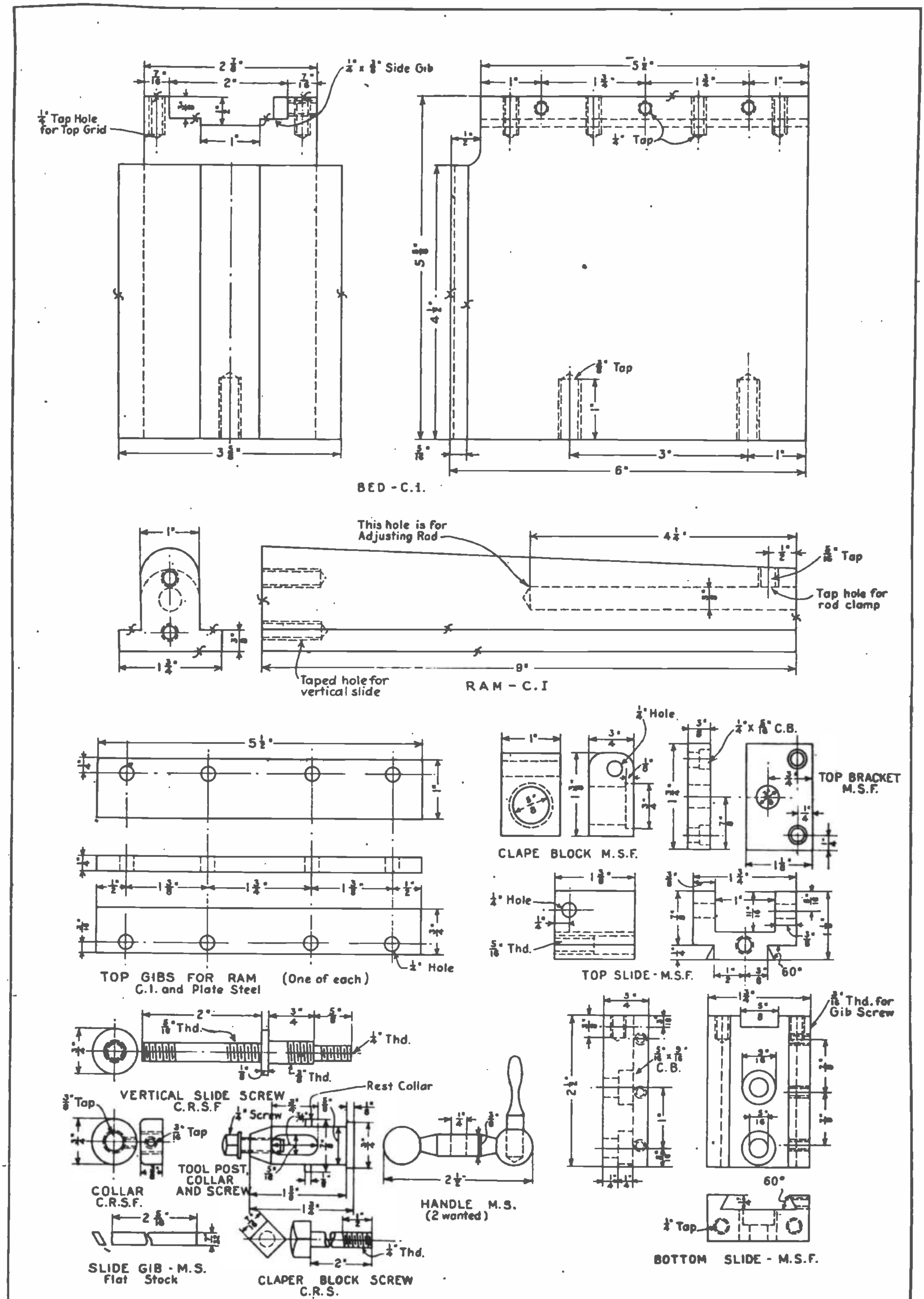
sions and this should be machined if possible. The ⅜ in. hole in the rear of the ram is for the adjusting rod and this is to bring the stroke of the ram to any desired position over the work.

The Vertical Slide. The bottom slide is the first job done. This is a piece of C.M.S. and squared up all over and machined to the dimensions given. If cutters are on hand, the job can be done in a lathe, using the milling attachment which was built by the writer and which has appeared in a past issue of EVERYDAY ENGINEERING. The top slide is a piece of machine steel and is carefully laid out before any work is done on the piece. Then the slot one inch is cut as shown in the drawing. The angles were cut on the milling attachment. Next, the ¼ in. hole was drilled with clapper block clamped to the slide. The taped hole is left until the slide and top plate is put in place, so that both holes can be drilled and the slide taped properly.

The clapper block is a simple job and there is no need of explaining it here. The top plate is a piece of flat stock nicely polished and machined as per drawing. The screw is die cast and is turned from ⅞ in. stock. A collar is also needed for this screw. When threading the screw for the collar end it would be better if the die was put in a chuck and with the aid of the tail stock center the work can be threaded square and no trouble will be experienced when the collar is finally put in place. The collar should be turned up square in a lathe, using the screw as an arbor. The other parts are the tool post, which is shown with screw and rest collar all in place. The screw and collar should be hardened. The clapper block screw is turned up from square stock and left long enough so as to make a nice button finish flush with the nut after it is put in place. The handles are turned from stock. The drawing calls for two; one for vertical slide and one for cross rail screw.

The cross rail is made of cast iron and machined as shown. This should be finished all over and the cross slide should be scraped to the rail. The other parts are the gibs, nut, screw, end plates, etc., which need no description here. There is a binder hole drilled into the slide as shown. The clamp plates are made of flat stock. These plates should be pinned to the rail so as to keep them from moving in all directions when they are loose. The vise block is a casting and is machined according to the drawing. The 1⅛ in. hole was bored out in a lathe using an angle iron to hold the work. The vise is a Goodell-Pratt No. 72½ with a 1⅛ in. shank and it has a right and left screw, which makes just a suitable device for the drive on the shaper. The more to the center the T bolt is set, the larger will be the radius of the stroke


DRIVING SHAFT BRACKET C.I.
DRIVING PULLEY C.I.
1/4" Set Screw
DRIVING STROKE BLOCK
C.I.F all over
DRIVING SHAFT
C. R. S. F.
CONNECTING ROD
M. S.
STROKE ADJ. ROD
C.R.S.F.
ADJ. ROD CLAMP M.S.
GUIDE BLOCK M.S.
CONNECTING ROD SLEEVE
M. S. Hrd.
Nut and washer wanted or suitable large knurled nut
T BOLT FOR DRIVING BLOCK
M. S.
GUIDE BLOCK SCREW
T. S. Hrd.
Counter Bore
Taped hole for vise block
TABLE SLIDE FOR CROSS RAIL
C. I. F. all over
Set Screw
Taped Holes
Screw for Gib
Sq. Gib C.R.S.
CROSS RAIL - C.I.
Finished all over
SLIDE GIB - C.R.S.F
(Two wanted)
(NUT) M.S.F.
(For Table Slide)
Slot
Hole for Bolt
VISE BLOCK C.I.
For vise shank. Fit No 72 1/2 Goodell & Pratt Vise
Fit Handle
CROSS RAIL SCREW.
C. R. S. F.
Dowel Pin Hole
Ream
TWO END PLATES FOR RAIL
TWO CLAMPS
M. S. F.
Clamp handles two for cross rails and one for Vise block.
CLAMP HANDLES
(Three) M.S.



Side Gib
Tap Hole for Top Grid
Tap
BED - C.I.
This hole is for Adjusting Rod
Tap hole for rod clamp
Taped hole for vertical slide
RAM - C.I
Hole
C.B.
TOP BRACKET M.S.F.
CLAPE BLOCK M.S.F.
TOP GIBS FOR RAM (One of each)
C.I. and Plate Steel
Thd.
TOP SLIDE - M.S.F.
60°
VERTICAL SLIDE SCREW
C.R.S.F.
Rest Collar
Screw
TOOL POST, COLLAR AND SCREW
COLLAR
C.R.S.F.
HANDLE M.S.
(2 wanted)
Thd. for Gib Screw
BOTTOM SLIDE - M.S.F.
SLIDE GIB - M.S.
Flat Stock
CLAPER BLOCK SCREW
C.R.S.

each side of the center line. The handle and other minor pieces do not need very much description, so the builder is left to decide for himself whether to use handles or nuts.

Bracket. This is shown on the drawing and is the same thing that the writer is using. The only operations that were done on this piece were the drilling of the oil holes and set screw holes. The bracket, pulley, stroke block and driving shaft all came from a local junk dealer. The shaft was turned up as shown with two slots. This is to keep the shaft from swaying from side to side. To the pulley was added an extra set screw at the end of the shaft, as the other one persisted in coming loose while running. The block was drilled as shown with a 3/8 in. taped hole for the set screw.

The connecting rod is a piece of flat stock with holes drilled in both ends. The 5/8 in. hole in this rod is of the sleeve shown, which is 1/16 in. longer than the width of the rod. This is so that the nut can be tightened up on the T-bolt and at the same time it will leave the rod free to revolve. A small oil hole should be drilled into the connecting rod holes. The sleeve is a simple job and should be hardened if possible. A small block is made of steel. There are two 1/4 in. set screws taped into the 3/8 in. hole and they should be spotted into the adjusting rod, which is a piece of cold-rolled steel 4 in. long. The T-bolt was turned from 3/4 in. square stock and die threaded. The guide block screw was turned up from 3/8 in. square stock, and should be hardened. The adjusting rod clamp was taken from a water faucet and a 5/16 in. threaded stud pinned to it.

To Loosen Rusted Screws

ONE of the simplest and easiest ways of loosening a rusted screw is to apply heat to the head of the screw. A small bar or rod of iron, flat at the end, if reddened in the fire and applied for two or three minutes to the head of the rusty screw will, as soon as it heats the screw, render its withdrawal as easy by the screw-driver as if the screw had been only recently inserted.

Lacquers For Gold

ALCOHOL, 1 gal.; turmeric, 1/2 lb.; moderate for a week, then filter, and add gamboge, 2 oz.; shellac, 6 oz.; gum sandarac, 1 3/4 lb.; dissolve in a warm bath, and add 1 quart common turpentine varnish. For red lacquer use 1 1/2 lb. of annotto instead of the turmeric, and 8 oz. of dragon's blood instead of the gamboge.

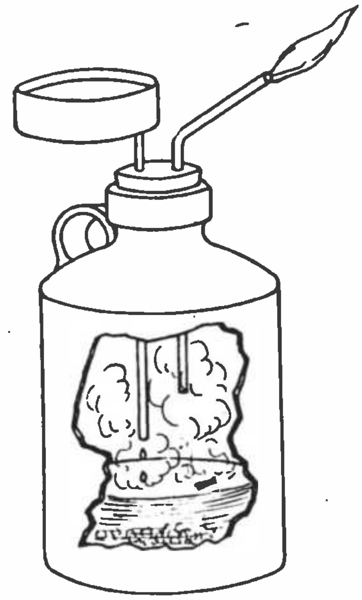
To Brown Gun-Barrels

MIX chloride of antimony to a creamy consistency with olive oil. Apply the mixture evenly to the heated barrel, allow it to act for twelve to twenty-four hours, then remove the excess with a woolen rag and repeat the operation. After the second application has acted for twelve to twenty-four hours, the iron or steel is covered with a bronze-like layer of ferric oxide and antimony, which resists the action of the air and may be made lustrous by brushing with a waxed brush. The sharpening of the chloride of antimony can be effected by adding a little nitric acid to the paste of olive oil and chloride of antimony so as to hasten the operation. Another formula is: Nitric acid, 1.5 parts; sweet spirits of nitre, 1.5; rectified alcohol, 3; blue vitriol, 6; tincture of chloride of iron, 3; distilled water, 100. Dissolve the blue vitriol in the water, then add the other materials. The burnishing and marking can be effected with the burnisher and scratch-brush. The polishing is best effected by rubbing with a piece of smooth, hard wood, called polishing wood. The barrel is finely varnished with shellac varnish and again polished with the hard-wood polisher. Some prefer the tone of brown produced by blue vitriol, 5 parts; sweet spirits of nitre, 5; water, 100. In any case the surface of the iron must be well cleansed and rendered quite bright; it is then freed from grease by rubbing with whiting and water, or better, with powdered quicklime and water. The browning composition is then put on and allowed to remain twenty-four hours. It is then rubbed off with a stiff brush. If not sufficiently browned repeat the last process after browning. Clean the surface well with hot water, and dry it. The surface can be burnished and polished. Varnish with tinsmith's lacquer, or with gum shellac, 2 oz.; dragon's blood, 3 drachms; methylated spirit of wine, 4 pints. The metal should be made hot before applying this varnish and it will present an excellent appearance. If the varnish is not required to color, but only to preserve the actual tint produced on the metal surface by the browning fluid, leave out the dragon's blood.

A Simple Substitute for Bunsen Burner

A SIMPLE but effective substitute for a Bunsen burner, operated by acetylene instead of illuminating gas, can be made from materials costing only a few cents. All that is needed is a medium sized bottle with a large neck. The writer used a jug for this purpose. A cork to fit the neck of the bottle, 4 ins. of 1/16 in. brass tubing, 4 ins. of 3/16 in. tubing and the cover from a small baking powder tin.

The tin cover is intended to hold water and should be soldered to the smaller tubing so that when the tube is run through the cork, the water will drip down into the bottle. Six or eight small holes are drilled in one end of



the larger tube, which is bent at an angle and the other end of this tube also run through the cork.

To operate the burner, fill the bottle about one-third full with calcium carbide, such as is used in acetylene gas generators, put the cork in place, but not too securely, so that it will work as a safety valve in case the burner tube becomes stopped up, and fill the receptacle with water. Gas will immediately begin to generate and by holding a lighted match to the burner it will soon come to a steady flame. The pressure of the gas in the bottle will regulate the flow of water.

This little device may be used for any purpose for which a Bunsen burner is employed. It is especially useful in workshops where illuminating gas is not obtainable.

R. M. Hendricks.

Preparation of Potash Water-Glass

MIX 15 parts of pure quartz-sand with 10 of potassium carbonate and 1 of charcoal powder, and fuse the mixture in a crucible. The contents of the crucible, when cold, is taken out, pulverized, and exposed to the air, being frequently stirred during the time. The powder is then several times washed with cold water, and then boiled with 5 parts of water until all is completely dissolved. The solution is then filtered and evaporated to a specific gravity of 1.25. In this manner a sticky, syrupy liquid is obtained which, on exposure to the air, dries to a transparent glass.

Another receipt: Quartz-sand 15 parts, potash 5, and anhydrous soda 4. It is prepared as above.

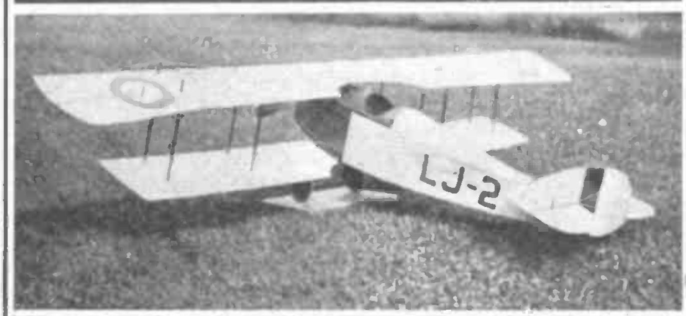
Ford Motored Airplane Proves Practical

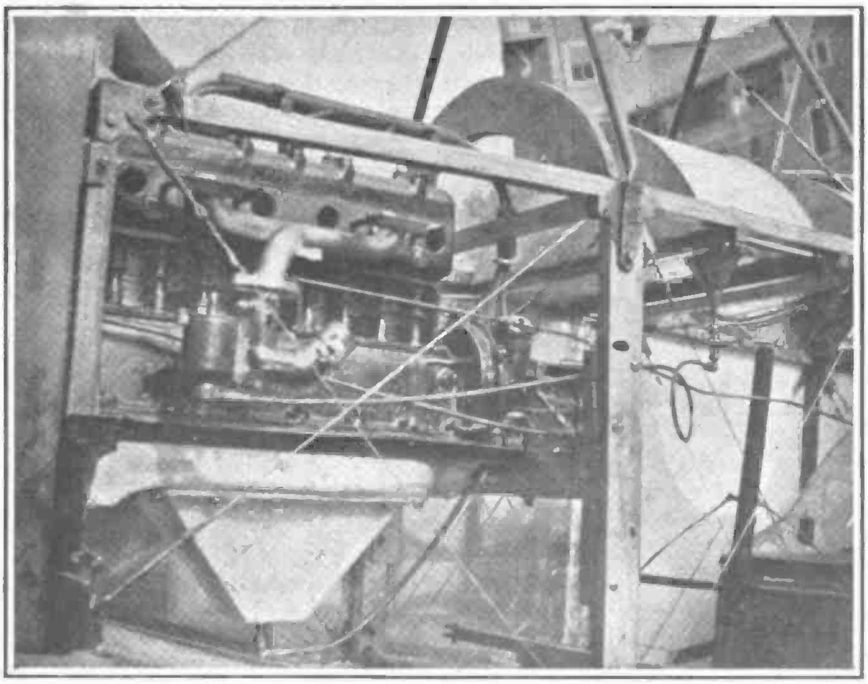
By E. H. Holterman

Former Flying Instructor, U. S. Army

A POINT that is interesting to many aviation enthusiasts, especially those who are building full sized airplanes of their own, is the use of a modified Ford motor as power. The photographs herewith show a successful biplane built and flown by the writer that is equipped with a modified Ford engine and which flies very well indeed when one considers the low horsepower. The motor shown weighs 195 lbs. after alterations have been made, but it is believed that this weight can be cut down in a new form the writer is experimenting with. The propeller that seems to work the best is 6 ft. 6 in. in diameter by 4 ft. 6 in. pitch. The complete machine illustrated weighs 580 lbs., which the writer considers unnecessarily heavy for such a small machine and which can be reduced to less than 500 lbs. by refinement of construction.

The main dimensions of the machine are 18 ft. length, 25 · ft. spread, 4 ft. chord, 4 ft. 6 in. gap, and while official speed tests have never been made, from previous experience it is estimated it will fly at least 45 miles per hour. One of the machines illustrated is without a 4 ft. overhang on the upper wings which is shown in the other machine. This added surface will give a better landing speed and will also enable the machine to get off the ground easier.





Views at top show Ford motored airplane flown successfully by E. H. Holterman of Woodstock, Vt. The LJ-2 is the machine after the overhang had been added to the top plane to obtain more surface. The illustration of the modified motor shows method of installation in fuselage

How to Rebuild Ford Motor

To rebuild a Ford motor for use in an airplane, I have found that the following changes are necessary. First, get a Ford motor block that has been used enough to have smoothed the cylinder walls to a glossy finish, but has not been worn to an oval or "out of round" shape. Get a set of Lynite or other light magnalium alloy pistons. In getting connecting rods, try to get them as near an equal weight as possible, as they vary quite a bit in weight. Drill holes along the rods between the flanges to lighten them, and at least two holes into the rods through the bearings for oiling. Balance them up equally after having fitted them to the crankshaft. The crankshaft should be well balanced also. The regular Ford camshaft may be used or one can put in a special, high speed shaft as desired. It is advisable to get some Dodge car valves, as they are a bit larger than the Ford valves. By reaming out the valve seats a bit the Dodge valves will fit nicely and give you more power. You can either put on an Atwater Kent timer with battery and cells or mount a small magneto for ignition as desired.

Special Precautions for Oiling

For the base or oil pan you can use the Ford crank case by cutting the rear end off so that it will come within the flange of the crankshaft, and weld a piece on with a pocket for a piece of felt packing to keep the oil from coming out. The front end is cut off at the beginning of the oil case. Cut slots about three inches long in the inspection plate between the dip grooves of the connecting rods to allow the oil to drop into the oil sump. This sump is nothing more than an oil receptacle from which the oil is pumped through a tube on to the bearings. By taking a copper pipe and attaching small nipples such as they use on shower baths so that the oil will be pumped directly on to the bearings, you will have no trouble with bearings. A small gear pump attached to the oil sump (below your oil level) driven either by a chain or shaft and gears will keep a constant stream of oil to your bearings. A Zenith carbureter gives good results and is very light, having an aluminum manifold.

Mounting Nose Type Radiator

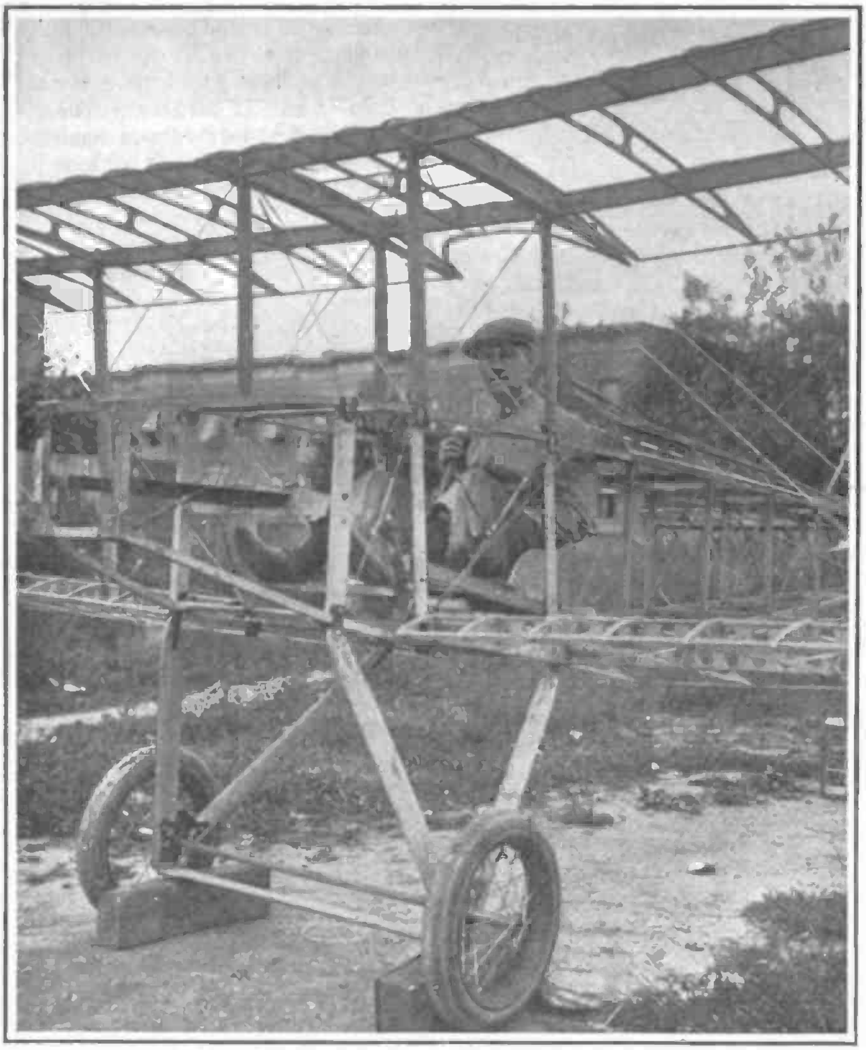
If the motor is to be used as a tractor, and you wish to have the radiator in the nose, an extension with two flanges will have to be made, one flange to be bolted to the flange on the crankshaft, then a space of a few inches (corresponding to radiator depth), then another flange, and if preferred a shaft extended from this second flange for the propeller. The cylinder head will either have to be machined off along the outlet "hump" and another piece welded on with the outlet for the water turned in the opposite direction, or else plug up the opening for the water and tap into the head at the opposite end. If the radiator is to be overhead or along the side, the cylinder head can be used as it is by making a simple connection, and no propeller extension will be necessary to go through the radiator. No water pump is needed. Keep the weight down on everything, taking off more when you think you have taken off as much as possible.

Pilot Holterman in the Ford motored airplane built and flown by him

The building of such a machine is not beyond mechanical skill of the average amateur, as the construction of practically all parts excepting alterations in the motor can be done with the ordinary wood working manual training equipment. The work of construction of such machines is made considerably easier by purchasing supplies which are available on the open market, these comprising everything from a complete set of blueprints to all of the metal fittings and wooden parts in completed or knockdown form. Modified motors may also be obtained from dealers who are making a specialty of this work.

Common Failings of Amateur Builders

It has been my experience that the common failing of amateur aircraft builders is to build their machine heavier than really needed because they do not realize the necessity for light construction to insure successful flying with low powered motors. Those who have had experience in the Air Service have a realization of the strength and size of various structural parts, but most amateurs make them too large and of unsuitable materials. There is no reason for the use of heavy construction in a small low powered airplane because the flying speed is low and the stresses on the parts are not severe. Particular attention should be given to paring down weight in small items, as these mount up to an astonishing total in the aggregate. Machines examined by the writer that have been built by amateurs have had 3/8" bolts used where 3/16" or 1/4" would have had ample strength, and fittings of 1/8" sheet metal when 1/16" gauge stock would have been amply strong. Aluminum should be used wherever possible in preference to heavier metals. Do not use heavy 19 strand wire cable and correspondingly large turnbuckles for taking loads that are way under the capacity of "aviator cord" cable or hard wire and lighter turnbuckles.



John F. McMahan, a Brooklyn, N. Y., aviation enthusiast and expert builder of model and full size airplanes, seated in the fuselage of airplane built by him which is to be powered with a Ford motor. He has previously built and sold a similar machine. The illustration shows many details of construction in both wings and fuselage framework

FLEXIBLE PONTOONS FOR SHIP SALVAGE

IN view of the importance of salving ships sunk during the war, and of the all-round costliness of the ordinary barges or lighters used for ship-lifting, special interest is attachable to the experiments recently carried out on the raising of the S.S. "Main." The S.S. "Main" was sunk by gunfire from a German submarine in Luce Bay. Salvage operations were undertaken by the Ardrossan Salvage Company, and Vickers' flexible pontoons were used.

Made of special canvas and cables, the completed pontoons weigh only 1 ton; but, when inflated with air and submerged in water, are capable of lifting 100 tons. Two of these pontoons were used, being fixed to the sternpost of the sunken ship and inflated by means of an air-compressor on a small tug. The vessel was successfully raised, and was beached for pumping.

An advantage of these canvas pontoons is that, when not in use, they can be packed into a very small compass, and stored in the hold of the salvage ship until required.

ELECTRICAL PROGRESS DIGEST

Air From the Turbine Room Used for Heating

THE temperature of a turbine room in an electrical generating station is kept at a temperature much too high for the comfort of the operators. A large lighting company in Springfield, Mass., put a plan into operation which permits the utilization of this surplus heat in the heating of various other departments of its organization. In the winter the air is drawn from beneath the roof of the turbine room into the basement of the switch house where a blower discharges it through steam coil heaters. Another system of ducts collects the air and discharges it through ceiling registers into the switchboard room. In this way a comfortable temperature is maintained in all departments.

Electricity In Agriculture

THE prejudice of the German farmers against electrical appliances has now been overcome, and they are being used for a variety of purposes.

Small progress has been made with electric ploughing machines, but the war has produced a great development of ploughs driven by petrol engines. Threshing-machines driven by electric motors have become extensively used, mechanical milking machines have been found capable of replacing milking by hand, and electrically-heated hatching machines are coming into favor.

The stimulation of the growth of crops by subjecting them to electric radiation has not yet become practical owing to the lack of physiological knowledge of plant growth, and the absence of data from which the best voltage and form of current can be ascertained. It has, however, been demonstrated that the humidity of the air plays an important rôle in determining the effect of the electric radiation. The use of artificial illumination of crops certainly hastens growth, but the cost is such as to render it commercially useless. The drying of crops by electric heaters is effective, but too costly; on the other hand, the drying process has been carried out successfully, for example, at Duisburg, by utilizing the waste heat of electric generating stations. Promising experiments have also been performed at the Dresden Technical College in the artificial heating of the ground by the waste heat of such stations.

Pupinized Short Telephone Cables

THE loading of short telephone cables with Pupin coils decreases the damping, but does not necessarily increase the efficiency of the whole conducting circuit. There is a certain length of cable (between 3 and 6 km.) which may be called the critical length, above which the loading with inductance improves the efficiency. For lengths less than the critical value the efficiency depends greatly on whether a central battery or local battery is used. Furthermore, the efficiency of such short-loaded sections is determined to a great extent by the characteristics of the sections to which it is joined at both ends. If a short length of cable lies between to overhead sections, it is useless to pupinize it unless the adjacent overhead lines are also pupinized. If the cable is connected only at one end to overhead conductors and at the other end directly to the apparatus, the activity in the receiving and sending apparatus (with local battery) increases with moderate loading of the cable, but falls again with heavier loading, as long as the overhead line is not also pupinized. The longer the overhead line, the more certain is the gain achieved by loading the cable. On the other hand, with a central battery there is no object in pupinizing the cable unless the overhead line is similarly treated. If the short cable section is directly connected to apparatus at both ends and a local battery is used, the efficiency may be raised by moderate loading of the cable, but it will fall again with too great loading. On the other hand, if a central battery is used, the use of loading in a local service is undesirable under any circumstances.

Projected Hydro-Electric Installations In Spain

ACCORDING to the *Rivista Tecnica d'Elettricita*, numerous applications have been lodged for concessions to construct hydro-electric generating stations in Spain.

The falls of the Iucar, near Valentia, will supply to the town a power of 6,400 h.p. The hydro-electric station at Linares has been linked up by a 70,000-volt line to the generating station of Penarroya. A company with a capital of 150 million francs has been formed to exploit the falls of the Douro, near the frontier between Spain and Portugal. The total available power is 150,000 h.p., and it is intended to transmit power to Madrid and Bilbao, and it is hoped that power from this station will be utilized by the northern and eastern railways of the peninsula.

The Photo-Electric Cell In Wireless Communication

THE photo-electric cell which has been described in the *Physical Review* (2nd series Vol. VII No. 1) had recently been tried as a receptor of wireless signals with marked success. Experiments have been made in both receiving and transmitting. The tube not only holds possibilities as a receptor, but as a producer of electrical oscillations as well. If the photo-electric cell is developed to a point where it will be practical to apply it in a commercial way, the change will be a revolutionary one.

The photo-electric cell was developed by Kunz and Stebbins. It has an inner coating of an alkali metal (sodium, potassium, etc.,) which is rendered sensitive by the introduction of hydrogen while the tube is excited. This results in the formation of a hydride, which under, the action of light, changes the effective resistance of the tube.

The photo-electric cell has been employed in many different ways. It has been used as a photometer in stellar photometry, physiology of plants, photo-chemistry and for the transmission, reflection, and radiation of light. The cell is used in connection with a battery with a potential of from 120 to 200 volts, and a galvanometer of high sensitivity.

Use of Tungsten for Contact Points

PLATINUM for use as contact points has many advantages. It is not oxidizable, is not attacked by acids or gases and is capable of withstanding great heat.

A writer in the *London Electrician* recently described his experiences with tungsten as a substitute for platinum. Tungsten is a metal that possesses nearly all the properties of platinum and it has been found to make very good contact points. The author of the article experimented with vibrating contacts of tungsten on a heavy current circuit and after a considerable period found that they stood up nearly as well as platinum contacts. The author suggested the employment of a sharp-pointed lower electrode.

An Electrically - Equipped Lighter

By William H. Easton

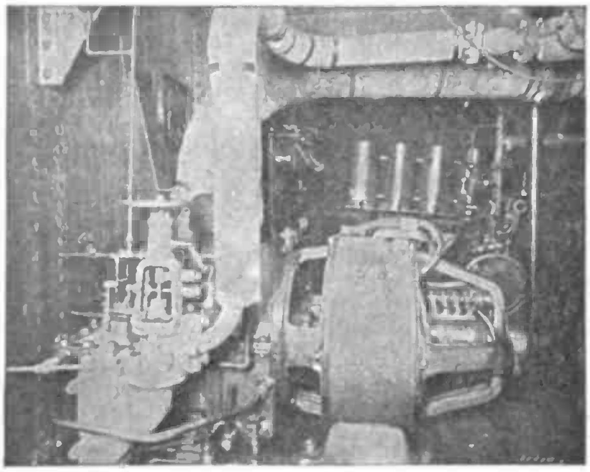
PENNSYLVANIA Railroad Lighter No. 151 enjoys the distinction of being the first vessel of her type to be equipped with electrically-operated winches exclusively. She is used for carrying express shipments around New York Harbor; and as this service is one in which time is an important factor her winches were arranged for electric drive, instead of the usual steam engines, because it was believed that the use of electricity would materially reduce the time required for handling cargoes. She has now been in commission about two years, and experience goes to show that this idea was correct; for, although it is difficult to carry out an accurate efficiency test in the handling of miscellaneous packages, it is generally conceded by those who are familiar with her work that No. 151 can take care of 300 tons while the average steam-operated lighter is disposing of 200 tons.

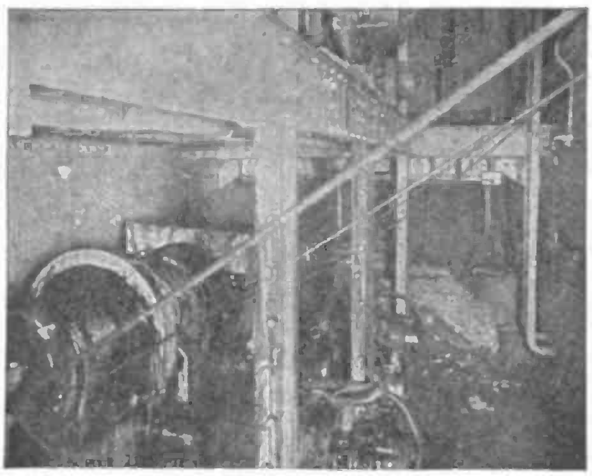
As shown by the illustration, No. 151 has two systems of booms, one forward consisting of a single main boom with a maximum capacity of 10 tons, and one aft, of the mast and yard type, with a maximum capacity of 2 tons. Most steam lighters of the capacity of No. 151 have only one boom system; but with electrical operation two can readily be employed because the motor-driven winches are so compact that they can be housed in a very small compartment. This compartment is situated in the hull just forward of the pilot house; all the lines run down in front of the pilot house to their respective winches in most direct manner possible.

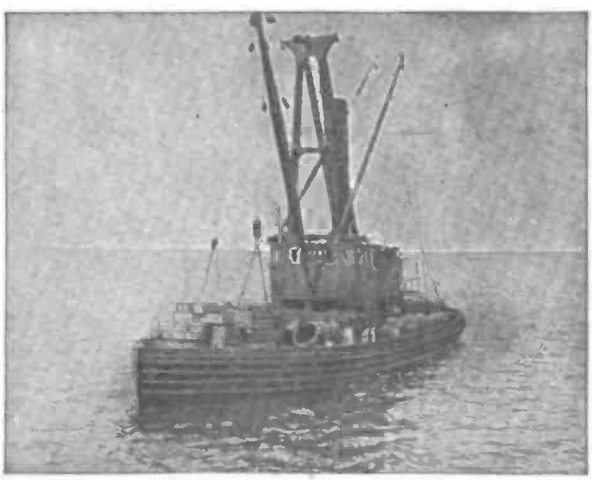
There are eight motors altogether, their purpose and size being shown in the following table:

Service	H.P.
For Forward Boom—	
Main Hoist	24
Main Boom	24
Starboard Guy	15
Port Guy	15
For Aft Booms—	
Starboard Hoist	15
Starboard Guy	15
Port Hoist	15
Port Guy	15

These motors, shown in the photograph, are of the Westinghouse direct-current crane type, totally enclosed and equipped with magnetic brakes. Each motor is geared directly to its winch and the winches are arranged in two rows, one being placed above the other.


The turbine-driven generator in the hold of the lighter


The motor-driven winches aboard the lighter


The electrically-equipped lighter

The control of the winches is located in the pilot house. The four controllers (one for each motor) for the forward boom are located at the forward end of the pilot house. For the aft booms, there are two sets of controllers, one located at each side of the pilot house, either of which can be used. The object of this arrangement is to give the operator an unobstructed view of the operations of the booms under all conditions.

The controllers in the pilot house are of the type known as "master switches." They do not control motors directly, but control the operation of a series of magnetically actuated switches, which make the actual connections. These switches are mounted on panels located in the motor compartment, and some of them can be seen in the upper right-hand corner of the photograph. There are several advantages of this arrangement. In the first place, the master switches handle only small currents needed to energize the magnets and so are light in construction and easily handled. Secondly, the heavy cables carrying the motor currents are of minimum length, and do not have to be run up to the pilot house and down again. Finally, the magnet switches permit the use of automatic acceleration; that is, the operator is not obliged to operate the master switches slowly in order to prevent burning out the motors by applying the currents too suddenly. He merely moves the handles at any speed he pleases, and the magnet switches then close in the proper order and at the proper rate. The motors are thus protected from injury, and all of their operations are carried out at the maximum speed consistent with safety. Each controller provides a number of motor speeds.

The current for operating the motors is generated by a 25-kilowatt, 125-volt Westinghouse turbine generator, shown in the top photograph. This unit consists of a high-speed turbine geared to a standard generator. It is operated by steam at pressures of from 75 to 250 lbs., and can be used either condensing or non-condensing. A governor keeps the speed, and therefore the voltage, constant, and an emergency stop prevents accidents.

EXPERIMENTAL CHEMISTRY

The Preparation and Use of Permanganate Solutions

By Albert T. Fellows

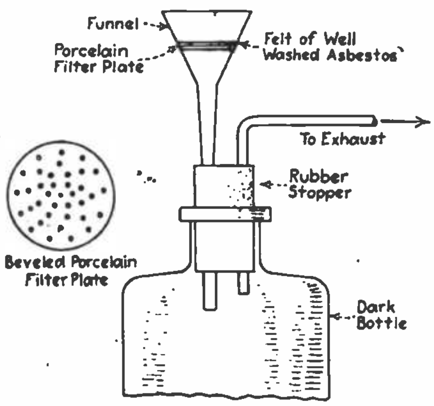
TO the amateur chemist struggling along in his laboratory, the preparation and use of volumetric solutions of potassium permanganate opens up a new field which is really a branch of quantitative analysis. Not only is it of value to him to know how to go about the determinations, but he also receives from carrying out these determinations a vast amount of practical knowledge such as he would obtain only at college or any industrial laboratory. The procedure which the writer is about to describe is exactly the same as that used at any laboratory carrying on determinations of the various elements, and the best of it is that all of it can be done with a very small laboratory equipment and at slight expense.

