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METAL VS. WOOD IN AIRPLANES

WHEN John B. Moisant built his all metal monoplane at Mineola, Long Island, over a decade ago, he little dreamed that he was proposing a method of aircraft construction that was destined to receive serious consideration and practical application in a World War, that even at that time was being thought of by the nation that has made the greatest progress in metal airplane construction. There is no doubt that the commercial airplane of the future will be made largely of metal, just as the ocean liners and modern steam locomotives, passenger and freight cars are, not forgetting the automobile and motor truck.

THE all metal internally trussed monoplane of German construction now being demonstrated in this country, which has made commendable flights, has given the engineer and aviation enthusiast a glimpse of what is possible in real commercial aviation. The performance of airplanes operating on this principle of construction enables one to entirely revise former operating costs, and economical aerial transportation becomes more feasible. The new streamlined all metal monoplanes are just as far ahead of the externally braced wood and fabric biplanes as the automobile is superior to the prairie schooner as a method of transportation.

METAL has many advantages over wood as a structural material in various classes of work. Metal does not swell due to moisture or contract when moisture dries out, as wood does. The new Duralumin or other aluminum-magnesium alloys combine great strength and light weight. Metal is fireproof, wood is not. While metal parts can be fabricated easily, that material cannot be worked rapidly and economically without expensive machinery. When large outputs are involved, metal airplanes will be built cheaper than wood and fabric ones. Steel will be used for many parts now made of wood, and at less cost.

WOOD, however, is a cheap, strong, and easily obtainable structural material that is ideal for experimental and development work, because it is so easily worked with simple tools. No expensive dies or special machinery are required to work it, and wood and fabric as well, can be treated with chemicals so they are practically fireproof. When types and designs change rapidly, wood is a good material for airplane framing. When aeroplanes can be produced in quantities as are motor cars, then metal machines will be justified on the cost basis alone.

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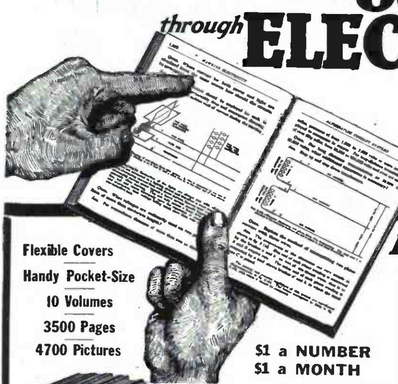

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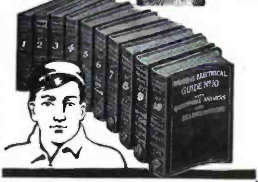

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What is New in Aviation

A Review of Foreign Post-War Airplane Designs Showing the Great Strides Made Toward the Eventual Development of Commercial Aeronautics Abroad

By Victor W. Page, M. S. A. E.

PART I

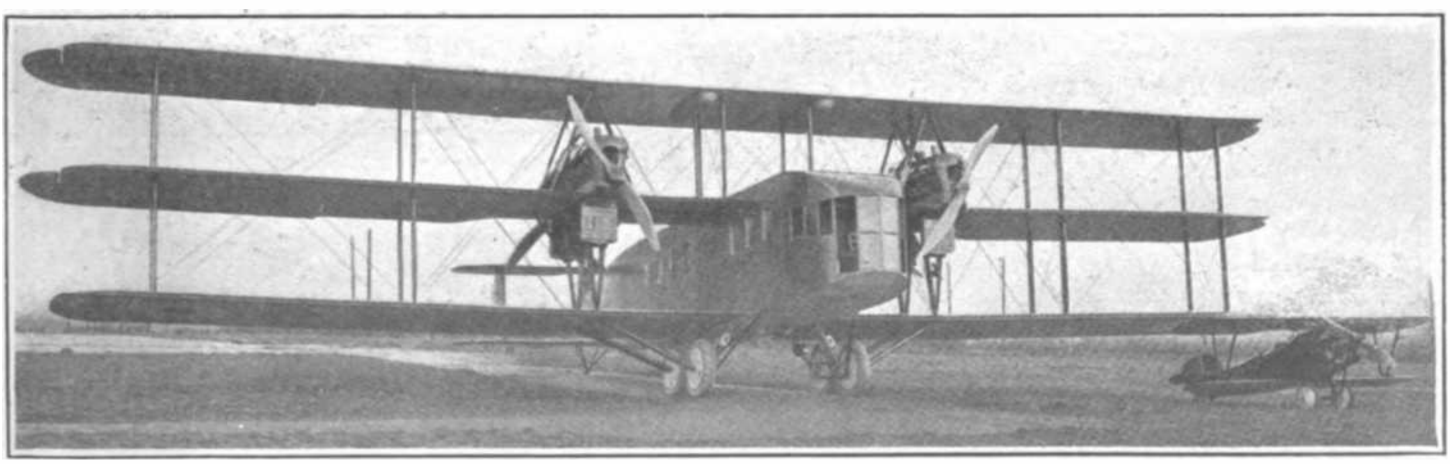
THE airplane development that has been noted during the past year has been mainly of a commercial character, and while no radical changes have been noted in the design there has been a greater realization of underlying aerodynamical principles, so that practically all of the airplanes of modern development show that rules of practice as relates to design are fairly well appreciated by engineers. The airplanes of the present time are good examples of the best engineering practice, and designers are now concerned with problems incidental to making airplanes more efficient. As a result, many excellent machines designed especially for commercial work have been produced by airplane constructors all over the world.

At a recent aero show held in England, only three out of about thirty machines exhibited were military types. Of the number remaining, two were small, single seaters of low power intended for sporting purposes, and one a racing machine pure and simple. Of the remaining craft, over half of the number were provided with enclosed cabin accommodations for the passengers. This indicates that there is a decided tendency towards providing comfort for passengers who may desire to travel by air. It is now an accepted principle of design, that cabins must be provided on commercial passenger carrying machines, but there is considerable difference of opinion as to how these cabins should be arranged. It is not a difficult proposition to design a very efficient cabin on machines having two or more motors mounted between the planes. In such machines practically the entire front and central portions of the fuselage are available for passenger accommodation.

In most of the multi-engine machines, it is possible to extend the passenger accommodations from a point forward of the leading edge of the wing to a point some distance aft of the trailing edge. The quarters for the pilot are usually in the nose of the fuselage. It is not such a simple matter to design a cabin for passenger carrying on machines using but one engine. In one system of construction the pilot can be placed ahead of the passengers, in others he must be placed at the rear. Considering the matter from the pilot's point of view, the forward position is undoubtedly preferred on account of providing superior opportunities for observation.

In the matter of power plants, practically all of the machines that are being offered at the present time for commercial or sporting purposes, use the fixed cylinder engines. While the rotary engine has many good features, it is apparent that it is not as economical in fuel and oil consumption or as enduring as the more conventional types are, so that one need not expect to see the rotary engines widely adopted in civil aviation.

One of the points on which considerable work is being done is in reducing the risks of fire by better power plant installation and by taking precautions, such as using fire-proof tanks and fire-proof bulk heads in fuselages when the engine is installed in that member. The advantage of the fire-proof tank is that it safeguards the possibility of fire following a crash and



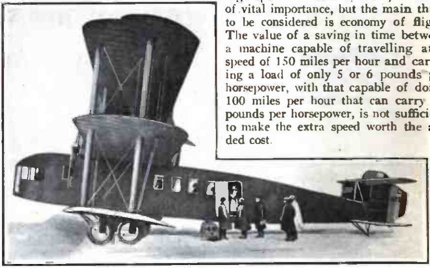
The Bristol Triplane Pullman express compared to a small single seater biplane to show its massive size. Its proportions are so good that this comparison is necessary to bring out its large size which would not be evident otherwise also reduces the liability of the machine catching fire while in the air. Care should be taken with carburetor placing so that any gasoline that may flow out of it will drip clear of the machine and not collect around the power plant. Then again, special pains should be taken in the installation of electric wiring and placing of ignition units. Gauze screens to prevent back-firing of the engine through the carburetor are also installed in the induction manifold.

The newer types of machines show that metal is being more seriously considered as structural material for airplanes as they are commercialized. The work done on the development of all-metal airplanes by the Germans has certainly influenced the designers of other countries to use metal in the construction of various parts of their machines. While it has not been impossible in the past to build machines entirely of metal, the designers have found that in the period of constantly changing designs that the usual wood and fabric structure was better. Another thing that is noted in the newer machines is the attention being paid to the elimination of parasitic resistance by the elimination of struts and wiring bracing and the use of internal braces in fuselages and wing structures.

Another feature that must become more popular as airplanes are commercialized, is the building of airplanes of unit parts as much as possible, so that in event of damage to one part, it will not be necessary to remove or scrap the adjoining pieces. For example, on a one-piece fuselage such as a monocoque construction, any real damage to any part of the fuselage usually calls for a complete new one. If a fuselage was built in two or more sections, as is noted on some of the newer machines, then only that section that is damaged need be replaced. The fuselage may be made in three pieces, the front one being comprised of the engine housing, the middle one, the passenger cabin and the aft portion, the tail end supporting the empennage.

Another thing that can be changed to advantage, is the method of installing the engines, so that many parts must be removed before the engine can be taken out of the fuselage. It would seem that a desirable change in design would be to have the engine compartment so built that it could be released from the fuselage as a unit when repairs were necessary and a new power unit installed in its place so that the machine would not be laid up for extended periods. Engine trouble will undoubtedly be one of the main reasons for putting airplanes out of commission, while if the easily renewable power units were available, any firm using a number of airplanes for commercial work could make the repairs needed at their leisure and install substitute spare power plants to keep the planes in commission.

In studying the specifications of the new machines, we find that the loading per horsepower is gradually growing and this of course will make for more economical airplane operation. In machines intended for speed or war use, a loading of ten pounds per horsepower was considered as an extreme that should not be exceeded. This of course meant that speed and climbing ability increased very much, but that the load carrying capabilities were reduced. In very few instances in commercial work, is such performance, i.e., high speed and rate of climb, a matter of vital importance, but the main thing to be considered is economy of flight. The value of a saving in time between a machine capable of travelling at a speed of 150 miles per hour and carrying a load of only 5 or 6 pounds per horsepower, with that capable of doing 100 miles per hour that can carry 20 pounds per horsepower, is not sufficient to make the extra speed worth the added cost.



Side view of the Bristol Triplane Pullman express showing door by which passengers enter cabin

It would seem that commercial airplanes that are capable of a speed of 100 miles per hour would be superior to any existing means of commercial transportation, such as locomotives, steamships, or automobiles. The locomotive is the only transportation agent that is capable of carrying passengers continuously at speeds anywhere approaching the airplane and in most cases its maximum average speed is but little more than half the velocity that can be maintained by the airplane.

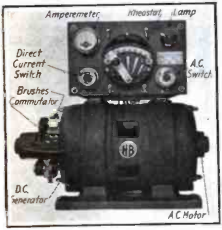
Commercial aviation can not be ex-

(Continued on page 504)

View of the JL6 all metal internally trussed monoplane, an aircraft of German design and development that is recognized as the most efficient and economically operated airplane type yet built for commercial use

A BATTERY CHARGING OUTFIT

ALL garage men are interested in battery charging as it is a profitable source of income if a charging appliance can be obtained that is economical to operate in regards to both current consumption and upkeep expense. There have been numerous types of rectifiers made for garage use, all of which have advantages. Many garages are successfully using the motor generator type of charging set and this has been proven to be an economical means of charging batteries. It is stated by makers, that devices of this kind do not need any manipulation or special bulbs as some types of rectifiers do and also that they will charge for extended periods without bulb renewals as are sometimes needed in rectifiers of the bulb type.



Compact battery charging outfit

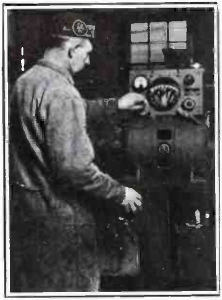
The outfit shown in the accompanying illustration consists of an alternating current motor which drives a direct current generator. The two electrical machines are mounted together on a substantial base and in a casing which insures that both machines will be kept in absolute alignment. The switchboard rheostat is carried above the motor generator unit and carries various appliances, clearly illustrated, these consisting of D.C. and A.C. switches and regulating rheostat, an ampere meter and test lamp.

There are four binding posts or terminals at the switchboard, alternating the current going to the two upper binding posts, this being taken from the lighting or power lines in the garage, while to let forth direct current which is generated by the dynamo, is taken from the two lower binding posts and directed to the charging line. The direct current armature and the A.C. motor rotor are supported at each end by ball bearings, which is a refinement of design of considerable value on equipment that must be continuously operated.

Another illustration shows the simple means of regulating the current supplied to batteries by the rheostat, while the view of the battery room shows a modified form of this battery charging outfit that can be used in connection with a number of rheostats, whenever a large number of batteries are being charged.

The small outfit has a capacity for charging from one to ten six or twelve-volt batteries. The larger outfit, which is used in connection with the four rheostats and switchboards, will charge 32 batteries. It will develop at the generator end 60 to 70 volts and 30 amperes. The dynamo is driven by a five horsepower A.C. motor.

It will be evident that by the use of one of these sets that absolutely direct current is generated, which battery makers claim is more suited for battery charging purposes. The function of a rectifier is to divide the alternating current so that the battery is really charged in a series of impulses or beats, so that the batteries will last longer when charged by apparatus supplying a continuous direct current, than those in which the alternating current is rectified and which deliver a pulsating direct current to the battery charging lines.



Battery charging current is easily regulated

Battery room showing installation of rotary-converter for battery charging purposes

With a device of the form illustrated, it is claimed that it is possible to charge batteries at a cost of from four to twelve cents each for current. The garage men will readily appreciate that this offers a source of profit inasmuch as the batteries when charged do not require continuous supervision but need only periodical inspection. One of the many features in operating a successful battery charging set is to use dependable charging equipment and the only way one can obtain the best charging results is by careful investigation of the different appliances on the market. Many sets similar to those illustrated have been sold and are now in daily use and are giving good results.

What is claimed as a long distance speed record for airplanes has recently been reported from Italy, where a biplane with a 750 h. p. twelve cylinder Fiat engine carrying two passengers in addition to the pilot, went from Turin to Rome a distance of 388 miles in two hours and 15 minutes, an average speed of over 172 m. p. h. The same machine a few days previously, carrying four passengers and a pilot, was credited with a speed of 161.5 m. p. h. The latter flight was made in an aerodome so that the effect of wind was eliminated.

A 300-Watt Arc Light Transformer

By H. H. Parker

Drawings by the Author

THE small magnetic leakage transformer described below was designed to furnish a stepped down voltage of 30 or 60 for experimental work with an arc struck between two half-inch standard carbons, which would cause no undue disturbance on the 110 volt 60 cycle house circuit to which the transformer primary was connected. There will be sufficient current at 30 volts, to operate a small arc and of course a more intense one at 60; the contacting of the carbons to strike the arc causes only a light flicker on a forty watt lamp on the same branch—very much less disturbance than the running of a fractional horse-power induction motor. The windings allow for about five amperes at 60 volts and five or ten at 30, depending upon whether one or two coils are used, in the secondary; this is sufficient for ordinary purposes though the transformer is not of sufficient capacity for an electric furnace or other heavy work. An interesting experiment is to strip the wood off an ordinary pencil, break the lead in half and attach the two pieces to the 30 volt terminals, using a single secondary coil. A small but energetic arc will be struck which will throw off considerable light. Here is a suggestion for the model making enthusiast: a miniature searchlight operated by small pencil carbons should prove most realistic and give an intense light.

The transformer as described is designed for either 110 or 220 volts by connecting the two primary coils in parallel or series; the secondary voltages will be the same in each case. The standard frequency of 60 cycles is provided for; other frequencies require a change in the cross section of the core, as explained later. The secondary winding is in two coils also; they may be connected in series or parallel or used separately.

To start with, we have the well-known transformer equation:

$$T = \frac{E \times 1000000000}{4.44 \times f \times B \times A}$$

Where "T" is the number of primary turns,
"f" the frequency,
"B" the magnetic flux through the core,
"A" the area of core cross-section.

It is assumed that the core will be built of "stove" iron, the most easily obtained material; for such iron, "B" is usually given a value of 40,000. If transformer iron or silicon steel can be obtained, a smaller core may be used, for "B" will then be 60,000 or more. Our core will be given an area of two square inches, making it 1¼ inches wide and 1⅝ inches thick. With "f" at 60 and "B" 40,000 the above equation gives 516 as the number of turns required; we will use 500.

If other material is used for the core, as mentioned above, or a different frequency, the following core areas are suggested:

With "B" at 60,000 and "f" still at 60, "A" will be 1.37 sq. in.; a core one inch wide and 1⅜ inches thick would do. The number of turns would be the same.

At a frequency of 25 cycles, "B" 40,000, "T" 500, "A" would be 4.95 sq. in., requiring a core 2 by 2½ inches.

At 25 cycles with "B" 60,000, "A" would then be 3.3 sq. in. and the core would be 1½ by 2¼ sq. ins.

For a different frequency or value of "B," substitute the values in the above equation, with "T" at 500.

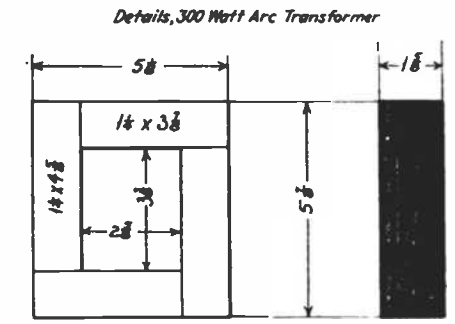


Fig. 1. 60—Core, "Stove" Iron, 0.025 or less. If transformer iron or silicon steel used, cross section may be reduced. See Text.

