PRACTICAL MECHANICS FOR EVERYDAY MEN

EVERYDAY ENGINEERING MAGAZINE

IT TELLS YOU HOW TO MAKE AND DO THINGS

VOLUME 9 JUNE, 1920 NUMBER 3

Heat Treating Alloy Steels

A Series of Simplified Articles Detailing the Various Methods of Heat Treating Modern Alloy Steels. This Instalment Explains the Various Heat Treating Processes for Simple Steels and Describes the Way They Are Applied in Everyday Work

By Victor W. Pagé, M.S.A.E.

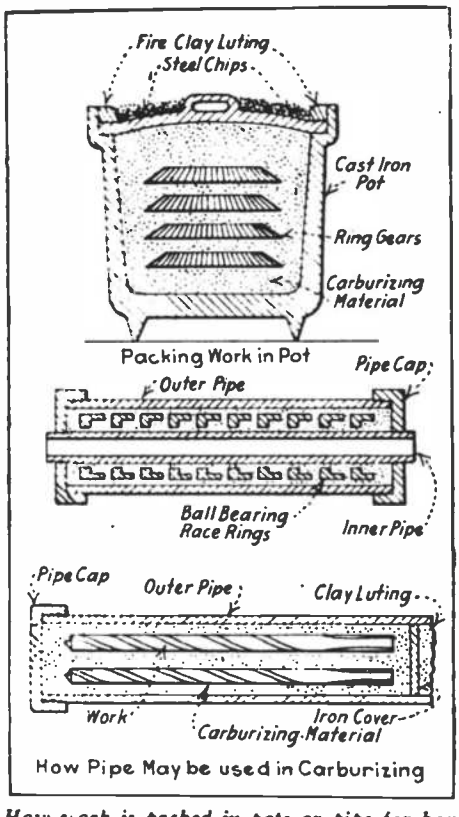
PART 2

IN the first article of this series, the point was brought out that heat treatment was an exact science and that modern methods of precision measurement made it possible to determine the best points to which various grades of steel should be heated and the temperature at which they should be quenched to secure the maximum benefit from the desirable physical properties of special steels. Before considering the treatment of different alloys, the writer believes that the non-technical reader can understand what is meant by heat treatment much better if the various simple treatments are defined and explained, so these are outlined in a manner that should be of value to the experimenter and practical man.

Annealing

Many varieties of steel are hard when the process of manufacture, especially if rolling or hammering is involved, is completed, these being principally grades used in tools and special machine parts. In order that they may be worked without too much trouble by ordinary machine tools it is imperative that the metal be soft, and this condition is obtained by a process known as annealing. While steel can usually be bought annealed cheaper than it can be treated at the factory or shop where it is to be machined, sometimes conditions materialize that make it necessary to anneal metal to facilitate work and reduce stresses upon the machine which completes the finished product. This process not only makes the steel softer, but also removes the internal strains or the tendency of the metal to crack and spring when hardened. The strains are caused by the rolling or hammering processes in the steel mill or forge shop while the rods or forgings were being made.

When the metal is a forging or a gear blank of nearly finished size, it is customary to remove part of the surface by taking several rough cuts, after which the piece is ready for annealing. In order to soften steel it is necessary to heat it to a uniform red heat and allow it to cool slowly, which process can be carried on by several methods.



How work is packed in pots or pipe for box annealing or carburizing

Box Annealing

The method commonly followed when the pieces are not of too large size is known as box annealing, and for this treatment it is necessary to have cast iron boxes or pots and furnaces of sufficient capacity, as it must be obvious that to do this work in a manner that is commercially practicable it will be necessary to treat a considerable quantity of work at the same time. The parts are placed in the container and packed in wood charcoal or other material of that nature which has been ground or pounded into small pieces. A layer of this material is first placed on the bottom of the box to a depth of an inch or more and then follows a layer of the steel, then another layer of charcoal, then more steel, and so on. For certain small work, the material may be packed in wrought iron pipe as shown in accompanying illustration.

How Pot Is Packed

The pieces of metal should not come within one-half inch of each other or within an inch of the walls of the container at any point, and the spaces should be filled with charcoal, the metal being covered with another layer of packing material about an inch in depth. This method of packing is repeated until the box is filled, care being taken that all pieces do not touch each other or the iron walls. A tight-fitting cover is then applied, and the seams are sealed to exclude the direct heat or hot gases of the furnace, by fire clay luting. Several test wires may be placed through the top of the box, which can be withdrawn from time to time to see if the contents are at the proper temperature if no pyrometer installation is supplied. The heat should be maintained a sufficient length of time to insure a uniform temperature and thorough heating of the parts and the color of the piece should not be allowed to go over a full red, as can be regulated by the heat of the furnace and determined by the test wires. After the box and contents have been maintained at the desired temperature for the proper length of time, the heat is shut off and the whole allowed to cool

slowly, the metal being left in the container until cold.

Two Simple Methods

Often in shops there are no facilities for box annealing and other methods may be used, though the work is not so uniform as by the treatment previously described. In one of these, the metal to be treated is heated in a forge or furnace until a uniform red, and then placed on a piece of board in an iron box, the wood resting upon a bed of ashes several inches deep. A second piece of board is placed on the pieces, and the whole covered with ashes. The pieces of wood will smolder and maintain the metal at a high temperature for some time, thus insuring gradual cooling, which is essential to secure a good anneal.

Another common method of annealing is to heat the pieces to a red heat and merely bury them in ashes, which is apt to give unsatisfactory results unless the ashes are also heated, which can be easily accomplished by burying a large piece of heated iron in the annealing box. When the steel piece has been sufficiently raised in temperature, this piece of iron is removed from the ash bed and the steel part buried in its place. The whole secret of successful annealing is to gradually heat and cool the metal to be treated; and the more gradually and uniformly the temperature rises and falls, the better the character of the work.

Hardening

After the parts have been machined to the finished or nearly finished size, approved practice is to further heat treat to either toughen or harden the steel. The amount and character of treatment depends largely upon the use for which the piece is intended and the composition of the material and will be fully considered in proper sequence. Steel may be hardened by several processes, the most common of which is raising it to a low red heat or dull cherry red and plunging it in some cooling medium such as water, brine or oil, or by case hardening, which merely acts on the surface of the metal if superficial methods are used or which can go to some distance below the surface if the work is properly carburized.

Steel should never be heated to a temperature greater than required to give the desired result, and the degree varies with the composition of the steel as relates to the carbon content, the size and shape of the piece and the purpose for which it is to be used. Much depends upon heating uniformly; the edges and corners should be no hotter than the center and the interior should be of the same temperature as the surface. If this precaution is not taken the metal may crack in the cooling bath, because uneven changes take place in the molecular structure. If metal is heated in an ordinary forge be sure that no air from the blast strikes it, which will prevent uniform heating.

When uniformly heated it should be plunged in a bath to give it proper hardness. It must be worked up and down rapidly in the bath to prevent the film of steam forming, which would surround the piece if kept in one position and prevent proper contact with the cooling fluid. If the piece is long and slender it must be moved up and down, but if short and with teeth on the outer edge, as on a milling machine cutter, or gear, it should be agitated rapidly so that all teeth will be cooled uniformly. If it is flat and has a hole through it, the walls of which must be hard, it should be so moved that the liquid of the bath passes through the aperture and at the same time strikes both faces.

Tool steel should always be hardened at a temperature (about 1350 to 1450 degrees) which leaves a fine grain when the piece is broken, which can be determined by hardening a test piece from the same bar as the part is to be made at various temperatures and breaking to determine the grain. A coarse grain denotes a higher temperature than is permissible. An excellent bath for hardening small pieces is said to be easily made by dissolving one pound of citric acid crystals in one gallon of water. The container should be tightly closed when not in use to prevent loss of evaporation. It does not require much experience to distinguish the silky, smooth grain that indicates that the piece was quenched at the proper temperature as compared to the coarse crystalline fracture that shows too high a heat.

A Rough and Ready Test

The notched bar test is an old one that is very good for purposes of comparison when work is heated in a forge and the eye is the only judge of temperature A bar of the same composition steel as that of which the steel tool or part is made is used, this being either round or square section about ½ in. in diameter and eight or nine inches long. It is notched every inch of its length and the notched pieces marked with a prick punch. The piece is heated in the forge so one end is hotter than it should be and the other end just showing color. The gradation of color is noted and the piece is quenched. When cooled, it is broken into its respective parts and the point or notch that shows the finest grain upon fracture indicates that the temperature to which it was heated was the best adapted to that particular grade of steel. Each section will have a different color when withdrawn, which will be remembered by the worker from the punch marks. In heat treating the finished piece, it is raised in temperature uniformly to the color that the operator remembers as having given the best fracture on the test bar. This is a rough and ready method of temperature determination that was popular before the days of precision heat measurements and is used today in many small shops when pyrometers are not available. The table below is a useful guide to temperature approximation by color, and while it has been widely published, its inclusion will save the reader looking it up.

Pack Hardening

Pack hardening is the method employed with pieces that are low in carbon and which cannot be treated by the ordinary processes without risk of springing or cracking them. The articles are packed in an iron box with some carbonaceous material and subjected to the action of heat to cause it to absorb enough carbon to enable hardening in an oil bath. While this treatment is not generally used, it is suitable for a number of different tools, such as milling cutters and taps or dies which must be hardened without altering the diameter or pitch, also for gears. The usual material employed is raw bone, charred leather or bone black which is mixed with an equal quantity of wood charcoal, coke or similar substance, both materials being reduced to particles about the size of a pea or even smaller, depending on the character of the work.

The pieces are placed in a container and packed in the same manner as for box annealing, and as is the case with that process, it is almost as cheap, as far as heat is concerned, to treat a number of pieces as it is one, providing the

HEAT DETERMINATION BY COLOR

Degrees F.	Degrees C.	Color of Heats	
752	400	Red-visible in the dark	Tempering.
885	474	Red-visible in twilight.	
975	525	Red-visible in daylight.	
1077	581	Red-visible in sunlight.	Annealing.
1292	700	Dark red.	
1472	800	Dull cherry red.	Hardening.
1652	900	Cherry red.	Carbonizing.
1832	1000	Bright cherry red.	
2012	1100	Orange red.	
2192	1200	Orange yellow.	Forging.
2372	1300	Yellow white.	
2552	1400	White-welding.	
2732	1500	Brilliant white.	

carburizing pot be of sufficient capacity. The pieces should be wired with ordinary iron wire of sufficient size to sustain the weight of the pieces when the wire is heated if their shape permits and one end of the wire should be covered with a luting of fire clay. Several holes should be drilled in the cover for test wires If they cannot be wired together, the pieces can be dumped on a coarse mesh screen so the carburizing material will not go into the quenching bath when the heated work is ready for cooling.

The box is placed in the furnace and heated sufficiently (about 1650 to 1700 degrees) to charge the parts with carbon. The time and heat varies with the character of the parts treated. For instance, with a piece of one-half inch diameter or under the heat is maintained for about one and one-half hours, while pieces from two to three inches in diameter must be heated for two and one-half to four hours after the parts have reached the carburizing temperature.

When the furnace has been maintained at the required temperature for the correct period the pot or pots are removed from the furnace and the covers taken off. The parts are then removed by means of wires attached to them and immersed in a bath of raw linseed or whale oil or other cooling medium. They should be moved about in the liquid until the red color has disappeared and are then lowered to the bottom and allowed to remain immersed until cold. When a piece of steel one inch in diameter or larger is hardened, it should be immediately reheated over a fire after cooling, to prevent cracking, which would be caused by internal molecular changes which take place after the outer surface is hardened and unable to yield. Reheating to a temperature of about 212 to 300 degrees Fahrenheit will accomplish the desired result without materially softening the steel.

Tempering

The hardening of a cutting tool, such as a chisel or lathe tool, makes it too brittle to stand up well in use, and consequently it is necessary to soften it somewhat. This operation is known as drawing the temper and is accomplished after the part has been quenched by reheating to a proper temperature. This is ordinarily determined by the color on the surface of the tool, which must be brightened previous to this operation. As the metal is raised in temperature a light, delicate straw color appears, and then in order, a deep straw, light blue, blue tinged with green and black. When black appears the temper is gone. These colors furnish a guide to the temperature and condition of the hardened steel. The

(*Continued on page* 266)

A New System of Airplane Propulsion

THIS proposed and experimental new system of propulsion uses the reaction from the pressure of a gas driven into the atmosphere by a blast engine; this principle has been tried before, but all previous machines had a very low efficiency. Any fuel whatever can be used, gasoline, kerosene, alcohol, etc. It is forced at high pressure to a burner. The proportions of the mixture of fuel and air can be regulated by a needle valve. The explosive mixture is lighted in the first instance by a sparking plug, and after that combustion continues uninterruptedly in the combustion chamber, which is made with fireproof sides. The mixture of gas and air is exhausted through a blast pipe and four blast engines—one large and three small, as shown at Figs. 1 and 2. At the inlet mouth of each of these air is drawn in by suction. The gas and air is exhausted by the last and biggest blast engine, and makes a direct thrust against the air at the rear of the engine. By this means a difference of pressure is set up between the inlet and the outlet of the tube, and is said to result in the propulsion of the craft. To obtain a high pressure of the gas, several means are provided by the inventor.

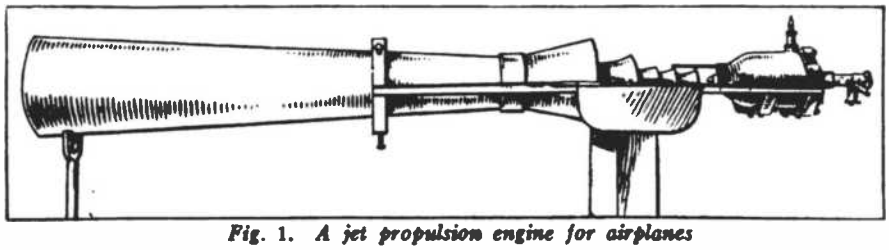
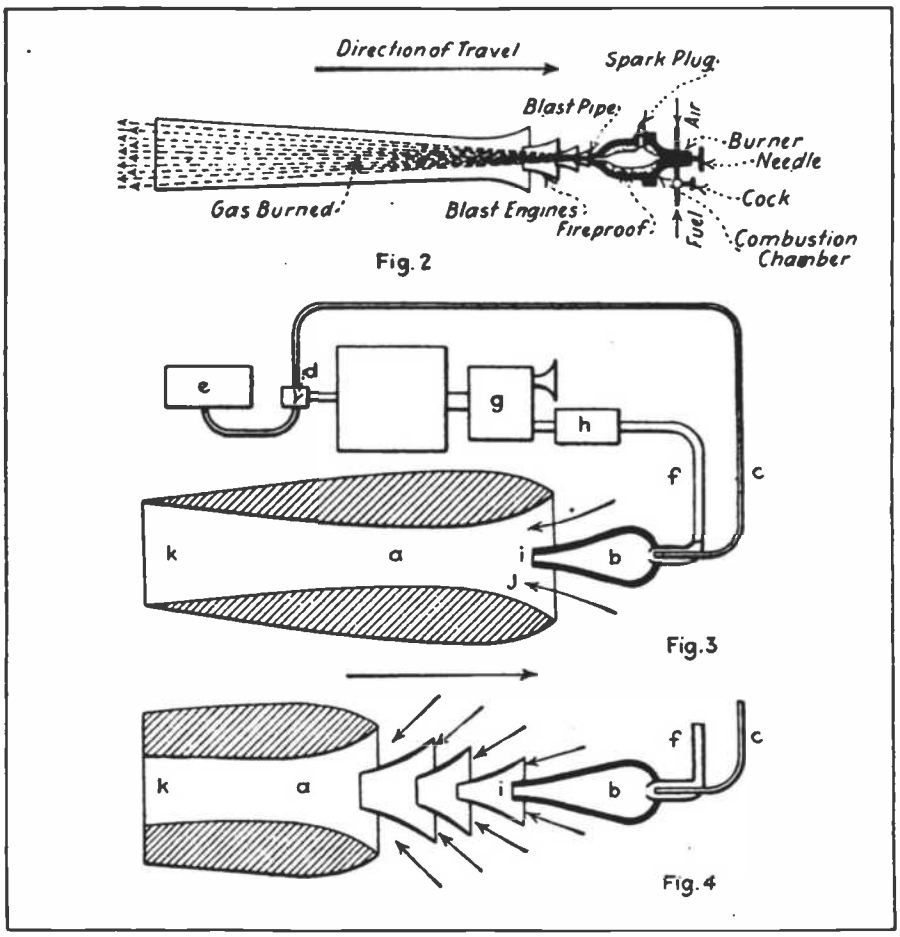


Fig. 1. A jet propulsion engine for airplanes

With reference to the sketches, Figs. 3 and 4 are modifications of the standard arrangement. In apparatus shown in Fig. 3 combustion chamber b is fitted in the front of ejector tube a, walls of b are lined with refractory material, and the chamber terminates at its front in a blast pipe i, which discharges into the blast engine a. Liquid fuel is supplied to b through c, and the air to support combustion through pipe f. The pressure in c and f is made greater than in combustion chamber b. The fuel burns inside b and the gases are discharged through i. The gaseous jet



Figs. 2, 3 and 4. Diagrams explaining principles involved in jet propulsion scheme for airplanes

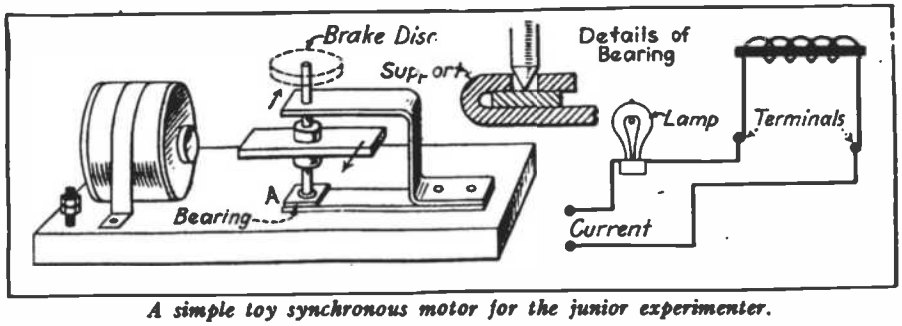
sucks in the surrounding air through j and transmits a portion of its energy to that air. The velocity diminishes in the rear portion of the blast engine, thus imparting increased pressure to the moving fluid at k. The difference in pressure between j and k exerts a thrust in direction of arrow f, and in opposite direction to that in which the fluid is discharged.

The engine shown in Figs. 1 and 2 was a trial machine; the inventor, Mr. Mélot, has been experimenting during the war at the Laboratoire du Conservatoire des Arts & Métiers with the French Ministre de l'Armement et des Inventions, and the results obtained are interesting. The machine gives 30 h.p. for a relative speed of 50 metres a second, the thrust is 45 kilogrammes. The trials gave a high efficiency.

The advantages of the system are numerous if it can be applied practically, seeing that the exploded gas pressure works directly to produce thrust to drive the machine without passing through the medium of a motor, transmission mechanism (geared engines only) and propeller. The construction is simple, as valves, pistons, connecting rods, crankshafts, water and oil circulation, etc., are all dispensed with. The weight per b.h.p. works out at .5 kilogramme (1.1 pound), which is a record in lightness, and the cost of the engine should also be extremely low. No trials of the device in an airplane are recorded, so one cannot judge its practical value by the theoretical considerations involved. Further details of actual trials in an airplane are awaited with interest, and will be sent as soon as available.—*E. H. Lémonon, Paris.*

A TOY SYNCHRONOUS MOTOR

THIS motor is designed to be run from an alternating lighting circuit. The axis is vertical, pointed at the lower end, and is supported in a frame consisting of a brass bracket screwed down to a base. Its pointed lower ends rests upon and turns upon a plate of glass, held in position by a bent plate of brass. This arrangement is shown in the small cut very clearly. The rotor is a bar of steel, which may be the armature from an electric bell. It is to be about two inches long, and through the hole in its center the shaft passes and two tightly fitting india rubber washers of rather thick stock hold the armature in place. A bobbin or induction coil with a core of soft iron wire is mounted close to the armature as shown in the cut. It will be seen that the bracket and foot of the frame and the brass part of the bearing for the foot of the shaft can all be made of a single piece of brass. The induction coil is connected in series with an incandescent lamp so as to cut down the current within safe limits, unless of course the inductance of the coil is enough to do it alone. The connection is shown in the diagram. When the current passes the armature or rotor is turned by hand tentatively, and after a few trials synchronous speed corresponding to the frequency of the current will be secured, when the motor will spin away of its own accord as long as the current passes. At the top of the shaft there is a drum, which represents a brake-drum or a driving pulley. For the induction coil a bobbin from a discarded electric bell will answer. By exercising braking action on the motor, by pressing on the little drum with the finger, it will be found that no change in the speed of the motor results. It must be synchronous in some way; it may run at a multiple of the speed indicated by the frequency of the current, but if the braking action is sufficient it will stop dead, but cannot be made to depart from synchronism, except by causing it to cease rotating.



A simple toy synchronous motor for the junior experimenter.

A TRUE EXPERIMENTER

THE late Lord Rayleigh has had his life's work commemorated in the scientific journals. He was a scientist whose work was of the nature which seemed to appeal to the less technically educated person. Investigating the sensitiveness of the ear he found that it could respond to pressure changes of one hundred millionth of an atmosphere. He found that the sensitiveness of the eye was of the same order. Investigating the action of the whispering gallery in St. Paul's Cathedral he put it, that the sound waves cling to the wall, as if hemmed in between two concentric doors. Another interesting demonstration was that to make the sound issuing from a fog-horn spread sideways in a horizontal plane, which is of course what is desired and necessary, an oblong aperture is most efficient, but curiously enough it should be a vertical and not a horizontal slot, as one would naturally suppose. Lord Rayleigh's advice to experimenters has been widely cited. It is, "Do not place too much reliance on the instrument makers." The great experimenter did his work, it is said, largely with wood, glass and sealing wax. This last fact should interest our working readers.

HELIUM FOR AIRSHIPS

HELIUM will certainly always be considerably more expensive than hydrogen, but there are two factors which to some extent reduce the importance of this. The rate of diffusion and consequent wastage with helium is only half that obtaining when hydrogen is used. This will, of course, reduce considerably the amount of gas consumed while an airship is lying in the shed, though it will not affect the loss of gas occurring while rising during a flight. In addition to the saving thus effected, helium is believed to be easier to repurify than hydrogen; although, owing to the comparative cheapness of the latter, it is doubtful whether the matter has been seriously considered.

When the purity falls below a certain figure the present practice is to "rip" the envelope and allow the hydrogen to escape into the air, the envelope or gas bags are subsequently reinflated with fresh gas. With the advent of helium, the gas will presumably be exhausted by fans into a reservoir, from which it will be taken to a purifying plant prior to being used again. This will naturally result in effecting a great saving in the amount of the gas that will be required.

The question of production is also extremely important from the practical point of view. Plants under construction capable of turning out 50,000 cu. ft. of helium daily are mentioned. This amounts to 18,250,000 cu. ft. per annum, or 1,520,000 per month. If this represents the total output of all the plants under construction it is totally inadequate. An airship consumes roughly its total capacity in gas per month, so that one modern rigid airship would require more than the whole output.

In Diesel engines an obturator has been tried to replace piston rings. This appliance is a brass or other metallic ring of U-shape in cross section, exactly like the leather ring used since early days in the hydraulic press. The pressure forces it out against the cylinder walls and it is reported as proving most effectual. It has a lap joint. It is considered good for a thousand hours running, and has operated well in a worn cylinder where piston rings failed in short order. A single obturator replaces all the piston rings.

A Study in Lenses

By J. F. Comstock

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NEARLY every person is more or less familiar with the many different types of optical instruments, such as telescopes, microscopes, reading leness, moving picture machines, opera glasses, etc. Few of us realize how the skill of the designer of these instruments was taxed in order that he might produce an article satisfactory to the user. The defects such as chromatic aberration, spherical aberration, astigmatism, coma and distortion are due to improper focusing of rays as they converge toward the axis after passing through the lens. In order that a lens may form sharp images it should focus rays of light coming from all parts of the illuminant at the same spot.

In the case of chromatic aberration, a single ray of light in traveling through the lens is divided into about six rays, i.e., red, orange, yellow, green, blue and violet. However, the red and violet rays are the only ones which are distinctly visible because the other colors overlap so much that they are obscured. In some lenses the focal spot of red light is separated from the focal spot of violet light by several inches, but almost any lens disperses red and violet enough so that they are readily found. It will be noticed that the focal spot for violet light is closer to the lens than the focal spot of red light. Then a screen placed at the focus of violet rays would show a small round spot of violet surrounded by red, and if the screen was placed at the focus of red rays it would show red in the center with a violet fringe.

A lens having this defect is not suitable for use in moving picture machines, projection lanterns, microscopes or telescopes, because its images would be fringed with colors. The correction applied consists of combining two lenses, one a convex, the other a concave, making the defect of one lens offset that of the other. Lenses combined in this manner are made of different kinds of glass. For example, one of the lenses is made of crown glass and the other of flint glass. Such a combination does not altogether prevent the dispersion of the colors, but it will generally be satisfactory for most practical purposes.

Spherical aberration is produced by a lens having different focal spots for rays of light leaving the lens at different distances from the center toward the edges. In Fig. 2 it will be seen

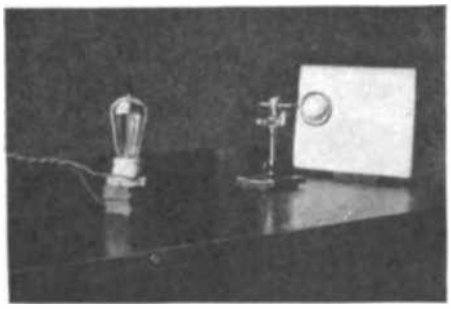


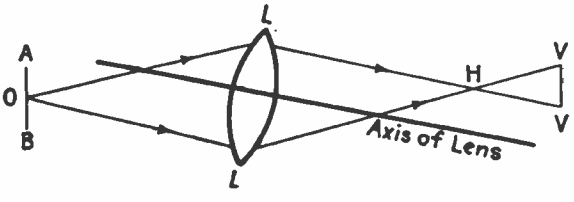
Fig. 1

that rays of light, A and B, diverging from O, reach the lens at widely separated points, and after passing through the lens are converged to different focal spots on the axis. Intermediate rays would also be present, but are not represented for the sake of simplicity and clearness in the diagram. It is clear that these rays would be focused at a succession of spots along the axis of the lens. Therefore, a lens having sperical aberration will produce a badly blurred image of objects placed a short distance away. Not only will the image be indistinct, but there will be a wide circle of light around the image causing it to be highly illuminated. Bright lines will appear dull because of the lack of contrast between these lines and the brilliant illumination surrounding the image.

Spherical aberration makes an electric light bulb very indistinct when viewed through a lens.. Fig. 3 shows a picture of a bulb after the edges of the glass had been screened. To demonstrate spherical aberration procede as follows: A reading glass is fastened into position about 8 in. from an electric light bulb and the image of the bulb is received upon a screen of white paper. The full size of the lens is used, thus admitting rays of light through the edge portion of the lens. This picture shows an indistinct image surrounded by a wide field of white light. Fig. 3 was made by admitting light from the lamp through a small opening in a screen placed in front of the lens, thereby shutting off rays from its edges. Of course, this decreased the number of focal spots along the axis because the edges of the lens were no longer used.

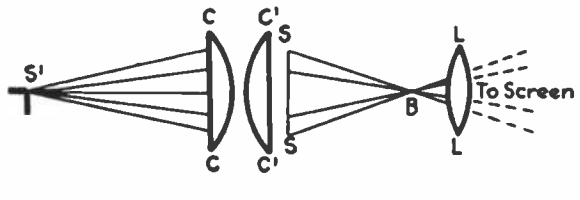
Anyone can easily demonstrate how the image produced by a lens increases in sharpness as the outer portions of the lens are cut off. Nothing is needed for the trial except an ordinary reading glass and an opaque screen which has a small opening through it. Hold the lens in front of an electric lamp and focus the image of the lamp on a piece of white paper. Now place the screen against the lens and focus again. With only the center of lens used, the image will be sharper and more distinct.

The wider the lens, the more necessary it is that it be corrected for spherical aberration, unless the lens is thick at the center, or, in other words, has a short local length. The preceding experiment demonstrates to the reader that a simple way to correct this aberration is through providing a stop either in front of or behind the lens. If one examines a camera which has but one lens, he will find that provision is made for decreasing the blurring of the pictures by using a lens of short focal length. It is also provided with a stop which may be changed in size, making it possible to use almost any width of the lens desired. Such an arrangement proves fairly satisfactory for correcting spherical aberration and is used on the cheaper grade of cameras. The success of these cameras is due to the fact that the single lens is of such shape and thickness that the distance between the focal spots of light coming from its



Shows how the lens "bb" is turned in order to have separate focal spots for vertical and horizontal lines.

Fig. 4



The arrangement of the Arc Light or Lamp (S) condensing lenses, Slide "SS" and objective lens "BB" is here shown for producing barrel distortion.

Fig. 14

edges and the focal spot of light from the center is small. It is clear that this kind of a lens does not form badly blurred images.

Lenses wihch have a large amount of spherical aberration are not suitable for use in cameras, telescopes or optical instruments which require sharp definition in their images. The means of correcting this defect in a camera lens are far more simple than the method used on telescope objectives. A camera lens usually has a short focal length compared to that of a telescope lens. On this account, the loss of brightness

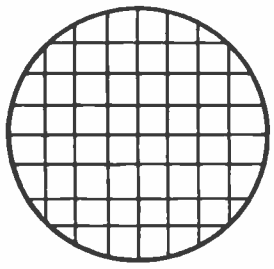


FIGURE 11

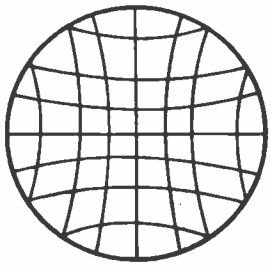


FIGURE 12
Pin Cushion Distortion

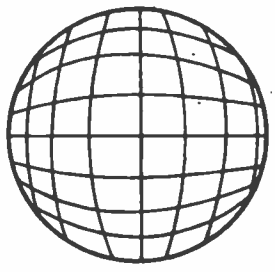


FIGURE 13
Barrel Distortion

of the image formed when the edges are screened does not interfere with the process of picture taking except that a longer exposure is required. Usually this does not inconvenience the operator. But a telescope lens in the objective must be of long focal length in order that the telescope may magnify greatly, and it also must be wide to enable it to gather enough light to illuminate the image. If the lens were narrow, as would be the case if the edges were screened to reduce spherical aberration, the image could be so poorly lighted that it would be seen only with difficulty. The method used on telescopes is too complicated for discussion here.

The presence of astigmatism in a lens, for some purposes, is as objectionable as spherical aberration. Almost any thin lens shows this imperfection, which may be readily observed by looking obliquely through a reading glass lens at the rulings on a piece of cross section paper. Under these conditions either the vertical or the horizontal lines may be blurred, depending upon the distance of the lens to the paper. A far more striking demonstration may be made by projecting the image of a cross ruled slide, made from a fogged photographic plate, upon the screen with the lens turned obliquely to the lamp as shown in Fig. 5, in which AB represents the slide and LL the lens. Light from a point O on the slide is focused by the lens along two lines, H and VV, the line H being perpendicular to the plane of the paper and the line VV in the plane of the paper. It is found by trial that horizontal lines are focused at H and vertical lines at VV. A lens, then, which has two focal spots, one for horizontal lines and one for vertical lines, has astigmatism.

In order to photograph these lines, it was necessary to use a lamp having high candle power and a frosted bulb in order that the slide might be highly and uniformly illuminated. A 100-watt tungsten lamp will answer the purpose. The slide was placed about four inches from the lens. Then the lens was set up about 6 in. from the slide so that the rays passed directly through the lens. Under these conditions the images of both vertical and horizontal lines were well formed. (See Fig. 5, which shows both lines in good focus.) When the lens was turned so that rays passed through obliquely, one or both of the lines became blurred. By changing the distance between the slide and the lens, and by moving the screen forward or backward, a position was found for the screen where the vertical line was well focused, and the horizontal line blurred, or even obliterated, and vice versa. Figs. 6 and 7 were obtained by placing a photographic plate at the focal spot for each line and by exposing for an instant. In obtaining these pictures for the purpose of illustration, the amount of astigmatism was exaggerated by throwing one of the lines completely out of focus.

Lenses having astigmatism cause considerable annoyance to the designer of instruments which are used to form images of straight lines running in different directions. There is no known method of correcting such lenses by combining other lenses with them so that the defect of one lens corrects that of the other, as was the case in chromatic aberration, and neither will the use of a screen to shut off the edges of the lens correct this defect. In fact, the design for a lens system free from astigmatism, called a stigmatic lens system, is accomplished by trial guided more or less by detailed mathematical calculations, the discussion of which is beyond the scope of this article. A stigmatic lens system should be used in projection lanterns, copying lens for maps, architectural plans, etc.

Perhaps one of the most interesting of the imperfections of a thin lens is coma. The most pleasing feature of this defect is the facility with which it may be illustrated. The only difference between astigmatism and coma lies in the width of the band of rays which pass obliquely through the lens. It is not even necessary to use a cross ruled slide. It is found that light from the lamp as arranged for astigmatism except the screen will form at H (Fig. 4), a flare illustrated in Fig. 9, and at VV (Fig. 4) a flare which is shown in Fig. 8. If the reader desires to reproduce these flares, he can easily do so by holding an ordinary reading glass in front of a strong electric lamp so that the rays of light pass obliquely through the lens, and by receiving the flares on a white screen. In order that both flares may be seen separately, he should focus for one and then move the screen until the other flare comes into focus. The presence of coma in a lens is as objectionable as the presence of astigmatism. It must be corrected or the images formed by the lens will be worthless. The correction of coma is as involved as that of astigmatism and is worked out in the same manner.

The image formed by a simple lens is generally distorted. Thus, Fig. 11 represents a square network of lines, and Figs. 12 and 13 are illustrations of two kinds of distortion, barrel and pin cushion. The cause of this distortion is due to the difference in magnification near edges of the field of view and the center. In Fig. 12 the magnification is greatest at the edges of the field of view, and in Fig. 13 the magnification is greatest at the center.

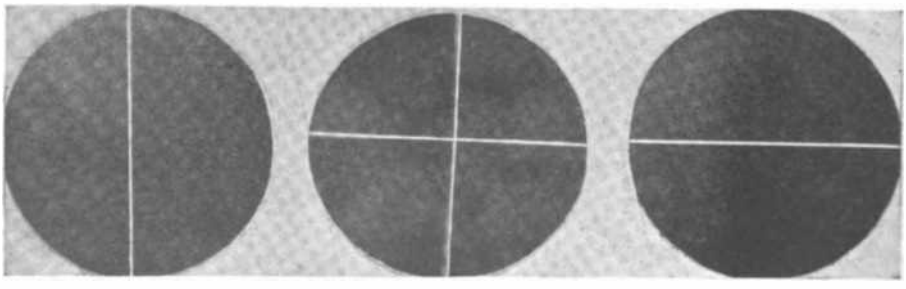


Fig. 6 *Fig.* 5 *Fig.* 7

A most striking illustration of distortion may be obtained as follows: A magic lantern is provided with a thin objective lens LL (Fig. 14). The image of a cross ruled slide is projected upon the screen. For this experiment either an arc light or a 250-watt lamp is needed to furnish the illumination.

The distance of the lamp from the condensing lenses CCC'C' should be so adjusted that the light after passing through these lenses is concentrated at B, Fig. 14, as if the point B were a small hole in the diaphragm in front of the objective LL. In this case the cross rulings as projected upon the screen appear like Fig. 13. If the lamp is now adjusted so that the light after passing through the condensing lenses is concentrated at B, as if B were a small hole in a diaphragm behind the objective lens, then the cross rulings will appear like the lines in Fig. 12.

These experiments show that one or the other of these distortions will appear according to the position of the diaphragm in front of or behind the objective lens. The convergence and the divergence of the beams of light may be easily seen by agitating small particles of dust in the region both in front of and behind the objective lens.

One can now see in a general way that distortion may be corrected by using two thin lenses with a diaphragm placed between them. Such a lens system is called a rectilinear or orthoscopic lens system. It will produce erect images and is very useful in photographing buildings, or for making accurate copies of drawings. A kodak equipped with rectilinear lenses makes a very satisfactory kodak, and will respond to almost any purpose for which a kodak is likely to be used.

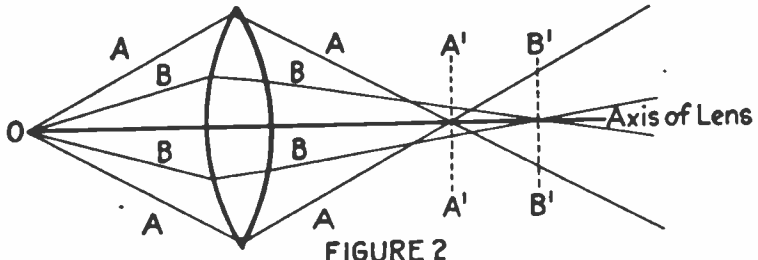


FIGURE 2
Showing the different focal spots for rays of light from different regions of the lens.

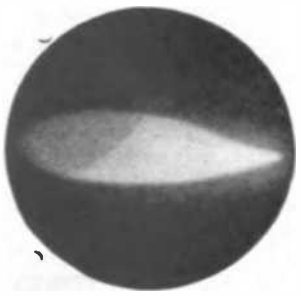


Fig. 8

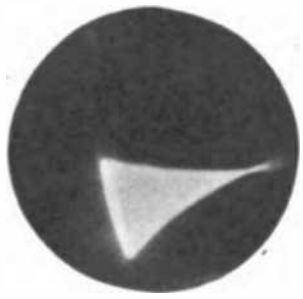


Fig. 9

Dressing an Alundum Stone

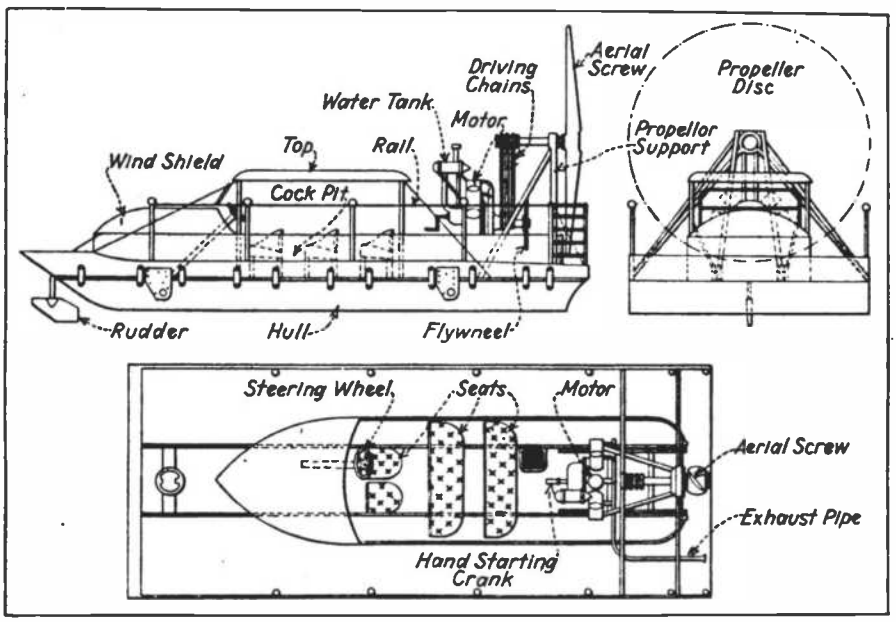
OUT of the raw material for bases, and awaiting more, I looked around my workshop for things which wanted doing. An examination of my alundum stone disclosed a distressing condition of that patient sufferer. Exigencies of floor room had located his giddy career in a dark obscurity. In the penetrating light of truthful day I gazed on his war-worn profile. He had gone to service three months ago in his remote station, an honest 4 in. by ¾ in. true and upright abrader; he was now a stale bath cad from which the currants had been stolen by fingers which left their larcenous indenture. Of course, I know now how he could and should have been cured, but star dressers and holders do not grow on the hedges in old Tyrone. Mounted on a mandrel and slowly rotated, the sufferer seemed hopeless, even if I could find means to grind away the superfluities of his constitution-to-be. If steel caused his present state, steel could cause a better state. Alas, for my high speed tool; half a minute's facing with it convinced me that was not the way to get a face on Alundum if I wanted my tool again. Try an old file! So the old file takes its place in the post. That file was ashamed of itself in twenty "whirls" and retired to its pensioned leisure. In assisting its retirement I tumbled on my head a piece of a broken Carborundum stone about 4 in. long and about a square inch section. Not large, indeed, but the material is uncompromising, and falling from a heavenly direction on the top of your thoughtful brow into your mouth, and from my mouth that thought issued, translated into "The very thing!" First repairing the damaged brow with a felt fastener, I bore the offending Carborundum again and "faced." Excellent, till about half in, when the forces of nature expressed themselves in a "jam," followed by a "d—." But something was happening, some dust was flying. Back and try again. No, "jam" again. A third try —worse! No, that is not the way, but apparently it is part of the way. If I could get the hills chiselled off I might get it. A few minutes with the chisel and hammer convinced me I could chisel bits off alundum. Nevertheless, light came into my darkness from this effort; this also was part of the way. So back to my Carborundum stone in the post; feed in, in rapid, short advances and withdrawals. Magic! I get right in to the mandrel, back and give the lead screw a quarter turn and "jab" at the face again. In again; now I am getting a face. Keep at it; in ten minutes I have a perfect face, but, alas, it is a beautiful cone. The Alundum certainly comes away, but, in lesser degree, does the Carborundum, and they face each other beautifully at an angle of nearly ten degrees. "Jabbing" in the tool post cannot cure that evidently. Well, as it is in the post, let us try the periphery of the Alundum. Feed in slowly, feed across rapidly back and forward. Beautiful! But, alas, I have nearly three-quarters of an inch to take off the diameter before I get a ssuare or nearly square corner with the face I have done; but I have a perfect periphery. The other face is then done, with like "coning" result to the first face. How is this to be cured? Well, I think I have learned that to dress Alundum I must hit it whilst it runs, and runs fast. Accordingly, I take the Carborundum stick, or stump, in my hands, get the tool post out of the way, and rub it vertically up and down, much as I see the harvester sharpening his scythe, against the coned face as it revolves, feeding in to the mandrel. Remarkable; in two minutes I have a true face, and in four minutes (will say six, if you like; time was made for trades unions) I have a perfect stone. In a minute more the calipers verify my eye, and the rule persuades me I have a stone now 4¼ in. by 7/16 fit for the front again.

All very painful to him who knows, of course, but I took more pleasure in that little stone regenerated out of my sheer ignorant perseverance than in getting a dozen new ones on credit. I now know all about the star dresser, and also the inertia stone dresser, and I know their working principle from my painful progress, but I also know now I can do without either and produce as good a job with a piece of another abrader rescued from the scrap heap to bring salvation to another erring spinner.

From "The Model Engineer and Electrician," London, England.

A SEA-SLED ON THE TIGRIS RIVER

THE names Tigris River and the city Bagdad bring one's thoughts at once to the "Arabian Nights" and to the great World War. It is on the waters of this river that the craft illustrated has been most successfully employed. The diagram with the legend tells the story of its construction in general. It weighs 5,500 pounds and is driven by a 250 h.p. Salmson gasoline engine, which actuates an aerial propeller at the stern of the boat. Up to a power rendition of 120 h.p. its efficiency is low, but as the power increases it gathers speed, and at 19 miles an hour begins to plane, and at 130 h.p. the speed runs up to 37 miles an hour and at 160 h.p. it shows 43 miles per hour. When it reaches a speed of 56 miles an hour the air resistance becomes



French sea-sled propelled by aerial screw used on Tigris River

the controlling factor. The aviation motor used to drive it is never put to more than half its rated power, and hence lasts very well. It takes about half the power of an ordinary speed boat. It is said that the French Government proposes using this type of boat quite extensively in their colonies. Its light draught is a most important feature on many rivers. At full speed or above the critical point the resistance sums up to that of the air added to that of a mixture of air and water against the bottom of the hull. The official report says that many and excellent trips were made by it on the Tigris. It has gone from Bagdad to Baidji in five and one-half and in six hours, a distance of 180 miles. The sea-sled principle, as it may be termed, is no new one; Lambert, in 1904, got over 22 miles an hour and Tissandier, in 1913, with 160 h.p., attained a speed of nearly 60 miles an hour. In comparison with Tissandier's record a 1,200 h.p. speed launch of the displacement type is cited which could only give a mile and a quarter better rate per hour.

CURRENT REQUIREMENTS IN DENMARK

DENMARK is at present supplied from 497 central stations having a total output of 108,000,000 kilowatt-hours per annum. The net sale to 205,000 consumers is 30,800,000 units for light and 54,700,000 units for power. The average net cost per unit in 73 towns is 4½d., in 387 villages 7½d., and 37 agricultural district 3¾d. The high cost in the villages is chiefly due to the load factor, which seldom reaches 0.10, and in a smaller degree to the high cost of fuel. With regard to future developments, it appears, according to the *Technical Review*, that a scheme is being considered which will enable a supplementary supply of electrical energy to be obtained from Norwegian waterfalls. The distance from the nearest suitable falls to Copenhagen is about 75 miles, and it is proposed to send 26,000 kilowatts at a pressure of 50,000 volts by an overhead transmission line running through Sweden to Malmô, and thence by submarine cable across the Sound to Copenhagen. The engineering difficulties in connection with this proposal are easily overcome, but the economic question presents some difficulty, as a low load factor would require a very expensive transmission line, and necessitate high prices to consumers. The estimated requirements of the country, provided cheap energy can be supplied, are about 450 million kilowatt-hours per annum.

PREVENTION OF DOPE POISONING

WORKMEN who apply dope to wing fabrics find it difficult to avoid the occasional splashing of dope upon their hands. When protective gloves are not worn the dope dries upon the skin to a film that is removed only through the use of strong solvents. Some workmen soak their hands in dope thinner (acetone, benzol, methyl acetate, etc.) in order to remove the dried dope films. As a result, cases of so-called "dope poisoning" have been observed. In some instances the hands may become greatly swollen and covered with an eruption.

It has been found possible to largely eliminate such trouble by having the workmen rub vaseline, glycerine or similar emollients upon their hands previous to starting work. The dried dope does not then readily adhere to the skin and may be removed at night by rubbing the hands with further quantity of emollient followed by washing with soap and water. A further application of emollient will serve to keep the skin from becoming dry and cracked.

Dopes containing tetrachlorethane, a toxic volatile solvent which causes pronounced jaundice to those inhaling it for protracted periods, is not approved in dopes used by the Navy Department. The solvents now used are relatively non-toxic. Their vapor, however, should be removed from dope rooms as rapidly as possible in order to provide plenty of fresh air for the workmen. This may be accomplished by the use of revolving ventilating fans placed at the floor level in order to rapidly withdraw the vapors, which are heavier than air. The inlet vents for the fresh air should be about 12 ft. from the floor level. Provision should be made for cleaning the incoming air and passing it over temperature regulating coils so that the temperature of the dope room should be approximately from 68 to 72 deg. Fahr.—*Bureau of Construction and Repair, Navy Department.*

ADHESIVE FROM SNAILS

MANY of the larger kinds of snails have at the extremity of their bodies small white bladders filled with a gelatinous substance. The *Scientific American* claims that this is the strongest adhesive known for the repairing of porcelain, glass, etc. The substance is applied thinly to both sides of the fracture and the broken piece is tied firmly together so that all is held in place. A rather longer time for drying should be given than in the case of ordinary adhesive so as to allow the natural glue to acquire the greatest degree of strength. When it is once really set the tenacity of this remarkable adhesive is astonishing.

The Gear Shaper and How It Works

A Description of the Principle Involved in Generating Gears by a Special Shaping Machine Using a Very Simple Cutter that Is Capable of Doing a Wide Variety of Accurate Work

WHEN one mentions gear cutting to the average machinist or mechanical man, the conventional milling machine, index head and revolving, formed milling cutter comes to mind. There are other ways of cutting gears that have advantages besides milling the teeth on the blanks by a formed cutter that removes the metal by a modified sawing action. The student or apprentice machinist will be interested in the description of gear shaper operation that follows and the more experienced machinist will readily perceive some advantages of the shaping process especially in making shoulder and internal gears.

The Fellows gear shaper, shown in an accompanying illustration, represent a type of gear-cutting machine that works on the generating principle, as it employs a gear-like cutter which generates the teeth of gears by a shaping action. The principle upon which this machine works is comparatively simple. Essentially, it is similar to the action of two gears in mesh, one the blank being cut and the other the cutter. The cutter is similar to an ordinary gear, except that it is provided with clearance on the teeth to permit of free cutting. This cutter is reciprocated up and down by means of a shaper ram, and at the same time work and cutter are slowly rotated in unison with each other.

Features of the Gear Shaper

The gear shaper has many interesting features embodied in its design. One of these, which is worthy of special attention, is the work-spindle and illustrates the principle of construction. The work-spindle is held in an apron which is hinged to the cabinet and is operated by a relieving mechanism which withdraws the work from the cutter on the return stroke of the latter. This work-spindle is of the reverse taper type. In other words, the work-arbor on which the blanks are held has a reverse taper and the more tightly the blanks are clamped to the work-spindle, the more tightly the arbor is held in the spindle; this forming a very rigid construction. In addition to this rigid support in the work-spindle, the work is also additionally braced by a work-support, which resists the thrust of the cut and greatly assists in eliminating all cutting strains.

Indexing Mechanism

It can be truthfully stated that a gear-cutting machine stands or falls on the merits of its indexing mechanism. It is the critical point in its design. The diagram, Fig. 3, shows the indexing mechanism employed on the Fellows gear shaper. It is of the continuous indexing type. It will be noticed in this diagram that both the upper and lower index wheels are tied together by change gears, and are entirely independent of the cutting mechanism. This feature on the gear shaper greatly assists in the production of accurate work.

Productive Capabilities

From the standpoint of production there are certain features about the gear shaper that are worthy of attention. One is that when compared with the hob or milling cutter, it is a much more efficient remover of stock. As is shown in Fig. 4A, the hob or milling cutter re-

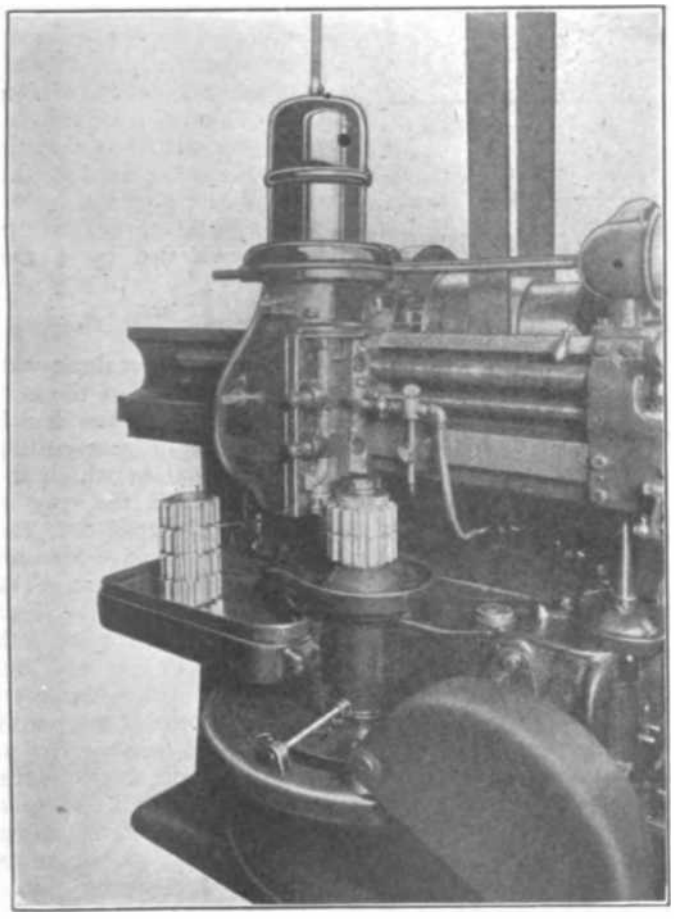


Fig. 1—Gear shaper cutting two 7/8-pitch stub tooth pinions for tractor work

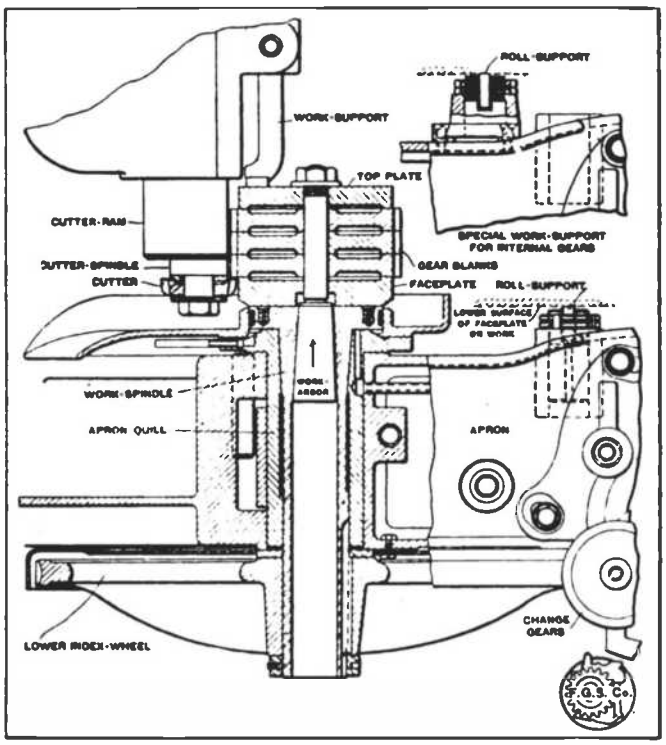


Fig. 2—Sectional diagram showing work-support and cutting ram of gear shaper, also design of work-arbor

moves a chip of varying thickness. It starts with a paper thickness and finishes at the top with a chip of greater thickness. The case is otherwise with the gear shaper cutter. Here, as is shown at Fig. 4B, the chip has its full thickness for the entire length of stroke. The gear shaper cutter in making a chip has a two-fold advantage. In the first place, it starts in at maximum thickness and keeps it up to the end of the stroke. In the second place, it gets under the metal at once, and in addition, owing to the rigidity of the cutter-slide, deflection of the cutter once it is buried in the work is impossible. This is very important, especially when cutting hard alloy-steel gears.