To make that which follows clearer and more interesting, let us first look into the theoretical side of the matter. Potassium permanganate, when in an acid solution and when any oxidizable matter is present, breaks down according to the equation: $2KMnO_4 \rightleftharpoons K_2O + 2MnO + 5O$. Thus, we see that every two molecules of permanganate is equivalent to five atoms of oxygen, and as two molecules of hydrogen is equivalent to one of oxygen ($2H + O \rightleftharpoons H_2O$) the two molecules of permanganate is equal to 10 of H. Shortly we shall use these ten molecules of H, but for the present attention is directed to the five molecules of oxygen. Now bearing in mind that two molecules of permanganate equal ten molecules of hydrogen, and recalling our definition of a normal solution (it is upon this basis that we make our solutions) which is a solution that contains in one liter the weight of active constituent that will react with one gram of hydrogen, and 316 gms. of permanganate, then our normal solution will contain 31.6 gms. per liter and the tenth normal (N/10) the one usually employed, one-tenth of this or 3.16 gms. in 1000 ccs. of water. In one cc. there are 0.00316 gms. (move decimal point). Now let us prepare some of this solution.

At this point our troubles begin. We cannot weigh our permanganate out accurately and dissolve it in a liter of water, as the salt cannot be obtained in such high purity, and even distilled water contains some readily oxidizable matter which is attacked by the permanganate precipitating MnO_2, which further hastens the decomposition.

To overcome these difficulties we must weigh out about 3.3 gms. of pure potassium permanganate crystals and dissolve this amount in one liter of distilled water. This is then boiled for about five minutes and the solution allowed to stand in a bottle with a plug of cotton in the neck for five or six days, during which period the permanganate has plenty of time to oxidize all the organic matter which is present.

After this, we carefully filter it through an asbestos pad (paper would introduce more organic matter) into a brown glass stoppered bottle or even one which is painted black, as light hastens decomposition. A convenient method of filtering is to insert a two-hole rubber stopper in the bottle carrying a 6-in. funnel and another tube connected to the exhaust. In the funnel is a ½-in. porcelain filter plate supporting a well-washed felt of asbestos. By starting the exhaust the solution is thoroughly and quickly filtered.



Arrangment for Filtering Permanganate Solution

Our real work should begin now that we have a pure solution of the permanganate, but it is much too concentrated, so we must dilute it considerably. This is called standardizing and there are many methods. The one which is perhaps the easiest and quickest from our standpoint follows: First prepare a N/10 solution of oxalic acid. After this, get the purest crystallized oxalic acid obtainable and weigh out 6.25 gms. and dissolve this in 1000 ccs. of H_2O. This is slightly below its real value, for, to be exact, we should dissolve 6.255 gms. of 100 per cent. oxalic acid in 1000 ccs. of H_2O. Of course, 100 per cent. oxalic acid is not to be had, and such a high degree of accuracy will probably not be required for our purpose. Take 10 ccs. of this N/10 oxalic acid solution and transfer it to a beaker with a pipette and add 1 cc. of pure concentrated sulphuric acid. This warms up considerably, and before it cools add the permanganate solution from a burrette in small quantities, shaking the flask after each addition and toward the end reducing the flow to drops. When the last drop is added it imparts a pinkish tint to the solution which persists for ½ minute. Then carefully note the number of ccs. used and then dilute the test solution with a specially distilled water (water distilled as usual, but before beginning the distillation adding about one gram of potassium permanganate to get rid of the ever present organic matter) so that the permanganate solution corresponds volume for volume with the N/10 oxalic acid solution at 25 deg. C.

To get it quite clear how the solution is diluted, let us take a practical example. First we took 1000 ccs. of pure potassium permanganate solution and 50 ccs. for the burrette and measured this accurately into the burrette. This left 950 ccs. in the bottle. Assuming that 9.5 ccs. of permanganate was sufficient to impart a pink tint to the acid for ½ minute, we must add 47.5 ccs. of the specially distilled water as the 9.5 ccs. of permanganate ought to be equal to the 10 ccs. of acid. Then we must add 0.05 ccs. for every 10 ccs. in the bottle, as there are

95 or 47.5 ccs. This is thoroughly mixed and a new test made till 10 ccs. of the acid just decolorizes the 10 ccs. of the permanganate. We must not forget to discard the contents of the burrette after each trial and to use a burrette having a glass stopcock, and above all to be scrupulously clean.

Now that we have our N/10 solution let us learn how to use it. Potassium permanganate may be used in volumetric determinations of a number of elements, some of which are iron, calcium, manganese, phosphorus, molybdenum, oxalic acid, hydrogen peroxide and red lead, etc.

As space is limited, let us take as an example an analysis of an iron ore, as the determination of iron is perhaps of the greatest importance. It is based upon the oxidizing action of the permanganate to change iron in the ferrous condition to the ferric.

For analysis we take a 10 gm. sample of ore, powder it and treat it with 10 ccs. of concentrated hydrochloric acid. Upon heating, the iron is dissolved and a residue is left. This is filtered off and the filtrate is saved. Some of the iron in the filtrate is in the ferric condition and must be reduced. This is accomplished by adding about 3 gms. of granulated zinc to the flask containing the iron solution and closed by a small funnel. Ten ccs. of concentrated sulphuric acid are added, and when all the zinc is dissolved the solution is ready to be titrated.

Now we run in the permanganate solution very slowly (this is called titrating). The solution turns a yellowish tint as each drop of the crimson purple permanganate solution is quickly decolorized. At the end we must go very slowly, for the last drop imparts a pink tint to the whole solution for ½ minute. Now we note the number of ccs. consumed, and, as each cc. is equal to 0.005589 gms. of iron in the ferrous state, to find out how much iron was in the solution we multiply the number of ccs. consumed by 0.005589 and the answer is the number of gms. of iron in the solution. For instance, if 45 ccs. were required to produce the pink tint, then there was 45 times 0.005589 or 0.240905 gms. of iron in the 10 gm. sample.

The following is the table we will use frequently in making our calculations, the same as in the foregoing example.

One cc. of N/10 Potassium Permanganate is equal to:

Potassium permanganate...	0.0031606
Iron (ferrous)..........	0.005589
Ferrous carbonate........	0.011505
Ferrous oxide...........	0.007138
Ferrous sulphate anhydrous $FeSO_4$..............	0.015085
Ferrous sulphate 2Fe SO_4 $3H_2$	0.017767
Oxalic acid (crystallized)..	0.006255

Now we see that these figures are the molecular weights of the substance moved four places to the left, and we will be able to deduce them for ourselves.

If our answer is reported, as, say iron in ferrous sulphate, to find the amount of the element in the compound we use the following:

Fe in FeO is 0.77727%
Fe in $FeSO_4$ is 0.36751%
Fe in $FeSO_4$ $7H_2O$ is 0.2008%
Fe in $FeSO_4(NH)_2SO_4 6HO$ is 0.14239%

These percents are also easily found by means of solving a simple proportion, such as the following for example: Fe : FeO :: X : 100, by substituting the atomic and molecular weights required.

Producing Low Temperatures

By G. E. Meredith

WANTING to test several samples of insulating compounds under winter conditions, the writer began to look up the subject of freezing mixtures, using materials at hand such as ice, sulphuric acid, caustic potash, etc. Several hand books were found with practically the same information in them, part of which is given below.

Snow or crushed ice two parts and salt (sodium chloride) one part. Temperature lowered approximately to 5° F.

Snow or crushed ice three parts, salt (sodium chloride) two parts and sal ammoniac (ammonium chloride) one part. Temperature lowered approximately to —12° F.

Snow or crushed ice three parts and dilute sulphuric acid (oil of vitrol) two parts. Temperature lowered approximately from 32° F. to —23° F.

Snow or crushed ice eight parts and muratic acid (hydrochloric acid) five parts. Temperature lowered approximately from 32° F. to —27° F.

Snow or crushed ice three parts and caustic potash four parts. Temperature lowered approximately from 32° F. to —51° F.

In testing the compound, it was in a quart glass jar and this was in turn placed inside a two-gallon earthen jar. The ice was packed between the jars and commercial battery acid 1.250° poured onto it. The temperature was lowered in the inner jar to 28° F. in a few minutes and the writer was able to hold it there for about one-half hour. This meant a lowering of the temperature of 57° F. from room temperature.

The inner jar was a quart bottle with the top cut off. It was a rather novel sight to see the jar with a heavy layer of frost on it in the middle of July. The temperature of the solution was much lower than the inside of the inner jar, and by using a Dewar flask for the ice and acid, a much lower temperature would be produced, as the radiation is cut down.

Finding the Flash Point of Kerosene

KEROSENE is a liquid which is being utilized more and more in the household for both light and heat.

A very large number of fires are laid to the account of petroleum, and the danger is by no means small. The greater number of these fires are due to the overturning of lamps and oil stoves. In many of these cases the oil continues to burn fiercely after the stove or lamp has been upset. However, this should not be, for an oil is procurable on the market which would extinguish such a blaze. This oil is carefully fractionized and freed from the more volatile products. Furthermore, this oil does not cost any more than the more dangerous kind, and is fully as economical.

The problem of determining whether an oil is safe or not is one which is eminently fitted for the amateur chemist to solve. It is known as finding the flash point or the fire test of the oil.

The flashing point of kerosene may be approximately determined by proceeding in the following manner: Pour a small quantity of the kerosene to be tested in a small crucible or evaporating dish. Then place the crucible upon a water-bath and a theremometer is suspended in the oil.

Heat the water carefully until the thermometer registers 30° C. (86° F.). At this temperature cautiously draw a lighted match across the surface of the liquid.

If the oil does not inflame, repeat the match test at each rise of 5° C. until it does flash. Do not permit the oil to burn, but allow it to cool to the 5° point at which it was before it ignited. For example, at 45° C. a certain sample did not flash, at 50° C. it did flash. The analyst allows it to cool to 45° C. again and then very cautiously repeats it till at, say, 47° C. it flashes once more. The flashing point in this case is 47° C. and not 50° C.

Experience has shown that there is no danger with an oil possessing a flashing point of 40° C. (104° F.). The best grade oil sold in the United States is known as water white and flashes at 65.5° C. (150° F.). However, the writer understands that there are large quantities of oil on the market having a flashing point of from 24° to 40° C. Such oil constitutes a very great source of fire danger. The author has found no difficulty in procuring an oil with a fire test of from 60° to 62° C. The safe limit is 40° C. or 104° F. In certain countries this point has been fixed by law as the minimum.

An Experiment in Physical Chemistry

IN the realm of physical chemistry theory is king. Demonstrations and experiments are few in number. But, those experiments which do appear are bound to be excellent ones. This is principally due to the fact that many of them have been devised and performed by the great masters such as Faraday, Fischer, Ostwald, Van't Hoff, Coehn, Haber and many others. Physical chemistry is quantitative in nature not qualitative; it wants to know not only how, but how much.

The reader will recall that in his high-school chemistry, he learned that all thiosulphates (especially including the acid) are rather unstable and break down into sulphur, water and sulphur dioxide as expressed by the equation: $Na_2S_2O_3 + 2HCl = 2NaCl + H_2O + S + SO_2$ or in an ionic equation simply $H + S_2O_3 = HSO_3 + S$. It will be advantageous for the experimenter to repeat this qualitative experiment to refresh his memory.

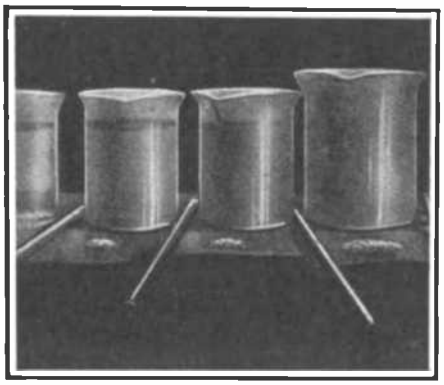
Make a concentrated solution of the hypo. (as the sodium thiosulphate is commonly called) and add a few drops of concentrated hydrochloric acid. At first, nothing appears to take place, but after several seconds a white milky precipitate of sulphur is seen in the solution and the odor of sulphur dioxide is apparent.

From such experiments as these physical chemistry strives to draw broad generalizations. These are almost always obtained by quantitative experiments. In this case, it is to prove that certain reactions take place in a time relation to the masses of the reacting substances. In other words, we are working in a sub-topic under the head of "The Law of Mass Action."

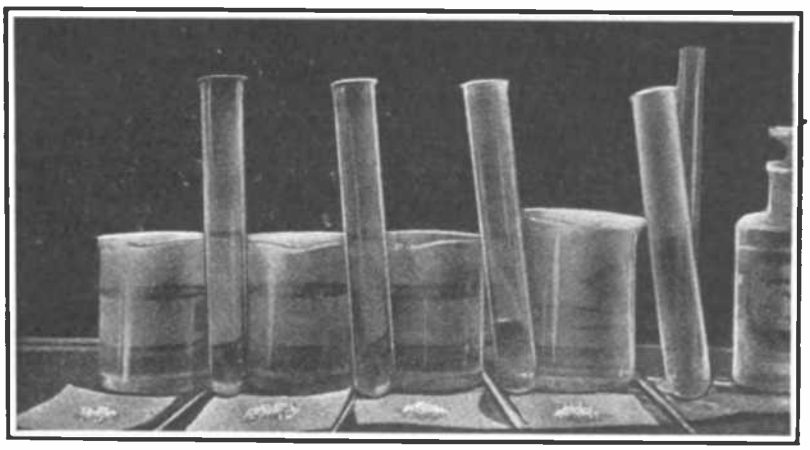
This particular experiment is easily adapted to the resources of the youthful scientist. The procedure is as follows: Weigh very carefully 0.1, 0.2, 0.3, and 0.5 gram of sodium thiosulphate ($Na_2S_2O_35H_2O$) into four separate beakers. Add 100 cc's of distilled water to the salt in each beaker and allow it to dissolve. In three separate test tubes prepare dilute solutions of hydrochloric acid by adding 1 cc. of concentrated hydrochloric acid to 20 cc. of water. In a fourth test tube, place 1 cc. of the concentrated acid without any water whatsoever in the tube.

Arrange the beakers in a row according to the hypo content, the test tubes so that the one containing the 1cc. of concentrated acid is before the beaker with the highest hypo. content.

This is shown in the first photograph, the beakers containing the clear solutions are in back of their respective test tubes and the piles of hypo. before the beakers graphically shows the quantity in solution.



The beakers after eleven minutes



The four test tubes and beakers with the sodium thiosulphate before them

Pour the four test tubes of acid into their respective beakers, noting the exact time. Carefully watch the beakers and at the first sign of a separation of sulphur note the exact time.

In the second photograph, the beakers are shown after eleven minutes have elapsed. One can see the last three beakers exhibit varying degrees of milkyness, while the first is still perfectly clear.

For the beakers above illustrated, the following results were obtained:

No. 1 (extreme left)	19	minutes
No. 2	8	"
No. 3	6	"
No. 4 (extreme right)	3	"

If any of the readers fail to get identical results they ought not to feel discouraged for their results are probably correct though differing from those above. This is inevitable since the purity of the sodium thiosulphate, the concentration of the acid, the temperature and many other causes are bound to cause the results to vary.

Ostwald, Holleman and V. Oettingen, who have carefully studied this reaction, are all agreed that the sulphur is immediately formed on mixing the acid and salt solutions. They explain this peculiar phenomenon by assuming that the sulphur remains in solution until a definite concentration is reached or a certain change has taken place which causes the appearance of visible sulphur particles.

An older hypothesis is that the thiosulphuric acid formed by the interaction of the acid and the salt remains entirely unchanged till the sulphur appears, and the decomposition is started at this moment. However, this is incorrect, for if we treat a dilute thiosulphate solution with the acid and neutralize this acid with a base before the sulphur has started to deposit, it is found that the deposit will appear in due time.

Holleman believes that a certain part of the free thiosulphuric acid must decompose, but the sulphur is in such a finely divided state that it cannot be detected till it has gathered together in larger particles. This is, by the way, a nice little opportunity for some serious research by the amateur chemist, for who can tell but that one of the readers may be able to make some useful contribution to the solution of this problem.

Those amateur chemists who limit their experimental work entirely to the realm of strict chemistry are missing much by not devoting some time to experiments in the fascinating field of physical chemistry. Physical chemistry is nearly as broad and interesting as the science of chemistry itself. It is only during the last half century that physical chemistry has been elevated to the plane of a distinct and separate branch of science. Some very important discoveries have been made in this branch of science and more will be made.

Readers' Workshops Page

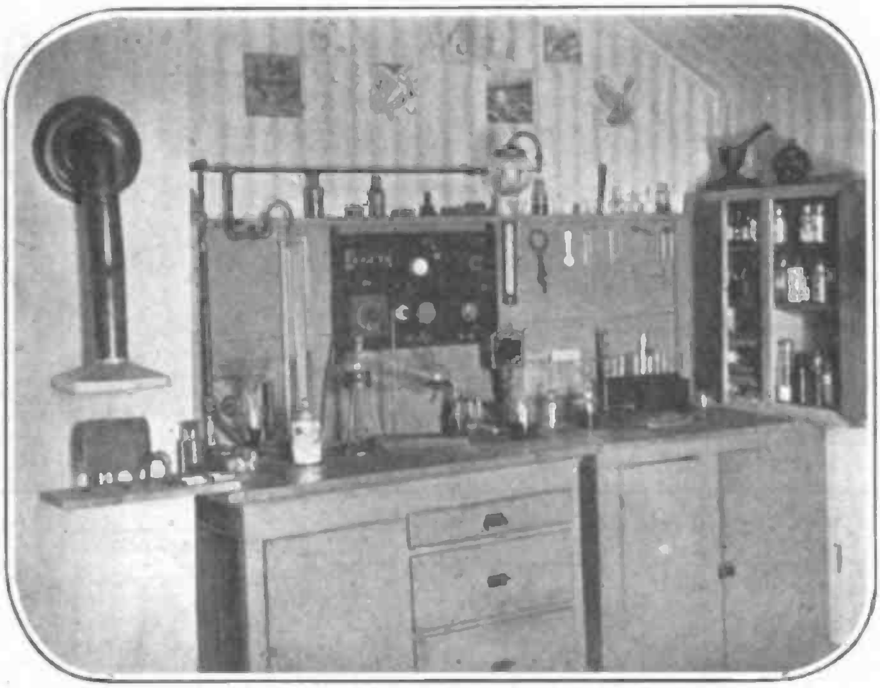
FROM month to month descriptions of the workshops of our readers' will appear on this page together with photographs of the shops and any noteworthy piece of work that may have been made in them. This will be a feature of EVERYDAY ENGINEERING MAGAZINE as long as we are able to obtain the descriptions. All descriptions sent in will be paid for at our regular space rates.

To the fellow who owns a shop or laboratory, there is always a certain pleasure in seeing the shops of others to learn what they are doing and how they have arranged their apparatus. The following description is that of the shop of Mr. Ernest C. Neubert in the owner's words:

"My shop or laboratory is nine by twenty-one feet, with three windows and two doors, all of which slide into the partitions.

"The walls and ceiling are of carsiding, ⅞ of an inch thick, giving a solid wall on which to fasten instruments and shelves. The walls, ceiling and shelves are painted white to give all the illumination possible.

"There are thirty-five drawers under the benches, each 14 x 22 inches, and from four to eight inches deep; also many cabinets above the benches, all of which were made during spare time. The switchboard, drawers, benches and cabinets are varnished with light oak, and shellaced. There is a dark-room, 7 x 9 feet, and another small room used for lumber and extra equipment.



A well equipped laboratory for chemical and electro-chemical work

"I made the desk shown in the picture. The five drawers on each side, and the bookshelves above, are of yellow pine; the top, thirty inches by six feet, and the legs are of red wood, varnished with light oak.

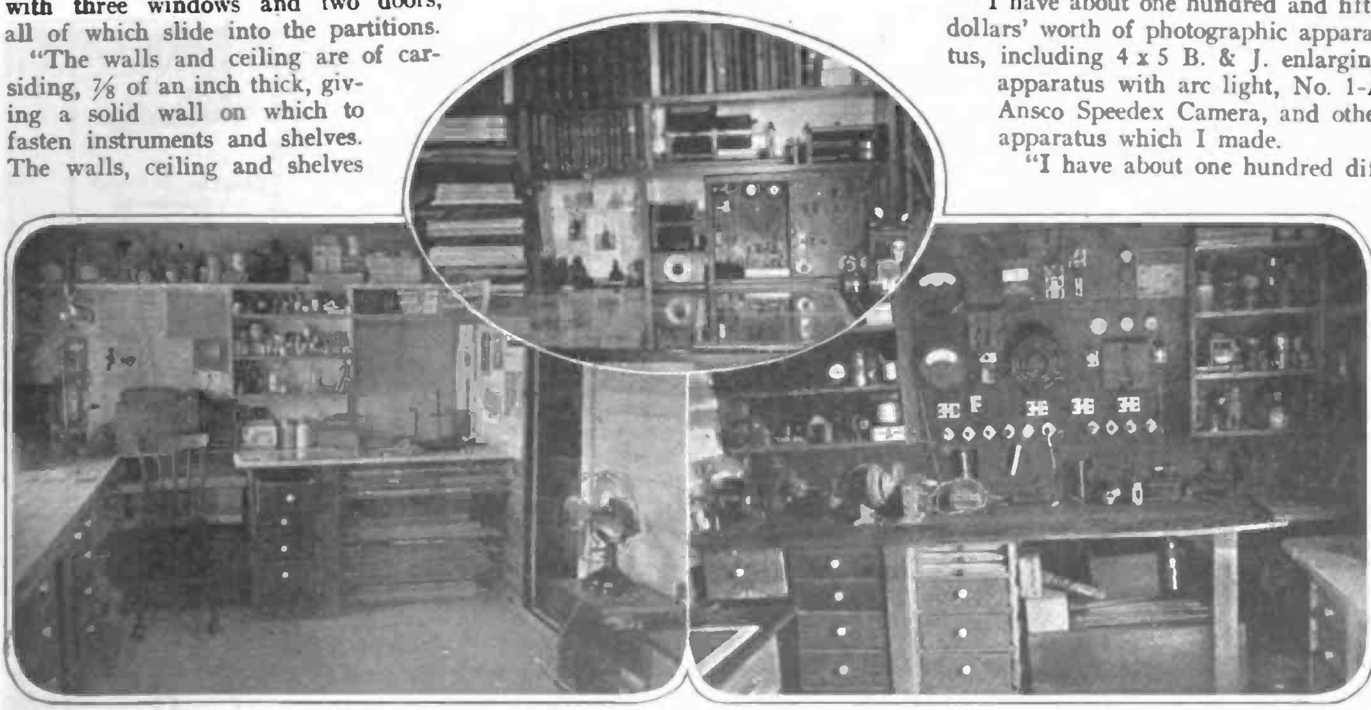
"I have about one hundred dollars' worth of wireless apparatus, mostly of my own construction, and about two hundred and fifty dollars' worth of books, including I. C. S. Reference Library, Hawkins' Electrical Guides, and numbers of others on photography, chemistry, and all branches of electricity; also a complete set of magazines since 1915, including Everyday Engineering, Popular Mechanics, Popular Science, Electrical Experimenter, Wireless Age, Electrical Review, and others.

"My power board includes watt meter, three volt meters, two ammeters, two rheostats, and motor generator. I have four storage batteries of three cells each, and have made three good Tesla coils from time to time.

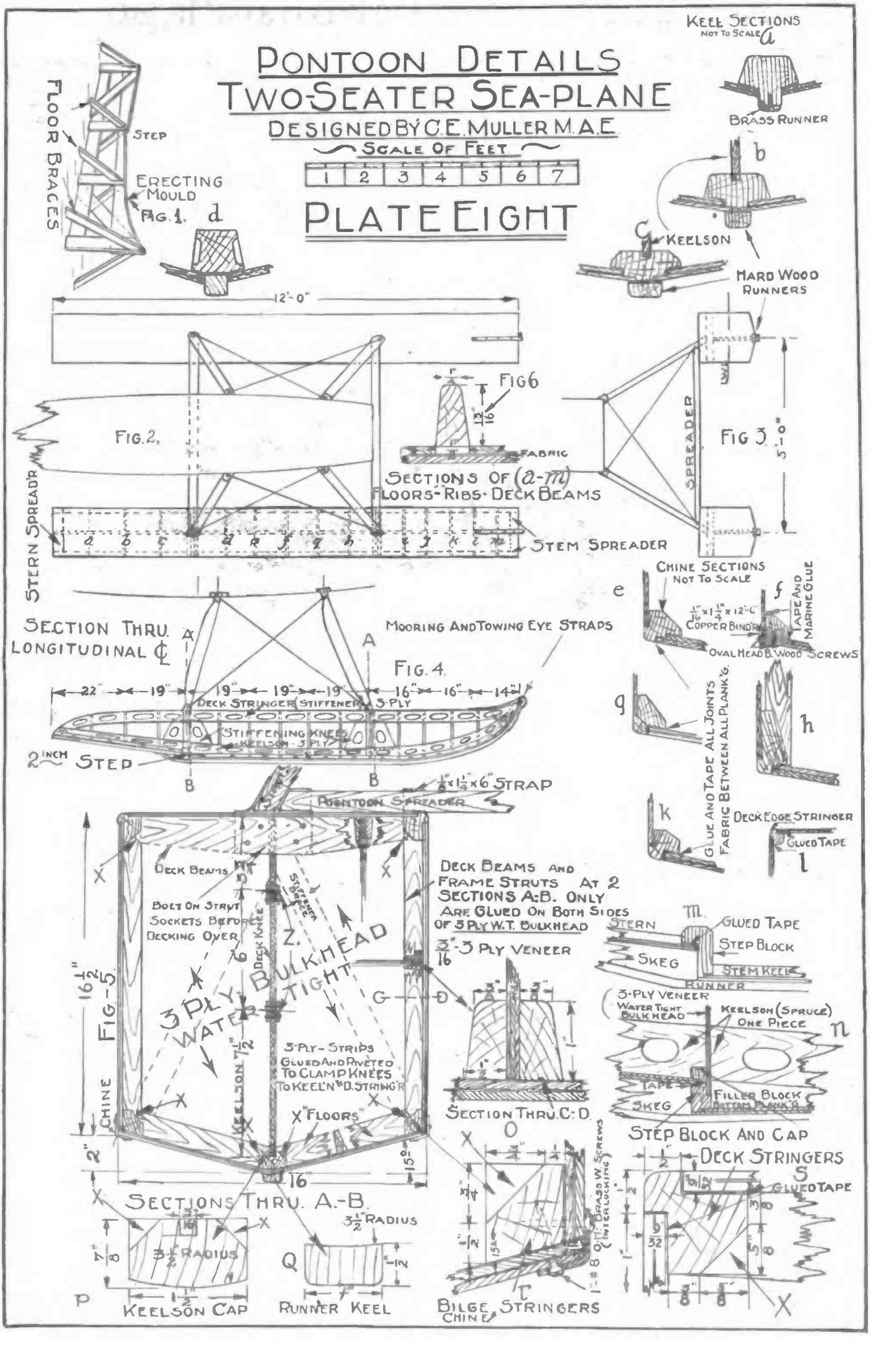
"I have about one hundred and fifty dollars' worth of photographic apparatus, including 4 x 5 B. & J. enlarging apparatus with arc light, No. 1-A Ansco Speedex Camera, and other apparatus which I made.

"I have about one hundred different kinds of chemicals, and own about one hundred dollars' worth of tools, including bench drill, breast drill, complete set of twist drills, wood bits, and set of chisels, pliers, planes, ham-

(Continued on page 327)



Several views in the workshop and laboratory of Mr. Ernest C. Neubert of Neosho, Mo.


PONTOON DETAILS
TWO-SEATER SEA-PLANE
DESIGNED BY C. E. MULLER M.A.E.
SCALE OF FEET
PLATE EIGHT
FLOOR BRACES
STEP
ERECTING MOULD
FIG. 1.
KEEL SECTIONS NOT TO SCALE
BRASS RUNNER
KEELSON
HARD WOOD RUNNERS
FIG. 2.
FIG 3.
FIG 6
FABRIC
SECTIONS OF (a-m) FLOORS-RIBS-DECK BEAMS
SPREADER
STERN SPREAD'R
STEM SPREADER
SECTION THRU. LONGITUDINAL ℄
MOORING AND TOWING EYE STRAPS
FIG. 4.
DECK STRINGER STIFFENER 3-PLY
STIFFENING KNEES
KEELSON 3-PLY
2 INCH STEP
CHINE SECTIONS NOT TO SCALE
COPPER BIND'G
TAPE AND MARINE GLUE
OVAL HEAD B. WOOD SCREWS
GLUE AND TAPE ALL JOINTS FABRIC BETWEEN ALL PLANK'G
DECK EDGE STRINGER
GLUED TAPE
STRAP
PONTOON SPREADER
DECK BEAMS
BOLT ON STRUT SOCKETS BEFORE DECKING OVER
DECK KNEE
3 PLY BULKHEAD WATER TIGHT
3-PLY-STRIPS GLUED AND RIVETED TO CLAMP KNEES TO KEEL'N & D. STRING'R
KEELSON
CHINE
FIG-5
"X" FLOORS
DECK BEAMS AND FRAME STRUTS AT 2 SECTIONS A:B. ONLY ARE GLUED ON BOTH SIDES OF 3 PLY W.T. BULKHEAD
3/16" 3 PLY VENEER
SECTION THRU. C: D.
STERN
GLUED TAPE
STEP BLOCK
SKEG
STEM KEEL
RUNNER
3-PLY VENEER WATER TIGHT BULKHEAD
KEELSON (SPRUCE) ONE PIECE
TAPE
FILLER BLOCK
BOTTOM PLANK'G
STEP BLOCK AND CAP
SECTIONS THRU. A.-B.
3 1/2 RADIUS
KEELSON CAP
RUNNER KEEL
BILGE STRINGERS
CHINE
O. H. BRASS W. SCREWS (INTERLOCKING)
DECK STRINGERS
GLUED TAPE

Building A Two-Passenger Seaplane

By Charles E. Muller, M.A.E.
Consulting Aeronautical Engineer

PART SIX

Pontoon Construction

THIS subject is so large and fascinating that it is rather difficult to confine the types and processes with specific instructions to the limits of this article. A brief classification of methods of planking will follow the description of all the various components that enter into the construction of the pontoons for this two-seater seaplane, and no particular difficulty should be experienced in building them.

Keels and Keelsons

A study of the keel sections a-b-c-d and in Fig. 5, Plate 8, will give a fair idea of the more common and practical methods of constructing these members. Keelsons are illustrated in b-c and in Fig. 5. They are employed to stiffen the float longitudinally, also strengthen the bottom to withstand the terrific impacts of landing shocks and the water pressure at high speeds. Sometimes more than one keelson is used for rigidity in wide floats and flying boats. The keelson is usually notched over the "floors" (this is the technical name given to the cross frames or ribs of the bottom structure), especially when the keelson extends to the bottom planking without using the cap strips.

For the pontoons described this is recommended, but the cap strips are cut in short lengths and are fitted between the floors, this locking them in position. Keelsons are made of various woods—the determining factor being the depth of section permitted. When used without caps, thin, deep sections of spruce, white pine, Port Oxford and white cedar, yellow pine, an even bass wood are used.

Chine Stringers

Sections shown in sketches e, f, g, h, k and in Fig. 5 will illustrate the general methods of chine stringer construction. Keels and chine stringers are usually made of white ash, white oak or spruce. Ash is recommended for the floats. Chine and deck edge stringers are always, where possible, continuous members from stem to stern.

Bulkheads

Owing to the 100 per cent over capacity of flotation in these pontoons, they are each divided only into three watertight compartments by the two main bulkheads of three-ply wood. It is made by (Marine) glueing three laminations of birch or beechwood, about ⅛" thick recommended in this case, laid so the center layer grain runs 90 degrees to that of the outside layers. The bulkheads also serve as formers and stiffeners to the hulls and rigid anchorages for the strut fastenings. They, in turn, are strengthened by battens diagonally braced to chine stringers, and by knees of the same material, clamped to the center deck stringer and to the keelson by seam strips that are glued and riveted as shown at z in Fig. 5, Plate 8. A cross section of the floors, ribs and deck beams used throughout the pontoons is shown at Fig. 6. The only exceptions are where they are fastened to the bulkheads shown in Fig. 5. These are tapered one side only, the untapered side is glued and riveted to the bulkhead. White ash for frame floors, etc., is recommended, as this material will retain the screw threads better than the soft woods and stand the impacts better.

The false keel runner, shown at Fig. Q, is a hard wood strip sometimes shod with a brass strip to stand the wear and tear of sliding up the ways or on to the rafts. On light machines of this construction, ash or oak false keels will suffice without the metal strip, as they are so easily renewed. The false keel is continuous from the mooring eye strap to the stern. The chine, as the junction of the bottom and sides is called, is protected by methods shown at e, f, g, h, k and r. That shown at r has been selected because it is simplest and very satisfactory in every way.

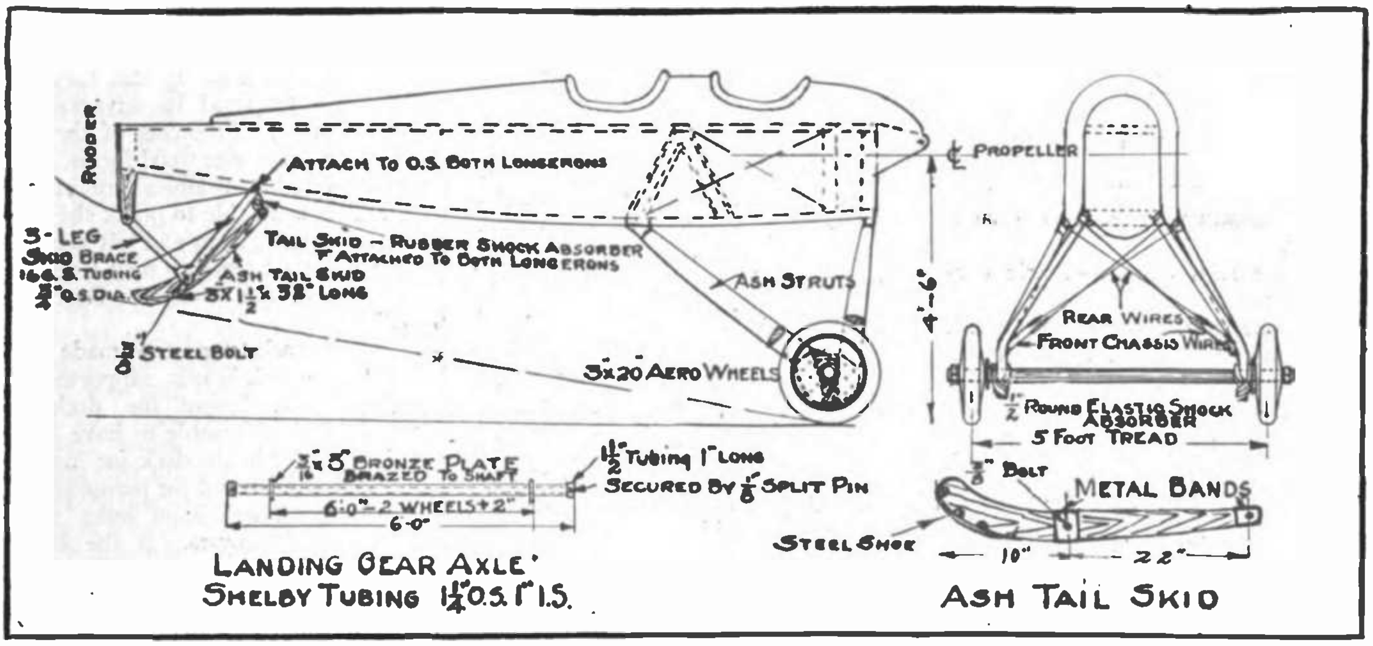


Plate 9. Wheeled landing gear to be substituted for pontoons if desired

Step

The step is made of 2" x 2" x 15" white ash or oak, tapered from its lineal center to a ¼" edge with a rabbet for the planking and the bulkhead, as shown at n. The step clamp (cap strip) is made of same material 1½" x 1⅝" x 15", as per the cross section at n.

Filler Block and Skeg

This block, sometimes called the "dead wood wedge," may be added or be an integral part of the keelson. The skeg is of hard wood and it is used to fill in the recess behind the step, making a solid bearing for the after part of the runner. It should be very strong as often the seaplane is balanced on this point to turn it or raise it to place small trucks under the floats. This differs from boat practice as the skeg, sometimes called a shoe, is usually of metal attached to the dead wood extending sternward with a bearing for the rudder and providing protection for the propeller.

The stern and stern spreaders are ash pieces shaped to strengthen the bow and stern, holding the chine and deck stringers rigidly.

Planking

The planking is undoubtedly the main step of the pontoon, bracing it in lieu of wiring and must be watertight. Taking advantage of the wide experimentation and practical testing of this type of machine, I strongly recommend the double skin, opposite diagonal planking for this flat back and flat side pontoon. Careful consideration has been given to the contraction and expansion due to the constant wetting and drying which these floats are subjected to under severe conditions. Available space only permits bring description of the commonly used methods that have proven satisfactory in actual service. They are divided into groups to assist the reader to gather a fundamental knowledge of planking.

Group I

Deck Planking

1. Single skin with seam strip backing.
2. Single skin outside—fabric covering.
3. Double skin, inner one diagonal, outer one planked, fore and aft, fabric between.
4. Double skin, except outer skin is planked diagonally opposite.

5-6. Three-ply laminated wood with or without fabric covering.

Group II

Bottom Planking

1. Single skin with seam strip backing.
2. Double skin, inner 45 degree diagonal, out skin diagonally opposite, fabric between.
3. Double skin, diagonally opposite, fabric between.
4. Treble skin, two inner skins diagonally opposite, outer planked longitudinally, fabric between all skins.
5. Three-ply laminated wood.

Group III

1. Three-ply laminated wood.
2. Double skin, diagonally opposite, fabric between.

Planking woods used are white pine, spruce, white cedar, Spanish cedar and mahogany.

Plank-Fastenings

Plank fastenings, for material of the thickness used in these floats are brass and copper rivets known as canoe rivets. These vary from 3/8" long upward. When long rivets are used through stringers, or ribs, etc., a washer or burr is used to rivet the end over. Short rivets can be driven in and turned over in alternating directions nearly as fast as wood screws and will not loosen up so readily. Wood screws will strip the thread in the wood if driven too hard but may be used advantageously in stringers, beams, etc. All wood screws used are of brass and have flat heads.

Fabric Covering

Fabric covering for the outside or between layers for small floats must be very strong and light, but with sufficient body to hold the "Liquid Marine Glue" with which it is saturated when applied. Linen covering used on airplane wings has proven very satisfactory, also silk and cotton have been used. The finishing room, where varnishing, painting, glueing, etc., are done, should be kept at not less than 65° minimum to 80° maximum. It should be dry and well ventilated. Follow explicity the directions sent with the special glue.

The planking is carefully sandpapered to a smooth finish, thoroughly brushed and a thin sizing coat of glue applied, when thoroughly dried. A second coat is then added over which the linen or silk is rapidly stretched, before the glue sets. By using Jeffery's Waterproof Liquid Glue, the need of hot irons is eliminated. Satisfactory results are produced by smoothing the fabric with a cold iron or block of wood. A third coat of glue is applied over the fabric, thoroughly covering it. The outside planking is then laid on. Sometimes the planking is sewn together with bronze wire instead of riveting. The wire stitching runs with the grain and is bedded in flush with the outside planking, particularly in "treble skin" construction, where the outside plank is laid longitudinally.