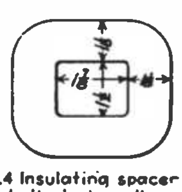


Fig. 4 Insulating spacer fibre or shellacked cardboard. Trim edges after in place and coils wound

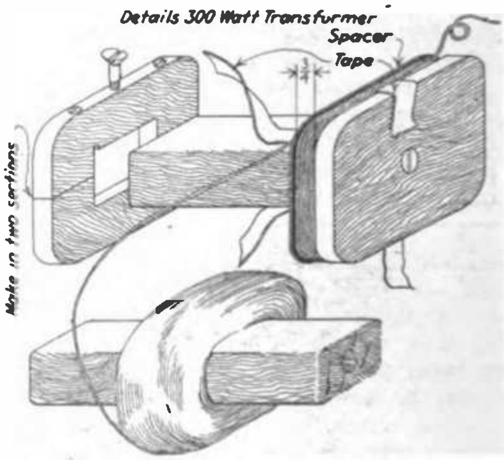


Fig. 3 One section (half coil) wound on mandrel, remainder of wire rewound on another mandrel ready to start second section in opposite direction, when flange is screwed in place

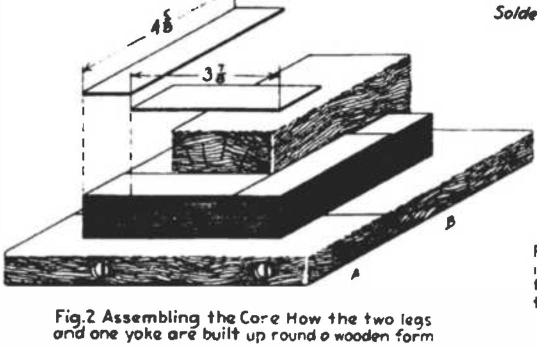


Fig. 2 Assembling the Core How the two legs and one yoke are built up round a wooden form

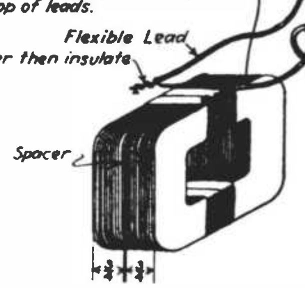


Fig 6 One coil complete, temporary tape bindings in place and off of mandrel; ready for final tape wrapping. How leads are soldered so as to leave coil in same direction.

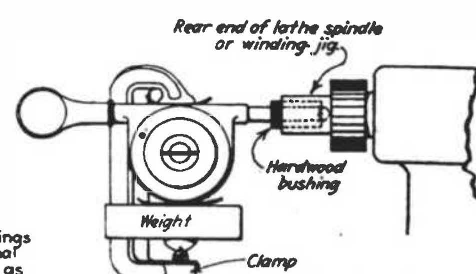


Fig. 5 How Speed counter may be attached to lathe or winding jig to count the number of turns in coil winding.

Construction of Core

Taking up the core, primary and secondary windings in order: for the core, get some black stove iron, as thin as possible, though it generally runs about 0.025 inch in thickness. If obtainable, regulate transformer iron or silicon steel will be better and a smaller core may be used as mentioned above. Have this iron cut up, if possible, into strips an inch and a quarter wide; the amount required depends upon the thickness of the iron. Then cut up the strips in two lengths for the core and yoke pieces, to the dimensions given in Fig. 1; pile them up, clamp in a vise and file the ends even and square, then separate and give one side of each a thin coat of shellac. When dry assemble the two cores and one yoke around the wooden form shown in Fig. 2, being careful to stagger the joints. The other yoke must be left off until the windings are in place, when the pieces are pushed into place separately. The pile should be 1⅝ inches high when tightly compressed; clamp the two legs to the board "B" and remove the board "A." This frees the yoke, which may be clamped or held in a vise while the legs are freed from board "B." Round the corners of the legs very slightly, then wrap tightly with black friction tape, always keeping a clamp just above the tape as it is wound on. Wind on a single layer of cambric "armature" tape on each leg, release the yoke and clamping only the corners, wrap this also with friction tape. Give the whole several coats of shellac, especially the taped legs where the windings will be located.

How to Make the Primary Coils

Now for the primary: we will use two coils, connected in parallel for 110 and in series for 220 volts; two No. 17 dcc wires in parallel will carry about three amperes and 1000 turns of this will be used, in two coils of 500 turns and each coil wound in two sections of 250 turns each. Winding in this manner subdivides the E. M. F. in the coils and as both ends are on the outside, the bothersome inside end is eliminated. Make a wooden winding mandrel as shown in Fig. 3, the core being 1½ by 1⅞ inches to allow room for the tape wrapping on the coils. One flange of the jig should be adjustable; for winding the first section it should be placed ¾ inch from the end flange; after the first section is wound it is moved along to allow for winding the second section of the same width.

Prepare some sheets like those in Fig. 4, of thin fibre shellacked cardboard or other insulating material. Thread one of these spacers on the No. 17 wire, then the loose jig flange and then pull through and measure off about 224 feet of the wire, enough for 250 turns approximately. Without cutting the wire slip the spacer and flange over the mandrel, with the wire just measured off OUTSIDE; then wind it temporarily around the OUTER end of the mandrel, screw the flange in place ¾ inch from the other end, lay some friction tape in the groove on each side to hold the sections temporarily when wound and wind on 250 turns; the wire is fed from the spool while the first portion measured off stays on the mandrel and revolves with it. This winding may be performed upon a lathe or a made-up winding jig or even simply by hand. As it is bothersome to keep track of the exact number of turns, if a revolution counter is at hand it may be attached to the rear end of the lathe spindle as shown in Fig. 5 or to the shaft of the winding jig. A weight clamped to the body keeps it from turning with its spindle.

One section being wound, stay the loose end and move the flange along for its second position; the first section will usually remain in place without taping. Wind off the outer portion of the wire on to another mandrel or spool; it will be necessary to pull it through the flange or if the latter is made in two parts and screwed together this trouble will be obviated. The wire being rewound, the second section of the coil is ready for winding, but be sure to wind this in the OPPOSITE DIRECTION from the first, otherwise the two sections will neutralize each other. Another method would be to wind the two sections, separately and opposite, then solder the inner ends together, but while this might be practicable with the No. 17 wire, the secondary wire is much heavier and might cause difficulty in making a smooth joint; the joint would also have to be specially insulated.

The two sections being wound, bind them temporarily with the friction tape and slip off the mandrel; the coil will then look like Fig. 6. Solder flexible leads to the coil and as it is convenient to have both leads leave the coil in the same direction, solder one reversed as shown. Insulate the joints and then soak the whole coil in shellac and bake in an oven. When dry and hard wrap the coil in cambric or insulating tape (Do not use black friction tape) beginning the wrapping under the leads and working away from them around the coil and back over them. Secure the tape with a few stitches and give the tape several coats of shellac. Mark the corresponding end of each coil so that they may be properly connected in series or parallel.

300 Watt Transformer

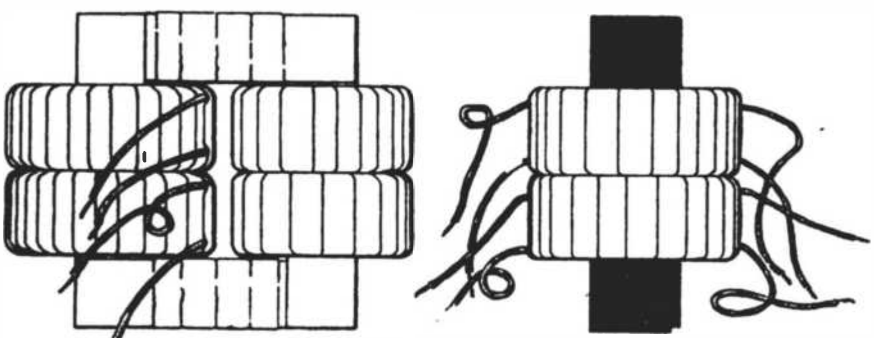


Fig. 7 Transformer Complete (Except for Connection Panel)

Winding Secondary Coils

The secondary coils are wound in the same way but they will be harder to wind as the wire, No. 12 dcc is rather stiff. Each coil will contain 136 turns in two sections, 68 turns, or about 60 feet, to the section. As the leads should always be carried to some kind of connection panel and as flexible secondary leads would have to be rather heavy, it would be best to carry out the No. 12 wire itself to the panel; the No. 17 wire, being smaller, would be in danger of being broken.

If the builder desired a different secondary voltage, the number of turns could be varied in accordance with the proportion

Primary EMF: Secondary EMF= No. turns in primary: No. turns in secondary.

After all the coils are thoroughly baked dry, they are slipped over the legs of the core; if a coil should stick, taper off the end of the wooden winding mandrel and drive it into the coil to open it slightly. The two primary coils are on one leg and the secondary on the other; this arrangement is best for the purpose the transformer is to be used for, as there will be a certain amount of magnetic leakage when the secondary terminals are shorted, which will assist in cutting down fluctuations in the house circuit. To complete the core assembly, the remaining yoke pieces are pushed into place across the top of the core, the corners clamped, the yoke taped and the clamps released for good. Fig. 7 shows the transformer complete, but no connection panel or mounting is shown.

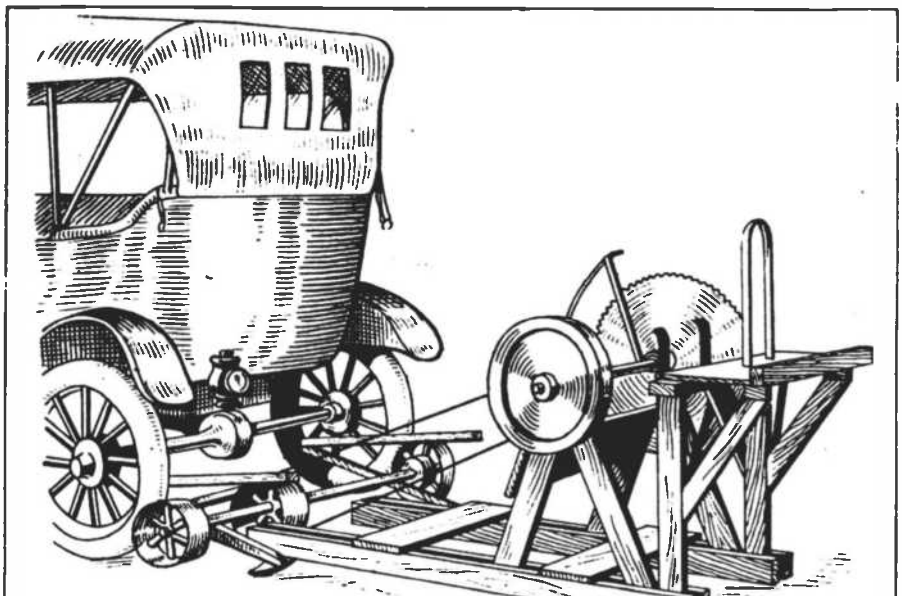
Utilizing Auto Motor Power for Driving Machinery

A NUMBER of appliances have been constructed to make use of the power of engines of Ford and other cars, for driving machinery. All may be practical, but some are better adapted to the work than others. The better types of these devices are installed at the front of the engines, having power take-off mechanism or transmitters that are firmly attached to the frame of the car. The type for transmitting power that is directly connected to the crank-shaft of the engine, by a coupling that remains permanently on the crank-shaft, has been previously described in EVERYDAY ENGINEERING MAGAZINE. In a recent issue an extemporized rigging was described by which an automobile furnished power for a factory. The accompanying illustration shows two methods that will interest our readers as they are easily carried out and while it is not an economical proposition to use an automobile as a power plant as a permanent installation yet for intermittent or emergency work, it is well to know that this can be done without injury to the car mechanism.

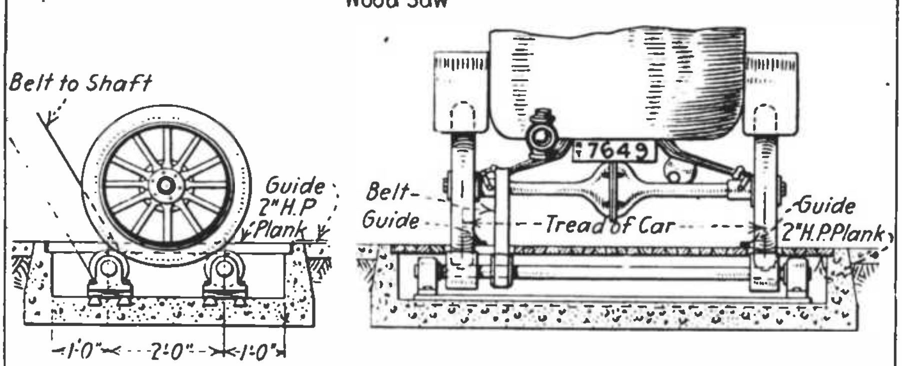
In one type of power take-off or transmitter, the power is taken from the rear wheels. To use this no changes in the car are necessary. The transmitter consists of a pair of jacks connected to a shaft having three pulleys, two being of one size and the third or center pulley a smaller size. The transmitter is placed under the rear axle and with the jacks the wheels are lifted and positioned so the tires bear against the faces of the two outer pulleys. The engine is started, the high speed clutch engaged and the rear wheels drive the pulleys and shaft. Power for driving machinery is taken from the center pulley. A governor is not used, the regular spark and throttle affording control. Because of friction, the power delivered at the rear wheels is not as large as with the type coupled to the engine. No statement is made by the manufacturers as to the power obtained for useful work, but apparently it is adequate for the purpose desired. The manufacturer claims that the power obtained will drive wood saws, concrete mixers, grinders and other machinery of a like type.

A home-made transmitter was described in a recent issue of the *Automobile Journal* and the owner claims that he operates a small shop with power from his car. When not in use on the road, the car is backed into a shed adjoining the shop, at the back end of which a concrete pit has been made. In this pit are two short lengths of shafting supported by suitable bearings, the shafting being spaced about 24 inches apart. The front shaft carries a pulley at each end to engage the faces of the wheel tires. The rear shaft carries the two pulleys for engaging the wheel tires and a pulley for running a belt to a line shaft in the shop. Slots are cut in the floor so that the car may be backed into them, the wheels engaging the pulleys of the power transmitter.

The wheels are held in place by the weight of the car and the width of the slots. The owner makes the suggestion that the car may be anchored at the sides to keep the tires from working against the slots, but if flat-faced pulleys perfectly leveled are used he claims little trouble will be experienced. Hard wood blocks placed under the pillow blocks of the bearings serve as cushions and the method of obtaining power is the same as with the device shown above it.



Showing the Power Running a Circular Wood Saw



End and Side Views of Pit and Arrangement of Pulleys and Shafting for Home Made Power Attachment Using Ford Motor for Power by Utilizing Frictional Adhesion of Tires to Pulleys

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It is said that from the days of Hannibal to the days of Waterloo, the size of an army was restricted by pestilence. Preventive medicine has made enormous strides in the last few years and armies are now subjected to the most active and efficient methods for preventing all diseases. This, on its face, has a humanitarian aspect, but the result has been to make possible the use of the enormous armies of the late war that caused the enormously greater loss of life and production of misery than in the olden times. While chemistry is thus busy saving lives, it has been calculated that in the late war over 30% of casualites among the United States troops were due to chemical gas attacks. Chemistry bids fair to be an increasing factor in offensive warfare in the future.

Camphor moth balls and tobacco have been used for preserving woolen goods and furs from moths during the summer. Neither of these have been proved to be really effective. The French wrap the article in newspapers, and it is quite a possible theory that the odor of printers' ink plays a part in the precipitation of the goods from destruction.

A GIANT GERMAN AIRSHIP

AN interesting report on German progress in aviation has been made by Col. William Hensley of the balloon and airship division of the Air Service. Col. Hensley flew to Scotland on the return trip of the R-34 through the courtesy of the British Government, and shortly thereafter departed for Germany. He reports that the Germans gave him every opportunity to see the various creations in heavier and lighter-than-air craft and afforded him an opportunity to pilot the giant passenger airship Bodensee. He was shown through the Zeppelin works at Lowenthal, where he saw the giant L-72 which was designed and constructed for the sole purpose of bombing New York. He sought out the pilot of this machine, learning that this man was the coolest, most daring and efficient of German war pilots and had successfully bombed London ten times, raked Dunkirk and caused great havoc on the Russian front early in the war.

The enormous airship is unique in many ways. To camouflage it to the minimum of visibility, the belly is painted black, its sides are splotched with cloud-effect gray, while the top is painted a medium amber color. At between 5,000 and 10,000 feet these colors fit in almost perfectly with the sky. The L-72 is 779 ft. long, has an 89-ft. beam and is 95 ft high. It is propelled by six 260 h.p. Maybach engines at a speed of 91 m.p.h. and the capacity of its fuel tanks is 11,000 gal., which gives a cruising radius of 9,500 miles. The hydrogen capacity is 2,470,000 cu. ft. and the total lifting power is 86 tons, with 50 tons of this available as dispensable lifting power. The L-72 was designed to carry 5½ tons of bombs in addition to the crew, fuel supplies and stores.—*Air Service News Letter.*

A Steam Traveling Crane

A Suggestion for the Model Maker Who Wishes to Make an Interesting Working Model of Unusual Design

By T. S. M. Stirling

WITH the coming of winter again and inclement weather, when one feels the comfort of being indoors, we all begin to look for something interesting to take up our attention. And for some readers of EVERYDAY ENGINEERING who no doubt are interested in mechanical work there is pleasant entertainment in their workshops, be it merely a few tools and a collection of odds and ends or the splendidly equipped workshops of those more fortunate, who had more cash at their disposal.

The question of what to make is often a tiresome one for some inexperienced model makers, and how to go about it and what is required in the way of material is a source of worry to the inexperienced.

A very interesting model to build and operate is a steam crane. It is not too difficult to be beyond the average amateur mechanic and requires but a few feet of track to run on, is a compact model with a variety of motions and the material necessary is very modest and requires but a small outlay.

I shall endeavor to describe this little engine and begin with a summary of the material required, which in the case of the engine described is as follows:

A piece of seamless brass tube 9 in. long, 3 in. in diameter for the boiler. Two discs of brass cut to fit the inside of the tube should be of 3/32 in. in thickness for the top and bottom. A piece of seamless brass tube 6 in. long, 1½ in. in diameter, 3/32 in. thick for the control flue. Four pieces of brass tube about 2 in. long. Standard ⅛ in. brass pipe is very good for the cross water tubes. A piece of ½ in. hardwood 10 in. long, 5 in. wide for the crane deck. About 1 sq. ft. ⅛ in. sheet brass for the main bearings of the engine. Two cylinders ½ in. bore, ¾ stroke. These can be obtained in castings and built up, or bought already finished. The question of cylinders can be best dealt with to suit the requirements of the individual. Double acting oscillating cylinders can be used with excellent results, or two slide valve cylinders. I would recommend ready made slide valve cylinders and the link motion reversing gear of the large machines can easily be left out, if so desired, and the load controlled in lowering by the hand brake. If one has a lathe in the workshop the castings of cylinders can be made up and finished with ease, the necessary data for the operation being usually furnished by the makers. An internal gear 3 in. in diameter and a pinion of the same pitch ½ in. in diameter. Two bevel gears ½ in. in diameter, 3/16 in. hole, completes the swinging motion. One gear 3 in. in diameter and pinion ½ in. in diameter for the hoisting motion. These were obtained from an old telephone magneto, the pinion being bushed to fit the crankshaft. Six other bevel gears are required for the traveling motion; these should be ½ in. in diameter, 3/16 in. hole and the same pitch. Also, there are four locomotive trailing wheels 1¼ in. in diameter on tread, but any size near that which would be suitable. Some ¼ in. steam pipe and various odds and ends to be found in the scrap box.