Another feature of the gear shaper is the small amount of excess travel necessary as compared with the milling cutter or hob. The milling cutter or hob has to travel the distance X before getting into full depth as shown in Fig. 4C. It therefore must be fed that much more than the width of the gear being cut. With the gear shaper cutter, the excess stroke need never be more than 3/16 of an inch greater than the width of the gear; just enough to allow for relieving the cutter and returning it at the end of the next cutting stroke. This is shown at Fig. 4D.

Coarse Feed and Fine Finish

Coarse feed and fine finish is another advantage of the gear shaper cutter as compared with the hob or milling cutter. The gear shaper cutter and the work rotate together, as indicated by arrow in Fig. 4E, while the cutter is reciprocated as a shaper tool in a direction at right angles to the illustration. The successive outlines in the figure show the position that the cutting edge occupies for each successive stroke. The distance between any two adjacent outlines indicates the thickness of the chip at that point. One of the chips has been cross-hatched to show its shape. Here it will be noticed that the thickest part of the chip comes in the middle of the tooth space away from the finished surface. As the chip approaches the finished surface it runs out to a thin edge, which is just the right condition for a fine finish. This illustration is greatly exaggerated so that conditions are much better than they appear in the illustration.

Cutting Helical Gears

The description, previously given, has referred to the gear shaper as it is built for the cutting of spur gears. The gear shaper is also adapted to the cutting of helical gears, and accomplishes this in a very unique manner. The principle of the machine is similar to that used for cutting spur gears, with the one exception that a different form of cutter-slide is used and a different type of cutter. Fig. 5 shows cutter-slide, cutter-spindle and cutter assembled, but removed from the machine. Here it will be noted that the cutter used, instead of having teeth like any ordinary spur gear, resembles a helical gear with the one exception that the cutting face of the teeth are located at right angles to the helix angle of the teeth.

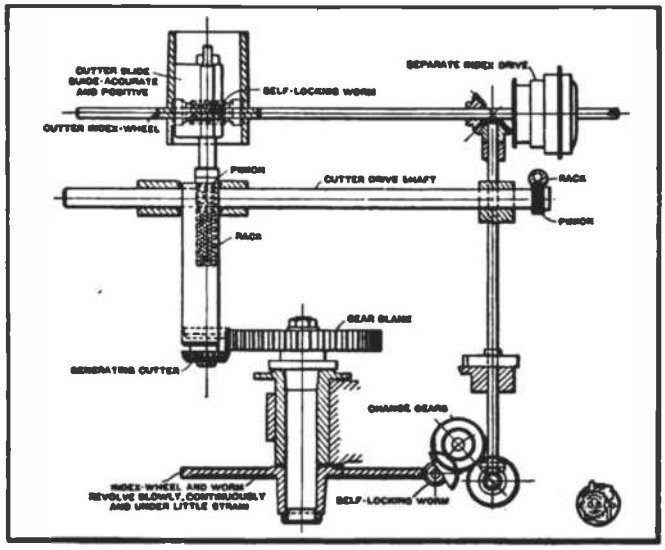


Fig. 3—Diagram explaining action of gear shaper indexing mechanism

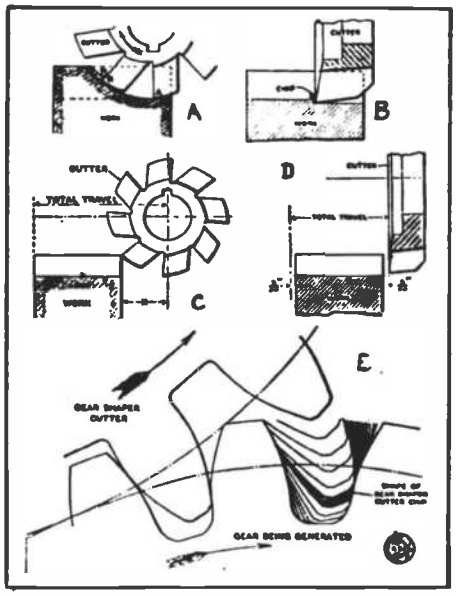


Fig. 4—Diagrams showing advantages of gear shaper cutter

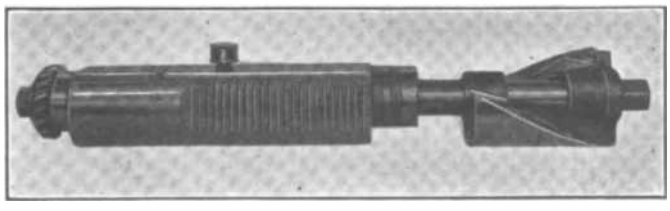


Fig. 5—Cutter-slide, cutter and cutter-spindle of gear shaper for helical gear work

It will also be noticed that the guide is of twisted form. This guide has the same helix angle as the cutter and by means of a shoe in the worm-wheel housing controls the action of the cutter as it is reciprocated back and forth past the face of the work. In other words, the helical guide controls the helix angle of the gear that is being produced, and it is in this one feature that the gear shaper differs from all other gear-cutting machines used for cutting helical gears. In other words, the helix angle of the gear being produced is under absolute control, because it is not accomplished by change gears and the setting of index heads which are not easily so controlled. Another feature of the helical gear shaper is that the gear shaper cutter used for this work is ground all over after hardening, including the involute curves of the teeth which are generated by a precision process.

Adaptability of the Gear Shaper

The preceding description dealt with the features of construction of the gear shaper, and we have shown how it differs from other types of gear-cutting machines in the method in which the cutter works, and also in the way in which the cutter is controlled. The gear shaper has other exclusive features which give it considerable range of adaptability. Fig. 1 shows the gear shaper cutting two 7/8-pitch stub tooth pinions for tractor work, whereas Fig. 6 shows the cutting of a shoulder gear. In order to cut this form of gear with a rotary cutter it would be necessary to have a much wider space between the flange and the gear teeth. The gear shaper can be operated into a narrow recess, and is thus adapted to the cutting of this form of gear.

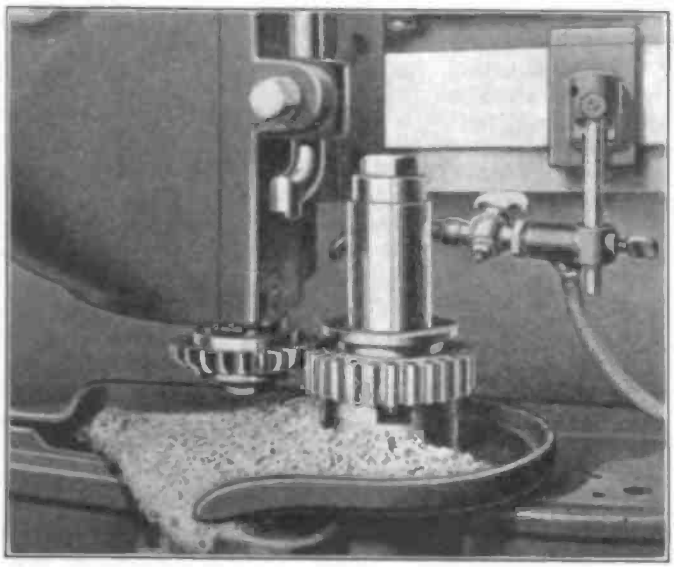
Another form of gear which shows the range of the gear shaper is illustrated in Fig. 7. This three-step gear for a gas engine transmission is made in one piece. The gear shaper cutter can be used for generating all three steps with ease and precision. This form of gear cannot be generated on any other type of gear-cutting machine.

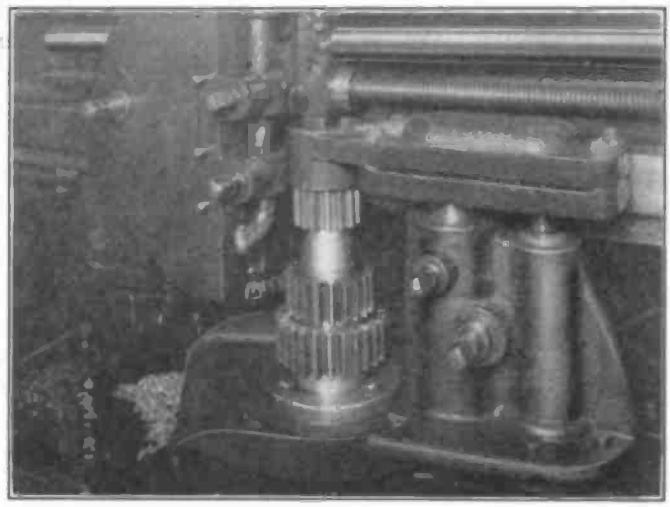
In connection with the description of the helical gear shaper, previously given, it was stated that the cutter was controlled in its action on the work by means of a helical guide, but no men-

tion was made of the range of this type of machine. Fig. 8 shows the helical gear shaper generating a combined internal and external helical gear the same cutter being used for both external and internal gears. The helical cutter can also be worked into a narrow recess, which is a feature that is of prime importance to designers desirous of producing compact mechanism.

England, Franklin and Cameron in this country went through a full range of experiments with air-cooling, followed by water-cooling in the case of the European manufacturers and early users of the products of some of these pioneers recall that they failed rather because of lack of the materials now available than for lack of the specific knowledge based on experience which

ready for use and in making pipe may prove to be applicable for fin-jacketed cylinders of plain concentric form, with removable head. Tungsten irons have been used for air-cooled cylinders and in the field of aeronautical engineering, we see a number of examples of aluminum cylinders with steel or iron liners, the aluminum having greater heat conductivity than either iron or steel. The





Figs. 6 and 7—Examples of work that can be done on the gear shaper

RENEWED INTEREST IN AIR-COOLED ENGINES

THERE is a renewed interest in the air-cooled cylinders that points to a return to the earliest experience with light internal combustion engines, for it is a fact that the first specimens beyond the experimental stage were unjacketed, and it is also noteworthy that, when indirect or water cooling was first applied, it was limited to the regions of the cylinder head and valve chambers. De Dion and Aster, in France and Lanchester and Holden, in

is now found in so many text books.

The problem of materials which combine higher conductivity with freedom from distortion and which are capable of withstanding prolonged spells of a high working temperature, is still formidable, but it may be that its solution will be found rather in improved foundry methods than in some new grade of material. On this score, it may be well to note that the "whirling" method—American by the way—of casting, now being used with some success for casting piston rings almost

use of alloy steel air-cooled cylinders machined from the bar or forging and having flanges machined therein is too costly for automobile engines. The Franklin automobile engine and the various motorcycle power plants prove that air-cooling is practical when properly carried out.

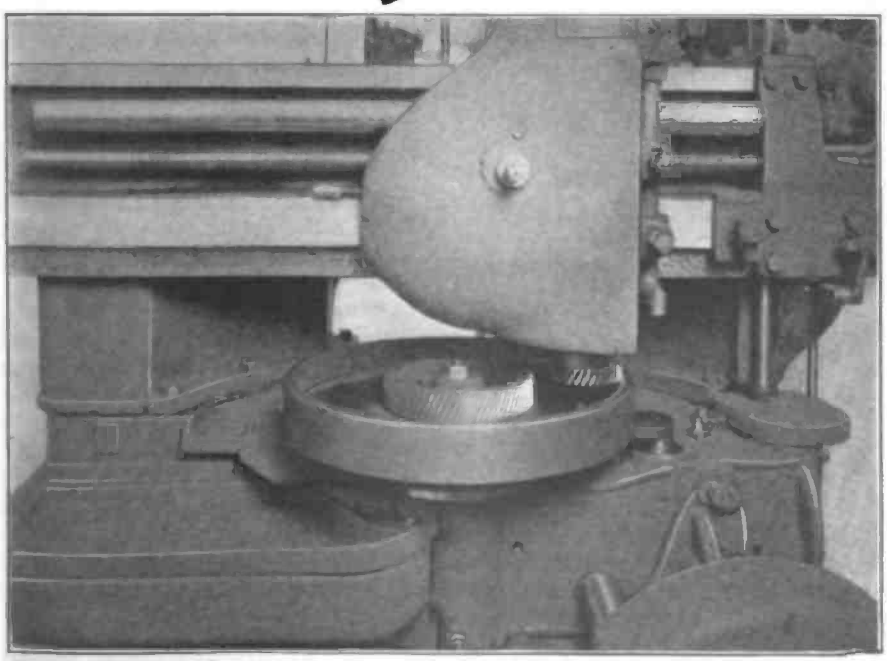


Fig. 8—The gear shaper is capable of cutting internal or external helical gear teeth with the same cutter

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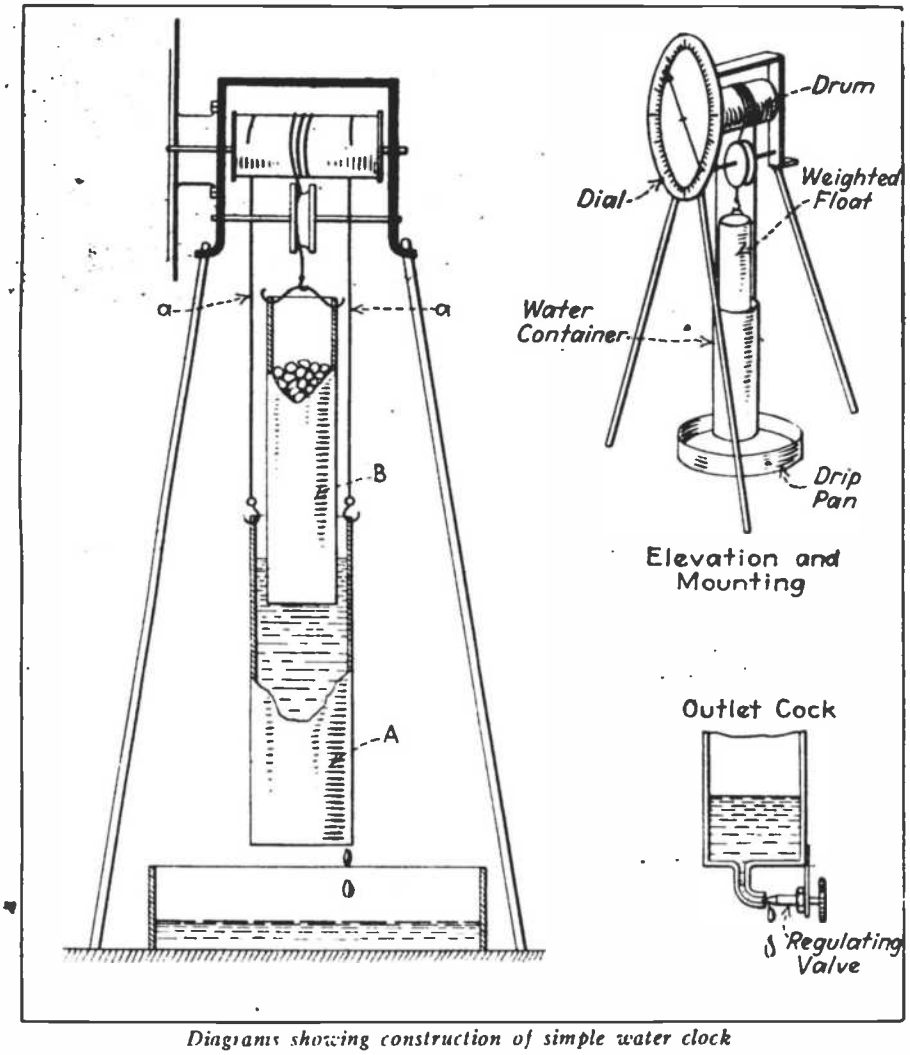
General Squier's report on the work of the United States Signal Service Corps states that of all electric apparatus regarded as adequate at the beginning of the war, hardly a single piece was in operation at the armistice. The *London Electrician* comments with great favor on the document and is especially pleased at its early issue. Whatever good has been done by the corresponding English department is unknown for lack of a report. The American department drew men in from telegraph and telephone companies. A million batteries were produced, and over a hundred thousand telephones, and over eight thousand sets of one single type of wireless apparatus were sent to France. Seventeen hundred miles of pole lines were erected in France and 37,950 miles of wire were laid.

In France a company is going to make artificial fuel from lignite and peat by a special process. In the same country fine refuse coal is saved, often on the smallest scale by householders, by mixing clay with the culm as a binder. It is said that the process has been known in Wales for centuries. From South Africa come reports of enormous coal deposits in the vicinity of iron beds. The coal situation of the world is far from acute apparently.

A SIMPLE WATER-CLOCK

A CLOCK, whose movement is produced by the escape of water from an orifice, represents one of the earliest mechanisms for the indication of time. In the cuts are shown a very simple construction of clock in which one of the difficulties incident to such devices, irregularity of movement due to the changing level of the water, is almost completely obviated.

At the top of a frame is carried a drum, to the front extension of whose axis is attached a clock-hand. A dial, marked with the hours of the day, is also there, the axis of the drum passing through it, thus bringing the index or hand in front of the dial, as in any clock. To two cords, a, a, wound on the drum, both in the same direction or sense, is attached the cylindrical vessel, A. When the clock is wound up the vessel, A, is at its lowest point and is full of water. Suspended by another single cord is a second cylinder, B, nearly of the same diameter as the other. A guide pulley, b, over which its suspending cord passes, keeps it in line with the other cylinder, into which it descends as the first one rises. This reverse motion of the two cylinders is brought about by the suspending cord of cylinder, B, being wound in the opposite sense to that of the cord of cylinder, A. An opening at the bottom of the cylinder, A, permits the water, with which it is charged when the clock is wound up, to escape. It is here that the distinctive feature of this clock appears. As the water escapes from A it tends to rise because the cylinder, B, weighted with shot, pulls it upward. But as it rises, the cylinder, B, descends into it and acts to maintain a nearly constant water level within it. The result of this is that the water escapes with a nearly uniform rate, giving a uniform action to the hand on the face of the dial. The small cut shows a construction of adjustable outlet for the escape of water.



Diagrams showing construction of simple water clock

WHALE'S LIVER FURNISHES PERFUME

AMBERGRIS, which forms a basis for the best quality perfumes and scents, is found as an unattractive looking mass floating on the sea or lodged on the shore. History does not record how such an unlikely substance suggested itself as a perfume, but it has been in use for centuries. Its origin, however, has been known for a comparatively short time. It is a morbid secretion of the liver of a sick sperm whale, and ashen-colored and waxy in appearance. Although unpleasant in sight and touch, it gives off a fragrant musky odor when warmed, even in the raw and unprepared state. It is subjected to chemical action to extract the active principle, called amberine, from which the perfume is actually derived. This material is also used as a remedy for catarrh and nervous diseases and is very valuable. The largest pieces on record weighed 130 pounds.

REMOVING GASOLINE FROM NATURAL GAS

THE belief which has prevailed in more than 2,100 towns and cities in the country where natural gas is used that it was being robbed of a portion of its heat value by the gas companies through taking the gasoline from the gas has been upset by the result of a series of investigations made by the Bureau of Mines. These showed that the natural gas consumers, which are in excess of 2,000,000, lose practically no heating value through the process. In fact, the Bureau claims that the taking of the gasoline from the natural gas is a benefit to the consumers and to the country as a whole rather than a detriment.

The heat value of 1 gal. of gasoline in natural gas is approximately 1¼ cents, while this same quantity of gasoline is worth from 25 cents to 30 cents to the automobile user. By removing the gasoline from the gas 1 gal. will equal 35 cu. ft. of gas, but this is not taken from the consumer since the gas is measured at the meter in his residence or place of business and he actually obtains 1,000 cu. ft. of gas irrespective of whether the gasoline is removed or not.

When the gasoline was not removed the gas companies experienced difficulty due to the condensation of gasoline and water in the pipe lines, the mixture disintegrating the rubber gaskets in the couplings with a resultant large leakage of gas and the consequent lowering of the pressure. If this gasoline were not taken from the pipes the Bureau states that several hundred million gallons of gasoline of the highest fuel value and adaptability would be practically wasted instead of being added to the country's supply. All of the gasoline obtained in this way has a low boiling point, that is, it vaporizes easily, which makes it valuable for starting automobiles, especially in cold weather.—*U. S. Bureau of Standards.*

In testing aeroplane engines in England, trouble was found in reaching accurate results on account of the different sizes and inaccuracies of the carburetor jets. Eventually they were tested by measuring the rate at which gasoline would flow through them and this was found to be far superior to any attempt at gauging. It was found to be so accurate that when an airplane was shipped without its carburetor one could be picked out by this simple test which would fit it.

Systematic Location of Carburetor Faults

Where Defects Are to Be Looked for in Modern Float Feed Carburetors and How They Can Be Located by a Systematic Inspection and Knowledge of Symptoms Denoting Trouble

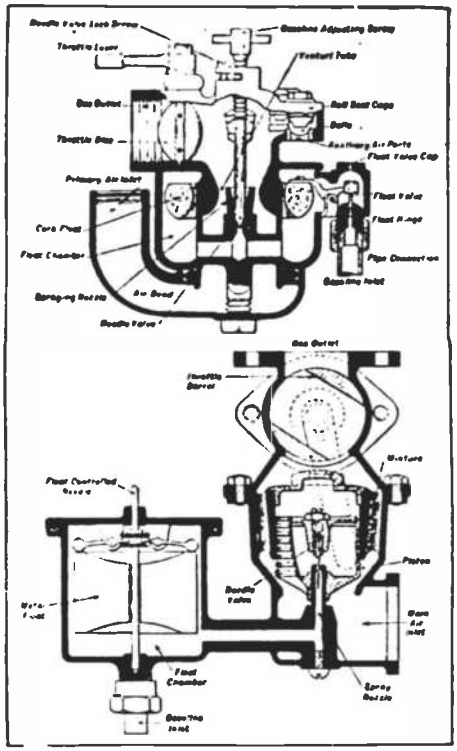
By Victor W. Pagé, M. S. A. E.

HAVING once learned how to adjust a carburetor to supply the properly proportioned mixture for different operating conditions from instructions in last issue, the motorist will realize that he has found a remedy for many motor ills, because a large proportion of motor troubles, such as misfiring, backfiring in the carburetor, loss of power, etc., are generally due to some faulty carburetor adjustment. There are, to be sure, a number of other troubles likely to occur, and while the symptoms are similar to those caused by ignition system faults, the operator who is familiar with carburetor action should have no trouble in locating them quickly and ascertaining positively if they are the result of faulty carburetor action or due to the ignition system.

Taking up the various causes which contribute to loss of power, misfiring and trouble in starting the motor, we have: Dirt or water in the carburetor, clogged fuel pipe, obstructed spraying nozzle, clogged gasoline filter, leaky metal float or fuel logged cork float, poor or stale gasoline, a loose throttle valve or connection and air leaks in the inlet manifold. If the motor refuses to start and the ignition system is known to be in good condition, the fuel tank may be emptied, the gasoline line shut-off valve closed (it may jar partly or wholly in the "off" position), there may be dirt or water in the carburetor or a choked fuel pipe, or perhaps the fuel level is too low in the float chamber. As a cold motor and stale fuel are the most common hindrances to prompt starting, the first step is to prime the carburetor and fill the float chamber with fresh gasoline. Almost every carburetor is provided with a "tickler" and in most cases priming is all that is needed to supply gasoline enough to insure prompt starting of the motor.

Start a Systematic Search

However, if the motor still refuses to operate, the trouble is deeper seated and should be found by a systematic search. To locate the trouble without undue delays the various parts of the fuel system should be examined in turn. First, the tank should be looked into to see if it contains sufficient fuel. The filter screen of the carburetor should be removed and cleaned, since the fine mesh is very likely to become clogged with dirt or lint filtered out of the fuel. If the wire gauze is in good condition, examine the pipe line for obstruction. Test the supply pipe by opening the drain cock under the float bowl of the carburetor; if the pipe is constricted, but little or no fuel will be forthcoming. If no gasoline issues and there is plenty of fuel in the tank and one is sure the drain cock is not stopped up,



Sectional view at top shows concentric float carburetor with cork float. In the design shown below, the float chamber is at one side of the mixing chamber and a metal float is used

it is reasonable to assume that the supply pipe is choked and it should be removed and cleared out as previously described. If the obstruction is not in the pipe it may be located in the shut-off valve, or perhaps in the fuel line filter.

Obstructed Spray Nozzle Common Fault

An obstructed spraying nozzle or jet will sometimes be found the cause of trouble, as the opening in this standpipe is very small, even a tiny particle of foreign matter will be enough to constrict the orifice and so deprive the motor of the proper amount of fuel. Flooding the carburetor will sometimes dislodge the obstruction but if it does not the spray nozzle should be removed and a fine wire poked through from one end to the other. Compressed air may be used as outlined in an accompanying illustration. Fine particles of lint sometimes work through the strainer and collect into a ball, which floats about and is drawn into the nozzle by the suction of the engine. In cases of this sort the motor will start easily but invariably commences to misfire, slow down, and finally come to a stop. This peculiar behavior is caused by the greater suction at high speeds, which draws the foreign matter in the jet and so chokes the bore, but as the motor slows down and the suction decreases the obstruction will fall away from the jet opening. It is sometimes possible to remedy this trouble by racing the motor and opening and closing the throttle valve quickly, which will give momentary increased suction, often sufficient to suck the particles of rust or lint or drop of water through the nozzle opening.

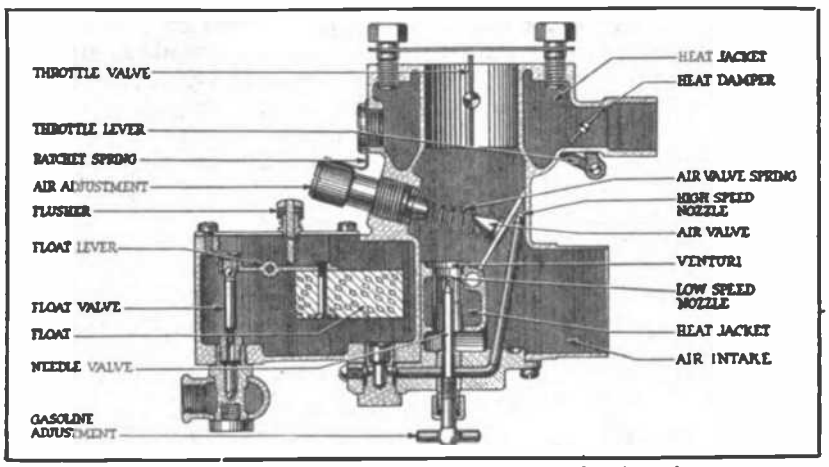
Fuel Level Adjustment Important

It may be observed that in those carburetors where no fuel regulating means is provided, that the height of liquid in the spraying jet is an important adjustment. The repairman should not be too hasty about altering the position of the spray nozzle in the mixing chamber. If the jet is placed too high the fuel level will be considerably lower than it should be, and while the nozzle will then feed enough gasoline for high speeds, owing to the increased suction, the vacuum created at low velocity will not be sufficient to draw up the required quantity of fuel. On the other hand, if the nozzle is placed too low, the fuel level will be raised unduly and the carburetor will show a tendency to flood. As the proper adjustment can be determined only by experimenting, when the nozzle is so adjusted that the motor will get the proper amount of fuel at both high and low piston speeds, the spray jet should not be disturbed again. The only way possible to raise the nozzle is by inserting thin washers made of brass or copper shim stock between the spray nozzle and its seat. The only way the nozzle can be lowered is by removing the packing washers, sometimes placed between the nozzle

and it seat in the mixing chamber. Alteration of nozzle position is work for the carburetor expert only.

Two Parts of Conventional Carburetor

There are two parts to the usual float feed carburetor and either of these is apt to cause trouble. In the float chamber any defective condition that will prevent the float control valve from seating properly will result in flooding,



Sectional view showing construction of Marvel-Buick carburetor

which will be evidenced by a rich mixture. If the passage the valve controls becomes clogged up then there will not be sufficient liquid in the float chamber and the engine will misfire on account of the deficiency in the fuel supply. If the float needle valve is adjusted in such a way that it will close too soon the mixture will be deprived of gasoline on account of the level being too low in the float chamber.

About the only trouble that can materialize in a mixing chamber is clogging of the spray nozzle with dirt or water and failure of the auxiliary air valve to open properly. If the spray nozzle is constricted, not enough gasoline will enter the mixture. If the auxiliary air valve opens too much an excessive amount of air will be admitted in proportion to the gasoline, whereas if the valve does not open enough, the mixture will be rich.

Connecting Union Coupling

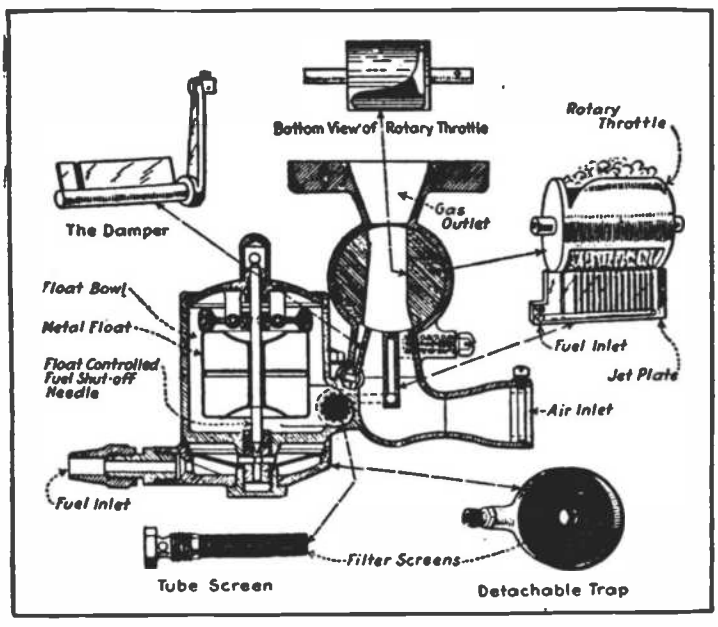
The repairman or motorist often finds it necessary to remove the fuel pipe from the carburetor and it is often noticed that after this is replaced a slow leak will develop around the joint. It is not difficult to connect the coupling if this is properly done, but it is important that the nut of the coupling is started evenly on the threads of the joints. The nut is often tightened when it is cross threaded and sometimes, even when successfully started, it must be screwed all the way home with a wrench, due to cramping of the pipe. The secret is to secure proper alignment of the components before making a connection. If after having properly aligned the parts and screwed the nut fairly tight, the joint should leak slightly, do not exert undue strain on the union in an endeavor to make a tight connection, but loosen it and apply common yellow laundry soap to the threads and screw it back in place.

If a pipe is a short one and there are two couplings, it is well to loosen both unions and start the nuts at each end at the same time, screwing them down together. In this way a tube bent in several places, which tends to shorten it, may be straightened without straining any of the threads on the joints and besides, it is always easier to center a loose pipe and start the nut correctly on the thread than to try and line up a pipe fastened rigidly at one end.

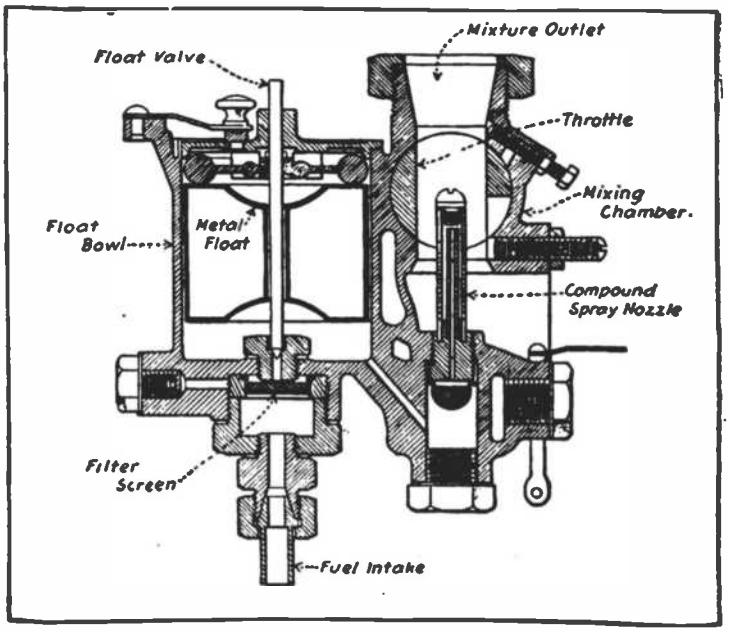
Cause and Repair of Flooding

If the repairman notices continuous flooding or dripping of the carburetor, this indicates either a badly seated needle valve, a leaking metal float, or a fuel-soaked cork float. If the float control valve itself is at fault, this is probably due to poor seating. The valve should be carefully ground in by using a small amount of powdered grindstone dust and oil. When doing this work, care should be taken to keep the valve stem in a vertical position, and when finished both the valve and its seat should be smooth and bright.

If the valve spindle is bent, remove the float, place the bent spindle on a block of wood, carefully straighten it with a few taps from a light hammer. In cases of continual flooding examine a metal float for minute holes or leaky seams, which must be soldered up. Owing to the extreme thinness of a hollow metal float, care must be taken to heat the metal as little as possible. As instructions will shortly be given for repairing metal floats and finding the leak, no trouble should be experienced in making repairs to this member. The use of hard or silver solder, which requires a blow-pipe or torch, should be left to those sufficiently skilled to manipulate the heating flame properly.



The Master multiple nozzle carburetor parts and how they fit in the assembly of the mixing chamber



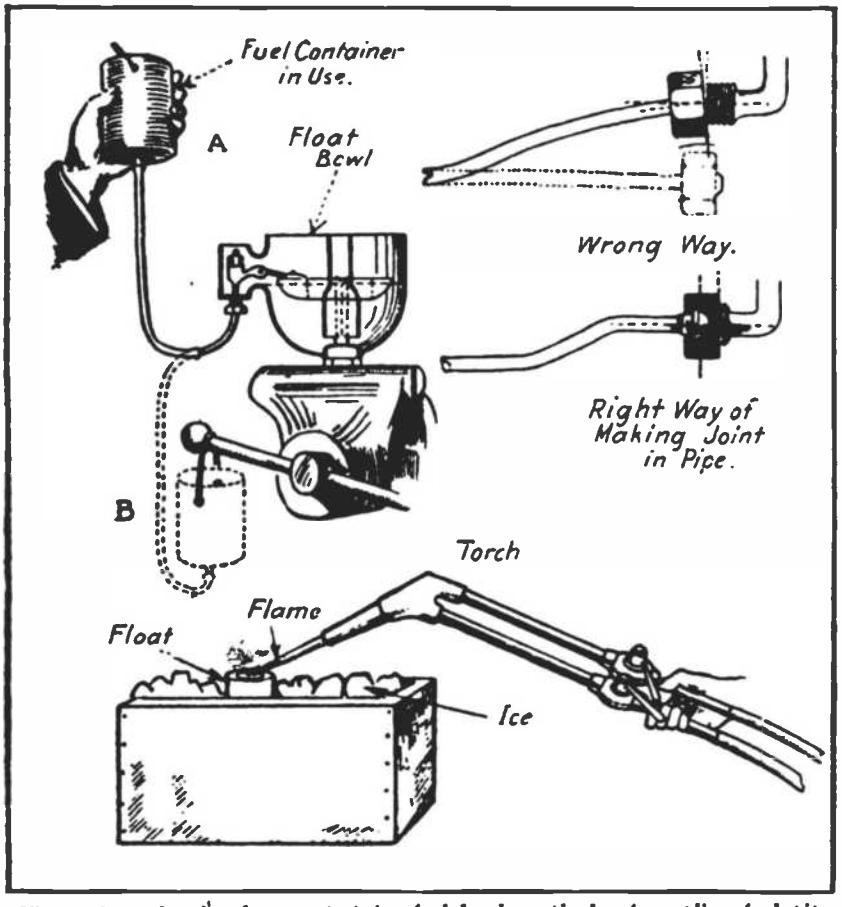
The Claudel carburetor is an efficient device of French design having a compound spray nozzle of distinctive construction

In order not to disturb the balance of the float, only a little solder should be used, and care should be taken that none drops inside the float itself.

Cork Floats Absorb Liquid

Mention has been previously made of the way a cork float will gradually absorb the liquid owing to its porous nature and how it will lose its buoyancy when it is fuel soaked. The remedy is a simple one, the cork being placed in a moderate oven so it will be thoroughly dried out and afterward it is given a couple of coats of shellac to make it liquid proof. It will be found that shellac dissolved in grain alcohol will resist the action of gasoline better than that dissolved in wood alcohol. In some carburetors the float is carried directly by the needle valve spindle, which has the valve at the top so that it may close the fuel opening when the gasoline reaches the proper level. If the level is too low the float may be shifted on this spindle to ride at a slightly higher level, which permits the float chamber to fill up more. If the float level is too high the float may be lowered on its spindle in order to close the valve sooner or when the float chamber has less gasoline in it. When leverage is used, the lever may be bent to change the position of the needle valve relative to the float. If toggle levers are used, as is the case with a metal float, shift the collar on the valve stem.

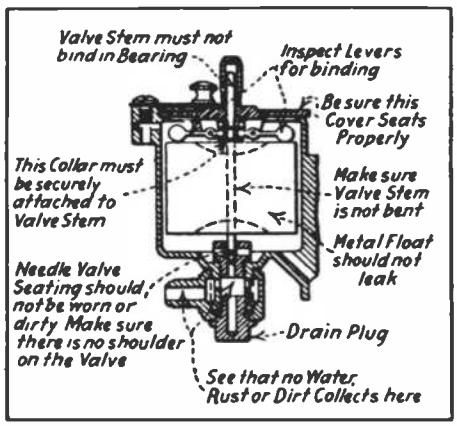
A cause of trouble in which no control of the motor may be had by moving the throttle lever is due to loose throttle connections. It sometimes happens that the set-screw used to fasten the butterfly or disk valve in the inlet pipe to its spindle becomes loose and allows the shutter to shift about and thus partially or wholly close the opening. In this case the motor cannot be speeded up. If the valve is loose and drops into the pipe in such a way that it does not obstruct it to any extent, it will be found impossible to slow down the motor as there is no means of cutting off the supply of gas to the cylinder. If the mixture volume is controlled by a sliding shutter or barrel throttle, this may stick in either the open or closed positions, in one case permitting the motor to speed up to its limit, in the other extreme it will prevent speeding up. Troubles with the throttle valve or connections are easily recognized because the motor will refuse to respond to the movement of the hand lever. An uncommon source of trouble may be a bit of stray waste left near the intake opening or the primary air supply when cleaning the motor. This waste may be sucked into the air opening and will cause trouble by reducing the amount of air supplied for mixture. Air screens also clog with dirt at times.



Illustrations showing how to test for fuel level, methods of coupling fuel pipe and suggestion for brazing a hollow metal float

Soldering a Metal Float

In repairing or making sheet metal floats, such as are used in the gasoline chamber of the float feed carburetor, one often experiences some difficulty in sealing up any small vent which makes the float air and liquid tight. When a metal float fills with gasoline, it becomes heavier and the float level is altered so it is imperative that the fuel be expelled from the interior and the hole sealed. The usual way to do this is to first locate and enlarge the hole through which the fluid reached the float interior.



What to look for when inspecting float chamber

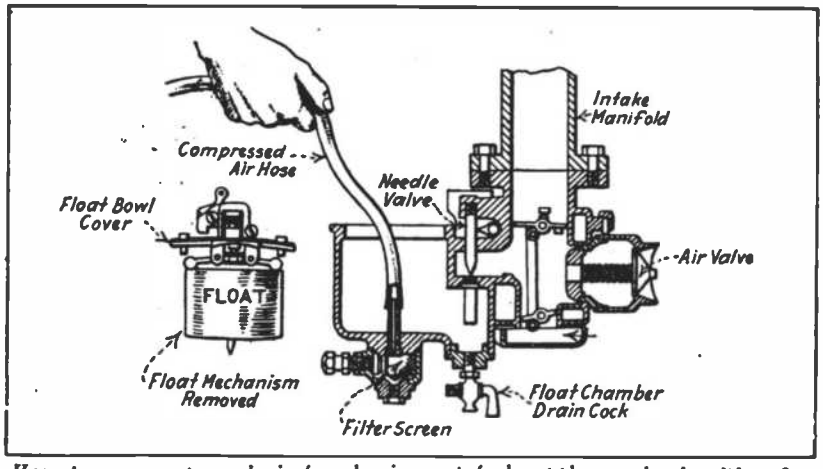
To locate a leak, the float is held under the surface of boiling water, which evaporates some of the gasoline inside the float and evolves a gas which indicates the hole by escaping through it because of the pressure inside the float. The hole is then marked and made larger with a needle drill. Another small hole is made in the float so the interior can be thoroughly cleared out by air pressure or by placing the float in an oven where the heat will evaporate the gasoline. After the float is emptied, it is necessary to close up the openings. This may be done with an ordinary soldering iron, though most mechanics having the facilities prefer to braze the opening, because by this means one can seal it and use a minimum of metal, which is not liable to upset the balance of the float and interfere with the level in the spraying tube.

In brazing a joint or vent in a perfectly tight receptacle, the job is often a failure because the air contained in the float becomes heated and produces a pressure that may result in having bubbles in the brazed seal. To make it possible to close the opening in a positive manner, the copper or brass float may be placed in a box of ice, as shown in accompanying illustration, this tending to keep the air contained in the float cool despite the heat imparted to the float by the brazing flame.

How to Test Fuel Level

After a carburetor has been in use for some time, wear may exist at the point of the needle valve or at the needle valve seat, or there may be some depreciation in the fulcrum joint of the

lever connecting the float with the needle valve. A good way of testing the float level is shown in cut herewith. The float chamber of the vaporizer is held in a vise and gasoline is allowed to flow from a small can which is joined to the fuel inlet pipe by a piece of rubber tubing. The gasoline will flow from this can into the float bowl and raise the float as the chamber fills. The level of the gasoline should be just a little below the top of the stand pipe in the mixing chamber. If the level is too high, this will be evidenced by a liquid overflowing at the stand pipe, if it is too low this condition may be easily ascertained by inspecting the height of liquid in the jet. If one suspects that the jet is clogged or that the gasoline feed connection on the float bowl is constricted by dirt it is a simple matter to clean the passages out by using a compressed air hose as shown in cut.



How to use compressed air for clearing out fuel supply nozzles in either float or mixing chamber

A ONE MAN TORPEDO BOAT

A PARTICULARLY practical weapon of offense and defense in war is the one man torpedo boat illustrated herewith which is designed to carry a full-size 21-inch torpedo loaded with as much as 500 pounds of gun cotton. It is the invention of W. Shearer and has a number of features we feel sure will interest those of our readers who are boating enthusiasts. It is capable of a speed of 30 miles per hour and is powered with an eight-cylinder engine of 5¾-in. base and 6 inches stroke, rated at 200 horsepower. The torpedo is carried in a special compartment forward which can be flooded by opening a hinged door forming the bow, and when the latch is released the torpedo leaves its chamber and speeds away under its own compressed air power of 2,250 pounds, which gives it a speed of 40 knots. As soon as the torpedo is discharged, the door is closed and the compartment is pumped clear of water in less than a minute by the powerful centrifugal pump provided for that purpose. When the front end is lightened the boat can make a quick get-away and there will be very little chance of it being hit by enemy gun fire. When submerged, the craft offers an extremely small target, which compensates to some extent for its reduced speed.

METAL CLEANING POLISH

TO prepare a metal polish that will form an emulsion of cream consistency, and which will not precipitate, use the ingredients listed below and in the proportion specified.

Water	10 pounds
Pine Oil	2 "
Sodium Olegate (Soap)	2 "
Silex	5 "

Heat the water in a large boiler, when the water is hot, but not boiling, add the sodium oleate, in small quantities at a time and continue to stir constantly while adding. When the mixture becomes creamy or thick, add the silex in small amounts, until all of it has been placed in the mixture, constant stirring is also necessary when adding the silex to insure uniform intermixture. The mixture should now be removed from the heat, but while still warm add the pine oil, and stir well while adding. After the oil has been added the polish is allowed to cool, and after cooling can be poured into suitable containers.

TO REMOVE BURNT OIL FROM STEEL

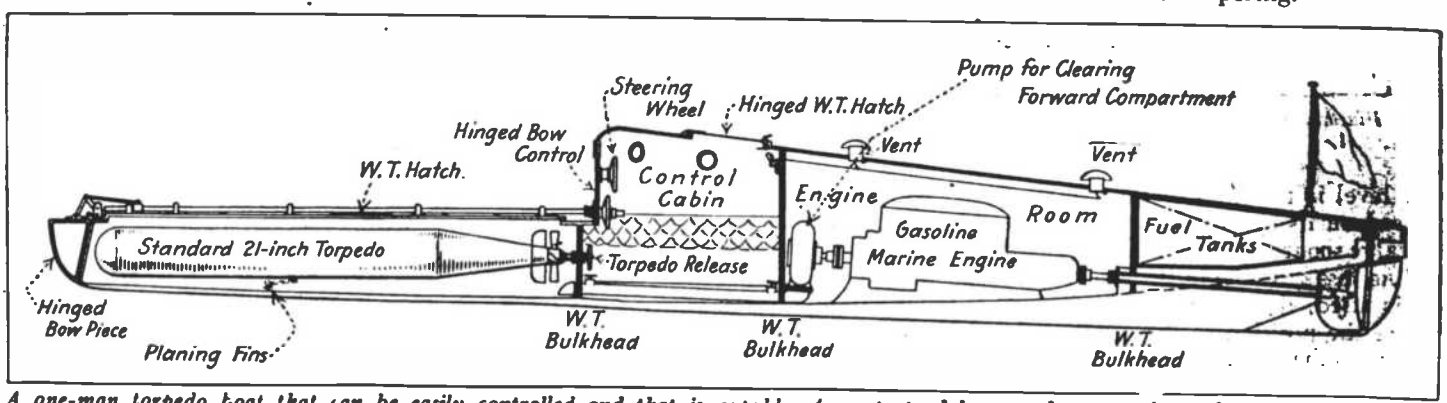
TO remove excess oil from parts that have been hardened in oil, place the article in a small tank of gasoline which, when exposed to the air, will dry off immediately, allowing the part to be polished and tempered without the confusion and unsightly marks of burnt oil.

BATH FOR HARDENING HIGH-SPEED STEEL

AN excellent bath for hardening high-speed steel consists of a mixture of table salt and paraffin oil in the proportion of one pound of table salt to each gallon of pure oil. The steel is heated to a lemon color and plunged into the bath, being kept in motion until it has thoroughly cooled. The steel should come out of this bath gray in color and nearly free from black spots. The bath referred to can be used for almost all brands of high-speed steel with good results. It has been used to great advantage for the Midvale steel and also on a large number of tools made of Novo, Simeteora, Rex, Jessop, High-Speed and Blue Chip steel. On all these, good results have been obtained, but it may be added that this bath seems to give the best results with the Midvale steel.—*American Blacksmith.*

TO HARDEN DRILLS FOR CUTTING GLASS

TO harden drills for cutting glass, dissolve zinc in muriatic acid to saturation, then reduce the solution by adding an equal volume of water. Dip and use without tempering.



A one-man torpedo boat that can be easily controlled and that is capable of great speed is a good means of naval offense and defense

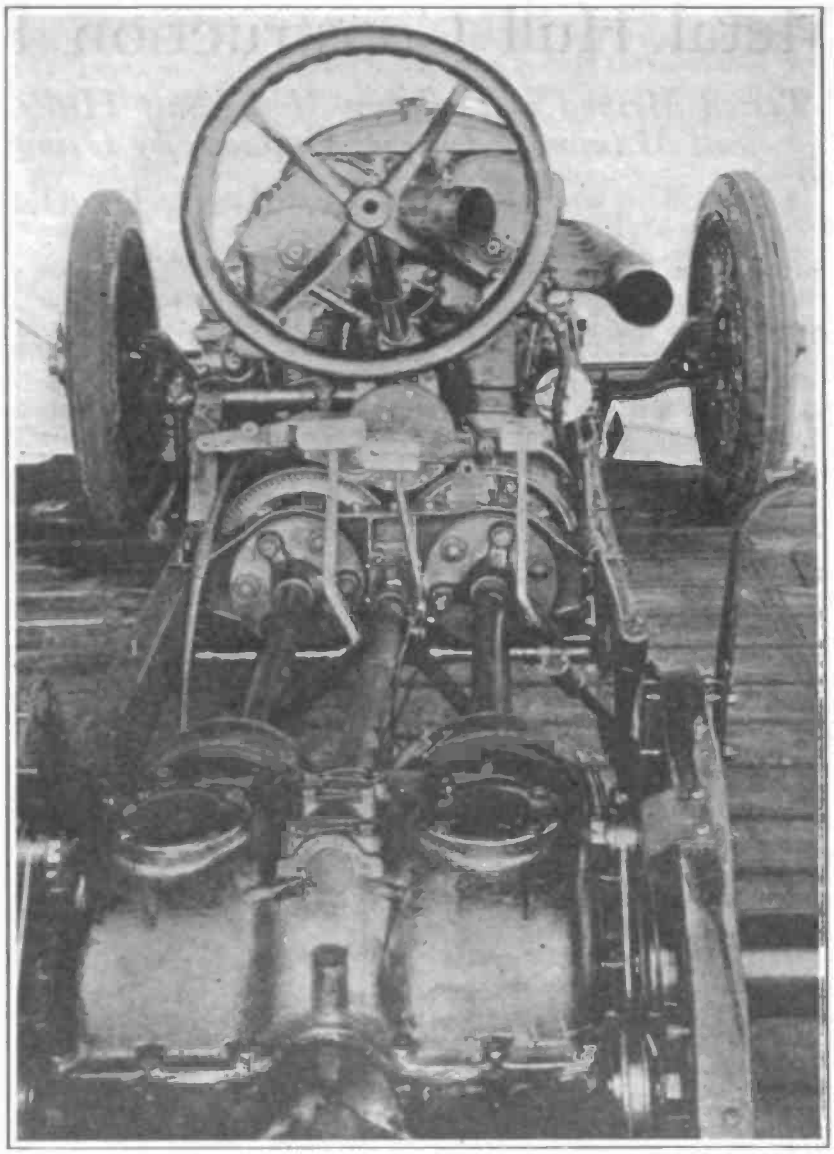
RECORD-BREAKING RACING CAR

ABOUT ten years ago Glenn Curtiss broke speed records with a special motorcycle at Daytona, Florida, and was reputed to be the first to make a mile at a speed of more than two miles per minute in a wheeled vehicle by covering the distance in 26 2/5 seconds. This very high speed was attained by using a freak machine he had built to try out an eight-cylinder, air-cooled motor that Charles Kirkham had designed for airplane work and for use on a machine that was the pioneer of the present long line of Curtiss craft. Specially built steam cars have also covered the famous beach sand course at speeds exceeding 120 miles per hour. Tom Milton, a well-known racing car driver, driving a special freak car propelled by two engines, is credited with having broken all world's records for the mile and two-mile recently at Daytona by covering the former distance in 23.07 seconds or at the rate of 156 miles per hour, and the latter space in 46.24 seconds.