A word of warning may not be amiss regarding the fabric covering. The shape of this pontoon is surely so simple that if care be taken to eliminate all puckers and air pockets, by working them to the edges and copper tacking along the stringers, no difficulty will ensue. The simple form described has been chosen with the requirements of the amateur builder in view.

Building the Pontoons

The erection mould, Fig. 1, is usually used where the pontoons are large like the N. C. flying boat hulls, or large seaplane pontoons, but the smaller ones, like canoes, launches, and small boats, are built keel up. In this case ws save this time and expense if the two sides be constructed on a temporary table top of 7/8" x 20" wide x 14' long. This may also be used to form the chine and deck edged stringers on, if the side elevation Fig. 5 be carefully laid out, and blocks properly located and fastened.

A level floor may be used for the same purpose and also to lay out the deck stringers and keelson. Then the pontoon sides are placed top edge down on horses or boxes, then fastened to the two watertight bulkheads next the keelson and floors, followed by fitting the keelson cap and step. Great care must be taken to have the sides line up, which is best accomplished by the use of a 24-inch steel square. A slight variation in these pontoons will manifest this discrepancy by a turning tendency in the water or a "weather helm" while flying. Check up carefully before planking. Be sure to glue and tape all stringers where planks are fastened. Start the planking at the step work aft to the stern, then from the step forward.

The planks forward of the step are steamed in the center and bent over the keelson cap to approximately 15 degrees above the horizontal. Aft of the step, the planking is horizontal and easily applied, then place the step in position, glue and rivet to the bulkhead. then plank forward. If the forward planking is prepared in advance by being steam bent in excess of the required 15 degrees over wood forms, half your construction troubles are eliminated. It is advisable to plank the two pontoons opposite right and left handed so that when set together they give the appearance of the so-called "Herring-bone."

The strut sockets must be made and bolted to the deck beams, supported by the bulkheads, before the deck is planked. It is advisable to have suitable hand holes in the deck for inspection of the interior and for pumping out the seepage. These hand holes must have watertight covers. If the lower wings are increased to a four-foot chord, the rear strut anchorage is located farther aft (approximately six inches), this necessitates the rear bulkhead and step being placed at the new position. As designed, the chord of the lower wing is two feet six inches, as outlined in Part I, August, 1919.

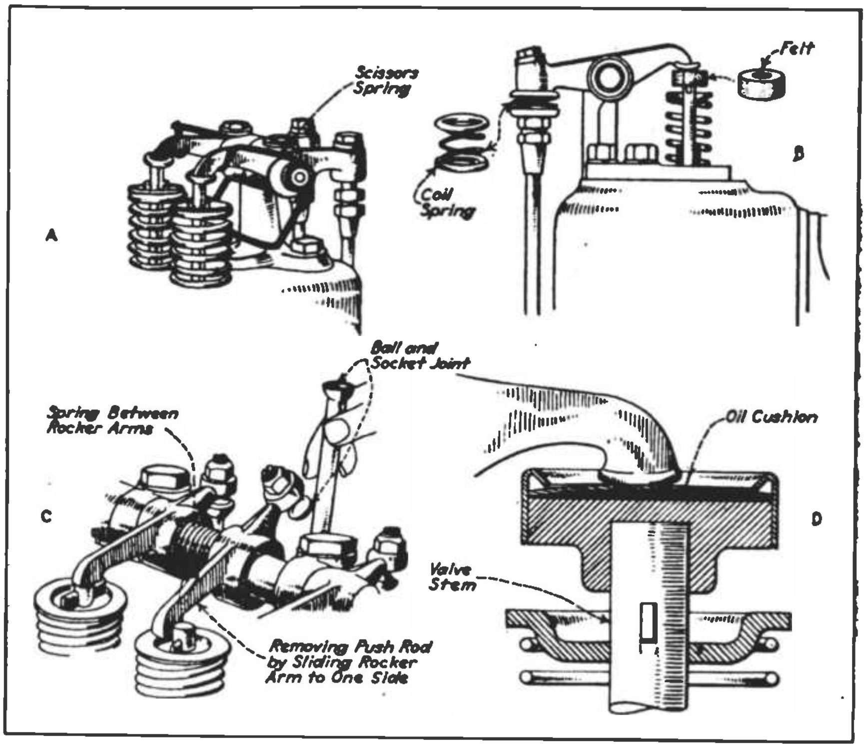
Wheeled Landing Gear

As previously stated, this machine may also be used for flying over land if sufficiently large bodies of water are not available for making the experimental flights. The details of a landing gear suitable for transforming the machine from a seaplane to an airplane that can take off from and alight on land is outlined at Plate 9. The construction is very simple, in fact it is considerably easier to build a landing gear than it is to construct the pontoons.

EVERYDAY MOTORIST

Silencing Noisy Overhead Valves

ONE of the disadvantages advanced by those who do not favor the overhead valve type of motor is that after these have been operated for a time they are apt to become noisy due to lost motion at the various points in the valve operating linkage. There is really no excuse for this lost motion in any engine that is properly taken care of and parts kept oiled. It is evident that many inexperienced motorists may neglect such essentials as push rod adjustments to maintain the desired clearances between the ends of the rocker arms and valve stems. A number of methods for taking up this lost motion automatically are given in accompanying illustration. At A, a scissors spring bent up of spring wire is installed around the valve rocker bearing pins in such a way that one end of the spring fits under each valve rocker and keeps the other end of the lever in firm contact with the push rod. The system shown at B does the same thing except that a coil spring is interposed between the rocker arm and tappet rods. A piece of felt in the form of washer is placed over the end of the valve stem and is kept saturated with oil so that the end of the valve stem is constantly lubricated. In some engines of recent development the rocker arms are mounted on a hollow shaft through which oil circulates, thus insuring that this bearing will always be properly lubricated. A ball and socket joint is used at the ends of the tappet rods which is not apt to wear as quickly as the old type yoke and pin connection. In one modern engine a spring is placed between the rocker arms and by compressing this spring either rocker arm may be pushed to one side and the push rod or tappet easily removed. With this type of valve operating mechanism if the caps or sockets on the tappet rods are kept full of oil there will be practically no noise in the valve operating mechanism. A simple fitting is shown at D consisting of a cap member designed to be installed on the top of the valve stems between that member and the end of the rocker arm. An oil cushion is interposed between dished plate and the top of the cap, the function of this being to absorb the shock of the rocker arm end and also to permit of a closer adjustment than would be possible if the rocker arm operated directly against the end of the valve stem.



Methods of silencing overhead valve motors recently developed

Benzol as Fuel

THE secretary of the Automobile Association of Great Britain has sent out some figures tending to show the economy to British motorists of using benzol as fuel. The figures converted into U. S. measure are as follows: Price of No. 1 gasoline today, 60 cents a U. S. gallon; price of N. B. A. benzol, 54 cents a gallon; initial saving, 6 cents. It must further be remembered that at least 15 per cent. more mileage can be obtained from benzol than from the best petrol, and that therefore the equivalent prices per gallon of benzol and gasoline are 45.5 cents for the former, as against 60 cents for the latter. On a yearly mileage of 10,000 miles on a car doing 16 miles to the gallon this is equivalent to the saving of $90, to say nothing of the sweeter running and extra power said to be obtained from this fuel.

Cleaning Paste for Hands

A satisfactory hand cleaning paste for the home or shop worker should have incorporated a satisfactory detergent or cleaner of sufficient strength to attack grease, dyes or inks, as well as the more soluble dirt and at the same time should not contain any excess of alkali as this will injure the skin. The green soap which forms the base for this formula below, together with the ammonia water and oil of turpentine embody all the features mentioned above. An abrasive or dirt cutter is very essential and finely powdered pumice stone is the best that can be used. Scenting oils are added to impart a pleasing odor to the preparation. The ingredients are:

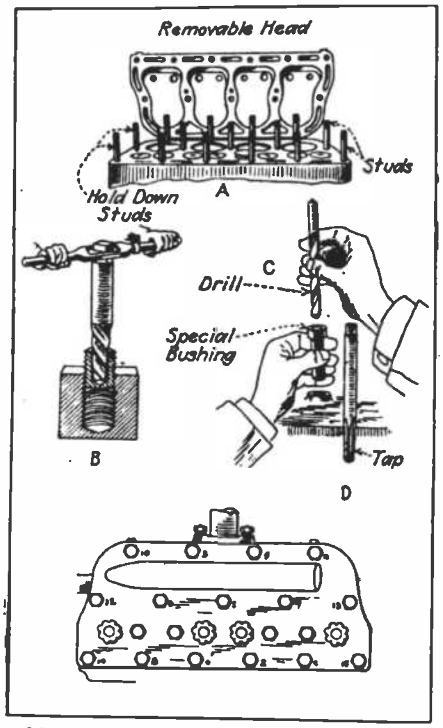
Soft soap................90 ounces
Ammonia water.......... 6 ounces
Turpentine, sufficient to form a stiff paste........
Powdered pumice stone....30 ounces
Essential oil (either oil of wintergreen or oil of sassafras .... 3 ounces

Mix the soap and ammonia water and add the turpentine. Heat the mixture by using a double kettle to secure a water bath. Allow the mixture to heat until a jelly-like mass is formed and while still heated, add the pumice stone and stir well while adding, so that it will incorporate thoroughly without forming lumps. After all the pumice stone has been added, continue to stir for five minutes, at the same time, dropping in the essential oil.

that is to be used for perfuming. Set aside to cool for some five to ten minutes and while still syrupy, pour into containers.

Removing A Broken Stud

WHEN the detachable cylinder head type of motor, as shown at A in accompanying cut, is repaired, unless care is taken in tightening down the retaining nuts, one is apt to twist off a stud bolt where it goes into the cylinder block casting and usually it twists off flush with the casting so that its removal is not an easy matter with ordinary tools. One way is to drill a hole into the center of the stud and then using a specially fluted stud extractor and tap wrench, as shown at B. Sometimes the broken portion may be so tightly rusted in the cylinder block that it must be drilled out. Special sets as shown at C may be obtained to fit the popular cars using this system of head construction. A bushing that acts as a guide for the tap drill is placed in the bolt hole and insures that the hole will be centered and not damage the thread in the head casting. The remaining portion of the stud is cleaned out with the tap, so a new

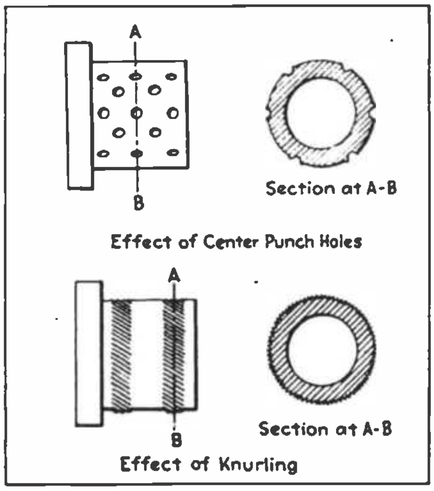


Methods of removing broken stud from cylinder block

bolt or stud may be placed in the hole. Even such a simple thing as tightening down the head casting retention nuts may be improperly done. To insure an even bedding down of the head, it is advisable to screw down the nuts in the order indicated at D. Nut number 1 is the first to be screwed down because it is at the center of the casting, then numbers 2 and 3 are tightened down, and the rest in the numerical order indicated to insure even clamping.

A Putting-on Tool

HOW often at some time or other have mechanics wished for something in the way of a putting-on tool. As it is always easy if a piece is too large to remove metal in order to bring it to proper size this proposition does not worry even the poorest mechanics. But what is to be done if the piece is too small? A common method and a brutal one is to take center-punch and upset the surface of the metal in order that it shall be a tighter fit in the hole. A bushing or a rod, if not too small, is often treated in this manner and may be forced into the hole, but one resort-



Enlarging outside diameter of small bushing in an emergency

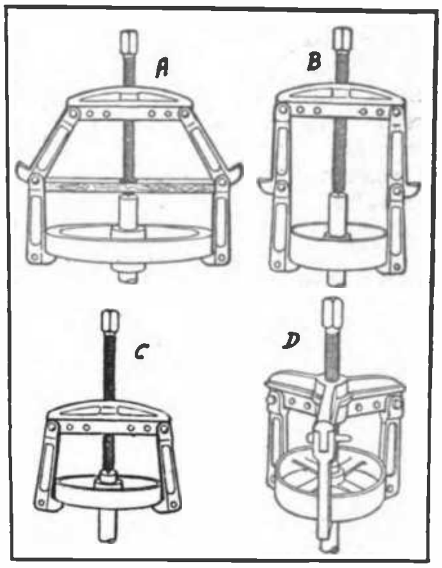
ing to such methods may seriously distort the piece. A more effective method of "putting-on" is by means of a common coarse knurl, knurling the bushing the entire circumference in several places. This will have the effect of expanding the outside diameter almost one-thirty-second of an inch if desired and is much neater and infinitely superior to the use of prick-punch marks, which is an unsightly and unreliable method of increasing the effective diameter. The great advantage of knurling is that the metal is equally and uniformly expanded, does not look bad if for any reason the bushing or rod is withdrawn and what is more important for anything that must be a tight fit, it is not apt to work loose. Another method is to sweat some solder on the outside of the piece, this being easily done if the bushing is of brass or bronze. The layer of solder should be applied as uniformly as possible over the entire surface.

If the car engine employs the thermo-syphon system of cooling be sure to keep the cooling system filled with water. When the water falls below the inlet connection of the radiator then circulation is seriously retarded. Even the circulating pump system needs to have a full radiator at all times in order to insure the best results.

Utility of Wheel Puller

THE wheel puller is a very useful appliance. Special forms suited for the general run of repair-shop work are shown herewith. The type shown at A is a two-armed puller having two sets of arms, the lower set may be attached to the upper arm as indicated. This makes it possible to handle work of relatively small diameter that is beyond reach of one set of arms as shown at B, or on work of large diameter that would be beyond the capacity or spread of the beam when used as at A. In this case a piece of wood is being used as a spreader for the arms. It is relatively easy to move work near the end of the shaft, this involving the use of only one set of arms as shown at C. The use of the three-armed puller, which is a superior form for general service to that shown at C, inasmuch as it is not apt to rock over to one side or the other when the pressure is applied is shown at D.

When exploring the lower parts of the chassis, check over the brake rods to see if they have pull springs to insure full release when intended as this will prevent bands dragging, and a hot brake drum will be avoided.



Showing use of two and three arm wheel and gear pullers

Excessive and continuous carbonization in one cylinder of a multiple cylinder engine generally can be traced to a bad set of piston rings, which allow too much lubricant to work by into the combustion chamber. The fitting of new rings is necessary in such cases to remedy the faulty condition.

The motorist should remember that ordinary vaseline is perhaps the best medium available for coating battery terminals and connectors. The vaseline acts to minimize corrosion from acid or water that may have been spilled on the sealing compound.

Superchargers and Supercharging Aviation Engines

A Concise Explanation of the Advantages of Supercharging to Maintain Sea-Level Horsepower in Aircraft Power Plants at High Altitudes

By Major George E. A. Hallett, U.S.A., M.S.A.E.

THE need for aeronautical engines that will deliver the same power at 20,000 or even 30,000 ft. altitude as they develop at sea level is very real and very great, in not only military but also in commercial aviation. Much success has already been attained with supercharging devices in this country and a certain amount of success in Europe. It must be admitted that there have been some failures also. Supercharging, as the term is generally used, means forcing a charge of greater volume than that which is normally drawn into the cylinders by the suction of the pistons in conventional internal-combustion engines.

Why Supercharging Is Needed

At 20,000 ft. altitude the atmospheric pressure is roughly one-half that at sea level; hence about one-half the weight of charge is drawn into the engine and less than one-half the power is developed. At 25,000 ft. altitude less than 25 per cent. of sea-level power is delivered. If at these altitudes air is supplied to the carburetor at sea-level pressure, or approximately 14.7 lbs. per sq. in. absolute, the power developed by the engine becomes approximately the

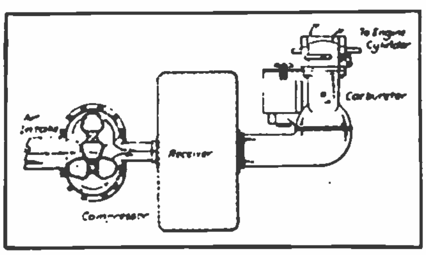


Fig. 1—Root type blower

same as when running at sea level. The low atmospheric pressure and density at great altitudes offer greatly reduced resistance to high airplane speeds; hence the same power that will drive a plane at speed of 120 m. p. h. at sea level will drive it much faster at 20,000 ft., and still faster at 30,000 ft. altitude, and with approximately the same consumption of fuel per horsepower-hour.

There is little to be gained by supercharging at sea level to increase the power of a given size engine, because the clearance volume must be made greater than normal to prevent pre-ignition, with consequent decrease in expansion ratio and comparatively poor fuel economy. The fact that the clearance volume is increased removes the possibility of the engine developing full power at great altitudes unless a supercharging capacity greater than anything heretofore considered feasible is available. Supercharging, therefore, is most useful in maintaining sea-level horsepower in engines ascending to or working at great altitudes.

Major Hallett is Chief of the Power Plant Section, Engineering Division, Air Service, Dayton, Ohio. The discussion herewith is condensed from a paper presented at the Annual Meeting, January 7 and 8, 1920, of the Society of Automotive Engineers. Considerable interest obtains at the present time in supercharging aircraft engines, and it is believed that an authoritative exposition of this character will prove of interest to all our readers, even those who are not specially interested in aviation, because of the general engineering information it contains.

Forms of Superchargers

Superchargers usually take the form of a mechanical blower or pump, and, of course, require a driving gear of some kind. The type of blowers or compressors used to date include the reciprocating, Root displacement and centrifugal types. The reciprocating type was tried by the Royal Aircraft Factory early in the war, on an air-cooled R. A. F. engine, with practically no success. It seems that this type of blower was found to be comparatively heavy and also unsuitable, due to the pulsating pressure of the air delivered.

The Root type blower was tried by the Royal Aircraft Factory with little or no success. The trouble reported was "rough" running of the engine on account of the pressure pulsations in the air discharged by the blower, which tended to overcharge some cylinders and undercharge others, thus causing uneven impulses. It is reported that mechanical troubles also developed with this type of blower. George W. Lewis, of the National Advisory Committee for Aeronautics, is working on an improved Root type blower, shown at Fig. 1. Here the pulsations in the air discharged are synchronized with the suction strokes of the engine. It will be interesting to note how this develops.

The centrifugal type of blower was used by Prof. Rateau, in France, early in the war. He employed the exhaust gases of the engine to drive a high-speed single-stage turbine direct connected to the centrifugal blower, shown in Fig. 2. Some success was had from the start, but he encountered many mechanical troubles. It is claimed in recent reports that some fairly good results are being obtained by the French.

The Royal Aircraft Factory experimented in 1916 and 1917 with a gear-driven centrifugal blower, but as soon as an endeavor was made to run it at speeds that would step-up the pressure to the 5 or 6 lbs. required, great difficulties were encountered on account of the inertia and momentum of the compressor rotor and the high-speed end of the gear-train, which resulted repeatedly in the breakage of the gears when the engine was accelerated or decelerated. To eliminate this trouble a friction clutch, designed to slip under excess torque, was tried, but only partial success was achieved, and the clutch itself

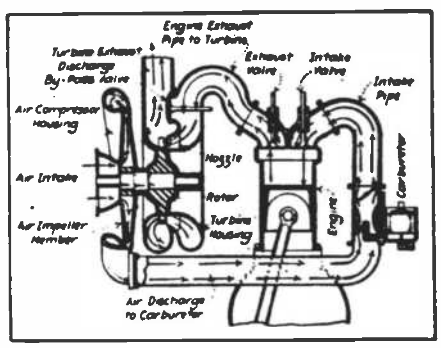


Fig 2—Centrifugal type blower

gave considerable trouble. Light flexible vanes were then tried on the compressor impeller, but this expedient has not proved successful to date. Similar experiments were conducted by the A. E. F. in France, but were concluded by the signing of the armistice.

The United States Air Service started work on the Rateau type of turbo-compressor soon after we entered the war. The work was done under the supervision of E. H. Sherbondy, who worked in conjunction with the Rateau-Bateau-Smoot Co., which handled the Rateau patents in this country, and designed a turbo-compressor which seemingly embodied many improvements over the Rateau type. Three of these machines were built and given ground tests on Liberty engines. The arrangement of the engine and the supercharger is shown in Fig. 3. Considerable trouble was encountered due to overheating of the exhaust-driven turbine, and even the use of a special heat-resisting metal in this part did not overcome the trouble. Soon after Mr. Sherbondy began work on the turbo-compressor, Dr. S. A. Moss, chief of the turbine research department of the General Electric Co., asked permission to carry on some work on the same general type. He built one turbo-compressor which was also a modification of the Rateau type but differed considerably from Mr. Sherbondy's machine. This device was tested on a Liberty engine at the summit of Pike's Peak and developed approximately sea-level horsepower there, at an altitude of 14,000 ft. It was capable of making the engine preignite at that height. The Moss supercharger, as first built, was of rather crude construction, and much mechanical trouble was encountered with all parts except the rotating element.

After the armistice was signed all work on the development of superchargers was stopped. When the engineering division of the Air Service took over McCook Field and started to plan peace-time development, the supercharger situation was carefully considered. It was decided that it was important to continue development work along this line. It then became necessary to decide whether work should be continued on both the Sherbondy and the Moss machines, and, if not, which one should be developed. It was noted that although Dr. Moss' machine was comparatively crude, it contained some inherent advantages over the Sherbondy type, and no way was seen to overcome the faults of the Sherbondy machine. Therefore, the latter was dropped and the General Electric Co. was given a contract to rebuild the old supercharger designed Dr. Moss. The new device is now being tested in actual flight and giving very interesting results. Figures on the results obtained with the present Moss supercharger are naturally confidential. The indications are that the turbo-compressor is very durable and probably will outlast an aviation engine.

Carburetor Locations

There is still some question as to the best location for the carburetor in relation to the blower in supercharged engines. Apparently all positions have been tried:

(1) It is possible to use the centrifugal type of blower as a carburetor by placing a fuel jet within its housing and allowing the rotor to do the mixing. As the rotor usually runs over 20,000 r. p. m., it will certainly mix liquid fuel with air. This system would require a manual fuel adjustment, such as is used with the Gnome engine, for different speeds. With this arrangement there would be danger of an explosion in the blower in case the engine back-fire, because the mixture in the blower would be under pressure higher than atmospheric.

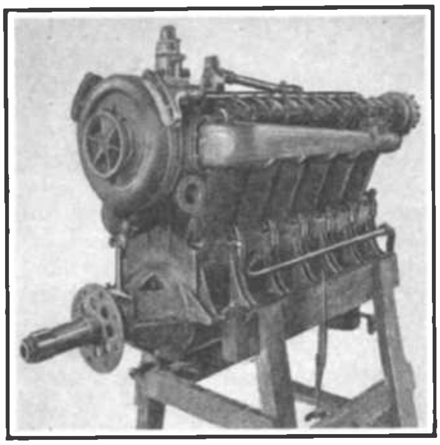


Fig. 3—How turbine type air compressor is installed on Liberty 12 aircraft motor

(2) The carburetor can be placed on the suction side of the blower. In this case the evaporation of the fuel will assist in cooling the charge during compression and the action of the compressor will improve the mixing of the fuel, but the danger from explosion remains to be overcome.

(3) When the carburetor is placed in the "normal" position and air is forced through it, it becomes necessary to "balance" the float-chamber with supercharger pressure. This somewhat complicates the feeding of fuel. Pressure gas-feed systems are "banned" in military planes and in any case with a pressure system the tanks would have to be made comparatively heavy to withstand the pressure which would be used at great altitudes. Where gasoline pumps are used it is necessary to regulate their discharge pressure as the plane ascends, because the fuel must reach the float-chamber at a pressure about 2½ lb. higher than that at the supercharger outlet. If the difference in fuel and float-chamber pressure is not kept in constant relation, the quality of the mixture fed to the engine will vary on account of the change in fuel level in the float-chamber. The engineering division has developed a very simple device that solves this problem effectively and is entirely automatic.

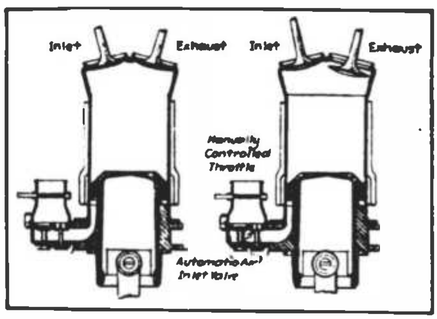


Fig. 5—Engine with built in supercharging piston construction

It would naturally seem at first thought that the extremely low temperatures always found at great altitudes would make possible the easy solution of cooling problems, but in reality the low density of the air reduces its heat conductivity and capacity for heat absorption to such a point that a supercharged engine developing sea-level power at 20,000 ft. requires a little more cooling surface than it does when developing normal power at sea level.

The Liberty engine and many others run best with a water temperature of about 170 deg. Fahr. To maintain the cooling water at this temperature in the reduced atmospheric pressure at 25,000 ft. it is necessary to use several pounds of air pressure in the radiator to prevent the water from boiling away. Very effective radiator shutters are needed when the engine is throttled to make a descent from altitudes of over 20,000 ft. to prevent the water in the radiator from freezing before warmer air is reached.

Contrary to expectations, the Moss turbo-compressor now being tested at McCook Field does not complicate the pilot's controls. On a normal engine the pilot handles the throttle and the altitude carburetor control which thins down the mixture as he ascends. With the turbo-compressor the altitude control becomes unnecessary up to the altitude at which the engine can no longer deliver sea-level power, but is used, as with a normal engine, if the plane is driven higher.

How Engine Speed Is Controlled

With the Moss turbo-compressor, when flying at low altitudes, the exhaust pressure is allowed to "waste" through manually operated "gates" in the exhaust pipes. As the plane ascends the pilot closes these gates a little at a time, and after he reaches a great altitude he can speed and retard the plane by the use of these gates. He uses the throttle only in case he wants to descend rapidly, when he closes it. In our test flights, we have provided the pilot with a sealed altimeter connected only to the supercharger pressure, so that it shows to what altitude this pressure corresponds. When at great altitude the pilot closes the exhaust gates until the pressure in the carburetors causes the altimeter to show sea-level pressure. This makes it unnecessary for him to do any calculating. If he makes the gage read lower than sea level, the engine will preignite. We have already been able to obtain sea-level pressure in the carburetors at well over 20,000 ft. The exact height cannot be mentioned at present.

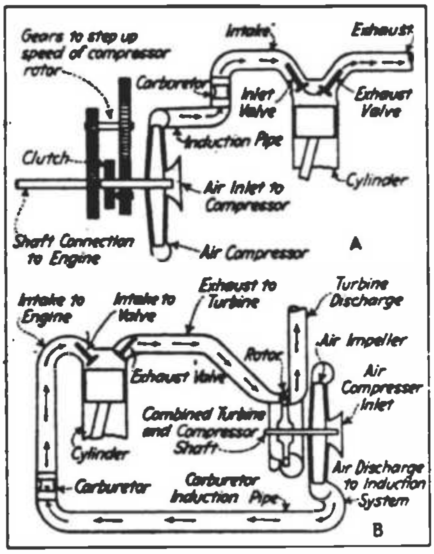


Fig. 6—Showing difference between gear driven and exhaust gas driven superchargers

With a normal engine the falling off in power as the plane ascends does not cause as much of a drop in propeller speed as might be expected, because of the reduction in density of the air in which the propeller is working. Our best engines do not lose over 75 r. p. m. at 20,000 ft. When an engine is supercharged so that the power remains constant as the plane ascends, the propeller tends to "race" at great altitudes. Therefore it is necessary either to use a variable-pitch propeller or to put on one that holds the engine speed down too low for best performance on the ground, but also does not allow the engine to race too much at great altitude. In our present tests we are using an oversize propeller and getting surprisingly good results, but we also have variable-pitch propellers about ready for test and should get much better performance with them.

There is an English make of supercharging engine in which air is compressed under the piston and by-passed through cylinder ports at the bottom of every stroke (see Fig. 5), supercharging at the end of the suction stroke and scavenging at the end of the exhaust stroke. It is claimed by the inventor that this scavenging makes possible the use of higher compression and greatly improves the fuel economy and brake mean effective pressure. It is believed that this engine will give rather limited supercharging and it may prove difficult to control the mixing or stratification of the air and mixture at some speeds.

It is believed that supercharging engines of the type mentioned will necessarily give a rather limited amount of supercharging. It is also believed that considerable difficulty will be encountered in obtaining the desired stratification in mixing conditions in the combustion chamber through any wide range of throttle positions. Also, some mechanical friction is added in this type of engine and it must be borne in mind that friction is particularly undesirable at great altitudes because it remains nearly constant from the ground up to great altitudes while the power falls off rapidly; therefore, the mechanical efficiency of the engine becomes very low.

It is already common practice to build aviation engines with compression so high that the throttle cannot be fully opened on the ground without injury to the engine. In this way, perhaps, the same power is obtained at 5,000 ft. as can be obtained on the ground. It has been suggested that this idea be carried further and that an "oversize" engine be built with much higher compression so that the throttle cannot be opened fully until a considerable altitude, such as 10,000 or 15,000 ft., is reached. It has been stated that such an engine could be made lighter, in proportion to the cylinder sizes, than a conventional engine, on account of the fact that the throttle would never be opened near the ground, but it is believed that when this idea is investigated it will be found that it is the inertia forces quite as much as the explosion forces that determine the necessary strength in most high-speed airplane engine parts and that therefore such an engine could not be built light enough to make it practical. In any case, it is doubtful whether this would give a really good solution for flying at 25,000 or 30,000 ft.

It is possible that centrifugal compressors can be operated satisfactorily by gears or by a belt drive. It is known that some designers are working on both of these problems..

The turbo-compressor in which an exhaust-driven turbine is used for driving the centrifugal compressor seems to present one fairly good way of accomplishing the desired purpose. The turbo-compressor itself is very simple, as there is only one moving part, namely, the rotating element consisting of the turbine wheel and compression impeller. The bearings of this rotating element do not seem to wear noticeably and the device imposes very little drag on the engine when not being used for supercharging. The turbo-compressor is also an effective exhaust muffler.

The Future of the Supercharger

It is believed that when the present type of turbo-compressor now being tested by the engineering division has been more fully developed, it can be built into an engine in a form which will add less weight and less head-resistance than the present machine, and naturally when we know exactly what additional cooling surface is required at a given height it will not be difficult to build this cooling surface into the airplane in such a form that

(*Continued on page 336*)

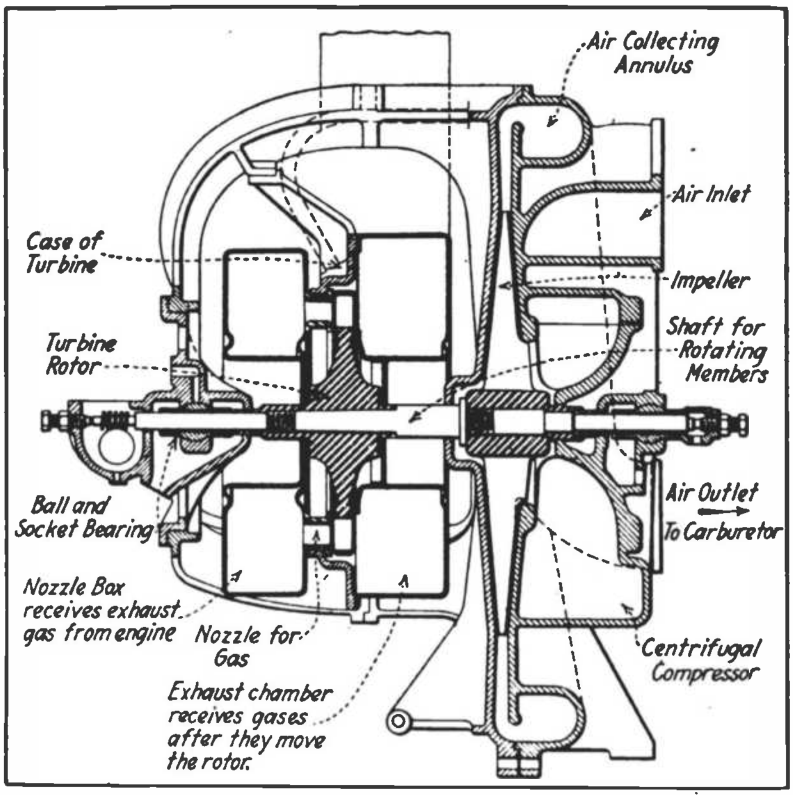


Fig. 7—The Rateau turbine driven centrifugal compressor for supercharging purposes

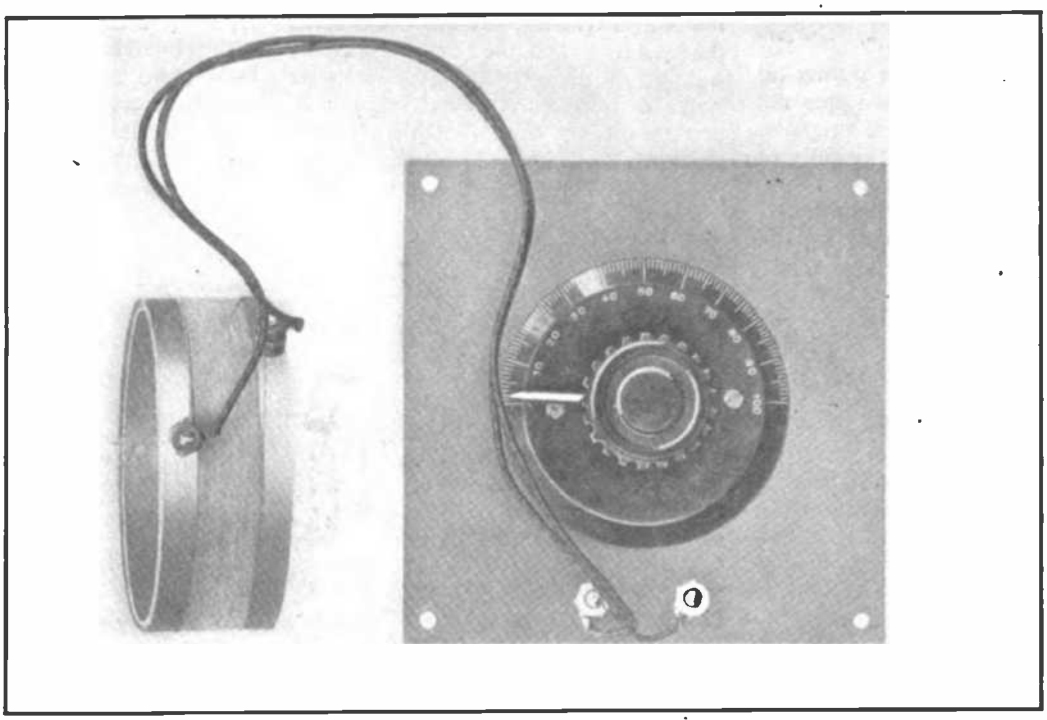
THE JUNIOR EXPERIMENTER

A Wavemeter for Tuning Transmitters

Do Your Part Toward Keeping Radio Work in Favor With the Government — Tune Your Transmitter

EVERY transmitting station needs a 200-meter wavemeter, for the good will of the inspectors and the Government depends upon sharp and accurate tuning.

So many times experimenters say, "No, I haven't a wavemeter because I can't get it calibrated, and they cost too much to buy already made."



This wavemeter, which needs no calibration against a standard, can be used to tune 200-meter transmitters

Those two disadvantages have been overcome in the type described in this article. The condenser presents the greatest difficulty. The condenser selected was of the Clapp-Eastham balanced type, fitted with bakelite end pieces as described in the December, 1919, and January, 1920, issues. It was calibrated against a standard condenser and gave the following capacities with a scale having 100° to a semicircle

10° = 0.00008 mfd.
20° = 0.00013
30° = 0.00018
40° = 0.00023
50° = 0.00028
60° = 0.00034
70° = 0.00040
80° = 0.00047
90° = 0.00055

With these figures the experimenter can draw his own calibration curve for the capacity of the condenser.

Connected to an inductance of 70,000 cms., the wavelength is:

10° = 140 meters
20° = 180
30° = 210
40° = 240
50° = 265
60° = 290
70° = 315
80° = 340
90° = 370

The coil must be made with great care, so that the inductance will not vary appreciably from 70,000 cms. A slight difference will not make a large error, so that it is practical to assume the accuracy of this instrument without actually calibrating it against a wavemeter.

A coil of this inductance can be made with 24 turns of No. 24 single silk covered wire wound on a form 3 ins. in diameter. This winding should occupy a space 0.6 in. long. The wires are run directly to brass screws which also act as terminals for the leads. No shellac or varnish should be used on the wire as this increases its capacity and throws out the calibration. Inductance of the leads can be neglected if they are not more than 18 ins. long. The lead wires should be bound together with string as this reduces their inductance and keeps it constant.

To measure the wavelength of a transmitter, one side of a crystal detector, shunted by a pair of telephones, is connected to one part of the condenser, or, if an audion is used, a wire can be run from the condenser to the grid. No other connection to the wavemeter is necessary.

Simple Experiments in Science for Beginners

By Judson Burns

EVERY young experimenter has a desire to extend his knowledge of science. The best and most practical way to do this is by experimentation. When an experiment illustrating some law is made, the person making it will remember the law much better than he would if he just read of it in a book. The writer does not wish to create the impression that reading and studying is not of value. The point to be brought out is that the performance of an experiment will do much more to impress a fact upon one's mind than mere reading can do. Not only this, but it will also greatly assist in understanding the principle involved. The few simple experiments outlined in the following paragraphs can be performed easily with very little preparation.

The first experiment has to do with atmospheric pressure. It is known that the atmosphere or air, as we are more inclined to call it, exerts a pressure of 14.7 lbs. per square in. upon the entire surface of the earth. If this pressure

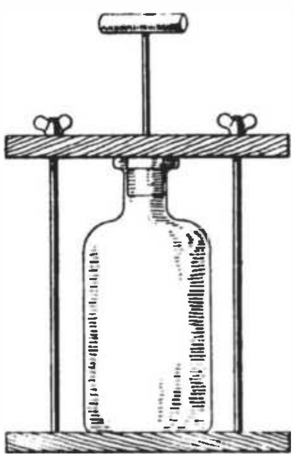


Fig. 4

is reduced in a vessel by a vacuum pump, the air on the outside will exert a pressure which will be equal to the difference in pressure on the outside and inside of the vessel. The pressure on the outside then will depend entirely upon the degree of the vacuum or the amount of air removed from the interior of the vessels.