The base or deck was first prepared; it was cut from the piece of hardwood 10 in. x 5 in., as shown in Fig. 1. The circular portion is the position the boiler is to occupy; it was planed and sandpapered smooth and given a coat of oil.

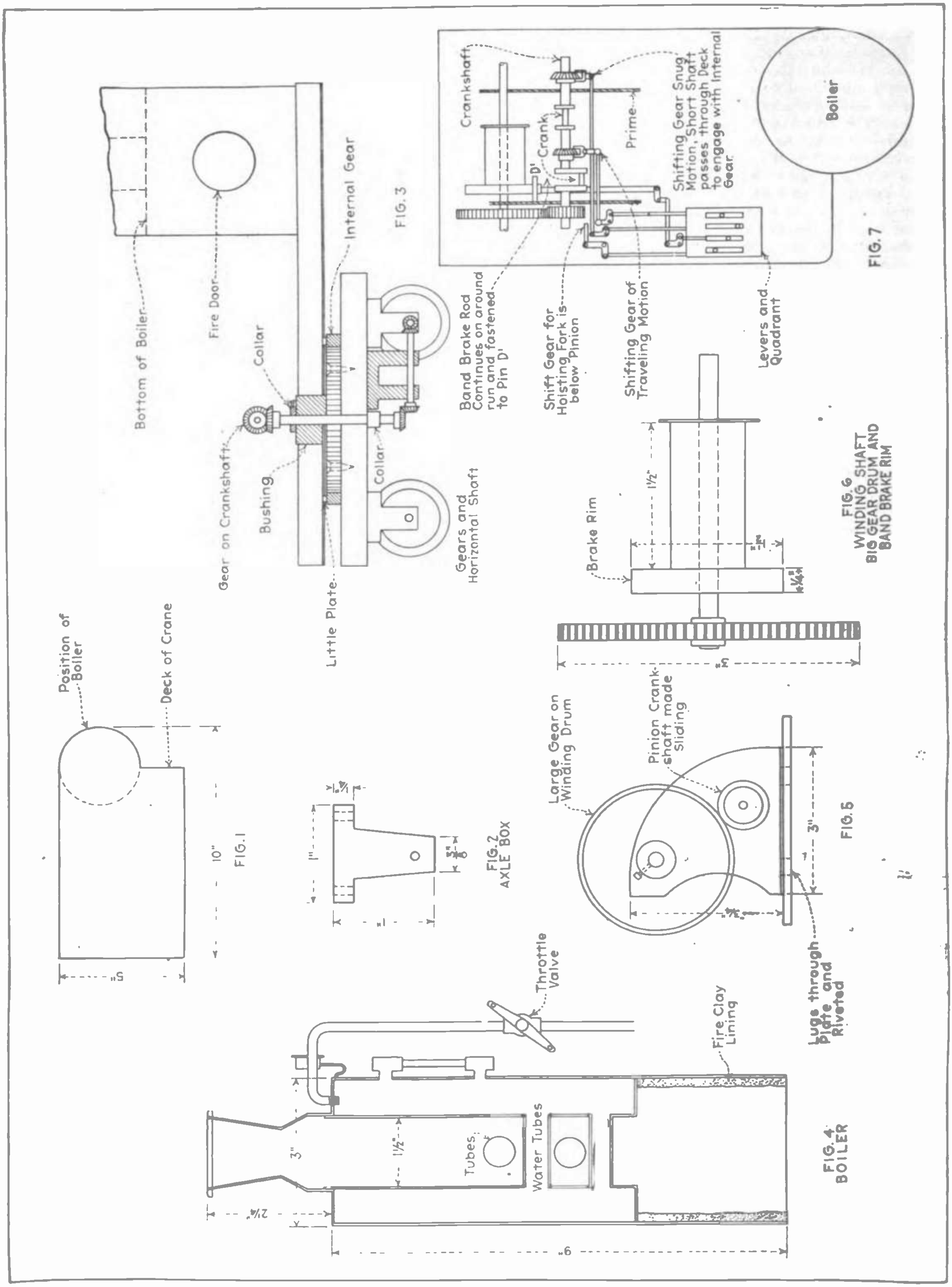
The truck was now built, the wheels were mounted on axles 3/16 in. in diameter silver steel and 4½ in. long. The wheels were already tapped for 3/16 in. axles when bought. Four axle boxes were made from scrap brass, and drilled 3/16 in. for axles and two ⅛ in. holes to take ⅛ in. bolts for fastening to under side of truck. The bolts were made from ⅛ in. brass wire and nuts were made by drilling down the center of a piece of small hexagon brass rod and cutting off ⅛ in. pieces with a hack saw, afterward filing them up on faces. The dimensions and shape of axle boxes are shown in Fig. 2.

The wooden deck can be smoothed and finished up to suit the builder; if it happens to be mahogany a coat of oil looks very well, or it can be left and given a coat of paint to match the remainder of the engine.

The truck deck was made 6 in. long and 5 in. wide. The axles were slipped in the boxes and the boxes set on the upturned truck deck. Boxes were bolted on a distance of 1½ in. from the ends of the deck and wide enough apart to allow axles to run freely. One of the ½ in. bevel gears was slipped on the rear axle and for the present left loose, having been fitted with set-screw previously.

The internal gear was now screwed to the truck with its center on the center of the deck. A center hole was drilled to take the 3/16 in. shaft which is to drive the truck in the traveling motion and form a pivot for the swinging of the crane deck. A brass bushing was fitted in the hole for the 3/16 in. shaft to pass through—just a small bushing long enough to pass through the hardwood and driven in the hole with a good tight fit. Two collars fitted with set-screws are necessary to hold the shaft in the required position.

The small horizontal drive shaft below the truck was now fitted up; a short piece of silver steel 3/16 in. in diameter made the shaft and the bevel wheels on each end were fastened with set-screws. Two small bearings were made from some scrap brass to carry the shaft. The arrangement of the gearing, truck and deck is shown in Fig. 3.


Bottom of Boiler
Fire Door
Collar
Internal Gear
FIG. 3
Gear on Crankshaft
Bushing
Collar
Little Plate
Gears and Horizontal Shaft
Crankshaft
Crank
D'
Prime
Shifting Gear Snug Motion, Short Shaft passes through Deck to engage with Internal Gear
Boiler
Band Brake Rod Continues on around run and fastened to Pin D'
Shift Gear for Hoisting Fork is below Pinion
Shifting Gear of Traveling Motion
Levers and Quadrant
FIG. 7
Position of Boiler
Deck of Crane
10"
5"
FIG. 1
FIG. 2 AXLE BOX
Brake Rim
1½"
3"
FIG. 6 WINDING SHAFT BIG GEAR DRUM AND BAND BRAKE RIM
Large Gear on Winding Drum
Pinion Crank-shaft made Sliding
Lugs through Plate and Riveted
3"
FIG. 5
Throttle Valve
Fire Clay Lining
Tubes
Water Tubes
3"
1½"
2¼"
6"
FIG. 4 BOILER

The main engine frames are made from the 1/8 in. sheet brass cut to the shape and dimensions shown in Fig. 5. The base of the frames were riveted through flat plates, as shown in Fig. 5, and they were drilled to take bolts to fasten them to the crane deck.

The shaft holes must be drilled in positions suitable to the diameter of gears used. If desired, small collars can be sweated onto the brass frames where the shafts pass through to make a larger bearing surface, and oil holes drilled. It makes a nice substantial job when done in this way. The winding drum was cast from babbitt metal, with a rim for the band brake, as shown in Fig. 6.

A built-up crankshaft is used very nicely, and it is easily made from 3/16 cut from 1/2 in. key steel made 1/2 in. in. steel for the shaft. The webs are wide and 1/4 in. thick, drilled and slipped on the shaft, and crank pins inserted. The whole thing is then well silver soldered, the pieces being afterward cut out between the webs and the little crankshaft filed up and finished with emery cloth. The dimensions are left to be made to suit the occasion and cylinders used.

The sliding gears which drive the swinging, traveling and hoisting motions are shown in Fig. 7. The keys for the gears to slide on were made by taking a piece of 3/32 in. square steel and riveting it to the shaft with three 3/64 in. pins, afterward cutting out the corresponding keyway in the gears with a small warding file.

The frames were set up on the deck, which proved a little tedious on account of getting the various gears meshing and running nicely together. Fig. 7 shows relative position of the parts. The cylinders used were set upon feet and bolted to the deck with four 1/8 in. bolts and small guide bars, and crosshead shoes were made, but these are not really necessary with so small cylinders. The throttle was an ordinary plug cock fitted with a small steel handle, which had a very good appearance. Drain cocks were fitted and operated by small levers between the cylinders. The levers and quadrant were made of brass; the arrangement of the levers and bars and gearshifts are shown in Fig. 7.

All the joints in the boiler were silver soldered, and this proved very satisfactory. The central flue was drilled in four places below the water line, and the four cross water tubes silver soldered in, as shown in Fig. 4. The holes in the top and bottom plate of the boiler were drilled around and cut out with the chisel and filed up to fit control flue. The control flue was now silver soldered to the two plates, the lower end being kept flush with the outside of the plate, and the upper end allowed to project through a little. These joints were all soldered on the water side and a liberal allowance of solder used.

The top and bottom were now silver soldered to the brass boiler barrel, previously drilling a 3/8 in. hole for safety valve in the top plate. The fire door was drilled around and cut out and the little door made from sheet brass and the firebox lined around the inside with fire clay. Three angle plates were made for fastening the boiler to the deck. The little safety valve was made from scrap with little trouble and works satisfactorily.

Two smokestacks were made from 1/32 in. plate and fits snugly over central flue, where it projects at the top. Pressure gauge, water gauge, blowdown cock, check valve and try cocks were bought articles, and they do not repay one for the trouble of making them.

In spite of the fact that the boiler design is somewhat unconventional, it steams very well, and when fired with a small kerosene vapor burner maintains 15 pounds pressure quite easily and "pops" in most practical fashion at 20 pounds pressure. It was tested to 50 pounds in a thorough hydrostatic test, and 15 pounds is ample to make the little engine run at a furious rate.

The boom was built up of oak and makes a smart looking and practical job. The arrangement of the cylinders, various shafts and gearing, gear shafts and levers can best be decided by the circumstances and the material at one's disposal. Small brass chain makes a nice looking hoisting line and fits nicely on the drum.

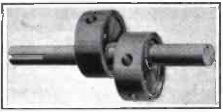
The whole machine was painted a dull gray with a few black trimmings and bright parts. There was a little hand boiler feed pump used to keep up the water, but the writer observed some good drawings of feed pumps in a recent issue of EVERYDAY ENGINEERING and in consequence did not deem it necessary to give a description of the pump used in this case.

The little crane makes an interesting model to construct, and is a most entertaining engine to watch in operation.

A NEW ROTARY STEAM ENGINE

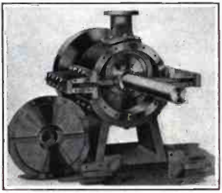
FOR many generations mechanical engineers of considerable renown have spent several days, months, and years in continued efforts to perfect a Rotary Steam Engine, the seed and germ of which was planted by James Watt before his death a century ago. Watt declared that his slide-valve engine was only an approximate machine and that the ultimate engine would, if necessary, be a Rotary engine, but such an engine, even the great Watt was unable to build.

Briefly described, the Bannon Rotary illustrated Steam Motor is a very compact steam engine and in its construction there is used only about one-fifth the materials of a slide-valve engine of the same horsepower. It is claimed that its compactness effects a saving not only in the material and labor used in its construction, but also a saving in foundations required in space in the engine room. The most startling thing about this engine is that it has only three moving parts; an eccentric piston keyed to the drive shaft and two sliding gates which operate with their ends forming



The engine rotor

contact with the periphery of the piston. These three simple moving parts are the heart and soul of the engine and any man, whether a mechanic or not, can quickly tear down and rebuild a Bannon engine, because it is so simple and easily understood. On the shaft of the two-cylinder engine there are two of these eccentric pistons, 180 degrees apart, which balances the shaft per-



Engine with end plate removed

fectly and eliminates all possibility of rust or any bearing surface. The engine has positively ***no reciprocating action*** to overcome and consequently no loss of steam and fuel which is always experienced in overcoming the reciprocal action of slide-valve engines.

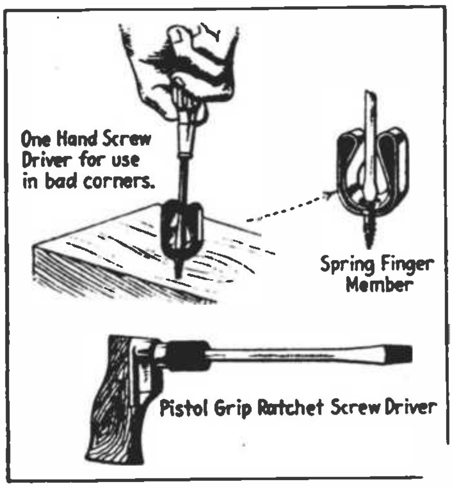
Possibly for the first time the acceleration and momentum of the piston is a decided advantage in the rotary engine as this piston moves always and continually in the same direction; whereas in the slide-valve engine these mechanical principles are a decided disadvantage inasmuch as the piston must be stopped and started twice in each revolution.

This Rotary engine is not at all like a Turbine inasmuch as the Turbine derives its power from the Kinetic energy of the steam, while the Rotary engine operates on the steam expansion, and it will start off with any load that it will carry subsequently; this a Turbine was never known to do.

SHOP PRACTICE

SCREW-DRIVER STUNTS

A NEW ratchet screw-driver recently developed has a pistol grip, as shown in accompanying illustration. This tool gives the user absolute control over the screw. It enables him to see exactly what he is doing, and get sufficient pressure to hold the blade in the screw slot firmly. The pistol grip gives the user a positive grip at all times. It does not matter whether the hands are oily, wet, tired or cold,



Screwdriver stunts

the comfortable shape of this handle gives the user certain control over the stubborn screw. The operation of the driver is simple. Only one hand is required, and it will work in any position. On the upper part of the blade, a convenient distance from the handle, is a knurled ferrule. With this an easily run screw may be quickly run in or out, without taking the hand off the handle. The blade is chrome nickel steel, heat-treated to give the most durable tip. The tip is cross-ground to prevent slipping from the screw slot.

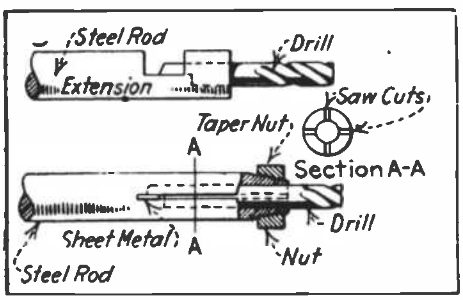
The one-handed man will find no difficulty now in driving screws, and his two-handed brother will be able to operate the screw-driver in corners and in restricted spaces where there is no room for a holding hand—there's many a place like that on motor boats, machinery and automobiles and also about the homes and shop. This device, made from spring steel, is so shaped that its fingers hold a screw in place on the end of a screw-driver. The upper part of the screw holder is secured to the screw-driver blade.

A small hand mirror will reflect light to any dark corner.

DRILL EXTENSION

TWO forms of drill extensions are shown in accompanying illustrations that can be easily applied when it is desired to drill a hole in a place that cannot be reached with a drill of the ordinary type and length. A rod of the proper size for the extension is selected and a hole drilled in the end to the size of the drill, a method shown at A. After the hole is drilled a portion is cut away and a flat end is filed on the drill shank to fit a flat in the extension socket. This makes it possible to drive the drill positively and also makes it possible to fit another one if the drill is broken as is often the case when the small diameter drills are used in extension shanks. Of course, it is possible to braze or solder a drill in the extension but when soldering is used the drill may turn in the socket and break the solder bond. If the drill is brazed, the parts are sometimes raised to a sufficiently high temperature to draw the temper and these must be re-hardened after the brazing operation is complete. It is more difficult to replace a broken drill when it is fast in place by either soldering or brazing.

Another modification which is not as well known as that previously described is shown at B. In this the extension rod

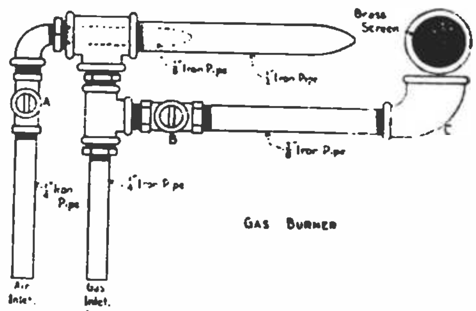


Drill extensions

is drilled just as in the previous instance but the drill is held in place by a different method. Two saw cuts are made in the end of the rod, these being at right angles to each other so that the end is really divided into four sections. A taper thread is cut on the end of the rod before the slotting operation takes place. A piece of sheet steel is forced in the lower end of one of the slots and acts as a driving member against which the flattened portion of the drill is placed. By tightening down on the nut the device acts just like a chuck and the four jaws are clamped tightly against the drill. As there is more elasticity to the jaws one extension shank will take drills that may vary slightly in diameter such as the body and tap size. An advantage of this form of extension is that by spreading the ends of the jaws apart and dressing them down for ¼th of an inch or so inside with a file as a square hole is obtained, the extension can be used for turning a tap and one extension shank not only holds the tap drill and body drill but also can be used for turning the tap and making the thread in the hole if necessary.