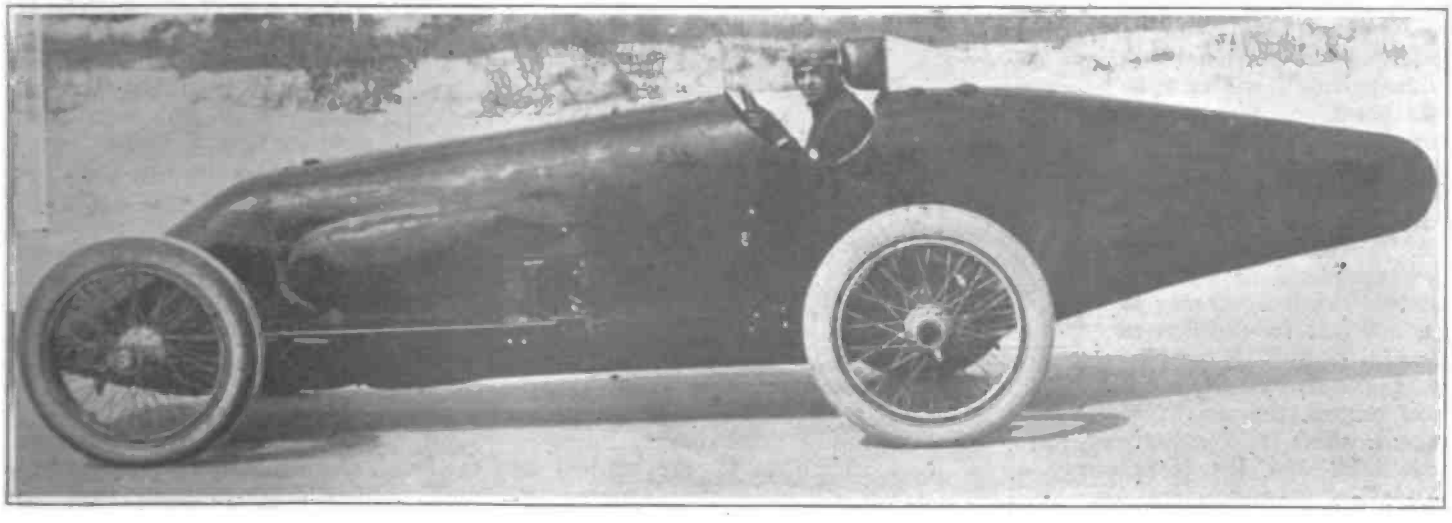
Students of aviation know that to obtain this high speed it is important to reduce the air resistance by stream-lining the car in just the same manner as an airplane fuselage is and for the same reasons. As the illustration shows, all parts of the mechanism except the wire wheels are enclosed and even the disturbance in air flow that might be produced by the driver's head is provided for as it is in the fastest scout planes by using a small sloping windshield in front and a tapering aluminum headpiece, well padded with an air cushion, back of the driver, so the continuity of air flow is not disturbed by eddies produced by the projecting parts of the driver's body.

The streamline enclosure of the chassis is not new, as attempts were made years ago to overcome the air resistance by this means, so the most interesting point and one that is a radical departure from conventional racing automobile design practice is in the engine installation. Reports are that the engines are eight cylinders each, the two combined making a sixteen-cylinder powerplant. The engines are placed side by side at the front end of the chassis as is usual practice. The engines deliver their power to a special rear axle construction, each engine having its own clutch and driving through flexible fabric universal joints and independent shafts to gearing in the rear axle. Each propeller shaft has a brake

(*Continued on page* 246)



Unusual arrangement of twin engines and dual drive on record-breaking racing car



Record-breaking twin engine racing automobile has carefully designed stream-lined body to minimize air resistance

Metal Hull Construction For Ship Models

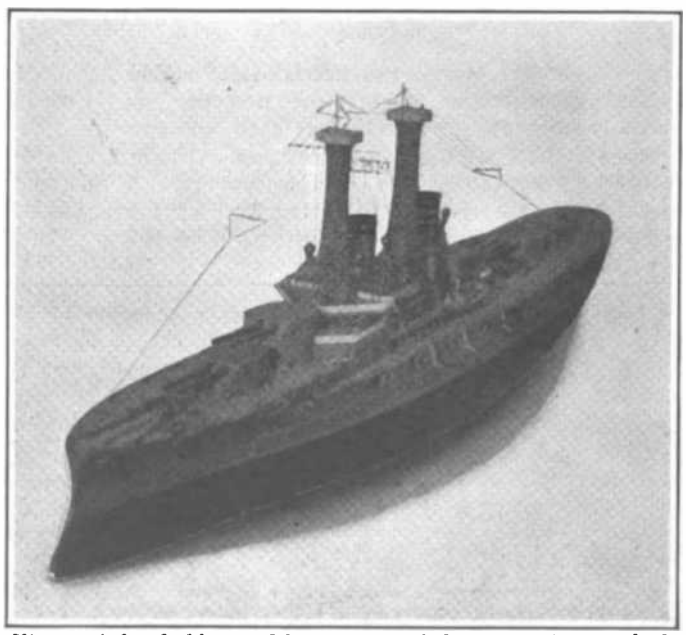
A Tested Method of Building Model Ship Hulls to Secure Strength, Lightness and Maximum Interior Capacity by Using Metal Sheet and Wire

By Chas. A. Myers, Jr., U. S. N. R. F.

THE writer, as described in a recent issue of EVERYDAY ENGINEERING, has for a number of years been building model ships and in this work improvement in the construction of hulls has naturally been an item to which he has devoted a great deal of time and effort. As a beginner he was satisfied with the wooden hulls made by the time-honored method of hollowing out a block of wood which had in its outward form been made to correspond with the measurements of the ship itself; or perhaps the somewhat more desirable "bread and butter" method. Wooden hulls, however constructed, represent a tremendous amount of work, and when finished they have so many disadvantages that they hardly repay the effort expended in the making.

Chief among these are their tendency to split, warp and rot and the difficulty of properly securing machinery and fittings in place. Then, too, in shaping the outside it is a mighty simple thing to slice off just a little too much—an error that it is not easy to correct by any means—and to get from the solid block type a hull that is thin-walled enough to be sufficiently light requires very careful handling of the tools. If the model shipbuilder happens to be a good carpenter or cabinet-maker, these difficulties may not be important, but if, like the writer, he is instead a metal-worker and only an indifferent kind of a wood-butcher, he will find himself very much out of his element.

The writer had this situation brought before him to the extreme in the case of a model of the scout cruiser "Birmingham", which he constructed a number of years ago. Here was a model built on the scale of ⅛ inch to the foot which as calculated from the plans would have a total displacement when completed of approximately 10½ lbs. Owing to the fact that in addition to powerful propelling machinery it was desired to install radio control, the weight of the hull, which is 53 inches long, could not exceed 2½ lbs. (excluding, of course, the superstructure) and still have the completed ship weigh within the allotted displacement. The writer was unable to accomplish this result with wooden hulls and he built at least half a dozen metal hulls of different forms of construction before hitting upon one that gave entire satisfaction. Since building the "Birmingham" (over ten years ago) the same method has been used in all subsequent models with uniformly good results.



Views of battleship models constructed by Mr. Myers which have a built-up metal hull as described

Two variations of the method of construction have been evolved depending upon the type of ship and the shape of the hull. Where the ship's bottom has a modified "V" shape (that is a pretty sharp rise to meet the turn of the bilge) and the length is fairly great compared with the beam it will be found possible to dispense entirely with athwartship frames in the completed model. In this case the cross-sections are reproduced from the plans to the proper scale from fairly heavy sheet zinc. At certain distances beginning on each side from the keel as a starting point semi-circular cuts are made in the edge with a fine round file. The distances at which these cuts should be spaced is determined by the width of plating desired and this, of course, is decided by the plans. In absence of definite information on this point, however, it may be said that plating wider than ¼ inch should not be used, and where the ship has a sharp turn at the bilge it may be necessary to make the plating considerably narrower and consequently the cuts closer together.

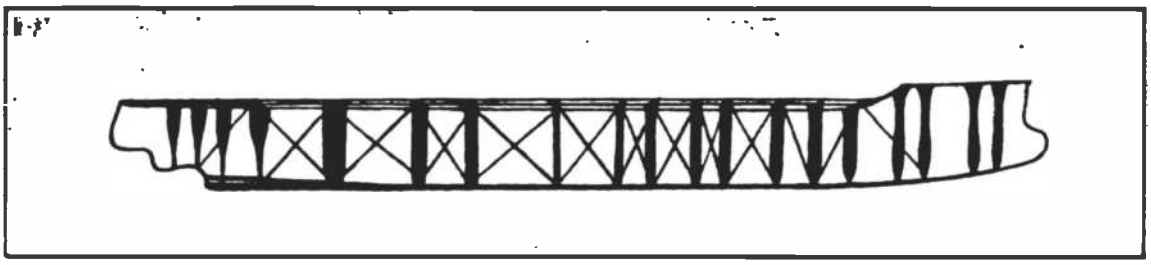
The zinc cross-sections being all ready, a hole about ⅛ inch diameter should be drilled at the center-line of each cross-section a definite distance, say 3 inches, from the keel. The cross-sections should now be strung onto a piece of straight ⅛ inch brass rod, or if this is unprocurable, ⅛ inch steel drill rod may be used. They should then be properly spaced and soldered in place, care being taken that they are all in proper vertical position, as otherwise the deck of the ship would be wavy instead of flat.

In the semi-circular cuts which have been made in the zinc cross-sections, starting at the keel, lay 3/32 inch diameter hard drawn straight brass wire from bow to stern, soldering it to each zinc cross-section. Cross wires should now be run from the top of one cross-section to the bottom of the next adjoining one, bracing them firmly together and in this process it is well to lay the whole set of frames on a bench to which the keel-wire should be firmly fastened. A good way to do this is to drive short nails with large flat heads into the bench along a perfectly straight line and countersink them flush with the top of the bench. The keel wire may

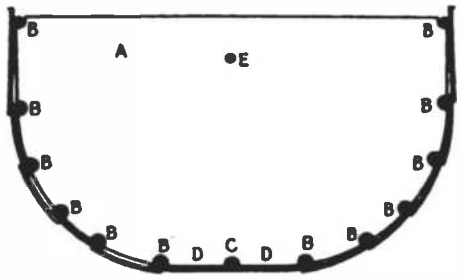
then be temporarily soldered to these nail heads which will hold the frames in position until they are properly braced and trussed together and all the wires have been run from stem to stern on both sides of the keel and right up to the deck line. The reader will, of course, understand that the round file used in making the semi-circular cuts in the cross-sections should not be larger in diameter than the longitudinal wires else the latter will not fit snugly in place in the cuts. At the first cross-section a stem piece is soldered perpendicularly to it and the wires are run to their proper positions at this point, cut off, and soldered to the stem and a similar procedure followed at the stern, the outline of which should also be faithfully reproduced in zinc from the plans. When all the wires have been soldered in place, the keel-wire may be unsoldered from the nails in the bench after which the hull skeleton is ready for the plating. If the cross-bracing has been properly carried out the framework should be so stiff that it may be supported at one point amidships without either end sagging down; and if the reader will refer to two of the accompanying cuts he will see the framework of the "North Dakota" with the bow piece (which in this case was made of heavy brass wire instead of sheet zinc) in position and a few of the longitudinal wires fastened in place. Another cut shows the various frames as viewed from dead ahead. The method of cross-bracing referred to above is very clearly shown in the broadside view.

The framework of our model now being complete, we are ready to proceed with the plating. In this the writer has developed two or three "kinks" which may help in making the finished model better able to withstand wear and tear. While ordinarily the plating would start at the keel and proceed on each side, it is a good plan to make the first strake (as the strips of plating are termed) of a V-shape so that the keel itself will fit in the angle of the V and the two sides will proceed up to and meet the first of the brass wires on each side of the keel to the outside of which, of course, they will be soldered. This presents a homogeneous sheet of metal to any rough obstructions on which the model may be placed—for instance, a pebbly beach; but on the other hand when the plating starts on each side of the keel and is soldered to it, a sharp stone pressing against the bottom strake close to the point where it is soldered to the keel would have a shearing effect and be liable to break the plating away from the keel.

The material to be used for the hull may be varied as desired, and if cost is of no moment, probably tinned copper or tinned brass will prove most satisfactory from the standpoint of resistance to corrosion. If the model is



View of partially completed metal hull frame



The right half shows the clinker method of construction, whereas the half on the left shows the other system described in this article: A = sinc frame (or cross-section), B = longitudinal wires, C = keel wire, D = first strake of plating, E = upper longitudinal wire

not to be placed in water very often, ordinary "tin" plate will be found to work very well indeed, and consisting, as nearly everyone knows, of nothing more or less mild steel which has been tinned (to make soldering easier) it is stronger and lighter than either brass or copper and is in addition the very material of which large ships are built.

The thickness to be used will depend upon the size and type of vessel and the kind of treatment to which it will be subjected and is therefore a matter for the judgment of the builder to determine. No hard and fast rule can be laid down as there are a number of considerations according to circumstances which should be given thought. In a general way, it may be said that the thickness known in the metal trade as "One Cross" should be used on the larger models (say from 24 to 60 lbs. displacement), whereas a somewhat thinner sheet should be used on smaller ships. On destroyers or scout cruisers, where everything is to be sacrificed for high speed, metal almost as thin as a sheet of paper and known to the trade as "taggers tin" may be employed.

Before cutting the metal strakes, patterns should first be cut in cardboard and it is well to call in outside assistance to hold the cardboard close to the wires while it is being marked as it is desirable to make the strakes as long as possible and it is absolutely essential that the cardboard conform exactly to the curves of the hull.

In fastening the plating to the longitudinal wires two methods may be used. The second strake (counting from the keel) may be laid on top of and soldered to the first strake and the third strake on top of the second and and so on up the side of the boat, which will produce a form of construction akin to that in a clinker-built wooden hull; or, a method in many ways preferable may be adopted. This consists in soldering the first strake in place, skipping the second strake altogether, soldering the third strake and then soldering the second strake on top of the first and third so that it overlaps them both. Thus the even numbered strakes will overlap all of the odd numbered ones. This is the method of construction used in building large steel ships and it has a number of advantages over the other. Both systems are clearly shown in the accompanying drawing.

As indicated at the beginning of this article the zinc athwartship frames may be removed either in whole or in part when the plating of the model has been completed up to the gunwale; but as previously stated they may be removed *completely* only in vessels having a sharp rise of the floor to the turn of the bilge. On ships with a fairly flat bottom (battleships, for example) most of the frames should be left in place in the finished model. In order to install boilers, engines and other parts of the machinery, holes may be cut in the frames, but it is strongly recommended that at least ½ inch of the amidships frames be permitted to remain attached to the longitudinal wires as they add comparatively little weight to the finished hull and give a really great strength to it.

To cut out the center of the frames the writer has employed the electric arc method very satisfactorily. One pole of the ordinary house current is grounded to the hull and the other pole, connected through suitable resistance permitting a flow of 5 to 10 amperes ends in a steel pencil. The pencil being touched to the zinc frame where it is desired to cut it away, the tremendous

heat of the arc melts through the metal almost instantly, very much after the manner of an oxy-acetylene cutter; and it might be added here that after the zinc bow and stern pieces have served their purpose of giving contour to the ends of the ship they may be entirely removed, as they will then no longer be of service.

The hull of our ship being now completed, it is necessary to add the propelling machinery and the deck and superstructure fittings; and an early number of EVERYDAY ENGINEERING will describe some of their constructional details.

STIRRING PAINT BY AIR

A WRITER in a recent issue of *Factory* calls attention to an important use of compressed air in large paint shops. Nearly all large plants, he says, have paint rooms of their own. Here is stored the paint supply of the whole factory. Because of the tendency of the paint to settle, it must be stirred up each time any quantity is withdrawn. As a rule, the stirring of paints by hand is done to the accompaniment of aching muscles and breaking backs. One good-size factory, however, performs the whole operation by the turn of an air-cock. There happens to be a high-pressure air supply handy to the paint room. Paint is kept in barrels, each containing a double wooden paddle. When the paint requires stirring, a pneumatic reaming tool is slipped over the end of the paddle shaft which projects above the barrel top. This shaft is held in place by two crossed pieces placed across the barrel head. By using the shaft in place of a reamer shank, the paddle is whirled rapidly and the paint mixed in a surprisingly short time. After one barrel of paint is mixed thoroughly the reaming tool is slipped over the paddle shaft in the next barrel. Thus the whole job is done quickly and with little labor.

CONCERNING TRUCK LOADS

LOAD distribution is of the highest importance. The motor truck is designed to carry a certain proportion of its load on the front axle and the remainder on the rear axle. If the body is not chosen properly for the sort of load to be carried, it will result in the load being concentrated at the wrong point. This gives the same effect as overloading, because if too much of the load is placed on the rear axle, it will not make any difference if the total load is under the normal capacity of the motor truck. The fact that bodies must be chosen not only to carry the load conveniently, but also to concentrate the load at the proper point, leads to some unusual constructions to meet unusual operative conditions.

Electricity Combats Smoke Nuisance

THE abatement of the "smoke nuisance," whether from industrial plants in large cities or smelters and similar industries in more or less isolated districts, is a problem that is almost as old as the industries themselves, yet, like many other problems, it is being solved electrically. The time may indeed come when Pittsburgh will be as clear as Washington, D. C.

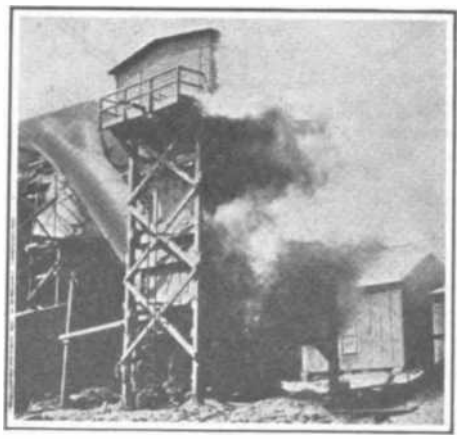
The Cottrell electrical precipitation of noxious fumes, objectionable smoke, etc., is a process which, stripped of its engineering technicalities, holds no small degree of interest for the general reader. The basic theory of operation of this electrical process is simply that any insulated body coming between an electrically charged point and an opposite charged plate receives the same electrical charge as the point, and since like charges repel, the body is thrown to the plate. This is also true of the particles of invisible gases, as is proved by the old physical experiment of blowing out a candle flame by putting it between a charged needle and a smooth, charged plate. In its simplest form the Cottrell apparatus consists of a metal pipe or flu through which the gas to be cleaned passes; connected to one side of a high-voltage direct-current circuit, and a wire along the axis of the pipe, which is connected to the other side of the same circuit.

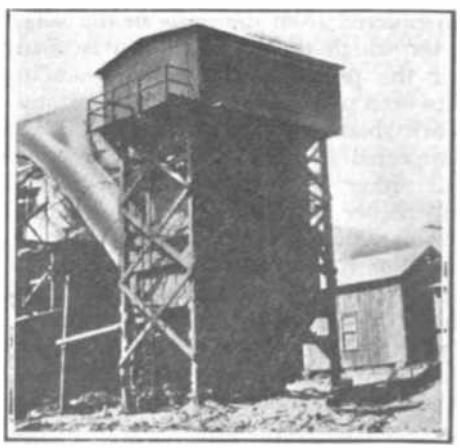
Since it is not practical to generate diret current at the high voltages—between 100,000 and 25,000 volts—demanded by this process, the electricity is generated as alternating current and rectified into direct before reaching the flue.

What happens is simply that the small particles of fume and smoke which are held in suspension by the gas passing through the flue receives the same charge as the wire and are either attracted to the pipe and held there or are attracted to each other, forming masses which are heavy enough to fall by gravity to the hoppers underneath. The pipes are relieved of their load by being periodically beaten with hammers, either electrically or by the hand.

This process will not precipitate pure gases, but many chemicals are in a gaseous state at high temperatures are either liquids or solids when sufficiently cooled. They can then be removed by the Cottrell process, as is actually done with arsenic in a Western smelter, whereby large amounts of this valuable element are recovered in a high state of purity. A large cement plant recovers many tons of potash dust per day which was hitherto pure loss but which now can be sold for fertilizer at almost as good a price as the cement itself.

In fact this process is applicable to all sorts of industries, such as smelters, blast-furnaces, chemical pants, and is used for the removal of the objectionable features from the smoke of incompletely burned oil and coal. Before its development many smelters in the West were forced to shut down by the Government because their fumes were destroying the vegetation for some distance around them. This Cottrell process has proved valuable, not only in abating smoke nuisances but in recovering valuable materials that have hitherto gone up in smoke and been completely wasted.





The view at left shows dust coming from a cement plant and how it was prevented by Cottrell process is made clear in the other picture

The pictures illustrate the electrical equipment built by the General Electric Company to meet the requirements of this process and also how the electric current eliminates the dust normally coming from a cement plant.

It is said that in Canada 50,000 ounces of platinum are lost annually by faulty placer mining. This does not say how much is left undisturbed in the ground. It is thought that Canada may become one of the world's greatest producers of this metal, now so scarce owing to the condition of Russia.

A NEW THERMOSTATIC METAL

A NEW, built up metal strip that bends when it is heated has just appeared. It is called thermostatic metal, and is a British invention. It is prepared by permanently uniting, throughout their length, strips of the two metals having widely different coefficients of expansion with heat, so that under a change of temperature the combined strip bends one way or the other. The reaction is stated to be always the same, in a strip of given length and thickness, for a given temperature change and thus to provide a reliable basis for temperature indication, control, or compensation in oven thermometers, electric heaters, ice machines, and other apparatus, including scientific instruments of high precision. The component metals will not corrode under ordinary conditions, and they may be used in any reasonable situation, without fear of deterioration or change in their operating characteristics. They will not separate, no matter how much the strip is bent, twisted or hammered, and even with heating the bond between them will not be broken down at a temperature below the melting point of the softer of the two. They can be formed into any desired shape and annealed after formation, and they can be safely employed at any temperature below 500 degrees Fahrenheit.

SOLDERING OF ALUMINUM BRONZE

TO solder aluminum bronze with ordinary soft solder, thoroughly cleanse from dirt and grease the parts to be joined. Then put the parts to be soldered in a strong solution of sulphate of copper and place in the bath a rod of soft iron touching the parts to be joined. After a while a copper-like surface will be seen on the metal. Remove from bath, rinse clean and brighten the surface. These surfaces can then be tinned by using a fluid consisting of zinc dissolved in hydrochloric acid in the ordinary way with common soft solder.

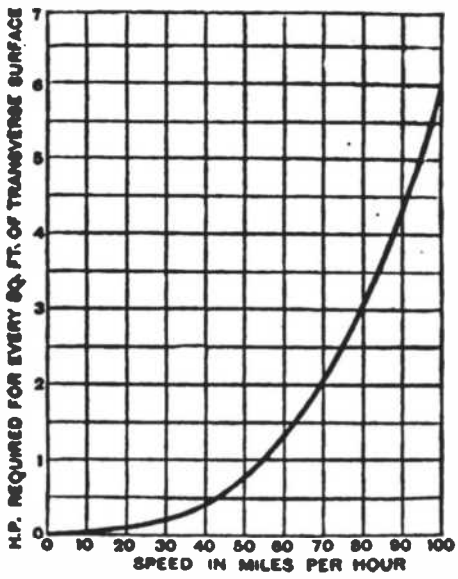
HEAT TREATING HIGH-SPEED STEEL

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

CALCULATING AIR RESISTANCE OF TRAINS

IN a recent isue of the *Engineer*, London, Mr. C. F. Dendy Marshall discusses the subject at some length, and states that, thanks to the work which has been done in connection with aeronautics, it is now possible to take the matter up and study it on a scientific basis, with a promise of substantial improvement.

The importance of the front wind pressure on the engine is not fully appreciated. The horsepower required to overcome it increases with the cube, not merely of the speed of the train, but



with that of what is called the "created wind," which in the case of an express train may easily exceed eighty miles per hour.

It may now be taken as established that, for speeds within and even far beyond the range of railway speeds, the resistance of the air to a surface moving normally to itself is represented by the expression KAV^2, where A is the area exposed, V the speed and K a constant. If A is measured in square feet, and V in miles per hour, $K = .0033$.

The constant .0033 applies to the total resistance and includes the now well-recognized suction on the back of a moving body. For plane surfaces normal to the wind M. Eiffel found in his famous experiments that the suction accounted for one-third of the total. The frontal pressure alone may, therefore, be taken as $.0022AV^2$, and the horsepower required for every square foot of exposed surface is

$$\frac{.0022V^3}{375}, \text{ or roundly } \frac{6}{10^6}V^3.$$

The value of this expression at 60 miles per hour is approximately one and one-fourth horsepower, and at 80 miles per hour three horsepower.

If we know the "all out" speed in a calm, say 70 miles per hour, numerical limits can be assigned between which the speeds will lie for any ratio of train to wind speed. These limits are shown in the diagram.

It will be readily understood without entering into calculation that the speed of the created wind creeps up as the strength of the natural wind increases, and that 80 miles per hour is quite a moderate figure to take for it, while the diagram shows how sharply the demand for power runs up with any increase of speed in that neighborhood.

We now know fairly well what should be the best shape for a body which is to be driven through the air at speeds of the order under consideration. The front should be quite "bluff," a sharply conical or wedge-shaped form not being at all the ideal to be aimed at. What is required is to eliminate every square inch of transverse flat surface that can possibly be dispensed with, smoothing off projections and putting in gentle curves parallel to the natural flow of the air.

RESISTANCE OF STRUCTURAL STEEL TO FIRE

SOME interesting figures relating to the behavior of structural steel at the high temperature of ordinary fires have been given by the United States Bureau of Standards. Naturally, the strength of steel at high temperatures has a very important bearing upon the stability of a structure which may be subjected to fire. Without any protective covering, steel columns fail after only ten or fifteen minutes of exposure to temperatures such as are reached in ordinary fires. Resistance can be greatly increased by the use of coverings of brick, concrete, plaster, tile, etc., to such an extent that columns so protected are unaffected after several hours' exposure to intense heat.

Tests have been made to determine the compression strength of specimens of structural steel when heated in an electric furnace to temperatures corresponding to dull-red heat (1100 degrees Fahrenheit) and loaded up to 20,000 pounds per square inch. It was found that structural steel loaded to 10,000 pounds per square inch fails at about 1075 degrees Fahrenheit, and under a load of 20,000 pounds per square inch failure occurs at about 925 degrees Fahrenheit. For practical consideration, however, the limit of utility may be regarded as reached at temperatures of about 130 degrees below those given above.

During the war, the number of carbon filament lamps made in the United States rapidly decreased until in 1918 only 12 millions were sold. They are very much less efficient than tungsten filament lamps and it is calculated that 24 millions of them would use a million tons more of coal per annum than would be required for the same number of tungsten lamps.

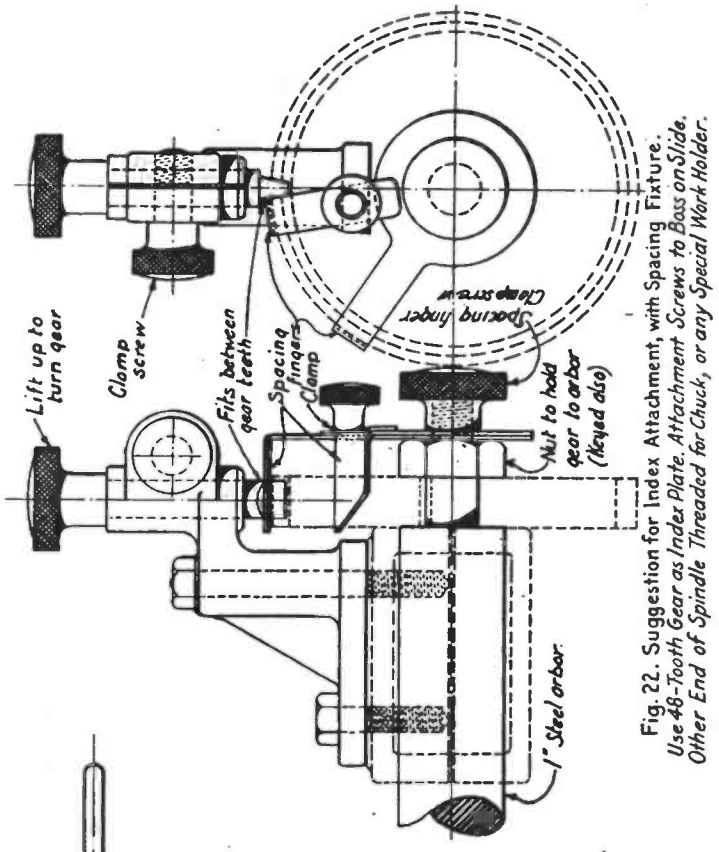


Fig. 22. Suggestion for Index Attachment, with Spacing Fixture. Use 48-Tooth Gear as Index Plate. Attachment Screws to Boss on Slide. Other End of Spindle Threaded for Chuck, or any Special Work Holder.

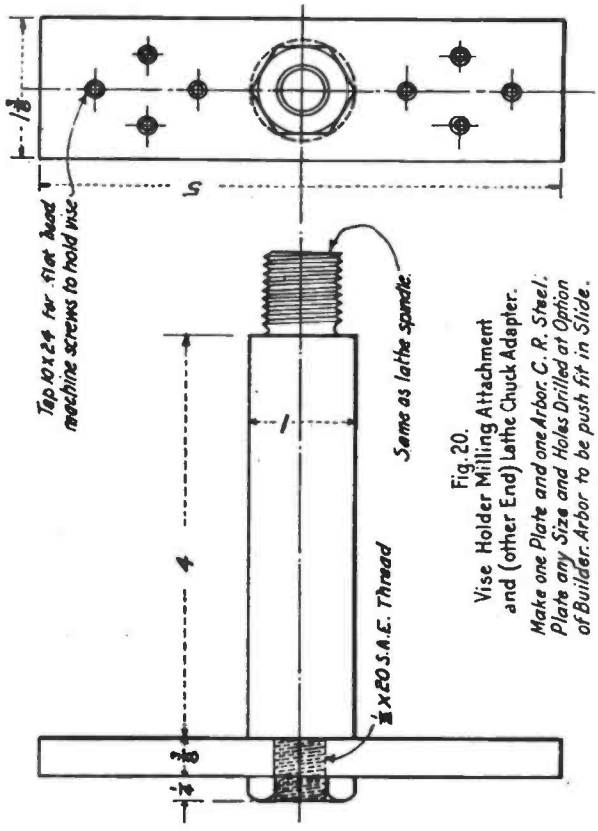


Fig. 20.
Vise Holder Milling Attachment and (other End) Lathe Chuck Adapter. Make one Plate and one Arbor. C. R. Steel. Plate any Size and Holes Drilled at Option of Builder. Arbor to be push fit in Slide.

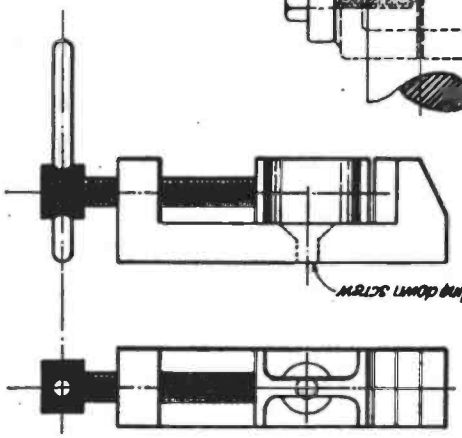
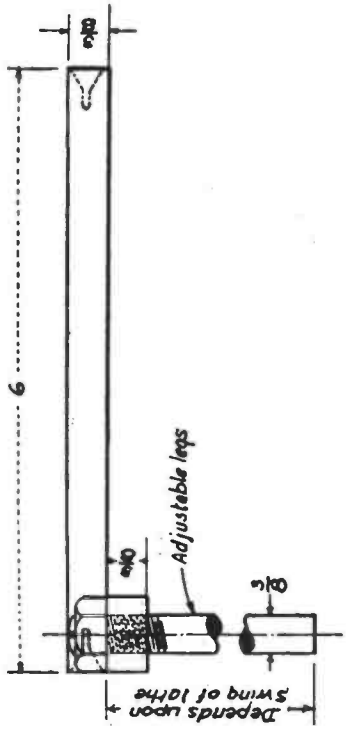


Fig. 19.
"Starrett" Toolmaker's Clamp #106. Used to Hold Shafting, Bars, etc. on Plate( ) for Milling. Use 10-24 M. Screens. Milling Cutter Held in Lathe Spindle. Also Used on Surface Grinding Table( )



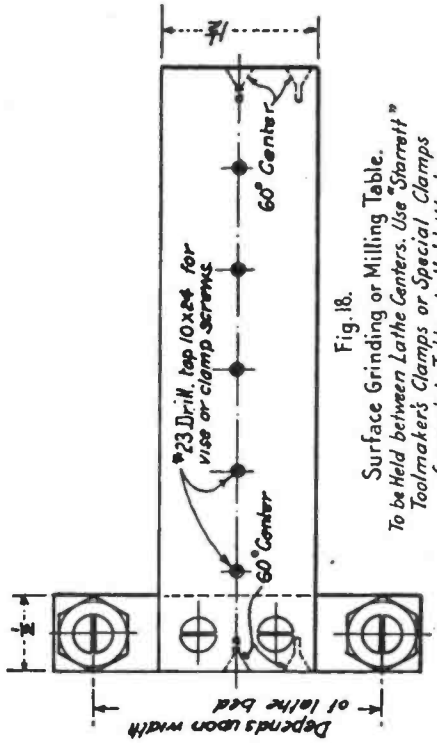


Fig. 18.
Surface Grinding or Milling Table. To be Held between Lathe Centers. Use "Starrett" Toolmaker's Clamps or Special Clamps Screwed to Table, to Hold Work. All Parts C.R. Steel.

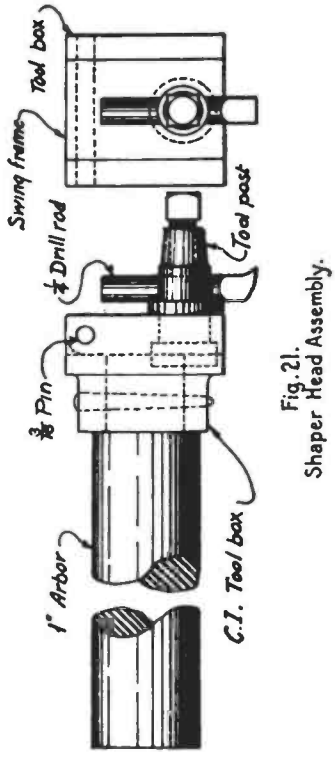


Fig. 21.
Shaper Head Assembly.

A Universal Lathe Attachment

By H. H. Parker

Drawings by the Author

PART II

Milling, Cutter in Lathe Live Center

ANOTHER way to perform milling operations is to hold the cutters in the live center of the lathe and the work in the attachment itself. Fig. 20 shows a flat steel plate bolted to a one-inch solid arbor which slips into the vetrical slide in place of the grinding or milling spindle sleeves and is clamped there. The work is bolted to this plate or held in one or a pair of the toolmakers' clamps screwed to it. Some kinds of work could be best held on an angle plate bolted to this arbor in place of the flat plate. The other end of the arbor is turned down and threaded the same as the lathe spindle, which allows of work being held in the lathe chuck screwed to the arbor, or to the lathe face plate. By the use of these various attachments, work of almost any shape may be operated upon; the feed can be by hand or power, longitudinal or crossfeed, and if the lathe is provided with a compound rest a still further variety of manipulation is possible. Fishtail cutters for slotting or keyways, end mills and side mills and angular cutters are used in the lathe chuck or the vertical slide spindle and ordinary twist and other drills are frequently brought into service for special off-center drilling operations.

Shaping

Still another use for the lathe attachment is for light shaping, the tool being mounted in a miniature swing frame on the end of an arbor or "ram" which fits into the horizontal hole in the vertical slide. Fig. 21 illustrates the general arrangement, though no dimensions are given, for the builder would be able to build a tool box to suit his own ideas without any difficulty.

The box is made either of cast iron or sawed from a block of steel and the groove may be milled or ground to shape by some of the devices described above. A rectangular block is pivoted to the box and should swing out and back easily, but without shake or lost motion, either at the pivot pin or between swing frame and sides of tool box. A half-inch hole is drilled in the lower end of the block and counterbored underneath for the tool post. This is made like the lathe tool post, only much smaller and provided with a quarter-inch slot for the shaper tool, made of a piece of quarter-inch drill rod with the lower end forged and filed to shape and then hardened. Square tool steel could also be used or an old square file broken up and sharpened. The tool box is either set screwed or pinned to the ram with a taper pin; the ram being cylindrical, allows of the tool being set at any angle. No attempt was made to give a feed to the swing frame itself, as in the case of large shapers; this might be practicable, but the regular vertical slide feed answers the purpose well enough.

The size, shape and character of the work determines its mounting—whether between centers, on the face plate or lathe chuck, on the little table shown in Fig. 18 or clamped to an angle plate on the lathe bed or directly to the bed itself. If on the table between centers the width that can be machined depends upon the width of the work or upon the amount the ram overhangs the table when parallel to it. With a very short stroke it might be possible to face the ram around at right angles to the lathe bed and use the cross feed screw. Ordinarily the lathe carriage is run back and forth by means of the longitudinal feed handle and rack, and while power feed might be used in some cases, the character of work suitable for such a small device makes hand feed the most practicable. By lengthening out the ram and clamping the work to a small table of some kind resting on the lathe ways, the transverse feed would be only limited by the width of the cross slide and the length of stroke by the length of the ram (within limits) and length of the work.

The builder will soon discover a great variety of operations which can be carried out to advantage by means of the various devices which have been described.

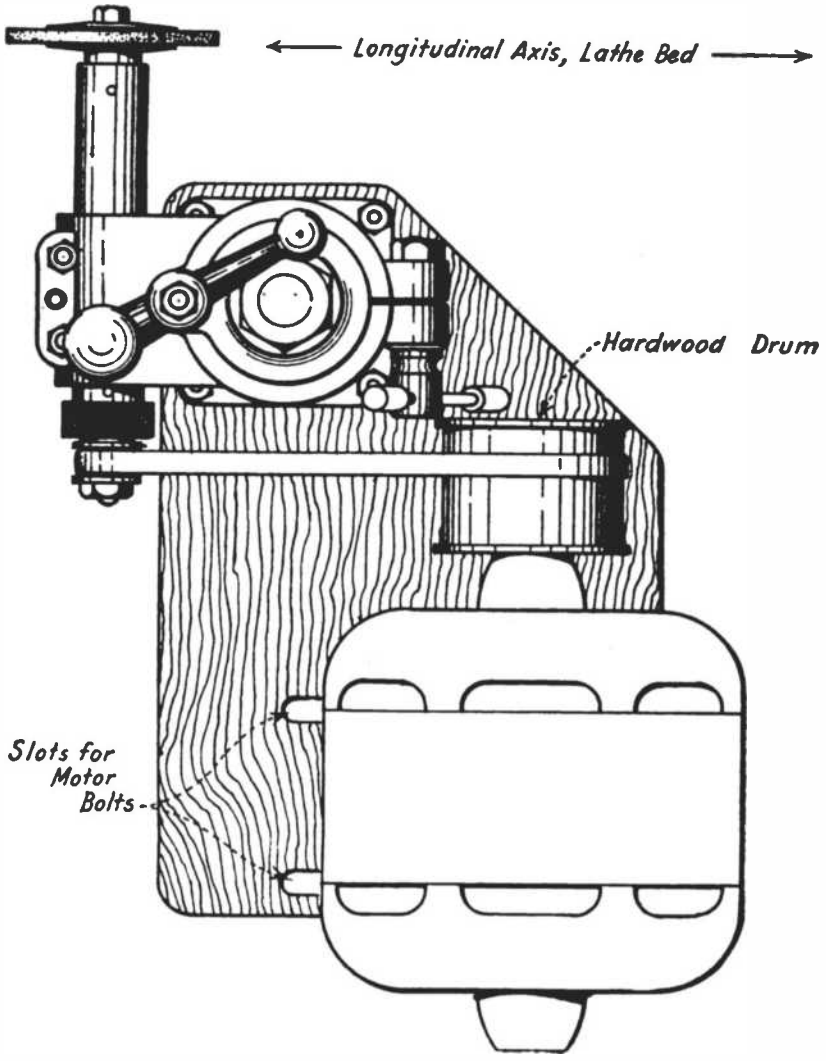


Fig. 2. Plan view showing motor drive

Indexing

One more application of this device remains to be described—its use as an index head. Fig. 22 suggests a layout of an attachment of this character,

though the actual dimensions would depend upon the size of gear used. As an example of its use, it might be required to mill a square or hexagonal head on the end of a bolt or screw. The bolt would be held in a chuck on the end of the index head arbor while the milling cutter would be rotated in the live center of the lathe and each time a flat was milled off the index gear would be turned the required amount to present the next surface to be faced.

As an accurate index plate is difficult for an amateur to construct, a gear is used for this purpose, preferably a new gear the teeth of which would be in good condition. If not badly worn, one of the change gears of the lathe could be used. One of 48 teeth would be best for general purposes; sometimes one of 36 teeth might be better. The pitch should be such that the diameter of the gear would be small enough to swing close up to the face of the vertical slide—about three inch P.D. would be right. The drawing shows the index fixture bolted to the vertical slide, a boss having been provided on the casting for the purpose. This is shown in Fig. 3, though the bolt holes are not. The fixture must be high enough to allow clearance for the 48 gear, but it would be a good idea to allow the stop spindle enough up and down motion to adapt it to the 36 gear also.

A one-inch steel spindle is turned up to make a push fit into the vertical slide; one end is threaded to take a lathe or other chuck which holds the work to be milled; the other end is turned down so that the gear will make a push fit over it, the gear being held by a locknut as well as a small key. The remaining portion of the spindle is turned down to about three-eighths in diameter and threaded. When in position the gear is prevented from turning by a vertical stop on the end of a spindle which slides in a reamed hole in the fixture casting and is clamped by a thumb screw which closes the split clamp lug. No play whatever should be permitted in the stop spindle, as this would spoil the accuracy of the device. This spindle has a small keyway cut in it, being milled or shaped by one of the methods described above, to prevent its turning. The end of the spindel, or the stop, is filed to an included angle of 29 degrees, to fit between the gear teeth.

As it is a nuisance to count the number of teeth every time the gear is turned, a pair of spacing fingers are shown. These are cut out of one-thirty-second iron or brass sheet and the fingers bent over at right angles to cover the face of the gear. The inside finger disc carries a clip and thumb screw; the clip extends over the edge of the outer finger disc and the thumb screw clamps them both together, yet allows the two to turn on the spindle, to which they are clamped when desired by a thumb nut on the threaded end.

In use, the fingers are so spaced around the gear that their outer edges cover the required number of teeth and one finger bears against the stop; then the end thumb nut is tightened. After the cut has been made, the vertical slide spindle clamp nuts are loosened enough to allow the gear and the fingers clamped to it to be turned; the second finger will then bear against the stop. The index spindle is then clamped, as well as the stop spindle. Then the end nut is loosened and the fingers, still clamped together, turned all the way around until the first one again bears against the stop. Then the end nut is tightened, another milling cut is made and the process repeated until the operation is complete.

When not in use, the entire index fixture may be removed by taking out the two bolts and withdrawing the spindle.

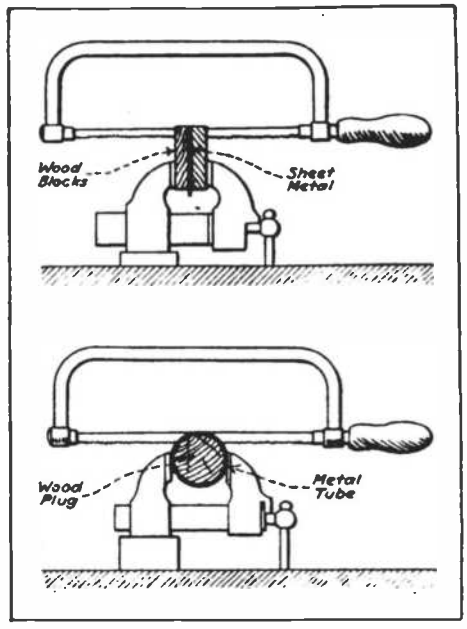
In concluding, the builder is cautioned to see that the column of the lathe attachment stands perfectly vertical when clamped to the tool side of the lathe; otherwise it may not give accurate results when in use. This depends upon the face of the tool slide being square and parallel with the lathe bed, assuming that the base of the column has been squared off accurately. If the slide is found to be out of true, a cutter could be rigged up in a sort of boring bar between centers and extending down to the tool slide. Then by running the carriage back and forth and moving the slide at the same time by the cross feed, the tool will act as a planer cutter and will face up the tool slide by taking a light cut across it. All play between the carriage, cross slide and ways must be taken up before beginning this work and also while the attachment is in use after completion.

HOMEMADE CANNED HEAT

WHILE up in the North Wisconsin woods last summer the wife of one of the resorters became ill and often during the night required some hot water. Since the small electric lighting plant was shut down every night after eleven o'clock and no other source of heat was available, the man set about to provide some means for heating the small quantities of hot water required. He managed to purchase some wax at a nearby general store, and this with some newspaper solved the problem. The newspaper was folded into strips about one inch wide with several thicknesses. The wax was melted and the paper rolled into coils, which were then dipped into the wax. The wax with the paper imbedded in it, all contained in the tops of tin baking powder cans, were stored away and used in the same manner as alcohol burners. They were very successful in operation and gave their inventor a feeling of satisfaction, particularly so since in everyday city life he was a prominent attorney and had little time to put on handicraft work — GEO. J. KIRKGASSER.

SAWING SHEET METAL

WHEN sheet metal or brass is to be cut with a hacksaw, clamping the material between two wooden blocks in a vise will greatly facilitate the process. Without this support, the thin metal may bend and buckle, the saw blades frequently breaking or stripping their teeth. Thin sheet metal tubes



can be cut in the same manner. A plug or rod of wood is forced in the tube and clamped in the jaws of a vise, the saw will cut right through the tube without the saw teeth catching, even if regular saw blades are used instead of the fine tooth saws generally used for tubing. The metal to be cut should be clamped in the vise so it will be rigidly supported and the hacksaw should just clear the vise jaws.

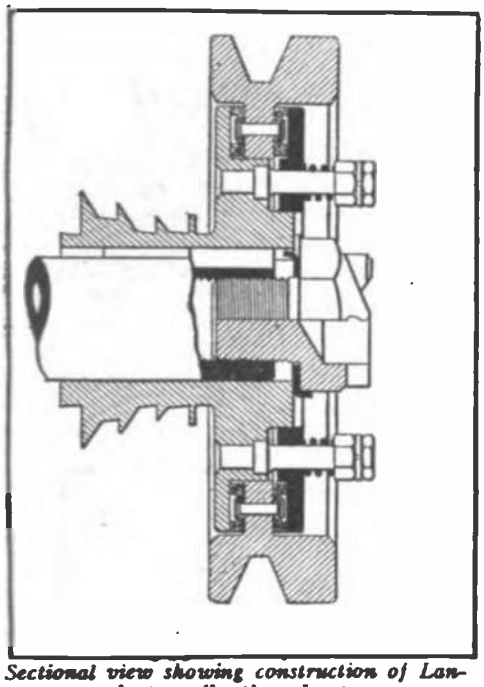
WHITEWASH FOR INTERIORS

NOTHING brightens up the interior of a dingy garage like a good coat of whitewash. Poorly prepared whitewash flakes off soon after being applied. The United States government standard receipt is probably the best there is. Slake one-half bushel of unslacked lime in boiling water, keeping the lime covered during the process. Strain and add a peck of salt dissolved in warm water. Add also three pounds of ground rice boiled to a thin paste and ½ pound of Spanish whiting. Dissolve one pound of clear glue in water and add. Mix whole thoroughly and let stand for several days. When ready to apply, heat thoroughly and apply as hot as possible.

EVERYDAY MOTORIST

LANCHESTER VIBRATION DAMPER

WITH a six-throw crank-shaft, whether there be six pistons or twelve, one of the commonest forms of vibration is that produced by the twisting of the shaft at certain speeds. The shaft has a natural period of vibration if deflected torsionally, and when the sequence of explosions coincides with the natural vibration period the pendulum effect causes the violence of the vibration to be increased. The vibration which is perceptible to the passengers in the car is due to the front



Sectional view showing construction of Lanchester vibration damper

crank throw twisting with each explosion, and then the spring of the crank jerking the piston back as soon as the power stroke is over. Elasticity of the steel causes oscillations to take place, so the crank flies back too far, springs forward again and so vibrates many times before returning to its proper position, by which time the succeeding explosion again displaces it. The oscillation of the piston disturbs the center of gravity of the whole piston mass much more than the first deflection does, and the object of the Lanchester damper is to resist the return spring of the crank so that the twist caused by the explosion is made "dead beat."

The original design of F. W. Lanchester, a leading British atomobile engineer, was to mount on the front end of the crankshaft a little fly-wheel and disk clutch, as shown in accompanying illustration. The inner member of the clutch was secured to the shaft and the fly-wheel rim rode loose. Thus when the crank twisted forward the inertia of the fly-wheel rim caused it to try to maintain a steady speed and the clutch slipped a little, and when the crank tried to twist back at the end of the power stroke the fly-wheel rim again resisted the tendency to oscillate. The sum total of effect is that the energy of the twisting crank is absorbed by friction between the clutch surfaces and the rapid oscillations are prevented. Something depends upon the strength of the clutch spring in the damper, as the little fly-wheel rim must be sufficiently loose to be able to act as described, but not so loose that the friction will be too small to absorb the energy of torsion. The adjustment is not delicate and once the proper strength for the clutch spring has been found the damper can be made on a production basis and fitted complete without any further attention. When first tried out the effect of the damper was amazing, turning a six-cylinder motor with a weak shaft and two bad vibration periods into a smooth-running and practically vibrationless one.

DRIVING AWAY FROM CURBS

IT is quite often the case that a car is parked so close to a curbing that it cannot be driven away. When this occurs place the jack under the center of the front axle, raise the car a few inches and then push the car off the jack sideways, away from the curb. This will give room to turn the wheels out enough to drive away.

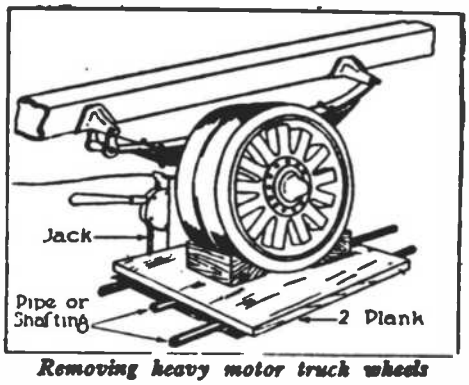
FITTING ROLLER BEARINGS

IN replacing roller bearings on a front wheel spindle on which it is a tight fit, many owners slip the bearing on to the taper end of the spindle and then put on the wheel, using it as a hammer to drive the bearing home. This is a poor method, as the bearing is likely to be injured. The hardened shoulder of the inner race, which receives the brunt of the blows, is especially liable to be broken.

For furnaces where a traveling chain brake is used in automatic stoking, a registering apparatus has been devised based on the rate of speed of the grate and the area of the hopper opening. From its registration the coal consumption has been found within a limit of accuracy of 5%.

REMOVING MOTOR TRUCK WHEELS

A SIMPLE device for removing motor truck wheels of the dual type and especially serviceable where one man has to do the work, is made from a two-inch plank, cut to the desired length and width. Jack up the wheel



Removing heavy motor truck wheels

several inches from the floor, lay four rollers, made from either iron pipe or old shafting, on the floor beneath the wheel, place the plank on top of them and chock the wheel at each side. After the wheel has been loosened on its axle it can be easily adjusted on the movable platform for further work.—*Automobile Journal.*

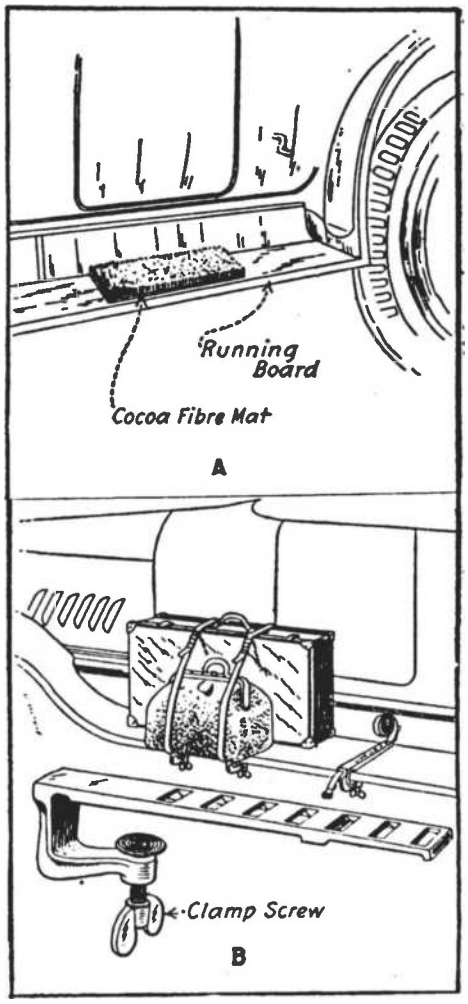
LOCATING UNUSUAL NOISES IN ENGINE

AS an aid to locating the cause of unusual noises in automobile engines, it is recommended that the engine be throttled down and the frequency of the occurrence of the noise determined. Generally speaking common engine noises occur at either camshaft or crankshaft speed. By noting when the knock occurs with reference to the rotation of one or the other of these shafts, it may be more easily classified. In every case main bearings produce knocks at crankshaft speed, as do also crankpin and wrist-pin defects. Knocks at camshaft speed, which is half that of the crankshaft, are usually due to a loose bearing or to end play of the shaft. If an attempt is made to classify these sounds before proceeding further in the diagnosis, much time and effort can be saved.

The annual expense of repairs for two pumps in use at Bridgewater, England, built by the Watt works in 1877, nearly fifty years ago, have been reported. For one year they amounted to a little over $20. Some years later the repairs run up to $75—a remarkable proof of good engineering practice.