The experiment illustrated in Fig. 1 will show that the atmosphere does exert a great pressure upon the earth. The materials needed are very simple. A shallow dish, a drinking glass, a candle and some water are all that is necessary to carry out the experiment. First, the candle is placed in the center of the shallow dish. Water is then poured into the dish. When this is done, the candle is lighted with a match, and while the candle is burning the glass is placed over it. When the glass is placed over the burning candle, the candle will be extinguished in an instant owing to the fact that it will consume all of the available supply of oxygen within the glass. This consumption of the oxygen within the glass will reduce the atmospheric pressure and part of the water in the shallow

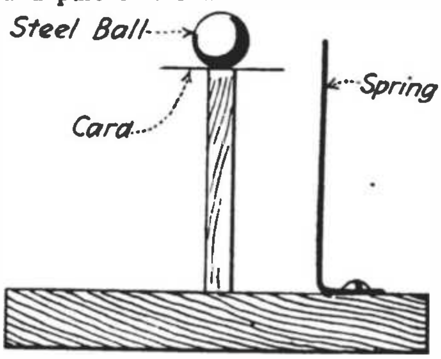


Fig. 3

dish will rise in the glass, force the remaining air upward until it is compressed to such an extent that the pressure on the outside and inside of the glass will be the same. This simple experiment is very instructive and never fails to interest those who watch it.

The experiment illustrated in Fig. 2 has to do with inertia. All matter has inertia. In other words, all matter is lazy. When in motion it does not have ambition to stop unless the forces that are moving it are overcome by friction. On the other hand, when matter is at

Fig. 2

rest it resists any force that tends to set it in motion. When a sudden force is applied to matter the property of inertia is very well illustrated. The inertia ball shown in Fig. 2 is used in the experiment. In the event that such a ball cannot be obtained, any heavy iron weight can be employed as a substitute. With the weight hanging in the manner shown, the end of the string is pulled and the force gradually increased until the string breaks. In this instance, the string will be sure to break between the ceiling and weight. If the end of the string is given a sudden jerk the string will be sure to break between the ball and the hand and the ball will remain attached to the ceiling. The sudden application of force to the weight causes it to offer considerable resistance and the string will therefore break between the band and weight. In other words, the ball is lazy and refused to move when a force is suddenly applied.

Another experiment showing the effect of inertia can be made by the use of the simple little piece of apparatus illustrated in Fig. 3. A large ball-bearing is placed upon a piece of cardboard which in turn rests upon a pedestal. A small piece of springy brass or watch spring is so fixed that when it is drawn back and allowed to go forward it will strike the cardboard under the ball-bearing a sharp blow. This causes the cardboard to fly from under the ball

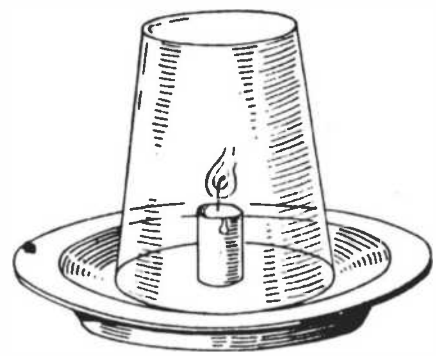


Fig. 1

and leaves the ball perched upon the top of the pedestal. If a piece of cardboard is gradually forced from under the ball, the ball would be sure to roll off. However, if a sudden application of force is applied to the cardboard it can be forced from under the ball without moving the latter owing to its inertia.

Inertia plays a great part in the science of mechanics. It is a property that mechanical engineers must ever watch for. In everyday life, the effect of inertia can be seen. If it was not for inertia, street cars and automobiles could reach full speed instantly.

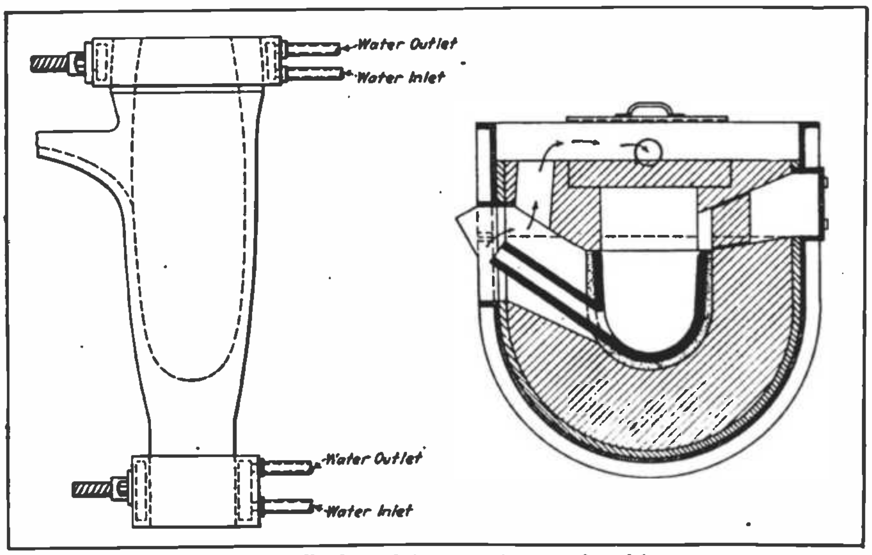
All solid and gaseous matter is compressible. By this is meant that it can be forced to occupy a smaller space by the application of pressure. There is, of course, a definite limit to compressibility which is different for different

(*Continued on page* 331)

EVERYDAY SCIENCE NOTES

BY PROF. T. O'CONOR SLOANE

We illustrate in the cuts accompanying this article an incandescent electric furnace. It is based on the principle of having the crucible, muffler or corresponding part of the furnace a conductor for the current. The current must be of high amperage, like a welding current. Its line is connected to the extreme ends of the furnace receptacle, and the current in its passage brings it up to any desired degree of heat. The degree of heat attained depends on the current and on the resistance of the same receptacle. It is clear that the degree of heat is thus easily regulated, and that by properly proportioning current and resistance, and by maintaining a constant voltage, an almost mathematical accuracy of temperature can be kept up indefinitely. A good conductor of heat is generally a good conductor of electricity. A plumbago crucible will conduct both; a metal crucible is a still better heat and electric conductor. Therefore a plumbago crucible for high heats and a metal one for low heats would seem to be the best selections.



Electrically heated furnaces for metal melting

One cut shows a furnace for melting metals. It is arranged to pour its charge by tipping. The conductors are connected at the sides of the crucible with water cooled joints. The intense current passes through the pot or crucible, brings it to incandescence, as great as desired, and melts its charge and keeps it in fusion as long as is required. The profile of another furnace is shown in the next illustration. This is also a tipping furnace; the heavy black line indicates the current carrying section. It suggests that a very heavy current must be required. A ventilating conduit carries off vapors while pouring. The voltage, of course, is low, so that a reasonable economy may be looked for. The third cut shows a heater for heat treatment of metals and the like. This is a cylinder of metal or other conductor, whose ends are connected by water-cooled joints to the electric line. Here especially it appears that a case is presented in which the facility of regulating the heat within a range of comparatively few degrees would be most valuable. In advanced heat treatment of steel, and nothing now passes except advanced methods, the pyrometer is constantly in use. But here the furnace itself is its own pyrometer to a great extent. Of course, as the furnace is used, the conductivity of its container and of the lining will vary somewhat, so it cannot be taken as a substitute for the accurate instrument.

Electric heating if the current is produced in a coal-consuming plant is very wasteful. The remorseless second law of thermodynamics gets in its work at the steam engine end of the plant. But once the current and voltage are produced the economy involved in their direct use may be very high. The heat engine, if a steam engine, with its low range of temperatures is the occasion of the loss. If the watts of electric energy are cheaply produced the efficiency may be very high. It is also most important to have the walls of the furnace of materials of low thermal conductivity. Little or almost no heat should escape by external cooling. The cut shows how such loss is guarded against in the carefully thought out construction of the furnaces shown.

A note of warning is sounded by a Swiss contemporary about aluminum electric conductors. The greatest care is prescribed for their handling by linemen. Bare pliers and other tools should not be used on them, a slip of sheet metal should be placed between the jaws of the tool and the wire. Where copper or iron is in contact with it the place should be protected from all moisture, as the metals form a galvanic couple with the aluminum, which will bring about its corrosion. Where it is wired to pole insulators the conductor and tie may be served with thinner wire to protect the conductor from wear.

Tungsten carbide has been produced of hardness only a little inferior to that of the diamond. It can replace bort, as the crude diamond is called, in diamond drills, stone saws, wire-drawing dies and the like. Its hardness is placed at 9.8 on the scale on which the diamond is 10.

From Berlin comes the idea of utilizing the electrolysis of water for the production of very high pressures for laboratory and experimental uses. A fraction of a cubic centimeter of water gives ¾ litre of gas at atmospheric pressure. The enormous pressure of 1860 atmospheres can be produced under the above conditions. The use of a U-shaped tube, arranged for the production of the gas in one end, will give the pressure in the other end away from the gases of decomposition, if desired.

It has been found that lead-coated iron resists the sand blast. The soft lead cushions the blows so that little or no effect results from the impact of the grains of sand. This has given a hint for the treatment of the blades of turbine water wheels. These wear away rapidly in sandy waters, so it is now proposed to coat them with lead, melted on, and make them secure against wear. The other impurities of streams, such as floating wood are easily screened out, but there is no getting rid of sand.

The rapid deterioration of porcelain insulators has brought out the suggestion that they should be made out of melted quartz. In the case of porcelain insulators at the end of the first year of service less than 1% are found to be defective; after 8 years, 6% and the deterioration then becomes very rapid.

Iron coated with lead has been produced, which is claimed to be better than tin plating and cheaper. The iron after pickling and washing is dipped into a solution of antimony chloride and then into melted lead, withdrawn and quenched in oil. Melted antimony sometimes is substituted for the lead. It is excellent for roofs, but cannot be used for pipes as galvanic corrosion is brought about by the lead forming a couple with the iron where the coating may be removed as at the joints.

A good deal of attention has been attracted to "kapok" as a filling for life-preservers. It is the fibrous mass of long hairs surrounding a tree seed from Java originally. There is also an Indian kapok. Twenty-four ounces in a life preserver will support a man in the water, and it never gets water-logged.

In Switzerland experiments have been tried with a mixture of coal gas and acetylene in equal proportions for car illumination. It is found to work well and to endure compression to nine atmospheres.

Concrete structures have proved anything but fireproof; the columns made of the material succumb to the heat in conflagrations. The U. S. Bureau of Standards has taken up the subject of making them fire-resisting. A coating of plaster of paris has been found efficacious. This material hardens by combining with water, so in a fire this has to be expelled, before the plaster falls to powder or loses its strength and shape. This takes time and during that time anything under it is protected in great measure against the penetration of heat. One suggestion is to make a form of plaster of finished outer contour but hollow, and to put the concrete into the interior by pouring. The reinforcing bars are put into the space also. The evaporation of the water from the plaster is a reminder of alum fillings for fireproof safes; this filling operates by absorption of the heat required to evaporate the water of crystallization of the alum; this absorption of heat keeps the safe from intense heat.

The liquid in a Zeiss level on an instrument captured from the Germans, was analyzed and found to contain a mixture of 90% benzol with alcohol. The viscosity of benzol is less than that of alcohol but greater than that of ether or carbon disulphide. Its coefficient of expansion is greater than that of alcohol and less than that of ether, and about the same as that of carbon disulphide. A certain amount of viscosity is not always to be regarded as a disadvantage in spirit levels.

For filling holes in castings the following mixture may be employed: Sulphur—50 parts; iron filings—20 parts; graphite—20 parts; all by weight and in powder. The powder is to be melted into place with a hot iron.

For sticking glass letters for shop windows on the glass panes, mix copal varnish—30 parts; turpentine—10 parts; glue in a minimum of water—10 parts; slaked lime—20 parts.

A green light in a signal lantern, it is said, can be distinguished from a red one irrespective of the color, by looking at them indirectly. The green light, it is said, gets brighter off the line of vision, while the red light gets fainter. This gives a hint of how a color-blind person might pass an examination calling for such a test.

It is important that the operation of a photographic shutter should not shake the camera. To test it for the quietness of its action a pencil may be fastened to the front of the box, projecting therefrom in a perpendicular line. The camera is arranged with the pencil in contact with a sheet of paper on the wall in front of it, the pencil point pressing lightly on the paper. The shutter is then sprung. If there is no motion, the pencil will not move and there will only be the mark of its point; if the camera is jarred by the action, the pencil point will make a line, straight or crooked, as the case may be.

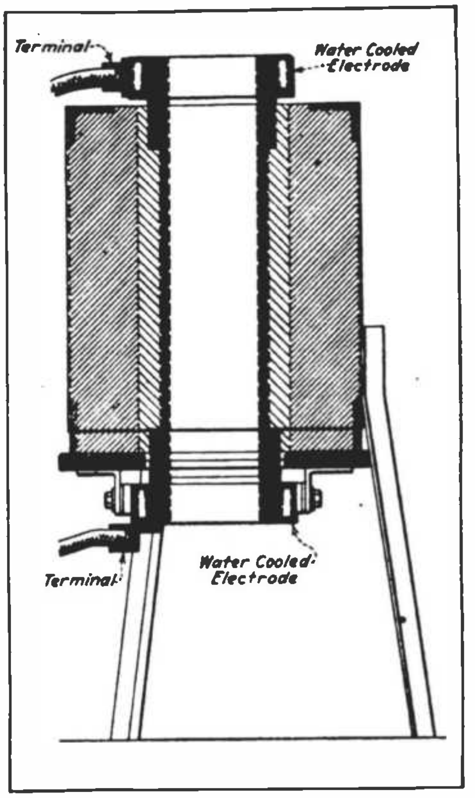
Concrete tanks are in use in England for holding mineral oils. A coating of rich cement is applied to the interior to make the tank more impervious, or else a solution of water glass is applied. Another use for concrete is for railroad cars; large gondolas have been successfully built using this material for the body.

Spitzbergen coal is attracting attention in England on account of the coal shortage in the home country. Owing to the cold, the coal is frozen, so there is no trouble with water in the mining operations.

The Sperry gyroscopic compass has a rotor weighing 45 lbs. which turns at the rate of 8,600 revolutions per minute. It is in an exhausted case, and after the current is turned off will operate for an hour by its own inertia. Owing to the motion of the earth, if a ship is going north the compass has to be corrected, as it is thrown off the meridian, when the ship is following the meridian course. A very curious use of the stabilizing gyroscope is to careen a ship. This operation is a sort of last recourse in some cases to get the vessel off a shoal; a ship draws less water careened to one side than when on an even keel.

Pulverized coal to be used as fuel is sometimes mixed with oil and is then termed colloidal fuel. This assimilates it to liquid fuel, and saves 1/3 of the expensive oil. It may be made liquid, semi-liquid or solid; in the latter form, it can be liquefied by heat. It is thought possible to use it in Diesel engines. It is said that Diesel invented his engine for the purpose of using powdered fuel instead of gas or oil or gasoline.

Considerable attention is now being given to the improved lighting of factories. A Chicago factory is cited in which by trebling the light the production was increased from 8% to 27% a pretty wide range. In a leather works the percentage of rejects was diminished 80% by improved lighting. The increased cost of such lighting is put at 1% of the payroll; in one of the great Detroit factories it is put at 0.3%.



Electrically heated furnace for heat treatment of metals

A registering compass for ships is a very old idea, but now comes a compass with a mirror mounted on the compass card, and with a selenium cell, which can be set so as to receive the reflection from the mirror, a lamp being provided for the purpose of giving light, to affect the conductivity of the selenium. As long as the light shines on the selenium nothing happens, but as soon as the ship is allowed to diverge from her course, the mirror is turned, by the action of the magnetic needle, the ray of light is deflected, the selenium changes its resistance and an alarm bell rings. The selenium cell is in circuit with a battery, and this rings the bell.

A very old idea has been brought forward in the journal of the Royal Society of England. It is to the effect that windmills may be used to charge storage batteries. This was done in this country, in at least one instance, many years ago. The author of the paper in question favors small windmills, as more economical of construction. He brings out a curious point to the effect that a windmill loses 9% of its power for every 1,000 feet increase in altitude.

The Arctic sea is less salt than the other ocean regions. It is attributed to the fact that as the fresh water from the great rivers enter it, their waters do not mingle with the rest on account of the freezing; the absence of diffusion keeps the surface water at any rate fresher than normal. Of the other oceans the Atlantic is reported the saltest, presumably because much of the evaporated water does not run directly back, the rivers taking the water from their water sheds back into the interior, before it runs into the ocean again. The Pacific is next in saltness, and the Indian Ocean the next.

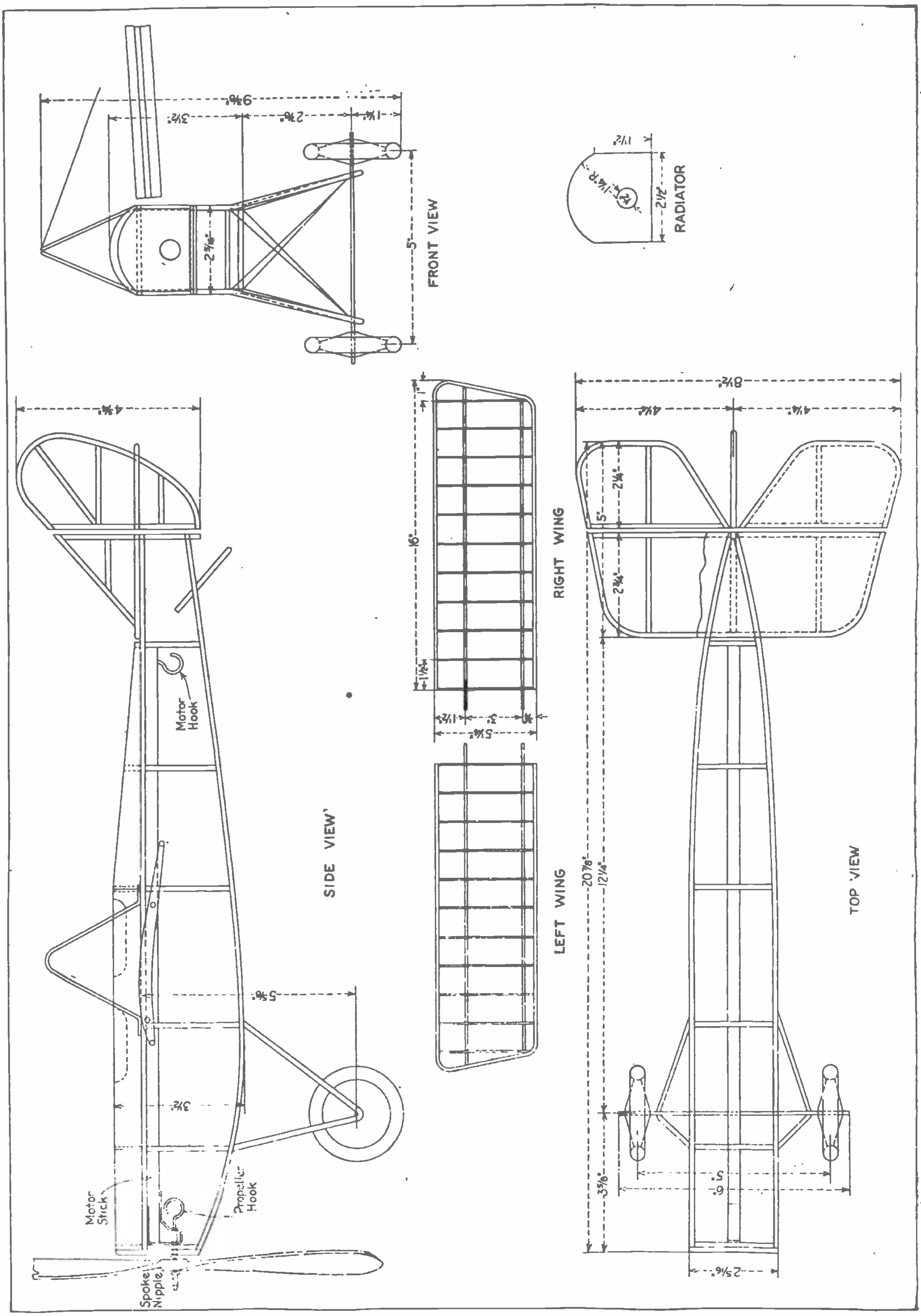
For taking down rivetted work, as in scrapping ships or in removing bolts, boltheads and nuts and similar service, considerable success has been attained with a species of gun. It has a short barrel provided with a plunger, fitting the bore, and is discharged by about an ounce of powder. The plunger is expelled by the explosion and breaks away the bolt-head or other object it is pointed at. The end of the plunger is held within about an inch of the thing to be hit. Places inaccessible to the ordinary chisel can be readily got at by this contrivance.

Thin mud has been experimented with in England for putting out colliery fires. Almost any material can be used, even coal slack, if fine enough, will answer. It is almost essential to have lime and clay present in the mixture. The material should be sifted after pulverizing, if not of sufficient fineness. It can be forced through pipes to a distance of 750 feet, even if there are bends in the pipe. This result was attained with a pressure of forty-five feet head of water.

During the war the English automobilists operated cars with coal gas in place of gasoline. Now it is felt that this material as a gasoline substitute should not be given up altogether and a committee report on it has been issued. Rigid or semi-rigid containers are advised. Great india rubber cloth bags were often used hitherto, carried on the tops of the tonneau hood. It is recommended that existing facilities for the use of gas should not be abandoned. The cost of compression alone on each thousand feet represents about fourteen cents per gallon of the gasoline it replaces. The treatment of this subject brings forcibly before us what the scarcity of gasoline in England meant; even now they are not prepared to put the inconvenient and expensive gas fuel into the discard.

The famous Sudbury, Canada, copper and nickel ores have been found to contain palladium and platinum, the former one predominating. In general, it appears, all sulphide copper ores contain metals of the platinum group, and a considerable amount is now recovered. The Canada Copper Co. reports in a ton of matte, the following quantities of the precious metals: gold—.05 ounce; silver—1.75 ounce; platinum—.10 ounce; palladium—.15 ounce.

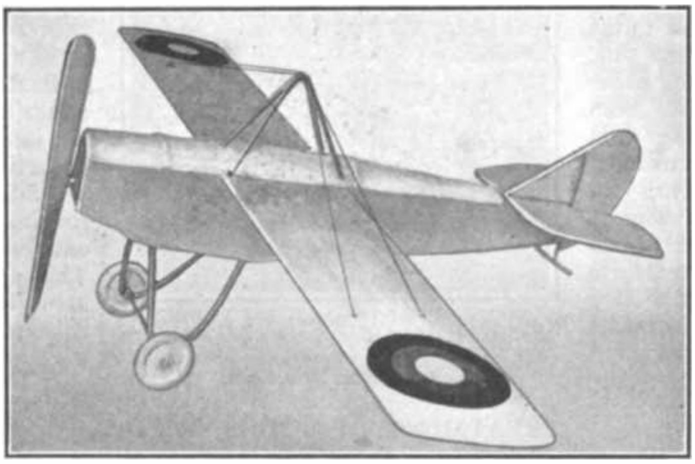
An ingenious and very obvious way to get rid of the shine of the surface of some silver trophy cups, which were to be photographed, and which gave only a blur when taken directly as they were, consisted in filling them with ice water. This produced the usual deposit of drops of water on their surface and they photographed perfectly. It is said that one of the most famous cups in the world, the American Cup, won by the old yacht "America" has no bottom, so this method wouldn't work in its case.


FRONT VIEW
RADIATOR
RIGHT WING
LEFT WING
SIDE VIEW
TOP VIEW
Motor Hook
Motor Stick
Propeller Hook
Spoke Nipple

A-34 Inch Spread Monoplane Model

By H. C. Ellis

BEFORE attempting to construct this model, study the drawings carefully. This machine should not weight over six ounces when completed if care is taken in the construction. This model has proven to be a fast and stable flyer and will withstand rough usage. Before taking up the construction of this model it is advisable for the reader to obtain the following: A small drill holder, one or more No. 61 drills, a sharp knife, a small hammer, a package of small nails 1/4" long known as brads and a medium size can of Le Page's glue.

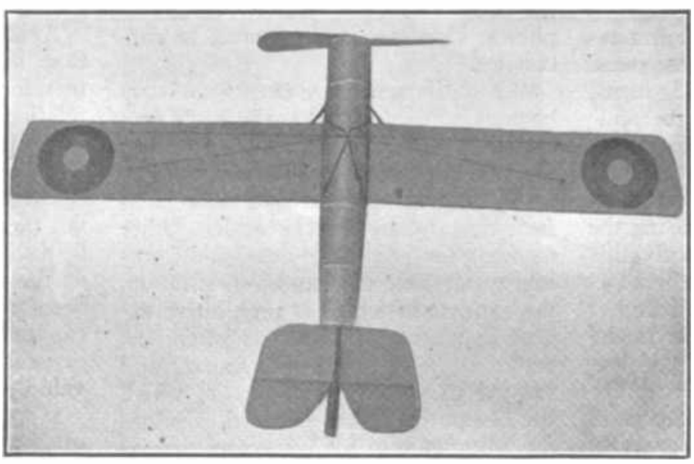


This flying monoplane model has speed and graceful lines

Fuselage

The Fuselage is built up of 1/8" square spruce. Obtain a board large enough to enable you to lay out full size the outline of the fuselage, stablizers, elevators and rudder. Care must be taken so as to make the curves exact. Now place along the lines of the layout headless nails, any size will do to hold the material in place while it is drying. Boil the longerons of the fuselage and the strips that form the edges of the stablizers, elevators and rudder in water at least half an hour. Then place the moist strips in the molding frame and allow to dry at least twenty-four hours. In the mean time the fuselage struts may be cut to size shown on the drawing. After the longerons are thoroughly dry mark off the positions for the fuselage struts. Using the No. 61 drill, bore holes in the longerons of the fuselage at the points where the struts are to be placed. Place a little glue on each end of the struts and by using the small hammer and nails fasten them in position to the longerons members. Care should be taken so as to avoid splitting the wood.

The radiator is of 1-16" spruce shaped as shown in the drawing and is fastened to the fuselage with nails and glue. The landing gear is of 1/4" reed bent to the shape shown by passing over a gas or candle flame. It is then bound to the fuselage with thread and glued. The axle is a piece of 1/8" steel rod cut to the length shown and bound with thread to the landing gear and glued. Aluminum disc wheels 2" in diameter are used.



Plan view of monoplane model that weighs less than six ounces

Tail Skid and Motor Stick

The tail skid is of 1/8" square spruce cut to the size shown and fastened to the fuselage. The motor stick is of spruce 5-16" square. This is fastened in the fuselage at two points only, that is, it is bound with thread and glued to the first and second fuselage struts. Before placing same in the fuselage attach propeller hanger, motor hook and propeller shaft as shown in the drawing.

Propeller Shaft and Motor Hook

The propeller is made of poplar or white pine, 12" in diameter and is medium pitch. If the builder is not experienced in carving propellers it is best to purchase same from a model supply house as this is the most difficult part of the model to make. The porpeller is attached to a 1-16" plain bearing propeller shaft as ball bearing shafts do not always give satisfaction, especially if not properly installed. The propeller hanger is made from aluminum 1-16" thick and is bent to the form shown in drawing. The motor hook is bent from a 1-16" steel rod to the shape shown.

Turtle Deck Formers

Make the turtle deck formers to the size indicated and fasten in place to the fuselage in the position shown, by glueing and drill a hole with No. 61 drill, place a small brad in it for extra strength. These formers are cut from 1-16" spruce.

Motors

Seventeen feet of 1/8" flat rubber is required for the motive power. This should be looped into 14 even strands. Place one end in the propeller hook and the other in the motor hook, before the fuselage is covered with the paper.

Main Planes

The ribs are cut from spruce 1-16" thick. The rib should be laid out full size, as it is reduced in the drawing. Care must be taken when cutting these ribs out to be sure and have them all the exact size and all holes for the wing beams, which are 1/8" dowels must be in line. As there is a number of ribs to be made, a metal pattern or template may be cut and drilled to act as a jig to insure uniformity in ribs. After the ribs are placed on the wing beams and are properly spaced according to the drawing they are glued and allowed to dry. After the glue is dry the edges, which are 1/8" reed, are put on. This is done by tying the reed back over the wing beams with strong thread and glueing the reed to the ribs. The wing tips are bent to the shape shown by bending only after heating by passing them over a gas or candle flame. Care should be taken so as to make all the tips the same shape. 1/8" Aluminum tubing is used for the wing beam sockets so as to permit the builder to dismantle the model easily. If unable to obtain aluminum tubing, brass or copper may be used. Two pieces of the tubing are required, cut to the length and attached to the fuselage at the points shown by the wing spars on the side view by binding and glueing.

Stabilizers, rudder and elevators.

The stabilizers, elevators and rudder are made of 1/8" reed for the edging and 1/8" square spruce for the filling in pieces. The elevators can be made in one piece with the stabilizer if desired as they are not movable after they are attached to the fuselage.

Covering and Doping.

Bamboo paper is used for covering the main planes, fuselage and controls. Cover the bottom first and allow to dry. After it is dry the extending edges may be trimmed off close to the reed edges. Then cover the top side. Care must be taken to have the paper lay even and without wrinkles. Both sides of the elevators, stabilizers and rudder are covered in this manner. After the covering is completed and the glue is perfectly dry, the dope is applied. This is best applied with a soft brush as a stiff brush is liable to puncture the paper covering. This dope can be purchased from any model supply house. Four ounces is required to dope the covering properly. Apply the dope evenly—then place away to dry.

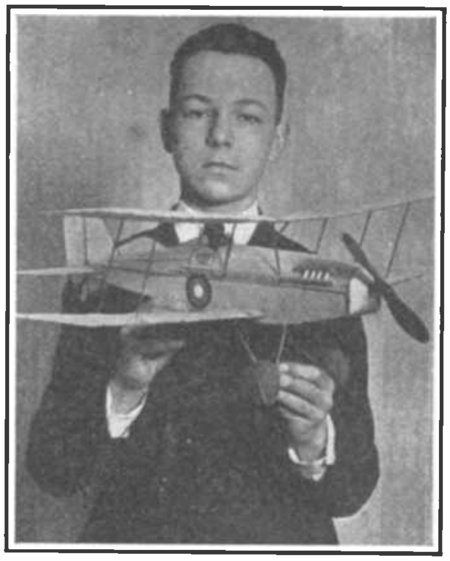
Assembling and Flying.

After the covering is thoroughly dry, the model may be assembled. If the elevator and stabilizers are made separately they may be joined together by drilling holes through the edges of same with a No. 61 drill and then joining them with fine wire. The rudder is attached to the rudder post in the same way. The extending ends of the wing beams are inserted in the aluminum sleeves forming part of the fuselage. The propeller is placed on the shaft so that the entering edge cuts the air first.

After the model is completed and assembled choose a field free from trees. Wind the propeller about 75 turns, grasp the model at a point in the middle of the fuselage holding the propeller from turning with the left hand. Launch gently forward from you in a level line at the same time releasing the propeller. Do not attempt to fly this model in a strong wind as the wind is liable to force it to the ground and it may be broken. To fly this model from the ground choose a hard and level surface. Wind the propeller 175 times, then place model on the ground and it will rise and make a graceful flight, but not as long a flight as when hand launched

SIMPLE TEST FOR BELTING

Strong vinegar will not affect belts of good quality except to darken the leather slightly, but if they are of poor quality, their fibres will swell and become gelatinous, so that this forms a good test for belting. A piece is cut off and immersed in the liquid for sufficient time to determine the action of the vinegar on the leather.



Robert Jares, a Chicago model enthusiast, has built a model biplane flier that will fly 130 feet in 20 seconds

TREATMENT OF BOILER FEED WATER

It is surprising, considering the importance of procuring a satisfactory softened water for boiler feeding purposes, that, except for certain special methods for producing small quantities of softened cold water, there have been no changes in the chemical methods employed for more than fifty years. Hydrate of lime, in the form of lime water or milk of lime, still remains the most economical and practicable means for neutralizing acids, absorbing carbon dioxide and converting bicarbonates to carbonates or hydrates. Soda ash is the usual substance for converting sulphates, chlorides and nitrates to carbonates.

Where the respective amounts of carbonates and sulphates are in high proportion, a single substance, sodium hydrate, may be employed both for absolutely carbon dioxide and for transforming sulphates and chlorides. Other methods for producing non-scale forming water are, of course, distillation, the expense of which is prohibitive except in marine applications where sea water is the only possible source, and the use of so-called Zeolites on which the Germutite system is based. Zeolites are suitable only for correcting permanent hardness, they introduce into the treated water, sodium carbonate in quantities proportional to the amount of lime and magnesium carbonates removed. For this reason, they are not suitable for softening water for boiler feed purposes. While the chemical reagents used for softening water are limited chiefly by the availability and cheapness of certain substances, the engineering methods and appliances by means of which the softening process is carried out have undergone a radical evolution even during the last year or so, so that their efficiency has been increased considerably. These improvements have to do principally with the correct use of heat for hastening or accelerating the chemical reaction and the perfection of means by which the chemical reagents are fed more accurately, the labor of handling chemicals and removing precipitates from the apparatus being thus greatly lessened.

FINISHING WOOD

To finish wooden handles, gun stocks and similar articles of wood and at the same time to preserve them, soak the articles in linseed oil for a week or so and then give them an occasional rubbing at intervals of a day or two until the desired polish is obtained. This preserves the wood and gives a natural finish that many consider greatly superior to the usual artificial finishes and colorings.

WOOD FOR A RIGID AIRSHIP HULL

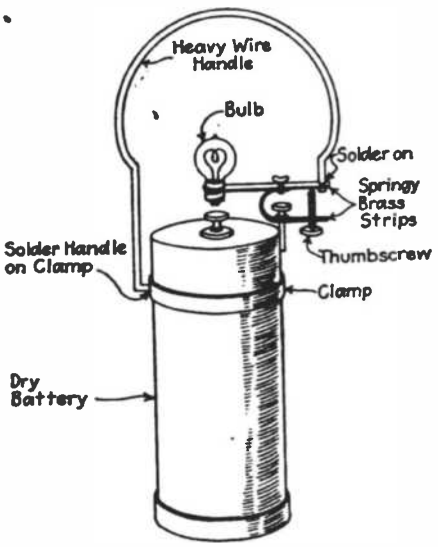
A well-known British firm of aircraft constructors has taken out a patent for a new design of rigid airship hull. A gas-tight shell is to be made up of several layers of wood veneer with fabric layers between, the whole cemented and stitched with fine copper wire, and with interior longitudinal and transverse bracing. The outer shell is intended to give the structure its chief strength and also acts as gas container. All the machinery and crew are carried inside the hull, there being no outside projections except the necessary fins and rudders for navigation which will mean a greatly lessened air resistance.

Another valuable feature claimed is that such a hull is unsinkable and therefore safe for ocean traffic. In the relation of weight to strength and carrying capacity, it offers material advantages over former methods of airplane construction. Models have been made but there is no record of full size craft being built to date so until the merits of the new system of construction has been proved by actual experience, one can only accept the report as one of general interest rather than practical value.

Squeaking in the brakes when applied is generally due to mud that has become imbedded in the lining and is forced against the drum when the brakes are operated. Sometimes this dirt may be washed out with kerosene, but if it is so firmly ground in that it refuses to come out, a little rosin mixed with castor oil and applied to the bands is recommended as a cure for the trouble.

Electric Lantern That Lights When Lifted by Handle

THE electric lantern shown in the sketch automatically lights itself when it is lifted by the handle, unless the thumbscrew is set to secure steady light in any position. One side of the handle is soldered to a metal clamp fastened around the battery about an inch from the top. The other end is soldered to a strip of springy sheet brass ½ in. wide and 2¾ ins. long. A small bulb is soldered into a hole at the other end of the brass strip. A piece of springy brass strip ½ in. wide is bent as shown in the sketch and screwed under the zinc binding post of the battery, and then fastened to the brass strip which holds the lamp by a small bolt and nut. The lower end of the brass strip is drilled and threaded to take a thumbscrew. When the lantern is lifted, the strain on the handle pulls against the brass spring, and forces the center of the lamp base into contact with the carbon pole of the battery. As long as the lantern is carried or hung up by the handle it will stay lit, but when put down, the spring forces the lamp out of contact. If the lantern is to remain lit, whether put down or held, the thumbscrew should be screwed till it comes in contact with the brass strip that holds the lamp.



Fine Jewelers' Rouge

SATURATE a solution of sulphate of iron (green vitriol) with a solution of oxalic acid. Filter and dry the resulting precipitate of pale-yellow oxalate of iron; place it in an iron dish and expose it to a moderate heat, whereby the oxalic acid will be decomposed and expelled, and a pure sesquioxide of iron will be left. This is very fine and can be used for producing a very brilliant polish upon the finest jewelers' work.

The American Society of Experimental Engineers

Who's Who In The A. S. E. E.

Cesario Tierra

Mr. Cesario Tierra, who is an active member of the American Society of Experimental Engineers, was born in Altimonon, Tay, Philippine Islands, twenty-eight years ago. He arrived in America during the year 1910. Upon reaching America, he immediately took advantage of its educational opportunities by entering a high school in California. He later attended the National University in St. Louis and in 1916 entered Lewis Institute, taking a course in mechanical engineering.

When the United States entered the war, Mr. Tierra was connected with the R. & V. Engineering Co., East Moline, Ill. This company was engaged in the construction of eight-inch shells and naval guns. Mr. Tierra was engaged as a tool maker with this company. From the above company Mr. Tierra went to the L. Wolfe Mfg. Co. in Chicago, Ill. He was also employed by this company as a tool maker. While being employed as a mechanical draughtsman at the Montague Works, Mr. Tierra invented an auto-condenser compressor. The claims for a patent are now before the Commissioner of Patents, Washington, D. C. Mr. Tierra is now employed by the Nordyke and Marmon Co., Indianapolis, Ind., as tool designer.

Ideas!

Have you an idea which you think would be valuable for the American Society of Experimental Engineers? If you have, please send it in to the Society and if it is feasible it will be brought before the Board of Directors at their next regular meeting. Ideas relative to the Society and its general welfare are particularly welcome and every member is urged to send any idea he has in for attention. Ideas concerning a method of increasing the usefulness of the organization without a great outlay of money are especially welcome. The Society has but one real aim—to give maximum assistance to its membership in their experimental work and study.

What Are You Doing In Your Laboratory?

Are you making some interesting experiments in your laboratory that you think the other members of the Society would like to learn about? Well, why in thunder don't you write them up and send them in for publication in the Bulletin?

Oftentimes experimenters wander into the offices of the Society and tell us of some interesting experiments they have made or of some device they have constructed. Yet it never occurs to them that this is just the kind of material that we are desirous of obtaining for publication in the Bulletin. Furthermore, that it is just exactly the kind of "dope" that their fellow members would be interested in. We feel pretty strongly about this and we earnestly hope that this little protest will do some good.