COMBINATION GAS BURNER

THE accompany illustration shows a very simple form of gas burner that is made up of ordinary standard pipe fittings. This is a combination burner that can be used to

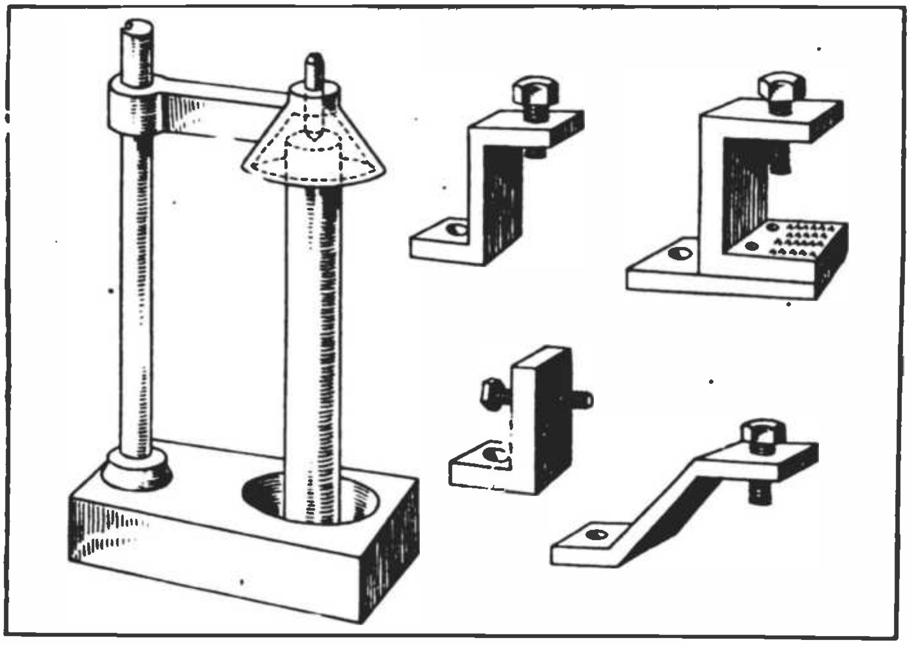


Combination gas burner

give a flame of large volume and low heating value, such as is often times needed in the shop, or it may be employed to give a blast flame for brazing. depending on which section of the burner is used.

DRILL PRESS KINKS

BAND iron and ordinary bolts or special screws form excellent clamps by which it is easy to secure work to the drill press table for drilling. They may be quickly attached to the table or to the angle plate and may be bent up from ¾ or 1-inch by 2-inch flat iron stock by any one who knows enough to heat the iron to the proper temperature, and then bending it by placing in a vise and hammering to the required form. Case-handened, cup point, special screws are excellent clamping members. Another useful device which is not difficult to make and which can be profitably added to the shop equipment is a centering jig which is especially valuable if one has a considerable number of short pieces of round stock to center for turning or threading in the lathe. A conical depression is placed in the base and a movable cone casting carries a special center punch in a suitable centrally placed bearing. This cone is attached to a sliding arm that is prevented from turning on the vertical shaft by a key

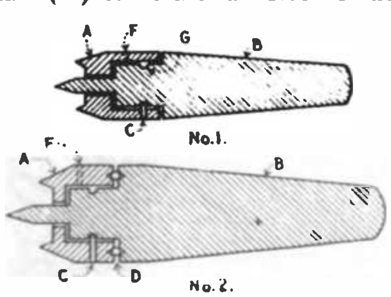


Centering jig for short round bars shown at left. Simple drill press clamp outlined at right

attached to the arm boss that slides with that member in a guiding key-way machined in the upright. It will be evident that cones will automatically center stock various diameters and that a suitable blow on the center punch will indicate the central point at the end of the round bar.

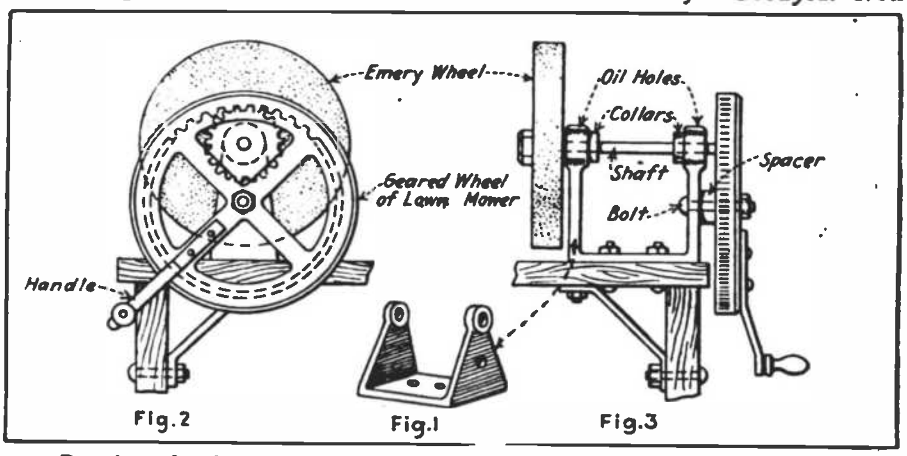
LIVE CENTERS

TWO useful and simple forms of live centers for use on wood turning and some forms of spinning lathes are shown in the simple diagrams herewith. The type illustrated as No. 1 consists of the usual form of taper shank (B) to fit the tail stock or head



stock, as the case may be. It is provided with a groove (G) machined around the surface on which the spur portion (A) revolves. A pin (C) fits into the groove and keeps the spur portion from coming off. The oil hole (F) is provided so that the bearing portion of the device may be adequately lubricated.

While this form is suitable for various kinds of light work, it is not well adapted for work where there is considerable thrust, such as metal spinning. For work of this nature the live center shown as No. 2 is best adapted, because, in addition to the other features of the simpler type shown above it, it includes a ball thrust bearing (D), which revolves with considerably less friction under heavy loads than a plain bearing would.



Drawings showing how old lawn mower may be used to make emery grinder

EXTEMPORIZED EMERY GRINDER

ANY one who is handy with tools and that has an old lawn mower that he does not know what to do with, can make an emery grinder that will be very useful for rough work. The drive wheel of the lawn mower, which is the large wheel on the side and its internal gear are used to turn the pinion that normally is fastened to the cutter axle. The bearing for the pinion shaft can be easily made from flat-bar stock having holes machined in it, in which bushings are placed for bearings or a simple cast metal supporter may be made from a home-made pattern. The driving wheel is held by a bolt which has shoulders on it and a separate collar is placed between the gear and the end of the supporting bracket. This collar should be made less in width than the distance from the inside of the gear web to the shoulder on the bolt in order that the wheel will be free running. A crank is made by bending up some flat bar stock and is riveted to the outside driving gear as depicted at Figure No. 3. A suitable handle is provided at the end of the crank by which it may be turned.

The part sectional view at Figure No. 2 shows the gears in mesh while the general construction of the device, which can be altered to suit individual requirements, can be readily ascertained by inspection of the assembled view.

POROUS CONDITIONS AFTER CURING

ONE repair man has complained several times about the porous conditions of repair jobs after curing. Upon investigation the fault was found to be damaged bead molds. The bead molds had been battered and bent until they would no longer fit the cavity snugly and would not slide forward. The sectional mold being tapered, the beads wedged before being placed into position. The clinch on the bead held the casing firmly and did not allow it to rest on the bottom mold of the cavity.—*Goodyear News.*

The United States Bureau of Standards has been investigating the mixing of concrete. Cement and water were mixed for a long period, 15 to 30 minutes, and to this mixture were added the sand and stone constituents of the concrete. The usual way is to mix all the constituents together for a few minutes and then to put the mixture in place. It was found that there was no advantage by this preliminary mixing of cement and water.

An interesting report from Portugal puts the total world production of corkwood at 396,832,000 pounds, of which 45% is produced in Portugal, 30% in Spain, 5% in France and Italy, and 20% in Algeria and Tunis.

Oil-Burning Locomotives

THE use of fuel oil as a standard combustible for locomotives is a more familiar practice in the Western than in the Eastern States. From the standpoint of the passenger it is most desirable, as the action of the burners can be and is so regulated by the fireman that there is a complete absence of smoke; cinders, of course, are also lacking. We give two cuts in this issue showing the distribution of parts in an installation on the Santa Fé system, and we give some of the results obtained in exhaustive tests recently carried out on that road.

The specific gravity of the oil was 0.958, a gallon weighing almost eight pounds (7.88 pounds at 110 degrees F.). It contained 18,550 British Thermal Units per pound.

The oil flame is known to be very severe on the metal of the fire chamber of the boiler, and even bricks succumb to its cutting action. Special oil bricks are supplied for general use in oil fires. Yet, all things being taken into account, it was found best to dispense with brick arches in the fire chamber, so as to leave it more open for inspection and to avoid the liability of bricks falling out of the arch and interfering with the operation of the blast pipe.

In some trials the burner was placed in the back of the fire chamber, in others in the front. Sometimes the seams of the boiler plates were protected by bricks.

The cuts accompanying this article are in such detail as to be self-explanatory.

Practically the same quantity of oil was burned per hour, whatever variety of apparatus was used, the brick arch construction being slightly less economical; 3,100 to 3,240 pounds per hour running time were the range of consumption. The water evaporated per pound of oil ranged from 14.06 to 14.60 pounds, which shows an efficiency of from 73.5 to 76.4 per cent, a very satisfactory result.

In the total figures recorded it is interesting to notice the great variation in oil consumed according to the conditions of the trip. In some cases less than half as much was recorded, but the efficiency figures in all cases came out very close to each other, as has just been shown.

While we may all be longing for the day when the locomotive engine will be relegated to the scrap-heap, and when electricity will do all the propulsion on our roads, the engine in question will not disappear for many years, so every effort to make it a better and more economical prime motor will be welcomed by the engineering world.

THE BUSY IGNITION SYSTEM

THE spark plug used for ignition purposes is one of the most important parts of the automotive power plant and when one considers the work it must do, it is remarkable that it will work for the extended periods it does without giving trouble. It is subject to alternate heating and cooling and must deliver a large number of sparks across its points as the accompanying table shows. The contact points of the primary timer also have some work to do because they must open and close for every spark that takes place at any of the plugs. Thus on a six cylinder engine, the contacts must make and break a circuit 3,000 times a minute, or 50 times per second at an engine speed of 1,000 r.p.m. Similarly, the induction coil must transform a low voltage battery current to a high voltage secondary current each time the contact points separate. Owing to mechanical and electrical limitations, it is usual to provide two sets of breaker points and two induction coils for high speed engines having more than six cylinders.

The heat generated in the cylinder at the instant of combustion is intense. The temperatures will vary from 3,000 to perhaps 4,000 degrees Fahrenheit, which intensity is illustrated by comparing the heat at which steel fuses, or about 2,550 Fahrenheit. The mean temperature of the cylinder is much lower

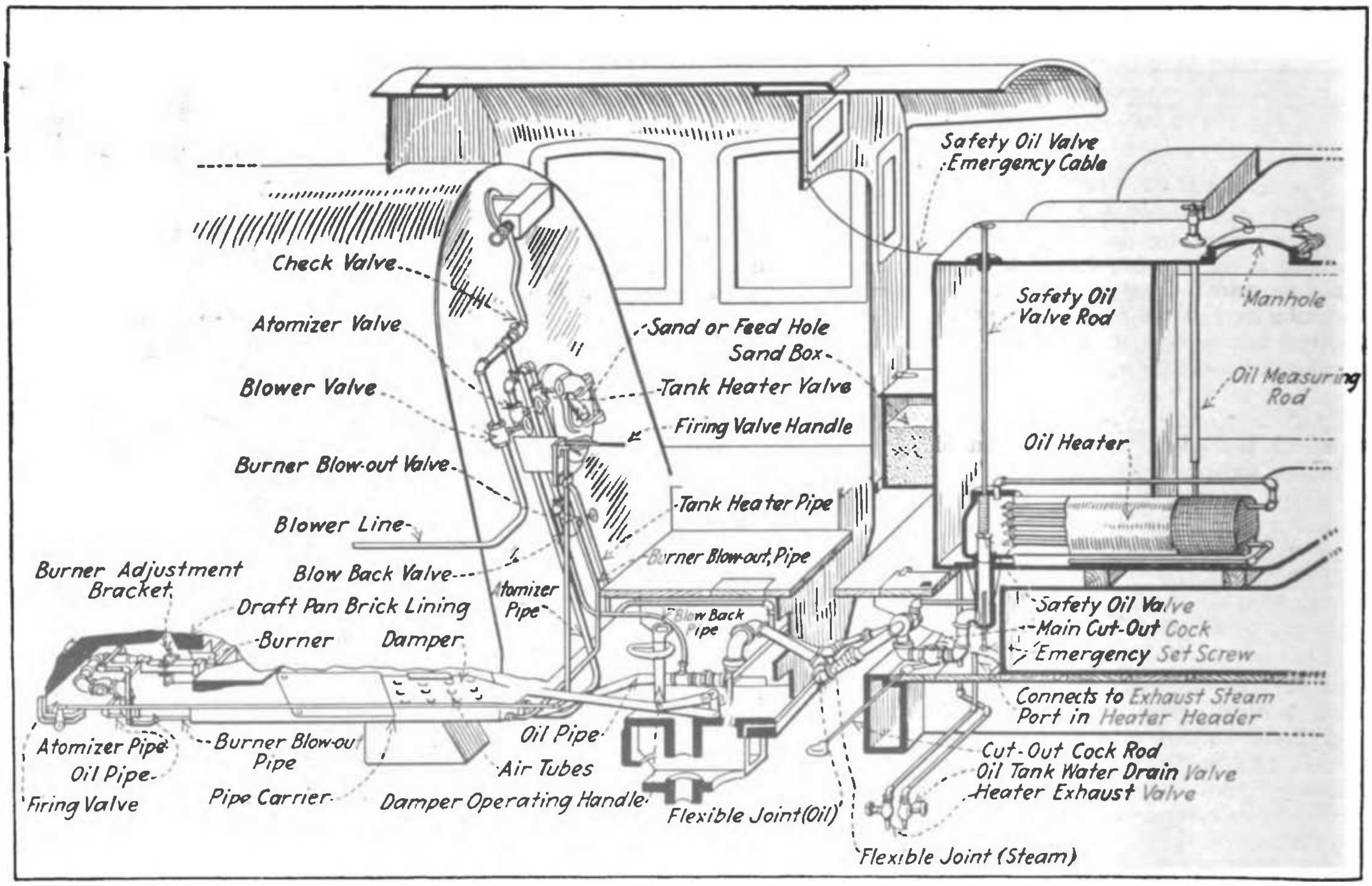
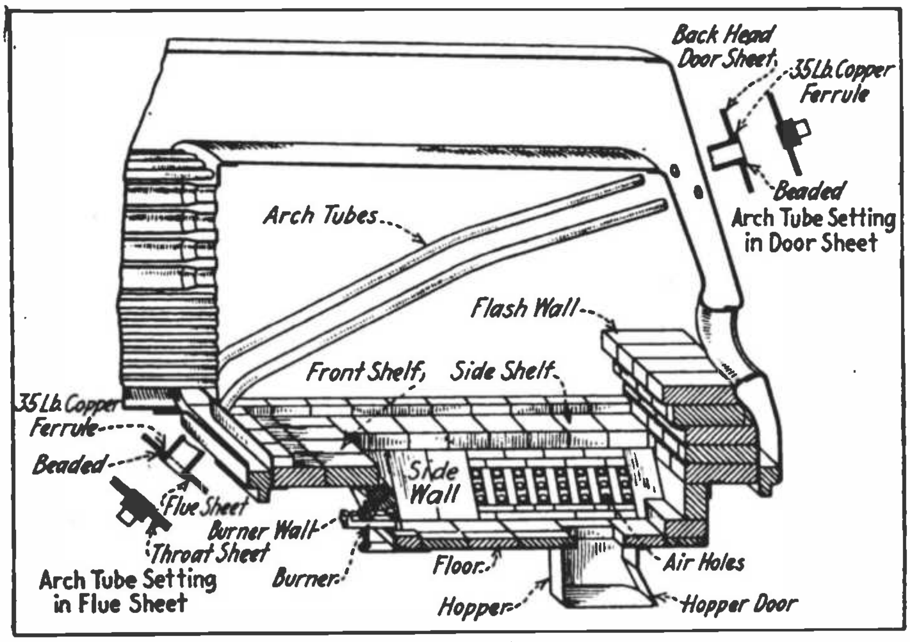


Diagram showing arrangement of piping for oil-burning locomotive

No. Cyl.	Engine R. P. M.	Power Impulses a Minute	Ignition Sparks a Minute a Cylinder	Ignition Sparks a Minute an Engine	Ignition Sparks a Second a Cylinder	Ignition Sparks a Second an Engine
1	1000	500	500	500	8.33	8.33
2	1000	1000	500	1000	8.33	16.66
4	1000	2000	500	2000	8.33	33.33
6	1000	3000	500	3000	8.33	50.00
8	1000	4000	500	4000	8.33	66.66
12	1000	6000	500	6000	8.33	100.00

because it is reduced as the piston descends for the power stroke, is cooled somewhat by the exhaust stroke, and is cooled decidedly during the intake or suction stroke and to some degree while the cool fuel gas is being compressed.

While the engine is in motion these cycles are repeated. The tabulation shows that with engine speed of 1,000 revolutions there will be an average of 500 power impulses for each cylinder, and an average of 8.33 ignition sparks created a second. This may appear to be comparatively slow, but from 1,800 to 2,400 revolutions a minute is not uncommon with standard automobile engines, and from 3,000 to 3,600 is sometimes reached with racing car engines. The maximum stated would be approximately 29 power impulses a second to a cylinder. But the term power impulses does not represent the rapidity of the consumption of the fuel in the cylinder. Considering the period of combustion, if the engine is running 1,000 revolutions a minute and each cylinder has 500 power impulses the time for each impulse revolution is slightly more than 1/6 second and if the spark is made 15 degrees advanced or before top center, and with 360 degrees for a revolution, the time for ignition would be 15/360, which allows 1/24 of the time for one revolution, or 1/144th of a second, for the gas to burn and create the expansive within the cylinder. This is so brief a period that it is not possible to make comparison. Yet in that time the electric spark must create a flame that will spread through every part of the combustion head. If the combustion chamber is irregular the flame will not be uniform in its progress in all directions from the electrodes of the spark plug, which is held to be the reason why L and T-head cylinder engines are either slower in action or develop less power than engines with valves in the heads.



Firebox arrangement of oil-burning locomotive

WHY WE TEMPER STEEL

In the vast majority of cases the writers who deal with the heat treatment of steel, when outlining the process of tempering, state that the object is to soften the steel. They say that steel, when heated to the required hardening temperature, becomes too hard and that therefore it is necessary to draw the temper in order to soften the steel. This is a common error—a failure to distinguish between the hardness and brittleness in the steel, two entirely different qualities.

Hardened steel is tempered in order to make it less brittle, but unfortunately the tempering process also softens the steel to some extent.