RUNNING BOARD ACCESSORIES

WHEN the interior of a closed car is fitted up with delicate trimmings and carpets like a lady's boudoir, and many cars are of this nature, it is an advantage to keep dust and mud off the floor, yet anyone stepping into the car from the street cannot help carrying in a little dirt on the shoes, no matter how careful they are. To avoid this, an idea which originated in Paris and ought to be popular in the big cities of America is worth mentioning. This



Useful auto running board accessories

is to have a small piece of stout door mat neatly cut and edged and strapped to the running board just below the door opening. The mat can be sewn to metal end pieces and screwed to the running board, or it can be fixed with screws and washers, the heads of the screws being well buried in the mat. A device of this sort is now marketed as an accessory.

Luggage carriers, as shown at B, are securely fastened to the running board by means of thumb screws. It is not necessary to drill any holes through the running board. It is claimed that the device will not rattle or work loose if properly installed. Suit cases, traveling bags, or parcels of any size may be safely carried and can be quickly strapped in place and removed. They do not touch the side of the body to mar the finish. The carriers may be removed in an instant and stowed away so that they are not evident when not in use and will not clutter up the running board.

CORRECT TIRE INFLATION

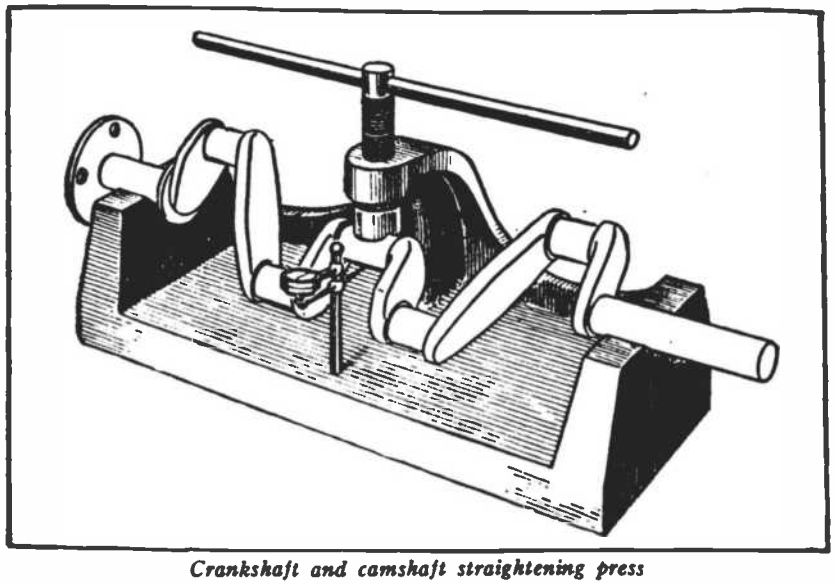
MANY motorists labor under the impression that they should run their tires under-inflated during the warmer summer months and fully inflated during colder winter months. This practice has become so general that one of the larger tire manufacturing companies has recently carried out a series of tests to determine the wisdom or fallacy of this practise. It remained for the B. F. Goodrich Rubber Co., Akron, Ohio, to test this theory. A 34 x 4 inch tire, for which makers prescribe a 70-pound pressure, was used for the test. Air at various temperatures was pumped into the tires and they were then run at excessive speeds under severe road conditions. The changes in pressure were found to be negligible. Goodrich recommends an even pressure the year round with adherence to the pressure designated for the various sizes of tires. Frequent observations conducted by experts of the company have demonstrated that the vast majority of motorists keep their tires under-inflated. Even if hot weather makes a slight difference in pressure it would be policy to risk it rather than take the chance of having the tire under-inflated. Of the two the latter is far the worse and more universal.

In this connection it is well to remember that air pressure is just as apt to increase in cold weather as in hot. This is brought about by the friction of the tire against the road where the traveling is rough. Yet the motorist never thinks of letting out the air in the winter months. A safe rule is to keep the tires inflated to the standard pressure. In order that the correct amount of air in tires may be readily ascertained, a standard table for all makes of tires is shown as follows:

Rim Sizes	Inflation Pounds	Rim Sizes	Inflation Pounds
28 x 3	60	33 x 4½	70
30 x 3	60	34 x 4½	70
29 x 3½	60	35 x 4½	70
30 x 3½	60	36 x 4½	70
31 x 3½	60	37 x 4½	70
32 x 3½	60	38 x 4½	70
33 x 3½	60	40 x 4½	70
34 x 3½	60	42 x 4½	70
36 x 3½	60	33 x 5	80
32 x 3	70	34 x 5	80
34 x 3	70	35 x 5	80
30 x 4	70	36 x 5	80
31 x 4	70	37 x 5	80
32 x 4	70	39 x 5	80
33 x 4	70	41 x 5	80
34 x 4	70	43 x 5	80
35 x 4	70	36 x 5½	80
36 x 4	70	37 x 5½	80
37 x 4	70	38 x 5½	80
40 x 4	70	39 x 6	85
42 x 4½	70		

SHAFT STRAIGHTENING DEVICE

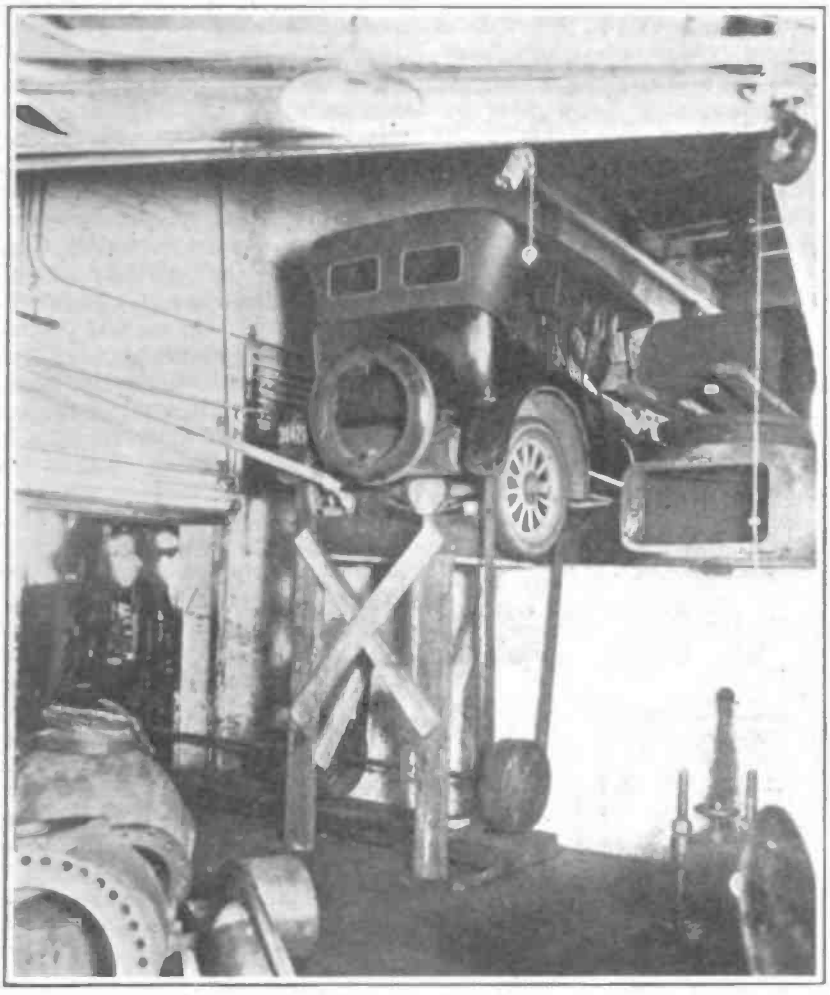
THE crank and cam shaft straightening press shown in accompanying illustration was designed for service stations catering to the Ford trade. It comprises two tools in one, is light in weight and very accurate in its work. The device consists of a bench rest, made of heavy cast metal, the ends vertical with V-shaped grooves for the shafts to rest in while straightening and a screw clamp in a vertical bracket, that fits the shafts at its center. The device is equipped with a dial test indicator reading accurately to a thousandth of an inch. Ford repairers are aware of the fact that Ford crank and cam shafts are bent very easily and by testing them during the course of repair, guess work on this score is eliminated.



Crankshaft and camshaft straightening press

AUTOMOBILE AS EMERGENCY POWER

OUR attention has been called to a factory in Chicago, engaged in manufacturing mechanical devices for the Government, which operated on the power of a standard touring car for twelve consecutive days.



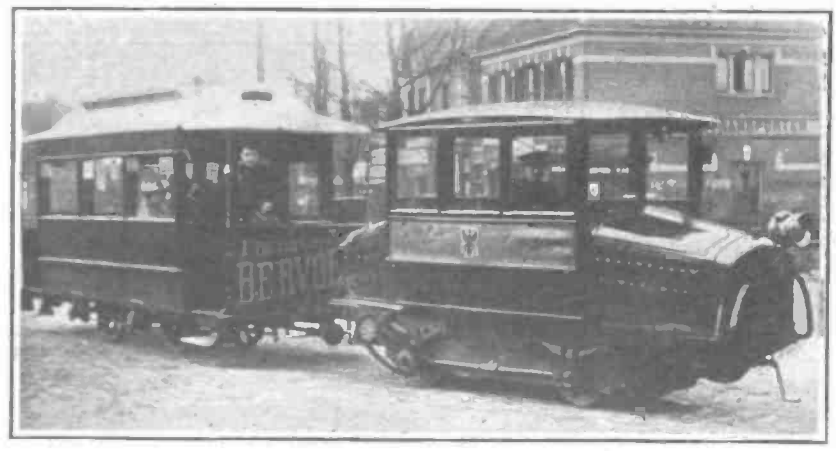
How an automobile may be belted to a line shaft as an emergency source of power

When the coal shortage threatened to tie up the plant, the president decided to press his touring car into service. It was rigged up in the factory as shown in the accompanying illustration with belts placed around the rear wheels and to a line shaft, in order to drive a 220-volt generator. This generator supplied current for lighting and also power for running the various lathes, drills and other machine tools as well as the automatic machinery throughout the factory. A belt was placed around each rear wheel and both wheels drive the shaft to prevent the wear on the differential gear which would be inevitable if only one wheel was used for driving the shaft.

In Boston, the Transit Commission tried the effect of paint on concrete reinforcement bars. This was done to see if it was practical thus to preserve them from corrosion, but it was found that their bonding strength was cut down below that of the plain bars.

AUTOMOBILE TRAMCAR TRACTOR

THE automobile engine has been put to a new use in Apeldoorn, Holland, as shown in the cut herewith. Two automobile power plants, each in its own hood, as shown, are mounted on a small four-wheeled truck and drive the wheels through a simple chain transmission, making an internal combustion engine propelled tractor. In this manner the horses used previously are replaced and the gasoline locomotive hauls one or two tramcars through the city streets with a considerable gain in economy and satisfactory operation, besides it has not been necessary to electrify the lines or build an expensive central power plant for generating current as is needed with the usual electrical railway system.



Gasoline tractor replaces horses for hauling tramcars in Holland

COTTON USED IN AUTO TIRES

IT is estimated that nearly four per cent of the cotton production of the world for 1920 will be consumed in the manufacture of pneumatic automobile tires, a total consumption of approximately 400,000 bales. The 1920 production of tires in the United States should approximate 40,000,000, to equip nearly 1,500,000 new cars and to maintain about 7,000,000 now in operation. Cotton promises to remain indefinitely as indispensable in tire making as rubber.

Many motorists wonder how much cotton goes into the manufacture of pneumatics. Tires now contains an average of four pounds—an increase of one pound, due to the increasing number of pneumatic truck tires, which require more cotton because of their size. Much of the cotton used is Egyptian or Peruvian. The larger companies use the cream of the world's crops—the 1⅛-inch staple or better. A few of the larger companies will make more than half the year's output—the remainder will be divided among more than 230 smaller concerns.

MANDRELS

IN general practice, mandrels do not require as high a percentage of carbon as cutting tools. Small-sized mandrels give good results when made from steel of from 1.00 to 1.10 per cent carbon. Larger sizes of mandrels are better when made of steel containing from .80 to 1.00 per cent. carbon. Material containing this carbon content will harden well and can be very accurately finished by grinding. This insures that the surface will be true and round and that it will be more resistant to wearing than a softer surface would be.

Experimental Physics

Ultra-Violet Rays—Part 2

By James L. Clifford

IN the first article of this series the experimental production of ultra-violet rays was discussed, and the construction of a simple arc lamp for this purpose briefly outlined. Ultra-violet rays are easily produced, and, in fact, are constantly about us, but their detection is not always simple. It is for this reason that their presence was so long unthought of.

The statement has been made that it is absolutely impossible for the human eye to detect ultra-violet rays. This is not entirely true, for pure ultra-violet light, after all of the ordinary wavelengths from .0004 to .0007 mm. have been filtered out by means of suitable screens, causes some impression on the eye. A hazy blue patch will be formed on the retina of the eye, caused no doubt by the fluorescence produced by the rays. Thus to say that they are invisible is not true, but for all practical purposes it may be accepted.

The two methods best applicable to the experimental detection of ultra-violet light are: the use of phosphorescent screens or the use of a special type of gold leaf electroscope. In the early work with this type of radiation, as also in the experiments with phosphorescent bodies, an instrument known as the Phosphoroscope was utilized. As this type of instrument is difficult to construct, and to properly adjust, it has not been used by the author.

For simple qualitative experiments with ultra-violet light phosphorescent screens may be used. Such a screen may easily be prepared in the following manner: A small quantity of the chemical, anthracene, is moistened with water and then thinly spread over a ground glass surface. When dry most of the anthracene will adhere to the glass. This fluorescent surface when exposed directly to the rays will glow brightly. If the reader is unable to procure any anthracene another screen can easily be made using Sidot's Blende (crystalline zinc sulphide) or Willimite. The powdered substance is evenly spread over a glass surface first covered with sticky gum arabic or other adhesive.

When observing ultra-violet rays by means of a phosphorescent screen it must be remembered that ordinary light also will to some extent cause phosphorescence. The effect of ordinary light may be found by interposing thick glass between the source of the rays and the screen. When this is removed the difference in intensity of the phosphorescence is caused by the ultra-violet light which reaches the screen.

This method, however, of detecting ultra-violet rays gives practically no opportunity for accurate work. The author has found that the best way is to utilize what is known as the photo-electric effect. If a metal plate is exposed to a beam of light of short wavelength the plate will assume a positive electrical charge. Thus if a gold leaf electroscope negatively charged is placed in ultra-violet light it will rapidly lose its charge. The explanation of this effect is really very simple. When the light having a very short wavelength strikes the metal surface a disturbance is immediately set up, ending in the emission of a negative electron as a ray. The electric potential of the plate was originally neutral (by a neutral potential we mean that there are equal quantities of both negative and positive electricity residing in the plate). The emission, then, of a negative electron obviously leaves the plate with a positive charge.

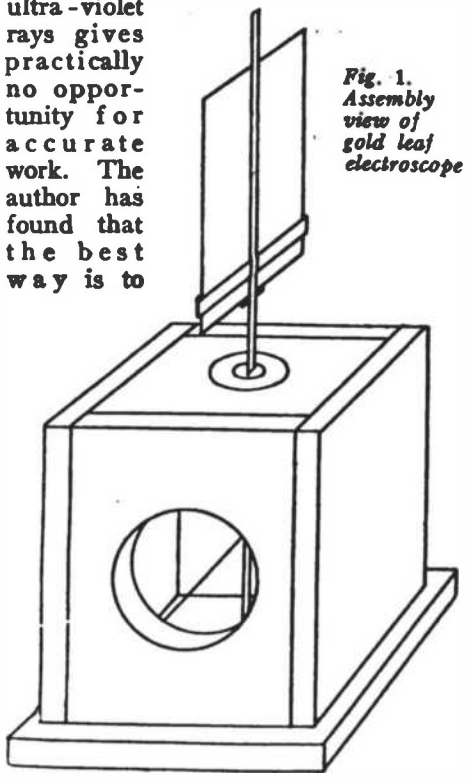


Fig. 1. Assembly view of gold leaf electroscope

A gold leaf electroscope having a definite surplus of negative electricity or a negative charge as we generally call it, is placed in the path of the rays. The negative ions are literally knocked off by the rays, thus causing the electroscope to discharge. The rate of fall of the gold leaf is the measure of the amount of ultra-violet light present. If, now, the electroscope is positively charged, the rays will have little appreciable effect. In some cases the electroscope will be a little more charged positively as a result of the emission of the negative electrons.

The construction of an electroscope as designed especially for this type of work by Mr. F. W. Russell is shown in Fig. 1. In Fig. 2 is shown the completed instrument to the right, and the arc lamp described in the first article to the left. The details of the instrument should easily be gathered from these illustrations.

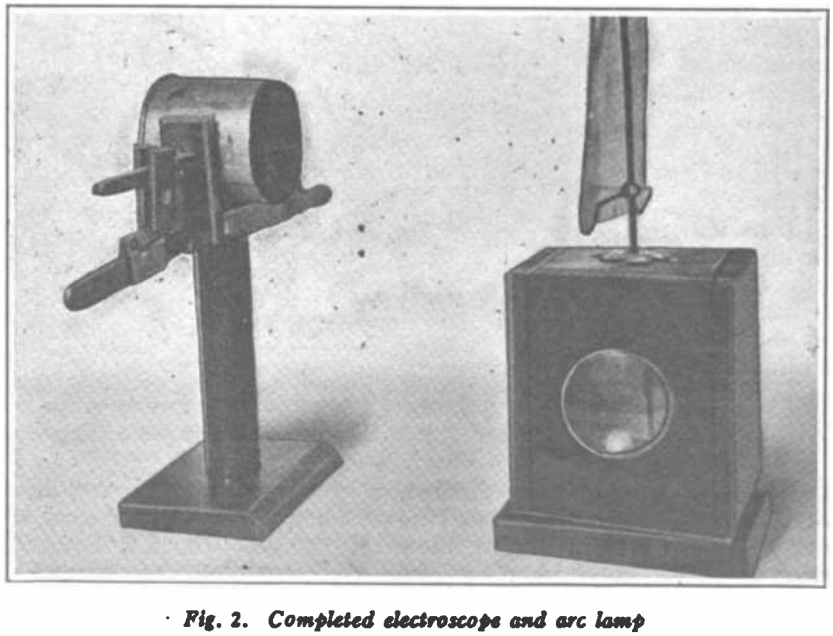


Fig. 2. Completed electroscope and arc lamp

The housing for the electroscope is of ½-inch oak or mahogany. In the front of the container a reading glass of about 4-inch focus is mounted, while directly in the rear of this is an opening over which a transparent scale of the type shown in Fig. 3 is glued. In the top of the housing a hole about ¾ of an inch in diameter is cut into which a cork snugly fits. The cork is hollowed out to allow the

electroscope proper to extend through, after which it is filled with melted sulphur and allowed to harden. The construction of the electroscope proper is depicted in Fig. 4. It is made of a well smoothed brass strip of ¼-inch width, and so shaped as to hold a metal sheet of about 4 inches by 4 inches. The metal plate was of aluminum in the author's electroscope, but some authorities use zinc for this purpose.

When the electroscope proper is assembled, well insulated from the cork by the sulphur, and well smoothed and polished to obviate leakage, a small strip of gold leaf is attached to the strip about an inch and a half from the lower extremity. A tiny drop of shellac will hold the gold leaf firmly in place. The cork is now put in place, and the electroscope is ready for use.

To charge the electroscope negatively it is only necessary to rub a glass rod with a silk or flannel pad, and then touch the plate of the electroscope with the rod. The desired charge may be produced by repeated applications of the charged rod. If hard rubber or ebonite is used instead of the glass, the electroscope will assume a positive charge, and will then be useless for detecting ultra-violet rays. For this type of work, then, glass must be used exclusively.

Now when the charged electroscope is brought in front of the arc lamp producing ultra-violet light it will be noticed that the gold leaf will immediately fall. The speed with which the electroscope is discharged by the ultra-violet rays produced by the arc lamp with soaked electrodes, is surprising. Even at the distance of ten feet or more the electroscope is easily discharged. When a glass plate is interposed the gold leaf comes to rest. The reason for this, as explained in the first number, is that glass is opaque to this type of radiation. The difference in the speeds of discharge of the electroscope can be used to determine the amount of high frequency radiation produced by the arc with various types of electrodes.

After using the electroscope for some time a very peculiar property will be noticed. The electroscope will refuse to discharge even when exposed directly to the radiation. Repeated attempts will fail and the electroscope will appear to have lost all its power to detect ultra-violet rays. If, however, the metal plate is now well sandpapered with emery paper, or better, well rubbed with a little wire wool, the power will be restored. The explanation of this peculiar property is in reality very simple. After repeated exposures of the plate to ultra-violet light the supply of free negative electrons on the surface of the metal is completely used up. The rays can find no electrons to force from the plate, and thus cannot impart to the plate any positive charge. If now, a new surface is formed the supply of electrons is again ready and the rays can again give the plate the necessary positive charge. It is necessary, then, every now and then to form a new surface on the plate.

It should not be necessary to go on with the innumerable interesting ex-

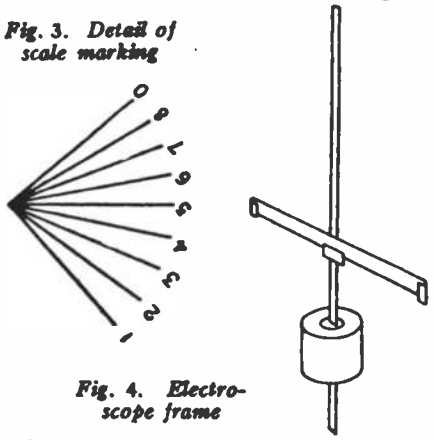


Fig. 3. Detail of scale marking

Fig. 4. Electroscope frame

periments which can be performed by the use of these two pieces of apparatus. To the experimenter interested in this type of work it should only be needed to suggest the fundamental principles involved, and his mind should supply the rest. Needless to say, any labor expended in the production of apparatus and in performing experiments with them, will not be wasted. It is a wonderful field for research and study. Ultra-violet light is little understood today, and practical use of it is almost unheard of. No one can say to what use it may be put in the future, for we are just beginning the century of radical discovery and experiment. It certainly behooves us to be working and thinking along this most wonderful field of modern physical science.

TREATING SULPHATED PLATES

IF, on test, the efficiency of a storage battery cell sinks to 50 per cent, or lower, the plates should be removed and washed thoroughly with distilled water. They are then placed in a cell containing a two to five per cent solution of caustic soda in water, and the charging current sent through the cell in the usual way. If the sulphate on the positive plate does not disappear during the time of the ordinary charge, and the solution gives an acid reaction with litmus paper, more caustic soda must be added to the solution, and the charging continued until the plate has the usual chocolate appearance. The plates should then be removed from the soda solution, well washed, replaced in the sulphuric acid solution, and the charging continued until gassing begins. Many cells have had their efficiences raised from 25 to 75 per cent, by six hours' charge, and many electricians believe that any plate which will hold together will well repay treatment by this method.

LEGALIZED FRENCH METRIC MEASURES

ON September 6, 1919, the French Chamber of Deputies legalized a set of metric measures, of which many are so familiar as not to need special notice but several are of interest in themselves and the whole set is to be noted as being based not directly on the familiar C. G. S. system, the centimeter-gram-second system, but on the M. T. S. system, the meter-tonne-second system. It was concluded that the meter-kilogram-second system, as well as the decimeter-kilogram-second system, gave units too small for commercial and everyday use. Of course the same objection applies in still greater degree to the C. G. S. system.

The first thing to be observed is that the metric tonne is a little less than the avoirdupois long ton. It is one thousand kilograms, which are 2,204.6 pounds avoirdupois.

The unit of angular measurement is the grade, symbol, gr., and is the one-hundredth part of a right angle. The degree, it is stated, can be used if desired.

The marine mile is to be one-sixteenth of a degree of latitude or 1,852 meters. The mass of the standard kilogram, preserved at Paris, is stated to be 27 milligrams less than the weight of a cubic decimeter of water at maximum density. This indicates the failure of the attempt to absolutely standardize units. The carat, used in weighing precious stones, is to be two decigrams.

The unit of density is the mass of a ton occupying a space of one cubic meter. The unit of force is the sthene, equal to one hundred million dynes.

The unit of pressure, the pieze, is the pressure of one sthene per square meter. It is equal to one thousand baryes.

The unit of power, or of energy rate, is the poncelet, one hundred kilogram-meters per second. This is 0.981 kilowatt. The unit of atmospheric pressure is 1,013 hectopiezes or 1.033 kilogram per square centimeter.

The unit of heat is the thermie, one tonne of water at 15 degrees C. raised one degree C. in temperature under a pressure of 1.013 pieze.

For low temperature work a unit, the frigorie, is defined as one millitherm.

The decimal candle, the unit of candle power of light, is one-twentieth of a violle.

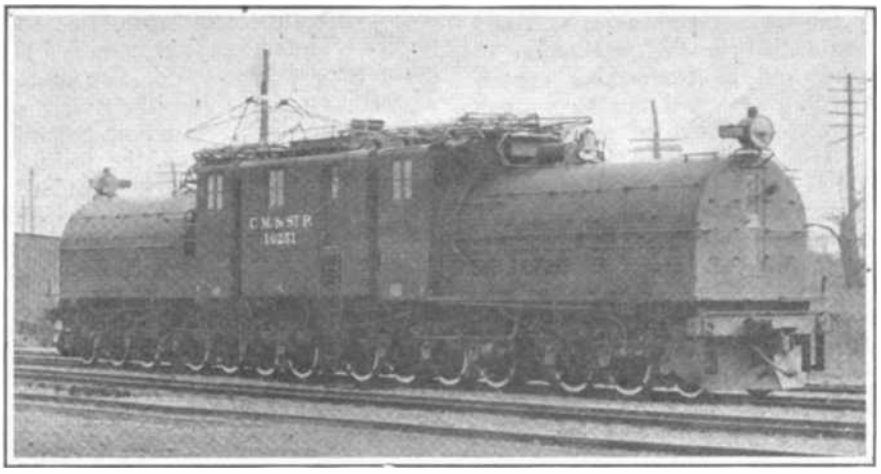
The unit of luminous flux is the lumen; it is the light of one decimal candle emitted for one second at a distance of one meter, covering one square meter on the surface of a sphere of one meter radius. It is a rare unit. Its symbol is lu.

The lux, symbol lx, is the light of one lumen distributed over one square meter; 10,000 luxes are equal to one phot.

ELECTRICAL PROGRESS DIGEST

LARGE STEAM TURBINE-GENERATOR HAS RECORD RUN

OPERATING without a shutdown for a period of 84 days, 11 hours, 36 minutes, the 45,000 Kw. Westinghouse turbine-generator at the power plant of the Narragansett Electric Lighting Company established, recently, a world's record for the continuous operation of a multiple-element steam turbine of the cross-compound type. During this run there were generated 51,104,000 Kk. hours or considerably more than the total output of the Narragansett Company for any year prior to 1915. In fact this unit generated about 85 per cent of the total station output. Furthermore, this record was made with the load varying from a minimum of 6,000 Kw. to a maximum of 41,000 Kw.



The enormous bulk of the new electric locomotives used by the Chicago, Milwaukee and St. Paul Railroad is supported by seven trucks or twenty-eight wheels

To some extent this continuous operation was made possible by means of an 800-gallon self-contained lubricating system. Oil is pumped through a cooler to the bearings at the rate of 600 gallons per hour.

One of the most important features of this run was the fact that the turbine was operating under ordinary conditions. No preparation was made for the run, for when the unit was started early last December there was no thought other than to operate for a week, which is the ordinary period of a run. Abnormal weather conditions, however, brought about such a demand for power that it was not considered economically advisable to shut down the unit until the conditions were relieved. Even at this time it was not necesary to stop the turbine but existing station conditions allowed this procedure.

ELECTROLYTIC TREATMENT OF METALS

COPPER has been purified by electrolysis for many years and recently much attention has been given to the development of the electrolysis of iron. The power required in any electric process depends on the amperes used and the voltage at which the work must be done—it is a question of watts. If either factor, intensity of current or potential drop, is low the power required is small. As the electrolysis of a metal requires a very low voltage a comparatively low power is required to carry out the process, notwithstanding the very large current needed. The principle of the process is simplicity itself. A solution is used capable of dissolving the metal, if it is made the anode; the current, which effects the solution also effects the deposition of the metal on the cathode. The potential expended on the deposition, however high it may be, is almost compensated for by the potential developed by the solution of the anode.

Various solutions are used where iron is to be electrolyzed; double oxalates or double sulphates may be employed; sulphocresylate of iron is also given as a suitable electrolyte. A rotating cathode is sometimes used. The material of the cathode is of interest as the iron has to be stripped therefrom, and copper and lead work well in this respect. The process is applied to the production of iron so pure as to take the place of charcoal iron, such as Swedish iron. It is also applied to the production of tubes.

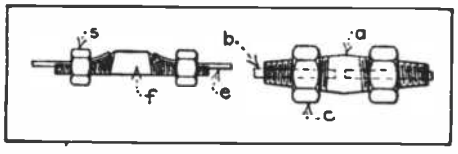
A number of cost data have been published, giving the result attained in France, and therefore not very applicable to this country. The cost is put at one hundred francs a ton above that of the original metal purified by the process. At ordinary temperatures 0.66 volt potential is required.

SIEMENS DRY CELL

The Siemens inert cell is attracting considerable attention. No chemical action whatever takes place in it until it is moistened. After that it operates exactly as a dry cell. An English contemporary suggests its availability for flashlight torches. The idea would be for the vendor to keep them dry on his shelves and when he puts one in a flashlight for a customer to charge it with water so that the customer receives a perfectly new cell. Dry cells even on open circuit gradually deteriorate.

SCREW COUPLINGS FOR CONDUCTORS

TWO variations in construction of couplings for electric wires are shown in the cut. The one for smaller wires consists of a central cylinder of metal with conical ends and on these ends right and left hand screws respectively are cut. Longitudinal grooves are cut through the threads on each end. Right and left hand threaded nuts screw on the ends over the ends of wires to be connected, jamming them solidly against the central piece making a very solid, yet easily released, coupling. In the other figure is shown a modification in which appear the conical right and left



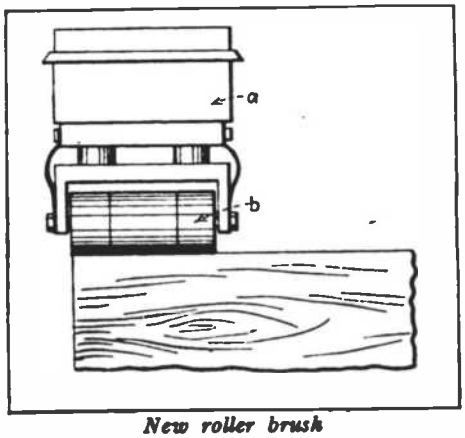
Simple screw couplings for wires

end screws. But here the central piece is cut in two longitudinally, axial grooves are made in each half, so that when they are put together an approximately circular aperture is formed. The ends of the wire to be joined are inserted in these grooves, which they just a little more than fill. The two nuts as shown are screwed up towards each other, compressing the halves of the coupling against the wire in the central groove. The coupling is instantly released by slacking the nuts.

Never use machine oil on the commutator of an electric dynamo or motor. It is matter out of place, does damage and serves no useful purpose.

COMMUTATOR BRUSH.

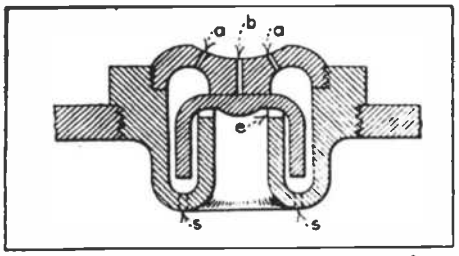
THE inventor of this brush proposes to substitute for the friction contact of the regular D. C. dynamo air motor a rolling contact as shown in the cut. The brush holder (a) carries rollers (b) which bear upon the commutator. He claims that much wear is avoided by this invention and that the grooves between the commutator bars never fill with carbon. It is also suggested that balls may be used instead of rollers.



New roller brush

STORAGE BATTERY STOPPER

THE object of this stopper is to prevent acid spray from being carried out of a storage battery during the charging operation. When a battery is gassed, a stream of bubbles of hydrogen are emitted and carry a certain amount of spray with them. In the stopper which we illustrated and whose construction is clean from the sectional view and which is supposed



Special cell vent for storage batteries

to be screwed into the battery jar top, the gas escapes through the apertures (e), then descends and the most of the spray, which it will have carried with it, runs back into the battery through the apertures (s). The gas now takes an upward cross escaping finally through the apertures (d) into the open air. The central opening (d) is provided with a perforated recess at the top of the plug, whose central aperture through which a trivial amount of liquid which may have escaped is returned to the jar.

The Puget Sound Traction, Light and Power Co. have adopted pulverized lignite as fuel. It gives 9,000 B.T.U.'s per pound and its culm gives 7,300 only. It is reduced to ½-inch size, dried, passed through magnetic separators to remove any fragments of iron, and is fed by screw stokers into the boiler furnaces.

THERMO-ELECTRIC BATTERY FOR AUTOMOBILES

IT is proposed to use the waste heat of the exhaust of the engine of an automobile to excite a thermo-electric battery. The couples are to be arranged radially about the exhaust pipe and their outer ends are to be cooled by the water of the circulating system. It is to be used to light the car or for the other uses on a car whose engine is running. It will not be of service except in such case, as if the engine is stopped it will give no current. As such a battery is almost indestructible and as the heat used by it is absolutely wasted in ordinary practice, there is much good in the idea.

PHOTOGRAPHING MAGNETIC CURVES

ALL are familiar with the production of magnetic curves by sprinkling iron filings on a sheet of paper held over a magnet. The filings arrange themselves along the lines of force, and varied results may be obtained by using different magnets, straight or horseshoe, and by using several at once, with their poles in various relationship. To photograph the curves all that is necessary is to use blueprint paper, to distribute the filings on it, and when they have been brought into their final position, by gently shaking, if necessary, to expose the paper to sunlight and then to develop by immersion in water. This will give a perfect and permanent reproduction of the lines of force of the field in question. Developing papers may be used, such as bromide paper, and the operation then must be done with observance of the regular methods of photography, using a non-actinic light in the distribution of the filings. The advantage of the blue-paper process is that it is so simple and easy, and a collection of curve-photographs obtained in this way may be quite interesting.

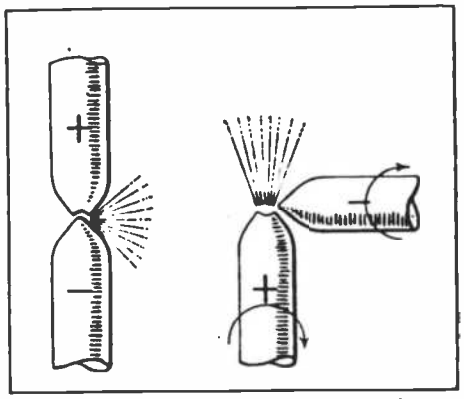
MERCURY RECTIFIERS

THE mercury vapor rectifier, acting by only letting one element of a two directional current pass through it, has attained considerable popularity, although now the Tungar rectifier is taking its place to a considerable extent. The mercury vapor rectifier needs a high vacuum. One of the terminals is mercury; this terminal must be the cathode; the anode may be a solid metal one. A current of three to five amperes is good practice. Some heat is generated; the mercury is heated and the solid anode may show low red heat.

The report appears in the English journals, that the London County Council is trying out no less than two trackless trolleys. This seems anything but a daring attempt, when it is remembered that such a system has long been in successful operation in the Orient.

ARC LAMP

IN an arc lamp 95% of the light is said to be in the crater, 4% in the negative pole and 1% in such portions of the carbon as are brought to red heat. To get the full advantage of the crater it is proposed to arrange the carbons at right angles to each other as shown in one of the diagrams instead of facing each other end to end. Of course the angle can be varied and it will probably be necessary to rotate the negative carbon and perhaps also the positive one in order to keep the crater in axial position.

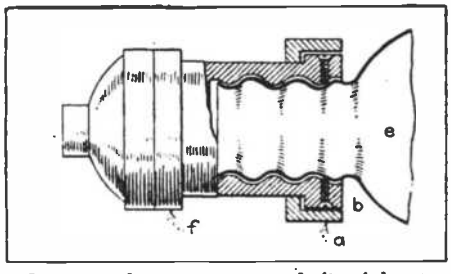


Novel arrangement for arc light carbons

The operations effected by electricity in the California citrus belt have excited some attention. The ground is irrigated by water distributed from electrically driven pumps and electrically driven machinery cleans the fruits, sorts, packs and labels it and is naturally called into use for driving the box-making machinery.

LAMP SOCKET

THIS socket is of the regular contion with the exception that it is arranged so that a special tool or key may be required to remove the lamps. The end of the lamp is screwed into the socket (f). Set screws (b) are provided which, when screwed up, preclude



Lamp socket to prevent theft of lamps

the unscrewing of the lamp from its socket. The heads of the screws are covered by a ring (a) which is constructed with any special form or lock desired, so that a special tool is needed to remove it. To take the lamp out of this socket this ring has to be removed so as to expose the heads of the screws to enable them to be turned back when the lamp is to be removed.

AVIATION BRIEFS

USEFUL LIFE OF AN AIRPLANE

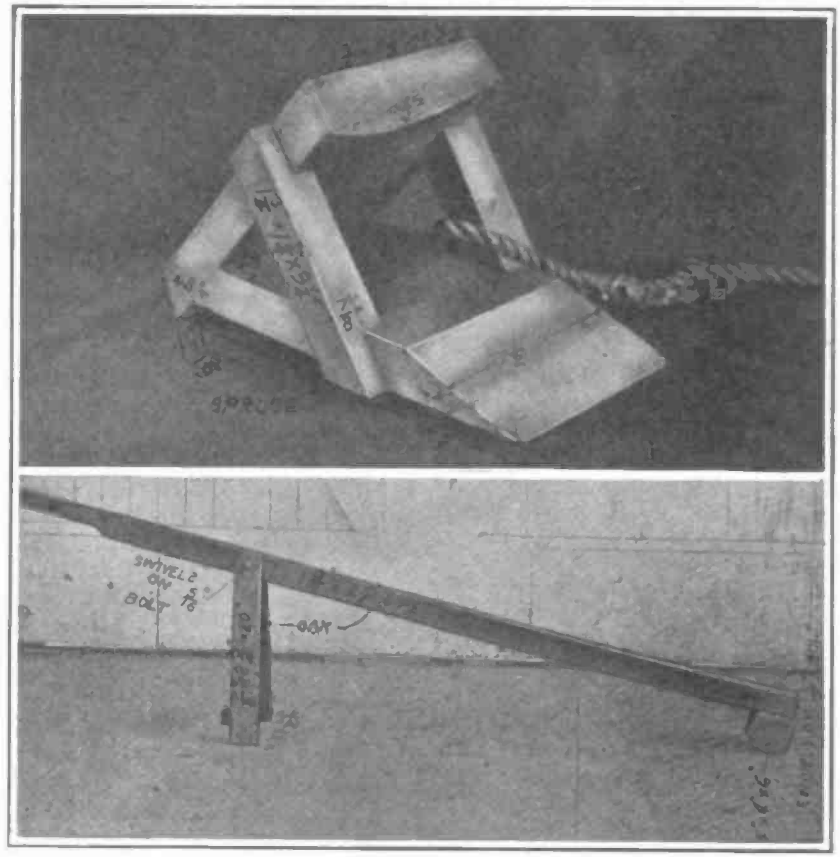
ONE of the drawbacks to the commercial use of airplanes has been their short life, which coupled with their high initial cost has resulted in unusually high depreciation charges. During the war, it was found that the average life of airplanes in active service was from sixty to ninety days so strength and endurance were sacrificed to gain the desired military advantages of high speed and quick manoeuvering qualities. The efforts of designers are now directed to increasing the life of both the power plant and airplane structures.

Many of the aeronautical engine manufacturers have remodeled most of their successful types with intention of increasing reliability. This has usually resulted in a slight increase in weight. The question of overhauling cost has been gone into and modern engines are so designed that their accessories, valve gears, and similar parts are easily reached for cleaning and adjustment. The result is that most engines on the market to-day for commercial use can be relied on, with proper use and care, for from 125 to 150 hours without being overhauled. And if, simple cranes or hoists, suitable benches, and other shop equipment are not available, valves may be ground and even pistons changed in many modern types without removing the engine from the engine bed.

One feature was developed as a result of the war which will have a great effect on the future use and development of aviation. This is the application of metal, such as alloy steels, duralumin, etc., to the structure of the airplane. The Germans were driven to this by the lack of a reliable supply of suitable lumber. Some French and English firms also worked on this problem, notably Brequet in France. Many inventors have brought forward alloys, new structural combinations, etc., with the object of using metal in whole or in part.

This development has been foreseen for many years, but presents a difficult problem. The effort to obtain the maximum of strength with the minimum of weight resulted in vastly refined types of internal structure and thorough investigations into the strength and properties of the available materials. All of this data and knowledge is now available to the designer who is working with the idea of durability.

The shortage of suitable linen prompted an investigation of other materials as a substitute. Various fabrics of cotton and cotton with linen were developed which have some properties of value that all-linen has not, besides being cheaper. Streamline wire was brought out of the experimental stage and can be obtained of equal strength and reliability with stranded cable. Very light sheet metal has been used for surfacing wing frames, which have already been constructed entirely of metal. All of these experiments cannot fail to bring out designs of planes and engines which will be much more enduring and lower in cost than present types. There is no reason why a good, substantial airplane cannot be built on a quantity basis cheaper than a good automobile and if it is reasonably enduring, its up-keep cost will be no greater than that of an automobile of similar capacity for a given mileage. Of course, before the airplane can compete with the automobile, to any extent, the demand must be large enough to warrant production on a large scale.



Two useful appliances for the airplane hangar. Dimensions of practical wheel chock are given at top and of a quick action lifting jack to go under the axle at the bottom

COMMERCIAL AVIATION IN ENGLAND

REPORTS from abroad indicate that the Handley-Page Co. is now making use of converted bombers, for continental air service. These machines are known as Type W-S, and carry 15 passengers or 2 tons of freight at a speed of 112 miles an hour. The first of these machines was exhibited at the Paris Aero Show, having been flown there from London. On the close of the exhibition this machine was flown back from Paris to London, making the flight in 2 hours 10 minutes. The average time between Paris and London is under 3 hours by air; by train and steamer the journey often occupies 14 hours. Since the London to Paris and Brussels air services were established on Sept. 2, 1919, until Jan. 29, 1920, Handley-Page machines had carried 924 passengers, 43,412 lbs. of freight and had covered a distance of 65,293 miles. On May 1, 1919, civilian aviation was established in Great Britain, and from that date Until Jan. 29, 1920, Handley-Page

machines carried 461 passengers, 44,805 lbs. of freight, and covered 74,743 miles.

A new service has recently been established between London, Paris and Brussels for carrying freight at reduced rates. The following is the scale of charges:

	Per Lb.
Shipments up to 10 lbs.....	*2/6
" from 10 to 20 lbs....	2/3
" from 20 to 50 lbs....	2/–
" from 50 to 100 lbs...	1/9
" 100 lbs. & over.....	1/6
Passengers baggage (unaccompanied by passengers).....	1/6
Minimum	5/–

* At English rates. Shillings equivalent to 25 cents and pence, 2 cents.

Numerous consignments of delicate articles, such as ladies silk dresses, scientific instruments, antiques, valuable flowers, are now constantly carried by air between Paris and London. Air service is proving itself particularly valuable for this class of transportation, for all danger of damage by rough handling is removed, and the risk of loss by theft becomes negligible.

FRENCH AERO ENGINE OUTPUT

ACCORDING to a paper read by M. Martinot-Lagarde, before the Society of Civil Engineers of France, the production of aircraft engines in that country increased from 40 per month in August, 1914, to 4,200 in October, 1918, or from 900 per year in 1914 to 34,000 for the first ten months in 1918. During the war a total of nearly 90,000 aircraft engines were built, representing an aggregate work of 100,000,000 man-hours, an output of nearly 2,000,000 hp. and a cost of 2,000,000,000 francs.

A NEW RECORD IN AVIATION

THE great transatlantic aeroplane A. R. F. which was completed on February 26, 1920, at the airship shops of the Fiat, began its flights at the Aviation Field of Mirafiori in Turin with a wonderful speed record, in which the world's record was beaten by the well-known aviator Lieutenant Francesco Brak Papa, who, with four passengers on board, attained the amazing speed of 261 kilometers an hour. The flight was carried out according to the rules of the International Aeronautic Federation and was officially supervised by the commissaries of the Aero Club of Italy, and by officers of the Italian Military Aviation, to whom was entrusted the duty of verfying the electric measuring apparatus.

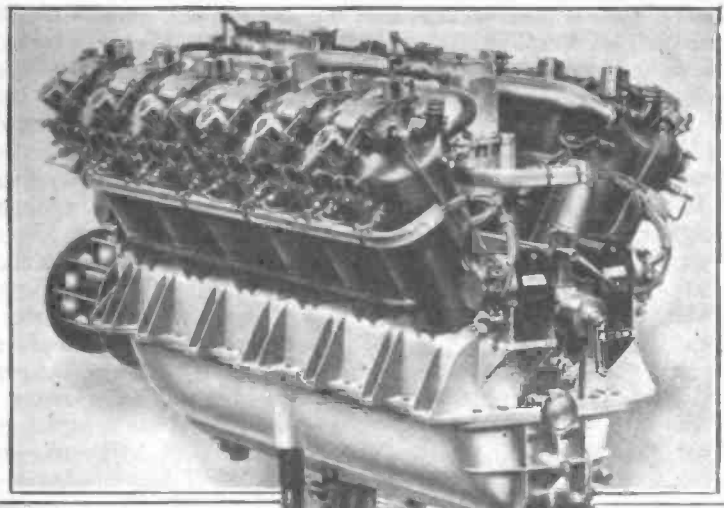
This record marks a decisive turning point in the development of aviation and shows the seriousness of intent and the broad means with which the great Italian Company, long known for its multiform activity in the various branches of industry, has persevered in the study of this new branch of engineering, before which there is certainly a bright future. The machine was the one invented by Engineer Celestino Rosatelli and shown at the International Exposition in Paris. It attracted the general admiration of engineers by its ponderous bulk combined with a pleasing elegance of form and harmony of lines. This craft is a biplane of conventional design propelled by the powerful 700 hp. motor illustrated, this is also the product of the Fiat Company. The machine has a capacity, in addition to the crew and instruments for fully 660 gallons of fuel, or sufficient to supply the motor for twenty consecutive hours, which renders it possible for the airplane to cover the great distance of five thousand kilometers without stopping, while the voyage across the Atlantic is only three thousand.

AN ELECTRICAL TURN INDICATOR

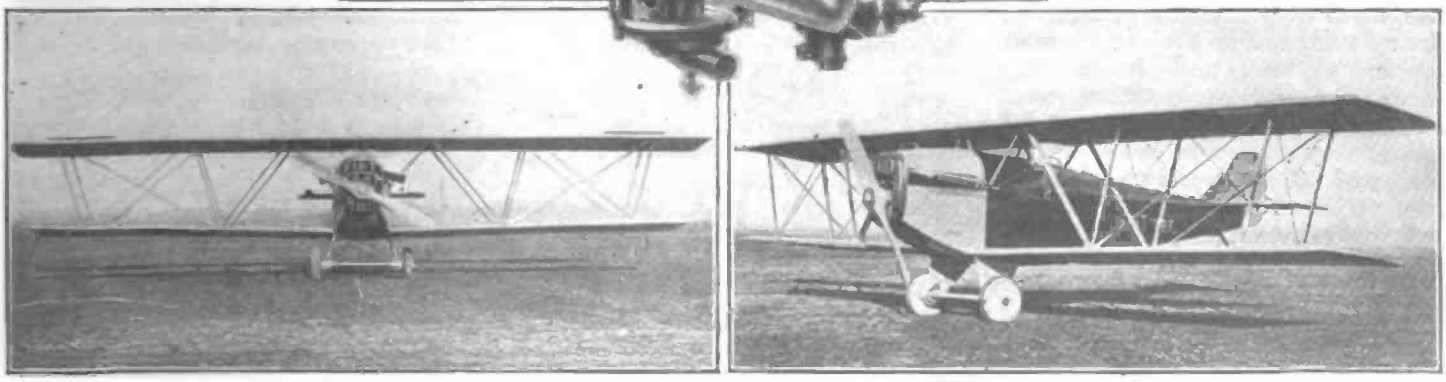
There has recently been introduced in German flying circles an instrument that indicates the difference in air speed between the two wing tips, which is but another way of expressing the rapidity of turns. Two venturi tubes are used, one over each wing tip. Each venturi contains three resistance thermometers, one in the throat, one in the entrance section, and one in the exit section. The temperature difference between the throat and the entrance and exit can thus be obtained for each venturi. By combining two instruments differentially, the difference in temperature between the two throats can be measured. This temperature difference will depend on the rate of turning. It is claimed that the electrical recorder has very little lag.

It is advised that lenses should be boiled in distilled water before being put in place and where it is possible the instruments should be airtight and filled with dry air.

The 700-H.P. F.I.A.T. aviation engine shown at the right is a good example of modern high power and light weight motor design. It is a twelve-cylinder type



F.I.A.T. four-passenger biplane shown below is a very efficient large capacity airplane design with amazing speed possibilities. It has a flying radius of twenty hours



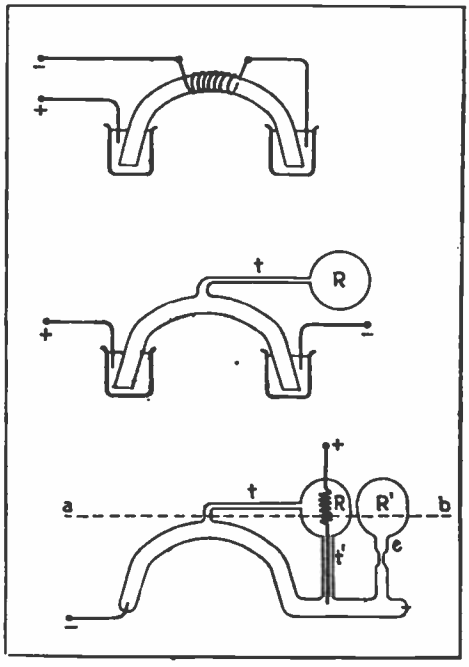
The Henri George Mercury Vapor Lamp

By Prof. T. O'Conor Sloane

THE quartz tube mercury vapor lamp of the ordinary type has various disadvantages. The fact that mechanism is required to rock or oscillate the lamp back and forward in order to light it, is one objectionable feature. It takes some fifteen minutes to get started into full illuminating power. Containing a quantity of mercury in a high vacuum there is danger of fracture from a mercury hammer, analogous to the well-known water hammer. No matter how well constructed as regards the joints, and no matter how pure the mercury and the quartz may be, there is always danger, that air will find its way into the interior, impair the vacuum and interfere with the proper operation of the lamp. Other troubles incident to their operation are cited. The lamp described here lights on turning on the current without rocking, has no vacuum in its interior, and starts into full operation at once. Referring to the three diagrams its operation and general features of construction may be followed out.

Suppose the tube in Fig. 1 was filled with mercury, and that its ends were open and were immersed in open cups of mercury; the pressure of the atmosphere would keep the tube full. If a current of electricity were passed through the circuit as shown, the mercury would complete the circuit. But if the current was of sufficient strength it would heat the mercury in the upper bent of the tube, would vaporize it and form a bubble, breaking the circuit and giving at least one of the conditions for starting an arc. This arrangement is very insensitive, as so much heat would be needed to break the mercury column. Now suppose a bulb or flask-like recipient, R, of Fig 2 communicated by the tube, t, with the upper part of the bent tube. A comparatively slight heating of the bulb, R, would form a bubble of gas in the upper part of the bent tube, across which an arc under proper conditions would spring. It is clear, that we have got rid of the need of rocking or oscillating the lamp to start it.

So much for the basic principles. Now referring to Fig. 3 we see there in diagram a bent tube hermetically sealed. The recipient, 4, communicates by a tube t, as before with the top of the bend, and by another tube, t', with the lower part of the working tube. A second recipient, R', with a stricture at e, gives additional capacity for mercury. Here too the circuit is differently arranged. One of the wires of the circuit enters the recipient, R, at its top, where it is sealed in, and wound into a heating coil passes down through the tube, t', into the mercury lying in the quartz tube. The other wire enters the quartz tube at its other end. The level of the mercury when the tube is inactive is indicated by the dotted line, a, b. When the current is caused to pass it heats the gas in R, expands it breaks



Figs. 1, 2 and 3—Diagrams showing principles of Henri George mercury vapor lamp

the mercury column and the arc starts. The recipient, R', receives any excess of mercury, the stricture preventing sudden changes and ensuring a steady action.