The A. S. E. E. and Inventions

It is only natural that the American Society of Experimental Engineers should encourage invention. In fact, approximately 9% of its members have obtained patents in the past. How many unpatented inventions have been evolved we have no means of telling.

What is the best way the Society can encourage invention? When the membership becomes larger than it is at the present writing, and a great many different inventions will be patented during the year by the members, the A. S. E. E. will give a medal to the originator of the invention possessing most merit. It would seem that this is practical. This is just another one of those things that can be done when the Society grows larger.

If any members have brought out any inventions recently, we would be very glad to receive the details for publication in the BULLETIN.

RADIO TELEPHONE AND TELEGRAPH APPARATUS

The Construction of a Radio Frequency Transformer

A New Field of Experimenting is Open to Those Who Work With Radio Frequency Amplification

RADIO experimenters have been slow to take up experimenting with radio frequency amplification, although it has been used commercially for more than two years. The reason is probably found in the fact that nothing has been written, in the wireless publications, on the construction of high frequency transformers.

This article is confined to the details of a transformer with which preliminary work can be done. Data and circuits will be given in the coming issues of EVERYDAY ENGINEERING.

WHAT THE RADIO FREQUENCY TRANSFORMER DOES

In an audio frequency amplifier, the incoming oscillations are first detected, and the low frequency currents are amplied in the succeeding stages. Therefore, in a set comprising a detector and three-step amplifier, signals can be heard by inserting a pair of telephones in the plate circuit of the detector or any of the amplifier tubes.

On the other hand, a radio frequency amplifier may have three steps of amplification and then a detector. Signals can be heard only in the plate circuit of the detector, for radio frequency currents are flowing in the amplifier tubes.

It has been found that signals below a certain strength cannot be made audible by any number of audio frequency amplifiers. The radio frequency currents, however, can be amplified to the required strength, at which point they will operate a detector and, if desired, audio frequency amplifiers.

There is one disadvantage in the use of radio frequency circuits. That is, radio frequency currents flow in the plate circuits through the transformer. There is a resonance effect due to the inductance of the transformer and the capacity between the plate and the filament of the tube. Consequently, the best results are obtained near the resonant frequency, although the resonance point is not sharp. This particular transformer, with the regular De Forest-Marconi VT, operates from about 1,000 to 5,000 meters.

DESIGN FEATURES

The first radio frequency transformers were made with air cores, the prevalent belief being that the losses in an iron core would be prohibitive at high frequencies. As a matter of fact, this proved to be untrue. Moreover, the distortion of telephone signals is less with an iron core transformer than with the air core type. At the beginning, silicon steel 0.0015 in. thick was considered necessary for the laminations. Steel of such a thickness is practically impossible to obtain, particularly in any quantity. Now, laminations up to 0.01 in. in thickness are used on some transformers.

The greatest difficulty is in the design of the transformer. First of all, following the present methods, a particular wavelength, at which the amplifier will operate at maximum efficiency, is chosen. With the capacity of the tube the primary of the transformer must form a resonant circuit, one in which the natural period will be that of the signals received. Next, at that frequency, the secondary impedance must equal that of the tube. If 3,000 meters is taken as the optimun wavelength, with a corresponding frequency of 100,000 cycles, at 4,000 meters the plate circuit will not be in resonance, and the resultant frequency of 75,000 cycles will give a lower secondary impedance.

Thus it can be seen that the design of a radio frequency transformer, at the present stage of development, is no easy matter. Variations in the steel further complicate matters so that, when the transformer is completed it may not do what was expected of it after all.

It is not proposed in this article to give absolutely accurate details which will produce a given result—that would be out of the question, considering the variations which experimenters are bound to put into their own construction. However, a working basis is provided which will lead to new ideas and developments.

CORE LAMINATIONS

Silicon steel for the core can be from 0.002 to 0.008 in. thick, preferably of the smaller size. Enough is needed to make a pile 3/8 in. thick. Before the steel is cut a template should be made of brass or steel, the exact size of the laminations, as shown in the detail drawing. Then, when the core pieces have been cut with snips to the approximate size, they should be clamped to the template and filed accurately. The dimensions of the two halves of the core are identical. There is an air gap between the parts when they are put together.

Four bakelite strips, marked A, are used to hold the laminations together. Before they are assembled on these strips, one-half of the laminations must be dipped in japan or varnish and hung on wires to dry. Then the plain and japanned laminations are put together alternately. This should make a total thickness, when the core is completed, of 7/16 in.

At this point mounting legs should be cut from a brass strip 3/8 in. wide by 1/16 in. thick.

COIL MOUNTING ASSEMBLY

A cardboard form (Fig. 2), C, is first made to go over the center part of the core. This supports two washers, E, over which a larger paper tube, D, is placed. The progressive assembly in Fig. 2 shows that another set of washers, B, are put over the outer tube. These washers carry the binding posts of the primary and secondary windings.

The tube C is made on a wooden mandrel 13/16 in. square. Bond paper about 8 in. wide is wrapped around it and varnished at the center part with Valspar. Enough sheets are used to make the tube about 3/64 in. thick. When completed the paper should be

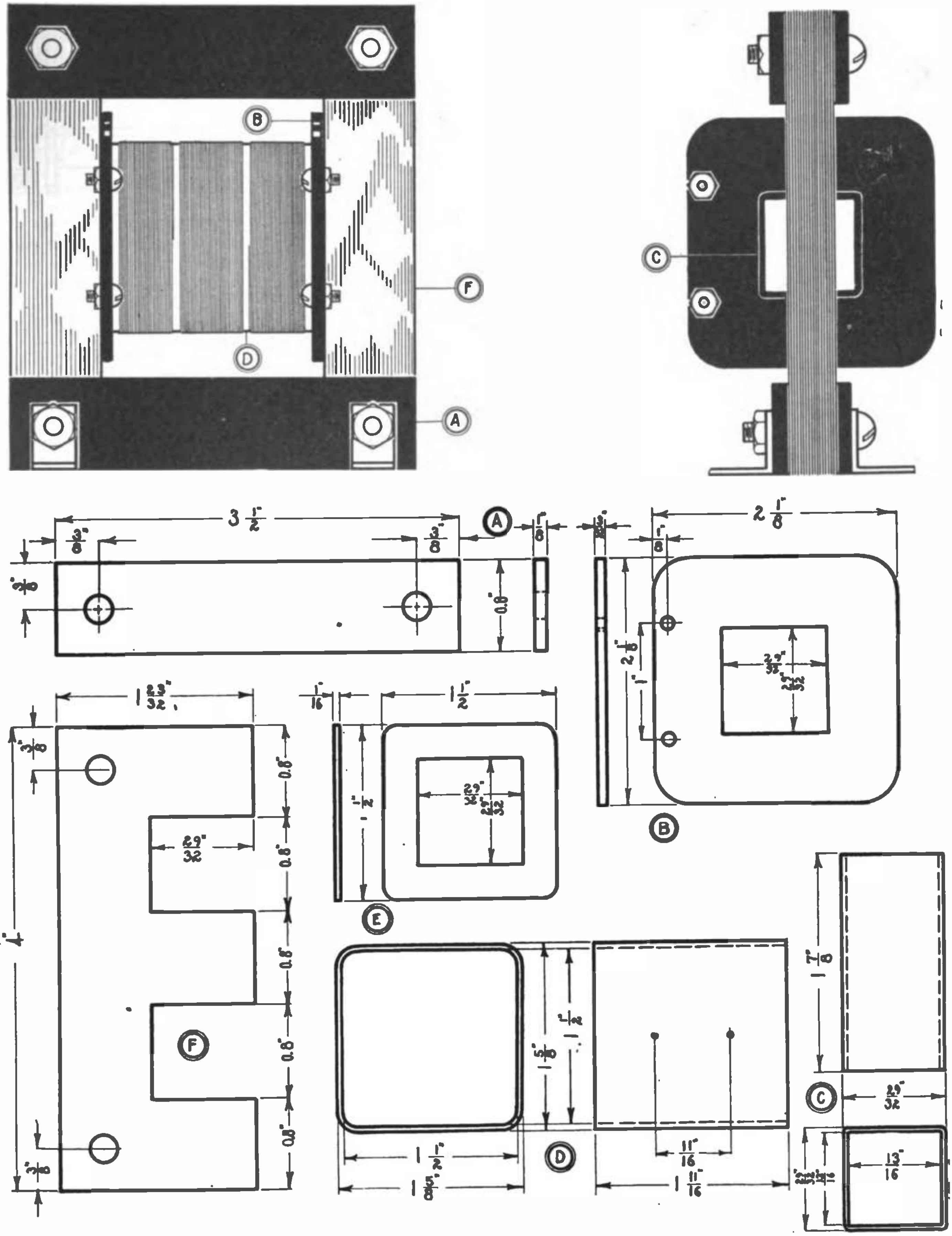


Fig. 1. The letters on the assembly refer to the details. This instrument calls for no difficult construction or expensive parts

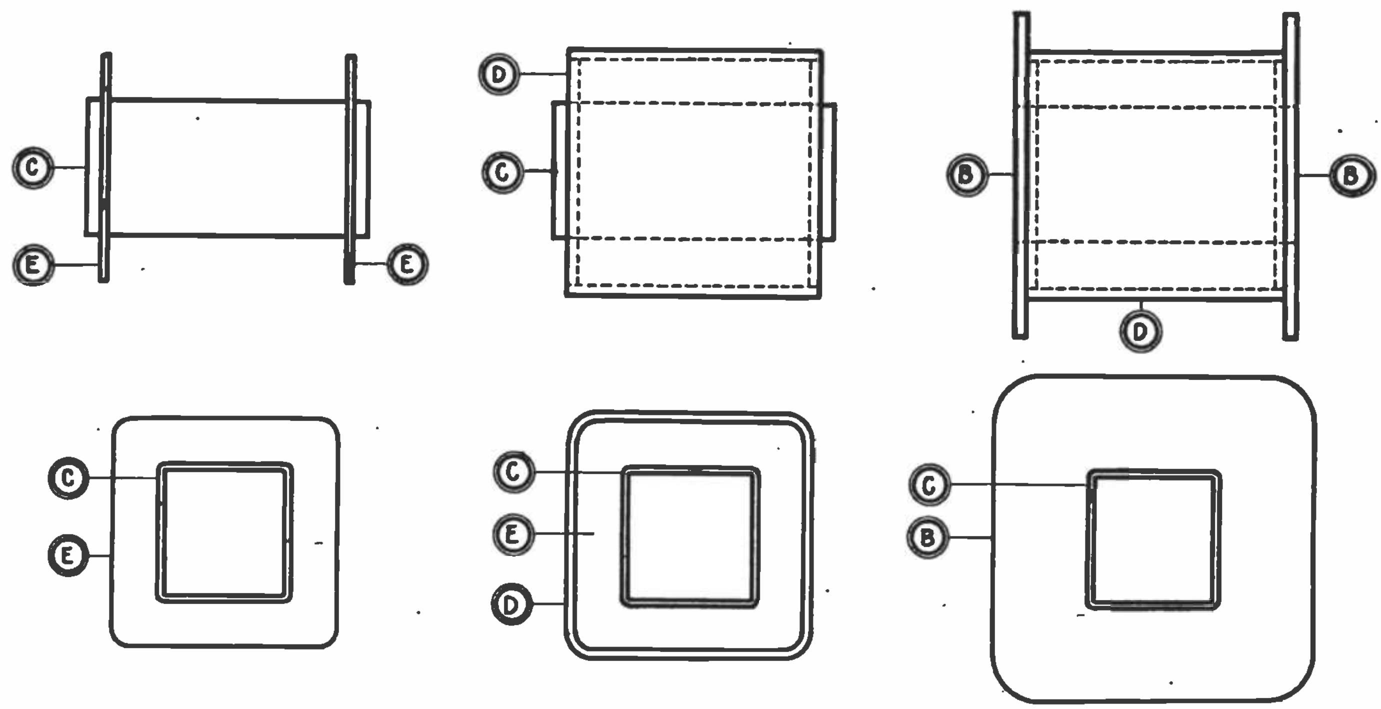


Fig. 2. Progressive steps in assembling the cores and end pieces which support the primary and secondary winding

wrapped with string and the whole outfit put in a warm oven to dry.

Wide paper is called for here because, if the Valspar leaks out at the edges, it will cause the paper to stick to the mandrel, making its removal impossible. After the drying process the tube should be cut to length before it is taken from the mandrel.

The end washers may be cut with a sharp knife from heavy cardboard to the dimensions given in Fig. 1. If cardboard of sufficient thickness cannot be obtained, several layers can be glued together and dried under pressure.

A larger mandrel must be made for the tube D, which carries the winding. This should be treated as explained in the first part of this section.

Primary and Secondary Winding

The assembled view in Fig. 1 shows the primary and secondary winding on the tube D. Two sections are used for the secondary, with the primary at the center. In the matter of winding the radio frequency transformer is much simpler than the audio frequency type.

First, the secondary coils are wound, each section having 90 turns of No. 40 single silk covered wire. The winding is of the ordinary sort secured with Valspar. Connections between the sections should be made inside the tube, and the wires soldered to make a perfect connection. Be sure that both parts of the coil are wound in the same directions, so that they will be equivalent to a continuous winding.

The primary requires 105 turns, also of No. 40 single silk covered wire. When the coils are completed, they should be covered with Valspar and baked dry in a warm—not hot—oven.

Leads can be brought from the coils directly to the binding posts, or pigtails, secured to the tube, can be used instead. The latter methods insures their permanence.

The beginning of the secondary should be brought to a terminal marked Sg, and the corresponding end of the primary to a terminal marked Pp. Thus, the Pp end will go to the plate of the first radio frequency audion, and the Sg end of the secondary will be connected to the grid of the next tube.

Assembly.

When the parts are ready, the tubes and end pieces should be assembled as shown in Fig. 2. An application of Valspar will keep the parts in place. Then the coil system is put on the core, and the end plates tightened until the laminations are clamped closely. If the coil mounting is not tight on the core, put a little Valspar on it and put it away to dry out. This varnish is better than glue for holding light parts, for once dry, it does not soften.

A Loud Speaker

SURPRISING amplification can be obtained with the device described in this article, though it is not intended to compete with expensive manufactured types. The loud speaker consists of a large box of thin wood, such as a cigar box. A regular 2,000 or 3,000 ohm receiver is secured at the center of the bottom, in such a way that the diaphragm faces upward.

Directly above the telephone receiver a hole is cut in the box and a small brass or tin horn fitted into it. The telephone is, of course, connected into the radio set in the usual part of the circuit.

When the telephone is actuated by the incoming signals, the box acts as a resonator, and the signals are conducted out by the horn. Signals of ordinary strength can be heard several feet from the loud speaker.

Cleaning Audion Contacts

The pins of an audion base must be cleaned periodically, as well as the contacts on the socket. There is a tendency for these parts to become oxidized, with the result that the resistance at the contacts becomes high.

Handling Detector Crystals

THOSE amateurs who are not fortunate enough to possess an audion detector should try to get the best results possible from their crystal detector. Few know how to do this.

The first thing to observe about the proper use of crystals is to see that their surfaces are kept absolutely clean. The experimenter cannot hope to do this by continuously handling them, as this will deposit a thin film of greasy matter from the fingers which will greatly interfere with the efficient action of the crystal through its high resistance. To keep crystals in a sensitive condition they should be handled with a small pair of tweezers. When the operator is through with his stations for the day he should remove the crystal from the detector stand and place it in a clean box where it can be kept free from dust and dirt. By following these simple rules the results obtainable with a galena detector will be entirely satisfactory.

The Radio Department

DID you ever hear of a "soundmeter", an instrument with a pointer to indicate the strength of a sound? Such an instrument has been invented by a New York man, Mr. McGall, although the operation of the device has not been disclosed because patent specifications have not been filed.

The instrument, outwardly, is just a small wooden box, carrying a glass at the top through which the scale and pointer can be observed. When the soundmeter is put near a buzzer or similar generator of air vibrations, the pointer moves according to the strength of the sound.

It is unfortunate that no manufacturer has offered to take up the production and development of Mr. McGall's soundmeter, since it promises to be a most interesting and useful instrument.

MR. MILLS, of the A. T. & T., would probably feel greatly relieved if someone would invent a method for measuring audibility. At the last meeting of the Institute, he seemed deeply moved in his discussion of the problem. Unfortunately, his was a mole's eye view of the subject rather than the bird's eye. We can thank the war for drawing many of our radio engineers from under their theoretical bushels into the open where their shining candles could glow with a practical and useful light.

DR. GOLDSMITH, at the meeting referred to, spoke of the necessity for considering the operators simultaneously with the development of new equipment. As he pointed out, the operator is the one who has to use the apparatus, and for that reason, it will not do to let the radio art so far outstrip the operators that they will be disgruntled by the new demands made upon them. Since the art must not be retarded, the operators must have the additional instruction necessary to keep them up with the art.

IT might be well for the experimenters to consider the value of the things they are doing. Of course, each one cannot make something better than anyone else, but each experimenter should stop to think whether the apparatus and experiments he is going to make are better or more worth while than anything before.

The construction of small portable receivers seems to hold a fascination for some. One particular enthusiast on such work comes to the Magazine office frequently, each time with a new pocket edition. The series up-to-date numbers ten or twelve kinds of small sets, but they are different only in small details. This man has not yet learned to design the circuits—the sets simply work because almost anything will produce signals from a nearby high powered station. The successive receivers represent no increase in the knowledge or ability of the builder.

A NEW contributor is represented in this issue of EVERYDAY, namely, H. W. Houk, of the International Radio Company. Mr. Houk, during the war, was one of the greatly envied men whose ability won him a place at the Paris laboratories of the A. E. F. His article on antenna period measurement is one of a number which he has promised to give the readers of EVERYDAY.

THERE was quite a flurry in the radio field when, a few months ago, it was announced that a static eliminator had been discovered. Much has been written also, in the less conservative publications, about buried wires which do away with difficulties from static.

Officials in the Bureau of Steam Engineering, the men who finally decide upon the merits of such systems, draw a distinct line between static reducers and static eliminators. While, to be sure, methods for reducing strays have been worked out, the man who has the real thing in static eliminators need not fear that someone else got there first.

Even Professor Pupin, who has probably done more in this direction than any other man, is willing to admit that the discovery of the copper-bound method is still a matter of future development.

A FEW years ago, when there were only a few hundred ship and shore radio stations, the supply of radio operators kept up with the demand. In the past year radio operating has taken its place among professions, but the number of men available has not kept pace with the increasing use of the wireless. Ship stations particularly have gone up and up in number. Land stations, as soon as the Government releases its control, will go up all over the United States, while installations in the South American republics are under construction, or are being planned.

The Post Office, as it increases its facilities for the distribution of mail by airplanes, will need more operators. A survey of the field shows that with these and other extensions in the use of wireless, the industry will, in the next five years, pass the most optimistic prophecies of five years back.

It is interesting to note, in this respect, that a new operators' correspondence school has been opened, offering a course prepared by L. R. Krumm, chief radio inspector, New York, giving prospective operators the benefit of his wide experience in the most effective methods for instructing and training of men for the Signal Corps.

SPRING days will be here soon, and experimenters will feel the call of out-doors. No reason, though, for leaving radio behind. Articles planned for next month include the design of a portable set which can be carried in the hand, or on the bicycle. With warmer weather there are also field tests with loop antennas, sets to be put up on the boat or at the bungalow. Tree climbing will become more popular, and higher antennas will go up.

We are getting ready new articles to suit the season, as well as those of all-year-round interest.

Radio Association

We wish to take this opportunity to call the attention of every radio amateur to the fact that a club under the name of the Ravenswood Radio Association, formed a short time ago in Chicago, has now become one of the strongest amateur radio organizations of its kind in the middle west.

It is composed entirely of commercial licensed operators and is working toward the raising of the amateur standard and the promotion of all legitimate work which will benefit the amateur.

It was decided that any amateur who was sufficiently interested to obtain a commercial license could qualify for membership in the organization. This will have the effect of having more amateur possessors of sufficient technical knowledge to put the amateur radio work out of the plaything class to which the average person not interested has assigned it.

The club has constructed an efficient wavemeter with which all members' apparatus will be tuned. Two of the members will be assigned to the task of tuning amateur sets throughout the city for a slight fee.

Weekly meetings are held at the club headquarters on Tuesdays at which the latest developments are discussed and explained by either members or some radio expert.

All amateurs are cordially invited to attend these meetings and the Secretary would be pleased to hear from all those interested in this organization.

Applications for membership are still open to all those who can qualify for entrance.

THE RAVENSWOOD RADIO ASSOCIATION,
1917 Warner Avenue, Chicago, Illinois.

Some Details of a New Condenser

Low Minimum Capacity and Unusual Mechanical Strength Are Outstanding Features of this Condenser

WHEN the condensers shown in Fig. 1 were brought into the office of the MAGAZINE, someone suggested tnat, if they were really as strong as it was claimed, they should stand two tests—first, that a man could stand on them, and, second, that they should not be injured when dropped at an angle from waist height in such a way as to land on the edge of the bottom end plate.

Another in the group maintained that, while a condenser might be specially built to stand such abuse, no one did it because any radio man with common sense wouldn't try such things on so delicate an instrument as a variable condenser.

But the experimenters' instincts prevailed and a condenser was put on the floor. Then a man weighing about one hundred and fifty pounds stood with both feet on the upper end plate. This was a more severe test than it appears to be at first thought, because the lower bearing extends below the heads of the screws which hold the fixed plates, so that entire weight was supported by the bottom of the lower bearing.

That test showed no ill effects. The plates were not bent, and nothing was loosened or injured. Then the condenser was held four feet from the floor and dropped in such a way that it landed on the edge of the bottom plate. Again the instrument came through no worse for wear.

The reason for this unusual strength is shown in Fig. 1, where a 0.0005 type is disassembled, with a complete 0.001 mfd. condenser at the right. The fixed plates, of 1/32-in. aluminum, are assembled on 10-32 screws, which are threaded into brass end pieces. In this way the fixed plates are assembled into a complete unit, independent of the end plates. This unit, with the heavy plates, washers, and assembly screws, is of great rigidity.

A feature of the variable plates, not found ordinarily in condensers supplied for experimenters, is that they are keyed to the shaft to prevent them from turning independent of the entire unit. Brass washers 5/8 in. in diameter separate the plates. Large and long bearing surfaces insure the perfect alignment of the moving parts.

The end plates are 3 1/4 ins. in diameter and 1/4 in. thick. An adjustable bearing and lock nut are fitted to the lower plate, allowing a variation of the tension and position of the variable plates. If the condenser is mounted on a panel, the screws holding the fixed plates to the upper end plate can be put in from the front of the panel, so that the upper plate will be flushed against the back of the panel.

Fig. 2 gives calibration curves for the two sizes. There are 29 plates in the small size, and 59 plates in the large condenser. The reason for the unusually low minimum capacity is found in the shape of the plates. Instead of being semicircular, they occupy only 165 degrees of a circle. Consequently, in the minimum position the fixed and variable plates are widely separated. This construction is also responsible for the perfectly straight line calibration right up to the maximum, while other condensers drop off at the upper end.

It will be seen that two types have a range of 0.00001 to 0.00058 mfd. and 0.000015 to 0.00115 mfd. Measurements of the capacity were made as follows, using a scale with 100 degrees to a semicircle:

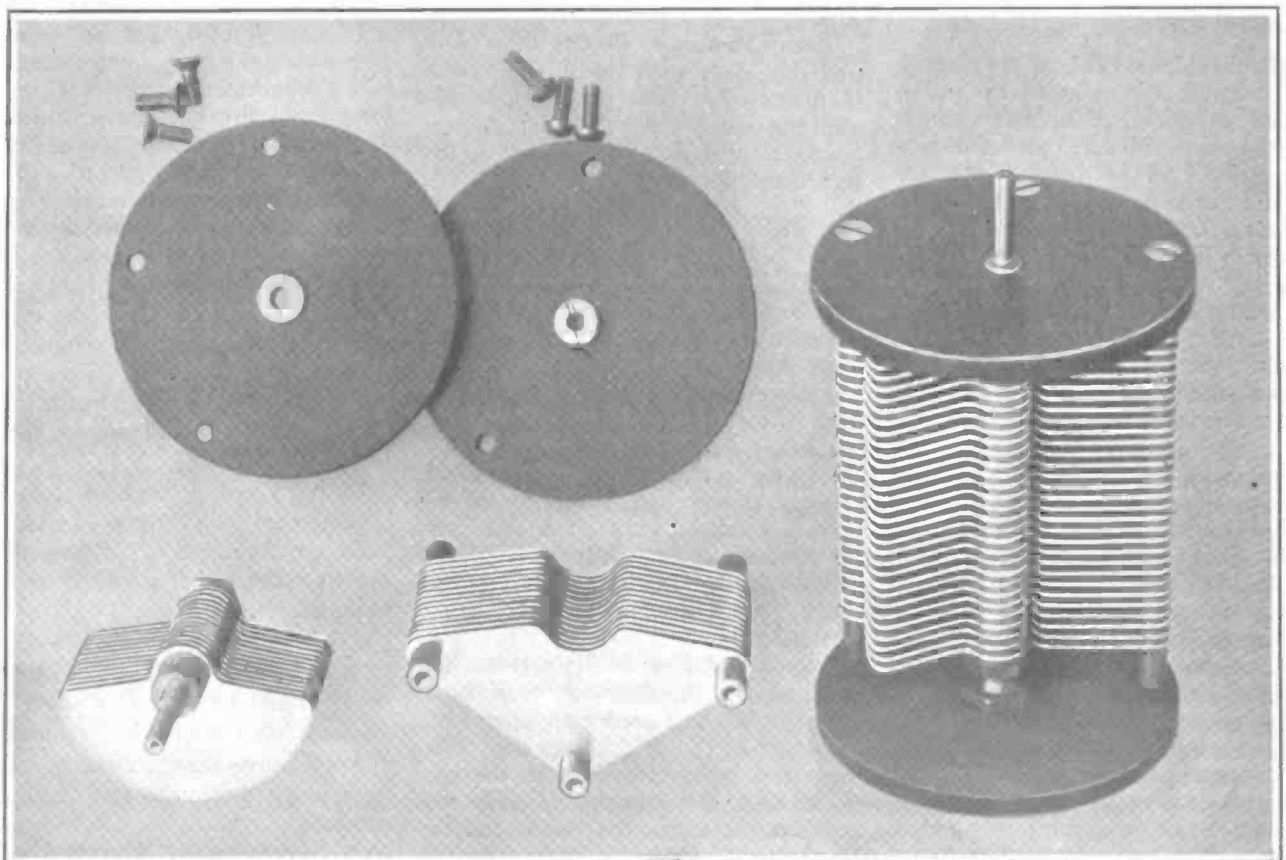


Fig. 1. The fixed and variable plates form complete units of great mechanical strength. End plates of solid bakelite prevent losses even at high frequencies

SMALL SIZE	
Degrees	*Capacity*
0	0.000010
10	0.000023
20	0.000085
30	0.000150
40	0.000210
50	0.000270
60	0.000335
70	0.000395
80	0.000460
90	0.000520
100	0.000585

LARGE SIZE	
Degrees	*Capacity*
0	0.000015
10	0.000050
20	0.000170
30	0.000295
40	0.000415
50	0.000535
60	0.000660
70	0.000780
90	0.000900
90	0.001025
100	0.001150

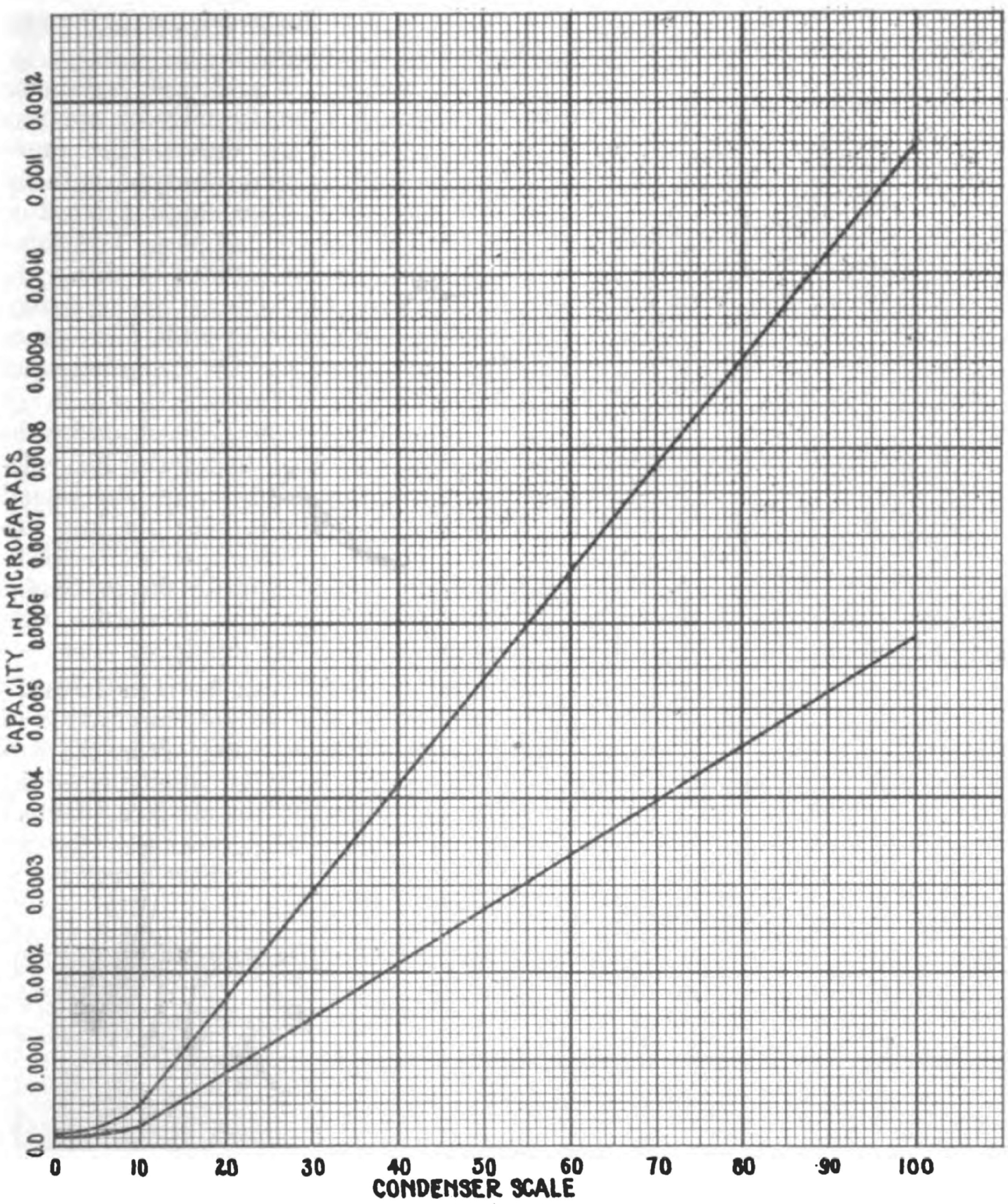


Fig. 2. Calibration curves of the two condensers

Effective Capacity Table

WHEN a series condenser is used for tuning the antenna circuit of a receiving set, the effective capacity is less than the capacity of either the antenna or tuning condenser. The table below gives the effective capacity with different values of antenna and condenser capacity.

To determine the effective capacity—that is, the value to be used with the inductance of the primary coil to determine the wavelength of the circuit—locate the column headed by the value nearest to that of your antenna. Then, in the column headed C, find the value of your tuning condenser. Run across horizontally to the column first found. The figures thus located will give the effective capacity of the circuit.

C	**0.0001**	**0.0002**	**0.0003**	**0.0004**	**0.0005**	**0.0006**	**0.0007**	**0.0008**	**0.0009**	**0.0010**
0.0001	0.000050	0.00006	0.00007	0.00008	0.00008	0.00009	0.00009	0.00009	0.00009	0.00009
0.0002	0.000060	0.00010	0.00012	0.00013	0.00014	0.00015	0.00015	0.00016	0.00016	0.00017
0.0003	0.000075	0.00012	0.00015	0.00017	0.00019	0.00020	0.00021	0.00022	0.00023	0.00023
0.0004	0.000080	0.00013	0.00017	0.00020	0.00022	0.00024	0.00025	0.00026	0.00027	0.00028
0.0005	0.000083	0.00014	0.00019	0.00022	0.00025	0.00027	0.00029	0.00030	0.00032	0.00033
0.0006	0.000086	0.00015	0.00020	0.00024	0.00027	0.00030	0.00032	0.00034	0.00036	0.00038
0.0007	0.000088	0.00015	0.00021	0.00025	0.00029	0.00032	0.00035	0.00037	0.00039	0.00041
0.0008	0.000089	0.00016	0.00022	0.00026	0.00031	0.00034	0.00037	0.00040	0.00042	0.00044
0.0009	0.000090	0.00016	0.00023	0.00027	0.00032	0.00036	0.00039	0.00042	0.00045	0.00047
0.0010	0.000091	0.00017	0.00023	0.00028	0.00033	0.00038	0.00041	0.00044	0.00047	0.00050
0.0011	0.000092	0.00017	0.00024	0.00029	0.00034	0.00039	0.00043	0.00046	0.00049	0.00053
0.0012	0.000096	0.00017	0.00024	0.00030	0.00040	0.00040	0.00044	0.00048	0.00051	0.00055
0.0013	0.000093	0.00017	0.00024	0.00031	0.00036	0.00041	0.00045	0.00050	0.00053	0.00057
0.0014	0.000093	0.00018	0.00025	0.00031	0.00037	0.00042	0.00046	0.00051	0.00055	0.00058
0.0015	0.000094	0.00018	0.00025	0.00032	0.00038	0.00043	0.00047	0.00052	0.00057	0.00060
0.0016	0.000094	0.00018	0.00025	0.00032	0.00039	0.00044	0.00048	0.00053	0.00058	0.00061
0.0017	0.000094	0.00018	0.00026	0.00032	0.00039	0.00044	0.00049	0.00054	0.00059	0.00063
0.0018	0.000095	0.00018	0.00026	0.00033	0.00040	0.00045	0.00050	0.00055	0.00060	0.00064
0.0019	0.000095	0.00018	0.00026	0.00033	0.00040	0.00045	0.00051	0.00056	0.00061	0.00065
0.0020	0.000095	0.00018	0.00026	0.00033	0.00040	0.00046	0.00052	0.00057	0.00062	0.00066

The minimum capacity of the tuning must be taken as ½ that of the antenna capacity, but the maximum can be so high as is desired. At a very low minimum the antenna circuit is practically opened.

For example, suppose a condenser of 0.0001 to 0.001 mfd. is in series with an antenna of 0.0004 mfd. At maximum, the effective value will be found in the column headed 0.0004, and across from 0.001 in the C column, giving the result as 0.00028 mfd.

At minimum, the tuning condenser must not be used less than one-half the antenna capacity, or 0.0002 mfd. The answer will be found in the 0.0004 column, opposite 0.0002 in the C column, or 0.00013.

Thus the effective capacity range obtained with the tuning condenser, then, is 0.00013 to 0.00028 mfd., even though the condenser has a range of 0.0002 to 0.001 mfd.

Turning a Thin Brass Disc

IT is out of the question to attempt to turn a thin sheet of brass when it is only held at the center by an arbor, and cutting and filing are nearly as impossible if a smooth job is required. An easy way to accomplish the work is to fasten the brass at the corners to a wooden disc, mounted on a face plate. A sharp tool will cut out a perfect circle in the brass.

Discs made in this way can be used as condenser shields. The disc should be mounted behind the panel, and connected to the ground side of the set. Plenty of space should be allowed between the disc and the condenser parts.

Book Review

STANDARD TABLES AND EQUATIONS IN RADIO TELEGRAPH, by Bertram Hoyle. 155 pages, cloth bound, 8½ x 5½ ins. Published by the Wireless Press, Ltd., Marconi House, Strand, W. C. 2, London, England.

English authors seem to take pleasure in compiling useful books of formulas and data on various subjects. Mr. Hoyle has done radio engineers no small service in preparing for them this book of information.

It is impossible to even attempt to list the subjects covered, for it seems as if everything is included, from definitions of electrical units to thimble sizes for wire ropes.

A complete index gives easy access to the various tables, formulas and definitions.

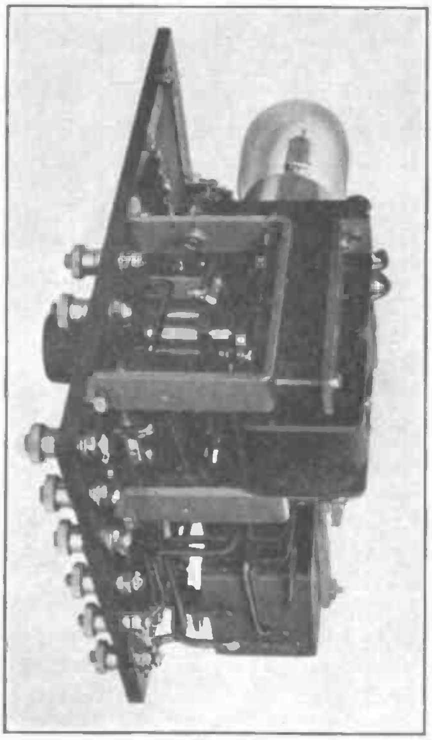
An Interesting Audion Control Box

This Set, from the Wireless Improvement Company, Operates on B Batteries or 110 Volts Direct Current

THE influence of manufacturing apparatus for the Government can be plainly seen in the new experimental equipment, an effect of advantage and credit to both the buildeds and users of the instruments. This audion control box, illustrated in Figs. 1, 2, 3, and 4, is of the regular Navy type with adaptions which made it quite versatile in respect to the important problem of plate voltage supply.

Beginning with the panel mounting, it can be seen that hinges are used, at the bottom, having the pin secured to one-half of the hinge. Therefore, when the panel is down, it can be slipped to one side and the pins pulled out of the other half of the hinges. In the closed position, however, the sides of the case hold the panel in position.