REPAIR POINTERS

When adjusting overhead valve clearances it is just as well to leave final adjustments until the cylinder head, as in the Chevrolet, etc., is firmly bolted down. The new gasket will give considerably as the engine warms up.

When setting ignition by the head center position of the fly-wheel it is sometimes advisable to look at the piston, as fly-wheels are not always in their original position.

Try hard oil on cylinder head gaskets instead of shellac.

IMPORTANCE OF BRUSHES

Approximately 90 per cent of starting and generator trouble is caused by lack of proper attention to brushes. A number of holders are so constructed that when the brushes wear out they wear on the commutator, causing it to groove. Yet there are many persons using automobiles every day who do not know what a brush is or that they have brushes on their starting motor and lighting generators and magnetos. Few realize the importance of the brush to automobile efficiency. A brush is the heart of the lighting and starting system. Without proper brush contact, or with poor commutation, one would be unable to start the car, to have a lighting system, and, where a distributor is used, to run it.

Lighting and starting systems were first installed on pleasure cars in 1912. Now they are placed not only on all pleasure cars, but on some makes and sizes of motor trucks and tractors. There are about a thousand kinds of brushes manufactured, varying in size from one-eighth of an inch square to 2½ inches square. Their carrying capacity varies from 30 to 300 amperes a square inch.

Brushes are made of copper gauze, or compounds of graphite, carbon and copper, depending upon the contact resistance and current required. The metal types contain from 15 to 90 per cent copper. Brushes other than the copper gauze type—the graphite compound brushes—go through a complicated process before they are ready for the market. The materials are first transformed into a fine powder, which is placed into mixing machines. This mixture is put into hydraulic presses, where it is subjected to a pressure of from 150 to 500 tons, and pressed into blocks varying in thickness from one-quarter to 1¼ inches. The blocks are then placed in furnaces giving a terrific and constant heat. They are left in the ovens for from seven to fourteen days, after which they are permitted to cool gradually. When the blocks are cold the ovens are unpacked and the blocks are sent to the cutting department and cut into the numerous sizes and shapes. Next they are brought to the drilling department, where holes are drilled with minute care in order that they may be assembled with the copper wires or "pigtails," which are either spun, riveted, screwed or soldered on to the brushes.

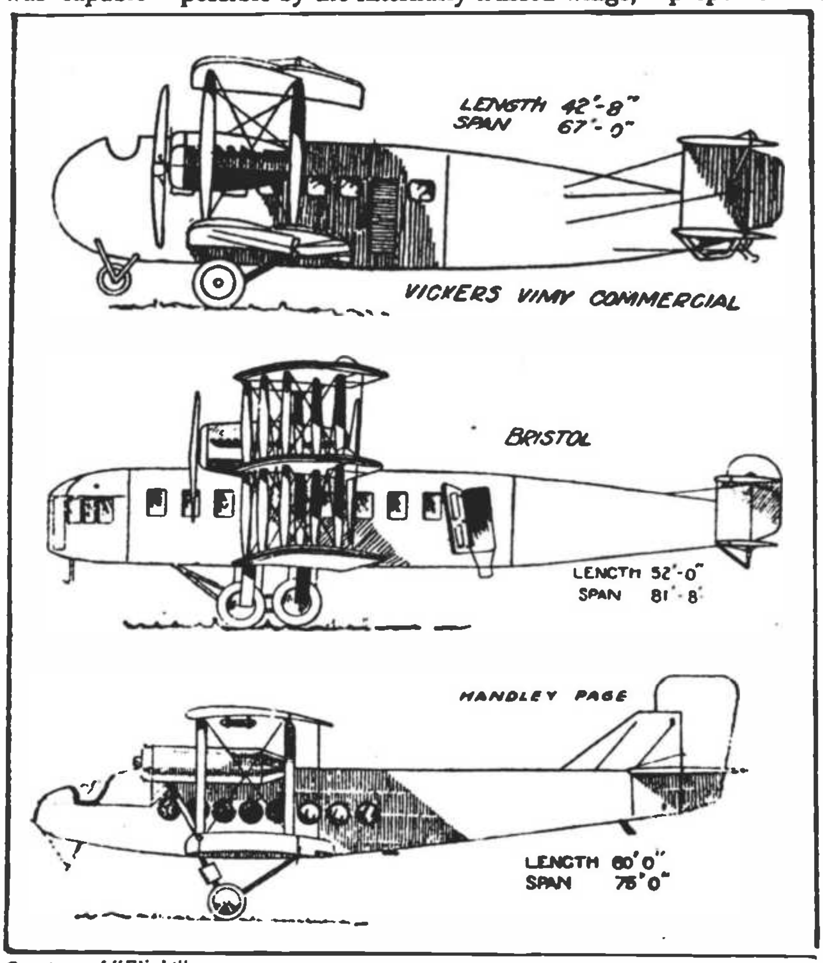
WHAT IS NEW IN AVIATION

(*Continued from page 492*)

pected to make real progress until it demonstrates that it provides speed, combined with economy and safe transportation. During the war, the DeHaviland No. 4 biplane equipped with a 400 horsepower engine was capable of carrying a pilot, observer and a few machine guns and necessary ammunition. By sacrificing both speed and climb, it may be loaded with a few hundred pounds of bombs. When this biplane was converted to mail carrying purposes, it required a 400 horsepower engine, to carry a pilot and less than 500 pounds of mail. Recent performances of all-metal, internally trussed monoplanes, show that it is possible, with but 180 horsepower to carry 1,000 pounds of mail at practically the same speed.

There is no question but that the capabilities of airplanes have been known for some time past, but it has also been appreciated that operating costs have been so as to retard civil aviation development. The expense of operating a plane equipped with two 400 horsepower engines that use about forty gallons of gasoline per hour and a correspondingly large amount of lubricating oil, would bring the fuel cost, with the present price of gasoline, to about $30.00 per hour. Lubricating oil for the same period would cost about $5.00 per hour and the depreciation of the airplane of the usual wood and fabric construction, might easily equal all the other operating expenses.

It is apparent that commercial aviation cannot be made practical if high operating costs are to prevail. The all-metal, internally trussed monoplane previously mentioned, has made a non-stop trip from Omaha to Philadelphia, a distance of about 1,400 miles in 11 hours and has carried three people that distance with an average gasoline consumption of about ten miles to the gallon. It has been stated that in the DeHaviland war-plane, that over 230 horsepower was expended in propelling parts that offer a parasitic resistance and that only 90 horsepower was expended to actually support the machine by the wings. On the newer types of commercial airplanes, every effort is being made to develop wings that will have high lift at comparatively low speeds and that will eliminate all possible waste of power by eliminating exterior parts that do not contribute to the sustentation of the airplane or its propulsion.



Courtesy of "Flight"

Side elevations of some of the best known English commercial airplane designs

The monoplane construction made possible by the internally trussed wings, which is one of the most efficient of modern airplanes, provides a structure that is possessed of a greater aerodynamical efficiency than any form of multi-plane can have. It is reasonable to believe that as airplane development progresses, we will find that machines of the future will be able to carry considerably more than their own weight. This has not been true in the past, as in the case of the DeHaviland mail plane, we have a total weight of 3,200 pounds, of which only ⅛th or 400 pounds represented useful paying load. Considerable interest is being displayed in designing types of air craft that will carry express matter economically and the writer feels safe in saying that it will not be long before it will be possible to carry material of that nature on long distance trips cheaper by air craft than it is by road with motor trucks at the present time.

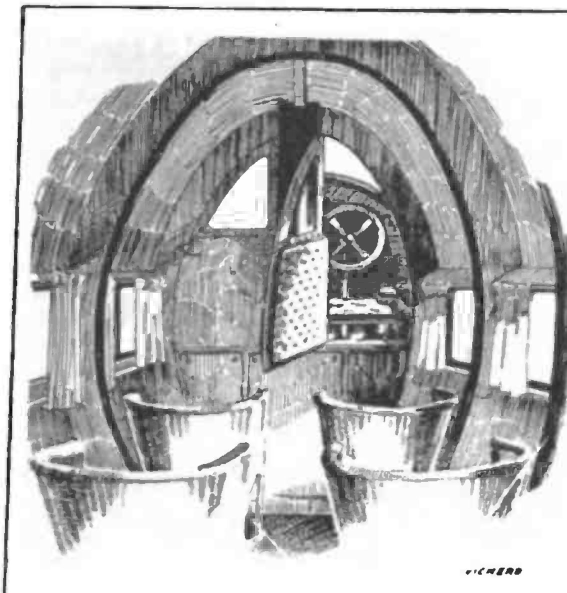
The advantages of all-metal construction and the elimination of bracing wires are many. One of the most important of these is that once an airplane of this kind is assembled that there is no possibility of losing its adjustment. In the present types of wood and fabric airplanes it is necessary to check up the alignment of the wings periodically and to go over all of the bracing wires every day to make sure that these are in proper condition and not too tight or too loose. The new method of metal airplane construction means that it beomes a structure that cannot be changed in form by any service for which it was designed. It may be compared to a bridge, which when once completed, preserves its form and needs but little attention to maintain it.

Another advantage of the all-metal construction is that a plane of this type may be left exposed to the weather, which will have no more effect on it than it has on modern motor vehicles, or other automotive equipment. It is not only in economy of operation that planes of this construction offer advantages, but also in that cost of maintenance is greatly reduced.

Bristol Triplane Pullman Express

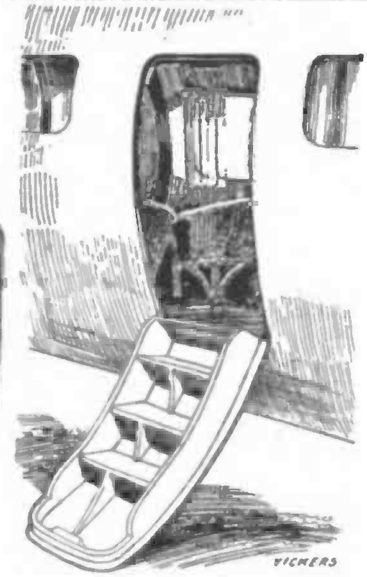
The *"Bristol"* Pullman Triplane, which can travel at over 130 m.p.h. combines with high speed luxurious comfort for its passengers, reliability and absolute safety. With two only of its four engines in operation, flying speed can be maintained. The roomy Pullman saloon, tastefully decorated and electrically lighted and heated, is seven feet in height and is fitted with comfortable fauteuils for the 14 passengers carried, in addition to the pilot and engineer. The gasoline tankage is sufficient to allow of a non-stop flight of 600 miles.

The ordinary uncorrected air speed readings show a maximum speed of some 134 m.p.h. With the engines at little more than half throttle the speed recorded was in excess of 100 m.p.h. No actual figures were taken at the time of these tests concerning the climb, but it was said that it climbed much more like a fighting machine than a passenger plane. Especially satisfactory was the fact that the machine on every occasion took off from the ground within, at the most, 180 yards after the engines had been let out, whilst a similar run after landing was



Courtesy of "Flight"

Interior view of the cabin of the Vickers Vimy commercial shows luxurious appointments for passengers and pilot's seat in nose



How the door of the Vickers Vimy commercial airplane folds down to permit passengers to step into the cabin in the fuselage

The seat back of one of the Sopwith models folds down on the arm rests to give the passenger a higher seat if desired

experienced. The whole of the first half of the fuselage is formed into a commodious and luxurious cabin, providing accommodations for 14 passengers in addition to the pilot and engineer, the latter occupying the extreme fore part of the cabin. The cabin is 7 ft. in height, and a central gangway affords access to the comfortable fauteuils which, though removable are normally placed on either side of the cabin. Large Triplex glass windows are provided for the convenience of each passenger, and an adequate system of heating and lighting by means of electricity is installed.

The question of ventilation has also been carefully studied. Any or all of the seats may be removed for the conveyance of mails or cargo and a total space of 570 cubic feet can thus be made available.

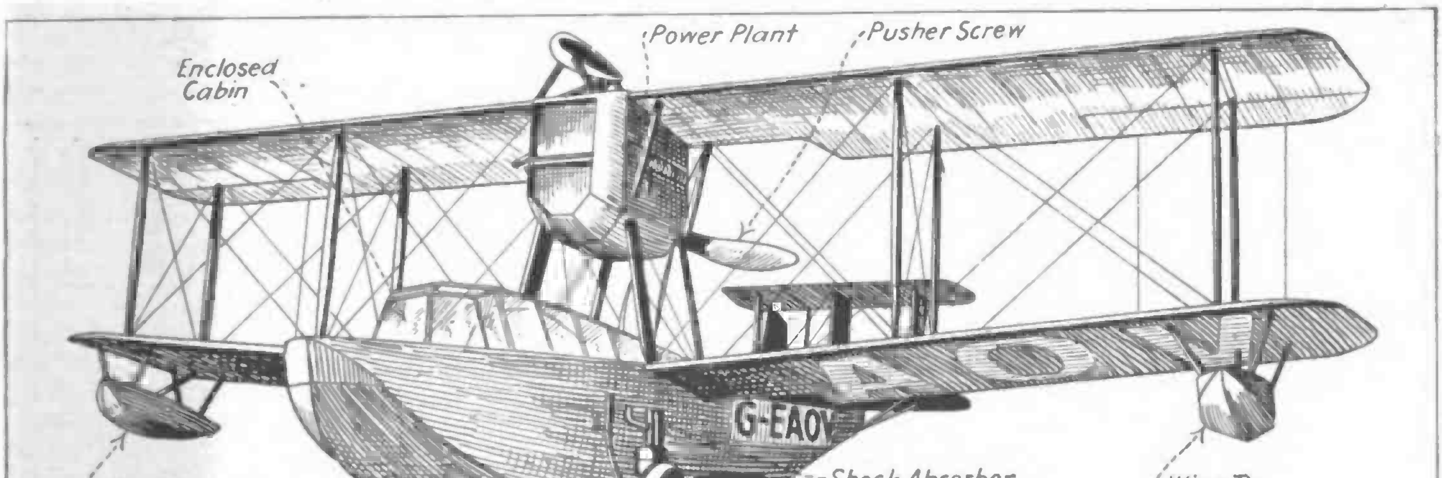
In addition to the two pilots the machine is capable of lifting a load of 2,700 lbs. with fuel for five hours' flight, or alternatively 4,000 lbs. with fuel for two and a half hours' flight. These figures are based on an economical speed of from 100 to 105 m.p.h., i. e., at three-quarter throttle giving a sufficient reserve of power to reach a maximum speed of 125 m.p.h or more if necessary. All three planes are given a sweep back and a dihedral angle, but are not staggered. Balanced ailerons are fitted to the top and middle wings. The tail is of the biplane type with three fins and rudders. The four engines, each of 410 h.p., are mounted two in tandem on each side of the fuselage on the middle plane, and each unit drives a tractor and pusher screw.

Handley-Page Model

The machine is a medium size twin-engined biplane, specially designed for commercial use, having an exceptionally large carrying capacity and reserve of power. The particular machine shown has two Napier-Lion engines, but these may be replaced by either the Liberty engine or Rolls-Royce "Eagle" VIII. The fuselage provides one large saloon or cargo space, which is entirely free from wires, tubes or internal structure of any description. The planes are arranged to fold, thus allowing the storage of the machine in a very small space, and owing to the special design of the wings, the overall height of the machine is kept smaller than usual. The weight of the machine fully loaded is 12,000 lbs.—which includes fuel for 6½ hours' flying and a useful load, in addition of the crew, of 3,200 lbs.

The planes follow the same general arrangement as previously employed on the large four-engine machines. The spans of the top and bottom planes are

(Continued on page 561)



The Vickers Viking Amphibian, an airplane type that can make landings on either land or water with perfect safety

Simple Model Steam Engine and Boiler Construction

By Wm. A. Helms

PART III

THE readers who have built the engines described in the past issues successfully have no doubt, after a time, experienced a lack of interest in the model in its present state. They would not be good model engineers if they did not try to improve upon it, especially as they become more efficient in the use of the tools. The first step taken is usually to add some arrangement to make the engine run in either direction. Therefore I shall deal in this article with the reversing arrangement of the single acting oscillating engines and with the multiple cylinder type.

It is extremely simple to reverse oscillating cylinders. It is this reason which makes them sometimes preferable in model work. Reversing can be accomplished by two different means. (1.) By employing a four-way cock, which is placed between the boiler and the engine. (Fig. 1 clearly shows the principle.)
(2.) By a false port face, which according to its construction is either placed between the cylinder and steam block (see Fig. 2) or at the back of the steam block (see Fig. 3). The ports are so arranged that the moment the reversing plate is moved it instantly changes the direction of the steam.

While theoretically the four-way cock seems to be the simplest method, the model engineer who undertakes to make one will find it to be a very troublesome task, especially for the beginner. For this reason I will pass this method and come to the reversing plates.

To make the reversing plate shown in Fig. 2, we take a 1/8 in. or 5/32 in. piece of sheet brass and cut out the false port face to the shape given in Fig. 2A. Having finished this we find the center for the pivot pin hole and take the distance from the center of the pivot pin to the center of the cylinder steam port, and describe a circle on the false port using the center of the pivot pin as center of the circle with that distance as radius. The three port holes of the reversing plate are found on that radius.

Having found the centers of the steam ports and drilled them, we recess the outlined grooves to half the thickness of the plate and drill the pivot pin hole. The only difference in the construction of the reversing engine besides the reversing plate is the arrangement of the steam ports in the steam block. They are placed vertical to the center of the line instead of on either side (see Fig. 2b). Fig. 2c shows a cut through the reversing plate, and Fig. 2d the reversing plate placed on the steam block to give a clear view of the different steam ports and of the passage of the steam.

The third and simplest method for reversing an oscillating cylinder also employs a reversing plate, but the latter is placed on the outside of the steam block instead of between the steam block and cylinder (see Figs. 3 and 4). This makes it necessary to face the steam block on both sides. The only difference in the port holes is an additional port for the entrance of the steam. The latter is drilled half way into the back of the steam block a little above the pivot pin. This hole meets the steam passage which is drilled through the side of the steam block (see Figs. 3A and 3B). Fig. 3C shows a front view of the reversing plate. The shaded portion is to be recessed to half the thickness of the plate. Fig. 3D is a section cut of the reversing plate. Figs. 3E and 3F show how the movement of the reversing plate changes the direction of the steam. Fig. 4 gives a sectional cut of a single acting single cylinder oscillating steam engine with reversing plate attached.