The breaking of the mercury column is thus provided for, and the next question is what gas should be used to fill the recipient, R. The gas is to be at

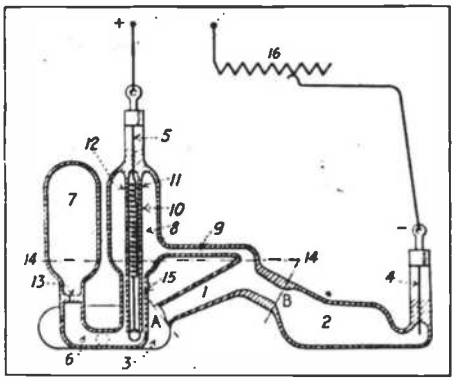


Fig. 4—The Henri George mercury vapor lamp

atmospheric pressure; hydrogen will not do for at such pressure it will prevent the formation of the arc; air contains oxygen which would attack the mercury in action; nitrogen does not work well as it forms a deposit on the walls of the tube, probably an unstable nitride, and interferes to a considerable extent with the action. It is the use of the rare gases of the atmosphere, which has made this lamp successful. If the mercury column is broken in an atmosphere of neon, argon or helium the arc always forms and starts at once into full action, provided the gas is absolutely dry. If there is any moisture present hydrogen is formed by dissociation and the action is interfered with.

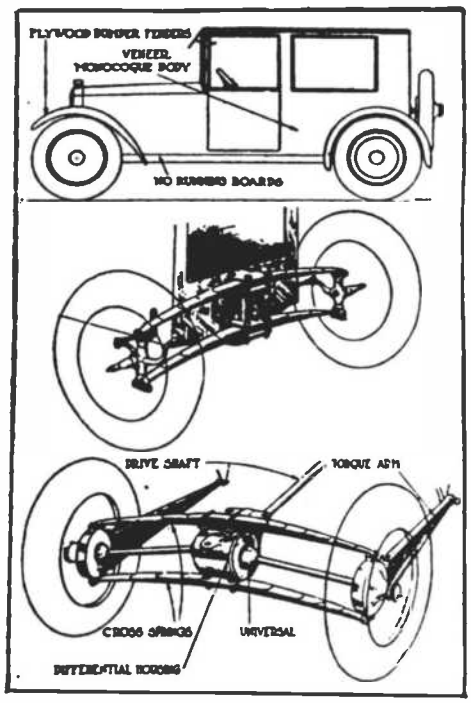
The actual lamp is shown in Fig. 4. The quartz tube, within which the arc is formed is indicated by 1, W is the cathode reservoir of mercury, 3 is the anode reservoir, 4 and T are the positive and negative terminals. The recipients, 7 and 8, corresponding to R and R' of Fig. 3, are connected by the tube 6. The tube, 9, corresponding to T' of Fig. 3, must be three-sixteenths or more of an inch in diameter. The tube, 10, containing a heating coil of tungsten, 12, has a hole in its wall at 11; the lower end of the wire is always immersed in mercury at the base of the lamp. At 13 is the steadying stricture, the line 14, 15 shows the level of the mercury when the lamp is inactive. At 15 there is an annular space between the concentric tubes. The lamp is hermetically sealed. The lamp operates on direct current, regulated by a rheostat, 16; this is set so as to give a current of eleven amperes when the lamp is in operation.

To start the lamp, the current is turned on by a switch. The coil, 12, becomes hot, the gas expands and breaks the column of mercury in 1, the arc forms and eventually plays from A to B; the excess of mercury rises into 7. In a lamp for a 115 volt circuit, the current drops to four amperes at a voltage between the terminals of eighty to eighty-five volts. The mercury vapor soon expels all gas from the arc-tube, 1, and in five or ten seconds the lamp is in operation. The long period of waiting, incident to the use of the ordinary quartz tube lamp is done away with, and the fact that the pressure in the lamp is practically atmospheric disposes of the trouble of leakage into the interior of any air. The lamp is started by the turn of a switch, no rocking is needed to draw out the arc. Its action is made steady by the stricture at 13 as previously explained.

To make twist drills available for drilling marble, a French contemporary gives the following instructions: One side of the point is to be kept at the regular angle of 59°. The other side is to be ground off to 48°. Both angular measurements are referred to the axis of the drill. Another thing recommended is to file or grind a slot across the point at 90° with the cutting edge about one-quarter of an inch deep.

EXTREMELY LIGHT AUTO BODY

MENTION has been previously made in these columns of the influence of automobile engine design principles on the development of the aerial power plant and now we find that aerial designers are contributing to the refinement of automobile construction, especially as relates to body construction. Our contemporary, *Automotive Industries,* describes a special five passenger Sedan body which is claimed to weigh only 120 pounds for a car of 112 inches wheelbase. These bodies are constructed on airplane



Light car has novel spring suspension

fuselage principles and are of a three-ply veneer combination. The great strength and light weight of plywood permits it to act as a sheathing and at the same time contribute considerably to the strength of the structure. The veneers usually employed consist of two plies of birch with a play of mahogany between. The thickness used in auto body work is ⅛ inch.

At the last summer meeting of the Society of Automotive Engineers there was an interesting discussion on a five passenger Sedan that would weigh 900 pounds complete. In this car, the sills and frame are combined and the axles are replaced by cross-springs, which perform the functions of both springs and axle. The drive to the rear is through propeller shafts with universal joints. Plywood is used practically exclusively in the construction of the car, even the fenders being of this material. The cross-spring suspension is of particular interest, and is illustrated herewith.

There is nothing experimental about the construction as it was tried out on a light cyclecar six years ago. The rear construction is modified from De Dion practice of nearly twenty years ago and should prove practical in the new application. As will be evident, there will be very little unsprung weight and exceptionally easy riding should be obtained from this method of springing. As an example of the light weight of the plywood body, there has just been shipped to one of the well known eastern manufacturers a five-passenger Sedan body weighing 196 pounds. This car, which is known for its lightness, has hitherto used an aluminum body weighing 600 pounds.

NEW USE FOR POISON GAS

A NEW use has been found for surplus war stocks of asphyxiating gas. Some cases of typhus occurred in Paris, among refugees, and it was suspected that they originated from clothes from which vermin had not been entirely removed.

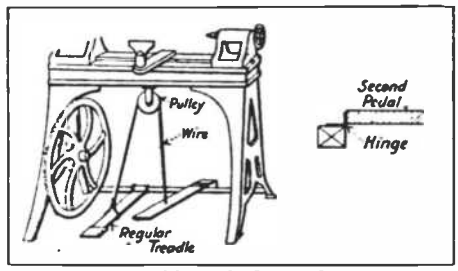
One of the measures used by the Pasteur Institute was to take the clothes, hair brushes and combs of those who had been in contact with persons affected and hang them for twenty minutes in a cylinder containing a mixture of chloropicrine, which was one of the asphyxiating gases used in the war. Twenty cubic centimeters of gas were used for every cubic meter of air and the mixture was heated to 45 degrees Centigrade. In addition to clothes the mattresses and blankets were treated in this way and it was found that as well as killing all vermin the gas disinfected them completely.

PROPOSES SHAFT TWELVE MILES DEEP

SIR CHARLES PARSONS, lecturing recently at the Royal Institution, referred to his proposal for sinking a bore hole twelve miles deep into the earth. He said that the cost of boring the hole would not be very great. In countries where the atmosphere is dry, the sides of mine shafts are cooled by sprinkling them with water, the evaporation of which cools the rock. This effect might be augmented by artificially drying and cooling the air before passing it down the mine. With still greater depths of shaft further methods of cooling would probably be necessary. The heat might be carried upwards by means of brine circulated in a closed ring of steel pipes with a rising and descending column, or a simpler method would be to arrange for a rain of liquid air down the shaft. When seeking the deeper portions of the shaft probably shields would be required to protect the miners from the splintering of the rock, since the intense compressive stress splits off scales from the surface, sometimes with considerable violence. When he first brought forward his suggestion in 1904, the estimate of the time required to sink a shaft twelve miles deep was eighty years; but with improved machinery and methods the records have been so much lowered that he now thinks an estimate of thirty years reasonable.—(*Compressed Air Magazine.*)

AUXILIARY LATHE PEDAL

IN the usual arrangement of foot lathes, the foot, which does the driving gives one impulse downwards for each turn of the flywheel, and then has to be raised simultaneously with the rising of the pedal. In the simple arrangement illustrated an extra pedal is provided, hinged to a block of wood, which block is screwed down to the floor. The two pedals are connected by



Auxiliary lathe pedal

a rope passing over a grooved pulley attached by a bracket underneath the lathe bed. In operating the left hand working pedal is pressed down as the flywheel turns. At the end of the down stroke, instead of raising the foot by muscular effort, the other pedal is driven down by the other foot, lifting the driving pedal and with it the other foot of the operator. This makes the work much easier as the feet press alternately down, and the tiresome lifting of the foot is done away with. The attachment of the second pedal to the floor-block is shown in the smaller figure.

The asphalt lake on the Island of Trinidad is one of the classic curiosities of the world. Owing to the closing of the Continental markets, the output was greatly reduced during the war, little more than one-quarter of the normal output being exported in 1918. In Trinidad and Tobago there are a number of wells, producing upward of 43,000,000 gallons in a year.

Continual reports are coming in from all over the world about iron ore and coal deposits. It is reported from Queensland that in one place there are 500,000 tons of magnetic ore. This ore has a way of being very pure or very impure and the Queensland ore is said to be of wonderful purity. Boring operations have shown the existence of many millions of tons of coal. In the existing condition of things it is a comfort to hear of coal and iron ore deposits.

Small Boat for Outboard Motor

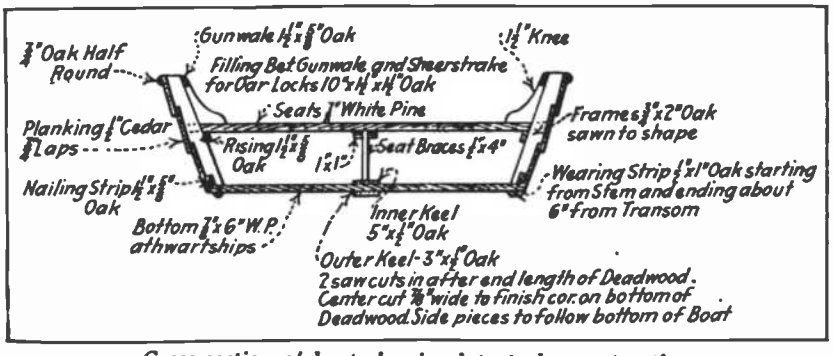
THE economical and simple installation of the various types of outboard motors intended to convert ordinary rowboats into motor boats is remarkable and many varieties of this type of light power plant have been made and have been found satisfactory in many respects. The average rowboat, however, is not well enough built to be adapted for an outboard motor or to warrant making it a semi-permanent installation. It is possible to build a small, inexpensive craft that will be as easy to propel with oars as a rowboat is and at the same time have proportions that make it much better suited to carry the added weight of the outboard power plant at the stern.

One of the requirements is that the after sections be fuller and the boat have more beam than would be the case if intended to be used only as a simple rowboat. The boat illustrated has been designed by an experienced naval architect, who has had considerable experience with small boats of this type. It is clearly outlined in the accompanying design drawings and its construction will be clear to anyone familiar with boat making. It should be of special interest to our readers interested in small boat construction. The boat has lap strake sides and the gunwale is left open so that any water collected in the boat will run out when the boat is turned on its side to clear the interior of water.

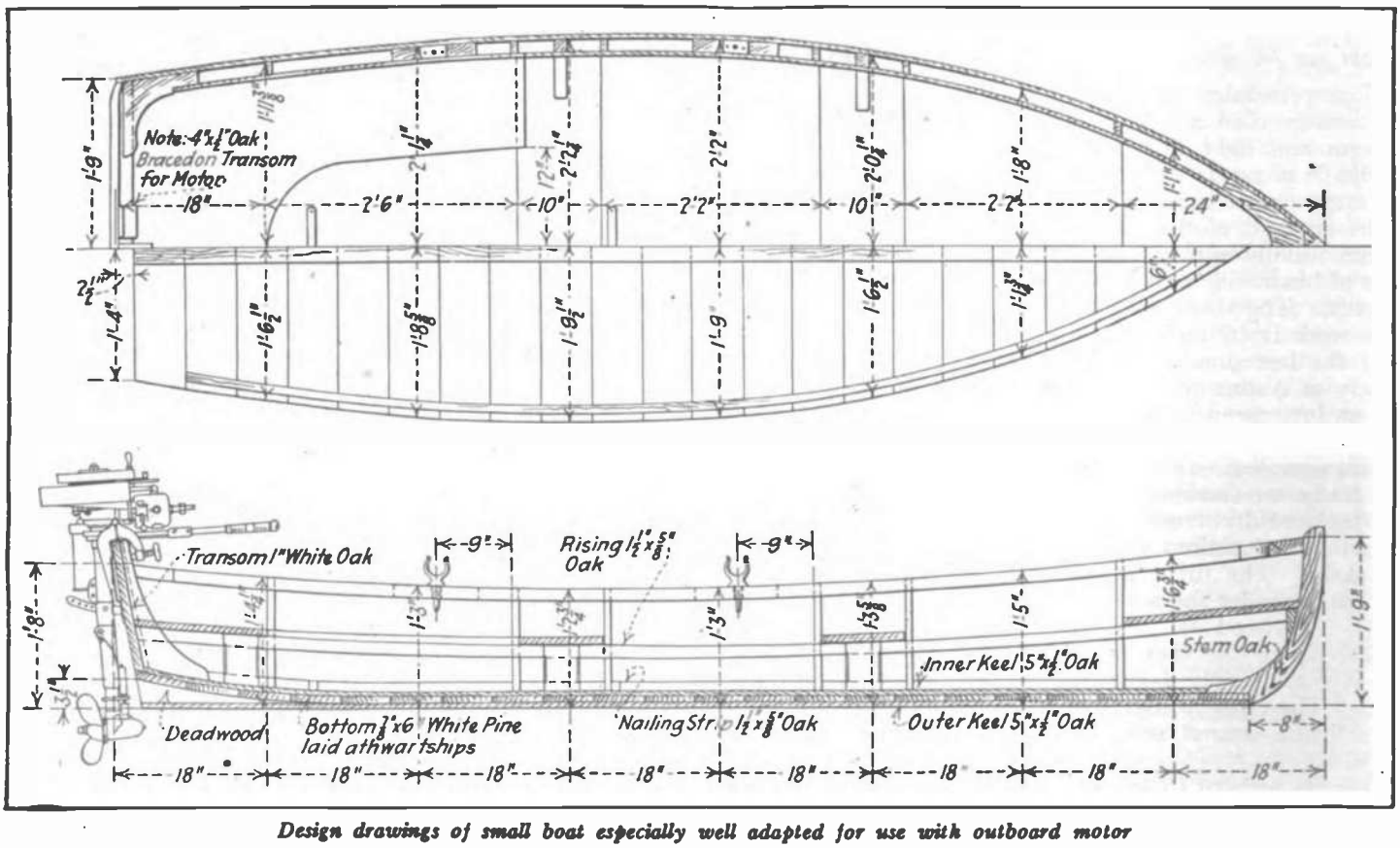
The main feature is the extra strength of the transom, which is materially strengthened to be better able to resist the vibration of the engine and carry the weight. Another feature is the design of the rear or stern seat, which is so shaped that the operator can sit comfortably in any of the positions he may desire to occupy while working at the power plant or controlling the boat. The sides flare out more than in the usual rowboat. This flare extends the entire length of the craft. This is to keep the boat dry in choppy seas by throwing the water to the sides as the boat progresses forward.

The broader beam at the rear will keep the boat from riding with its stem in the air as the ordinary rowboat does when it is fitted with a special outboard motor and enables the boat to sit better when the operator riding in the rear seat alone which brings most of the weight at the back end. The outer keel is made removable because a small boat of this kind is constantly hauled out on the beach and it may be necessary to replace the keel with a new one after the friction against sand and stones has worn out the old one. Rubbing strips are also provided along the sides and the removable keel piece and these strips may be used when necessary thereby protecting the bottom and side planks against undue depreciation.

A boat of this size is not only an excellent type of tender for larger water craft, but is also a very good and handy general utility boat for fishing and other work of that nature. It may be built of any of the woods recommended for boat construction in previous issues of this publication and the details of construction should be readily understood.



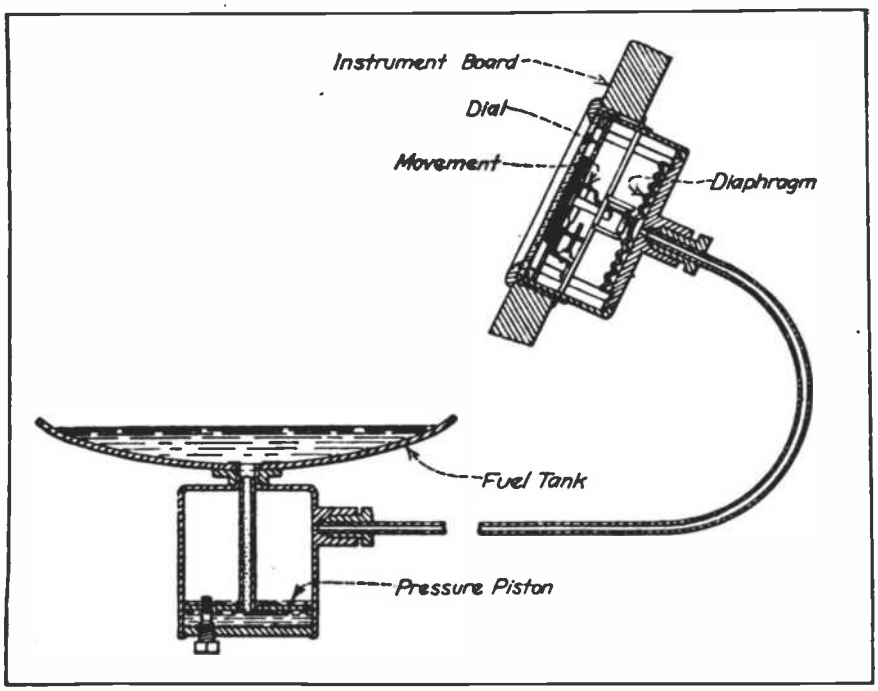
Cross section of boat showing lap strake construction



Design drawings of small boat especially well adapted for use with outboard motor

THE GASOGRAPH FUEL GAUGE

A TANK gage designed to be mounted on the instrument board and adapted to indicate the amount of fuel either in a seat tank or a rear tank has been placed on the market recently. The device contains no float, springs or wires, and it is not necessary to mutilate the tank in order to install it, as it screws into the drain opening. The principle of the device is as follows: The pressure due to the weight of the gasoline in the tank is transmitted through a small copper tube to the gauge on the instrument board, and this indicates the quantity of gasoline in the tank by an indicating hand moving over the dial. The principle on which the indicator works is the same as that of a pressure gauge or manometer, except that a diaphragm is used instead of a Bourdon tube. The instrument can be installed with tanks located anywhere on the car and using either vacuum or gravity feed. It is guaranteed for one year.



The Gasograph fuel gauge shows amount of liquid in rear tank on car dash

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Aeroplane propellers have been made of Bakelite-Micarta. Bakelite is familiar to our readers as an insulating material in the construction of fine electrical apparatus and many other places, where celluloid or hard rubber formerly figured. These propellers were found to be much stronger than wood, sometimes twice as strong, and therefore can be made thinner and lighter. To secure them to the engine light keys may be used, bearing directly on the material itself, instead of the heavy flanges, hubs and bolts used on wooden propellers. They were exposed during their trials for two summer months to changes of weather and varied in pitch only 0.2°. The plane speed and rate of climbing were about the same as with wooden propellers, but the engine speed was 100 r.p.m. less. They lend themselves readily to reinforcement by metal strips imbedded in them. It is claimed that one will outwear several wooden propellers.

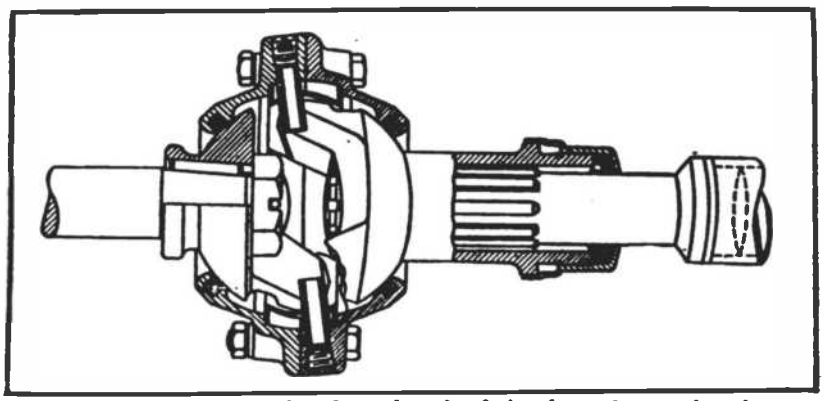
STRENGTH OF UNIVERSAL JOINTS

THE strength of the various parts entering into the construction of the average automobile is seldom appreciated by the layman. The great strength of universal joints was brought out by a series of torsion tests made in the Laboratory for Testing Materials of the Massachusetts Institute of Technology and shows how manufacturers of such components provide a large factor of safety so that breakage due to weakness of design is almost impossible.

The specimens were centered in a torsion machine. In the first test the universal was connected up at one end to a 1½-in. S. A. E. standard taper with S. A. E. standard key, and at the other end to a 1¾-in. S. A. E. standard ten-spline fitting. The joint failed under a twisting moment of 40,680-inch pounds, owing to the S. A. E. key shearing off. No damage was done to the ring, bushings or forks.

In the second test, made on the same joint fitted to new shafts, these being connected at one end by two 7/16-in. keys and at the other end by a 1¾-in. S. A. E. standard ten-spline fitting, the joint showed yielding under a twisting moment of 72,000-inch pounds, and failed under a twisting moment of 75,600-inch pounds. The shaft failed at the spline end by shearing at the neck. The keys started to shear slightly at the other end. No damage was done to the ring, bushing or forks. This would correspond to the transmission of more than 1,000 horsepower at a speed of 1,000 R.P.M., which is the normal speed of many auto and truck engines and which corresponds to the propeller shaft speed with the gearing in direct drive at car speeds ranging from 30 to 40 miles per hour, depending on the size of the rear wheels and final drive gear ratio. The most powerful average auto engine would not deliver over 50 or 60 horsepower at this speed so it will be apparent that the factor of safety is twenty.

In the third test the same ring was used as in test No. 2, but fitted with two new forks and shafts. The shafts were solid at both ends and fitted with two 7/16-inch keys in each. The joint showed yielding under a twisting moment of 93,000-inch pounds, and failed under a twisting moment of 100,000-inch pounds. The shaft was badly twisted at one end and the keys sheared. At the other end the shaft was slightly twisted and keys sheared. No damage was done to ring or bushings. The keyways in the forks were slightly twisted. A scale drawing of the joint tested, which was reproduced from "Automotive Industries," is shown herewith.



Tests of this universal joint show that the design has a large safety factor

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Musicians find the drum an unsatisfactory instrument for lack of harmonic overtones. From India comes the description of a drum whose parchment head is loaded with an adherent composition containing finely divided iron. Such composition lies in a central circle. Around the edge a second ring shaped membrane is secured and the effect of the loading is to produce good harmonic overtones.

The forests of the world are being depleted as we all know and from Brazil comes the statement that reforestation of the eucalyptus tree is proposed. Five years suffices for the growth of the tree to a commercial size, and the expense is figured at 3 shillings sterling per cubic meter of wood.

MANUAL ARTS AND CRAFTS

PROJECTS FOR THE SCHOOL, HOME OR SHOP

SLIPPER BOX AND FOOT REST FOR THE BEGINNER

THIS foot rest is also used as a receptacle for father's or mother's slippers. It surely will be a very acceptable birthday or holiday gift. It may be made from any convenient material. Ordinary soap boxes or canned-goods boxes at the corner grocery store will suffice for the stock required. The dimensions may be varied to suit the builder. The principle factors governing the size is the material at hand, the comfort of the user and the length of the slippers. The principal aim in this design is simplicity of construction, all butt joints securing the components by lock-nailing with one and one-half-inch number sixteen finish nails or brads.

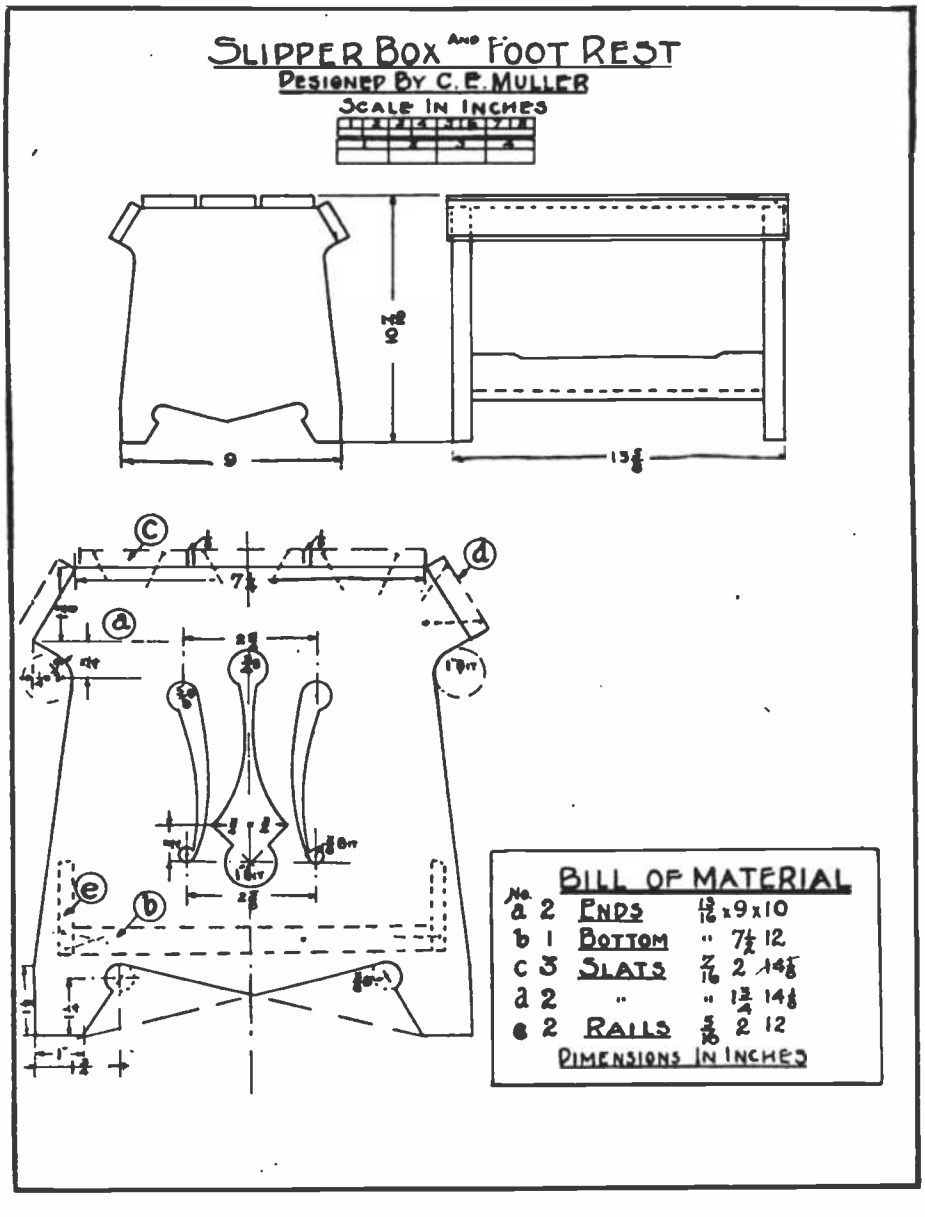
Chestnut, whitewood, cypress, redwood and pine are recommended for the beginner. The hardwoods, plain or quartered oak, ash, mahogany or black-walnut from old furniture will be found excellent material for the advanced workers and will take a much nicer finish.

The ends may be braded together when fashioning the contour. The design is such that only a few bits, a cross-cut saw, a plane and spoke-shave are necessary to shape it. The cross-cut saw will saw with the grain well enough if a rip saw is not available.

The first step is to establish the working edge, second, square off the length, saw to within a sixteenth of the line, if great care is taken to do this accurately, no further tool operation will be necessary either on the top or bottom of the end pieces "A." Third, lay out the centers of the 5/8-inch holes for the foot and the 1-inch holes for the sides, then the sloping angles for the slats to dimensions or at 60 degrees to the horizontal. You will observe that the lower recess section is made so that the contour can be sawed with any saw in the line indicated by the dashes. This, if carefully done, will only require touching up with a rasp or coarse sand paper. The particular part of this operation is to resolve to maintain the lines tangent to the circles. That particular feature instantly indicates the workmanship and skill of the worker, or as it is more commonly called, the carefulness of the student.

A very easily produced design to add to the pleasing appearance of this project, especially when the end pieces lack character of grain is shown in the large end detail. The design is merely a suggestion of a method that may be used. A series of different sized holes would also serve the same purpose. It is urgently recommended, however, that any change in this design be drawn out on paper full size or to correct scale, then submitted to others for criticism before adoption. This may be easily done by shaping the piece, then tracing around it on drawing, wrapping or even news paper. This will be found interesting and decidedly instructive to the amateur. I find it very convenient when designing or helping the students to develop the initiative to fold a sheet of paper on the symmetrical center line shown in the end detail layout, full size, one-half of the design, then cut out the pattern. It can then be altered to suit one's fancy. The law of design will be taken up in a future article.

In all projects where only butt joints are used it is essential that the nailing be given due consideration. In this case the bottom will require four 1½ No. 16 brads driven in No. 1 and 3 approximately 15 degrees, diagonally in a horizontal plane, left to right 2 and 4 right to left. This will lock the nails similarly to those shown at C. Here again it may be necessary to caution the amateur to be on his guard not to nail too closely to the edges or ends of the slats. The nails or brads act as wedges and may split those parts, especially in hard woods. To eliminate any



possibility of this occurring, close-fitting holes may be drilled for the brads with either a twist drill or brad awl if very cautiously done. The brads must be set very little, care must be taken not to let the nail set slip as it would scar the wood and perhaps split it. Finish the project by any of the methods described in previous articles.

MISSION CHAIR

THIS style chair is of the simplest possible construction and when carefully made is substantial, comfortable and appropriate for a dining room. It is designed particularly for the amateur that appreciates the mission style. It is usual to start work of this character by getting out all the stock to size and dressing all surfaces that show in the finished product.

It is advisable for the amateur to set up the front and back posts in the position they are to occupy relative to one another in the finished product and mark off with penciled symbols the approximate location of the mortises. (This will prevent a possible error by laying out mismated legs.) Then place them on the bench, side by side, accurately squaring, with a try-square across the bottom of the legs. Now gauge all the mortises precisely from the same relative corners so that any difference or error in dressing the posts will not be noticeable. Next the rails are laid out and cut to length allowing for two 1-inch mortises. It is recommended that one of each of the various members be accurately cut to length, then used as a template to mark off, by using a sharp knife, the similar parts.

Now lay out the shoulder lines and the cheeks of the tenons. The shoulder lines must be exactly squared on the four surfaces by a knife mark; this if carefully done, will not only insure a perfect joint but will assist in forming a clean cut shoulder. A back saw or mitre box will be found to work very satisfactory when cutting the tenons. It is customary to make the mortises first and fit the tenons in their respective positions, as they are made when produced by hand methods.

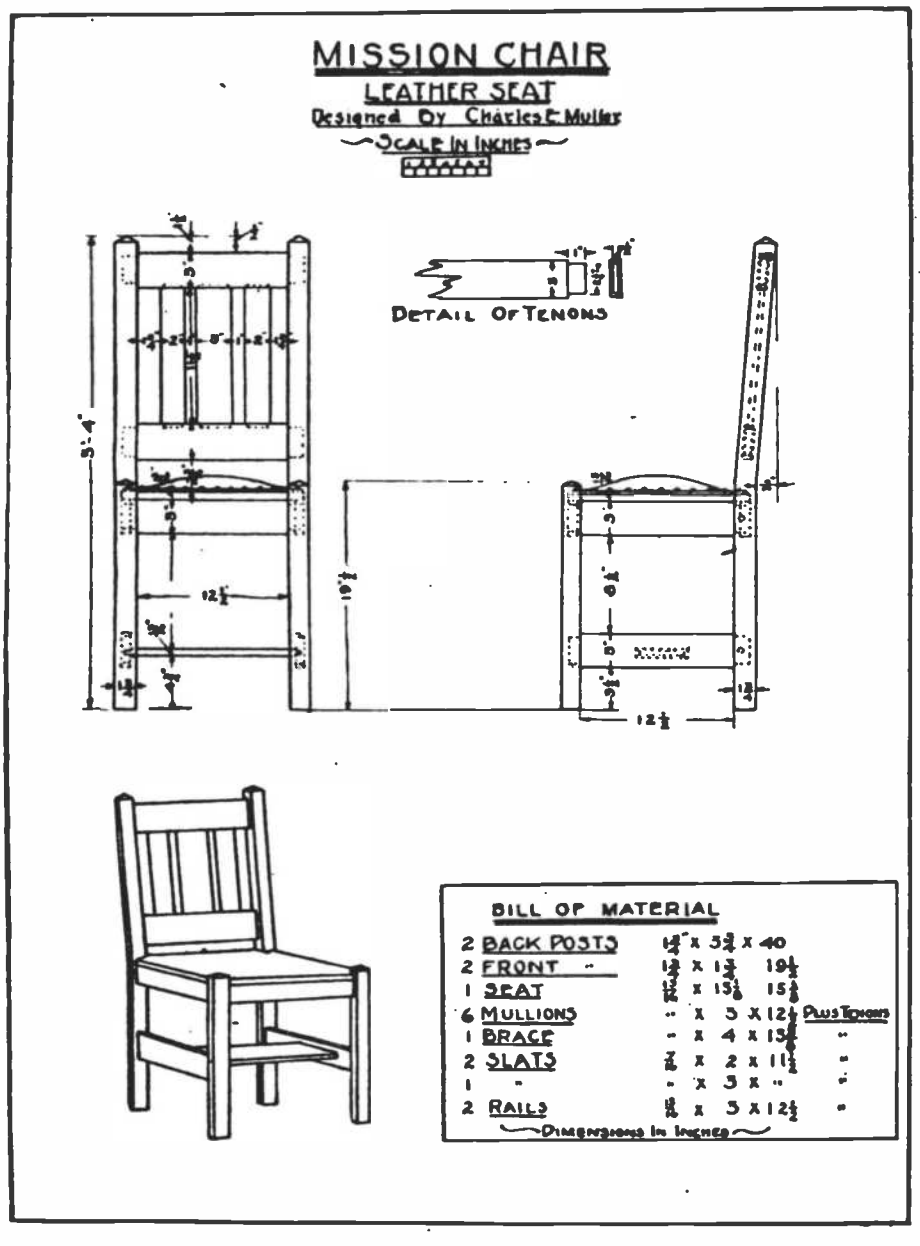
When gauging the mortises care should be taken not to scratch beyond the shoulders, so that no gauge marks will show after assembling the parts. Bore a series of holes with an augur bit that just fits the width of the mortise. A Stanley bit jig is surely worth the price, and will positively insure excellent results. It may be also used to employ the dowel method of construction, which is a good substitute for tenons. Many cabinet makers and practical carpenters use the dowel method, using two or three ⅜-in. dowels 2 in. long instead of the tenons. The centers of the dowels may be located by driving in small brads, cutting off the heads with nippers, then pressing the adjoining surfaces accurately against these brad joints. Using the intersection of the lines produced by the gauges and a squared penciled line is the common method. The slats are usually housed into the back rails their full thickness and width about ½ in deep.

The rule for size of tenons is to make them one-third of the thickness of the material, but when used with a thicker post they are increased in width, always allowing sufficient shoulder stock to avoid crushing the softer side grain. While the drawing shows the back and front of equal width, the back may be an inch or more narrower if desired, but this entails a much more difficult problem of angles in the side rails and mortises or tenons.

When "gluing up," the two front legs are clamped together until the hot glue sets. The back posts are glued together in a similar manner. Then the front is assembled to the back of the chair with all four legs setting squarely on a level floor or bench.

The chair is now finished by an application of the desired filler or stain as per the manufacturer's directions or a home-made stain may be made of any pigment dissolved in turpentine, kerosene or even gasoline. Water and alcohol stains are sometimes used. Cut nails soaked in vinegar for a day or two will produce a pleasing brown stain. It is suggested that the amateur try this on a specimen of his waste wood, as all stains vary in shade and affect different varieties of wood in various ways.

Wipe off all surplus filler or stain. Let it dry thoroughly before applying a thin coat of orange shellac. After shellac has hardened, sandpaper with No. 00 grade sheets. Over this apply several coats of good rubbing wax a little at a time, well rubbed in. Each coat is to be well polished with felt or flannel and dried. A lustre will appear after a second or third coat. This may be purchased especially prepared or



may be made of beeswax with only sufficient turpentine to produce a paste. Care must be taken not to add too much wax, as it fills the small pores and produces a chalk-like appearance.

The leather seat is then tacked on with No. 43 gilt-headed upholstery nails. These seats may be purchased in great variety in imitation or genuine leather. Coil springs may be added to these seats. There is a patented metal frame work with attached coiled springs that makes a very durable and extremely comfortable seat. Burlap, webbing or canvas strips may be used to fasten the springs to, and a cover cushion with horsehair or cotton padding produces a very comfortable seat. In the latter cases a seat frame is used instead of the one-piece seat. The front piece should extend the full width of the chair, thus avoiding the joints in front. Cane seats are neat and comfortable, and this method of construction will be explained in a coming issue.

PASTE FOR CLEANING HANDS

A GOOD mixture for cleaning grimy hands is made by pounding a cake of "Sapolio" or "Bon Ami" up quite fine and stirring it into a cupful of pure leaf lard, heated very hot. Stir until well mixed and when it is partly cool pour into a tin or tins of convenient size to get the fingers into.

PLUGGING HOLES IN CAST IRON

A GOOD mixture for plugging blowholes in cast iron is made of sulphur, cast-iron borings, sifted very fine, and graphite. Melt the sulphur in an iron ladle and stir in as much of the sifted borings as the sulphur will allow, not making it too thick to pour readily. Add a small quantity of graphite, say a tablespoonful to a quart of the mixture. Pour into the holes while hot and after it is cool smooth off with a file. When holes are filled with this mixture on surfaces to be machined, a finishing cut can be taken over it which will obliterate the holes.—*American Blacksmith.*

Glue for Model-Making

THERE are several grades of glue, the best of which is made from scraps of hides. This is translucent and of an amber color. As glue is indispensable to the amateur who makes models with paper, or of wood, it may be interesting to learn how to prepare it. Glue may be melted in a pot, set within a larger pot, water separating the two to prevent overheating. Melting glue in this way about the house this way is objectionable, owing to its disagreeable odor. A liquid glue, however, may be made by adding acetic acid (strong vinegar will do), or a very small quantity of nitric acid, to its solution. Its property of adhesion is in no way destroyed by this action. If vinegar is used, the glue may be dissolved in it for a fluid, instead of water.

A strong glue that is liquid, or gelatinous at will, may be made in small quantities, liquified and kept in an ordinary bottle. Take of a good quality commercial glue, broken in small pieces, sufficient to fill a wide-mouthed bottle. Pour over the glue dilute carbolic acid of the strength recommended and sold for household purposes. The bottle may be heated by setting it on the back of a stove; or it may be laid slanting in the top of a lamp chimney, the wick first being lit and turned down. The glue will soon commence to bubble, or boil, and it is advisable to turn the bottle occasionally.

The thickness and fluidity of the glue is maintained at any degree sought by adding glue or carbolated water, as indicated. The quickest drying glue is that which is rather stiff at normal temperatures; this may have to be heated a minute on a lamp before it will flow freely. If made thin, it far "out-sticks" most glue. The glue does not smell offensive, as it would if it was melted in the well-known glue-pot. It is spread with a mucilage brush, and, as used, a supply of glue and diluted acid are added from time to time to replenish the stock.

A special glue may be made by dissolving purified glue in nitric ether, when there will be obtained a free-flowing ether glue. A few pellets of india rubber added to the solution will give the mixture the power to resist moisture.

A NEW HIGH-SPEED ALLOY

A NEW high-speed steel containing no tungsten has appeared and advantages of both a practical and economical nature are claimed. It is cobalt-molybdenum steel, the cobalt apparently acting as a stabilizer and as correcting certain disadvantages said to exist in molybdenum-tungsten steels. The alloy is claimed to be very efficient. The hardening is said to be more definite as well as simpler, since the hardening temperature required is only in the neighborhood of 2,000 degrees Fahrenheit. The steel is also reported to machine well, as it is exceptionally soft and cuts easily for a nature hard stock. The specific gravity of como steel, as the new alloy is called, is reported to be equal to that of the old carbon tool steels, and so 10 per cent less than that of the tungsten high-speed steels. As a result it is estimated that a given weight of steel will produce 10 per cent more tools than the same weight of regular high-speed steel. The new alloy is a British invention.

CEMENT TO STOP LEAKS IN FUEL TANK

DURING the war numerous experiments were made with the object of securing a means for easily and quickly closing rents in gasoline tanks. Toward the end of 1916 the testing laboratory of a French technical school was requested to analyze and test a special putty, called Ob. The analysis gave the following results:

		Per cent
Soaps	fatty acids	17.05
	alkalies	3.60
Glycerine		4.00
Water		21.45
Various mineral materials		53.90
		100.00

	Per cent
Clay	95.20
Lime	3.00
Magnesia	0.40
Sulphuric acid	1.40
	100.00

In order to determine how this putty behaved under the influence of vibration, a 40-gal. tank was mounted on a light motor truck. Nine holes were punched in it, varying in diameter from 0.4 to 0.8 in. and located at different heights. These holes were closed up by means of plugs made from the paste or putty under test.

The truck was driven a distance of 34 miles over bad roads at an average speed of 13 m.p.h. A single crack formed in one of the plugs and this was stopped by applying more of the putty. After 23 hours of testing there was no oozing out of liquid at any of the plugs and the conclusion was reached that this putty or cement may render great services in stopping leaks in fuel tanks. —*La Technique Moderne.*

Leaky boiler tubes are sometimes plugged up by conical plugs driven into their ends. This keeps the boiler in action until a chance arises to put in a new tube. In England recently such a tube in a locomotive boiler blew out its plug which was 4½ inches long. It killed a man by the force of its expulsion, indicating the danger of this practice.

Advocates of the obturator for gas engines claim that the piston-ring friction may constitute seventy-five per cent of the total mechanical losses in the internal combustion engine.

Foreign Biplane Flying Model

THE model flyer illustrated in accompanying drawing is of German origin and the description is reprinted from one of the German aeronautical publications and according to the report in the description, it has given very good results. As all dimensions are given and the drawing is exceptionally clear, there should be no difficulty experienced by any model maker building this machine. The main stick may be made of spruce and can be braced as indicated by a flying wire. The landing gear may be made up of wire or very light strips of spruce.

The frame work of the wings and tail structures can be constructed in the way that has been described in a number of issues of this magazine by using reed or making the ribs of balsa wood. the spar of spruce and the trailing edge of fine wire. It will be noted that the main planes are of unusual design, the entering edge being straight, while the trailing edge is scalloped on account of the ribs being different lengths. It is important that the bottom wing be given a slightly greater angle of incidence than the top wing as this will give the machine greater stability and make it easier to fly on an even keel.

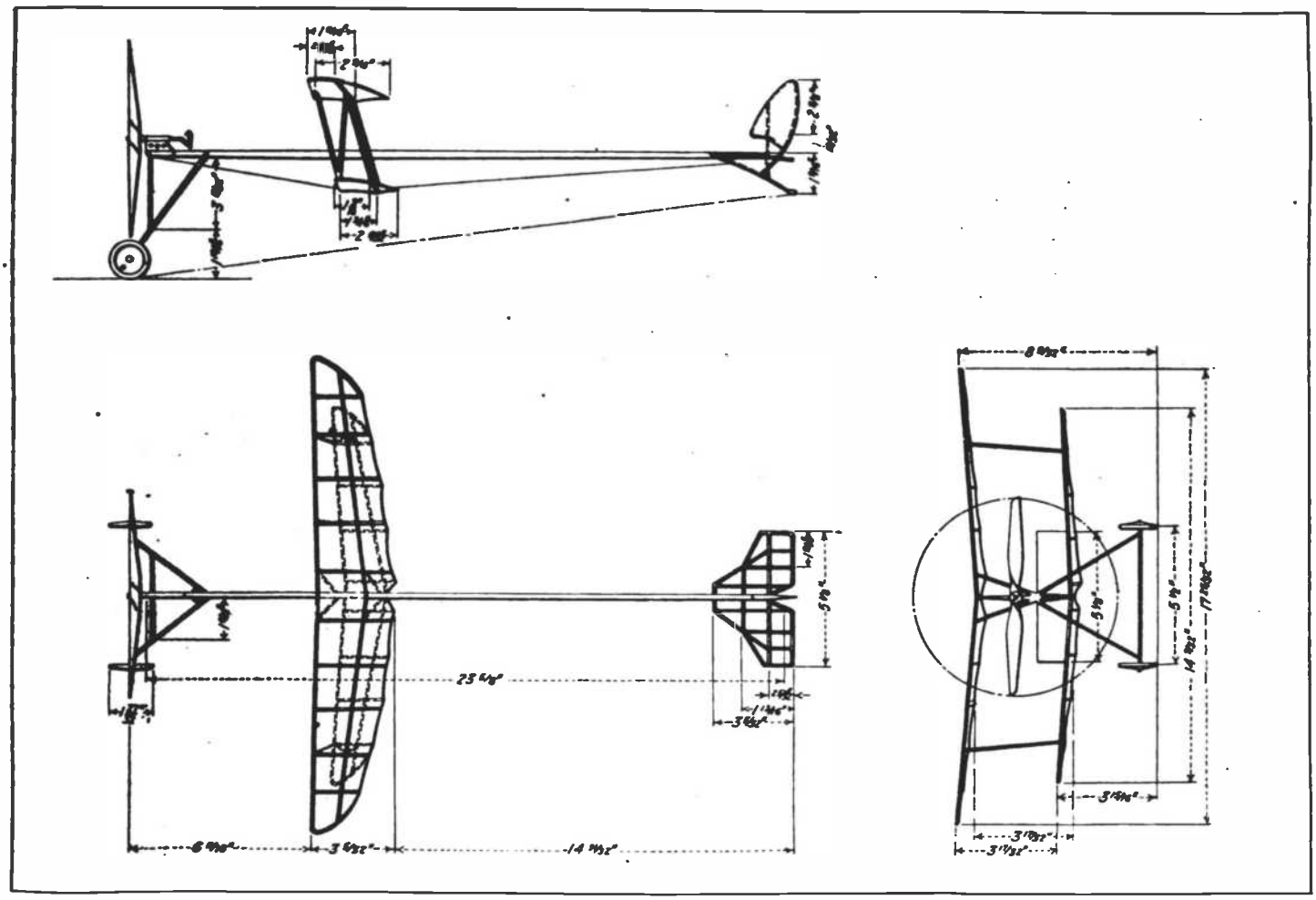
Care should be taken to balance this machine accurately, which can be easily done by moving the biplane wing structure back and forth on the motor stick until the machine flies on an even keel. If the machine is tail heavy, the biplane wing structure may be moved a little further back on the stick. If it is nose heavy, the wings may be moved forward. After the proper position has been determined, the center section struts attached to the wing structure should be fastened securely to the motor stick. In this model, the rubber motor is placed above the motor stick and the center section struts are arranged in V form, having the apex below the stick in order to provide sufficient space for the rubber motor to pass between them above the stick. The view shows that the wings are not only given a pronounced dihedral angle of five to seven degrees, but that they are also staggered in relation to each other. The rubber band motor is not shown in sketch, but is made of ⅛ in. by 1/32 in. flat rubber, the rear end being attached to the rudder post, the front end to the propeller hook in the usual way. From ten to fourteen strands can be experimented with to determine the best number to use.

Those of our readers who are interested in models suitable for long flights and of simple construction will find that illustrated a novel departure from the usual simple "flying stick" types that have been described in detail in past issues of EVERYDAY ENGINEERING MAGAZINE.

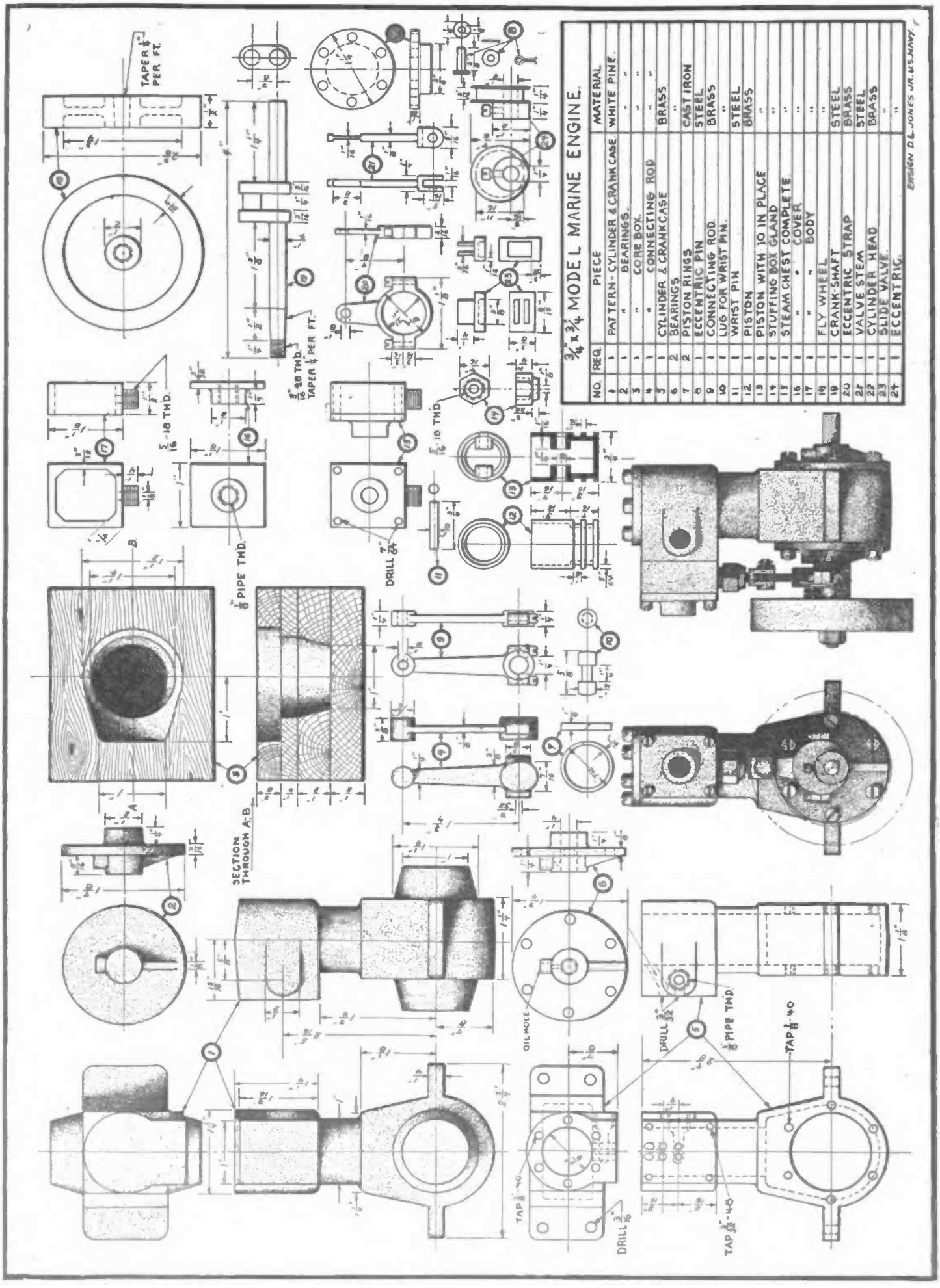
ALUMINUM SOLDERING

For those who wish to embody aluminum in their designs, but are unable to solder it, the following information will be useful. For an aluminum solder to be successful, it must contain a percentage of phosphor tin. A solder I can personally recommend is composed of tin, 75.5 parts; zinc, 25 parts; phosphor-tin, 1 part; and aluminum, 1.5 parts. Melt the aluminum first, add the zinc in small pieces, then the tin in small pieces, and, finally, the phosphor tin. Stearin is by far the best flux to use.

The temperature required to make a sweated joint with the above solder is about 700 deg. Fahr., and a blow-pipe is preferable to a soldering bit, as heat may be maintained. If, however, a bit is preferred, it should be aluminum or nickel instead of copper.—F. J. CAMM.



Details of foreign biplane flying model of novel construction



A Model Marine Steam Engine

By Ensign D. L. Jones, Jr., U. S. N.

Engineering Officer, U. S. Submarine S-16

THIS engine, while not strictly following marine-engine design, makes an excellent working model engine for driving a small model steamer or for direct connection to a small dynamo. It is of the single-action type with trunk piston and is made throughout of brass and steel. An exceedingly high speed can be obtained with an engine of this type, and the construction is much simpler than that of the double-acting type.

The first thing to make will be the pattern for the cylinder and crankcase. Figure 1 shows the general dimensions and construction of this pattern which should be made of white pine. The cylinder is not cored, as a much smoother casting can be obtained without core work and the extra time of making the pattern with cylinder core is offset by the slight extra work of boring the cylinder. Sharp corners should be avoided and should be filletted with beeswax and a slight draft is given the pattern from each side of the center line to facilitate drawing the pattern from the sand. The pattern is painted with black shellac and the core prints with orange shellac.