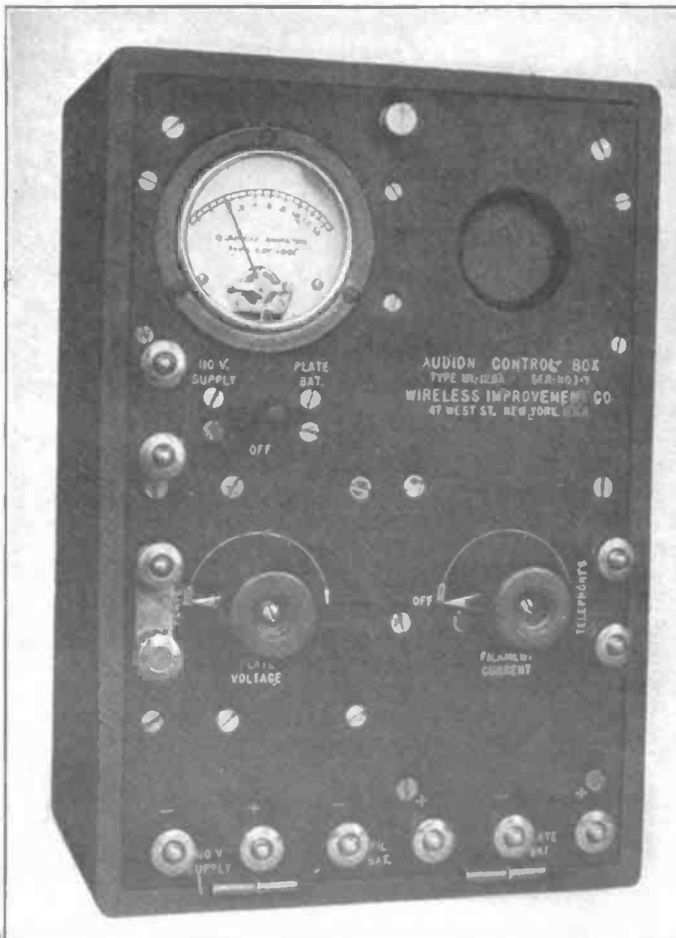
Fig. 1 shows a small thumb screw at the top center of the panel and at Fig. 4 a threaded block inside the case. To lock the panel, the thumb screw is turned tightly into the block. Supports are fastened rigidly onto the panel, Fig. 4, to keep it from falling down. These strips catch on angle pieces inside the case. A little inward pressure releases them so that the panel can be lowered further or removed.



At the rear, Fig. 2, the impedance, audion socket, fixed condenser, ammeter and grid leak are shown. The impedance, of the closed core type, is in the direct current plate supply circuit to smooth out current ripples. The paper condenser is put across the line. The method of supporting the impedance and audion should be studied, as it may present suggestions for designing other equipment.

Fig. 4 shows the rheostat under the socket. This is of the regular Navy design, made up of resistance wire wound back and forth on pins set into two bakelite discs. The carbon sector potentiometer is hidden under the condenser. It controls the voltage from the plate battery or 110-volt supply.

Other details can be seen from illustrations. The circuit employed is of the usual type. Change from the battery to 110 volts is accomplished by an anti-capacity, double-pole, double-throw switch. Experimenters who try



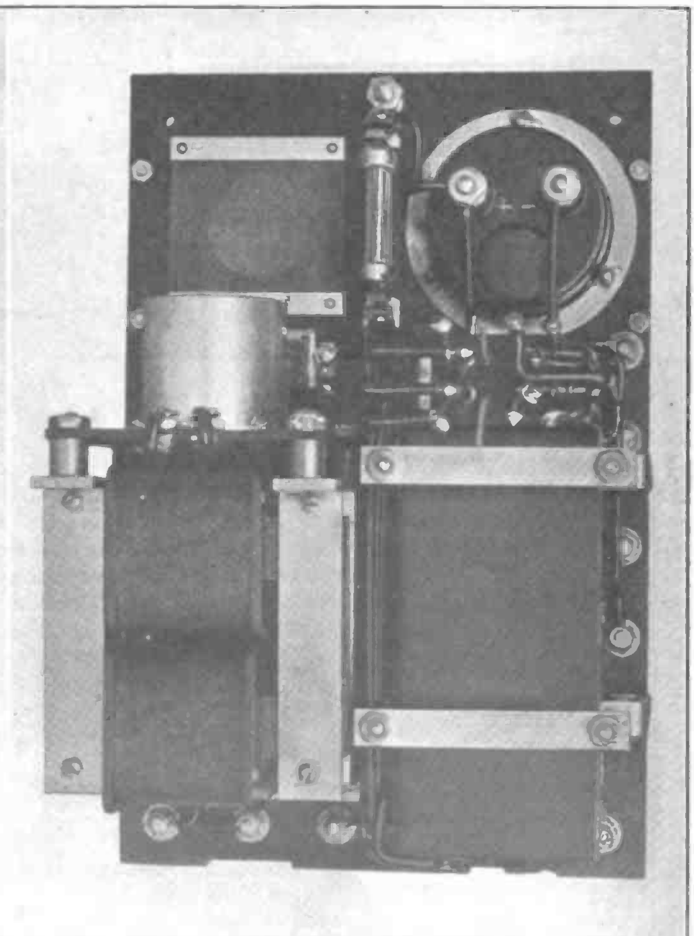


Fig. 1, left. The change from batteries to 110 volts is accomplished by a switch just below the ammeter. Fig. 2, right. A closed core impedance is used to smooth out the 110 volts. Fig. 3, above. Compact design is characteristic of this equipment to run their audions on 110 volts should benefit by the experience of the author, at the laboratory of the magazine. It was a simple matter to set up two iron core chokes with a condenser across them. To prevent any accident, fuses were put in front of the choke coils. When the circuit was closed the fuses blew out. Everything was all right, but the fuses blew a second time. Finally it was suggested that we had a two-phase line in the building and that this circuit must be on the wrong side. It appeared that that must be the trouble, for the polarity of the 110-volt circuit leads were carefully tested, yet the fuses blew when the negative side was grounded.

Finally we called the electric light company and were informed that the installation was an old one and that the positive side was grounded. This will seldom happen at other places, but serves as a suggestion for those who experience any difficulties on this score.

Increasing the Efficiency of Honeycomb Coils

WHEN honeycomb coils were first manufactured for radio work, they were dipped in an insulating varnish to hold the turns together securely without the possibility of damaging them from handling and to protect the insulation on the wire.

It was known, however, that energy losses occurred in the varnish, as it acts as an imperfect dielectric between the turns. Therefore, if the varnish could be removed, except for a thin film, from the interior of the coils, the capacity and high frequency resistance would be reduced.

Of a number of tests to accomplish this result, the last was the simplest, most effective and most economical. The coils were dipped and then put upon a revolving shaft. Centrifugal force threw off the excess varnish and dried them so that the time required for baking was greatly reduced.

Honeycomb coils are all treated in this manner now, with the result that they are much more efficient electrically than before this new method was adopted.

Radio Traffic Association

THE prevalence of inefficient operating was responsible for the organization of the Radio Traffic Association of Brooklyn, N. Y., in January, 1917. It is again preparing to carry out its main objects, which are to minimize unnecessary interference and reduce inefficient operating by the dissemination of practical ideas. It also purposes to promote good fellowship and establish an efficient relay system among the amateurs of Brooklyn.

At present the officers are Ferd. C. W. Thiede, Chairman; Albert R. Heydon, Secretary; Ernest K. Seyd, Financial Secretary, and Clifford J. Goette, Treasurer.

All amateurs of Brooklyn, above the age of eighteen, desirous of connecting with an organization offering obvious advantages are cordially invited to communicate with the Secretary at 486 Decatur Street, Brooklyn, N. Y.

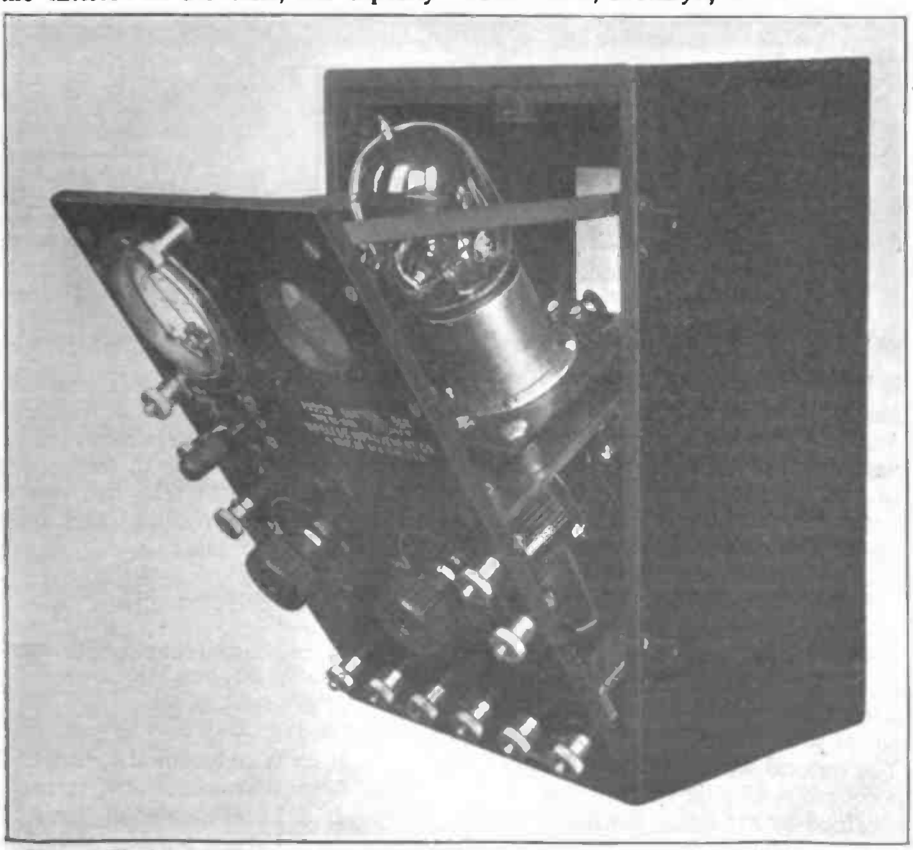
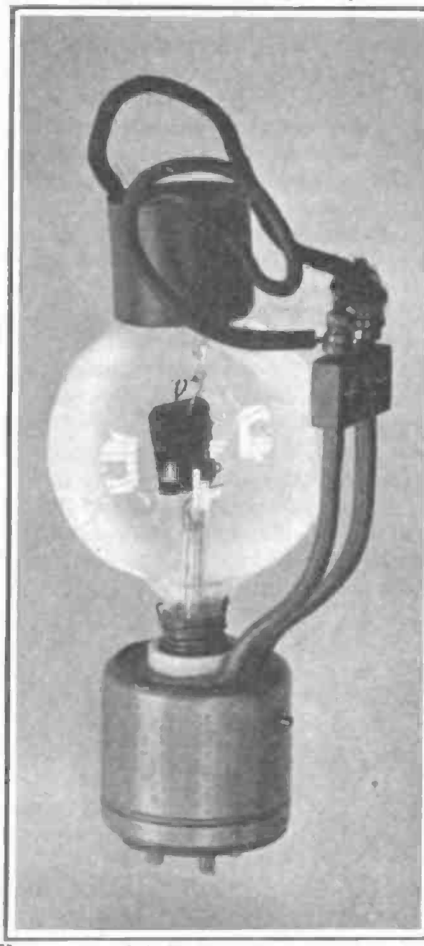


Fig. 4. The box partly open to show the interior construction of the audion control set

An Audion Socket Adapter

THERE is an astoundingly large number of the old style round audions still in use. An adapter by which



How a round bulb is used in a VT socket

the round bulbs can be used in a standard VT socket is shown in the accompanying illustration.

The main base came from a broken Western Electric VT1. To the grid and plate contacts inside the base, two copper wires, covered with empire cloth tubing, were soldered and brought up to a connection block. They take the grid and plates wires from the audion. The cylinder at the top of the tube was made of paper, filled with sealing wax, making an excellent protection for the wires and that end of the bulb.

A small porcelain socket, connected to the filament pins, is held in place by sealing wax. Paraffin is not good for this purpose, because, in a warm room, it becomes too soft to maintain the parts in position.

To use the round audion, it is only necessary to put the adapter in the standard VT socket, screw the bulb in place and fasten the gird and plate wires to the binding posts.

W. H. Howell.

Did You

send in your name for the Radio Register? Every engineer and experimenter should be represented. Don't have your name left out.

Measuring the Natural Wavelength of an Antenna

Accurate Results Are Obtained With A Simple Method

By H. W. Houck

USUALLY great difficulty is experienced in measuring the natural wavelength of an antenna. The usual methods are shown in Figs. 1, 2, 3, and 4, each of which has the disadvantage of not radiating a sharp wave. In fact, it is very difficult to detect a resonant point and if a resonant point is found it is so broad that accurate measurement cannot be taken. The reason for this broad tuning is due to the high decrement of the circuit. It is possible to get a very sharp resonant point by inserting an inductance in series with the antenna as shown in Fig. 3, because adding inductance in the circuit lowers the decrement and results in sharper tuning. This is easily seen from the equation

$$\delta = \pi R \sqrt{\frac{C}{L}}$$

where

δ = Decrement per cycle,
π = 3.1416,
R = Resistance in Ohms,
C = Capacity in microfarads,
and L = Inductance in microhenrys,

in which the decrement is shown to be inversely proportional to the square root of the inductance. This makes it possible to obtain a sharp resonant point, but the reading is worthless unless the value of the inductance is known and even then it requires a calculation which is difficult due to the correction factor caused by the distributed inductance and capacity of the antenna.

With the circuits shown in Figs. 5 or 6 and by the use of a curve which is easy to plot, it is possible to measure the natural wavelength with reasonable accuracy and little or no difficulty will be experienced in finding the exact resonant point. The inductance L should be a coil of wire whose diameter is small compared with its length, although the error is not great with any shape of inductance. This coil should have about 15 or 20 turns of wire and at least three taps. The method of procedure is as follows:

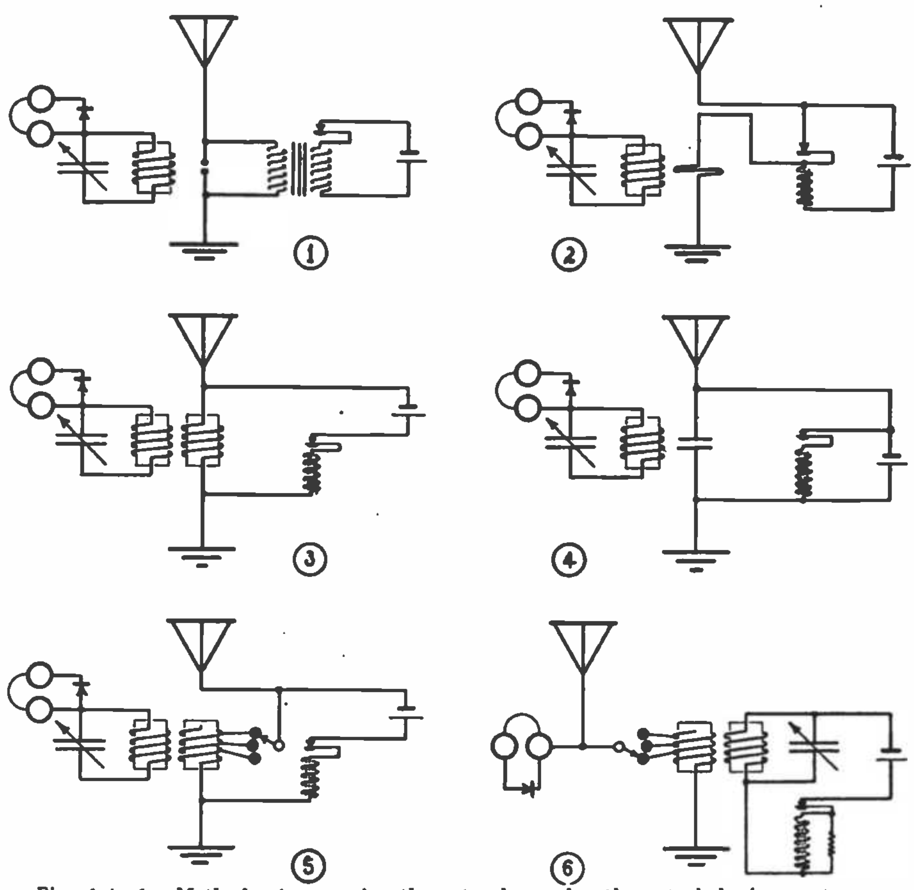
First, insert the inductance in series with the antenna, and provide some method of varying the number of turns of the inductance in the antenna circuit.

Second, excite the antenna as shown in Fig. 5, by connecting a high frequency buzzer and battery in series with the inductance coil L.

Third, place the wave meter near the coil, read the wavelength at different taps and record it together with the number of turns used in each case.

Fourth, on a sheet of cross section paper, with the wavelength on the Y axis and the number of turns on the X axis, plot the points and draw a mean straight line through them. The distance from the origin to the point on the Y axis where the line intercepts determines the natural or fundamental wavelength of the antenna.

If the wave meter is supplied with a buzzer and used as a generator of waves, the circuit shown in Fig. 6 can be used. In this circuit the detector is connected unilaterally to the antenna end of the inductance L. This connection gives a slightly sharper resonant point and is the most desirable to use.



Figs. 1 to 6. Methods of measuring the natural wavelength or period of an antenna

An example is shown in Fig. 7 in which the inductance L was a coil 3 ins. in diameter and 3 ins. long, wound with 24 turns of No. 12 B. & S. gauge bare copper wire. The measured wavelength with 24 turns was 590 meters, with 21 turns 570, with 16 turns 535 meters and with 11 turns 500. These points were plotted and the line drawn. The natural wavelength of the antenna is determined by the point on the Y axis, obtained by extending the line. Hence the natural wavelength was found to be 425 meters. This value checked within 1% of the actual value obtained by an elaborate vacuum tube measurement which involves too great an outlay of apparatus for the average radio experimenter. A similar means of antenna measurement was developed by the French Government during the war, and was used in French Radio Laboratories as well as in the field.

In some cases it is desirable to obtain the natural wavelength of an antenna without going to the trouble of drawing the curves. This is especially true in instances where an inspector has a large number of stations to measure in a limited time. In this case it is only necessary to take two sets of turns—wavelength readings and apply the following formula:

$$\lambda_0 = \lambda_2 - K t_2,$$

where

λ_0 = Natural wavelength,
$K = \frac{t_1 - t_2}{t_1 - t_2}$,
λ_1 = Wavelength at t_1 turns,
λ_2 = Wavelength at t_2 turns,
t_1 = Least number of turns,
and t_2 = Largest number of turns.

This formula may be derived from the curve shown in Fig. 7 and is applicable, of course, to any similar case. An example of this method may be taken from data already given. The two sets of readings taken are 590 meters (λ_2) at 24 turns (t_2) and 500 meters (λ_1) at 11 turns (t_1). By substitution in the formula we find:

$$K = \frac{\lambda_2 - \lambda_1}{t_2 - t_1} = \frac{590 - 500}{24 - 11} = 6.92.$$

Then: $\lambda_0 = \lambda_2 - K\,t_2 = 590 - (6.92 \times 24) = 424$ meters,

For instance, if we desire to load the antenna of Fig. 7 to 600 meters, we take two sets of measurements. These are:

$\lambda_2 = 590$ meters $t_2 = 24$ turns
$\lambda_1 = 500$ meters $t_1 = 11$ turns

$$K = \frac{\lambda_2 - \lambda_1}{t_2 - t_1} = \frac{590 - 500}{24 - 11} = 6.92.$$

Then:

$$T = \frac{\lambda_2 - \lambda_0}{K} = \frac{600 - 424}{6.92} = 25.43.$$

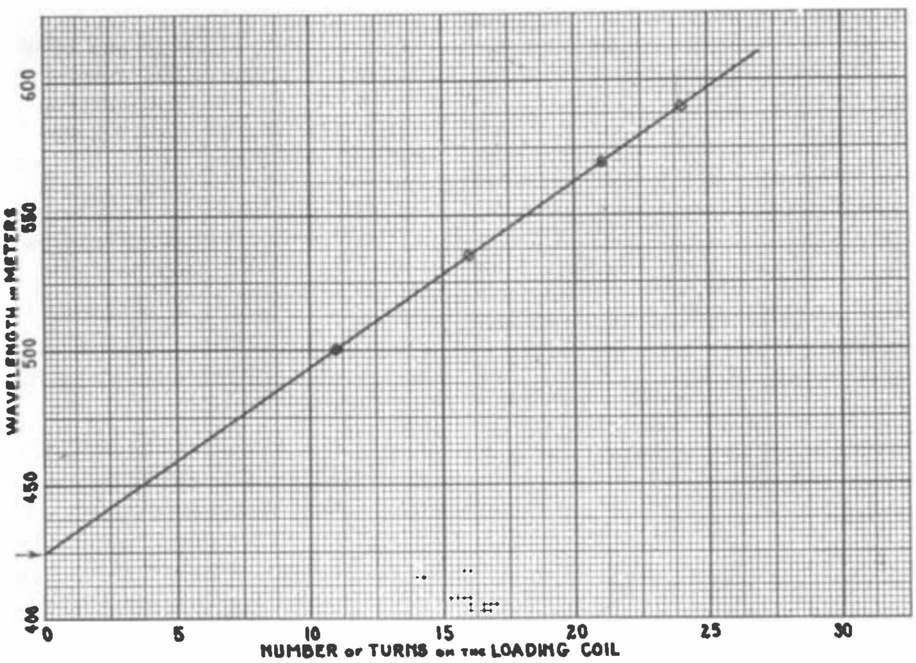


Fig. 7. Results of measurements by which the natural wavelength is obtained

which is probably a little closer than the results obtained by the use of the curve.

Another application of this formula is in the calculation of the exact number of turns necessary to load a given antenna to any wavelength. The coil used in loading the antenna must be of the same diameter and must have the same ratio of diameter to length as the coil used in making the measurement. It is also best to have the greatest wavelength reading at least as great as that which is to be used. The nearer these conditions are obtained, the more accurate the calculation.

$$T = \frac{\lambda_L - \lambda_0}{K},$$

where

λ_0 = Natural wavelength of for desired wavelength,
λ_L = Desired wavelength in meters,
λ_0 = Natural wavelength of antenna,
and K = Same as in the previous case.

Hence, 25.43 turns of the coil used in these calculations would give a wavelength of 600 meters.

From $$T = \frac{\lambda_L - \lambda_0}{K}$$

it is seen that with any number of turns we may readily calculate the corresponding wavelength from

$$\lambda_L = T\,K + \lambda_0,$$

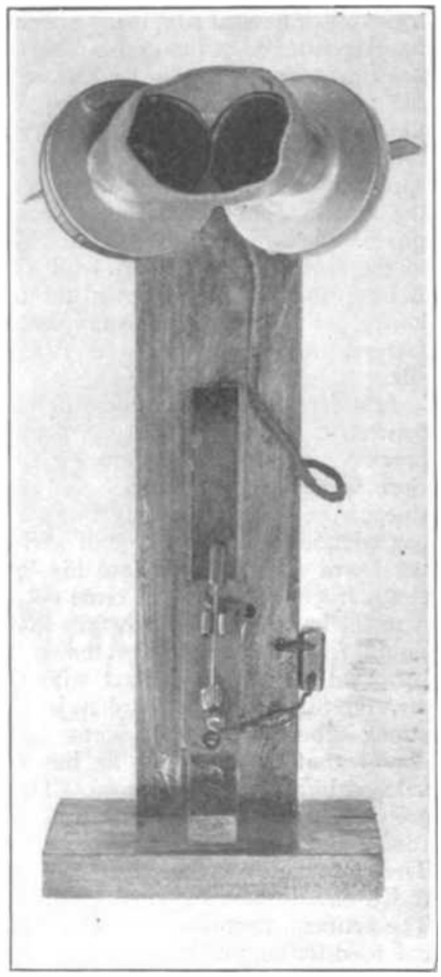
where: λ_2, λ_0, T, and K have the same significance as heretofore.

The principles above set forth may be applied to the measurement of capacities in open or closed oscillators, and is especially valuable in measurements of circuits in which the capacity predominates.

Measurements of this sort give the experimenter data on his station which takes the guesswork out of the design of apparatus.

Mounting Two Transmitters in Parallel

SOME particular experiment may call for a transmitter of extra carrying capacity under circumstances where nothing but the usual type is available. Heavy current transmitters are hard to obtain and expensive. A low resistance transmitter is especially needed for audion telephone sets when the transmitter is in the ground circuit.



Of a number of makes tried the Western Electric proved to have the lease resistance. Because the transmitters had to be mounted at an angle, and because they were fitted at the rear with lugs for the conventional type of support, it was necessary to think out a special type of mounting.

A solution of the problem was accomplished in this way: A bracket was cut from 1/16 in. brass sheet, with a straight center part and angle arms at the ends. The transmitters, with the mounting lugs horizontal, were fasttened to the angle arms, while the straight center section was secured to the top of a wooden stand.

Tests show that the modulation was improved by a sound box around the mouthpieces. Accordingly, a piece of light leather was wrapped around them and sewed together at the bottom and between the mouthpieces at the rear.

The switch on the stand is to open or close the battery circuit.

The Manufacture of Artificial Silk from Cotton Waste and Wood Cellulose

By Werner A. Schildknecht, A. S. E. E.

THE transformation of cotton and wood cellulose into lustrous silk is one of the triumphs of modern chemical science. On account of the high cost of natural silk, many attempts have been made in the desire to find a substitute for silk. The endeavors of the pioneer experimenters have paved the way to later research, and within a brief space of time a new industry has sprung up which is taking its place in the ranks of modern chemical enterprises. A new material has been added to the textile industry—artificial silk. A brief description is given in the following paragraphs of the history, manufacture, properties and uses of artificial silk.

In order to understand the difference between artificial silk and the natural product we will first see how the silkworm produces the thread. On each side of the silkworm's body there is a bag containing a sticky liquid. When the worm decides to go into his long sleep, from which he will come out as a moth, he begins to force this sticky liquid from two tiny holes under his lip. On coming in contact with the air, the little threads harden into a strong fiber-silk. The worm spins almost continuously until he has enveloped himself with a cocoon. There are usually four hundred yards of this costly fiber on an average sized cocoon. These are collected, boiled, the fiber is reeled off, washed, bleached and dyed. The artificial method is almost like the one used by nature, intricate apparatus taking the place of the silkworm.

The first mention on record of an attempt to make artificial silk dates back to the year 1734. In that year a French scientist, Reaumur, experimented with certain lacks and varnishes, which he forced through small holes in a steel die. The resulting fibers were silklike in appearance, but no commercial use was made of his invention. The subject lay dormant until Andemars, a Swedish chemist, developed a process for making artificial silk in the year 1855. He dissolved wood cellulose, obtained from mulberry trees, in a mixture of alcohol and ether. The threads after having been forced through dies had a silky luster; practically the same process is used to-day, substituting cotton cellulose and a great variety of wood cellulose for that obtained from the mulberry tree. Twenty years later, J. W. Swan, an Fnglishman, discovered a method. He dissolved guncotton in alcohol and ether, passed the pulp through fine holes, and hardened the threads by passing them through water. This product was very inflammable, however, and Swan's experiments were a failure commercially. Soon after Andemars made his discovery, Count Hilaire de Chardonnet, a Frenchman, began to investigate. He used cheap cotton to make the pulp. After much experimenting a factory was started at Besàncon. He achieved success in making the product and some of the finest artificial silks are at the present time made by his process. Chardonnet lived to see his invention a commercial possibility. In the year 1899 several silk gowns were exhibited at the Paris exhibition made from silk manufactured at Chardonnet's factory. This silk was not only non-explosive but even less inflammable than the natural variety.

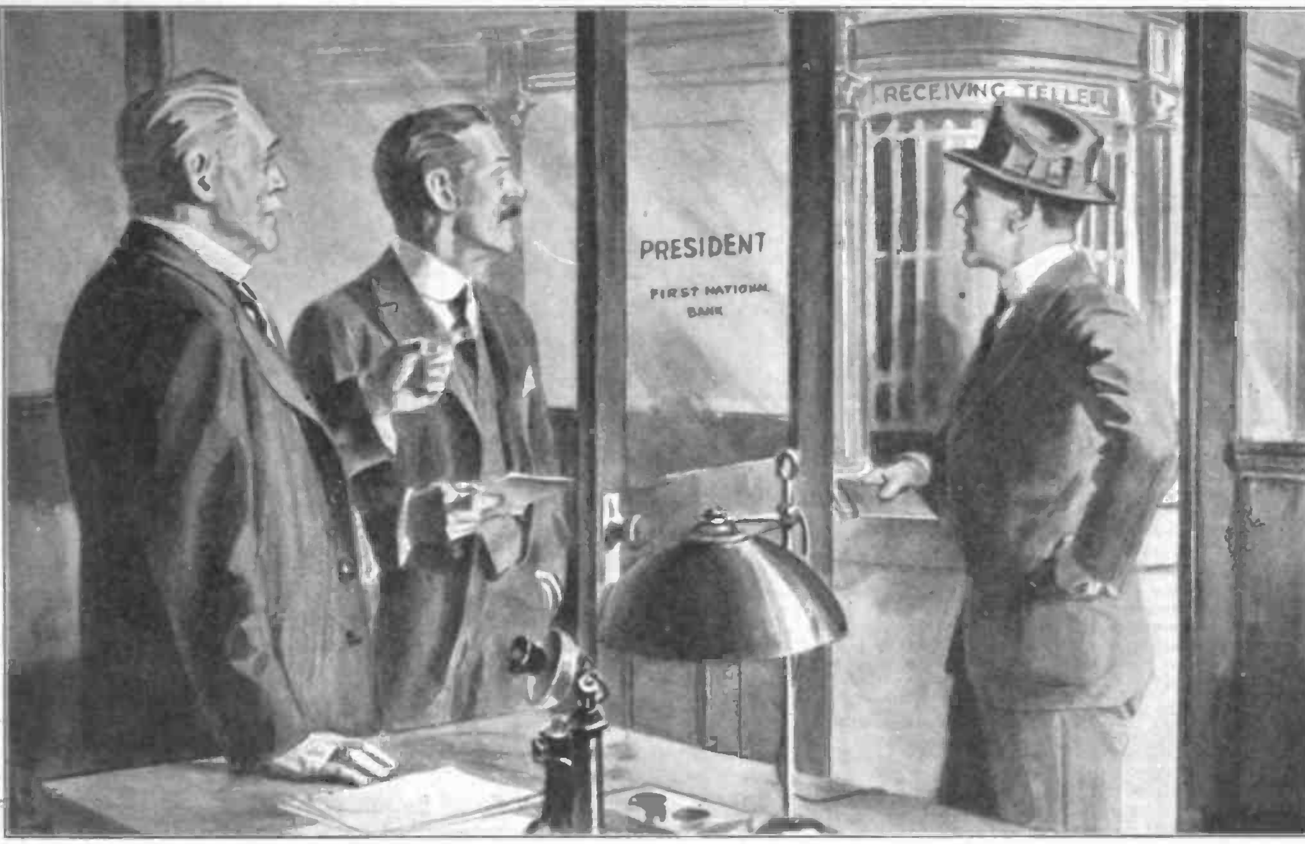
The Chardonnet process as practiced to-day is as follows: Bleached cotton waste is converted into nitro-cellulose by treatment with a mixture of sulphuric and nitric acids. This product is dissolved in a mixture of alcohol and ether. The resulting substances is called collodion. It is filtered and placed into a reservoir. From here the collodion is forced through capillary glass tubes, .08-.08 m.m. in diameter, under a pressure of 650 pounds per square inch. It issues in the form of minute threads. This operation is carried on in a warm chamber. The alcohol and ether evaporate, are recovered and thus used over and over. The threads as they issue are conveyed to a spool and ultimately a skein of lustrous silk is formed. In this condition, however, the substance is still more or less explosive and before any other operations are performed it must be denitrated. The threads are passed through a solution of ammonium hydrosulphide. This process renders the silk uninflammable. Then the material is washed and dried and is ready for dyeing. The threads are impregnated with coloring material and are then ready to be woven into cloth. They possess a high luster, great elasticity, and are capable of taking very delicate tints. The above process is used chiefly in France and many tons of the silk are manufactured there annually.

Another process in use is called the cuprammonium process. This consists in dissolving cotton cellulose in Schweitzer's reagent (ammoniacal cupric oxide). The pasty product is compressed in cylinders and the threads are forced out in thin streams. The fibers are hardened by being passed through acetic acid. They are then bleached with chloride of lime, washed and dyed. This silk was manufactured in large quantities before the war at Elberfeld, Germany. It is now being successfully produced in the United States. The annual production of silks made by this process is about 3,000,000 pounds.

The viscose process is one of the latest developments in the manufacture of artificial silk. In this process wood pulp is treated with a strong caustic soda solution. The cellulose thus obtained is treated with carbon disulphide. The resulting mass is called viscose. It is dissolved in water, filtered and exuded through capillary tubes. The threads are at once passed into a fixing solution of either ammonium chloride or ammonium sulphate. Here the filaments harden and are then subjected to heat when they are ready to be bleached and dyed. This variety of silk is one of the most popular of the artificial silks. In luster and tensile strength it compares very nearly with natural silk. Its quality is somewhat better than either the Chardonnet or cuprammonium silks, while the cost of manufacturing it is less. A large factory near Philadelphia, Pa., manufactures this type of silk. It is called wood silk, or pyroxylin silk.

A process which has lately come into use is to spread the pulp over a large flat surface, roll it out thin and engrave the thin sheet of silk with rollers. In this way the material can be given the appearance of having been woven. The resulting fabric is in great demand, as the cost is quite low, while the appearance and service are excellent.

Artificial silk to-day is taking the place of the natural product for making all kinds of ribbons, neckties, and for such trimmings where a high luster is desirable. Large quantities of it are used for covering electric wires. It is estimated that the quantity of artificial silks used in the United States is nearly 20% as great as the quantity of natural silk. Its cost is about one-half that of the natural product. It varies in price from $1.50 to $2.00 per pound. An average spruce or pine tree yields about $50.00 worth of wood pulp, which converted into viscose and spun into silk is worth approximately $5,500.00. Several factories are at the present time engaged in the manufacture of artificial silk and their product compares favorably with the best of European silks.



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NEW BOOKS

Behind the Motion Picture Screen, by Austin C. Lescarboura. Size 6¼ x 9 inches; bound in cloth; 420 pages printed on plate paper and illustrated with over 300 half tones. Published by the Scientific American Publishing Company, 233 Broadway, New York City.

Before passing on to the contents of this book, it might be well to inform the reader that its author, Mr. Lescarboura, has been a careful student of the subject it treats for a number of years and he does not write from the standpoint of the man who struggles to fill space with a subject he knows little or nothing about.

"Behind the Motion Picture Screen" is a book that explains every phase of the motion picture industry. Although non-technical in its tone, it thoroughly covers, in carefully selected terminology, all of the interesting work in connection with motion picture production. Not even the smallest detail that would have any interest to the layman seems to have escaped the searching mind of the author. Everything is presented in a delightful way; it is enjoyable reading matter from the first page to the last. The author's smooth, easy style adds tremendously to the information his words impart to the reader.

The book is divided up into the following chapters: I. Working Plans of the Motion Picture, II. The Artist Who Paints the Film Subjects, III. The Real Role of the Picture Actor, IV. The Motion-picture Camera, V. The Cameraman and His Art, VI. In the Land of Make Believe, VII. The Birth-place of the Motion Picture, VIII. The Generals of Shadowland, IX. Tricks of the Screen, X. From the Camera to the Screen, XI. Reporters of the Screen, XII. Putting It on the Screen, XIII. Pictures in Natural Colors, XIV. Filming the World Invisible, XV. Pictures That Talk and Sing, XVI. Cartoons That Move and Sculpture That Lives, XVII. Motion Pictures in Strange Fields, XVIII. Motion Pictures in the Home and Business, XIX. The Present Status of the Motion-picture Art, XX. The Future of the Motion Picture.

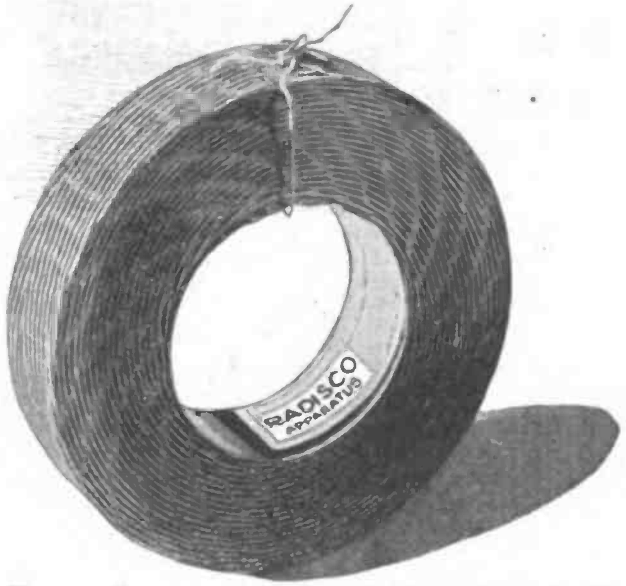
The technician will be particularly interested in the latter part of the book which tells of some of the real scientific achievements made possible through the motion picture. For instance, Prof. Bull's experiments with high-speed motion photography at the Marsey Institute in Paris are completely described. Motion picture photography through the microscope is also a very absorbing subject which the author did not forget. Motion picture photography by the aid of X-rays is another phase of the subject which is treated. Natural color photography, cartoon production — all are included in this noteworthy treatment.

Abrasives and Abrasive Wheels, Their Nature, Manufacture and Use. By Fred B. Jacobs. 321 pages, with 175 line cuts and half-tone illustrations. Size 5½ x 8½ ins., bound in cloth. Published by the Norman W. Henley Publishing Co., 2 West 45th Street, New York City.

During the past few years the modern abrasive wheel has assumed a very important part in the industry of the world. Its application has grown to a point where it is absolutely indispensable.

This book completely covers the application of abrasive wheels and abrasive substances to industrial purposes. The treatment is general in every respect and, unlike its forerunners, the book does not specialize on any one abrasive process, but rather contains a complete treatment of them all. The first chapter is devoted to natural abrasive substances and includes a description of sandstone, emery, corundum, diamond, garnet, quartz, flint, tripoli and pumice. The second chapter treats modern artificial abrasives and their physical and chemical properties. Carborundum, Aloxite, Crystolon, Alundum, Bauxite, Boro-carbone, Oxalumina and Adamite are included in the chapter. Not only is the use and nature of such substances given, but also the method of their manufacture. The third chapter is devoted to the manufacture of grinding wheeels and the data set forth will give the reader a very broad education in the general nature of ordinary grinding wheels. Chapter five describes grits and grades and knowledge along this line is absolutely essential to one who is connected with grinding work. To understand the grit and grade of a wheel is to understand its physical nature and what may be expected of it as regards cutting efficiency, etc. The chapter on testing wheels for efficiency gives some very valuable data that will be of extreme value to factory superintendents and managers, as well as purchasing agents. Laboratory tests are described and a chapter is also included on grinding wheels vs. grindstones, but of particular interest is the chapter on the economic advantage of using large wheels. This contains some actual figures that will be of great interest to large users of abrasive wheels. The argument set forth in regard to the advantage of large wheels includes some facts that would ordinarily escape the attention of purchasing agents. Chapter ten is devoted to truing devices for grinding wheels, while chapter eleven describes the process of rebushing grinding wheels. The design of dust collecting systems is treated in detail and many valuable suggestions given, together with photographs of actual collectors. Safeguarding grinding wheels forms an important chapter of the book and safety engineers would do well to examine its contents. It tells

(*Continued on page* 349)



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That the RADISCO COILS are superior to any similar type of inductances is the opinion of several well known radio men who have received signals from very remote stations.