THE TWIN CYLINDER OSCILLATING ENGINE

We have now finished the single acting single cylinder oscillating engines and come to the twin cylinder

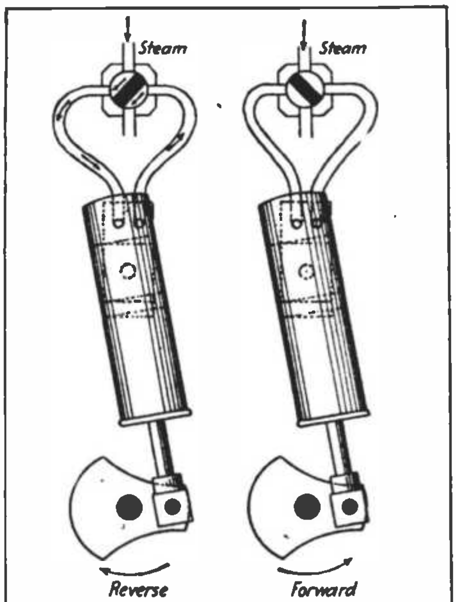


FIG.1. Reversing Oscillating Engine by Means of of a Four Way Cock

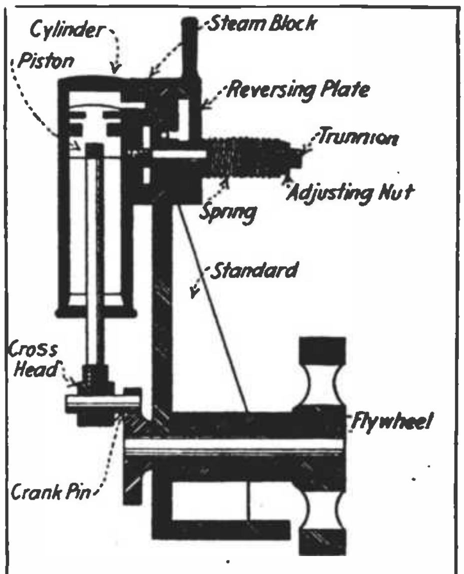


FIG.4. Section of Single Cylinder Reversible Oscillating Engine

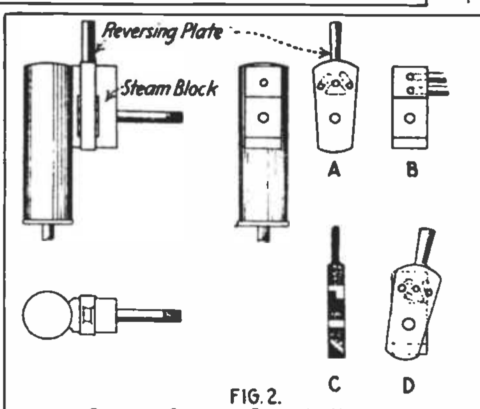


FIG. 2.
Reversing Oscillating Engine by Means of a Reversing Plate

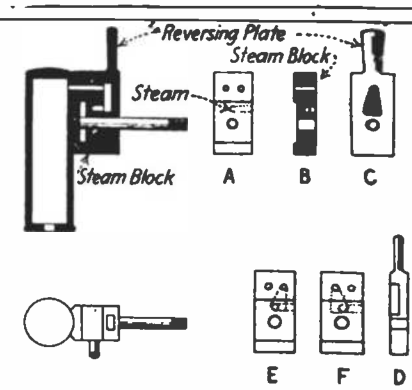


FIG. 3.
Reversing Oscillating Engine by a Different Type of Reversing Plate

type. Fig. 1A gives a front view of the engine with the left cylinder removed to show the steam block and the main frame which are cast in one piece. The dimensions of the latter are given in Figs. 2A and 2B. Fig. 1B shows a cut through the center of the engine with the left cylinder in place and Fig. 1C shows a top view of the engine with the left cylinder removed.

This engine is an ideal type to propel model boats as large as three feet, as the height of the engine is as low as possible. It is 2⅜ in. from the base to the cylinder top. Another important factor is that the weight of the engine is kept very low. The main frame is a light bronze or brass casting. The dimensions of the cylinders are ½ in. bore by ⅞ in. stroke. They can be either built up as described in the July issue or turned out of a bronze casting.

Fig. 3A shows a cut through the cylinder, piston connecting rod, and cross head. Fig. 3B shows the outside of the cylinder with the steam port and bearing surface. Fig. 4 shows the component parts of the cylinder and gives their dimensions. Note that the cross heads are halved to prevent angular thrust on the crank pin.

The flywheel is exceedingly heavy, with the weight placed in the rim to insure a steady and smooth running engine. Fig. 5 gives the dimensions of the flywheel, crankshaft and crank pin. The crankshaft is made out of a 3/16 in. steel rod. The crank pin is either turned out of a casting or out of a piece of brass.

In the next article I shall describe a suitable boiler for this engine and a 39-in. cabin cruiser which uses the boiler and engine as its steam plant.

NEW EGYPTIAN OIL FIELD

PROSPECTS of a good supply of oil fuel for Egypt are very promising. At the beginning of the war the Anglo-Egyptian Oilfields was the only one of the various companies formed to search for oil in Egypt that remained in operation, and down to 1914 the only finds of importance had been at Gensah, where none of the gushers that had been struck had given anything like a permanent yield. But the new field discovered in 1914 at Hurgada has been proved to be of singularly regular formation, and its yield has steadily increased, until, according to recent reports, it now stands at over 15,000 tons of crude oil a month. Meanwhile, the Suez refinery has been enlarged and there is every reason to hope that as much oil will shortly be available for internal consumption as can be dealt with by the company's existing facilities.

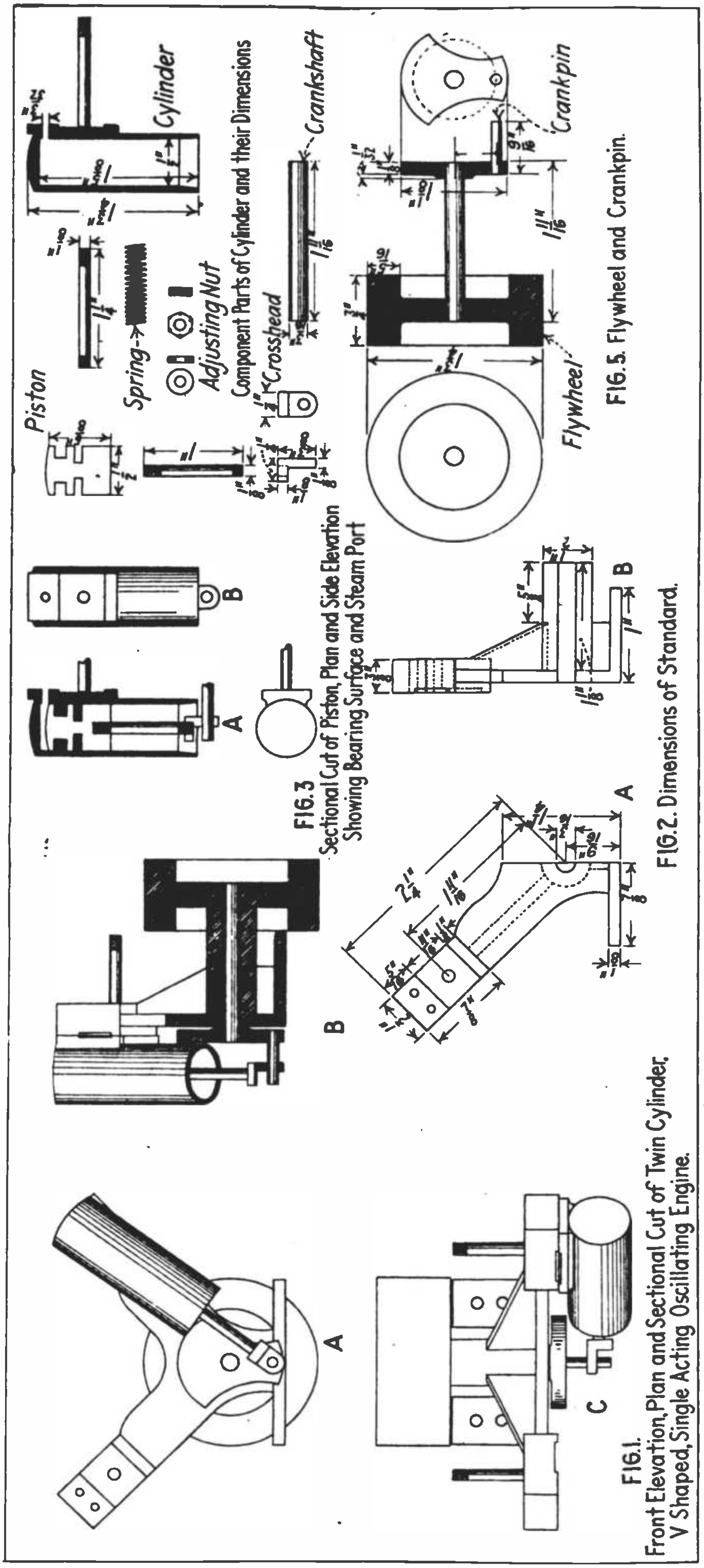


FIG.1. Front Elevation, Plan and Sectional Cut of Twin Cylinder, V Shaped, Single Acting Oscillating Engine.

FIG.2. Dimensions of Standard.

FIG.3 Sectional Cut of Piston, Plan and Side Elevation Showing Bearing Surface and Steam Port

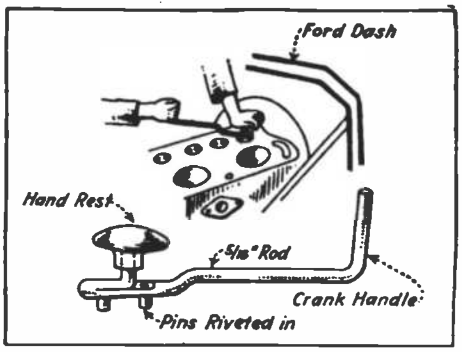
Component Parts of Cylinder and their Dimensions

FIG.5. Flywheel and Crankpin.

EVERYDAY MOTORIST

SIMPLE VALVE-GRINDING TOOL

MOTORISTS and repairmen who have tried to grind in the valves in the rear cylinder of the Ford engine realize that it is somewhat of a task to oscillate the valve head with the usual form of valve-grinding tool that will handle all of the other valves properly.

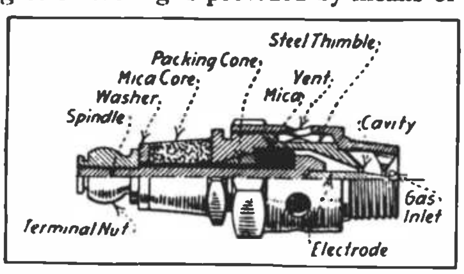


A simple valve grinding tool

A simple tool that may be easily made is illustrated herewith. This may be bent up of cold-rolled steel stock 5/16 or 3/8 inch in diameter. The shape of the tool can be readily ascertained by referring to the sketch. A slight off-set is provided to carry the hand rest, which may be made of a small door-knob or easily turned out of hard wood for the purpose. This hand rest should be of free fit on the upwardly extending off-set. A grinding handle is provided and the pins which fit in the holes in the valve head are easily inserted in a slightly flattened section and are riveted in place.

SELF-CLEANING SPARK-PLUG.

THE B-G spark plug, which is shown herewith, is a practical self-cleaning type that has been widely used in aircraft work and that is now being offered to automobilists. The points are cleaned by the gas movement produced by the peculiar construction. Some degree of cooling is provided by means of

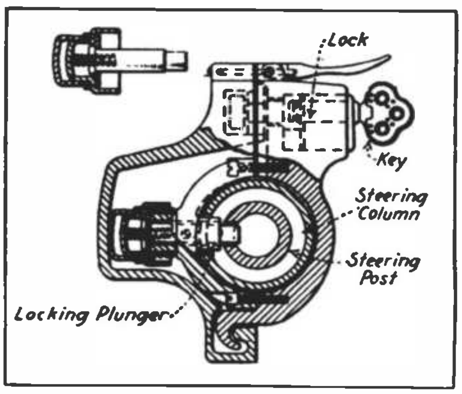


A self-cleaning spark plug

air vents to the chamber surrounding the steel thimble. As the exploding gases are in contact with this thimble, the internal heat is conducted to the outside and dissipated. A cavity may be noted near the bottom, extending up into the steel thimble to a point near the center, where the space is filled by the mica insulation. Into this cavity four gas inlets extend, in addition to the gap around the sparking point. During the compression stroke, fuel gas is forced through all of the entrances into the cavity and with sufficient speed through the spark gap to clean it thoroughly just prior to ignition, it is claimed. When the spark jumps, the gas within the plug explodes, along with the charge in the cylinder, and during the power and scavenging strokes the confined and expanding gases rush out of the plug cavity and blow out any carbon or oil that may have accumulated.

A STRONG AUTOMOBILE LOCK

THE ever-increasing activities of the car-thief naturally call attention to devices designed to curb the crook's ambitions in a number of ways. One of such locks shown in accompanying illustration operates by making it impossible to turn the steering wheel of the car after the lock had been closed.



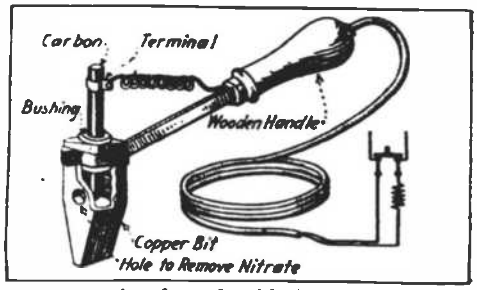
A strong automobile lock

The lock is secured to the steering column by a hole drilled through it as well as through the steering tube or post and locking action is by means of a steel pin which enters hole in steering tube. The location of the device, immediately under the steering wheel, makes it easy of access. The locking plunger is engaged by closing down the removable cap piece which is held by a hinge joint at one end and a lock at the other. When the device is in the unlocked position the cap is swung back and the spring pressed plunger comes out of the hole made to receive it in the steering post.

From the standpoint of traffic authorities this mode of automobile theft prevention has a number of advantages, one of which is that its application does not make it altogether impossible to move the car for a short distance, as in case of fire or other emergency. The thief, however, even though he might succeed in starting the car, could proceed only in a straight line, something which would make it very difficult to get away with the car.

ELECTRIC ARC SOLDERING BIT

THE following description of a novel soldering bit that can be easily made by the experimenter is by B. A. Briggs and is reproduced from a current issue of *Power*. Most electric soldering irons are constructed so that they are heated by the current passing

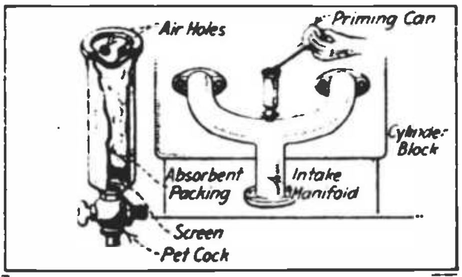


Arc heated soldering bit

through a resistance coil inclosed in a tube attached to the top of the iron. The illustration shows an electric soldering iron that is heated by an electric arc in the iron itself. A hole is bored in the center of the iron having a diameter equal to the outside diameter of the tube of a battery bushing down to where the iron begins to taper. A standard battery porcelain bushing B is placed in the hole and a 3/8-inch arc-lamp carbon C is placed in the bushing and allowed to come down in contact with the bottom of the hole, then the carbon is withdrawn about 1/4 in. to establish the arc. The iron should be connected to a 110-volt circuit and resistance enough connected in series to keep the current down to between two and three amperes. About 30 ohms will be sufficient. This resistance may be made of about 600 feet of No. 18 B. & S. iron wire and connected in the circuit, as in the figure. The soldering iron is connected to the circuit with the positive terminal on the carbon, as shown in the illustration. The carbon is held in place in the bushing by small metal wedges, and adjustment of the carbon is made by tapping it down to give the desired length of arc. A second hole is bored at right angles to the first so as to allow the arc to be cleaned of the nitrate that forms around it.

SUPPLEMENTARY CARBURETOR

THE electric motor starter has not made the progress abroad that it has in this country and many cars are used in England and France that have no means of starting the engine other than the usual hand crank. As many trucks in this country are not fitted with electric starting means, a description of a device which is used in England to facilitate starting the engine should be of interest. This is known



Supplementary carburetor

as the Blake supplementary carburetor and is an extremely simple fitting, the construction of which can be readily ascertained by studying the sectional view in the accompanying illustration.

The fitting is made of tubing having a detachable pepper-box top at one end and a cock at the lower end. The tube is fitted with packing material which is used to vary the suction for different engines by being packed in more or less tightly as conditions demand. The top is formed in the shape of a cup and it will be apparent that any gasoline or ether used as priming fuel dropped into the depression will sink down into the absorbent packing material, which may be asbestos fiber or of similar substance. The cock is opened when it is desired to start the engine, and air entering in through the holes in the top of the device will become instantly saturated with fuel particles in passing through the packing material, which naturally has become soaked with fuel.

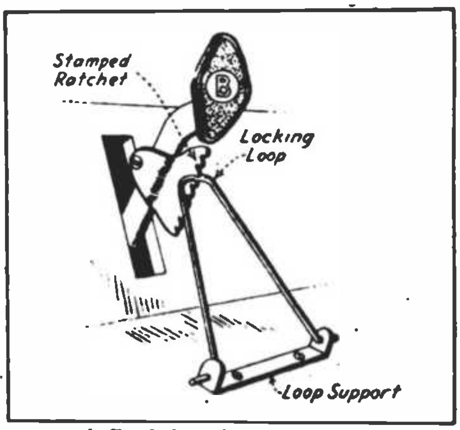
The device screws into the center of the intake manifold and is readily installed on practically all engines. On those forms where the manifold is cast integral with the cylinder block and the carburetor bolts against the block, the supplementary carburetor may be fastened into the carburetor by being placed between the throttle valve of that member and the passage in the cylinder block. A device of this kind can be fitted on engines that are equipped with electric starters, as it will make starting much easier in cold weather or damp weather and reduce the strain on the automobile battery.

A FOOT BRAKE ACCESSORY

THE attachment shown in the illustration is interesting, as it provides a simple means of holding a Ford car on steep gradients. It consists of a ratchet clamped by a screw to the arm of the brake pedal and a wire loop hinged to a small bracket screwed to the footboard. When the brake pedal is depressed the loop falls into one of the notches in the ratchet and locks the pedal in that position. To unlock the device the pedal is depressed slightly, when the loop may be lifted out of engagement and swivelled back out of the way against the floor. In cases where a thick floor mat is used, the position of the loop can be raised slightly by fitting it into another pair of holes in its bracket. The device is of English origin.