The core-box, Figure 3, is built up of four thicknesses of white pine cut to dimensions as shown on the drawing.

The pattern for the bearings is shown in Figure 2 and that for the connecting rod in Figure 4. The crank end of the connecting rod pattern is made slightly oval in shape so that when the casting is cut in two and squared off it will be round.

When the patterns are finished they are taken to a foundry and a casting obtained. Cast iron would make the best working engine, but brass is easier worked and makes a nicer looking model and will give nearly as good satisfaction.

The first thing to be done to the cylinder and crankcase casting is to bore and face the cylinder. The cylinder is chucked in the lathe and the cylinder top faced off to dimesions. The cylinder is accurately centered and a small drill is run through and then drilled or bored out to about 47/64 inch and afterwards reamed out to ¾ inch.

The casting is now set up in a shaper or miller and the crankcase sides and steam-chest shaped to dimensions. If no shaper or miller is at hand this work can be done as well in the lathe, though great care must be taken to have the two sides of the crankcase parallel with each other.

The castings for the bearings are now drilled and reamed to ¼". They are then placed on a mandrell and turned to dimensions. The six holes for the securing screws are layed off and drilled with a number 41 drill. The two bearings are now clamped to the crankcase side—first passing a piece of ¼" rod through them to secure alignment—and the crankcase drilled with a number 41 drill. The bearings are now removed and redrilled with a ⅛" drill and the holes in the crankcase are tapped with a ⅛"-40 tap.

The crankshaft is turned from a piece of ⅜"x¾" cold-rolled steel. Figure 19 shows the dimensions of the crankshaft. The tapered end for the flywheel is tapered ¼" per foot and the threaded part threaded 3/16"-28 thread.

The piston, Figure 12, is turned from round brass stock. Two grooves are cut for the piston rings. The lugs for the piston pin, Figure 10, are turned from ¼" round brass stock and are soldered to the inside of the piston. The centerpiece, which insures alignment of the two lugs, is drilled away when drilling for the wrist pin.

The piston should be a tight fit in the cylinder and should be lapped in. The piston rings are turned from cast iron.

The bearings, crankshaft and connecting rod are now assembled and the piston placed on top center. The clearance between top of cylinder and top of piston is measured and the cylinder head is turned up to just touch the top of the piston. The placing of a piece of 1/64" sheet fiber packing under the cylinder head will give the necessary piston clearance.

The steam inlet and exhaust ports are layed off and drilled. If the maker has some very small jeweler's files the steam ports can be squared off.

The steam-chest, Figure 17, is cut from ½" flat brass stock and the cover, Figure 16, is soldered and sweated to the chest.

The slide valve is filed and cut from a piece of ½" square brass stock. The exhaust side should be chipped out first with a small cape chisel and the rest of the valve finished by filing. The valve face and steam-chest face are finished by grinding and scraping, to make them steam tight.

The eccentric, Figure 20, is turned from brass stock and has ⅜" throw. The eccentric strap is cut from 3/16" sheet brass.

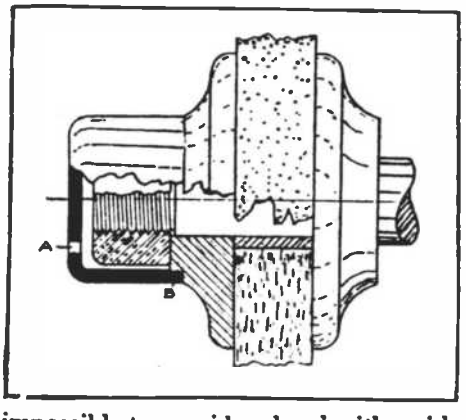
The valve stem is turned from cold-rolled steel. The location of the slotted part is found by placing the eccentric in the middle position, that is 90 degrees from top center, and the slide valve is placed in middle position. The valve stem is marked and the flat filed to fit the slot in the valve. To set the valve, the piston is placed on top center and the eccentric 90 degrees ahead or behind the crank, depending on which direction the maker desires the engine to run.

The flywheel is turned from solid stock or a pattern can be made and a casting obtained. The flywheel hub is drilled with a 7/32" drill and tapered with a number 4 taper-pin reamer to fit the crankshaft. The flywheel is drawn up tight on the crankshaft with a 3/16" nut.

The engine is now assembled and is ready to run. All parts should be polished and buffed and left unpainted.

SAFETY CAP FOR GRINDER SPINDLE NUT

THE cap illustrated is a valuable safeguard on grinding wheels where considerable work has to be done on the side of the wheel and where it is



impossible to provide a hood with a side piece covering the nut. "A" indicates one of a pair of holes for spanner wrench. The thread "B," cut in the washer, must be right hand or left hand, the same as on end of spindle.

On the European Continent efforts are being made to use cast iron wheels on trolleys instead of steel-tired wheels. The latter are not only expensive but under existing conditions are hard to get. Considerable success has followed their use. On the driving wheels over 10,000 miles without excessive wear have been attained and five times as much have been obtained on trailers, where there is no question of traction.

EVERYDAY SCIENCE NOTES

BY PROF. T. O'CONOR SLOANE

THE SKIALYTIC OR SHADOWLESS LIGHT

THE name of this lamp, invented by Prof. K. Verain, means shadow-dissolving. It is specially designed for surgeons' use, though there are many other fields in which it might be used. An incandescent lamp is carried in the axis of a Fresnel lens, such as is used in lighthouses. The lamp and lens are surrounded by a reflector, composing the frustrum of a cone. From the Fresnel lens light rays go out horizontally in all directions. No light is permitted to go directly downwards; the rays are refracted into the horizontal plane by the lens, as shown, and are reflected downwards and obliquely from the frustrum shaped reflector as indicated by the dotted lines in the diagram, Fig. 1. An object on the table, which we may suppose to be directly under the reflector, will receive light from all sides of the reflector. If the person operating under it leans over the table, he will cast hardly any shadow, for he will only cut off a part of the light. The skialytic is designed especially for surgeons, and the other cut, Fig. 2, shows it mounted over an operating table, and shows the system of suspension and different positions it may be placed in to meet requirements of different cases.

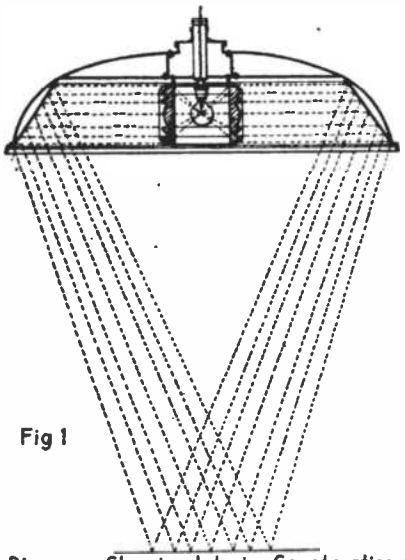


Fig 1

Diagram Showing Interior Construction of Lamp and Arrangement of Reflecting Surfaces

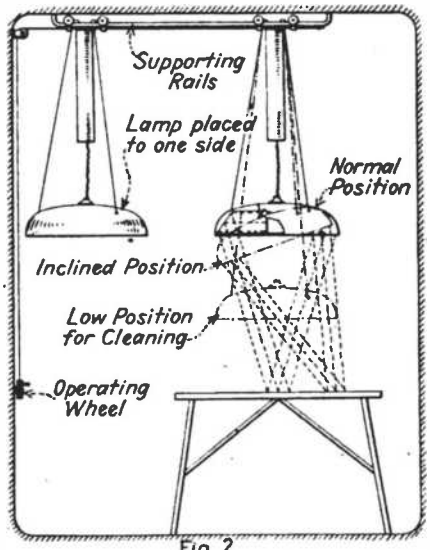


Fig 2

Showing Various Positions of Light

Preliminary work has been started on a pipe line from the British Channel at Havre to Paris. It is to be a double line, a five-inch pipe for gasoline and a ten-inch pipe for fuel oil. There will be five pumping stations on the line, and its capacity will be 4,500 tons of fuel oil and 1,000 tons of gasoline per day. There will be a 60,000-ton reserve tank at Paris.

A tunnel for vehicles and foot passengers across the Scheldt is contemplated, to be completed in 1924. There are to be three parallel tunnels, with two lifts or elevators for foot passengers, two for autos and light vehicles and two for heavy trucks. It is to be 2,100 meters, upward of 6,700 feet, long. A race should be started between this tunnel and the much-debated Hudson River tunnel, as they are both of fairly close length.

Seventy per cent. of the world's nitrogen should be used in agriculture. One of the effects of the war was to employ vast quantities of nitrogen in explosives, so as to diminish directly the fertility of the land. Efforts are being made to get the nitrogen out of explosives for commerical use.

To secure clear vision through a glass windshield in rain or snow, it has been suggested to have a disc of glass arranged to be rotated at a rate sufficient to throw off water or snow by centrifugal force. A circle of eleven inches diameter of clear vision was obtained on trial of an apparatus of this nature.

A metallic driving belt packed with paper yarn to give a soft adherent running surface has been tried out in Germany. It consists of short flat-wound wire spirals which are fastened together by pins passing through eyes at the ends so that it is virtually a chain. The sections are wound alternately right and left handed. Wood or pasteboard is packed in the interior so as to keep the paper packing in place. They were found to be suited best for slow drives on large pulleys and for long spans having two or three times the power of leather belts of the same width.

The spark discharge of a Leyden jar of less than .001 millifarad capacity has been used for motion photography. The spark gap consists of two aluminum hemispheres separated by one millimeter. The discharge gives 50,000 sparks per second, so that an enormous number of exposures per second can be obtained. A strong blast across the spark gap prevents arcing and the Leyden jar is only charged up to 5,000 volts potential. After discharge, it is at once recharged from a circuit of 12,000 to 18,000 volts.

A mixture of carborundum, 75 parts, and water glass, 25 parts, has been recommended for an application to the interior surface of gas retorts. Another mixture consists of carborundum, 85 parts, and fire clay, 15 parts. It should be put on cold and be given 24 hours to dry before firing up.

In utilizing gases from blast furnaces for heating the hot blast stove and any other purposes, the large amount of dust has been a great trouble. The dust fuses on the bricks and is deposited on metal flues or tubes, making them non-conductors and hence interfering with the efficiency of the plant. The dust sometimes makes large clinkers. Considerable success has been experienced in electrical separation of the dust. In one process, the Cottrell apparatus, the gas is passed through 6 in. vertical pipes. In the center of each pipe an electrode chain or wire with a 15-pound weight at the bottom is suspended. The pipes are grounded, but the wires are fully insulated and are negatively charged with 35,000 to 50,000 volts. The gases pass upward through the pipes, the dust collects on the chains and pipes and both are rapped periodically by an electric hammer. Fifteen to 20 kilowatts will clean 45,000 to 50,000 cubic feet of gas per minute. If the furnace is running on pig iron the potash contents may run as high as 9% and with ferro-manganese there may be 20% potash contents in the dust collected. A cubic foot of purified gas will contain less than 1/10th grain of dust.

Some examples of trees used as conduits for the water supply of London prior to the advent of cast iron pipes were discovered during some excavations in a street in London. Several fir tree trunks, about twenty feet in length, were unearthed, with the center bored through at a diameter of eight to ten inches. They are in a fine state of preservation, although it is estimated that they have lain underground for at least 200 years.

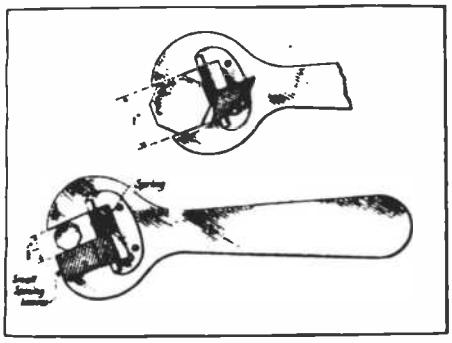
For years Peru has had great silver mines. It is an ancient industry of the country, but the value of the metal made the work only slightly profitable. Recent advances in its price have witnessed the reopening of these mines, with the employment of many men at good wages, and the development of a profitable and extensive business.

According to *Coal Age*, the principal gases found in coal mines are the following: Methane or marsh gas, sometimes called light carbureted hydrogen (CH_4); carbon monoxide (CO); which is the "whitedamp" of miners, carbon dioxide (CO_2), which, mixed with nitrogen, forms the chief ingredients of the blackdamp of miners. In addition to these principal gases, occur, in limited quantities, hydrogen sulphide or sulphurated hydrogen (H_2S), the stinkdamp of miners and the heavy hydrocarbon gases that are associated to a limited extent with methane; namely, ethene or ethylene (C_2H_4) belonging to the olefine group; and ethane (C_2H_6), belonging to the paraffin group. Of the gases named, methane, olefiant gas, carbon monoxide and hydrogen sulphide form explosive mixtures with air in certain proportions. Carbon dioxide and the nitrogen of the air are the only ones that are not explosive.

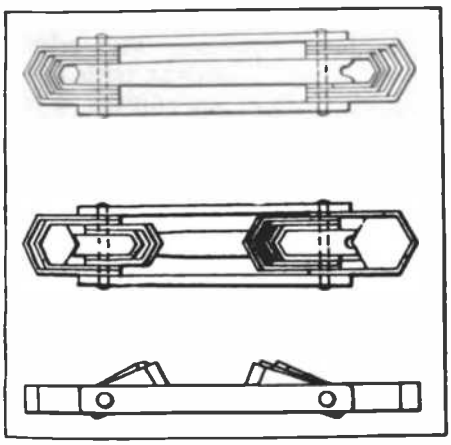
In Canada pneumatic tamping tools have been used on the railroads for tamping down the road bed. In has been found that they reduce the cost of this work 38 per cent, and that four men can cover from 400 to 700 feet of track in a day.

ADJUSTABLE WRENCHES

THE illustrations show two adjustable spanners or wrenches, whose construction is particularly adapted for portable or even pocket tools. In the open ended spanner the size of the opening is adjusted by turning in or out of the opening one or more of the little strips of steel as shown in



the cut. In it some of the strips are shown turned out of the opening, adapting it for a medium sized nut. The range of sizes covered by this construction may be quite large and the writer's experience with it has been very satisfactory.



The other cut shows a closed spanner of similar type. Here the adjusting strips take the form of loops. Swung outwards they give an almost complete hexagonal opening, and this opening is larger or smaller according to the number of loops swung out. The cuts show several openings, and illustrate the extent of variation of which it is capable.

In firing guns the copper rings of the shells foul the bore and to prevent this an alloy of 60% tin and 40% lead, identical with solder, has been tried in the chamber. Under the influence of the discharge the tin is supposed to unite with the copper, forming a fusible alloy and the lead is distributed along the bore, and is taken as acting as a lubricant for succeeding rounds. In France during the war, tin-foil wrapping from the fuses used to be put into the powder chamber to prevent fouling on the same lines.

It is claimed, that by utilizing the waste heat in steel works for the operation of the boilers driving the power plant, a saving of 43.75% was effected, which figured out at 987½ pounds of steam per ton of ingots produced. It is also claimed that by more perfect methods 1200 pounds of steam could be produced.

The land and sea are both slightly radioactive, the land being the more active. Owing to the greater area of the water over that of the earth, the total radiations from the water and land surfaces are about equal in amount.

The investigation of vertical air currents is exciting interest in aviation circles abroad. The use of pilot balloons for this purpose, whose ascents are to be observed and timed by trigonometrical observations and watch is an old story, but now it is proposed to use vertical axis anemometers of the registering type. It is probable that one will be installed on the Eiffel Tower in Paris.

In the British Navy there are now some 600 sets of reduction gears to bring the speed of turbine-driven propellers down to the proper limit. Nearly eight million horsepower are thus taken care of. A single ship is cited, on which there are four sets, transmitting 36,000 horse-power each. A standard ratio is one to eight or nine. In some instances the gears lasted over six years, and only two or three had to be refitted, no real break-downs were recorded and the gears after dressing were put into service again. Only two fractured teeth were reported. The use of gears, giving proper turbine speed and propeller rotation, increased the efficiency of the plant 15 to 20 per cent.

From the district of Minas Geraes in Brazil deposits of iron ore calculated at two thousand million tons are reported.

The water power of England has been estimated as only one and a half million horse-power, or about one per cent of the water power of the earth. She is assigned two and a half per cent of the coal of our planet. Blast furnace practice there has been unfavorably criticised. It is claimed, that by efficient methods 10,000 horse-power could be produced from three blast furnaces where now but little is utilized, and that half as much could be saved on the fuel side by better methods. It is only recently that the saving of potassium products from the flue dust has been taken up seriously. The gases evolved from the stacks are practically producer gas and could be used to drive internal combustion engines. Electric ore reduction furnaces, if actuated by water power, indicate an enormous saving of fuel, as only enough coal has to be used to reduce the oxide, the heating being done by the electric current. To effect this economy in coal the electricity must be produced by water power.

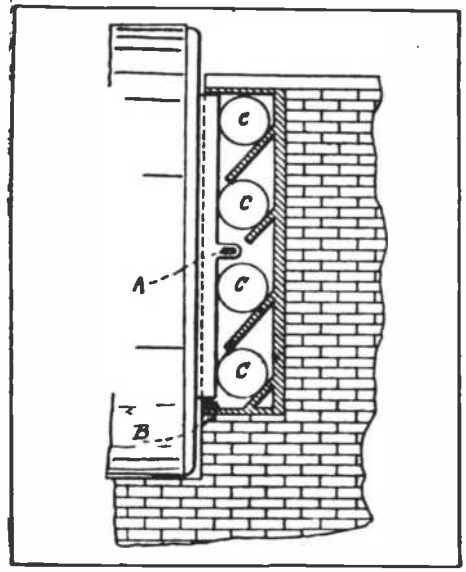
In Neuilly, near Paris, a physician was recently killed by a shock from an X-ray apparatus. If the apparatus is operated by an alternating current, a fuse on the supply line will not protect the secondary as regards its shock capacity. Practitioners using modern high power apparatus, such as Coolidge tube sets, should see to the insulation.

A small amount of water in a tungsten filament lamp soon destroys the filament. The tungsten is oxidized at the expense of the water and the tungsten oxide volatilizes and is deposited on the inner wall of the bulb. The free hydrogen reduces it to metal, forming water again, which reacts again in the same way, and the cyclic action goes on until the filament succumbs.

The statistics of the atmosphere as regards barometric pressure and temperature changes have been investigated with results of considerable certainty. At an altitude of four and a half miles the annual variation of temperature is at a maximum; at altitudes from five and a half to seven miles and a quarter the annual variation falls off rapidly. The diurnal range of temperature existing at the surface of the earth practically ceases at less than a mile altitude. Local variations in barometric pressure nearly disappear at twelve miles altitude.

EXPANSION JOINT IN BOILER SETTINGS

THE cut shows a system of constructing a gas tight joint in furnace work, which joint is undisturbed by expansion and contraction due to the heat of the furnace. It is supposed to be adapted for use in a boiler



setting, but it is quite suggestive of other uses. The problem is to maintain a tight joint between the boiler on the side of the cut and the plate A. The latter is supported by a small roller, B, and on the other side of the plate, the side remote from the boiler, a number of rollers, C, C, resting on inclined projecting plates constantly press against the plate. The rollers are perfectly free in their mounting, so that whether the boiler shell recedes or advances, they adjust themselves to its changes and exert a constant pressure against the boiler. This goes to ensure a tight joint under all the changes to which boilers and similar structures exposed to heat are liable.

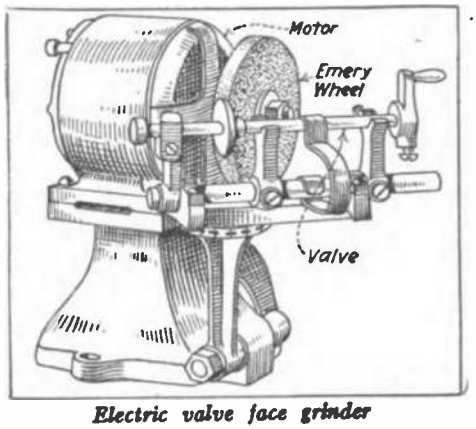
It is calculated that the inefficiency of the steam boilers of Great Britain accounts for 15 to 20 million tons of coal per annum. It is held by expert engineers, that the operations of boilers should be conducted in a scientific way, the water and coal used should be accurately known and the flue gases should be analyzed. There are various simple ways of getting at the composition of flue gases without much special skill as well as quickly. The subject of mechanical stokers has recently been debated there, and no very definite conclusion was reached as to whether they economized coal or not. Both views were upheld by different authorities.

Copper is poor metal to cast, as it fails to run well and does not fill the moulds. It has been found that by melting it in an atmosphere of hydrogen gas and allowing it to cool therein, it retains much of the gas and becomes quite tractable and gives good castings. Hydrogenized copper has higher electric resistance than the pure metal. It is thought that this may be due to the segregation of sulphides and arsenides of copper, which then form films enveloping granules of the metal.

Some years ago the metal molybdenum was of little use except as the characteristic element in a reagent used to determine phosphoric acid. Fertilizer laboratories were the principal consumers. Now it has come into its own as an alloy for steel and as a material in the construction of incandescent lamps and Coolidge tubes. It is produced in Canada, and the output there is rapidly increasing.

ELECTRIC VALVE GRINDER

THE valve heads are very easily pitted or scored. It is not possible to refit them by the simple grinding hand process without the expenditure of considerable time. The electric grinder illustrated herewith makes it possible to face a set of eight average sized automobile motor valves in from ten to fifteen minutes that would ordinarily require three hours to complete "rough grinding" in. The work is very accurately done and the machine is adpatable to a number of different valve sizes.



Electric valve face grinder

The grinding wheel is equipped with a high-speed half-horsepower motor of standard design which is attached to a rigid base. The motor may be operated from any lamp socket by a simple snap of the switch. Special arrangements are provided so it is possible to grind valves accurately that have no centers. The arrangement is such that the valve is moved back and forth across the wheel, being rotated by a small hand crank in order to insure a smooth finish on all parts of the valve head. While the machine is designed initially for facing valves, it can be provided with an extra hub and wheel and used to advantage in grinding small tools such as drills and chisels. The machine is adaptable for various sized valves and is indexed so that the table may be set to grind different angles of valve seatings.

ESTIMATING HOW MUCH PAINT TO USE

IF one intends to paint a building it may be difficult to know just the number of gallons required. While the quantity of paint varies with the surface to be covered, the following method of measurement is an accurate guide: A good grade of prepared paint will cover at least 350 square feet to the gallon, two coats. First, measure the distance around the house and multiply by the average height; then divide by 350 and the result will be approximately the number of gallons to buy. Of this quantity one-fifth will represent the paint required for trimmings, cornices, etc.

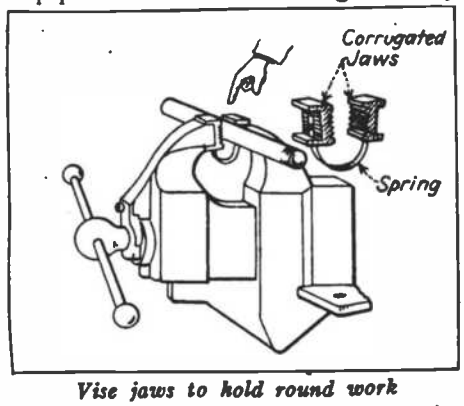
RECORD BREAKING RACING CAR

(*Continued from page* 217)

drum mounted at its rear end, a constricting band-brake working on each drum. No change speed gearing appears to be used in this unusual racing vehicle nor is it needed, because the car is much too powerful for street use and it is not difficult to "get away" by slipping the clutches when racing. Four carburetors are used, each one apparently serving a unit of four cylinders, two carburetors being employed on each engine. The engines are overhead valve types, very similar in construction to airplane motors, the cam shaft being carried above the valves and thoroughly enclosed. The method of final drive appears to be by two sets of bevel gears to a through axle to which the driving wheels are attached, this construction making it possible for either engine to drive the car if the maximum power is not required, and for this reason independent clutch control seems to be provided so one or both engines may be used at will. Of course, when breaking world's records, all the power that can be produced by both engines is needed, but for running around one engine would suffice. As is usual in racing-car practice, no differential is used.

SPRING VISE JAWS

A FITTING that finds ready use in repair shops and service stations is the vise jaws shown in accompanying illustration with which it is possible to use the ordinary bench vise as a pipe vise or for holding securely



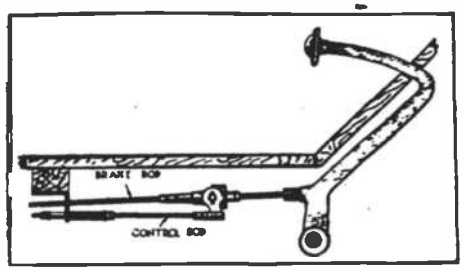
Vise jaws to hold round work

round bars of iron or steel. The device consists of two jaws shaped to fit the main jaws of a vise and held together by a flat spring. These vise jaws occupy but little space and it is stated they will fit any vise, large or small, as the jaws may be spread apart or closed to take the different sizes of pipe or iron rods.

It is noted that in X-ray work a "hard" tube, which means a tube of very high vacuum, has high penetrating power but low actinism, so that it does not give satisfactory photographs. A tube with lower vacuum, a "soft" tube, gives well-defined and clear photographs but is deficient in penetration.

AUTOMATIC BRAKE ADJUSTER

AN automatic brake adjuster described in *Automotive Industries* and illustrated herewith, is undoubtedly an entirely new device in the automotive parts and accessories field. To apply the adjuster the brake rod is cut, or made in two parts, each part being threaded to fit the device. The control rod is set in about the position indicated. Upon application of the brakes, the adjuster mechanism moves forward, with the exception of the lower portion, which is held by the guide clip through

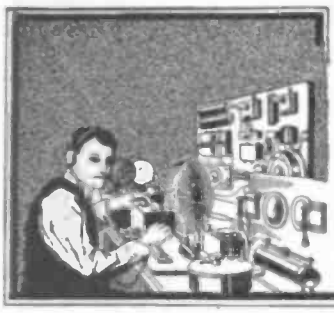


Automobile brake adjuster

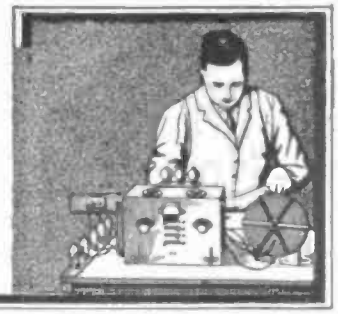
which the rods pass. This relative movement of the different parts causes the small crank of the adjuster to turn through a certain angle, which becomes greater as the brakes wear, acting upon a ratchet wheel. When the pedal is released, the adjusting sleeve is turned automatically by the ratchet and takes up the slack. It is claimed for this device that it gives an equal brake grip on both sides of the car without a brake equalizer, that greater braking surface is brought into play, and that the resulting uniformity of action enables the driver to much better estimate the distance required for stopping.

STELLITE ALLOYS

AN alloy consisting of practically pure nickel and chromium was produced, as long ago as 1899, by Mr. Elwood Haynes, of Kokomo, Ind., by heating their mixed oxides with aluminium. This alloy proved to be practically insoluble in nitric acid, even when boiling. It is malleable when cold, and under proper annealing can be worked into sheets and wire. An alloy of cobalt and chromium was produced, which showed the same untarnishable properties, possessed much greater hardness, and was malleable at a bright orange heat. In 1909 a cutting blade was made of the alloy, which took an edge comparable to that of tempered steel. Later, tungsten or molybdenum was added, and the alloy thus produced was sufficiently hard to turn iron and steel on the lathe. Later experiments demonstrated that such alloys, when properly formed, would scratch any steel, and would stand up under much higher speeds on the lathe than the best high-speed steel tools.



RADIO
TELEPHONE AND TELEGRAPH APPARATUS



A Heterodyne Wavemeter for 170 to 21,000 Meters

Design Data For a Laboratory Oscillator Which Can Be Used As a Wavemeter, For Heterodyne Receptions, And Many Other Purposes.

By M. B. Sleeper

THE problem of building any type of wavemeter for a long range of wavelength, and particularly a heterodyne wavemeter, is not an easy one if accuracy and permanence of adjustment are required. The instrument illustrated here and built in meter panel, vacuum tube control panel, inductance panel, and variable condenser panel. Although the instruments might have been mounted on a 10- by 10-in. panel, the constructional operations are greatly facilitated by dividing the apparatus into four sections.

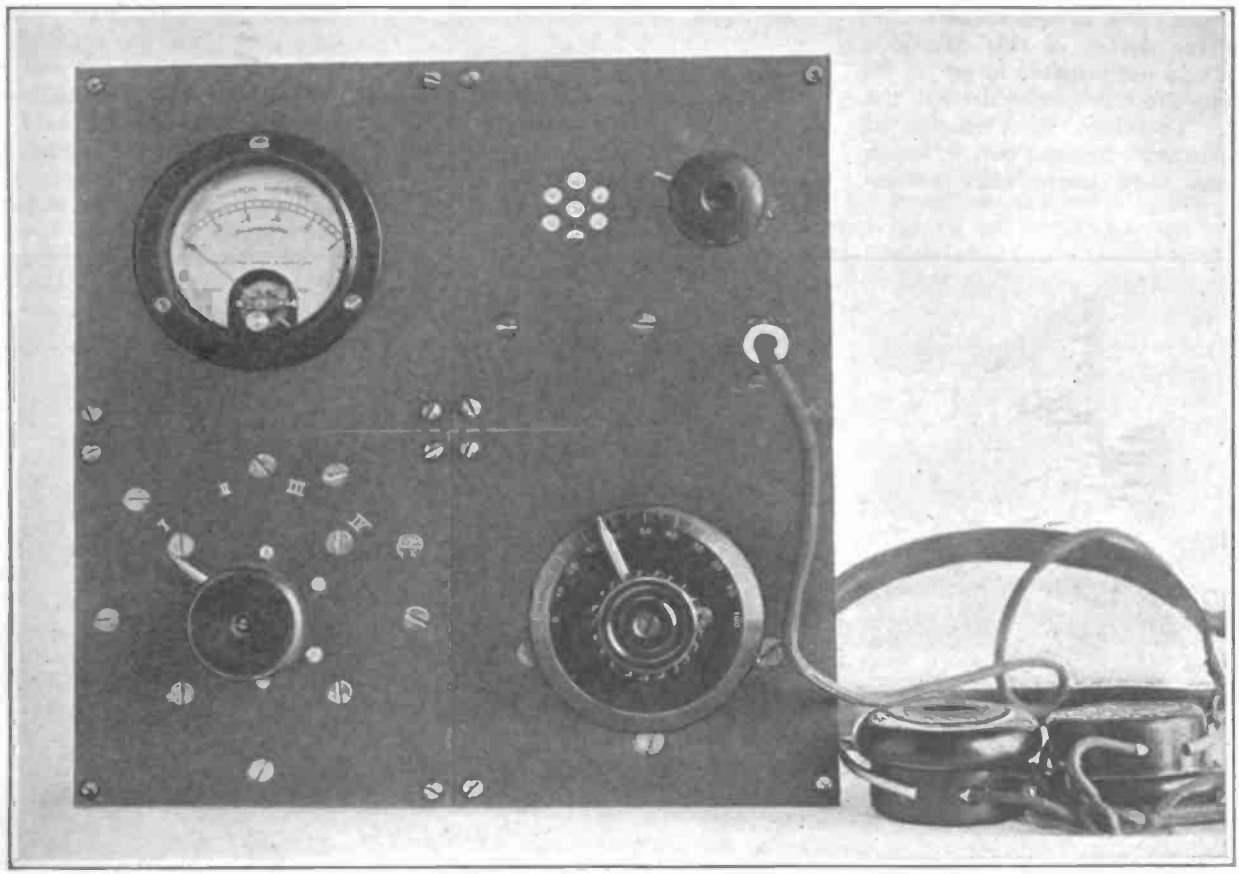


Fig. 1. Illustrating the completed heterodyne wavemeter, ready for use

EVERYDAY'S laboratory, has, however, proved to be admirably adapted for the work of calibrating wavemeters, condensers, and inductances, and for other purposes which require a calibrated generator of continuous oscillations.

General Description

This apparatus was made up on four bakelite panels 5 ins. square and ¼ in. thick. Thinner material would not have stood the strain of the heavy parts. The four units comprise the milliammeter panel, vacuum tube control panel, inductance panel, and variable condenser panel.

Variations of the wavelength is accomplished by a switch on the inductance panel, and the close adjustment by the condenser. The strength of the oscillations is controlled by the filament brilliancy, which can be regulated by the rheostat.

Figs. 1 and 2 show the general arrangement of the assembled apparatus. These photographs were taken before the individual instruments were connected, so that the vacuum tube and inductance panels could be shown separately.

Milliammeter Panel

This section was described in the May, 1920, issue of EVERYDAY. It consists simply of a Weston model 301 meter reading from 0 to 1 milliampere, which can be read accurately to 0.01 milliampere. The meter is of the flush mounting type fitting into a hole 2⅝ ins. in diameter in the panel. Fig. 3 illustrates the rear of the panel and meter.

The purpose of the meter is to show the plate current in the oscillator. Its use was explained in the May, 1920, issue.

Vacuum Tube Control Panel

A detailed view of the control panel is given in Fig. 3. It will be seen that,

at the rear, are a Paragon filament rheostat, Murdock socket, and a jack for the telephones. The B battery is carried on a support made up of brass strips, 3/8 by 1/16 in.

The same brackets that hold the battery also carry the audion socket. Because of the design of this Murdock socket, it was not possible to get at the connections after it was secured to the brackets. Therefore, short lengths of copper wire were brought out, to which connections were made after assembling.

To permit the operation of the set without the telephones, a closed circuit jack was used. That is, when the plug is removed, the spring contact closes the plate circuit. Otherwise, removing the telephones would leave the plate circuit open and inoperative.

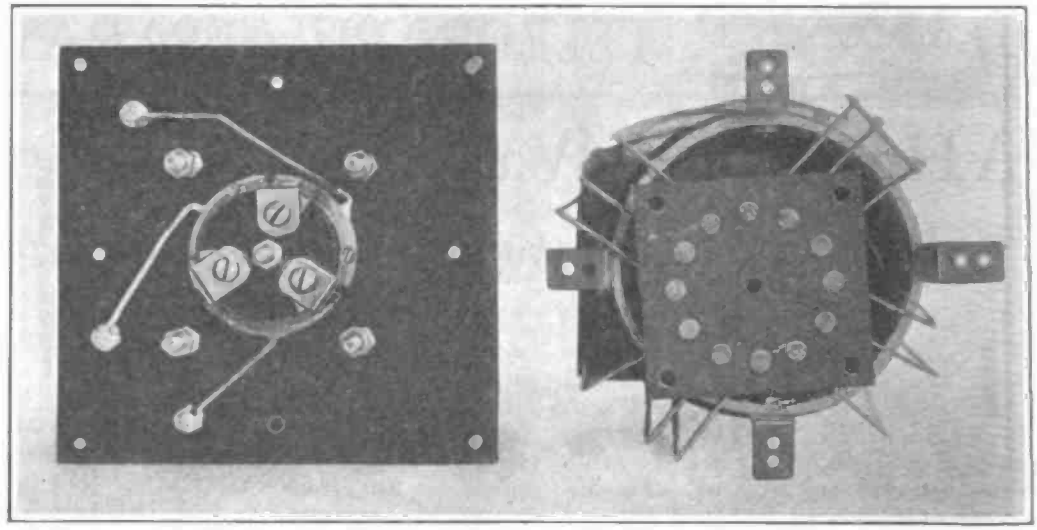


Fig. 5. The rear of the inductance panel is shown at the left, and the sub-panel, to which all connections from the coils are made, at the right. Double contact arms, carried on the bakelite disc, make connections to the front with the three brass sectors, and to the rear with the switch points. The screws which hold the sub-panel can be seen protruding from the main panel. In the view at the right, the sub-panel is held in place only by the heavy copper wires which run to the taps on the coils

The Inductance Panel

This is the most difficult part, from the point of view of the constructor, about the apparatus, and one which calls for patience as well as skill. To understand just what is required, the wiring diagram, Fig. 6, should be studied carefully.

Essentially, this is the familiar center tap type of oscillator. In positions I, II, and III of the switch, the small coil is used. Turning the switch changes the taps from the coil to the grid and filament, while the plate remains connected to the end of the coil. At position IV, the small coil is disconnected altogether, and the grid, plate, and filament joined to the long coil.

Wavelength ranges, with the G. A.

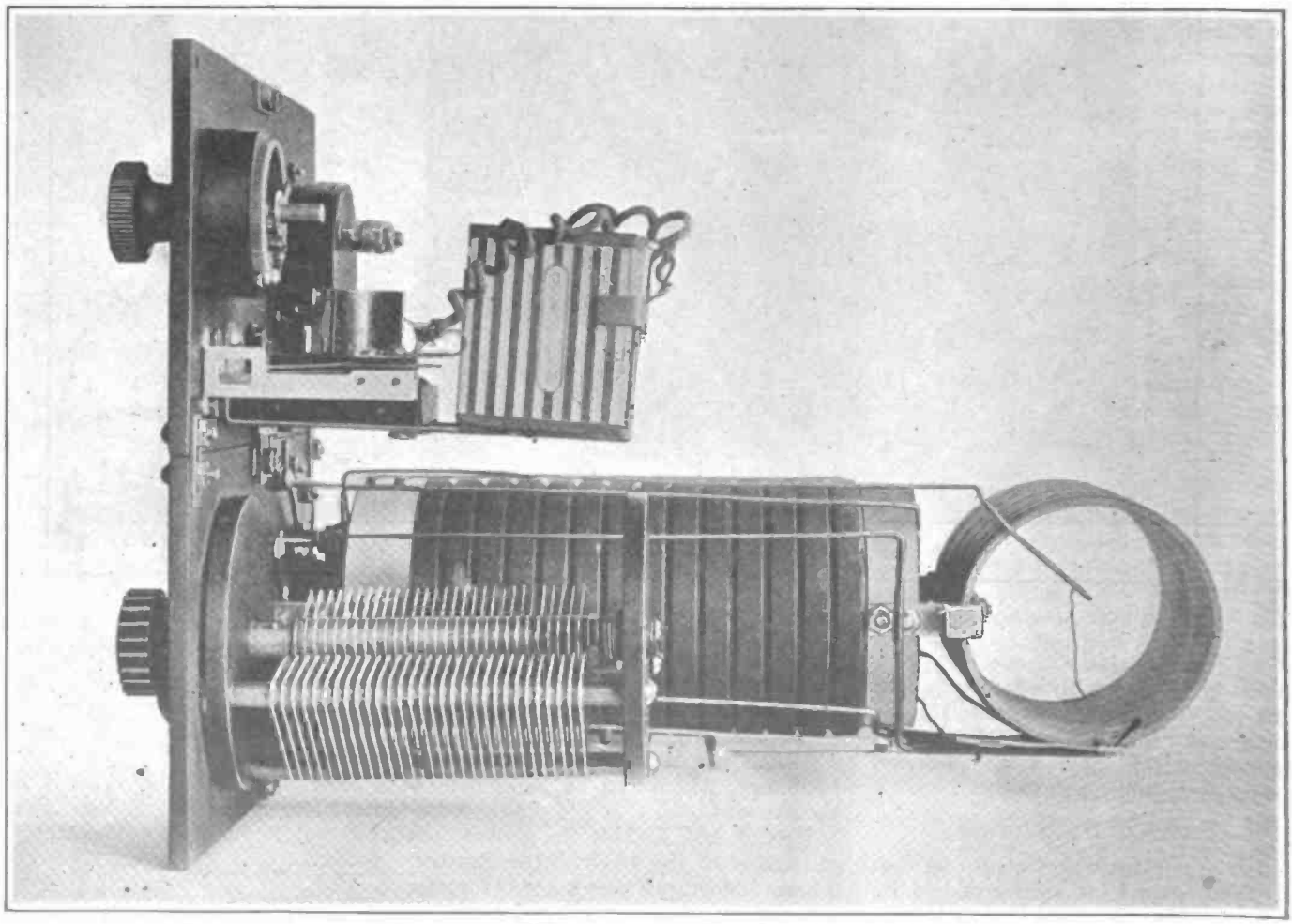


Fig. 2. A side view of the apparatus before the connecting wires between the panels were put on

standardized condenser shown, were as follows:

Section	Wavelength Range
I	170 to 790 meters
II	460 to 2,160 meters
III	1,115 to 5,230 meters
IV	4,610 to 21,650 meters

About 5 deg. at each end of the condenser scale were not used when these measurements were taken.

The small coil is 3½ ins. in diameter, wound with 2 banks of No. 24 S. S. C. solid wire, giving 45 bottom turns per inch. The taps were taken off as shown in the table below:

Section	Filament	Grid
I	15 turns	30 turns
II	51 turns	101 turns
III	179 turns	360 turns

The lengths of the grid sections, measured from the start of the winding, are:

Section	Length
I	0.34 in.
II	1.13 ins.
III	4.00 ins.

These sections give inductance values of:

Section	L
I	160,000 cms.
II	1,200,000 cms.
III	7,000,000 cms.

A tube 3½ ins. in diameter and 8 ins. long was required for the larger coil. This was wound with 13 sections in the manner described in the May issue. There were 20 bottom turns to each section, built up seven layers deep. Thus there were 119 turns per section, or a total of 1,547 turns in the entire coil. This winding gave an inductance of 114,000,000 cms.

Fig. 4 shows the complete coils. Although the smaller coil was fastened by screws to a bracket secured, in turn, to the larger coil, no screws can be seen on the former coil. As a matter of fact, flat head screws were put into the tube, with nuts and washers on the inside, before the coil was wound. The screw heads were sunk just enough so that the wire could be put over them.

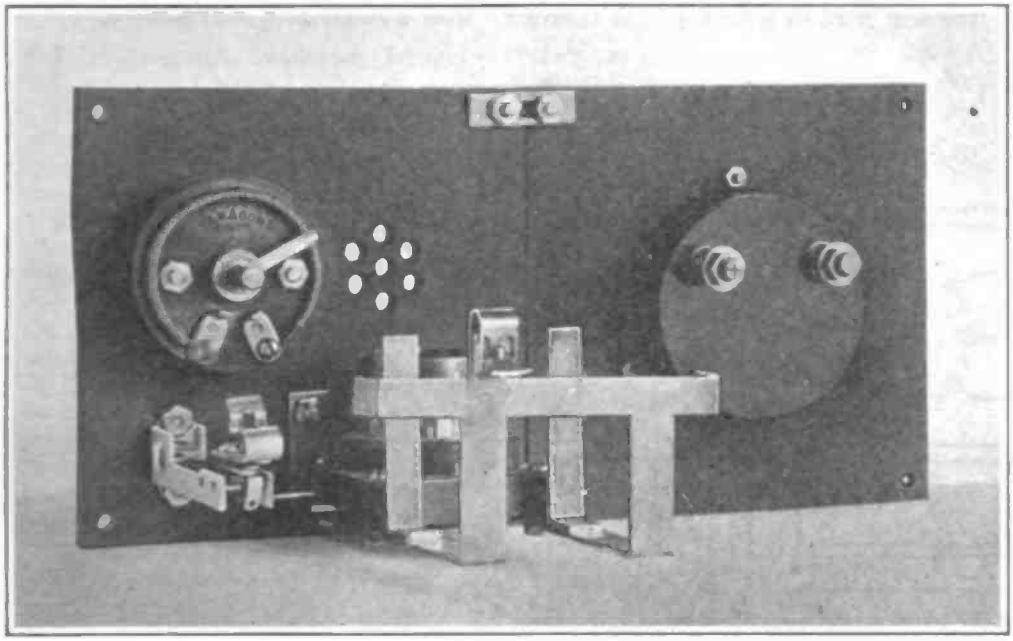


Fig. 3. A detailed view of the audion control and milliammeter panels. The wires from the socket, to which connections were made, can be seen, as well as the method of mounting the socket and B battery. Fahnestock binding posts are secured to the supporting frame and the telephone jack, to which the B battery leads are run. The Paragon rheostat is admirably adapted to apparatus of this sort because of its small size and the ease with which it can be mounted. This illustration also shows the system employed to fasten the panels together

Four brass angles of ⅜- by 1/16-in. stock were used to hold the larger coil to the panel. The work of mounting the coils required considerable care to secure the necessary rigidity. G-A-Lite tubing was employed, and proved quite satisfactory, the bakelite would have given still more strength.

Fig. 5 illustrates the inductance switch. Essentially, there are 3 circular brass segments on the main panel, and 12 switch points on the sub-panel. A bakelite plate, carrying three sets of double contact arms is located between the two panels and operated by the handle at the front. The purpose of the switch has been explained, and can be understood from the diagram. The

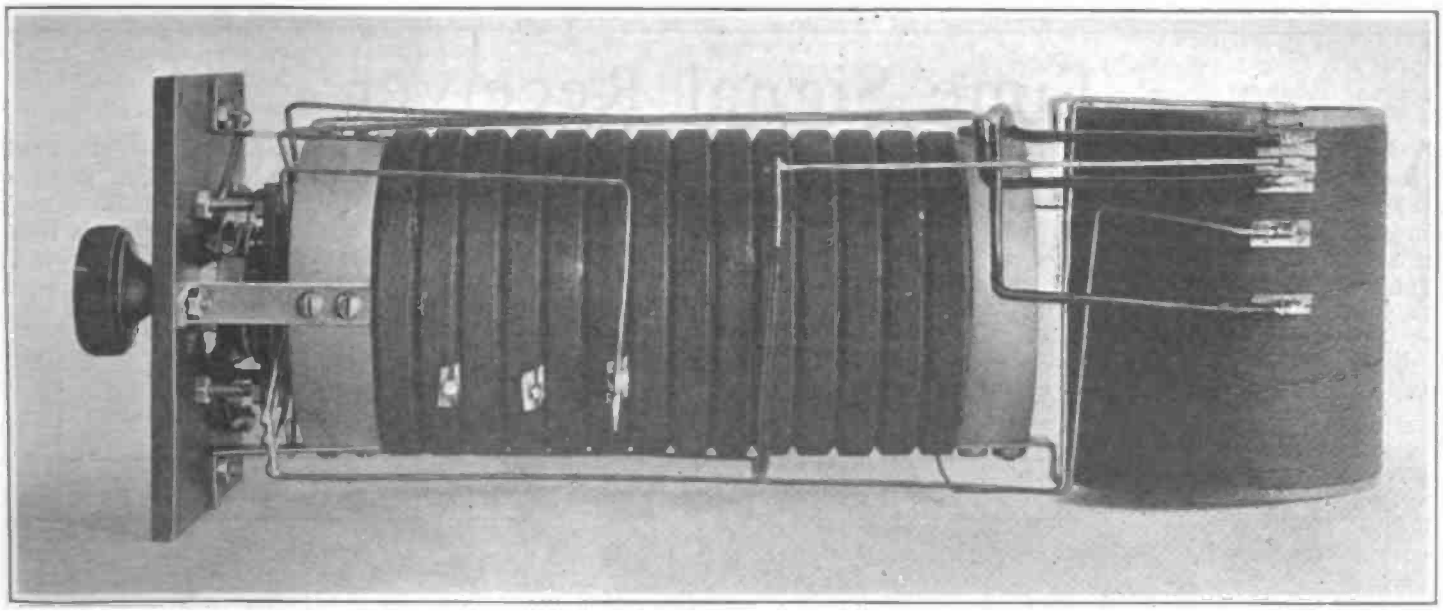


Fig. 4. Here is the inductance panel all finished. The sub-panel mounting can be seen at the left

various taps from the coils are soldered to their respective switch points, while the leads to the grid, plate and filament are taken from the brass segments.

These segments were made by bending a piece of 3/16-in. square brass rod into a circle. Then the three parts were cut out and fastened to the panel by 2-56 flat head screws with nuts at the front.

The sub-panel is supported by four long screws put in from the front of the panel. Nuts in front and behind the sub-panel hold it in place. Adjusting the tension on the contact arms was a delicate matter. Therefore, the sub-panel was put in place, and long leads of No. 16 bare copper wire were soldered to the switch points before the large coil was fastened on.

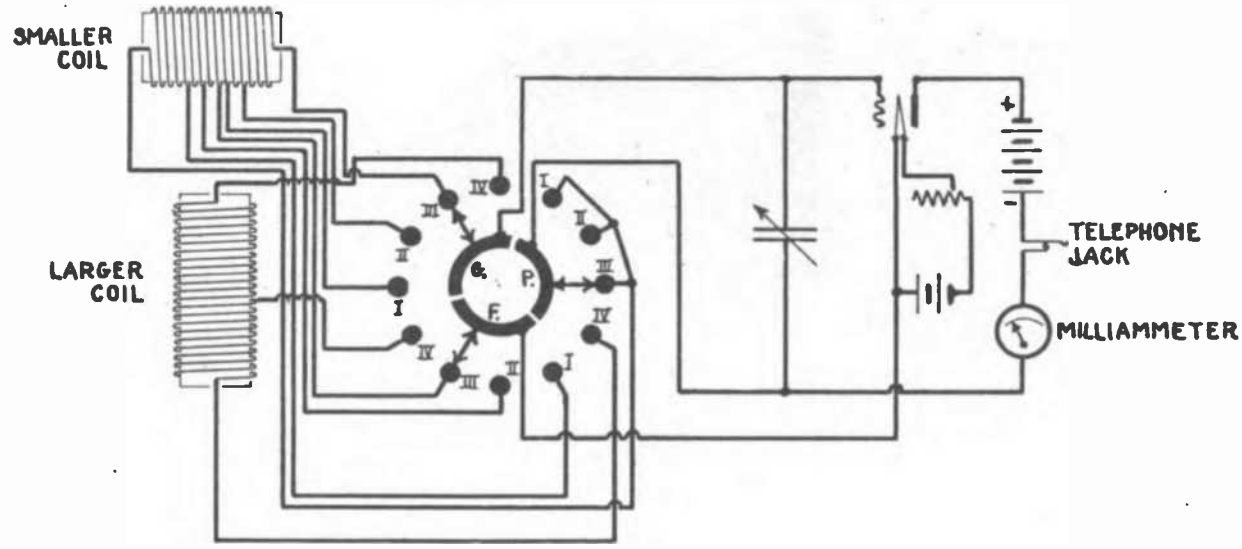
Condenser Panel

This panel carries only a large size G. A. Standardized condenser, with an A. H. Corwin indicating dial. As may be seen from Fig. 1, the dial is fastened to the panel and a pointer put in the handle where the set screw was supposed to go. A hole was drilled into the handle to take a 6-32 screw, for which the end of the shaft was already threaded.

This condenser was chosen because its design assures a permanence of calibration.

Connecting the Instruments

Fig. 6 shows clearly the circuit employed and the method of connecting the switch points and sectors. Since the B battery is contained in the set, no external connections are required except for the filament battery, unless a larger amount of power is required from the oscillator than can be obtained with a small 22½-volt battery.



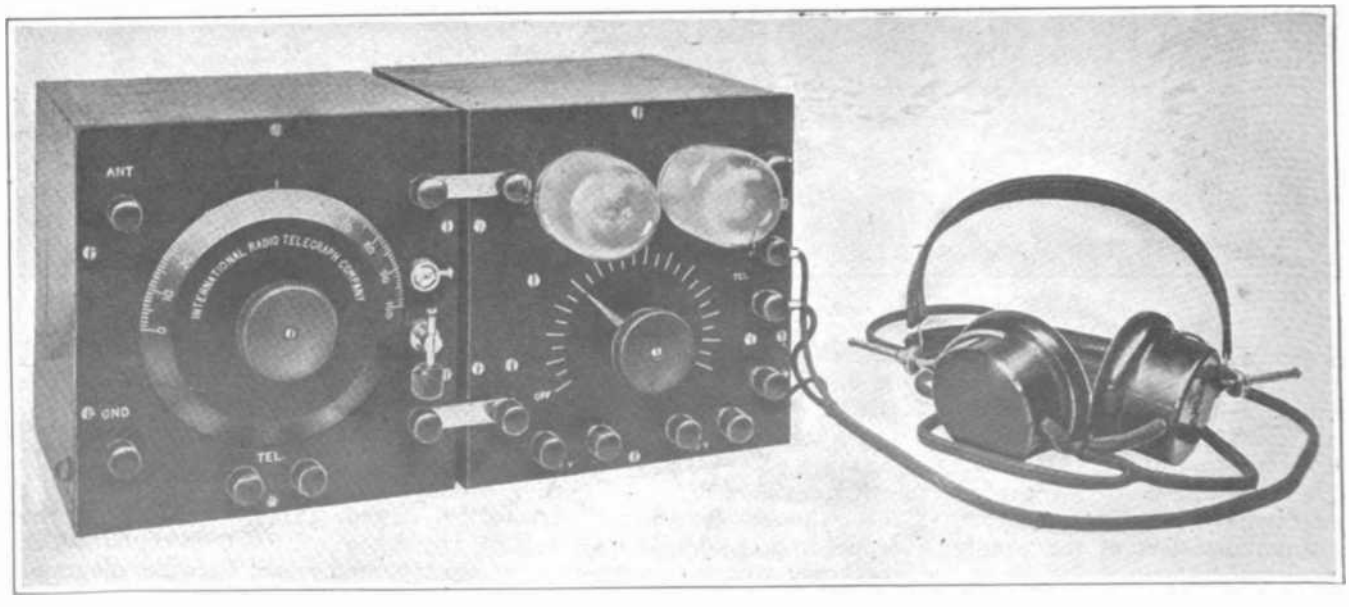
Calibration

No calibration for this wavemeter will be given, as there are bound to be discrepancies between any two instruments, though built identically. However, a heterodyne wavemeter can be readily calibrated from any other type of wavemeter, and more accurately than is possible with the usual crystal detector and buzzer exciter.