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ATLANTIC CITY, N. J.: Independent Radio Supply Co. 118 So. New Jersey Ave.

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BOSTON, MASS.: Atlantic Radio Co., 34 Batterymarch St.

BROOKLYN, N. Y.: Kelly & Phillips Electric Co., 312 Flatbush Ave.

BRONX, NEW YORK CITY: Amateur Wireless Equipment Co. 1390 Prospect Ave.

CHICAGO, ILL.: Chicago Radio Laboratories, 1316 Carmen Ave.

HAMPTON, N. H. De Lancey Felch & Co.

LOS ANGELES, CALIF. The Wireless Shop 511 W. Washington St.

McKEESPORT, PA.: K. & L. Electric Co., 427 Olive St.

NEW CASTLE, PA.: Pennsylvania Wireless Mfg. Co., 507 Florence Ave.

NEWARK, N. J.: A. H. Corwin & Co., 4 West Park St.

NEW ORLEANS, LA.: L. A. Rose, 4323 Magnolia St.

PITTSBURG, PA.: Radio Electric Co., 4614 Henry St.

PHILADELPHIA, PA.: Philadelphia School of Wireless Telegraphy, Broad and Cherry Sts.

PROVIDENCE, R. I.: Rhode Island Electric Equipment Co. 45 Washington St.

SCRANTON, PA.: Shotton Radio Mfg. Co., P. O. Box 3, also at 8 Kingsbury St., Jamestown, N. Y.

SPRINGFIELD, MASS. Electric Service Co. 585 Armory St.,

TORONTO, ONTARIO, CANADA: The Vimy Supply Co. 585 College St.,

WASHINGTON, D. C.: National Radio Supply Co. 1405 U St., N. W.

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Readers Workshop Page

(*Continued from page* 293)

mers, saws and many other things.

"I made a lathe on which I use the chuck from the bench drill. I find it very useful in winding coils, transformers and light lathe work.

"I value my shop at about one thousand dollars, and am spending all I make from it for tools and new equipment.

"I am eighteen years old, and for the last four years have been collecting and making apparatus which I now have.

"I obtained most of my material from scrap heaps and the junk yards. This is the second shop I have built and I believe it is nearly complete. A good work-shop at home is the best thing in the world for an industrious young fellow. You will always find a proud boy, with plenty of friends to help him, when he can say 'I made it.'

"His shop can lead him to be an inventor, electrical engineer or contractor, besides merely a 'shop tinker'."

A description of the laboratory shown in the middle of the page follows:

"The electrical power plant of my laboratory is a six-volt, eighty-ampere hour storage battery, located in the lower left-hand cabinet. My main experiments are in electro-chemistry, dye stuffs and explosives.

"My equipment is all home made, excepting the glassware. The small gas furnace I made out of 16-gauge iron and lined it with asbestos, three-eighths thick. The cabinets I also made in my small wood-working shop. I could not get a picture of my shop, owing to the nature of the building it is in, but here is a list of what it contains: One speed lathe, jig-saw, rip and cut saw, disc turning machine, emery wheel, and small drill press. My motive power is a 1½ horsepower gas engine."

Writing on Metals

Cover the plate you wish to mark with melted beeswax which can be done by heating the plate slightly and rubbing the surface with wax. When cold write whatever you wish to inscribe plainly with a stylus, taking care to go clean through the wax right down to the metal. Make an etching fluid to the proportions of which put one ounce muriatic acid and 16 ounces of nitric acid by weight. Mix and shake well together; apply the mixed acids with a feather, carefully filling each letter. Let the acid remain in contact with the metal for a period of 1 to 10 hours, according to the depth of the etching desired, then stop the process by washing the plate with water and removing the wax. The design will be found clearly etched on the metal surface.

Iron Paint

A paint intended for covering damp walls, kettles, or any vessel exposed to the action of the open air and weather is made of pulverized iron and linseed oil varnish. If the article is exposed to frequent changes of temperature, amber varnish and linseed oil varnish should be mixed with the paint intended for the first two coats without the addition of any artificial drying medium. The first coat should be applied rather thin, the second a little thicker and the last in a rather fluid state. The paint is equally adapted as a weatherproofing for stone, iron or wood.

Lacquer for Bright Steel

A cold lacquer that requires no stoving for steel is made as follows: Mastic resin, 8 ounces; camphor, 4 ounces; spirits of wine, 1 quart; sandarach resin, 12 ounces; gum elemi, 4 ounces. Digest, filter and use the lacquer cold. The consistency of the lacquer may be varied by adding more or less alcohol.

Slipping Belts

A piece of beeswax held against a loose, slipping belt will cause it to grip the pulley like a tight belt. The wax is applied while the belt is in motion.

3 inch Dial only..............75 cents
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3 inch Dial with Knob mounted...$1.30
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These dials are of fine black polished composition with radial lines and figures accurately engraved and filled with brilliant white. Diameter of dial is 3 inches and they are 3/16 inch thick. The edge is bevelled. The hole in the center will pass 8-32 screw and there are three holes around the center hole to fasten on knob. (These holes are not shown in cut.) We can furnish dial alone or with fine Bakelite Knob mounted. This knob has a set screw to clamp shaft of instrument to which dial is to be applied.

If your dealer cannot supply you send us his name with your order. Immediate deliveries.

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Laminated closed core, two coil type

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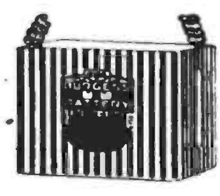

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LOMBARD Box 442 ILLINO

Supercharging Aviation Engines.

(*Continued from page* 301)

very little weight and head-resistance will be added.

The uses of the supercharger for military service can be divided into, first, for airplanes in which it is desired to reach extreme altitude; second, for airplanes in which it is desired to increase the rate of climb and horizontal speed, and therefore maneuverability at altitudes where it is intended to fight; and, third, for airplanes which carry large loads, such as bombers, which normally are handicapped by having a very low ceiling and whose entire usefulness would, if larger engines were installed to pull them to a higher ceiling, be lost on account of the larger amount of fuel and other material that would have to be carried, thus decreasing their radii of action.

The application of superchargers in commercial airplanes of the future seems assured because superchargers will make possible for more miles per hour and more miles per gallon with a given engine and airplane, and speed is the main advantage of air over other kinds of transportation. It is thought by many qualified judges that by flying at a sufficient height with a supercharged engine and a suitably designed airplane, a speed of 200 m. h. p. can be maintained.

In the heavy load-carrying type of plane which must necessarily cross mountains or perhaps fly above storms and clouds, the necessary height can be reached with smaller, cheaper and more economical engines if they are fitted with superchargers. It is obvious that in really long cross-country flights or trans-continental flights with mail or passengers, the logical course is to fly at 25,000 or 30,000 ft. altitude where the resistance to speed is low and great speed can therefore be attained provided the engine can deliver high power economically, which it can do if equipped with a supercharger.

As a graphic illustration of the advantage of a supercharged engine, it is pointed out that at 25,000 ft. altitude a supercharged 250-hp. engine will deliver as much power as a 1000-hp. engine without a supercharger; and, of course, the former will weigh many hundred pounds less, its fuel and tankage will weigh very much less, the first cost will be much lower and the structure of the airplane can be made much lighter.

EDITORIAL NOTE:—Serious attention was given to this problem in Europe and early in 1915 the French authorities inaugurated a series of experiments to determine a method of maintaining constant atmospheric pressure in the carburetor regardless of altitude. In this country, however, nothing was done on this problem until our entrance into the war made it imperative. This neglect was inevitable because of the lack of interest in aviation matters on the part of the authorities and legislators in this country, so we are really trailing along behind the French, British and Italians in this important development work, just as we are in general aeronautical progress. Each of the nations mentioned have carried out experimental work on supercharging independently of the others. It is a striking indorsement of the turbo-supercharging scheme, as first worked out by Prof. Rateau in France, that at the present time this method is most in favor with all experimenters after other systems have been given exhaustive trials. This applies as well to European development work, which was begun two years before our own. Work in this country has practically all been with the Rateau system, modified mechanically in details but still preserving the same principles of operation as first advanced and tried by Rateau. Suffice it to say here that the Rateau system so far appears to have the most advantages.

Supplementary illustrations at Figs. 6A and B shows the gear drive system at A and a simplified exhaust turbine cycle is shown at B. The original Rateau turbine design is shown at Fig. 7 and it will be apparent that it is the basic type from which other superchargers of the later development have been adapted.

The exhaust-gas turbine offers considerable that is of advantage as it can be connected direct with the exhaust ports of the engine by special pipes replacing the standard manifolds so that all the products of combustion must pass through the exhaust turbine nozzles and give up its energy to the motor and the driven impeller of the into the atmosphere through the discharge passage. In the designs which have been tried thus far, the driving rotor and the driven impeller of the centrifugal compressor are mounted on the same shaft. The building of the turbine and compressor as a unit results in an exceedingly compact machine, which in most instances can be mounted directly on the front of the engine as has been done in the application to the Liberty engine shown at Fig. 3. The possibilities of the supercharged engine opens up a new field for aircraft development, as Major Hallett has so clearly brought out in his paper.—*Victor W. Pagé.*

Simple Experiments In Science For Beginners

(*Continued from page* 303)

substances. In the case of liquids, the degree of compressibility is very small compared with solids. For all ordinary pressures, water is absolutely incompressible. This can be shown by the simple device sketched in Fig. 4. A small bottle is clamped between two boards by means of two long bolts. A plunger passes through the top board and fits snugly into the mouth. When the plunger is forced down into the mouth of the bottle with the application of considerable force the bottle will burst.

Another very interesting experiment can be performed by the aid of two small pieces of cloth, one black and one white. It is claimed that white clothes are much cooler in the summer time than black clothes. There is a scientific reason for this assertion. It is known that heat waves can be reflected just as light waves can be reflected. White always reflects heat waves while black absorbs them. Therefore, it is really true that black clothes are warmer than white clothes because they absorb heat waves. This fact can be proven by a very simple experiment. On a cold day, when the sun is shining, the piece of black and white cloth previously mentioned are laid on top of the snow in the sunshine. After a few minutes the snow under the black piece of cloth will be melted while the snow under the white piece of cloth will remain frozen. This proves beyond all reasonable duobt that the black piece of cloth actually absorbed the heat waves and melted the snow underneath, while the white piece reflected the heat waves and protected the snow underneath.

A very interesting experiment can be carried out by melting glass in the flame of a torch and allowing it to drop into a bath of cold water. This will result in the formation of little drops of glass with a long tail. When the end of this tail is pinched with the fingers, the entire piece of glass will be shattered into tiny bits. This results, owing to the state of molecular stress which was caused by the sudden cooling of the molten glass. These drops are called Prince Ruperts Drops.

Origin of "Watch Your Step"

FROM an analysis of nearly ten thousand accidents recently reported by manufacturers, chiefly electrical, in the United States, the highest percentage of those that occurred outside the companies' premises were attributed to slipping, tripping and falling, hence the origin of "Watch Your Step." This means that the greatest danger lying in wait for a man in his hours of leisure is the pavement beneath his feet. The highest percentage of falls came from those occurring on the level, while others came in the following order of seriousness: From elevations, from ladders, over obstructions, on stairs, from poles, into excavations, from temporary supports and from scaffolds.

On the companies' premises, "handling material" comes first. Accidents from electric current—from shock, burns, eye-flash—rank fourth in a list of eighteen classes of accidents. Only .7 per cent of all the accidents reported were due to exhaustion from heat, which seems strange—one imagines that more suffer from heat prostration than is actually recorded.

From a general consideration, injuries to fingers were highest, eyes next, and ears last in a classification of thirty-five anatomical locations. From the standpoint of occupation, linemen ranked first and carpenters lowest.

Perhaps the most interesting classification is that which considered the length of service. Of all the accidents reported, 25.9 per cent, or the highest single percentage, had all been in the employ of the companies less than six months. Those veterans of over twenty years' service contributed only 1.1 per cent to the casualty list.

To determine the seriousness of the various causes of accidents, by consideration of the number only, resulting from each cause, is misleading. While only 8.3 per cent were injured by electric current, these accidents were responsible for over 70 per cent of the total lost time, and 70 per cent of the serious and fatal accidents. The fact is, however, and it is encouraging, that 75 per cent of this class of accidents are preventable when the proper safety devices, such as enclosed switches, rubber gloves, etc., are installed, while falling will continue as long as man fails to "Watch His Step."

Writing on Glass

The glass should be warmed to 120° and not more than 140° F., or until no more vapor is evident. The surface of the hot glass should be bathed with the following varnish, taking care to move the plate just as if applying collodion in photographic work. The varnish is made of 5 grams mastic in sheets, 8 grams dammar and 80 grams of 90% alcohol. The solution is made in a firmly corked bottle then water bathed and filtered. This varnish is very brilliant, hard and transparent. After the varnish is dry, drawings in India ink can be made on the surface, and this method can be followed for marking bottles, making lantern slides or for photographic purposes.

Drilling Job.—Sometimes tapped screw holes require that the lower part of the holes should be larger so that there will be no thread in that part of the hole. It may be impossible to approach that part of the holes from the bottom. Special boring bars are used when the hole is large. If the hole is small, drill the first part of the hole to the required depth that is to be the drill diameter, then take the same drill and grind off one of the cutting sides, throwing the point of the drill out of center. This will increase the diameter of the lower part of the hole in a ratio corresponding to the eccentricity.

Electric Oven Efficiency

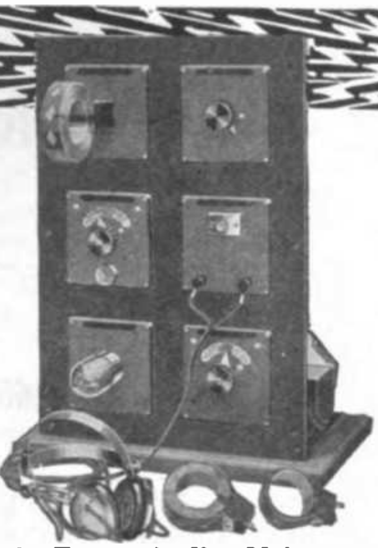
THE *London Electrician* reports some recent tests of electric ovens. They were coated with non-conducting material, and the door fitted in a wedge-like seat or jamb, so as to save all possible waste of heat. It took 28 minutes to get a temperature of 350° F, which was rated as a cooking heat. Then 10½ lbs. of roasting beef were put in, and the oven in the next 12 minutes showed a temperature of 394°. All the switches were now shut off and the meat was left to cook by the heat present, fireless cooker fashion. It was sufficiently cooked without any more current being turned on. In the 35 minutes of heating and cooking 3 kilowatts was the rate of expenditure of electric energy; of course for the actual cooking, as the meat only was acted on by the current for 12 minutes, this reduces to 1¾ kilowatts. The expression "hay-box" is used in the English journal in referring to the insulated construction of the oven —this where we would say fireless cooker.

Electric heating in technology is applied among other uses to japanning, to Sherardizing iron, to core ovens and to the expanding of gun-sections for shrinking. In Sherardizing, iron is bedded in zinc dust and zinc oxide in powder, as usual. The heat is brought up to 700° F. When the metal object in its dust packing is thoroughly heated a lower heat is maintained for two or three hours, when the heating current is cut off. As soon as the temperature falls to 50° the oven is opened and the work is taken out. For gun-shrinking operations a temperature of 700° to 1000° is required.

Electric Hand-Lamp

A FOREIGN electrical firm has produced a novel electric hand-lamp, which is claimed to be cheaper to operate than lamps fitted with dry cells or small storage battery. The source of current is a cell with lead superoxide and zinc plates immersed in sulphuric acid, which combination gives 2.45 to 2.5 volts. The body of the lamp is supported on a trunnion so that it can be tipped through 90°. In the position of rest the liquid lies in a protruding chamber, the plates being thus lifted out of the electrolyte. When the lamp is required the body is tilted so that the liquid flows back so as to immerse the plates. When the lead plate is discharged it is replaced by a charged one, which may be kept ready charged in store for a lengthy period. The charging of these plates is carried out very cheaply at depots. They will give 25 hours' burning with one charge and be charged 100 to 150 times. The charging of the lead plates cost about one cent per hour of burning. The lamp will burn about 25 hours on one charge and is very economical.

DE FOREST



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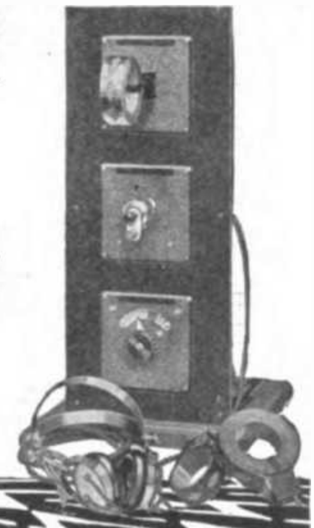
FOR the Radio beginner, or even for the experienced Amateur, here is the simplest, most satisfactory and least expensive way to secure reliable, efficient and scientific Receiving Apparatus. We have just completed two new Unit-System Receiving Sets, specially designed to give beginners and others complete outfits of the most advanced type, designed for greatest efficiency and offered as complete outfits containing everything required to set up and operate a Radio Receiving Station. Both Sets are part of the de Forest Unit-System and more advanced apparatus may be added at any time without discarding previously purchased units.



de Forest Audion-Unit Radio Receiving Station
(6-panel set illustrated above)

A larger and wider range Set with Audion Detector and large assortment of "Honey-Comb" Coils, giving wider receptive facilities. 6-panels in all, with all necessary apparatus and supplies, including "B" Battery. Arranged for expansion when the owner desires.

de Forest Simplified Radio Receiving Station
(3-panel set illustrated at right)

Also complete in every detail, including short, medium and long wave-length de Forest "Honey-Comb" Coils, Detector, Condenser, Head Telephones, Antennae Wire—everything needed to set up and operate an efficient Receiving Station. Complete instructions for assembling and operating included.

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Secondary Calibration, LRD-1200 Coil Coupling Fixed at 2½ Ins.
Primary Condenser, Murdock 0.001 MFD. Max. Secondary Condenser, Clapp-Eastham 0.001 MFD. Max.

Cond. Degrees	Wave-Length	Station
10	4,000	XDA
13	6,000	MFT
14.5	7,400	GB
17	8,400	NPG
20	9,000	UA, NWW
22.5	9,500	LCM
28	10,500	YN
31.5	11,000	IDO, UA, NPM
34.5	11,500	NDD
41	12,200	POZ
45.5	13,000	NPL
51	13,700	NFF
55	14,000	MUU
69	15,200	YN
82.5	16,700	NSS

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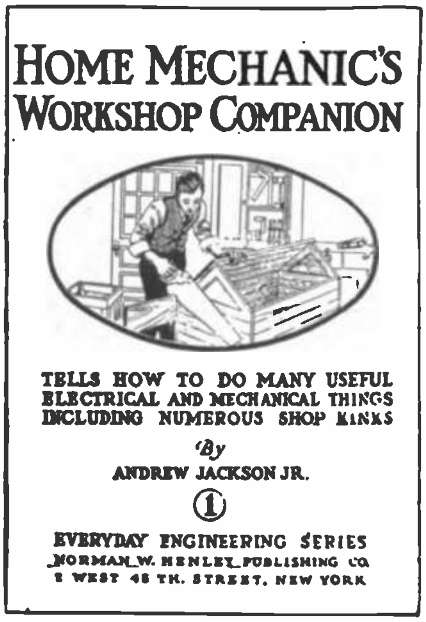

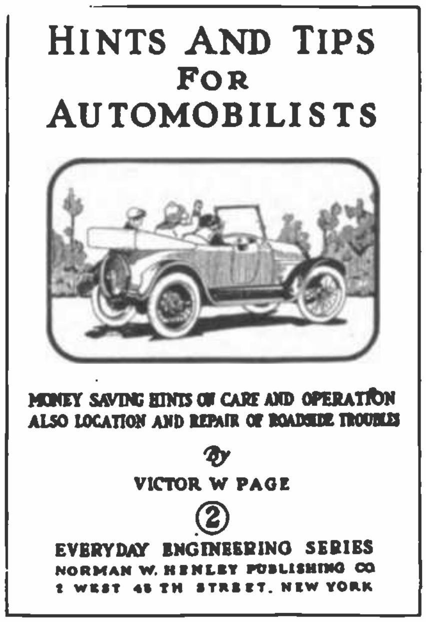

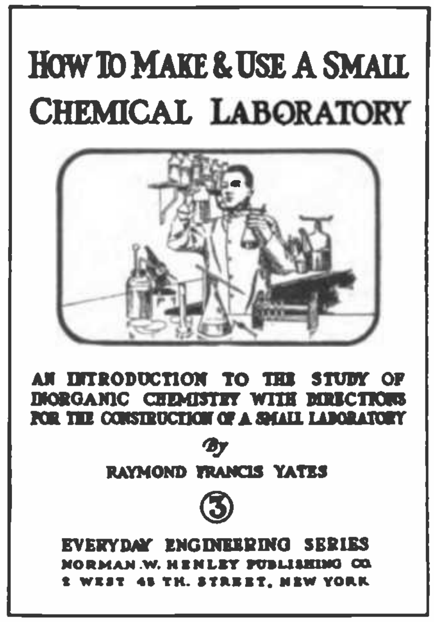

For the Handy Man in the Home or Shop

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

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

The subject matter is divided in five parts as follows:

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

For the Automobile Owner or Driver

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

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

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

For the Student Chemist and Experimenter

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

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

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

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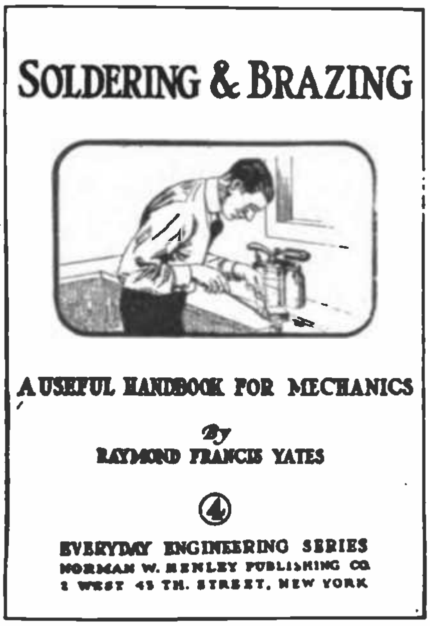

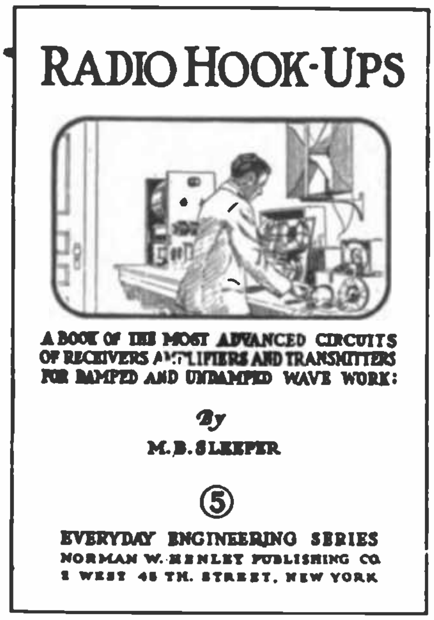

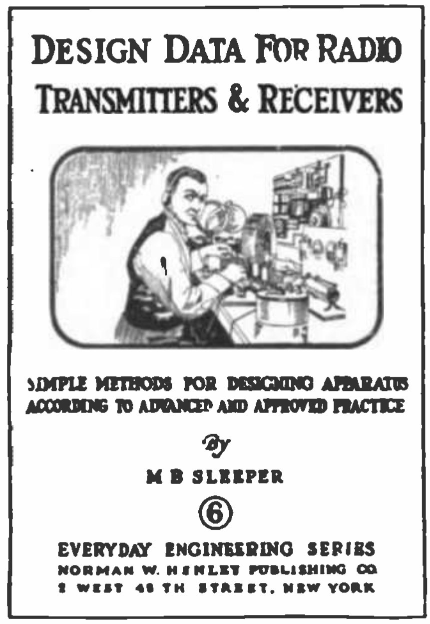

For the Mechanic and Model Maker

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

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

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

For the Radio Experimenter and Amateur

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

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

For the Radio Engineer and Student

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

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

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PAINTING WITH A GUN

THE modern method of applying various kinds of points and other protective coatings by the use of compressed air is rapidly superseding the old hand-brushing method, not only by reason of the great saving in time and labor, but also due to the fact that better results are obtained.

There is hardly a comparison between pneumatic painting and the old-style way. One handy workman, for instance, can do the work of three to twelve or more skilled painters using hand brushes, depending upon the nature of the work. Uniformly finished coatings free from streaks and brush marks are produced. Rough, irregular surfaces and those inaccessible or difficult to reach with a brush are readily coated. Where single coat work is required, either a lighter or heavier coating can be obtained than is possible with hand brushes. The gun, for such is the usual name of the pneumatic painting device, may be quickly mounted on an extension pole attachment for painting surfaces beyond the reach of the operator. The air-tight material container prevents the formation of paint skins, and makes it impossible to combine dirt with the paint. These are but a few of the leading advantages of the pneumatic system of painting.

Pneumatic painting equipment consists of a container; a flexible, metal-lined hose; a heavy rubber air hose; and the paint gun or nozzle member. Some materials require continuous agitation in order to keep the heavier parts in suspension, and for this purpose an agitating attachment is employed. This device is screwed into the main air port in the bottom of the control head. The agitating is done by air, which, after passing through this attachment and bubbling up through the paint, is allowed to escape through the bleeder valve in the control head. When using certain varnishes and enamels, on the other hand, it has been found that, in order to obtain the best results, the air should be heated before it reaches the gun. If this is done and the material is also heated before being placed in the material container, a perfectly smooth coating can be obtained. For this purpose an electric heating attachment is sometimes used with a pneumatic painting equipment. This attachment may be operated from any ordinary electric light socket. It is so designed that it may be turned on at the same time as the gun trigger is pulled by the natural grip of the hand.

Compressed air for the paint gun is generally supplied by a compressor unit which may serve several paint guns at one time.

Today paint guns are employed to a very wide extent. In many industrial establishments they are employed for all kinds of painting. In the production of explosive shells during our participation in the world war, the old inefficient method of applying protective coatings by dipping, pouring and swabbing, was dropped in favor of pneumatic painting.—*Compressed Air Magazine.*

SOLDERING GASOLINE TANKS

Two fatal accidents due to the explosion of so-called empty drums which had contained petroleum were reported to the Government (British) Inspectors of Explosives during the past year. In one case the drum had but recently been emptied, but in the other steps had been taken to remove all trace of petroleum by thoroughly washing out and rinsing the drum. The victim of the explosion, an experienced chemist, then put a light to the bunghole, either to prove that no inflammable vapor remained or to burn out the residue, and a violent explosion followed. This accident is one more indication of the difficulty of rendering safe a vessel which has contained petroleum spirit, owing to the density of the vapor, which is about two and a half times as heavy as air, and to the very small proportion of vapor required to make an explosive mixture with air.

WATER INJECTION AND ENGINE PERFORMANCE

A SHORT investigation has been conducted at the Bureau of Standards to determine the effect of water injected into the intake manifold of an internal combustion engine. This investigation was carried out on two different engines, truck and automobile, but the results in general are such as to apply airplane engines.

The first series of tests was conducted to determine whether the use of water injected into the intake manifold has any effect on the horsepower output and fuel economy; the second series to determine the effect upon the carbon deposit on the cylinder walls and piston heads.

The data obtained indicate that in an engine of good design there is no appreciable gain in power or fuel economy due to the injection of water, but in a badly carbonized or a poorly designed engine, where hot spots due to improper cooling are present, a slight increase in power may result. If enough water is used, it will remove a small portion of the carbon but will cause at the same time a considerable reduction in the operating efficiency of the engine.

The maximum amount of water used in these tests was limited to that which did not materially interfere with the normal operation of power output of the engine and the results do not indicate the value of much larger quantities of water as injected under special conditions solely as a carbon removing agent.

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Chord	4 Ft.
Wind area with ailerons	206 Sq. Ft.
Gap between planes	4 Ft. 3 in.
Overall length	18 Ft. 11 in.
Overall height	8 Ft. 1 in.
Dihedral	3 degrees
Stagger	8 in.
Incidence	4½ degrees
Rudder area	6½ Sq. Ft.
Fin area	2½ Sq. Ft.
Stabilizer area	20 Sq. Ft.
Elevators (2) area each	8 Sq. Ft.
Wing section R A F	No. 6
Engine	35 H. P.
Propeller	6 Ft. 6 in., 3 Ft. Pitch
Weight empty	450 lbs.
Speed	30-85 M.P.H.

PERFORMANCES:

Maximum speed	35 H.P.	85 M.P.H.
	24 H.P.	70 M.P.H.
	18 H.P.	60 M.P.H.
Minimum speed		30 M.P.H.
Maximum Climbing Speed	35 H.P.	820 Ft.
	24 H.P.	530 Ft.
	18 H.P.	330 Ft.
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Useful load		225 Lbs.

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THE CEILING OF AN AIRPLANE

THE power required to sustain an airplane in the air varies inversely as the square root of the density of the air. For instance, at an altitude of 18,100 ft. the density—calling that at sea level 1.00— is only 0.50. Therefore, if the power required to sustain the airplane at sea level is denoted by 1.00, that required at 18,100 ft. is $1/\sqrt{0.50} = 1.414$. At the same time that the power required to sustain the plane has increased 41.4 per cent., the maximum power of which the engine is capable has decreased substantially 50 per cent. The ceiling of a plane therefore is limited by the increase in the power required for its support and a decrease in the engine power output with augmented altitude. By means of superchargers it may become possible in the future to eliminate the latter factor to some extent, but there is no known practical expedient for increasing the supporting value of the air under the wings as it becomes thinner. It has been suggested that variable surface aerofoils be used so more wing surface will be available in thin air and be reefed in at lower altitudes where the air is denser.

RESISTANCE OF NOSE RADIATORS

EXPERIMENTS were carried out on a model fuselage 60 in. long, 10 in. wide and 13 in. high, to determine the effect of placing a radiator in the nose of a fuselage as compared with the effect of placing a radiator of the same core construction, having an equivalent cooling capacity, in the free air and streamlining the nose of the fuselage.

The following conclusions were drawn from the experiment:—

(1) The resistance of a fuselage with streamline nose is increased more by removing the streamline nose and substituting a radiator than it is by adding an equivalent free air radiator and retaining the streamline nose.

(2) Between good radiators for each position the increase of resistance due to the nose radiator is roughly double that due to the free air radiator.

(3) Above a very low mass flow, the nose radiator becomes relatively worse and worse as the mass flow is increased by opening the vents at a constant free air speed. This fact is of great importance, since the space available for a nose radiator is so limited that the highest possible mass flows are used in practice.

(4) It is found that the relative efficiency of the nose radiator and the free air radiator does not change appreciably with free air speed for a given setting of the vents. (*Aerial Age Weekly.*)

Principles of Rotary Engines

(*Continued from page* 269)

secured to the pressed steel carriers of the engine, and runs far enough back so the pilot can crank the engine. The oil tank may be connected with the air-pressure line, so that the suction of the oil lamp is not depended upon to get the oil to the pump. From the bottom of the oil tank a pipe leads to the pump inlet. There are two outlets from the pump, each entering the hollow crankshaft, and there is a branch from each outlet pipe to a circulation indicator convenient to the operator. One of the oil leads feeds to the housing in the thrust plate containing the two rear ball bearings, and the other lead feeds through the crank-pin to the cams, as already explained.

Owing to the effect of centrifugal force and the fact that the oil is not used over again, the oil consumption of a revolving cylinder engine is considerably higher than that of a stationary cylinder engine. Fuel consumption is also somewhat higher, and for this reason the revolving cylinder engine is not so well suited for types of airplanes designed for long trips, as the increased weight of supplies required for such trips, as compared with stationary cylinder type motors, more than offsets the high weight efficiency of the engine itself. But for short trips, and especially where high speed is required, as in single-seated scout and battleplanes or "avions de chasse," as the French say, the revolving cylinder engine has the advantage. The oil consumption of the Gnome engine is as high as 2.4 gallons per hour. Castor oil is used for lubrication because it is not cut by the gasoline mist present in the engine interior as an oil of mineral derivation would be.

The Le Rhone Motor

The Le Rhone motor is a radial revolving cylinder engine that has many of the principles which are incorporated in the Gnome, but which are considered to be an improvement by many foreign aviators. Instead of having but one valve in the cylinder head, as the latest type "monosoupape" Gnome has, the Le Rhone has two valves, one for intake and one for exhaust in each cylinder. By an ingenious rocker arm and tappet rod arrangement it is possible to operate both valves with a single push rod. Inlet pipes communicate with the crankcase at one end and direct the fresh gas to the inlet valve cage at the other. Another peculiarity in the design is the method of holding the cylinders in place. Instead of having a vertically divided crankcase, as the Gnome engine has, and clamping both halves of the case in a groove around the cylinders, the crankcase of the Le Rhone engine is in the form of a cylinder, having nine bosses provided with threaded openings into which the cylinders are screwed. A thread is provided at the base of each cylinder, and when the cylinder has been screwed down the proper amount it is prevented from further rotation about its own axis by a substantial lock nut, which screws down against the threaded boss on the crankcase. The external appearance of the Le Rhone motor is clearly shown at Fig. 1, while the general features of construction are clearly outlined in the sectional views given at Figs. 6 and 8.

Connecting Rod Big Ends Work in Grooved Plates

The two main peculiarities of this motor are the method of valve actuation by two large cams and the distinctive crankshaft and connecting rod big end construction. The connecting rods are provided with "feet" or shoes, on the end which fit the grooves, lined with bearing metal which are machined into crank discs revolving on ball bearings and which are held together so that the connecting rod big ends are sandwiched between them by clamping screws. This construction is a modification of that used on the Anzani six-cylinder radial engine. There are three grooves machined in each crank disc and three connecting rod big ends run in each pair of grooves. The details of this construction can be readily ascertained by reference to explanatory diagrams at Fig. 8A. Three of the rods which work in the groove nearest the crankpin are provided with short shoes. The short shoes are used on the rods employed in cylinders Nos. 1, 4 and 7. The set of connecting rods that work in the central grooves are provided with medium length shoes and actuate the pistons in cylinders Nos. 3, 6 and 9. The three rods that work in the outside grooves have still longer shoes and are employed in cylinders Nos. 2, 5 and 8.

How One Tappet Operates Two Valves

The peculiar profile of the inlet and exhaust cam plates are shown at Fig. 8, while the construction of the wristpin, wristpin bushing and piston are clearly outlined at the sectional view on the same plate. The method of valve actuation is also clearly outlined in an illustration at Fig. 6, which shows an end section through the cam case, and also a partial side elevation showing one of the valve-operating levers, which is fulcrumed at a central point and which has a roller at one end bearing on one cam while the roller or cam follower at the other end bears on the other cam. The valve rocker arm actuating rod is, of course, operated by this simple lever and is attached to it in such a way that it is pulled down to depress the inlet valve and pushed up to open the exhaust valve.

A carburetor of peculiar construction is employed in the Le Rhone engine, this being a very simple type, as outlined at Fig. 7. It is attached to the threaded end of the hollow crankshaft by a right and left coupling. The fuel is pumped to a spray nozzle, the opening in which is controlled by a fuel-regulating needle having a long taper, which is lifted out of the jet opening when the air-regulating slide is moved. The amount of fuel supplied the carburetor is controlled by a special needle valve fitting, which combines a filter screen and which is shown at B. In regulating the speed of the Le Rhone engine, there are two possible means of controlling the mixture, one by altering the position of the air-regulating slide, which also works the metering needle in the jet, and the other by controlling the amount of fuel supplied to the spray nozzle through the special fitting provided for that purpose.

Explanation of Le Rhone Engine Action

In considering the action of this engine one can refer to Fig. 9. The crank O. M. is fixed, while the cylinders can turn about the crankshaft center O and the piston turns around the crank-pin M, because of the eccentricity of the centers of rotation the piston will reciprocate in the cylinders. This distance is at its maximum when the cylinder is above O and at a minimum when it is above M, and the difference between these two positions is equal to the stroke, which is twice the distance of the crank-throw O-M. The explosion pressure resolves itself into the force F exerted along the line of the connecting rod A-M, and also into a force N, which tends to make the cylinders rotate around point O in the direction of the arrow. An odd number of cylinders acting on one crank-pin is desirable to secure equally spaced explosions, as the basic action is the same as the Gnome engine.

The magneto is driven by a gear having 36 teeth attached to crankcase, which meshes with 16-tooth pinion on armature. The magneto turns at 2.25 times crankcase speed. Two cams, one for inlet, one for exhaust, are mounted on a carrying member and act on nine rocker arms, which are capable of giving a push-and-pull motion to the valve-actuating rocker-operating rods. A gear driven by the crankcase meshes with a large member having internal teeth carried by the cam carrier. Each cam has five profiles and is mounted in staggered relation to the other. These give the nine fulcrumed levers the proper motion to open the inlet and exhaust valves at the proper time. The cams are driven at 45/50, or 9/10, of the motor speed.

The Colors of Chromium Compounds

THE object the author had in mind in writing this article was solely to show the experimental chemist the various colors which the presence of chromium imparts to its many compounds, and also how he may prepare them himself. Every compound of chromium is exquisitely colored. The element itself is a very lustrous, silvery-gray metal. Its name comes from the Greek word meaning color;. this, of course, refers to its highly colored compounds.

The most important compound is potassium di-chromate ($k_2Cr_4O_7$) and it is the only chromium compound which need be purchased. With this we start out on our display of colors, for it is in beautiful rose colored crystals. When a hot solution of this is treated with a base such as sodium hydroxide the lemon-yellow colored chromate (K_2CrO_4) crystalizes. This solution of potassium chromate will frequently be employed. If, instead of treating the hot solution of potassium di-chromate with a base, an acid be employed; chromic anhydride or the trioxide will crystalize out in the form of dark red needles. With this compound many interesting experiments may be performed. It destroys paper by oxidation. Dry ammonia gas as well as alcohol take fire when brought into contact with it.

Returning to our solution of potassium chromate, we will precipitate several insoluable bodies. The first is silver chromate (Ag_2CrO_4). This is prepared by mixing solutions of silver nitrate with potassium chromate. The silver chromate is thrown down as a beautiful scarlet-red powder. If we use lead nitrate in place of silver nitrate we precipitate a beautiful yellow body which is lead chromate. This is known commercially as chrome yellow. If this chrome yellow is treated with an insufficient quantity of sodium hydroxide to dissolve it, it changes into chrome red, another common pigment. If we take a barium salt, as the chloride, and mix it with the chromate, we have another yellow compound ($BaCrO_4$). This, if mixed with just the right amount of hydrochloric acid, gives one of the finest shades of orange imaginable. Salts of stontium and calcium behave in a similar manner.