IMPROVEMENTS IN VALVE MECHANISM

MUCH ingenuity has been displayed in making the valve actuating mechanism of the modern car as silent as possible, and there is no doubt that a quiet running engine appeals enormously to the average owner-driver. One of the difficulties of obtaining silent valve mechanism is the necessity



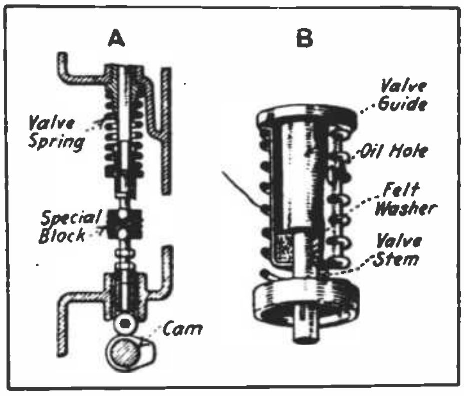
A Ford foot brake accessory

for clearance between the valve stem and the valve tappet. The coupling here described has been designed expressly to give quiet running by an English inventor.

The illustration, which is taken from the *Autocar*, is self-explanatory and, as will be seen, the ordinary tappet is replaced by a pair of blocks with special curved faces. These curves are struck from centers eccentric to a line drawn through the pivot centers of the blocks. The blocks are mounted on spherical ends attached to the valve stem and valve tappet and are held apart by a light spring. The action is as follows:

When the valve is at rest, the blocks are in contact eccentric to their pivot centers, but when pressure is applied—that is, when the valve is being raised—the curved faces are caused to roll together until the point of contact is concentric with a direct line of pressure. In the arrangement shown, the blocks are of circular formation, and a tongue and groove are used to maintain the blocks in correct relation.

The device shown at B is intended to prevent air leaks, rattle and wear in the exposed valve mechanism of engines made several years ago, before the importance of enclosing the valve operating mechanism was recognized. The construction is very simple, an oil-soaked felt washer being carried in a special stamped cup member held in place against the cylinder by the valve spring as indicated. It is specially good for engines having worn inlet valve guides.



Improvements in valve mechanism

POINTS TO WATCH

ASBESTOS packing is used on the flanged joints of the exhaust pipe. These gaskets can be had in various sizes to fit standard manifold connections. If they are not available asbestos board will answer the same purpose. It should be soaked in water and rubbed with graphite before it is put in place. Inlet manifold joints can be made tight with shellac.

The joints in the cooling system, such as unions, flange elbows, etc., may be smeared with read lead and oil. At this season of the year, the owner should go carefully over the water connections to make sure they are tight. It is a good plan to get under the car occasionally and inspect the radiator for small leaks. There is but one real remedy for such leaks, solder.

CASING MUST BE DRY BEFORE REPAIRING

CERTAIN porous conditions resulting from moisture in the casing to be repaired can often be traced to numerous tread cuts through which water has penetrated and soaked the fabric of the carcass. Before repairing, casings should be carefully inspected for tread cuts and consequent moisture in the carcass and allowed sufficient time to dry thoroughly. If there is moisture in the casing when it is built up the heat applied in curing will cause steam to form between the piles and the result will be bubbles and an imperfect cure. — *Goodyear News.*

At Lakehurst, N. J., a hangar for rigid dirigibles is being built whose inside dimensions are 803 ft. by 262 ft. floor area and 172 ft. in height. It will be the largest roof in America with an absolutely clear space below it, for, of course there can be no intermediate supports.

The Romance of Tungsten

By E. W. Davidson

A CASUAL look at the filament of the incandescent lamp in your library or at the tiny spark coil or breaker box contacts on your automobile brings no suggestion of the romance of science which lies back of those devices. It is the romance of tungsten, one of the heaviest of metals, a metal nearly 140 years old but which resisted the efforts of mankind to make use of it in its pure state for about 130 years.

But the service pure tungsten has rendered the world in the last decade since it was "conquered" is almost too great for calculation. Tungsten in its various forms reduced America's electric light bill a billion dollars a year and more than double the usefulness of the incandescent lamp. Ductile tungsten kept the automobile industry alive during the war. It helped make possible the Coolidge x-ray tube with tungsten targets which tremendously increased the value of the x-ray machine to mankind. With it the pliotron was built so that wireless telephony could be developed to a useful and dependable point. With it the tungar rectifier was created so that owners of automobiles could charge their cars in their own garages by simply plugging into a light socket. With it phonograph needles are being made more than 50 times as good as the steel and the fibre needles, heretofore the best that could be produced.

Tungsten bullets might have served in the recent war as projectiles hard enough to pierce the heaviest armor the Germans could put on their air-craft, for a few were made to prove their usefulness in that capacity, but the plan to use them was given up after a less expensive way to accomplish the result was discovered.

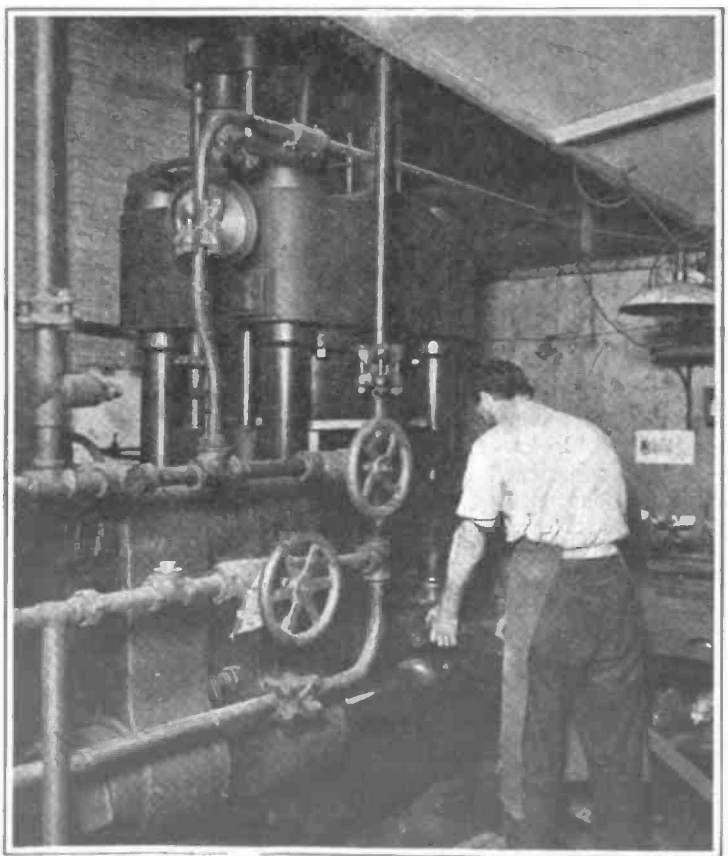
This Hardest and Heaviest of Metals Was Brittle and Therefore Unworkable in Its Pure State for More Than a Century After Its Discovery Until Dr. W. D. Coolidge Made It Ductile. Tungsten Saves This Nation Alone a Billion Dollars on Its Annual Electric Light Bill and Otherwise Benefits Mankind — EDITOR.

Before the war only a few thousand tons of tungsten ore were mined in all the world and the price of raw tungsten ranged around 90 cents a pound; but with the war came a tremendous demand for tool steel hard enough to work at high speed though red hot. Tungsten was required as an alloy to make such steel.

The price rose steeply when the supply diminished before the sudden demand until it reached $7 or $8 a pound. The world's production in 1918 mounted to 35,800 tons. The control over the sources of it was 59 per cent American and 35 per cent British. The price and production slumped with the end of the war until today raw tungsten can be bought for a little over a dollar a pound.

Most of the adaptions for tungsten are due to a discovery made by Dr. W. D. Coolidge, a physicist in the research laboratory of the General Electric Company of Schenectady. He was the first man to find a way to work this most brittle of metals. He made it ductile and thereby hangs this tale.

For about 100 years tungsten had been known before it was put to any use whatever, even as a mere alloy. Its presence was first noticed by Scheele and Bergman in 1781. They found traces of it in a metal called scheelite and coined the name "tungsten" for it from the Swedish "tung" meaning weighty and "sten" for stone. In 1783 three Spaniards discovered tungsten in the mineral Wolfram. To this day



Pressing tungsten powder under 16 tons pressure into 16 by ¼ by ¼ inch slugs. This is the first stage in working tungsten. The slugs are too crumbly to be handled

Putting a tungsten slug into treating "bottle" where an electric current is passed through it in a hydrogen atmosphere. This makes the tungsten a degree stronger there is little tungsten taken from any other minerals. It is found in small quantities in Cumberland, England; Limoges, France; and in parts of Connecticut and North Carolina, but most of it comes from Colorado, and China.

Extracted from these minerals and pulverized, tungsten was found useful in certain steel alloys. Mixed with an adhesive it was made into lamp filaments that were efficient but exceedingly fragile. However no metallurgist was able to discover a way to work tungsten separately. This was because in pure metallic form it is absolutely brittle. It confounded all experts with its utter intractibility. The established processes in working other metals proved useless with tungsten.

Perhaps it was this very thing which finally brought about the harnessing of this valuable metal. Because it had so steadfastly refused for more than 100 years to respond to the arts of the metallurgist, Dr. Coolidge, with the instinct of the true scientist pioneering in untrodden fields, tried ways that any metallurgist would have thought an idle waste of time. The result was that after long effort and many failures he finally made tungsten ductile and workable so that it could even be drawn like wire down almost to the gossamer fineness of spider's web and still be strong enough to permit its winding and curling into almost any shape. When he had done that he had conquered tungsten and made possible many devices which could never have been built without ductile tungsten.

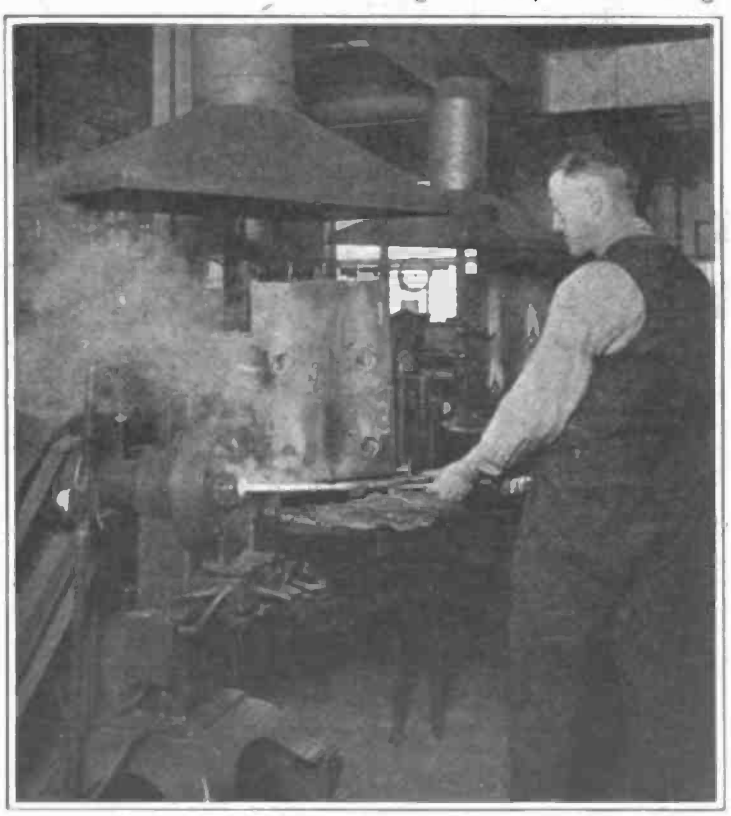
The radical difference in workability between tungsten and normally ductile metals, the difference which nonplussed the scientific world for more than a century may be explained thus: Pure tungsten pressed into bars is brittle after the very treatment which makes other metals most ductile. It differs from all other ductile metals in that when composed of grains it is extremely brittle at "room temperature," but is ductile at this temperature when fibrous.

Dr. W. D. Coolidge who made tungsten ductile. In this photograph he holds part of the Portable X-ray which is another of his triumphs

Many an experimenter had sought to work tungsten mechanically. But none had ever succeeded in getting this intractable metal into a form suitable for mechanical working. Moissan, by an electric furnace method, obtained tungsten in a porous condition which could be slightly compressed and the pores closed up by hammering when hot. However nobody in the world suspected at that time that if tungsten could be obtained and put into suitable condition and then mechanically worked at suitable temperature, its inherently brittle nature would gradually disappear. But nobody knew how even to make a start upon the problem of working tungsten.

To make any ordinary metal soft it is heated above its annealing point and then cooled down to room temperature. Doing this to tungsten however left it as brittle as ever. Violating all metallurgical rules and working for years with utmost patience, Coolidge discovered the astonishing fact that the only way to make tungsten ductile was to mash tungsten's grains out into fibrosity and thus make the metal ductile cold and this he did by first heating it to a degree below its annealing point and then mechanically working it with infinite pains at a variety of heats each cooler than the one before until the metal got down to room temperature. A similar treatment, if applied to ordinary metals would destroy their ductility. He worked out a process which, if followed without the slightest deviation, stretched the grains out, thus attaining

Squirting pulverized tungsten ore into furnace which removes oxygen and produces pure tungsten in powder form ready for compression into bars which are hammered and then drawn into finest wire



The operation of putting red hot tungsten bar through one of the many swagers whose revolving hammers chatter on all sides of the bar reducing it to smaller and smaller diameter is shown at the right ductility. But if the working varied from his process, failure resulted. The tungsten would smash to flinders at a stroke when it got cold. This elaborate and delicately measured system of working tungsten is a scientific triumph. Thus was tungsten finally made ductile.

The greatest immediate use for it was in the making of electric lamp filaments. Previously the best filament was made of fine tungsten powder, mixed with a binder into a plastic mass which was squirted through fine dies to produce fragile "wire."

This was an enormous improvement over the old-style carbon filament, thanks to the facts that tungsten, with a melting point of 3350 degrees Centigrade will stand more heat than other metals and its vapor tension is so low that even under tremendous heats its volatile decomposition is slow. Tungsten even in this form made so good a lamp that it saved the American public a billion dollars a year on its electric light bill. But filaments of those days could not withstand the slightest jar during the process of manufacture. They necessarily could not be strongly mounted in lamps.

Pure tungsten, on the other hand, drawn into filaments can stand almost anything. For one thing it is heavier than any other metal. Whereas wrought iron weighs 490 pounds per cubic foot, and lead 708 pounds, tungsten tips the beam at 1193 pounds. Its tensile strength is startingly high. After it has been worked down to drawn wire of about a thousandth of an inch diameter its tensile strength is no less than 600,000 pounds per square inch of cross section. This is greater than the best piano wire.

To produce tungsten from the sheelite or wolframite the ore is fused with alkali carbonates and the fusion dissolved in water. This may be changed to tungstic oxide by adding acid. The oxide, a yellow precipitate, is then filtered off. The tungsten oxide is purified to any desired degree by dissolving it in ammonia and then precipitating by adding acid, followed by filtering and washing.

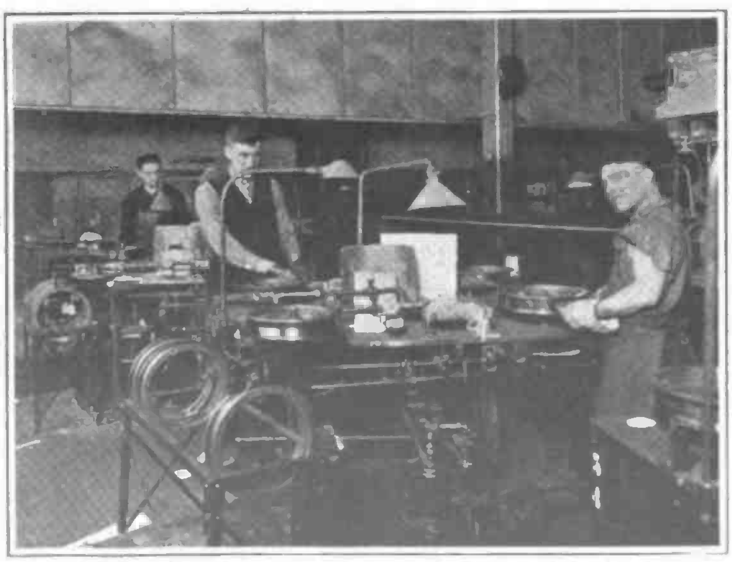
Winding the tungsten wire into incandescent lamp filament coils

To use tungsten in lamp manufacture, it is dried, mixed with thorium nitrate solution and then thinned with water into a batter. This is dried and heated at 2000 degrees Fahrenheit for an hour in a silica or fire clay crucible to agglomerate the fine particles into coarser ones. This mixture is reduced by hydrogen at 1800 degrees Fahrenheit into tungsten metal powder.

The reduced tungsten powder is poured into a steel mould which is a slab whose face bears a groove a quarter of an inch wide and deep. Under hydraulic pressure of 16 tons per square inch this groove full of powder is pressed into an ingot 16 by ¼ by ¼ inches. The pressure has been exerted on the sides of this ingot, not the ends. The ingot at this stage is too fragile to handle.

The slug next goes into an electric furnace where it is baked at about 2400 degrees Fahrenheit. Now it is strong enough to handle. It is then sintered in a hydrogen atmosphere, the bar being heated for 10 to 15 minutes to about 5000° Fahrenheit by the passage of an electric current through it.

The bar, though brittle when cold, is ready to be worked. It is heated to about 2800 degrees Fahrenheit, and passed through the revolving dies of a swaging hammer which reduces its size and produce it in rods growing smaller and smaller and necessarily longer and



After tungsten has been swaged down to heavy wire, the drawing process begins. Here it is being drawn through a gas flame and then through a die reducing it from 0.030 to 0.014 inches. It is tough and thoroughly ductile by this time but is far too large for lamp filaments and must be drawn down again

Drawing tungsten down to finest proportions, about four ten-thousandths of an inch is one-sixteenth of the size of fine human hair. It is used as filament in smallest "bug" lamps. The thread of tungsten passes through lubricant, then through gas furnace which has a diamond die at its end nearest the operator longer as the metal goes through one swaging after another until it gets down to a diameter of three hundredths of an inch. It is now a metal that is ductile and its strength has increased with leaps and bounds so that at a diameter of three hundredths of an inch it can stand a pull in the proportion of 215,000 pounds per square inch of its diameter.