Time Signal Receiver

A NEW time signal receiver from the International Radio Company is illustrated here. Very small and simple in design, this set is particularly well suited for the use in watchmakers' stores, on shipboard, and under similar circumstances where no skilled radio operator is available.

At the left is a variometer, on the panel of which is a crystal detector, to be used when the vacuum tubes are not in operation. The second cabinet contains a detector and a one-stage amplifier. This combination gives a set of very high sensitivity, making possible the reception of time signals from a considerable distance, even with a small antenna.



Condenser Capacity Ratio

Pointing Out the Significance of Capacity Ratio, and Means for Obtaining Maximum Wavelength Range with Concentrated Coils

THE variable condenser, formerly used to a limited extent to regulate the wavelength of the secondary of a receiver, has come into much popularity since the introduction of concentrated inductances.

Since the inductance steps, with the news coils, are necessarily large, a variable condenser is required to tune over a range of wavelengths. To keep the number of coils required to tune from 200 to 2,000 meters, for example, as low as possible, the condenser must be of a type to give a maximum wavelength range on each coil.

Antenna series condensers will not be considered here, as they are not widely used by the experimenters, but only condensers shunted around the primary and secondary inductances.

Effects of High and Low Capacity Ratios

A variable condenser generally has a range of 0.0001 to 0.001 mfd. Connected around an inductance of 1,000,000 cms., the wavelength in meters, at the maximum and minimum capacities, can be determined by

$$\lambda = 59.6\sqrt{L_{cms.} \cdot C_{mfd.}}$$

giving

minimum wavelength = 596 meters,
maximum wavelength = 1,885 meters.

If, however, the capacity variation had been from 0.00002 to 0.001, this would have given a range of

minimum wavelength = 267 meters,
maximum wavelength = 1,885 meters.

In other words, the greater the ratio

$$\frac{\text{C max.}}{\text{C min.}},$$

the greater the wavelength range that can be obtained from a given inductance coil.

The wavelength range is in proportion to the square root of the ratio

$$\frac{\text{C max.}}{\text{C min.}}$$

Take the example above:

$$\frac{\text{C max.}}{\text{C min.}} = \frac{0.001}{0.0001} = 10.$$

The square root of 10 is 3.16. Therefore, if the wavelength at 0.0001 mfd. is 596 meters at 0.001 it should be $596 \times 3.16 = 1{,}883$ meters, or practically the value shown. The second condenser has a ratio of

$$\frac{0.001}{0.00002} \text{ or } 50,$$

the square root of which is 7.07. Therefore, this gives more than twice the wavelength variation of the other condenser and, as a result, requires only one-half as many coils to cover a given wavelength range.

To make this more clear, the tables below have been made, comparing the two condensers:

0.0001 to 0.001 Mfd. Condenser
Capacity Ratio = 10

120,000 cms. coil
min. λ, 206 m.—max. λ, 653 m.
1,200,000 cms. coil
min. λ, 653 m.—max. λ, 2,065 m.
12,000,000 cms. coil
min. λ, 2,065 m.—max. λ, 6,529 m.

0.00002 to 0.001 Mfd. Condenser
Capacity Ratio = 50

600,000 cms. coil
min. λ, 206 m.—max. λ, 1,460 m.
30,000,000 cms. coil
min. λ, 1,460 m.—max. λ, 10,320 m.

This shows that the condenser with a capacity ratio of 50 covers, with two coils, almost twice the range covered with three coils and a condenser whose ratio is 10.

The foregoing does not, however, apply to antenna circuits, for there the capacity of the antenna must be considered. It must be remembered that the antenna capacity is added to the capacity of the shunt condenser. Hence, if a tuning condenser of 0.0001 to 0.001 mfd. is used with an antenna of 0.0005, the effective capacity variation is from 0.0006 to 0.0015 mfd.

Because of the antenna capacity, the ratio $\frac{\text{C max.}}{\text{C min.}}$ is $\frac{0.0015}{0.0006} = 2.50$. The square root of 2.50 is 1.58, as compared to 3.16 in the case described before. Thus it can be seen that the wavelength range covered by one coil in the antenna circuit is greatly reduced.

Now, if an antenna of 0.0002 mfd. is used, the ratio, with the same condenser, is $\frac{\text{C max.}}{\text{C min.}} = \frac{0.0012}{0.0003} = 4$, the square root of which is 2, instead of 1.53, as found before. This shows that a low capacity antenna gives a longer wavelength range than the high capacity antenna.

A condenser of high capacity ratio helps somewhat in the primary circuit, although not as much as in the secondary. Connected with the 0.0002 mfd. antenna, the ratio is $\frac{0.0012}{0.00022} = 5.5$, the square root of which is 2.35, or slightly higher than the other.

A reduction of antenna capacity suggests a decrease in the size and a corresponding loss of efficiency. This is not true, however, for a high capacity multiwire antenna is no better for receiving than the low capacity single-wire type.

The conclusions to be drawn from the foregoing are that, to get the greatest wavelength range with the fewest number of coils, the antenna should be of the low capacity single-wire type, and that the tuning condensers should have a high ratio of maximum to minimum capacity.

SPECIAL SIGNALS FOR CHECKING WAVEMETERS

INFORMATION has been received from France that the stations at the Eiffel Tower and Lyons are sending out test signals to permit the checking of wavemeters. Experimenters should have no trouble in hearing these signals.

On the first and fifteenth of each month Eiffel Tower sends out special C. W. signals for the checking of wavemeters, as follows:

On 5,000 meters—At 6.00 P. M. and for one minute, a series of A's followed by a dash lasting for three minutes.

On 7,000 meters—At 6.10 P. M. and for one minute, a series of B's followed by a dash lasting for three minutes.

The programme is then continued by Lyons, as follows:

On 10,000 meters—At 6.20 P. M. and for one minute, a series of C's followed by a dash lasting for three minutes.

On 15,000 meters—At 6.30 P. M. and for one minute, a series of D's followed by a dash lasting for three minutes.

At 6.45 or 7.00 P. M., according to the time required for the measurements, the actual measurements of the emitted waves are sent out by Y N, on 15,000 meters, and repeated thrice.

Example:

A— 5,170 meters.
B— 7,090 meters.
C—10,025 meters.
D—14,990 meters.

The time indicated is Paris time, which is earlier than ours. Therefore, the proper allowances must be made for the part of the country in which the experimenters are located.

The Measurement of High Frequency Resistance

Part II. Circuits used for resistance measurements, and an explanation of their use

By L. M. Clement

The ability to measure the high frequency resistance of coils opens to the experimenter many new, interesting, and possibly profitable lines of investigation. Signal strength and the sharpness of tuning must be considered in relation to the resistance of the circuits. All kinds of tests and comparisons can be carried out by the man who has the apparatus for measuring high frequency resistance.

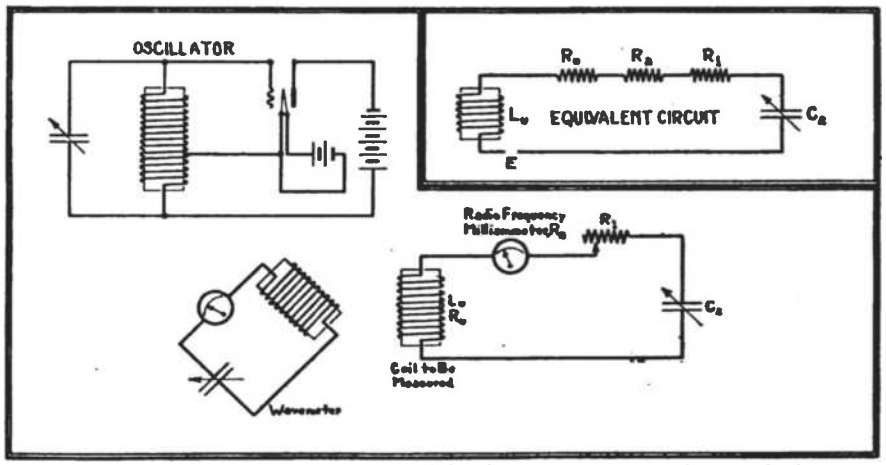


Fig. 5. This circuit is used in the resistance variation method

1. Bridge Method

An adaption of the well-known low frequency impedance bridge at once suggests itself for the measurement of resistances at high frequencies. Such a bridge is illustrated in Fig. 4. The low frequency bridge is supplied by an audio frequency current which is made audible by means of a pair of telephone receivers. The bridge is balanced when there is no sound in the telephones.

The current of a frequency at which the measurements are to be made is supplied by the vacuum tube oscillator through the transformers L and T, across the bridge at CD. The detecting apparatus is connected across AB. In this bridge r_1 and r_2 are non-inductive resistances which are made equal so that the resistance R will represent directly the unknown resistance. The unknown, usually a coil, is placed in series with a condenser which is adjusted until resonance is obtained, that is, until the inductive reactance of the coil equals the capacity reactance of the condenser. The resultant reactance is zero and the coil acts as if it were a resistance. This is assuming that the coil has no distributed capacity. The effect of distributed capacity has been discussed elsewhere.

In high frequency measurement work, the frequency is beyond the range of audibility and for this reason it would not be possible to determine the balance point accurately by ordinary methods.

Two general methods are available, namely, the use of a modulated high frequency input to the bridge and a radio frequency detector connected across its output or a radio frequency input, and a heterodyne detecting system across the output. Such an arrangement is shown in Fig. 4.

The frequency of the oscillator is determined by the inductance and capacity in circuit. The wave length of the oscillations is expressed approximately by

$$\lambda \text{ meters} = 59.6\sqrt{L\text{cms. } C\text{mfd.}} \quad (1)$$

The bridge oscillator, the heterodyne oscillator B, and the detector tuned circuit A should be calibrated and carry scales which make them direct reading. This is of inestimable value in the actual manipulation of apparatus.

The resistances r_1, r_2, and R must be non-inductive and should have a resistance characteristic independent of frequency. This can be accomplished by the use of extremely fine wire of some non-magnetic metal such as "Advance" or "Manganin".

In order to obtain satisfactory results with a bridge of this sort, it must be very carefully constructed and very well shielded. If the shielding is imperfect there may be enough leakage to obscure the null point.

Operation of the Bridge

The unknown inductance should be connected in series with a condenser of such a value that series resonance can be obtained. Set the bridge, the heterodyne oscillator and the detector circuit A at the desired frequency. Adjust the oscillator B until a convenient beat note is heard in the telephones, adjust C_2 until minimum sound is heard in the telephones. Adjust alternately R and C_2 until a balance is obtained, then the resistance of C_2 and L_u is equal to R.

Unless the bridge is very carefully constructed and thoroughly shielded it is very difficult to obtain reliable results with this method. The method is best

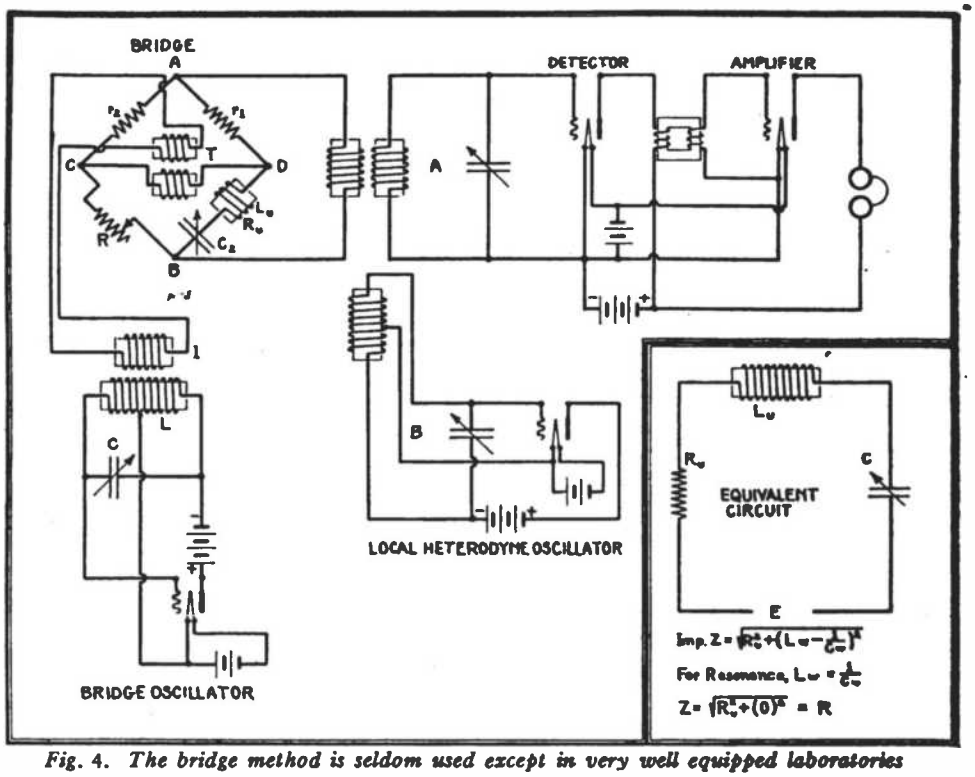


Fig. 4. The bridge method is seldom used except in very well equipped laboratories

suited to the laboratory which has facilities for building this type of high grade apparatus.

2. The Resistance Variation Method

The so-called resistance variation method of determining the resistance of a coil at radio frequencies has been used very successfully to a considerable extent.

If the calibration of the meters is accurate and the resistances are reliable over the frequency and current range used, very accurate results can be obtained with this method.

A diagram of the apparatus and connections involved are shown in Fig. 5. The coil to be measured is connected in series with an accurate radio frequency milliammeter of known resistance R_a, a condenser C_2 and a variable radio frequency resistance R_1. The oscillator should be coupled very loosely to the measuring circuit and be able to deliver enough power to it, under this condition, to give nearly full scale deflection of the indicating instrument.

The oscillator is set to generate the frequency at which the measurement is to be made, the resistance R_1 is cut out and the condenser C_2 is adjusted until the measuring circuit is in resonance with the oscillator. This is true when the current is maximum and equal to I_m.

For resonance the reactance of the coil, $2\pi fL$, is equal to the reactance of the condenser, $\frac{1}{2\pi fC}$, and the impedance of the circuit is then equal to its resistance. The power delivered to the circuit is expressed in terms of the current and resistances as follows:

$$\text{Power} = I^2_m\ (R_u + R_a) \qquad (2)$$

Now insert a resistance R_1 of some known value in the circuit and note the current. Let this value of current be I. The power dissipated in the resistances will now be expressed as:

$$\text{Power} = I^2\ (R_u + R_a + R_1) \qquad (3)$$

Assuming the total power in the circuit is the same in both cases we can equate equations 2 and 3 and solve for $R_u + R_a$,

$I^2_m\ (R_u + R_a) = I^2\ (R_u + R_a) + I^2R_1$ from which

$$R_u + R_a = \frac{I^2R_1}{I^2_m - I^2} \qquad (4)$$

When the current is reduced to 0.707 of the maximum value the resistance R_1 is equal to the sum of the resistances of the coil and the meter. This is seen by substituting for I the current value 0.707 I_m.

Then

$$R_u + R_a = \frac{(0.707\ I_m)^2R_1}{I^2_m - (0.707\ I_m)^2}$$

or

$$= \frac{0.5}{I - 0.5}R_1$$

which gives

$$R_u + R_a = R_1$$

This method, although it involves much less apparatus than the bridge method, is hardly a method which many amateurs can use.

3. Substitution Method

The connections of the apparatus necessary for the measurement of resistance at radio frequencies by the so-called substitution method is illustrated in Fig. 6. The apparatus consists of a vacuum tube oscillator A capable of generating alternating currents of the desired frequency. The oscillator is very loosely coupled to a wavemeter of the ordinary type. Resonance is indicated by a maximum reading of a sensitive galvanometer which is connected across a crystal detector of any ordinary type. The detector is connected in series with a very small condenser and the combination is connected across the wavemeter condenser. This arrangement affords better tuning as less resistance is introduced in the wavemeter circuit, due to the detector, than in the ordinary connection.

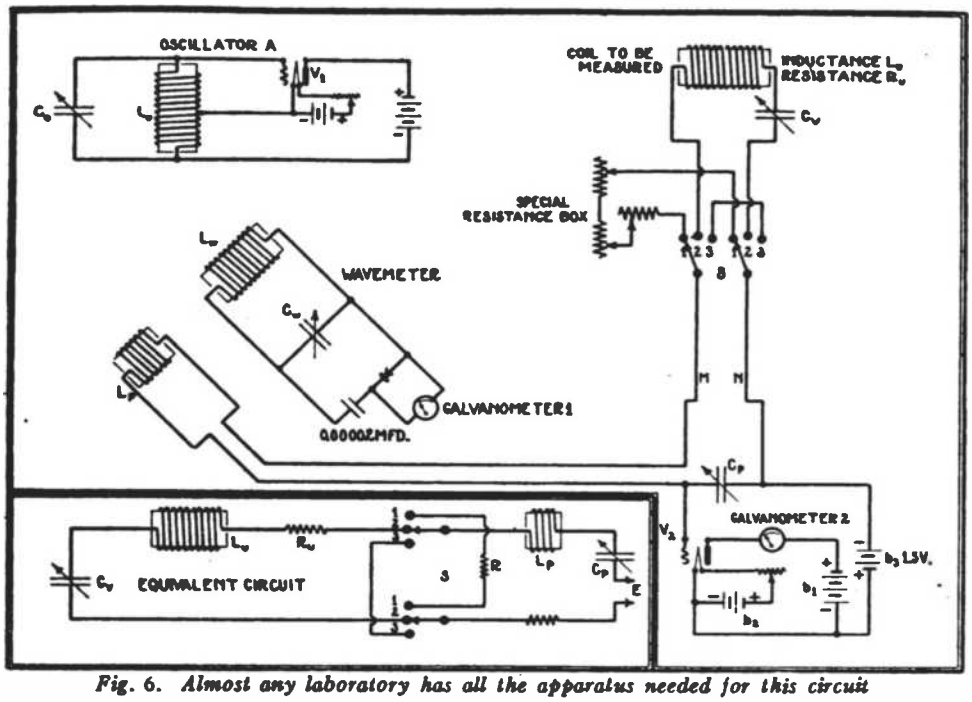


Fig. 6. Almost any laboratory has all the apparatus needed for this circuit

The coil to be measured should not be coupled with the oscillator to any measurable extent and for this reason the coil L_u, its condenser C_v and the pick-up circuit condenser C_p should be placed at some distance from the oscillator. Usually 15 feet is sufficient separation. An alternate plan would involve shielding the oscillator and the pick-up coil.

The pick-up coil L_p is coupled to the oscillator or wavemeter loosely and connected to the measuring circuit by a pair of twisted leads. This is done to prevent the leads from picking up any stray field.

The voltage across the condenser C_p is indicated by means of the vacuum tube circuit, consisting of the tube V_2, the galvanometer G_2, and the plate, filament, and grid batteries b_1, b_2, and b_3 respectively. The tube acts as a detector and the change in the galvanometer reading is an indication of detected current or voltage applied to the grid. The voltage will be the same for two successive readings if the galvanometer G_2 deflection is the same in both cases. This galvanometer can be of either the Rawson Unipivot or the moving coil wall type and it is not necessary that it be calibrated.

The condenser C_v and the wavemeter should be carefully calibrated so that the value of inductance and distributed capacity as well as the resistance of the coil can be determined.

This method because of its simplicity, ease of operation and accuracy has found quite a wide application in experimental laboratories.

Operation

The oscillator should be adjusted to the wave length at which the resistance of the coil is to be measured and the wavemeter adjusted to resonance with the oscillator. Place the switch S, Fig. 6, on position 3, which short circuits the leads M and N. Adjust the condenser C_p so that the circuit C_pL_p is in resonance with the oscillator. This is indicated by a maximum reading of the galvanometer G_2. It is obvious that L_p should be so chosen that it will resonate with the oscillator for some value of the condenser C_p.

The equivalent circuit is shown in Fig. 6 with the switch S thrown to position 3. Then E is the alternating E.M.F. induced in the circuit from the oscillator. When the circuits are in

(*Concluded on page* 260)

Duo-Lateral Type Inductances

A New Machine-wound Coil of Very Low Distributed Capacity and Resistance

FROM the point of view of the radio man, other lines of work must seem very dull, for there is no other industry in which so many new and clever ideas are brought out in such rapid succession. It almost appears that there is nothing more to be added to the line of radio achievements save a substitute for electricity itself.

The duo-lateral coils, invented by Mr. Giblin of the Electrical Products Manufacturing Company, and distributed by the Pacent Electric Company, are different from the familiar "Coto-coil" in that the wires of every other layer are between the wires above them, instead of being directly below them. This effect can be observed in the unmounted coils shown at Fig. 1. As a result of this change from former practice, the distance between the wires of alternate layers is increased. Tests on these coils show that this new method of winding decreases the distributed capacity, and, because a smaller number of turns is required for a given inductance, the length of wire and, consequently, the resistance is lowered.

A table is given here showing the number of turns, the high frequency resistance at various wavelengths, and the distributed capacity, as well as the natural periods of duo-lateral coils of various inductances. All sizes are 2 ins. inside diameter and 1 in. wide.

DATA FOR DUO-LATERAL INDUCTANCES

L Mhs.	H. F. R. Ohms at	λ Meters	C Mfds.	Natural λ Meters	Turns	Wire S. C. C.	Diam. Ins.
0.045	1.9	150	17	70	25	24	2 3/16
0.075	2.6	200	17	86	35	24	2¼
0.156	4.2	300	18	102	50	24	2 5/16
0.36	6.3	400	19	150	75	24	2⅜
0.66	27.2	500	19	220	100	24	2½
1.40	38.0	700	20	290	150	24	2⅝
2.50	48.0	1,000	20	350	200	25	2½
4.20	63.0	1,400	20	420	250	25	2 15/16
6.25	68.0	1,500	21	540	300	25	3
10.62	73.0	2,000	22	700	400	25	3¼
17.6	75.0	3,000	23	860	500	25	3½
25.0	90.0	4,000	23	1,120	600	28	3⅝
38.0	97.0	5,000	23	1,260	750	28	3 5/16
72.8	104.0	8,000	24	1,750	1,000	28	3¾
116.6	125.0	10,000	24	2,200	1,250	28	4 1/16
171.5	140.0	15,000	25	2,600	1,500	28	4 7/16

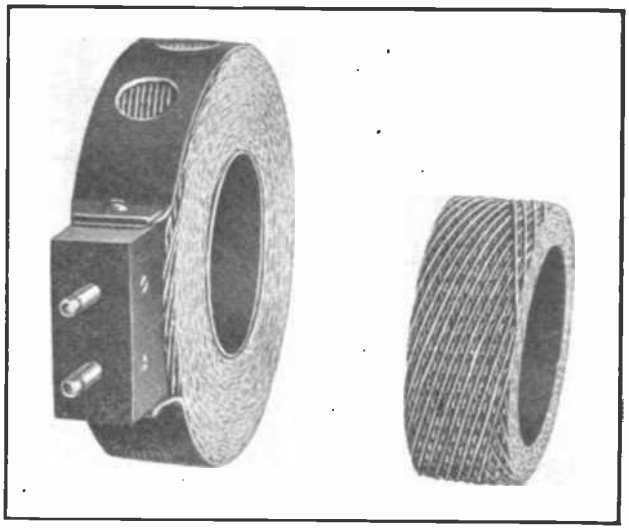


Fig. 1. Mounted and unmounted duo-lateral inductances

In Figs. 2 and 3, a new type of inductance mounting is illustrated. Here the panel effect is achieved by connecting the shafts of the handles to the shafts of the movable plugs by bevelled gears. Another improvement is the indicating dials. Connections from the movable plugs to the binding posts are made by flexible conductors.

The plugs are of the Pacent type, made up of a grooved plug which snaps into a spring socket, similar, in principle, to the Pacent binding posts.

A three-coil mounting permits considerable flexibility of circuits. The most usual method is to use the center coil as the secondary, one outside coil as the primary, and the third as a tickler. Another way, for undamped wave reception, is to replace the tickler by a very small coil in series with a separate oscillator. This serves to heterodyne the incoming oscillations.

Again, the three coils can be connected in series, and used as a variometer.

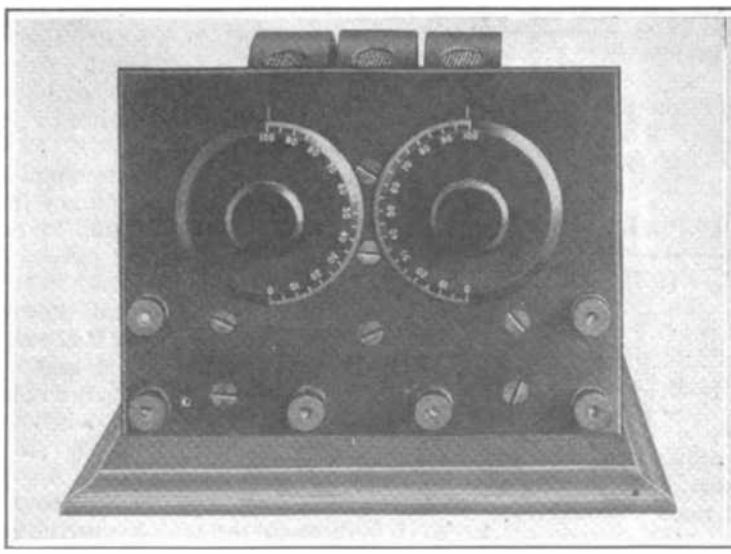


Fig. 2. Primary and tickler coupling are controlled from the front of the panel

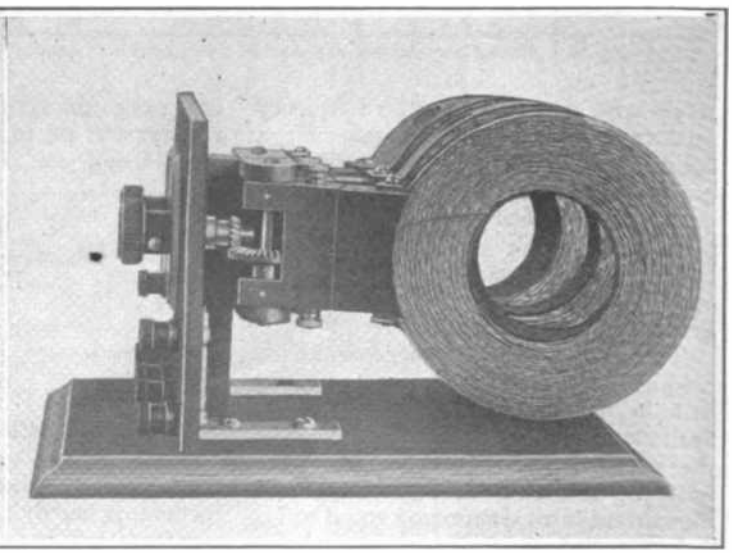


Fig. 3. Showing the bevelled gears by means of which the the coils are turned

The Radio Department

EVEN when the automobile had passed the "gasoline wagon" stage, and people had come to realize that this new means of conveyance was destined to become a permanent factor and one of tremendous influence upon civilization, the automobile was not popular, so that one could say, for example, that one man in every one hundred, throughout the nation, owned a car.

The nationalization of any product depends upon three things—its value as a convenience or necessity, its value as a pleasure, and its cost.

The automobile, for the first few years, possessed the first two points of popularity, but not the third. Having these two properties, the mastering of the mechanical difficulties did not trouble the public. All they required was an automobile at a moderate price. Since that result was accomplished by the manufacturers, we all know the remainder of the story.

Has the foregoing any bearing on radio telegraphy or telephony? Most certainly. Radio, a necessity in many cases, has the imaginative appeal which makes it a tremendously fascinating hobby. Its technical problems make it interesting, and its rapid and continuous changes and developments maintain the fascination which it has for every man or boy *once he has put up a station.*

There is the point which has been so sadly neglected by the manufacturers.

Sit down with your catalogs and find out first what you need for a beginner's station, and then what it will cost. Being quite ignorant of the requirements of a radio receiving set, you probably will not be able to find out what you need, if you depend upon the catalogs to tell you.

If you are determined to have a radio station, you may hazard an inquiry to one of the manufacturers. The result may put an end to your interest in radio. Or you may know an experimenter who has a station. He will, of course, suggest the purchase of the best instruments, wishing to assure the success of your outfit.

Then comes the reckoning of the cost. It will vary from fifty to two hundred dollars.

How many men want to put that amount into something they know nothing about, and have no assurance of the results to be obtained, or their continued interest in the purchase after it is made? Between these two experiences through which the average beginner must go, it is a wonder that anyone ever takes up radio work.

The introduction of a complete receiving set, with materials for an antenna and a set of simple instructions, to sell at twenty dollars, would give a greater impetus to radio experimental work than any of the new ideas which have been brought out in the last ten years. This set should not be cheap because it is cheaply made, but because the design is very simple. It must be a set which will not get out of order, and can be operated successfully by anyone who knows nothing about radio.

If those who are mildly interested in wireless could get a set at a low price, and make it work, they would quickly respond to the call of radio, and join the ranks of those who spend all the time and money they can spare for better apparatus. The problem is to make it easy for a man or boy to start. The number of such prospects far exceed that actually doing radio work now.

Incidentally, this is the time to prepare for the manufacture of such a set, as there is just time enough before the fall season starts. The men who operate such a set this winter will be buying expensive apparatus next year.

NOW a word to those who are making their own instruments. In a recent discussion concerning a new device to be sold for experimental work, one of the men at the head of a large supply company said, "There's no use in putting so much finish on the instrument. It's too good. Experimenters don't care how a thing looks as long as it works—at least that is my opinion from what I can judge by the stations I have seen."

Let us hope that this man's idea was not correct. No matter how well an instrument may work, if it is merely thrown together, an experimenter cannot feel the pride in it that he would if it looked like a real job. We cannot all be instrument-makers, to be sure. At the same time, a careful choice of materials and a little extra care make a very great difference in the completed apparatus.

The main trouble with the experimenter is that, when he decides to build an instrument, he wants to make it immediately. Rather than wait to get the proper materials, he falls back on makeshifts. That is why his set gives the impression that he doesn't care how it looks as long as it works fairly well.

WHILE the experimenters have, no doubt, all they can do to keep up with developments in this country, they should have an eye on the other side of the ocean. As they were surprised to know to what extent radio research had been carried on during the War, they may be again surprised at the work subsequently accomplished.

In the May, 1920, issue of EVERYDAY, there were the names and addresses of several British radio societies. Since England and France have worked together, practically all the European developments are known in England. Correspondence with those societies will certainly be helpful and interesting at both ends.

Such success has been attained by some of the A.R.R.L. stations, that transmitting across the ocean to a well-equipped English receiver is not at all out of the question, and arrangements could be made without difficulty for the attempt. The accomplishment of such a feat would be no inconsiderable feather in the cap of the operator, and the League would share in the credit. Someone will do it. The question is who will be first.

HOW many radio catalogs have you? Probably fifteen or twenty. When you try to arrange them in your bookcase, what is the result? You can't keep them in an sort of order because no two are the same size. They can't be put in a loose-leaf binder, in fact, they are rather a nuisance to have around except that you can't get along without them.

Think what it would mean to have all your radio catalogs and bulletins printed on the same size paper. Then they could be readily filed and kept in proper shape without losing the little ones, or having the big ones all bent up.

If each experimenter, when he writes for a catalog should say at the end of his letter:

"P S. I hope you print your catalogs on 8½- by 11-inch sheets, so I can keep them neatly filed."

the companies might realize after a while, that, to have their catalogs preserved and not lost in the shuffle, they should use regular size paper which, incidentally, is more economical than the small sheets.

FOR next month, there will be even more radio articles than in this issue, an increase of three pages over May. The constructional article will be a two step radio frequency amplifier, not radical in design, but an example of the best practice. A new type of concentrated inductance, entirely different from any other will be described with tables and data on the use of all types of coils for receiving work. Another feature will be a description of radio equipment suitable for small boats. Illustrations of transmitters, receivers, and directional receivers will be shown.

Mr. Clement, although he is taking a well-earned vacation on the Pacific coast, has written an article on the measurement of inductance, describing a method which, as might be expected, is quite different from the usual practice. In fact, the inductance is measured on a resistance box.

A Duplex Radio Telephone Set

This Equipment, Built By the Western Electric Company, Transmits and Receives Simultaneously

THE question of two-way radio telephony in which two speakers may carry on conversation without the necessity of changing the circuit connections from the receiving to the sending condition or the reverse, and which for brevity will be spoken of as "duplex radio telephony", is one which has been of considerable interest to radio engineers for sometime and while a number of attempts have been made to obtain such communication it has not come into general use. This is, no doubt, due largely to the enormous ratio between the power developed for transmitting purposes and the power of the received energy at a given station which makes it exceedingly difficult to prevent an overwhelming amount of side tone during the transmitting period, that is, the presence in the operator's receiver of the message which he is endeavoring to transmit. This condition has made necessary thus far the use of a circuit in which a switch or key of some kind is employed for throwing from the receiving to the sending condition, the set normally being in the condition for reception and being thrown into the other condition only during the actual transmitting period, during which time the local receiving circuit is entirely disconnected for its own protection.

The Western Electric Company has recently designed and built duplex radio telephone sets for the United States Navy which, in accordance with the definition of the term, permit two people at remote stations to converse with one another by radio without the necessity of throwing switches and with no more thought to the question of whether one is transmitting or receiving or both than is done in the case of an ordinary wire telephone conversation.

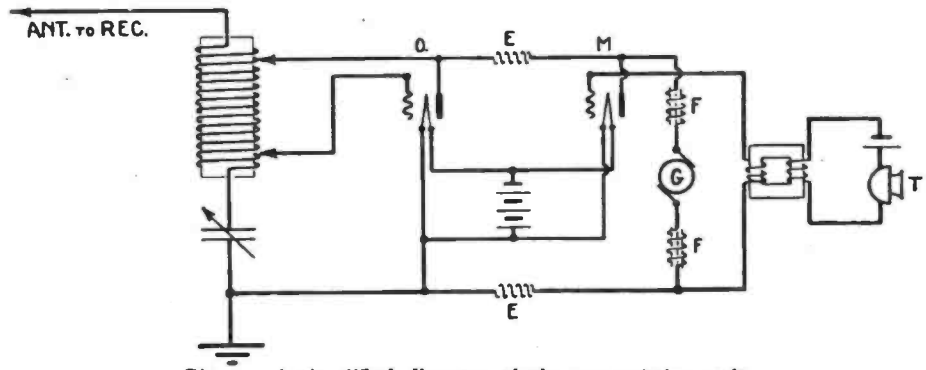


Fig. 4. A simplified diagram of the transmitting unit

There are a number of different arrangements which might be used for successful duplex radio signalling. One method would obviously be to have two separate antennae, one for transmitting and one for receiving, the two antennae being tuned for different frequencies or being so related by form or position that the receiving antenna is not affected materially by the transmitting antenna. This is particularly convenient if the receiving and transmitting stations can be separated by a distance of a few miles, the speaker being located at one or the other station or at some intermediate point and being connected to the two stations by means of wire connections. Another method would be to use a single antenna for transmitting and receiving in which some balancing scheme reduces the amount of transmitted power which enters the receiving circuits. In places of restricted space, such as sea going vessels, it is apparent that the first method cannot well be used, and that the second method offers a satisfactory solution of the problem, if a sufficiently accurate

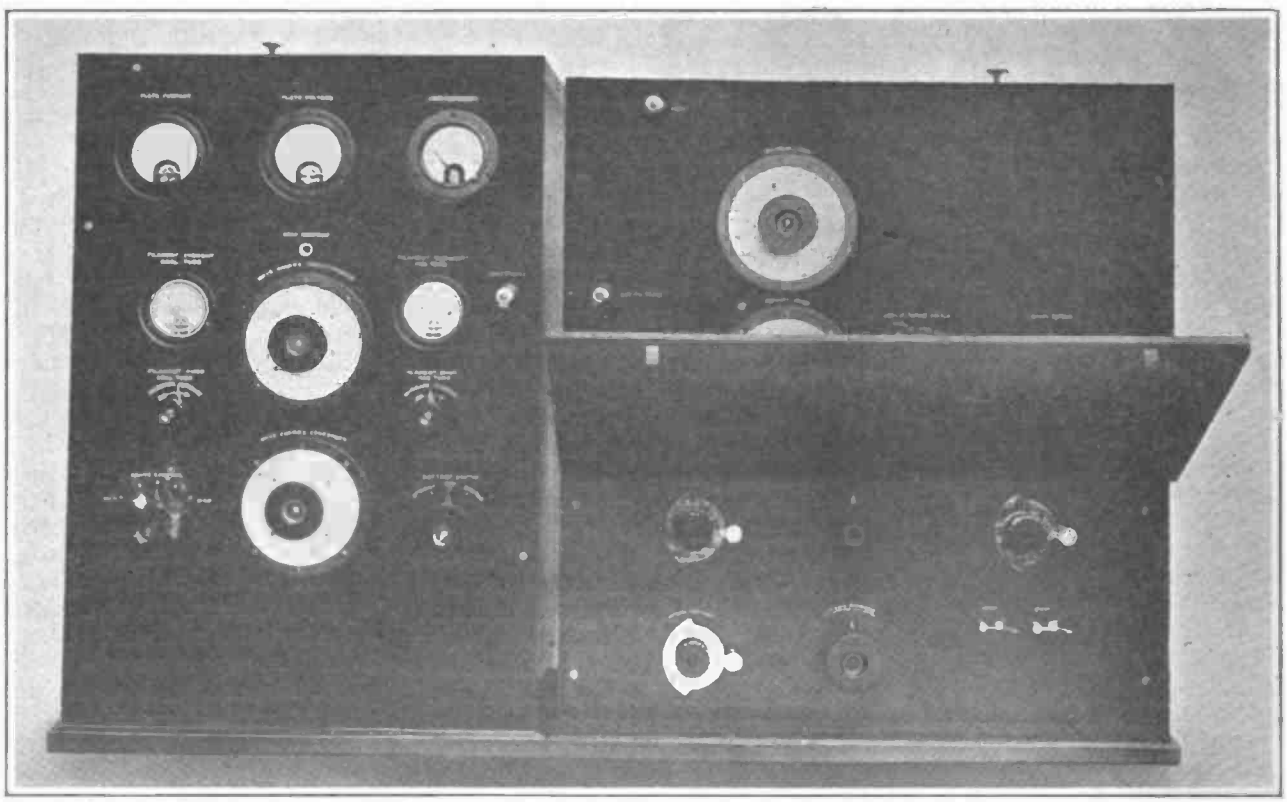


Fig. 1. The complete duplex radio telephone system, comprising a transmitter, receiver and dummy antenna

balancing of the circuits can be obtained, so that the transmitter does not affect the receiver to any great extent even though both circuits are associated with one and the same antenna.

the Navy based on the second method. Figure 1 shows a photograph of such a set, which consists of two units, A and B.

The Unit A, to the left, comprises the

and the other as a modulator tube. The Unit B, to the right, comprises an artificial antenna and the receiving circuit, and the interior of this unit, also looked at from the rear, is shown in Figure 3.

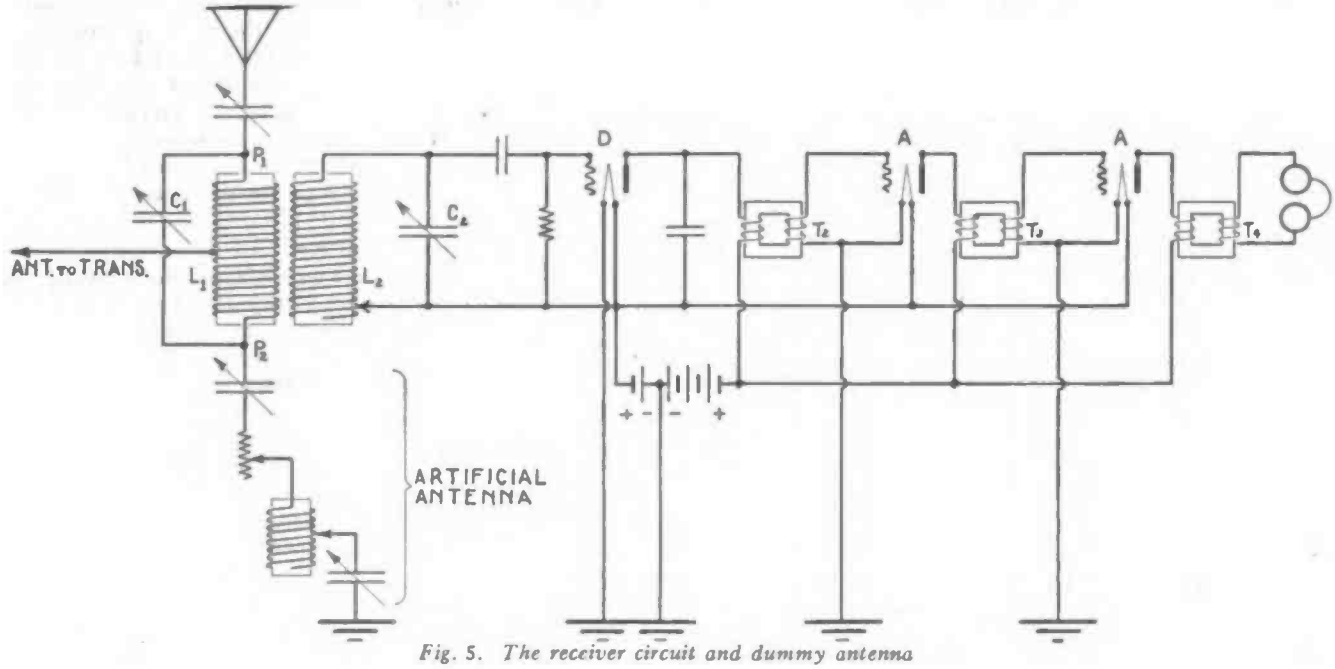


Fig. 5. The receiver circuit and dummy antenna

The Western Electric Company in cooperation with the United States Navy used the first method some years ago in connection with radio communication between Washington and battleships at sea. More recently it has built sets for

oscillation generator with its modulator circuit and as such is the transmitting set. Figure 2 shows the interior of this unit looked at from the rear. It will be noted that there are two vacuum tubes, one of which acts as an oscillator,

In this unit three vacuum tubes are shown, one acting as a detector and the others as amplifiers of the detected signal. In setting up the station it is only necessary to connect a terminal from the Unit A to a terminal on the Unit B;

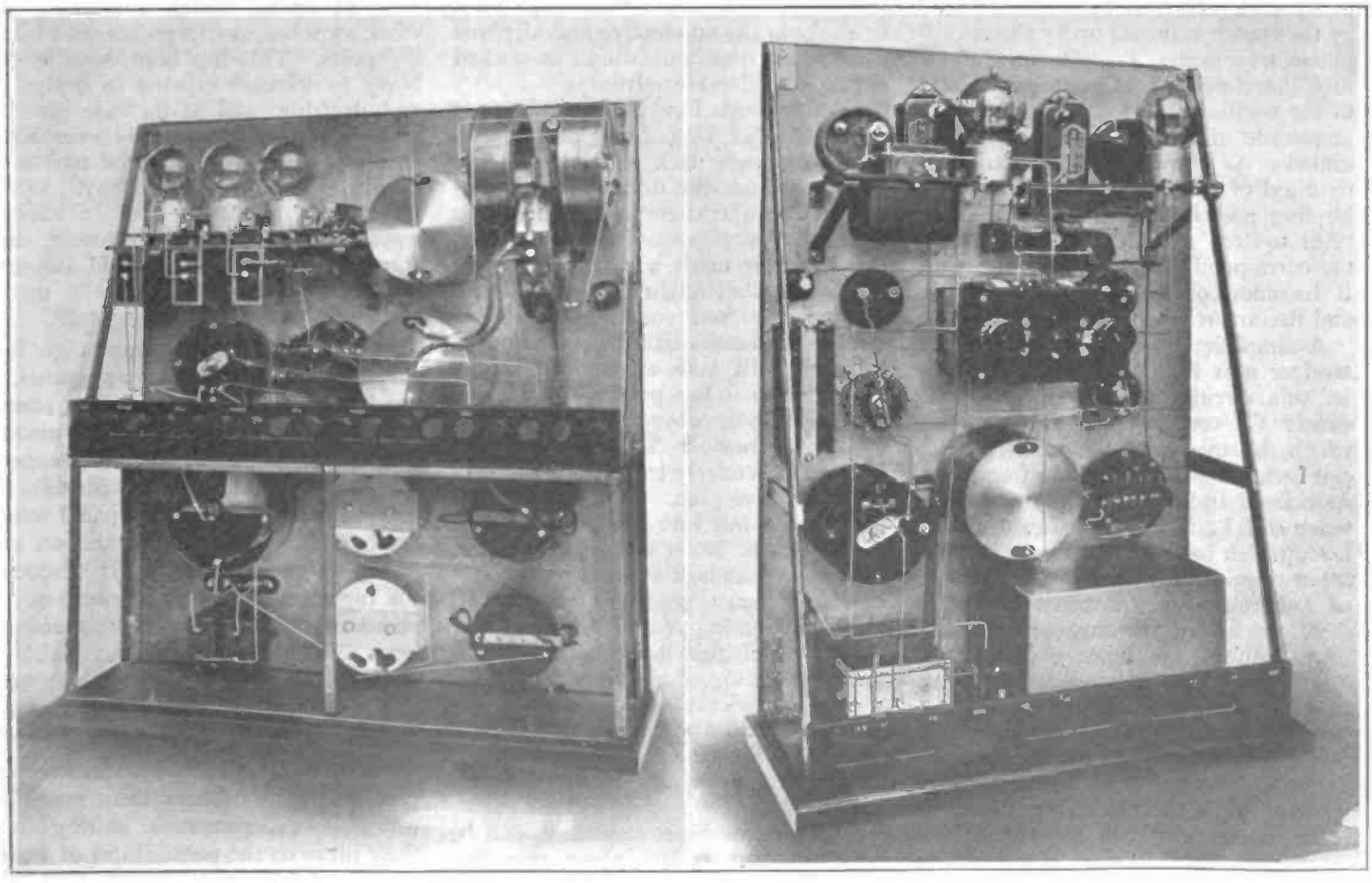


Fig. 3. The receiver is mounted above, and the dummy antenna below. This unit is also completely shielded

Fig. 2. Interior of the transmitter. The rear of the panel is shielded, and the set, when in use, is fitted into a metal case

to connect the antenna to a second terminal on the Unit B, and to make two ground connections, one from the Unit A and one from the Unit B. In addition, of course, the usual connections of batteries, transmitter and receiver must be made, provision for these connections being shown in Figures 2 and 3. This particular set is arranged to communicate with any one of three stations.

A simplified circuit diagram of the transmitter unit is shown in Figure 4. A variety of oscillator circuits may be used, one which is particularly useful and which is shown here, is the Colpitts oscillator. This circuit includes a tuned circuit having two capacities in series, the one capacity consisting of a condenser of suitable dimensions and the other capacity being that of the radiating antenna. One terminal of the filament is connected to a point between these two capacities. The plate and grid are connected respectively to points on the inductance L. Power is supplied to the plate circuit by the generator G. Such a circuit will oscillate at a frequency determined by the capacity and inductance of the tuned circuit. These oscillations are modulated by the Heising method, which is shown in the diagram as consisting of a vacuum tube connected in parallel to the oscillator tube. Suitable choke coils E and F are connected to this circuit as shown. The impedance offered by the modulator tube M is determined by the potential of its grid, which in turn is controlled by the speech wave set up by the microphone transmitter T. The modulator tube therefore acts as a variable shunt to the oscillator and thus controls the amplitude of the oscillations to be radiated. As shown in the circuit one terminal of the inductance L goes to a binding post indicated in Figure 1 as "Ant. to Rec." and upon connection with the corresponding terminal on the Unit B becomes connected to the radiating and the artificial antenna.

A simplified circuit diagram of the receiver unit B is shown in Figure 5. In this circuit the coil L_1 and condenser C_1 constitute a tuned circuit which, by means of the condenser C_1 can be tuned to the signaling frequency. Associated inductively with the inductance coil L_1 is a second tuned circuit L_2C_2 which is connected directly to the input circuit of a vacuum tube D acting as a detector. The detected current is then impressed through the transformer T_2 on the input of a vacuum tube A acting as an amplifier, and the output of this amplifier tube is then impressed, by means of a transformer T_3, on the input circuit of a second amplifier tube in the output of which is a transformer T_4, the secondary of which contains the telephone receivers. The amount of amplification obtained can be adjusted by means of the variable resistance in the output circuit of the detector tube. It will be noted that one terminal of the filaments of the tubes are all connected to ground and the other terminals are connected to the positive pole of the filament battery, the negative pole of which is grounded. The filaments are thus supplied with heating current in parallel. The battery B is used for the plate circuits of the three tubes in parallel. From the mid point of the inductance L_1 is a lead going to the binding post marked in Figure 1, as "Ant. to Trans." and is used for connecting the Unit A with the Unit B.

In view of the balanced arrangement oscillations coming from the Unit A to the mid point of the inductance L_1 divide equally, half of the energy going to the antenna and the other half to the artificial antenna. This leaves the points P_1 and P_2 always at equal potentials as far as any disturbances arising in the Unit A are concerned and they therefore produce no effect upon the receiver circuit. Oscillations received upon the antenna, however, are not so balanced and therefore will produce an effect in the telephone receivers.

The essential point of this circuit arrangement is the presence of the artificial antenna, which is naturally made to simulate the actual antenna as closely as possible, both in oscillation and damping characteristics. Obviously the greatest difficulty in a circuit of this type is in the balancing of the two circuits so that P_1 and P_2 will actually be equal potential points. In the designing of such balanced circuits the Western Electric Company has probably had more experience than anyone else because of the extensive use of such balanced circuits in ordinary telephone practice. In this circuit, however, the requirements are much more severe than in ordinary telephone circuits because of the high ratio between the transmitted and the received power.

In a later modification the set is divided into three units, A, B and C, the Unit A being the same as before, the Unit B including the receiving circuit and the inductance L and condenser C_1, and the Unit C including the artificial antenna alone. This arrangement has certain advantages in flexibility. In particular it permits the artificial antenna Unit C to be placed in a more or less inaccessible and useless space, a matter of importance in airplane work.

The Possible Standardization of Radio Equipment

MANUFACTURERS in various lines have found it advantageous to co-operate in the standardization of certain parts of their products. Particularly in the automotive and airplane fields, such standardization has worked out to considerable advantage.

Such methods have been proposed, at different times, by radio engineers, but, partly through lack of interest and partly through the difficulty of bringing the manufacturers together, nothing has been accomplished. In fact, no one has ever made a definite proposition as to what might be standardized.

Obviously, someone must outline a method of standardization before manufacturers will take an interest in the idea. Since it has proved so valuable in other lines, why should it not be applied to radio? There are a number of men entirely capable of drawing up a tentative plan. That such a system can be put into practice is shown by the U. S. Navy's radio piece part method of standardization.

The primary objection which will arise in the mind of each manufacturer is that to change his products means the re-designing of all his apparatus, a serious consideration, of course. Offhand, it might appear impossible to correlate the many special features of instruments from as many different sources.

At the same time, something can be done, unquestionably, along this line which will be of very considerable benefit to the entire field.

In outlining a possible system, consideration must first be given to such things as are used by all companies, such as knobs, scales, indicating devices, switches, switch points, and binding posts. This has been done by the Navy to decrease expense in designing and drafting, and to increase production. It does not mean necessarily, however, that a standardized part is to be made by only one company. While these parts might be used in various ways by different manufacturers, uniformity to this extent would improve the appearance of a set made up of instruments from several sources.

Before too many companies go into the building of sectional apparatus, it would be well to determine on a standard panel size, and a method of mounting. The argument that an experimenter having bought instruments of one company of one size of panel would not buy other apparatus on another size panel, is not sound, for it discounts the ingenuity of the experimenters. A standard panel size or combination of sizes would be very well received.

Other features can be treated in a similar manner by the far-sighted designer.

EVERYDAY ENGINEERING will be very glad to publish letters from manufacturers or experimenters, setting forth their ideas on the possibilities of standardizing radio apparatus, or their reasons for considering it impractical.

Radio Tuning Circuits

This Article Points Out Exactly What Happens When a Receiving Circuit Is Tuned to a Given Frequency

THE subject of capacity and inductive reactance was discussed in the May issue, and it was shown that, to obtain the maximum power, in watts, in an alternating current circuit, the current and voltage must be in phase, a condition obtained by using such a combination of inductance and capacity that the impedance is zero.

Tuning to a Given Frequency

Let us take a slightly different angle on this question of radio tuning circuits, to show more exactly what happens when a receiver is tuned to an incoming signal. First, we shall assume that the transmitter is working on 3,000 meters or 100,000 cycles. Since the secondary circuit is simple, we shall discuss it first.