There are also chemicals which contain chromium as their principal element, these are called either chromous or chromic compounds according to the valence of the chromium. One of the most important of these is chromic sulphate ($Cr_2[SO_4]_5$). To prepare a little of this, dissolve about one gramme of the potassium di-chromate in 10cc. of water and add one ccm. of ethyl alcohol. Then pour about 5 c.c. of dilute sulphuric acid (1 : 3) on the mixture just made and heat to boiling. We now have a dark green solution containing chromic sulphate. In this manner chromic chloride may be prepared by using hydrochloric instead of sulphuric acid. This solution is also green. If, instead of making it, one were to purchase it, it would come in purple crystals. These dissolve in water, if they are not too pure, to form a violet colored solution. If this is boiled it changes to a green solution from which crystals cannot be obtained. On cooling this solution, the green color reverts to the original blue (rather slowly with the sulphate) and now the sulphate crystalizes out in the original purple crystals which were first dissolved.

If ammonia or other hydroxide is added to a chromic salt the hydroxide Cr $(OH)_3$ is thrown down as a voluminous pale blue precipitate. If this is collected, dissolved in hydrochloric acid allowed to crystalize, and heated in an atmosphere of chlorine, or hydrochloric acid gas, the anhydrous chloride ($CrCl_3$) is formed. This has a beautiful reddish-violet color. This is ordinarily insoluable in water; but if a slight amount of chromous chloride is present, it dissolves very readily. This is thought to be an example of physical catalysis.

The chromous compounds are rather difficult to keep as they readily go over into the chromic state due to atmospheric oxidation. A good way to make chromous compounds is to change a solution of chromic chloride ($CrCl_3$) with zinc and sulphuric acid. Thus the green chromic chloride solution is reduced to a blue solution of chromous chloride ($CrCl_2$). If this be treated with a hydroxide the chromous hydroxide is precipitated (Cr (OH_2) as a brownish-yellow powder.

Other bodies containing chromium and of beautiful colors are chrome alums and chromyl chloride which is a dark red liquid closely resembling bromine in that respect. The chrome alums are blackish-purple crystals, which, when large, are delightfully beautiful. There are also browns among this family of color. One of them is chromium chromate; the other is the nitride made by passing ammonia gas over heated chromic chloride.

A very common test for chromic acid follows: Mix a little chromic acid with hydrogen peroxide, and a beautiful coloration is the result. This is due to the temporary production of perchromic acid.

Even nature herself employs chromium when she needs a coloring agent. The ruby, sapphire and garnet would be only clay without traces of chromic to color them.

A. S. F.

A Model Steam Engine

(Continued from page 266)

drawing. The piston rod is made of 3/16-in. stock 3¼ ins. long. The piston rod is turned down on each end so that it can be threaded to receive the piston and crosshead. The crosshead is built up out of small scrap brass pieces soldered together. The slide rods are filed to shape from a piece of steel measuring ⅛ x ¼ ins. These are fastened to the projections on the cylinder head on one end and to a bracket attached to the frame on the other. This bracket is bent to shape from ¼ x 1/16 in. cold-rolled steel. The bracket also holds the rocker, which member is filed from a piece of steel ½ in. x ⅛ in. The main rod is filed out of a piece of steel 5½ x ⅛ x ¼ ins. The frame is cut to shape from a piece of steel ½ x ⅛ in. in size. The crankshaft is ¼ in. in diameter and riveted to the crank.

By carefully examining the drawing and the photographs of the finished engine the mechanic will obtain any additional information that may be necessary for the construction of the engine. The writer is aware of the fact that the drawing is not as complete as it should be but he believes that all the necessary dimensions are given and that the builder will have little trouble in understanding the construction of the machine, as it is very simple and anyone having any knowledge of steam engine operation will be able to carry the project out successfully.

Recovery of Platinum from Platinum Solutions

FROM not too large baths precipitation of the platinum with sulphuretted hydrogen is the most suitable method, and preferable to evaporating and reducing the metal from the residue. The process is as follows: Acidulate the platinum solution with hydrochloric acid, and, after warming it, conduct sulphuretted hydrogen into it. The metal (together with any copper present) precipitates as sulphide of platinum. The precipitate is filtered off, dried and glowed in the air, whereby metallic platinum remains behind. From larger baths the platinum may be precipitated by suspending bright sheets of iron in the acidulated bath. In both cases the precipitated platinum is treated with dilute nitric acid in order to dissolve any copper present. After filtering off and washing the pure aluminum it is dissolved in aqua regia; the solution is then evaporated to dryness in the water bath, and the chloride of platinum thus obtained may be used in making a new bath.

BULLET-PROOF GLASS

A MOST interesting experiment with what is said to be a bullet-proof glass was recently made in New York City. A sheet of this glass was subjected to the fire of a .45 caliber automatic pistol at a distance of 12 feet, with the result that although the glass was shattered it stayed in place and resisted the penetrating force of the projectile. The exact nature of this material cannot be divulged at present for obvious reasons.

Great advances have been made in so-called unbreakable glass, the construction of which is in the form of a three-ply sheet of glass and celluloid, the latter being the middle member. Since it is cemented into a solid pane, the glass may shatter in the way glass does but it cannot leave the non-shatterable celluloid to which it is firmly cemented. Glass of this kind is extensively employed for eye-protecting goggles, airplane windows, wind shields, and other similar uses requiring non-breakable glass. From reports of the tests made with the bullet-proof glass, one can judge that the construction is similar to that of the "unbreakable" or triplex glass which has so many applications.

VANADIUM AS AN ALLOYING ELEMENT

VANADIUM has become one of the vital factors in the steel trade, entering into the manufacture of automobiles very extensively. Four pounds of vanadium added to a ton of steel results in an increase of 45 per cent in its strength and at the same time produces an alloy steel which has satisfactory machining qualities. The statement has been made that while the difference in raw material cost between vanadium steel and a carbon steel of approximately the same strength is too small to be of consequence, the difference in machinability makes a finished part of vanadium steel cost $6.50 and of carbon steel $13.00 It becomes evident that an alloy steel may frequently be employed for economic reasons alone, but that is a point much in favor of such alloys as vanadium steel which give us strength at low cost in construction. Some very important work remains to be done in the alloy field as we know all too little of the influence of many of the rarer metals on both ferrous and non-ferrous alloys.

In the Jutland battle the standard range finders used by the British fleet had 9 foot bases. These were only supposed to be accurate at 6,000 yards, and at Jutland some shooting was done at 24,000 yards. One squadron had 15 foot bases. Now 30 foot base range-finders have been introduced, which are accurate to less than 80 yards at a distance of 20,000 yards, or about 12 miles.

PROCESSES FOR TESTING RUBBER

THE author of an article on this subject in a German paper outlines the best known processes of testing samples of rubber. These are the "Pontio," the characteristic feature of which is the solution of the rubber, is a particular benzol homologue; the "Marquis and Heim," which is based on the fact that pure rubber in a chloroform solution, when treated with concentrated sulphuric acid, is precipitated as an amorphous substance easily recoverable by filtration; and "Vaubels," in which a chloroform solution of rubber is submitted to the action of potassium bromide.

He rejects Pontio's process as unreliable. The other two he recommended for practical work. For accuracy, there seems to be nothing to choose between them. A long series of tests on a great variety of rubber samples from different sources showed practically identical results.

Malleable Cast Iron

THE custom among most malleable iron makers is to use such irons only as are quite free from phosphorus and sulphur, for the reason that the process in use is designed especially to eliminate carbon, and after they have driven that out they have no desire to leave anything remaining which will make the metal brittle. By the use and mixture of certain brands of iron they have the means of converting their product into almost pure wrought-iron.

The melting is now done, on the large scale, in reverberating furnaces, and the iron is purified, to a certain extent, while in a molten condition by directing into the heating chamber a current of atmospheric air which mixes with the products of combustion. In its essential principles the method has a resemblance to Berard's process of steel-making, the gaseous currents of air or of the furnace may be used, as occasion requires, alternately, but the tuyeres are not, like his, provided with apparatus for adjustment. The process of removing impurities from the metal must not be carried so far as to detract from its fluidity at the temperature at which it is to be poured. These facts control the operation; the purer the metal is the higher is its melting point, and whatever impurities are allowed to remain must be such as may either be removed by subsequent operations or such as may be allowed to exist in the finished product. The useful function of the impurities is to lower the melting point in the scale of temperature. Small test pieces, of a finger's length, are cast from time to time until the right point is reached, as determined by the appearance of their fracture. The metal is then ready to be poured into the moulds, and as these will hold no large amount the pouring is generally done from hand ladles. After the case pieces are removed from the sand and have the risers, runners and spruce knocked from them, they are rattled in tumbling barrels to remove the adhering sand and scale and to expose the naked surface of the material to the ready access of the chemical agents of decarbonization.

The cast-iron pieces, hard and brittle, are now ready for the process which will alter them in their whole nature without subjecting them to any physical force. The process is one of dissociation of the compound cast-iron, which is carburet of iron the carbon has purposely been made to appear in its combined form and is not visible as graphite; the iron, when broken, exhibits a fine, white appearance of the fractured surface, with a suggested indication of lines radiating from the center.

The pieces are packed in cast-iron boxes with the rust or oxide of iron. These boxes are round or square, according to the shape of the work. If round, they are perhaps 2 ft. in diameter, and, if rectangular, they may be 2 ft. long, 1½ ft. wide and 1 ft. high. When these are filled rims of the same size are placed on them, increasing the height another foot, and when these are filled another rim, and still another is added, until the box is 4 ft. in depth, packed full of castings and oxidizing metal. This material may be wrought-iron turning chips which have been rusted by being spread upon a hot floor, where they are sprinkled with a solution of sal-ammoniac.

Transparent Paint for Glass

A shellac varnish made of bleached shellac can be used with various aniline dyes. The glass should be warm, but the varnish is used cold.

If the whole of the glass is to be coated, the method is to pour the colored varnish on and drain it off at a corner. Another method is to mix 1 part of turpentine with 2 parts of Venice turpentine and rub into this Prussian blue, crimson lake, India yellow or any mixture of these to produce the shade desired. Care should be taken to mix the color and the liquid intimately.

HARDWOOD FLOOR EFFECTS WITH SOFT WOOD

SATISFACTORY wood floors, approximating in effect and finish the oak and maple floors found in the best type of homes, can be developed, with the aid of proper finishing methods and materials, in such woods as pine, fir and cypress. These so-called "soft" woods are very durable and possess not a little natural beauty of grain. Hardwood effects are secured on soft woods by staining with an oil wood stain, consisting of a permanent color pigment in an oil vehicle. These stains are particularly adapted to use on the soft woods. The effect is completed by applying a thin coat of shellac and finishing with two coats of prepared wax or floor varnish.

The first step toward obtaining the desired finish is to sandpaper the wood smoothly. The stain should then be applied freely with a brush and, after being allowed to stand for about five or ten minutes, buffed off with a cloth. When the stain has dried for twenty-four hours, the shellac and wax or varnish may be applied as described. A deeper effect than that secured by the method outlined may be obtained by the use of a varnish stain over the oil wood stain. Both should, of course, correspond in color.

CARE OF ALUMINUM WARE

ALUMINUM ware, the kitchen utensils that are so attractive to housekeepers, must be well cared for if one would keep them bright. You may have been told that aluminum ware will not scorch, but if you leave a dry pan over an intense gas flame you will find a hole in the aluminum.

Heat penetrates aluminum twice as rapidly as it does tinplate, and three times as rapidly as it does iron. Not only does it heat more rapidly, but aluminum holds the heat longer. Consequently, the gas need be turned on full only at the beginning. It should be turned lower after the pot is heated.

Any discolorations on aluminum ware are sure to be on the surface only and can be removed by a good cleaning powder. Hot water and soap are enough to keep it in good condition usually, but any white metal polish will keep it bright and shining. Avoid coarse, gritty cleaning powders. Remember that ammonia, potash, lye, soda or strong cleaning powders will stain the inside of your kettles and the stain will be one you can never remove; so be careful. If a kettle or pan needs scraping, use a wooden spoon—not a knife. If so badly scorched that this does not answer, fill it with hot water and cover, then boil for several minutes and scrape with the wooden spoon or a clothespin. A piece of fine sandpaper is also good to brighten scorched spots.

SCRATCHED VS. SMOOTH JOINTS IN GLUING

The common assertion that scratched surfaces make stronger glued joints than smooth surfaces seems hard to prove. Comparative tests made on several occasions by the Forest Products Laboratory all indicate that the strength of these two types of joints are practically the same. The test specimens used by the Forest Products Laboratory were pairs of hard maple blocks, some with smooth and some with tooth-planed contact surfaces. These blocks were glued with a high-grade hide glue, allowed to stand for a week, and then sheared apart in an Olsen universal testing machine. Four joints of each type were compared in a single test.

Eleven such tests gave the average results shown in table.

It will be noted that in seven of the eleven tests smooth surfaces gave the better adhesion. Consequently it would seem that there is no advantage in tooth-planing wood for gluing purposes.

Comparative Strength of Scratched and Smooth Joints

Test No.	Scratched Joints: Shear strength Lbs., sq. in.	Scratched Joints: Wood surface in failure Per Cent	Smooth Joints: Shear strength Lbs., sq. in.	Smooth Joints: Wood surface in failure Per Cent
1	1787	25	1855	—
2	1366	—	943	—
3	1976	—	3086	50
4	2409	75	1571	25
5	2298	100	2416	100
6	1947	75	1678	62
7	2310	12	1800	—
8	1835	100	2455	100
9	1425	—	2180	25
10	2330	—	2395	62
11	2180	—	2520	75
Gen. Average	1988	35	2040	47

An Engineer In Modeldom

A Few Remarks On Efficiency

By Dwight S. Simpson, M. M. E.

WHAT is efficiency? Your dictionary will tell you. The encyclopædia will tell you a lot more, but what is it? In round numbers, the ratio of practice to theory—the equation between things as they are and things as they ought to but never will be. The expression of the reason why many minds that have tackled the problem of perpetual motion, have not achieved it. And it is queer that while we always speak of "efficiency" it is ever the lack of it that really interests us. And the lack of it is usually spent in heat. The average statesman, so called—saying little, though talking much—lacks it in great quantities.

To borrow from something I've read somewhere (we are seldom original) it is theoretically possible to fill a pail brimming full of water at the well and to carry it to the house without spilling a drop. As to the water—that is 100 per cent efficient. But, we stumble and spill a little, the pail swings and we spill a little more. We arrive with the pail only partly full and the ratio between what is in it and what it held when full, or when we started, is the measure of efficiency, which is always expressed as a percentage.

Suppose the pail had a hole in it so that all the water ran out and we arrive with it empty. Efficiency = zero per cent. We plug the hole partly so that the pail is just half full when we arrive. Efficiency = 50 per cent. A little better plug and by saving three-quarters of the water we have reached 75 per cent efficiency. The great aim of all engineers is to always keep fitting a little better plug.

Let us mend the leak and we come immediately to another phase of the question. Tom, the clodhopper goes to the well, and in returning falls all over himself and arrives with the pail half full. Brother Jack, quick on his feet, brings in his pail filled to the top. We know that the pail will hold the water, therefore Tom must have been only 50 per cent efficient, while Jack is perhaps 90 or 95 per cent.

This human side of the question has of late years engaged the attention of engineers, managers and even doctors, with the result of many piece rate and bonus systems of pay in factories and many beneficial changes of method in working. As an example, a laborer used to travel around with the same shovel day after day and all day long. Now a shovel can hold only a certain bulk, so friend laborer would for a time be lifting say sixty pounds of ore and in a few moments be exerting himself with a shovel full of perhaps three pounds of shavings. Nowadays in a well regulated plant it is the job and not the man that has the shovel. He shovels shaving with a fork that holds so many pounds. He shovels coal with a shovel that holds the same number of pounds. Ore with a smaller shovel that holds the same weight. As a result of lifting the same weight every time he does more work in the day with an expenditure of less actual energy (sometimes he doesn't feel that way about it). In other words, his output is greater for the same or less input. His efficiency is higher, just as Tom's in bringing in the full pail.

Let us look at it in another way. suppose we hire a man for fifty cents an hour (it is still possible to persuade a few men to work for that sum) and he drives fifty rivets in an hour, that being a popular sport these days. That costs us a cent a rivet so we will make a new arrangement and pay him not by the hour, but a cent for every rivet he drives. He can now be reasonably expected to drive about seventy-five rivets an hour. Let us revise the schedule again—offer him a cent a rivet for the first seventy-five in each hour and a cent and a half for each one over. He is liable to make it ninety or even a hundred. Now that man was not shirking in the first place. He doubtless thought he was giving a full hour's work. The added incentive of the extra pay simply urged him to extend his muscles a little further. Possibly he shortened the swing of his hammer, making the blows a little harder and quicker. Possibly he rearranged his forge or his holder on so that rivets would come faster and stay put. In other words, he has increased his efficiency. Unfortunately, we cannot figure in the human element and say just what 100 per cent efficiency is; all we can say is that figuring from the first output he has increased his efficiency by 100 or 150 per cent. He may still be only 30, 50, 70, or perhaps 95 per cent efficient. We cannot tell how far he can do.

These figures are not excessive. It has been proved that one can do two or even three times a normal day's work, and under proper arrangement, keep it up indefinitely without detriment.

Now that we have some idea of the ratio between theory, possibility and actual achievement, let us see where it gets us in our model engineering work, and go back to our first dry subject of water.

But first let me say to you who have some knowledge of engineering, don't let the glowing descriptions of 90 per cent machines get your hopes too high. Friction, radiation, magnetic, and electrical losses do not diminish in proportion to dimensional reduction of a machine. A thousandth of an inch is a thousandth of an inch whether it is on a three-inch bearing or a three-eighths-inch bearing and while it is but one three-thousandth of the larger, it is one three hundred and seventy-fifth of the smaller. Small machines and models, as a rule, are not more than two-thirds as efficient as their larger cousins.

Pumps

The first requisite in the design of a pump, model or not, is the amount of water required (in cubic inches) and the number of revolutions it is convenient to run it. The novice then arrives at a piston diameter and stroke so arranged that area of piston times stroke times revolutions (or number of strokes per minute) equals the cubic inches of water required. Some time afterward he is much peeved and surprised because he isn't getting water enough. Let's see why.

Of course, water is incompressible and all that, but valves have to move up and down, reversing their direction twice every stroke, and the water itself has to be reversed in movement through the pump. This takes an appreciable moment of time, which is fully grasped by the water and some of it slips back under the suction valve to the pipe. More slips back into the pump through the delivery valve, leaving less room for water on the next intake stroke. Our pump therefore draws less water than it should and delivers less water than it draws. This loss amounts to about 15 per cent normally, but may be increased by poorly fitted or too small valves, or pipe that is too small or has too many, or too sharp bends.

If the pump is run at more than 350 revolutions, more trouble will develop. I am fully aware that plunger pumps on the cheaper gasoline engines are run at 700 or a 1000 R.P.M., but they are much larger than the capacity required, arrived at by trial and failure and probably operate at about 25 to 40 per cent efficiency.

All these figures are referring to the water end alone and no account is taken

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Genuine Gold Bronze

LEAF gold is ground with honey upon a stone until the leaves are broken up and minutely divided. The mixture is then removed from the stone by a spatula and stirred up in a basin of water, whereby the honey is melted and the gold set free; the basin is then left undisturbed until the gold subsides; the water is poured off and fresh quantities added until the honey is entirely washed away. The gold is finally collected on filtering paper and dried for use. Gold bronze occurs in various shades of colors—red, reddish, pale, or dark yellow, as well as grennish—the color depending on the varying content of gold or the different mixture of gold with silver and copper. By boiling with various salt solutions or acidulated masses various tones may also be imparted to gold bronze. It acquires a vivid yellow color by boiling in water containing nitric, sulphuric or hydrochloric acid, a reddish color by boiling in a solution of crystallized verdigris or blue vitriol, while other shades are obtained by boiling in solutions of common salt, tartar, green vitriol or saltpetre in water.

Metallic gold powder is also obtained by dissolving pure gold in aqua regia and precipitating it again by an electro-positive metal, such as iron or zinc, which in the form of rods is placed in the fluid. The gold is thereby entirely separated. The rods used for precipitation must be scoured perfectly clean and bright. The lustre of the gold bronze may be heightened by rubbing after drying.

To Bronze Tin

PREPARE two solutions, one of one part ferrous sulphate (green vitriol), one part cupric sulphate (blue vitriol) and twenty parts of distilled water; and the other of four parts verdigris and sixteen parts vinegar. Thoroughly cleanse the article by means of a clean brush dipped in fine earth and water, and after throughly drying apply to both sides a light coat of the first solution by means of a brush. After drying, the article presents a blackish appearance. The second solution is then applied with a brush until the article acquires a dark copper-red color. It is now allowed to dry one hour, and then polished with a soft brush and finely elutriated bloodstone, the surface being frequently breathed upon so as to make the bloodstone adhere. In conclusion it is polished with the brush alone, which is from time to time drawn over the palm of the hand. To protect the bronze against moisture, cover it with a very thing layer of gold lacquer.

AN ENGINEER IN MODELDOM

(*Continued from page* 346)

of friction and head losses or the power required to drive the pump.

In general, then, it is necessary to gear our pump down to about 300 or 350 strokes per minute and to design it for a capacity of 115 per cent to 125 per cent of the amount of water required. Another time we will consider some of the details of design.

Centrifugal, gear and rotary pumps are not suitable for boiler feed and have been so little dealt with in the model field that it is hard to find what their efficiency might be. As their working depends largely on the closeness of fit, and as above explained a close fit is not so close, comparatively, in model work; it is probable that their efficiency is not more than half that of the reciprocating pump.

Dynamos and Motors

These being so nearly alike in their characteristics it is safe to consider them together for model purposes.

As in model work we rarely deal with powers greater than a horsepower, I believe it would be much better to rate all our machines by watts instead of fractional horsepower. Small dynamos and motors should be bought and sold this way, as ten watt, twenty watt machines, etc., and as the only satisfactory way of testing a small engine of any type is by an electric dynometer, why not use the watt to measure their power, too?

Large electrical machines operate normally on an efficiency percentage of 80 to 90 and even 95 per cent. In our small machines, friction surfaces are proportionately larger. Magnetic air gaps while actually the same may be proportionately as much as fifty times greater. Dead wire on the ends of armature coils is nearly as much as the effective wire between. It is therefore impossible to expect an efficiency of two-thirds more than 50 per cent.

That is to say, it is necessary to provide twice the mechanical power to drive a dynamo for any required output, and twice the electric power for the motor for the power wanted at its shaft. The other half the power is mostly heat.

Boilers

From the model standpoint, it is scarcely worth while going into the efficiency of boilers, as it is largely a discussion of water evaporated per pound of fuel, and the amount of fuel burned in a small boiler is of no great consequence. It is therefore sufficient to say that a model boiler of average type and construction will evaporate from 1 to 3 cubic inches of water per 100 sq. inches of heating surface. The former for pot boilers and the latter for the best water tube outfits. In all cases, it should be arranged to burn about a half pint of gasoline per hour for each hundred inches of heating surface.

This corresponds to an evaporation of 3 to 10 lbs. per sq. ft. per hour and for comparison it may be noticed that large boilers have evaporated as much as 17 to 20 lbs.

For high speed engines, having practically no cut off and expansion, about thirty feet of 5/16 in. tubing is required per horsepower. For this it is necessary to burn nearly a pint and a half of fuel per hour. The actual efficiency from a fuel standpoint is very low, probably about 7 per cent of the latent heat of the fuel being turned into power.

Engines

So much depends on the design of the machine, whether low or high speed reciprocating or turbine engine, that it is impossible here to say much about it. We will reserve the priceless information until some time when the Editor will let us have another page or so. Suffice for the moment to say that for small turbines of the De Laval type an efficiency of 40 per cent is all that can be expected, figuring from the latent energy of the steam before entering the nozzle. Doubtless about 30 or 35 per cent will be more common.

For large reciprocating engines, a mechanical efficiency of 80 per cent is fair practice. For our models, after all calculations for pressure, cutoff, etc., are made, 60 per cent should be deducted for friction and radiation losses. For the extreme high speed, racing engines, probably not more than 30 per cent of the calculated I.H.P. will be applied to the propeller.

Small internal combustion engines will probably operate at about 60 per cent of their figured power.

Propellers

Many scientific and painstaking experiments have demonstrated that for maximum efficiency a propeller should work with a 20 per cent slip, and that the greatest efficiency to be obtained is only 75. Now, in a model boat it is about impossible to tell at what revolutions the engine is running, and therefore at what slip the propeller is working. It is likely to be around 40 or 50 (we are always hoping for more speed than we get and design accordingly). This added to the necessarily large sections of the small blade reduces the theoretical efficiency to probably 40.

Storage Batteries

In the laboratory, the storage battery is most efficient, about 98 per cent of the current put in having been taken out. In our small one in actual use we will do well to figure about 60 per cent or possibly 70 per cent. This takes no account of damage to the plates or the fact that it is never wise to completely discharge the cell. It is no affair of mine if you mistreat them, but just as a tip, if you are willing to stand the expense or trouble, and if you want a little extra speed in that boat some day, you may wreck the battery, but you can get pretty near that 98 per cent—once.

Gearing

Spur gears are the most efficient and durable and if properly cut and fitted there seems to be no difference whether they are small or large. Efficiency is better at the higher speeds, running from about 90 per cent at a pitchline speed of three feet per minute to 98 per cent at a two hundred foot speed.

The same thing applies to worm gears with the added attraction that the efficiency falls off rapidly as the worm angle is changed from 45 degrees. Maximum possible efficiency about 92 per cent.

Belting

Efficiency figures of belting mean nothing. The following rules by F. W. Taylor will help to solve any problem of this nature:

A double leather or 6-ply rubber belt with an arc of contact of 180 degrees will give a pull on the face of pulley of thirty pounds per inch width of belt.

Eleven hundred feet of one inch belt passing around a pulley per minute will transmit one horsepower.

A single belt will do about 60 per cent of this.

Tackles

We all know that a rope and pulley will help lift a greater load than we make without it. How much? The good old fashioned rule for finding the weight required on the hauling end is to add 10 per cent to the load for every pulley in the tackle and divide the total by the number of parts sustaining the load.

In conclusion, don't reduce your own efficiency by trying to remember all this. Make a note on your card index or in your note book that all good engineers should have, as to the issue and page number and then when you do want any of these figures you will know where to find them and have them correct. This will be much better than misremembering the quantities and will possibly save me some "cursing out."

A careful study of these fact will probably remind "Mr. Average Experimenter" how really inefficient and careless he is in designing and constructing his apparatus. Only the very first principles of machine efficients have been treated in this article, but it is hoped that it will awaken a desire to carry the study further.

Book Reviews

(*Continued from page 323*)

how accidents are caused through careless mounting and guarding of wheels and how these accidents can be overcome by proper precautions. Abrasive cloths, papers, their manufacture, nature and use are fully described in Chapter Fifteen. The latter part of the book is a complete exposition of the actual shop use of grinding wheels in surface grinding, cylindrical grinding, internal grinding, special grinding operations, cutter sharpening and saw sharpening. This material is compiled with a special view to educating the reader regarding the actual application of abrasives in the machine shop.

We feel very safe in giving this book a thorough endorsement and we feel sure that all those who read it will feel amply repaid for their time and trouble.

BOILER FEED WATER, Its Effects, Treatment and Analysis, by Percy G. Jackson, F. I. C. Size 5 x 7½ inches; 100 pages. Published by J. B. Lippincott Company, Philadelphia, Pa.

The author of this volume had extensive experience as a chemist for a boiler insurance company. This position brought him in contact with all the problems that can arise in boiler operation. Cases of feed water trouble are so common that this information will be generally helpful to engineers and chemists. An expert chemist is often not immediately obtainable in an emergency and a knowledge of the principles and methods of application controlling the underlying causes of these troubles will present a large percentage of loss and delay in the operation of any boiler plant.

The contents include mineral constituents, corrosion, softening, selection of softening, priming; scale, grease, and overheating, methods of analysis, analysis of scale, control tests for water softening, sampling and solutions. The appendix gives some valuable tables and factors of atomic weights and Clark's table of hardnesses.

ANALYSIS OF BABBITT, by James Brakes. Size 5½ x 7 inches; 169 pages; bound in cloth. Published by the Allen Book & Printing Company, Troy, N. Y.

This book treats the analysis and manufacture of the alloy, babbitt. It is especially prepared for mining, civil, electrical and mechanical engineers who use this important alloy in their profession. It is also an important guide to manufacturing establishments that find use for babbitt in their work.

The book will also be found to be a valuable one for the young chemist who desires information on this particular subject.

The contents cover the properties, qualitative, volumetric and electrolytic analysis of babbitt compound. Antimony, tin, lead and copper are treated.

Adjusting Bracing Wires Scientifically

IT has been necessary in the past to depend upon the judgment of the mechanics assembling an airplane for securing the correct initial tension of the landing and flying wires, interplane or incidence bracing and drift cables, through adjustment of the turnbuckles. They secured what they considered the proper uniform tension by the "feel" of the wire or by listening to its vibrant sound when plucked with the finger. Either of these methods is crude and inaccurate, owing, among other things, to the widely varying diameter and length of the wires. Some experiments have shown that wires thus adjusted for equal tension have really varied by several hundred per cent. A dangerous condition may thus be developed by causing overloading of airplane members, such as struts, wing spars and fuselage compression members, through adjustment of initial tension. This emphasizes the need of an apparatus to eliminates all guesswork from wire adjustment and makes it possible to have the tension of opposing or co-acting bracing cables uniform to an error of less than 10 pounds.

The instrument consists, essentially, of a frame with supports spaced 10 inches apart, between which a section of the wire or cable is adjusted. Midway between these supports, and operated by hand grips, is a plunger which deflects the wire 0.1 inch from its normal position. The operation of deflecting the wire compresses a calibrated spring. A dial indicator measures the deformation of the spring and thus the load on the wire. One revolution of the indicator pointer corresponds to a load of 1,000 pounds, and the smallest dial division, to a 10-pound load.

The theory upon which the instrument is based is very simple. If a wire, under tensile stress, is supported at two points and loaded at the middle of the span thus formed, a system of three forces in equilibrium is established. If the span and deflection are kept constant, as in this instrument, the deflecting force is a constant fraction of the tension in the wire.

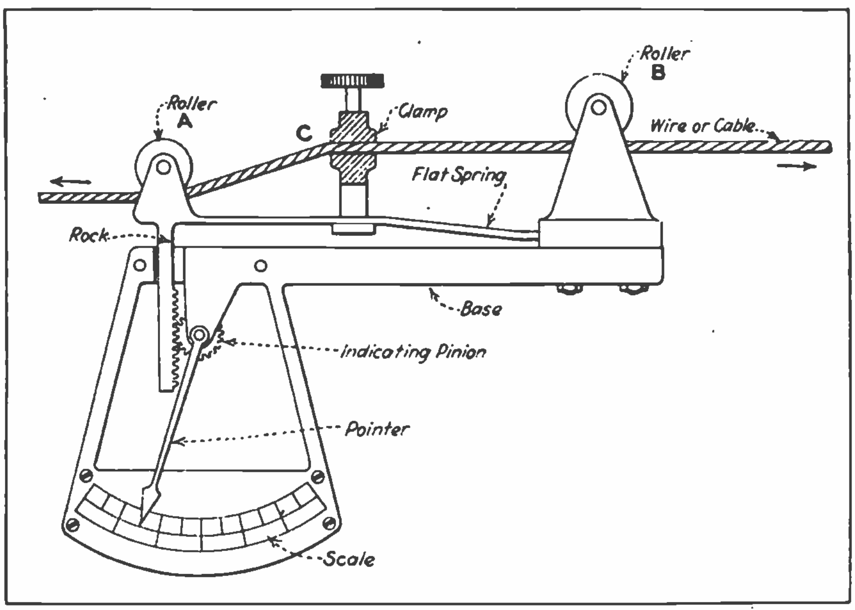

Diagram showing tensiometer for gauging tension of airplane bracing cable

determine accurately the load in a flexible tensile stressed member.

These parts of an airplane are subjected not only to the stresses imposed by the flying load, but also to the initial stresses, caused by the tension in the bracing and drift wires. An appreciable initial stress in these wires is necessary to maintain the alignment of the machine and in many cases the initial stresses have been found to form too large a proportion of the total load. Failure of the structure in service has sometimes resulted from an improper adjustment of the turnbuckles in cables.

A simple device, known as the Tensiometer has recently been described in Bulletin No. 32 of the National Advisory Committee for Aeronautics that

The Tensiometer is made direct reading by graduating the indicator dial upon the loading spring so as to read tension in the wire instead of load upon the spring. A second dial indicator allows the simultaneous determination of the deflection to the nearest 0.001 inch. The use of these two sensitive indicators for accurately determining the position and load upon the wire is, in a great measure, the reason why accurate results are obtained with the Tensiometer. In use it is advised to attach the Tensiometer to the wire. It is simply put into place and the grips are brought together until the proper deflection is obtained. The tension in the wire is then read from the other dial, which gives the value directly in pounds of stress.

A diagram given herewith shows the principle of a simple instrument of this nature used in England. The principle of this appliance is that if a wire is stretched between two fixed points, a pull is required to deflect or bend it and the amount of pull varies directly as the tautness of the wire and can be taken as a measure of the stretching force. For this purpose the guy wire to be tested rests on two rollers, A and B, and is clamped at C. The two rollers and clamp are not in a straight line, therefore the stiff spring to which one of the rollers is attached is deflected and the amount is transferred by a rack and pinion movement and indicated on a scale graduated in pounds by a suitable pointer.

Concrete Floats for Ship Salvage

THE first of a new type of "mystery ship" has been completed near Brighton, England. It has taken some months to construct and the cost approaches $5,000,000 for each ship. Altogether six are to be built. Unlike the ships built during the war, these are not intended for destruction, but for salvaging merchant vessels sunk by submarines around the British coasts. The position of these merchantmen have been ascertained and divers have reported that many can be raised and again fitted for service. The new salvage ships look like segmented towers, with broad ship-shaped bases. They rise tier on tier like a welding cake, each tier diminishing in size to the top one, which is over 100 feet above the base. Each tier is made of numerous blocks of concrete, honey-combed to withstand external pressure but otherwise hollow. Water-tight doors are provided by which the blocks can be filled with water and pumps by which the water can be forced out and replaced by air. These concrete tower-ships have no motive power and are to be towed in pairs to the neighborhood of sunken merchantmen. On a calm day the interior will be flooded and the ships will be sunk on each side of the wreck. Divers will lash them to the wreck with steel chains and cables, the water will be pumped out, and if all functions as intended the tower-ships will rise, bringing the wreck to the surface. The construction of these ships has provided a new industry for Brighton. Many hundreds of men have been employed and shipyards constructed where only mudflats and waste land was found.

ALUMINUM IN THE MOTOR CAR

By H. A. Tarantous, Member S. A. E.

JUST before the country entered the war the automobile industry was beginning to use aluminum alloys in a way that predicted the coming of the light car era, but just as all big movements have their obstacles so did the use of aluminum. Its price became prohibitive and then again all sorts of restrictions were put on the car manufacturers so that the whole movement was halted. But not for long. The car makers are again on the right track and aluminum alloys are going to be used in more cars and in a great number of units of those cars.

It is not speaking very well for our industry to say that it has had the opportunity to use aluminum alloys for many years past and has not taken advantage of the numerous advantages of it, especially its lightness in weight. Weight reductions must be made in our cars if they are to reach a point of efficiency comparable with other machinery we have been using. Automobiles are wasteful of fuel, oil and tires and cost so much to keep in repair because the cars are admittedly too heavy. Aluminum is perhaps the lightest metal we have and its alloys are not only lighter than most metals but equally as strong and in many cases stronger. Aluminum is easy to machine, it does not rust like iron or steel, it takes paint easier and it looks better. It is a great conductor of heat and thus runs cooler than other parts.

I doubt very much whether the average reader has ever seen a real aluminum car or ever dreamed that we would see aluminum wheels, aluminum body, engine and dozens of other parts made of this material. There is such a car in existence and its weight is so low that its fuel consumption is something like fifty miles per gallon and it runs about 1200 miles on a gallon of oil. Experimentally it has run upward of 50,000 miles and the repair cost has been one-third of that of an ordinary vehicle of today.

Light weight must be used in many parts which now are unnecessarily heavy. Following are some parts in the modern automobile which can be made of aluminum and made to give better service than the heavier car. Many of these are already in extensive use. Cylinders, crankcase, fan, water pump, mountings for auxiliary engine parts, spark and throttle connections, pistons, oil pump housings, all brackets, radiator core and shell, hood, fenders, running boards, body, windshield supports, clutch housing, many clutch parts, transmission case, rear axle housings, brake drums, wheels, hub caps, small parts, fittings and brackets, such as door handles, floorboards, certain bolts and nuts, mouldings, etc. Think of the steering system parts which could be made of aluminum.

It can readily be seen that if aluminum alloy is substituted for many of the iron and steel parts that the whole car would be considerably lighter in weight, and we all know that the lighter the car the less gasoline it uses, and the easier it is on tires. Above all, if the car is designed scientifically and the aluminum is used in the proper places, the engine can be made smaller and the same performance had as before. In other words, as you lighten you can reduce the size of the working parts and thus effect a still greater saving in weight.

It might be a surprise to many to learn that experiments have been made with practically every part of a car made of aluminum, including rims, propeller shafts, and other such parts. While it may not be possible to get aluminum to do all sorts of work, it certainly is clear that it can be made to do a great deal that now is being done by heavier parts.

It is possible by the use of aluminum to get a large car, which weighs considerably less than a smaller one of other materials, and have that larger car perform better than the smaller and be more economical. This can be done by the proper use of aluminum and scientific design, by getting the sprung and unsprung weights correct and by getting the correct spring suspension. Present owners know that when they drive along a road that is not very smooth the rear wheels leave the ground. If it were possible to keep the four wheels on the ground all the time the average car would give over 15,000 miles on a set of tires. That is just what one will get in a light car with a light axle, because there will be no grinding away of tread, but simple natural wear due to friction of the tire against the road surface. This is a small fraction of the wear a tire gets because it leaves the ground, spins rapidly in the air and then strikes the ground spinning. It is no different from holding that tire against a grindstone.

The reason the wheels leave the ground is obvious. The wheels, rim and the axle are so heavy that when the wheels strike a bump or a rut the whole unit moves upward and the springs cannot stop it from bounding up and down until the stored up energy is expended. The spring in order to prevent that bouncing would have to be stiff, and so soon as you make them stiff you bring about hard riding. The light weight will overcome this tendency, and coupled with a proper spring suspension will give a light vehicle that will hold the road at any speed in its range.

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