An inductance of 4,000,000 cms. or 0.004 henry is employed, with a tuning condenser of 0.0001 to 0.001 mfd. From (5) the reactance of the inductance, at 100,000 cycles, is

$X_1 = 2\pi \times 100{,}000 \times 0.004,$
$X_1 = 2{,}512$ ohms inductive reactance.

To balance this 2,512 ohms of inductance reactance, the condenser must be varied until a value is found which gives a capacity reactance of 2,512 ohms. Then, from (6), the reactance will be zero. The following table shows the reactance, at 100,000 cycles, of the condenser:

$C_{mfd.}$	X_c
0.00010	15,920
0.00020	7,940
0.00030	5,315
0.00040	3,980
0.00050	3,180
0.00055	2,890
0.00060	2,650
0.00065	2,450
0.00070	2,270
0.00075	2,120
0.00080	1,980
0.00085	1,870
0.00090	1,760
0.00100	1,592

This table is plotted in Fig. 5. The capacity reactance table and curve show that, as the frequency is increased, the reactance decreases. Another curve is given of the total impedance, or the value $(X_c - X_1)$, as indicated in the following table:

$C_{mfd.}$	X_c	$-$	X_c	$=$	X
0.00010	2,512		15,920		$-13{,}408$
0.00020	2,512		7,940		$-5{,}428$
0.00030	2,512		5,315		$-2{,}803$
0.00040	2,512		3,980		$-1{,}468$
0.00050	2,512		3,180		-668
0.00055	2,512		2,890		-378
0.00060	2,512		2,650		-138
0.00065	2,512		2,450		$+58$
0.00070	2,512		2,270		$+242$
0.00075	2,512		2,120		$+392$
0.00080	2,512		1,980		$+532$
0.00085	2,512		1,870		$+642$
0.00090	2,512		1,760		$+752$
0.00100	2,512		1,590		$+922$

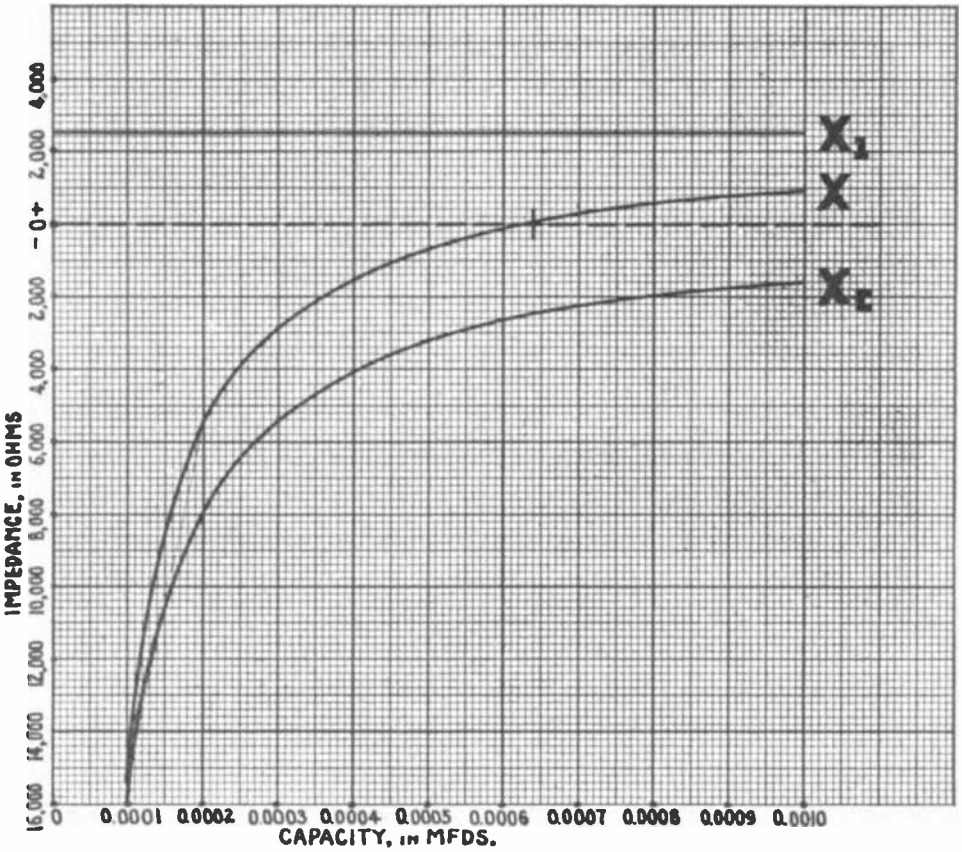


Fig. 4. The inductive reactance is constant, while the capacity reactance is varied above and below resonance

An examination of the table and curve shows that, with approximately 0.00065 mfd. and the 4 mh. coil, the reactance to 100,000 cycles is zero. Also from

$$\lambda = 59.6\sqrt{L_{cms.} C_{+mfd.}},$$

the wavelength with these values is

$$\lambda = 59.6\sqrt{4{,}000{,}000 \times 0.00065}$$

or $\lambda = 3{,}030$ meters.

In other words, the wavelength of the circuit, when its reactance to the incoming frequency is zero, is the same as the wavelength of the transmitter.

Tuning the Transmitter to the Receiver

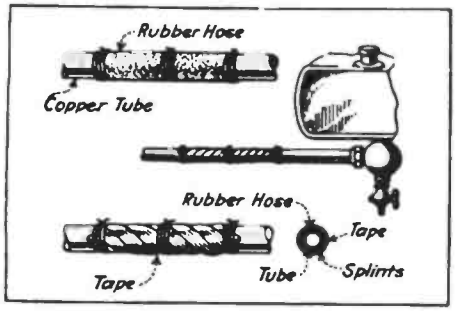
In operating practice, the transmitter is never tuned to the receiver, though this is done in adjusting wavemeter to a receiving circuit. Perhaps a coil of 10,000,000 cms. or 0.01 henry is connected with a condenser of 0.001 mfd. or 0.000000001 farad. The wavelength of such a circuit, from (9), is 5,960 meters. A wavemeter is coupled to the inductance, and varied from 4,000 to 8,000 meters. Let us see what the inductive and capacity reactances are at this range of wavelengths or frequencies. The frequencies corresponding to various settings of the wavemeter are:

Wavelength	Frequency
4,000	75,000
4,500	66,700
5,000	60,000
5,500	54,600
5,750	52,200
6,000	50,000
6,250	48,000
6,500	46,200
7,000	42,900
7,500	40,000
8,000	37,500

Then the inductive, capacity, and ef-

STOPPING FUEL-PIPE LEAKS

ONE of the simplest emergency methods is to utilize a section of rubber tubing which is slipped over the meal pipe, but if the break be in the center of the line and the rubber hose light-walled, the vibration would tend to chafe the rubber. The latter should be braced by splints and the manner of attachment is shown in accompanying cut. Where this is not obtainable a repair may be made with ordinary friction tape. Light splints or strips of wood are laid lengthwise on a first double winding of tape and in the same direction as the pipe and the outer tape wound as depicted, being tied with twine or copper wire. The wrapping should be smug where the break occurs to prevent leakage of the fuel. A small crack may be treated in a similar manner or by using soap and tape as the former is not affected by gasoline; in fact, a piece of this material is invaluable in the tool kit. Shellac may also be used in conjunction with tire tape. Any piece of rubber hose that will go over the pipe may be used to join the broken pieces of tube temporarily together.



LIGHT ABSORBING PROPERTIES OF WALL-PAPER

THE color of wall-paper used in a room may decide whether one lights one or more lamps. White walls absorb only thirty per cent of the light, but nearly everyone wants some color that is easier on the eye. Chrome yellow absorbs only thirty-eight per cent. Paper of an orange shade robs one of fifty per cent of his light. It is when one gets into reds and greens that the light begins to dim. A dark-green wall-paper, so restful to the eye, absorbs eighty-two per cent of the light; and paper of a deep chocolate color leaves only four per cent of the light rays for use. Its power of absorption is ninety-six per cent.

Norway is credited with the longest aerial power cable, which spans a stretch of water in one of the fiords. There are three cables with a span of 1,384 meters, nearly a mile; the cables are 40 meters above the water at their lowest point; in their crossing they drop 80 meters from the level line. In still weather the tension is four tons; when it blows it may be double this amount.

RECOVERY OF SILVER FROM OLD CYANIDE PLATING SOLUTIONS

THE baths may be evaporated to dryness, the residue mixed with a small quantity of calcined soda and potassium cyanide and fused in a crucible, whereby metallic silver is formed, which, when the heat is sufficiently increased, will be found as a button upon the bottom of the crucible; or if it is not desirable to heat to the melting point of silver, the fritted mass is dissolved in hot water, and the solution containing the soda and cyanide quickly filtered off from the metallic silver. The evaporation of large quantities of fluid is, to be sure, inconvenient, and requires considerable time, but the reducing process above described is without doubt the most simple and least injurious.

According to the *wet method*, the bath is strongly acidulated with hydrochloric acid, observing the precaution to provide for the effectual carrying off of the hydrocyanic acid liberated as given under gold. Remove the precipitated chloride of silver and cyanide of copper by filtration, and after thorough washing, transfer it to a porcelain dish and treat it, with the aid of heat, with hot hydrochloric acid, which will dissolve the cyanide of copper. The resulting chloride of silver is then reduced to the metallic state by mixing it with four times its weight of pulverized charcoal. The whole is made into a homogeneous paste, which is thoroughly dried, and then introduced into a strongly heated crucible. When all the material has been introduced the heat is raised to promote complete fusion and to facilitate the collection of the separate globules of silver into a single button at the bottom of the crucible, where it will be found after cooling.

If granulated silver is wanted, pour the metal in a thin stream, and from a certain height, into a large volume of water.

EMERGENCY DIMMER FOR AUTO LAMPS

THE cruising radius for motor trucks is constantly increasing and frequently the drivers are called upon to make deliveries in cities or towns where local ordinances demand a special kind of lamp dimmer, differing from that which the regulation at home requires. Sometimes this causes a lot of trouble for the driver, who must find some means of keeping within the law. In some cases it is possible to use mud, and by smearing it on the glass, the light is dimmed to satisfy the most exact guardian of the peace. Graphite grease or some other substance that makes a greasy smear, also furnishes an excellent emergency dimmer.

Should you know of a worthy young man desirous of obtaining a good technical education and making a good future for himself refer him to our announcement on page 274 of this number.

STAND-BY-LOSSES

A CHARACTERISTIC expression occurs in English engineering literature which expresses very well a source of inefficiency and low yield in mechanical operations. It is "stand-by-losses." It indicates such cases as the maintenance of steam pressure, with consequent expenditure of fuel, when the engine is not running and no steam is being taken from the boiler. An automobile standing at the curb with its engine running "idling" is the appropriate term, is a good example of a "stand-by-losses." A steam-trawler lying to on the fishing grounds is cited by an English contemporary as an example and this loss is taken as a plea in the use of the easily started gas engine in trawlers. There is no trouble in finding far too many cases of "stand-by-losses" in the engineering world. In the household there are numerous examples, and the extensive use of two very expensive sources of heat, gas and electricity, for cooking, is only made economical by the ease with which gas or current is turned off, minimizing "stand-by-losses."

PITH AS A LENS CLEANER

IT is said that any ordinary cleaning medium that can be used is likely to smear and even scratch a lens in the cleaning, the latter being a serious condition in the case of lens used in photographic apparatus, especially when used for photo-micrography or study of structure of metals. A very perfect lens cleaner can be made by using the pith of such plants as sunflower, rush or elder. Strips of the dry pith are cut, and these are fastened with an adhesive to a piece of cork. The pith may be arranged in rows, with small spaces in between. The lens is rubbed gently with the pith and all marks disappear.

The basic process of treating steel consists in general terms in the use of alkaline earths. The linings for the furnaces or converters work so effectually in removing the phosphorous from iron ore that phosphorous is desired for the process in order to provide heat. This impurity, which in other processes it is desirable to keep out of the iron ore, becomes an advantage in the basic process. When the slag from the basic process is finely ground it is used as a fertilizer. If the process is run simply from the steelmaker's point of view the slag may be a very poor fertilizer. Sometimes to make the slag more fusible calcium fluoride or chloride is added to the flux. This reduces the solubility of the phosphate and makes it of less use to the farmer. England is taking up the question vigorously with the idea of making the slag of high value in agriculture.

HEAT TREATING ALLOY STEEL

(*Continued from page* 203)

table herewith gives the color and corresponding temperature at which the various tools mentioned are best quenched.

Temperatures for Tempering

The following table gives the required temperature in Fahrenheit degrees to produce certain colors, when tempering hardened steel:

Lathe, shaper and planer tools:
- 430. Very light straw.
- 450. Light straw.

Taps, dies and wood turning tools:
- 470. Dark straw.
- 490. Very dark straw.

Hatchets, chisels, etc.:
- 500. Brownish yellow.
- 520. Yellow tinged with purple.
- 530. Light purple.

Springs, etc.:
- 550. Dark purple.
- 570. Dark blue.

The following table gives the proportional parts of lead to one pound of tin, which when melted will have the required temperature to produce certain colors on hardened steel, by simply immersing the parts to be treated in the molten metal:

TEMPERATURE

Color	F. Deg.	Proportions
Very light straw....	430	1¾ to 1
Light straw.....	450	2⅛ to 1
Dark straw.....	470	2½ to 1
Very dark straw...	490	3½ to 1
Brownish yellow...	500	4¾ to 1
Light purple.....	530	7½ to 1
Dark purple.....	550	12 to 1
Dark blue.....	570	25 to 1

When small work is tempered in large quantities the above method is expensive as the pieces are handled individually and is not as reliable as when the articles are heated in a kettle of oil, using a thermometer for indicating the temperature or in a lead pot furnace. A piece of perforated metal is used to keep pieces away from the bottom of the oil kettle, though a wire basket will serve the purpose even better. As soon as the parts are raised to the required temperature they are quenched to cool.

Case Hardening

When an article of low carbon steel is to have a hard surface it is not possible to treat it by merely heating and quenching, as there is not enough carbon in the steel to insure proper hardening. One process of treating such materials is known as "case" hardening and consists of covering the surface while red hot with some material which forms a coating or case steel, which can be hardened by quenching, as in previous processes. Small parts, such as nuts, bolts, cones, etc., may be case

(*Continued on page* 268)

HEAT TREATING ALLOY STEEL

(*Continued from page* 266)

hardened by heating red hot and covering with a thin layer of powdered cyanide of potassium, and when this melts, the article is again heated to a red heat and plunged in water. While the above process is suitable for hardening a few small pieces, it is not recommended for large quantities of work, as the results would not be uniform and the process would be too expensive, besides, the hardening is superficial and only a thin skin.

If many small pieces are to be case hardened at the same time, they may be treated in much the same manner as in box annealing. Granulated raw bone, and granulated charcoal should be mixed in equal proportions and a layer of this mixture placed in an iron pot box to the depth of one or one and one-half inches. A layer of the articles to be treated is then placed in this and these are covered with more material, the same care being observed in packing and with regard to test pieces as with other processes. After the container has been sealed with fire clay luting, it is placed in a carburizing furnace and the temperature maintained at a point which will keep the pieces at a bright red heat for periods varying with the degree of the surface hardening desired. Generally carbon will penetrate the surface of wrought iron or low-carbon steel one-eighth inch in 24 hours, but as it is seldom necessary to harden any deeper than one-thirty-second inch, the work may be taken out after four or five hours. After small pieces are heated the contents of the pots may be emptied directly into a tank of brine around which there is a constant circulation of water to keep it cool. If great toughness is required, the packing material is sifted out and the pieces quenched in oil. Large pieces must be dipped one at a time and can be wired so that they can be removed from the hardening box when desired. There has been great development of late in scientific heat treatment, which will be described more at length in other articles of this series. The processes which have been described are simple ones which are of particular interest to the practical mechanic or repairman and make clear what is meant by heat treatment.

(*To be continued*)

ED. NOTE. The next instalment will outline the construction of various forms of furnaces used in heat treating and explain how to distinguish the various types.

CARBON DETERMINATION BY ELECTRIC RESISTANCE

A METHOD, new in principle and extremely simple, has been recently brought out by J. R. Cain and J. C. Maxwell for determining the amount of carbon in steel. It is claimed to be accurate within one-tenth of one per cent. The details were published by the authors in the September, 1919, issue of the *Journal of Industrial and Engineering Chemistry*.

The fundamental principle of the method which, it is believed, is of wide application, is the change of electrical resistance brought about in a standard solution by the precipitation into it of another substance. This substance is, in this case, carbon dioxide, obtained by direct combustion of the metal. The standard solution is barium hydroxide of known electrical resistance. Hence the underlying chemical equation is:

$$Ba(OH)_2 + CO = BaCO + H_2O.$$

The increase in the resistance is due to precipitation of barium ions. Not only is the principle new, the assembly of apparatus is also new, and offers many advantages for technical work over the methods hitherto in use for the measurement of electrolytic resistance. These require a complicated and expensive set of apparatus. Other new features are: The application of the "nomograph" for the graphical representation of resistance data and the use of special conductivity cells with adjustable electrodes to facilitate the manufacture of any number of such cells without the same cell constant.

WESTINGHOUSE EQUIPMENT FOR SOUTH AMERICAN RAILWAY ELECTRIFICATION

FOR the Paulista Railway electrification in Brazil, the Westinghouse Electrical International Company announces the obtaining of contracts for four locomotives—two for passenger service and two for freight service. This electrification will initially be 28 miles in length, but later it is expected to make extensions which will include a distance of 100 miles.

The passenger locomotives have a one-hour rating of 2,000 h.p. and weigh 121 tons. They will be operated from a 3,000-volt, direct-current overhead trolley system and will be complete with regenerative control. They are designed for a maximum speed of 65 miles per hour and have a track gauge of 5 feet 3 inches. The freight locomotives have a one-hour rating of 1,500 h.p. and will weigh 87 tons. They are also operated from a 3,000-volt, direct-current overhead trolley system and will be complete with regenerative control. The maximum speed will be 40 miles per hour and the gauge five feet three inches.

HIGH SPEED AND ALTITUDE

A RECORD average speed of 155 m.p.h. has been maintained by a Breguet airplane equipped with a Renault 300 h.p. engine and the Rateau supercharger in a flight from Paris to Lyons, according to advices from Paris under date of April 14th. The distance was covered in 1 hr. 50 min. The high speed is attributed to the fact that Lieutenant Roget, the pilot, flew at an altitude varying between 17,000 and 20,000 feet.

At sea level the speed of this machine is only 93 m.p.h., so that by going to the higher altitude a gain of more than 60 m.p.h. on the average speed was obtained. At this height it was not necessary for the pilot and his mechanician to use oxygen masks and, with the use of the Rateau turbine compressor, there was no falling off in the engine power. It would appear that the wind did not assist in attaining the increased speed, for on the day of the flight the weather bureau reported that the direction was from south to north, or against the machine, with an average velocity of between 16 and 19 feet per second. This experiment appears to justify the prediction of Breguet that with air-tight cabins and the use of the Rateau compressor it would be possible to attain an altitude of 50,000 feet and fly at a speed of 250 m.p.h.

QUICK DRYING LACQUER COATINGS

SPEED of production on some products demanded the use of finishes that would dry within a few minutes, and cellulose lacquers or "dopes" were adopted with successful results. Such "dopes" were already in use for making moisture resistant and rendering taut the fabric wing surfaces of aircraft. They were composed of either cellulose acetate or cellulose nitrate dissolved in volatile solvents. For aircraft work their composition resembled those shown below:

Cellulose Acetate Dope

Methyl acetate	60%
Methyl ketone	10%
Benzol	15%
Acetone	10%
Diacetone alcohol	5%

Each gallon of dope made with the above liquids contained approximately seven to nine ounces of cellulose acetate, one ounce triphenyl-phosphate, and very small quantities of chemicals such as benzyl acetate, benzyl benzoate, and urea.

The various stabilizers and other solid ingredients in the dopes were used for specific purposes (such as to increase fire resistance and flexibility, or

to prevent the development of free acid or "blushing"), but are not usually required where the "dopes" are to be used only as protective coatings.

Cellulose Nitrate Dope

Butyl acetate	20%
Ethyl acetate	50%
Benzol	30%

Each gallon of dope made with the above liquids contained from six to eight ounces of cellulose nitrate.

Cellulose nitrate "dope" is greatly improved as a protective coating by the addition of from five per cent to seven per cent of castor oil or treated tung oil. Greater elasticity of film and slower evaporation result.

It is quite possible that cellulose nitrate lacquers made on the above basis will find application in peace times for certain specific purposes where quick drying, hard and elastic films are required. They may be admixed with pigments to produce colored coating which dry to a flat, washable surface. When mixed with aluminum powder or zinc powder, quick drying, hard primers for metal are formed. These may be used satisfactorily as the base for many metal finishes. As substitutes for shellac on some types of work they should also prove of value.

It should be pointed out that cellulose lacquers or enamels are not as durable as these made with oil or varnish. They are, however, useful for certain purposes where the longevity may be partly sacrificed to obtain rapid drying.—*Scientific American.*

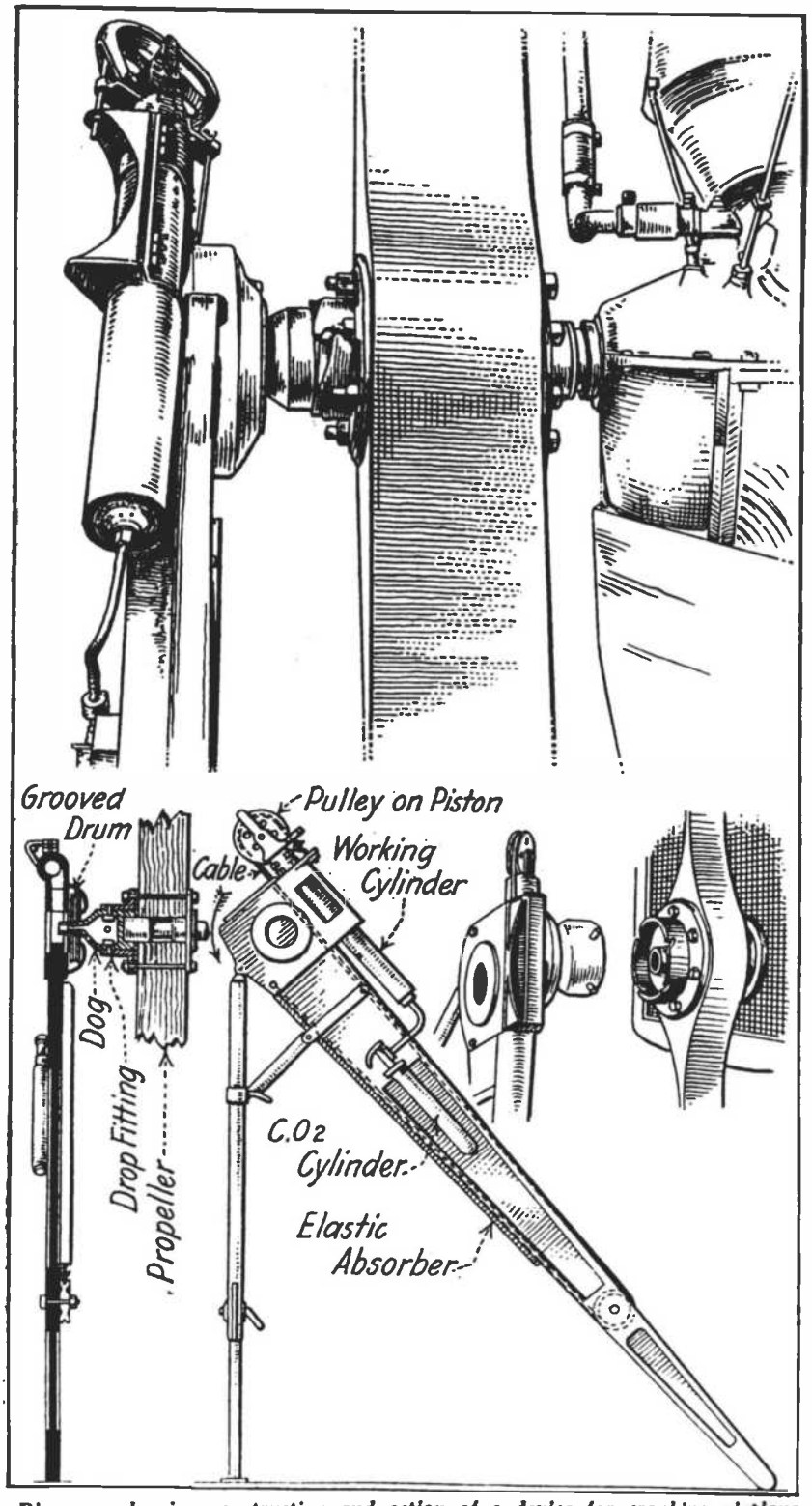
TEST SHOWS BENZOL DOES NOT INJURE INTERNAL COMBUSTION ENGINE PARTS

AN official report has been issued by the Automobile Association of England on the 10,000-mile benzol road test carried out on a touring car. The trial was organized with a view to discovering whether benzol of N. B. A. specification does or does not result in bad effect upon the modern internal combustion engine; examination of the engine and its parts at the end of the 10,000 miles produced no evidence of ill effects. Owners of both touring cars and business vehicles have been using benzol for many years with satisfactory results, but this is the first occasion on which a lengthy, searching and official test has been made.

The Sperry parachute weighs but 12½ pounds, and descends at the rate of 12 feet per second. This is the rate which would be reached in jumping from a height of less than three feet.

Cranking Propellers With Bottled Gas

EVERYONE interested in aviation is ready to admit that the present method of hand-cranking the propeller is primitive and certainly dangerous for the inexperienced. Yet for want of a really suitable cranking equipment this crude practice has persisted despite many attempts to introduce some mechanical means. Some attempts have been along the line of an electric or compressed air self-starter for the airplane engine, following types tried out in automobile practice; but even at this late date airplane designers are not anxious to add anywhere from 40 to 100 pounds of weight to their power plant especially if the plane is intended for military service. The preference has been given to portable propeller swingers, which could be carried about the airdrome and used for cranking any machine.



Diagrams showing construction and action of a device for cranking airplane engines by compressed air or gas. Upper drawing shows cranking clutch engaged with propeller

One of the most compact airplane propeller swingers is that invented by a Frenchman, M. Odier, and illustrated in the accompanying drawings which are reproduced from the *Scientific American*. In the first place, the weight of this propeller swinger is by no means excessive, so that one man can carry it about. It is compact and safe to handle. Briefly, the Odier starter consists simply of a two-leg stand carrying at its upper end a long steel cylinder and piston. Attached to the extremity of the piston, which projects outside the cylinder, is a pulley over which a cable is passed, having one end fastened to the cylinder and the other end wound four times round a grooved drum and then secured to an elastic absorber. The grooved drum is mounted on a short shaft having a bell-shaped extremity on which four projections are placed symmetrically around the periphery in such a way that they can be made to engage with sloping recesses in a standard fitting mounted on the boss of the propeller or tractor screw. The mechanism is actuated by turning a valve which releases the contents of a flask of carbon dioxide gas into the working cylinder. The gas pressure against the piston causes it to actuate the propeller and turn it over briskly by means of the cable and clutch mechanism. As soon as the engine starts, the clutch is released automatically just as that at the end of an automobile hand starting crank is. This device is much simpler than the automobile with propeller swinging attachment used on some American aviation fields.

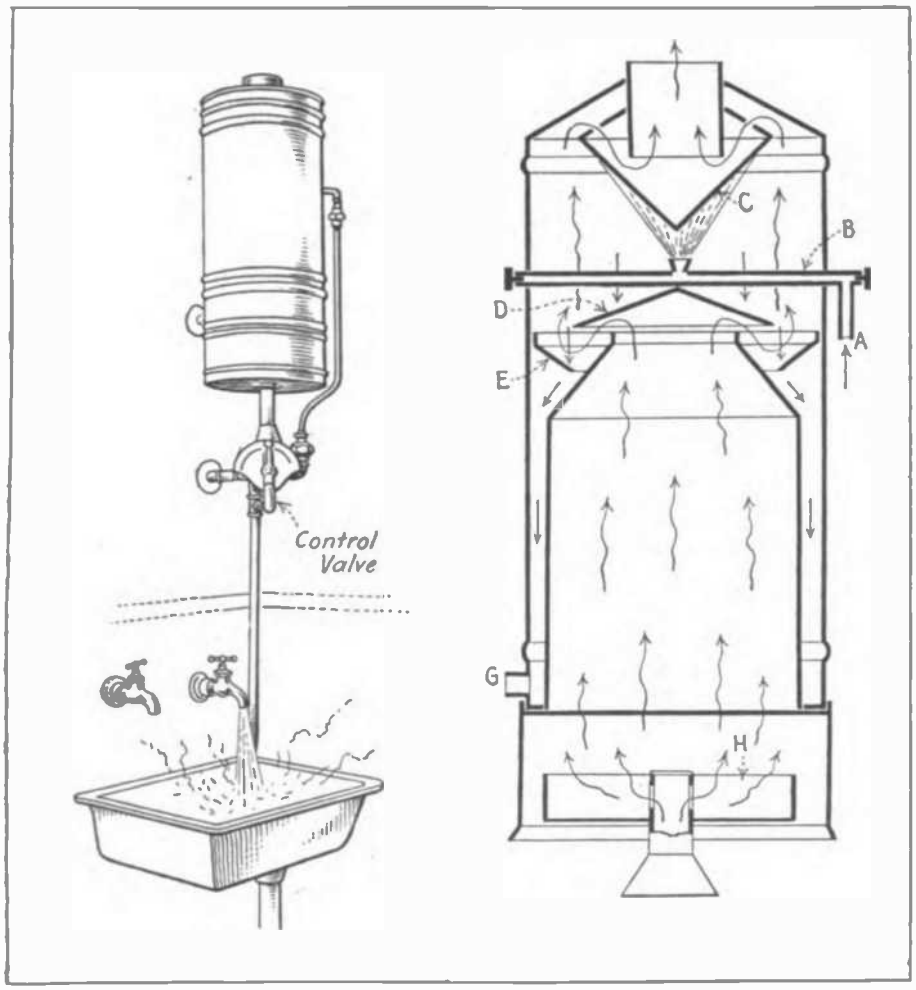
NON-CORROSIVE FLUX

THERE is no absolutely non-corrosive flux on the market, but the nearest approach to this ideal is probably attained by the use of a compound of rosin and stearic acid. The Naval Aircraft Factory has been using for some time past a flux composed of 75 per cent stearic acid and 25 per cent rosin. It is practically non-corrosive but it is not quite so powerful as the commercial fluxes; at the same time it is very satisfactory if the men do not expect to rely on it to actually *clean* the surfaces. The average commercial flux is composed largely of ammonium chloride, although the manufacturers sometimes claim to have a "secret" composition. Ammonium chloride is very hygroscopic, thus causing accelerated corrosion in the presence of moisture.

Owing to the high prices of crude oil and its distillates, many scientists are working on the problem of producing a synthetic fuel.

Instantaneous Water Heater

THE accompanying cut illustrates a new type of water heater that is being made for the trade by a Canadian firm. The principle used in heating the water is that of bringing the hot gases from the burning fuel into direct contact with the water in its passage from the inlet to the outlet of the container. This method provides for the utilization of every heat unit produced by the gas, and when properly regulated there is absolutely no loss of heat. The flow of the water and the consumption of gas can be easily regulated and the control of both is obtained by the single lever shown directly in front and a little below the container.



Diagrams showing installation and construction of simple, instantaneous water heater

This water heater requires no cumbersome tank, and can be supported by the fittings that are used to secure it in position on the wall or any other convenient location. The water does not lie stagnant while not in use, as there is practically no water in the tank at any time, the outlet being at the lowest portion of the water chamber. Even when in use the water passing through is virtually in suspension and very little weight is ever placed on the appliance. This permits the container to be made of light sheet steel that permits of instantaneous heating of the water when heater is operating.

The construction of the heater is shown in the line sketch. The cold water enters at A and passes into the cross pipe B and out at the opening in the middle where it is sprayed against the inverted cone C, thence dropping in succession to the baffle plates D and E and on to the inclined roof F of the inner portion, from where it flows down the side to the lower level to the outlet G. It will be seen that the heat—shown by the staggered arrows—must pass directly through the sheet of water as it drops from one baffle to another, thus absorbing all the heat of combustion.

In a recent book by a French author, American methods are the topic. The writer says that in factories the Americans are profuse of everything except time; the Germans save on time and material and spend on plant; the French economize on everything except time. He says that the Americans overwork machinery so as to scrap it and replace it by the most advanced kind.

PULVERIZED FUEL IN BRAZIL

SOME details of the use of pulverized coal on railway locomotives in Brazil are available from a report presented at the semi-annual meeting of the American Society of Mechanical Engineers. Two hundred and fifty locomotives have been equipped with pulverized coal and a number of tests were made that gave satisfactory results, full boiler pressure having been maintained throughout the test runs. The average analysis of the coal is given as follows:

	Per Cent.
Moisture	7.93
Volatile Matter	29.80
Fixed Carbon	43.07
Ash	19.20

The average number of thermal units per pound is 10,225. It was only by the adoption of a pulverized fuel system that the utilization of Brazilian coal became possible. This solution has therefore led to the development of the native coal fields of the country through the establishment of steamship and railway lines.

The report is very encouraging and is a positive proof that the same results could be obtained in many districts in other countries where the coal deposits may be of an inferior quality, but which could be utilized by the application of a comparatively economical process of pulverization that would render the coal available for the purposes desired.

DRESS SNAP FASTENERS IN ELECTRIC WORK

SNAP fasteners are much used by dressmakers in places where buttons formerly held sway. Now it is suggested that their use be extended to light types of electric work. By using them as terminals of wires, one part on each wire, or one part on a wire end and the other part on any place to which the wire is to be connected, a most convenient and neat system of connecting and disconnecting results. Especially is the use of these little appliances to be recommended for light or experimental work, where small wires only are used. The two parts are to be soldered to any desired places in the circuit.

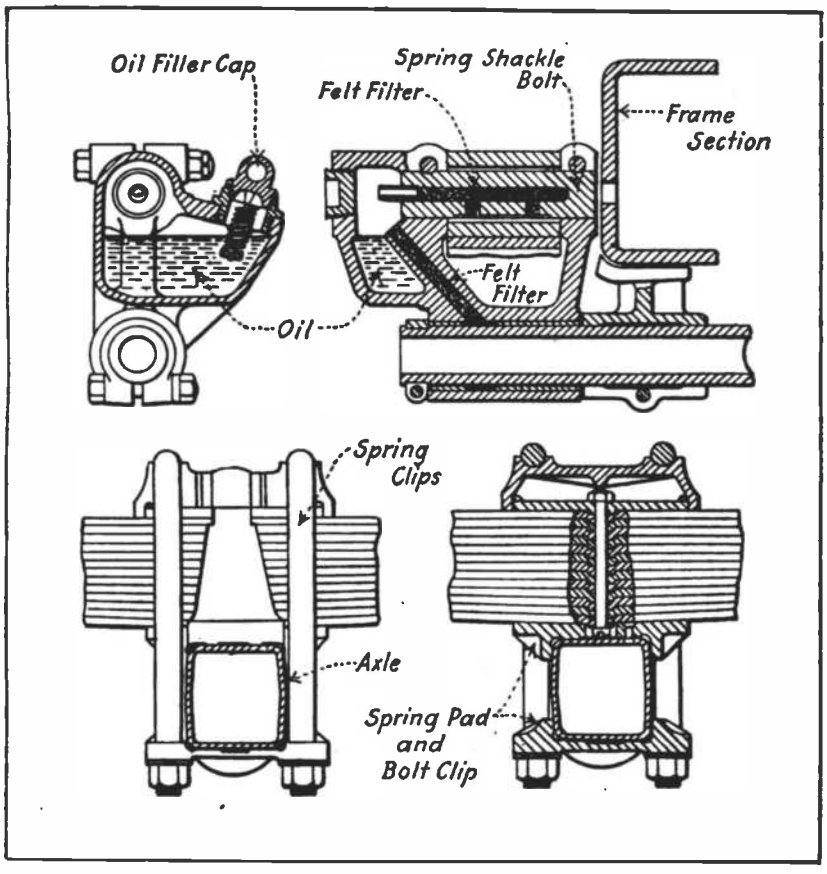
The well known action of magnesium-lead alloys in the presence of air has been suggested as a possible basis for making nitrogen gas. An alloy of 15% magnesium and 85% lead rapidly oxydizes in cold or moist air, falling to a black powder, which gradually becomes lighter in color, it is presumably a mixture of the hydrates. This is the action, which is suggested for the manufacture of nitrogen gas; simple exposure of air to the alloy would absorb the oxygen of the air and leave the nitrogen. An alloy of 65% of lead with 35% of magnesium boiled in water evolves hydrogen, the magnesium alone oxydizing. This gives a way of making hydrogen gas in conditions when other methods requiring chemicals or extensive apparatus might not be applicable.

MAGAZINE OILING FOR SPRING SHACKLES

THE method of spring-bolt lubrication, as applied to the 1½-ton Service truck model, is illustrated in accompanying cuts. A reservoir is cast into the spring shackle or bracket as a container for the lubricant and holds oil sufficient for a month of ordinary usage. Oil finds its way from the reservoir to the spring bolts through a system of holes drilled in the spring shackles and bolts. These holes are sufficiently large to avoid the possibility of clogging and are filled with felt packing to resist and regulate the flow of oil.

The spring bolts use oil only when the truck is in motion. To prevent surplus oil being delivered to the bolts when the truck is idle, the oil holes do not open directly into the lubricant in the reservoir, but come out at a point above the oil level. The holes, therefore, depend upon their supply from the splashing of the lubricant while the truck is in motion. The oil feed is also restricted by the felt packing to a flow just sufficient for the needs of the spring bolts. The reservoirs are filled through openings covered by caps that are held securely to their seats by springs. The reservoirs can be conveniently filled at the same time the engine crankcase is being given attention.

To prevent misalignment of the spring leaves which take the driving and braking torque reaction in trucks using the Hotchkiss drive, they are made cup-shape at the center bolt in this truck, as illustrated, so that when the spring is assembled all the leaves are fitted into one another, making it impossible for one leaf to slip over the other. A plate on the top leaf is dovetailed into the spring and held in perfect alignment with the spring seat on the axle by the spring clip pad, which in turn is tied to the spring seat by risers straddling the spring at each side and registering in slots provided in the clip pads.



Two new ideas for increasing life of motor truck mechanism. Magazine oiling at top insures constant lubrication of chassis parts. A secure method of spring retention shown below the oiling scheme

For portable or small size storage batteries, such as used on automobiles, a charging rate of one ampere per kilogram of lead in the plates is recommended. Too much surcharging is not approved. A quarter of an hour or twenty minutes gassing is given as a proper limit. A discharge rate of one and a half amperes per kilogram is prescribed as a maximum. The voltage should not go below one and eight-tenths volts to the cell. Desulphation may, if the sulphating is not too bad, be effected by filling the battery with weak sulphuric acid (3° Beaumé), after removing the regular fluid, and charging it at half the regular rate. When bubbles appear the charging is stopped and the battery is allowed to stand an hour. Then it is again charged until bubbles appear. It may be regarded as desulphated when, on starting to charge, bubbles are immediately given off. When this point is reached the weak acid is removed and replaced with 24° to 26° Beaumé acid. If the battery is to be stored, it should be charged, emptied and filled with distilled water and stored in a dry place.

FURNITURE FOR EXPORT TO TROPICS

FURNITURE, as well as other wood products used in the tropics, is subjected to the attack of insects known as termites. This attack is excessive in South America in the coastal regions north of Rio de Janeiro, and is so certain and so severe that, in the opinion of the Forest Products Laboratory, it is useless even to think of exporting wooden furniture to those regions unless the wood used is naturally resistant to termites or is treated with a poison which will prevent the attack of these insects. There are a number of species growing in Brazil and other tropical regions which are naturally immune to termite attack and which are used in those countries almost exclusively for the manufacture of furniture. None of the cabinet woods which grow in this country, however, possess such immunity.

Of course, in order to compete with the furniture now used in these regions, the United States product must be equally durable. One way of making it so would be to import cabinet wood from the region in question, make it up into furniture here and return it. A similar practice appears to have been very successful among European furniture manufacturers before the war, when much of the furniture sold in Brazil is said to have been manufactured in Europe from Brazilian woods. Another possibility that may be considered is the use of some of the cheaper domestic furniture woods for backs and cores, after thorough impregnation with a poison such as mercuric chloride, and the use of Brazilian termite-proof woods in the form of veneer for facing.

SIX-WHEELED TRUCK

CLAIM is made that actual demonstration and close tabulation of results appear to indicate clearly that the "six-wheel" or tandem rear axle construction with pneumatic tires on all wheels has steadier riding qualities, better traction, is less wearing of road surfaces, has lighter axles, smaller and lower cost tires and greater braking capacity, and the vehicle has greater operating radius.

This form of truck has six wheels, four of which are grouped under the rear end of a chassis in much the same form of assembly as the truck of the steam railroad coach. The development of this machine was due to the strong conviction of P. W. Litchfield, factory manager for the Goodyear Company, which was expressed at a recent joint meeting of the members of the Detroit and Cleveland sections of the S. A. E. held at Akron, that the heavy tonnage truck would be some

(*Continued on page* 284)

SIX-WHEELED TRUCK

(*Continued from page* 283)

form having more than four wheels. This is an evolution that may be comparable to the railroad car construction practise of grouping pairs of axles in frames known as trucks and mounting one of these trucks at each end of a car. There was no endeavor made to perfect such a truck design, but careful study was made of the practicality of pneumatic tires for vehicles built to haul heavy freights.

Special interest attaches to tire weight and cost, which are probably the factors that most deeply concern truck owners, and instead of using 48 by 12-inch pneumatic shoes, weighing about 398 pounds each, that are designed for five-ton trucks, with the tandem axle construction four 40 by eight-inch pneumatic tires, each weighing 119 pounds, are used. The four tires weigh 476 pounds against 796 pounds for the "giants," and as they are each 279 pounds lighter they can be handled far more easily, a matter of no small importance when changes are necessary, especially if the work must be done outside of a garage or service station. Not only this, the set of four tires will cost approximately a third less than the two larger tires. And as the same tire is used on all wheels the number of spares is reduced to that which will insure continuous service. This form of truck is still in the development stage, but offers interesting possibilities for future improvement providing it proves out in extended service.

ELECTRIC REDUCTION FURNACES

ELECTRIC furnaces used for heating and fusion of metals are economical more especially in those cases where what the French call white coal or water power is available. White coal is properly, or in the strict metaphorical sense, the streams from snow-clad mountains and from glaciers, or rather the source of such streams, the ice and snow on the mountains. When ore is reduced in a reduction furnace, such as a blast furnace, the coal performs two functions; it supplies the requisite heat and also is the reducing agent which takes up the oxygen of the ore so as to produce metal therefrom. But in the electric reduction furnace a new factor appears; the heat for fusion and for inducing the chemical reaction of reduction is produced by the electric current actuated by the requisite voltage. No coal would be required except for the fact that there is combined oxygen in the ore to be got rid of. Therefore a certain amount of coal is charged into the electric reduction furnace simply to supply the reducing agent. In an electric melting furnace no fuel is needed, the electric energy does everything, for it is simple heating which is required. But if ore, such as iron ore, is to be reduced in an electric furnace, carbon in the form of coal or preferably of charcoal is to be added, otherwise there will be no reduction of the oxide. There is a distinction to be drawn in the two classes of electric furnace. In the melting furnace is it possible to melt the metal without any foreign substance coming in contact with it; this is done in the induction type; an alternating current induces a current through the metal so as to bring it to any required temperature. In the case of the reduction furnace a reducing agent is necessary; this is always coal or charcoal, so that in the reduction of metals there is always some liability of contamination from the impurities of the coal or charcoal, although the latter is practically perfectly pure and will not contaminate the metal perceptibly. The induction furnace is not in extensive use. Its shape, as regards the hearth or crucible, is inconvenient. Arc furnaces are the usual type in the metal industries, and in them the electrodes may be the source of introduction of impurities.

It is the practice to distinguish between arc and conduction or incandescent furnaces. But the fact is sometimes overlooked that what is presumably an arc furnace may have the current of the arc conducted a part of the distance between the electrodes by the charge. In this case, and it is a usual one, the furnace may be looked upon as a combined arc and incandescent furnace. Especially is this the case where one set of electrodes enter the furnace through the bottom, so that the arc really has the upper layer of the charge as one electrode, and the current all goes through the body of the charge, heating it by direct incandescence, to which, however, is superadded the heat of the arc. It is fair to consider the arc the principal source of heat, although the fact, that the charge is eventually so hot, acts to increase its resistance and give it greater incandescing power.

A recent report on iron ore electric smelting in British Columbia has been issued. To produce a long ton of pig iron from one-third to one-half a horsepower year is required, so that a furnace producing fifty tons a day would require 8,000 to 9,000 electric horsepower. It was figured that by getting the cost of electric power down to ten dollars per horsepower year, electric smelting would be profitable. An item of expense cited is the electrodes, which alone, according to Swedish experience, cost about fifty cents a ton of pig iron produced.

Window Glass Manufacture

IT is remarkable how little the average person knows about the manufacture of common things in everyday use, and the value of these objects is only realized when we are deprived of their use for any reason. The value of window glass is known to us all, and it is a recognized necessity of our modern life, but how few of us have any conception of the processes involved in its manufacture. It is not generally known that the formation of the thin sheets of glass called for by the glazier follows the rather roundabout formula of blowing the glass into cylinders, to be later slit and flattened out into sheets, but this is the fact. The process outlined has been described in the *Scientific American*, and should be of interest to many of our readers who like to know how things are made.

Lumps of the raw glass are attached in furnaces to the ends of long tubes, and then heated to a sufficient temperature to permit of blowing. The entire blowing cannot be performed in a single operation, both because it is still done by human wind-power, of which no man has enough to blow a complete cylinder of the necessary size, and because the glass will not hold the blowing temperature long enough. In practice this tendency of the glass to cool is actually accelerated, in the first stage of the operation, by water sprays. In this stage the lump of glass adhering to the end of the tube is blown into a more or less indefinite shape, of which little more can be said than that it is roughly globular and quite small. It then goes back to the furnace for re-heating, and after the next bout with a blower it has become considerably enlarged, and assumed the general shape of a pear. The blower during the formation of this big bubble is relieved of the necessity for supporting the entire weight of glass and tube; a wooden form of the appropriate hollow shape is provided for him to rotate the glass in. The third stage of blowing brings the glass into the form of a long cylinder of very even section; so long, in fact, that pits have to be provided for the accommodation of the glass. The blower stands on the edge of these depressions, and holds the long narrow bubble down in them while he works at it.

The ends of the cylinder thus formed, of course, are closed; the blower and his assistant carry the cylinder down a sloping platform and place it in position on a bench, where it is held by wooden wedges. The two ends are removed, and then a rim of molten glass is smeared around the line of cleavage at each end to prevent splitting. This is easily effected by taking a lump of semi-molten glass on the end of a small rod and using the latter as a brush, drawing it about the circumference of the cylinder-end.

With both ends thus opened and made secure against damage, the cylinders are placed, usually three in a row, on a bench. Here they are cut longitudinally by a diamond cutter, a single slit being made in each cylinder from end to end—not two slits. The slit is held open by the insertion of one or two small wedges and the glass now is ready to go to the heating oven for flattening.

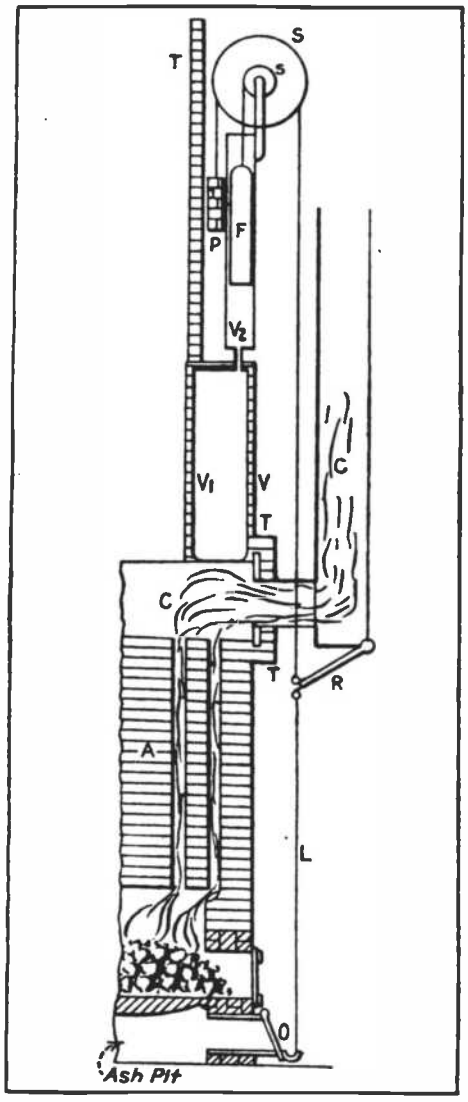
It is conveyed into this oven mechanically, and deposited on an iron table with a stone top, which is moved back and forth inside the oven by means of a long rod, protruding through a hole in the oven wall. The "ironer" stands at the door of the oven, and after pushing the glass off the loading frame and on to the table, he works at it with a tool consisting of a long handle with a block of water-soaked wood at the business end. The assistant at the table-controlling rod moves the table back and forth at the ironer's command until the glass has been successfully reduced to a flat sheet.

SEAPLANES RESIST WEATHER

AN indication of the worthiness of seaplanes—and, likewise, a demonstration of the practicality of such machines for commercial use—may be obtained from the experience of the naval air detachment of the Atlantic fleet in the winter maneuvers at the southern base. The detachment returned to northern waters with the fleet in April, the six F-5-L seaplanes, the main battle machines of the detachment, having been in continuous service for six months. Although showing hard service, the planes were still in good condition. The machines left the Naval Aircraft Factory in October, 1919, and, until their return to the North, had not had hangar or flying station service. They were cared for on the water or on the beach and were exposed to sun and rain in a tropical climate without protection part of the time during the rainy season. But despite this, no hull failures were experienced and wings were rebuilt and recovered without removal. Despite the fact that the hulls were barnacle covered and the soakage in hulls and wings totaled about 1,000 lb. per unit, the performance and air-worthiness were excellent.

HEAT REGULATOR FOR HOT-WATER HEATING FURNACES

THE simple regulator shown in the cut is given in a French contemporary as of home construction. In the cut A is hot-water heater boiler and C, C are the smoke-flue and chimney. The cross-hatched parts, T, T, indicate the hot-water conduits. The vessel, V, surrounded by the hot water, has within it a second vessel of a little less diameter, V_1, and this is surmounted by a



Heat regulator for hot water heating furnaces

still smaller vessel, V_2, in communcation with it by the pipe as shown. F is a float with suspension cord passing over and wound on a pulley or drum, s, and on the axle of this drum is a larger pulley, S, over which passes a cord with a counterpoise, P, at one end while its other lead actuates the chimney damper, R, and the ashpan damper, O. The vessels, V_1 and V_2, are filled with water to a proper level. Changes of temperature affecting the level of the water in these vessels, as it expands and contracts, open and close the dampers. This regulates the draft, reducing it as the furnace gets hotter and increasing it as the heat diminishes.

POTATO RHEOSTAT

A DECIDED oddity in the way of a rheostat is a potato. By thrusting two bars of copper or iron into a potato an adjustable resistance is at hand. By forcing the bars into the tuber, so as to bring their ends nearer together, the resistance of the simple rheostat will be decreased and vice versa. Heavy wires will do excellently for the rods, and the wires of the circuit can be twisted around their exposed ends. A heavy current will operate to dry the potato, it might even go so far as to cook it, so the resistance will be subject to an inevitable increase. It is quite possible that this simple suggestion might be of value. A horticulturist could undoubtedly suggest other products equally available for electric resistances.

ELECTRIC WATER BOILERS

Much interest is being taken in Switzerland in the line of electric heating on the large scale. Boilers are heated by resistance coils, which, in the case of direct current, must be kept out of contact with the water of the boiler by a quartz tube or otherwise, to prevent the production of of hydrogen gas, which might bring about an explosion. If alternating current is used, the liability of evolution of electrolytic gas disappears. So far no explosion has been chronicled and an efficiency of 90% in the generation of the steam has been obtained. This, of course, says nothing about the efficiency at the generating end of the electric system, but, as water power is used for this, the at that point efficiency is not a matter of great concern. In one system a coil of pipe filled with oil is surrounded by the water of the boiler and the resistance coils are immersed in the oil in the lower parts of the tube. It is not considered safe to exceed a temperature in the oil of 320° C. (608° F.). One arrangement is cited in which iron resistances are imbedded in a concrete block, their heat being transferred by means of oil pipes to the water in the boiler. 77% efficiency was claimed for this arrangement. The bakers of Switzerland are said to represent an annual consumption of over 350,000 tons of coal per annum and an effort is made to have them bake by electric heat.

Anti-rust oil, called slushing oil, is used extensively to preserve iron and steel from rusting. It has been found that there is a difference in oils as regards their usefulness in this regard, some adhering better than others. Some leave the surface in spots or areas. It is suggested that a test for adherence should be applied, the oil being applied to polished metal plates and being kept under observation for several days at a range of 60° to 95° F. to see if it adheres.

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