But it is still too large for lamp filaments though wound on drums it appears hardly coarser than linen thread. So it starts into the process of being drawn down by successive stages through diamond dies of smaller and smaller sizes, to any degree of fineness needed. On the drawing machines it unwinds from the feeding spool, passes through a lubricant, runs through a small gas furnace to attain red heat, negotiates the infinitesimal "eye" in the fragment of diamond clamped in its course, and is wound on a receiving spool ready for use.

Various of these fine sizes of tungsten wire are used for lamps of wide range of powers, the finest of them all being used for the tiniest of lamps such as "bug-lights" on automobiles and in flash lights. The diameter of this is 0.004 of an inch. It is six times finer than human hair. The original pressed ingot 16 inches long would produce more than 250 miles of such wire.

Tungsten wire thus produced is what has made the incandescent lamp the thing of power and service it is today in the form of the well known Mazda.

The metal is worked in various other ways for its various other uses, but it never could have been had not Dr. Coolidge spent years in experimenting with it beyond the point where the scientists and metallurgists of the world had written the word "impossible."

ELECTRICALLY PROPELLED BATH CHAIR

VISITORS at various shore resorts in this country that do not wish to exert themselves on the boardwalks are usually seated in light chairs pushed about by an attendant, who walks behind the chair or who is astride a bicycle attached to it, depending upon the construction of the conveyance in question. The accompanying illustration shows a simple electrically propelled chair which renders the occupant independent of any external source of power.

A light storage battery is carried in a special compartment at the feet of the occupant. The rear wheels are operated by a light-power electric motor, which is controlled by a simple switch conveniently placed at the side of the occupant. Two forms of brakes are provided, one of which is electrical, the other being controlled by the foot. The device is steered by a simple form of tiller and the control is so easy that anyone can learn to operate it after a few minutes' instruction.

As the speed of this self-propelled bath chair is very low, not being more than a walking pace, even if the chair should collide with some obstruction, due to the inexperience of the operator, no appreciable damage to either the vehicle or the driver will result.

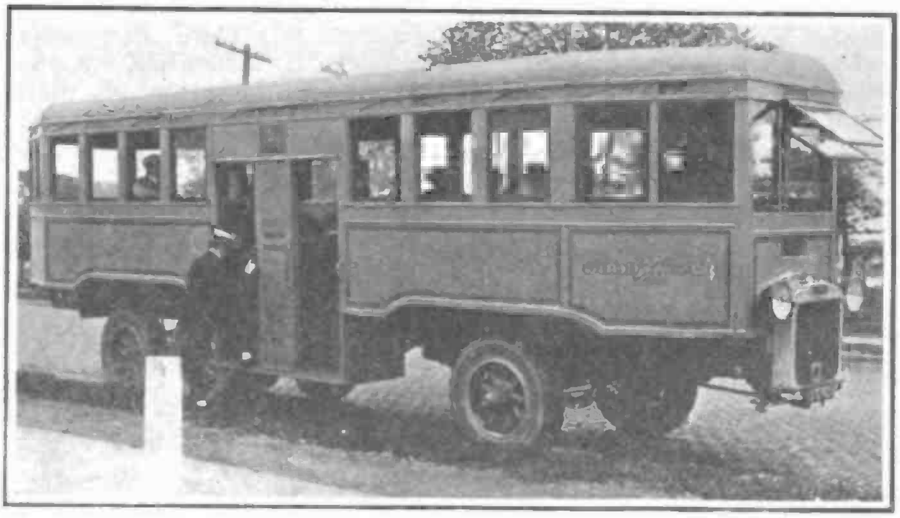
An electrically-propelled bath chair of English design

A SIX-WHEELED VEHICLE

EXPERIMENTS have been carried on by one of the large tire manufacturing companies that have resulted in the development of a special form of six-wheel vehicle in which the usual rear axle is replaced by a truck composed of two axles, each of which is provided with its own driving gearing and which are driven from the power plant at the front end in the usual manner. The use of four rear wheels makes it possible to carry very heavy loads on the pneumatic tires without using tires of excessively large size.

The use of pneumatic tires makes it possible to attain higher speeds with such a heavy vehicle than could be secured with the usual form of solid rubber or cushion tire. Such a design also makes it possible to use the same size tire on the front and rear wheels. The chassis developed by this tire company has been equipped with a special type of car body and is being used in an experimental way to determine its capabilities for passenger transport.

The body will accommodate forty-four passengers comfortably if only its seating capacity is utilized, but if standing room is called on also, it is claimed that ninety people can be carried. The body has a side-door entrance and exit and is operated on a "pay-as-you-enter" basis. It has the usual features with which any tram-car or omnibus is provided, such as adjustable windows, upholstered seats, electric lighting and signal arrangement, etc. The power plant is a six-cylinder, 75-h.p. gasoline engine which is mounted at the front end of the body.



A six-wheeled motor vehicle now in process of development

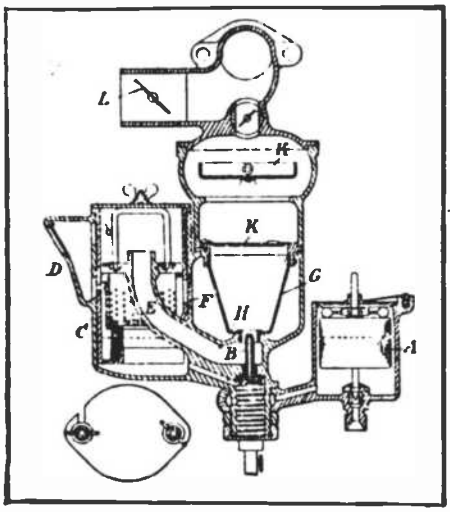
USEFUL AND INTERESTING INVENTIONS
AUTOMOTIVE-MECHANICAL-ELECTRICAL

SAND-MIXING MACHINE

A NEW sand-mixing machine to replace manual labor in mixing sand which has been employed in foundry molding has been invented by Russell C. Stokes of Portland, Ore. The mixing is done by a rotatable drum having sharply pitched spiral blades; these blades are arranged in a manner to allow them to engage and cast material toward the center of the path of travel of the body of the machine. A series of fingers around the central circumferential portion of the drum cast the sand rearwardly in the path of travel in granular condition. The mixing fingers are hinged and are spring-controlled, so that the springs will not be broken should they meet with any unusual resistance. In such cases an automatic mechanism operatively connected with the fingers releases the drum from operative movement. The drum is operated by an electric motor. Less power is required than would be necessary for blades arranged only to stir the sand.—Lester L. Sargent.

PARTIAL COMBUSTION TYPE CARBURETOR

A RECENTLY patented form of kerosene vaporized of the partial combustion type is shown in accompanying illustration which is the invention of an English experimenter, E. W. Thomas of Luton. The construction may be easily understood by referring to the accompanying reproduction of the patent office drawing. This is a vaporizer of the form in which a portion of the fuel is burnt for the purpose of vaporizing the main part. The oil is supplied through a float chamber A of the usual form, and passes to the jet B and the wick chamber C. A supply of air is drawn, through the flap valve D, into the wick



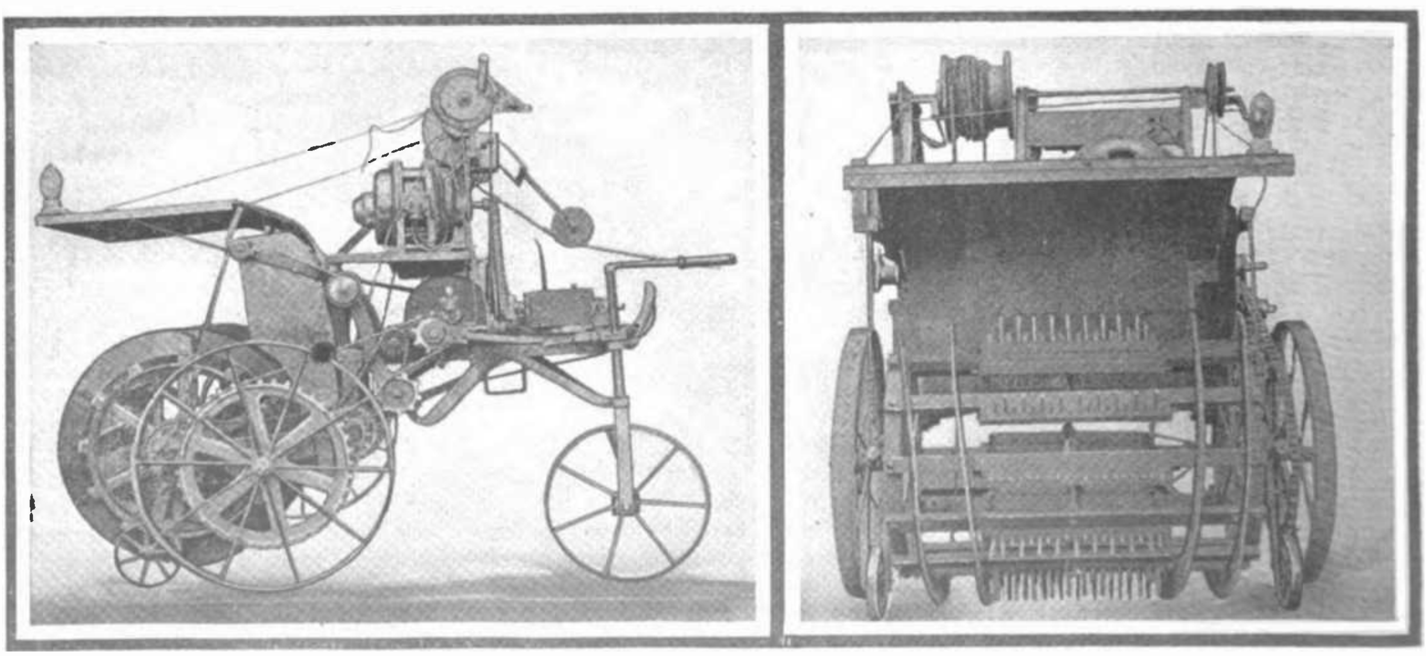
Partial combustion type carburetor

chamber, and there supports the combustion of part of the oil. The products of combustion pass, by the passage E, to the neighborhood of the jet and by the opening F to the exterior of the vaporizer G. These latter escape by the ports H. Baffles K K are arranged to intercept unvaporized oil, while air for the combustion of the resultant gas admitted at L, because the vapor coming from the producer portion is much too rich for energetic combustion in the explosion chamber of the engine and it must be thinned down by admitting auxiliary air.

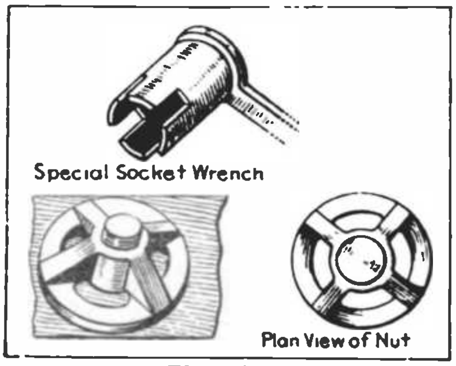
THE "WEB" NUT

THE ordinary hexagon nut is such a common object that few people give a thought as to whether it is the last word on the subject. As a matter of fact, an English firm has brought out an improved nut for which several advantages are claimed, especially for use in connection with aircraft. The general arrangement of the "Web" nut, as it is called, can be gathered from the sketch. It consists of a barrel with a flange at the lower end, and four webs arranged at right angles. The webs permit of the nut being screwed up or loosened by means of the special spanner, which is simply a short tube (with slots to fit the webs) attached to a handle, and the positive grip which is obtained makes the nut easier to tighten or slacken than is the ordinary nut.

It will be noticed that four slots are cut between the webs. Apart from the fact that this lightens the nut to a certain extent, it also permits of the nut performing the double function of nut and lock-out. When used on metal it is claimed that slight oxidization is permitted opposite the slots, and this is sufficient to prevent the nut working loose. Again, when used on wood, the



Sand-mixing machine for use in foundries invented by Russell C. Stokes of Portland, Oregon nut when screwed up allows the wood to swell into the slots just sufficiently to hold the nut and prevent it turning. As the nuts weigh less than those of

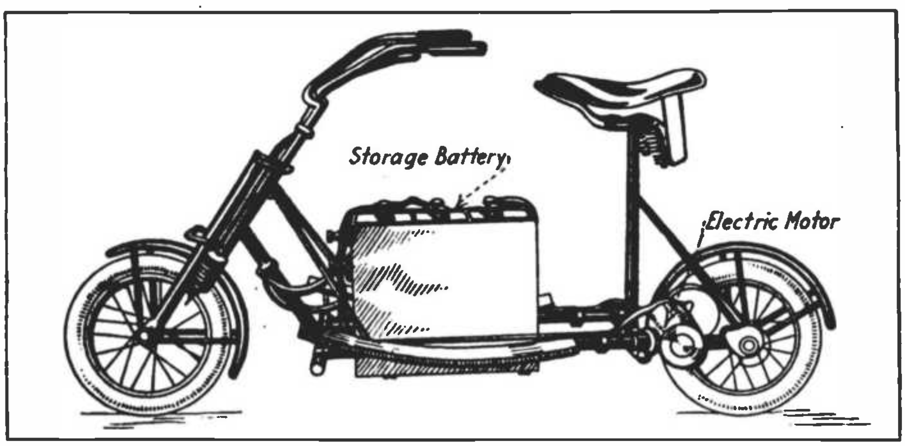


The web nut

ordinary design, and in ordinary cases render the use of a lock-nut unnecessary, it is possible to save a considerable weight by their use. The nuts are made in a wide range of sizes.

ELECTRIC MOTOR SCOOTER

THE experimental model of electric scooter illustrated here has been brought out in England and will attain a speed of 14 m.p.h. and cover about 40 miles on a single charging of the storage battery. The frame of the scooter is of duplex tubular construction so that a cradle is formed in the center of the frame. A ½ hp. electric motor, which with a reducing gear forms a single unit is bolted to the



An electrically-propelled motor scooter

rear part of the frame and drives the rear wheel which is 12 in. in diameter, through a small chain. It is expected that the diameter of the wheels will be increased to 18 ins. when the scooter is regularly placed on the market and the motor may be incorporated in the rear wheel. The battery which delivers current at 8 volts, weighs about 112 lbs. The cradle formed by the spreading of the two frame members supports the battery, which is readily detachable from the frame and can be moved on rollers to the charging point. It is expected that a charging plug will be provided on the frame of the commercial machines, thus making it possible for the battery to be charged without removing it. The control of the current from the battery to the motor is obtained by turning the right grip on the handle bar. A motorcycle saddle and footboards of ample size are included in the equipment.

A MOLDING MACHINE WHICH WHICH THROWS THE SAND

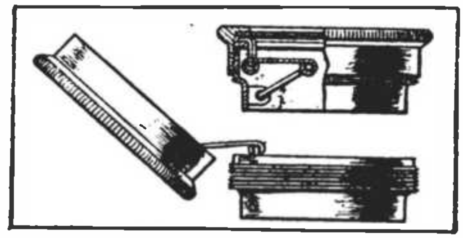
It will be possible before long to pour a casting without the use of a mold, so rapid are present advances. We have molding machines which do the work of several molders and now we have a sand throwing machine for filling molds. The experienced molder knows the effect and the practical value of throwing the sand in place, a handful at a time. So thrown the sand needs no further ramming. A machine to do this more expeditiously and with equal precision has been designed, and, after passing the test of several months experience in some of the Chicago foundries, has been put on the market.

The sand is thrown on the mold with considerable force by mechanical means. Hence a large quantity can be handled in a unit of time, so that finished molds should be turned out quickly. Obviously the density of the ramming can be regulated by controlling the speed of the impeller. The essential element of the machine is the throwing head, which is mounted on a double-jointed arm, allowing it to be swung into any required position over the mold. This head is connected by a shaft to an electric motor which runs at high speed. It is cast with three arms, on one side of which is a pair of brackets, to which the impeller is bolted.

When in use, the whole of the head is enclosed in a combination cast-iron and sheet-iron hood. The sand entering from a chute at the top, is violently ejected by the rapidly revolving impeller through a hole in the underside of the hood. For ordinary gray iron, a suitable speed is from 1,200 to 1,400 revolutions a minute; for steel castings a higher speed is required. The sand may be rammed at densities over the different parts of the pattern by passing the head slowly or quickly over the parts. Two standard types, one a tractor, the other stationary, are constructed.—*Scientific American.*

SCREW FILLER CAPS

TO prevent loss of the cap when disconnected, it is provided with a jointed link, one end of which is hinged to a lug within the filler-neck, the other end being hinged to lugs on a member rotatable within the screwed



Screw filler cap

cap as outlined in accompanying illustration. When the end of the cap is of metal, this member may rotate around a pin in the end face of the cap. When the end of the cap is a glass disc, the member can be, as shown, a ring retained between the cap. The jointed link permits the cap, when unscrewed, to be swung clear of the filler aperture and also to accommodate itself to the location of the cap on the filler neck for engagement of the threaded parts. This forms the subject of a recent British patent.

It has been seriously suggested that to economize in heating a house the chimney area, where open fires are used, should be restricted. It is claimed that with a large open chimney five to ten changes of air per hour may occur. Smoking chimneys are recognized as a source of great discomfort and damage from contamination of the air. Frequently it is said that there is a great loss of fuel due to the carbonaceous smoky particles, but one writer says that smokeless chimneys may indicate waste also if they are kept smokeless by the introduction of a great excess of air. Smoke, it is claimed by the same writer, only indicates one or two per cent waste of fuel, a smokeless chimney may indicate much more. The open-hearth fire, however, is coming to its own, as some recent experiments by the English Fuel Research Board show that 60 to 70 per cent of the heat in an open fire is usefully employed in warming the room itself and the general fabric of the building. Of the total heat of the coal no less than 20 to 25 per cent goes out into the room as radiant energy and with coke as much as 35 per cent may be so radiant.

Simple Keys and Keyways

Common Forms of Keys Used in Mechanical Work and Suggestions for Making Keyways Without Special Machine Tools

By Kenneth Alton

IN all machinery, and especially in automobiles and other automotive apparatus, numerous parts which must be removed from the pieces to which they are fastened and by which they are actuated when the mechanism is dismantled are held by a method of fastening called "keying." Various forms of keys are shown at Fig. 1, that at A being a form made from ordinary key stock which may have either rounded ends or square ends depending upon whether the key is to set into a keyway machined into the center of the shaft or at one end. If the keyway comes in the middle of the shaft, a round end key such as shown at A is generally used. If the keyway is at the end of the shaft, the key is apt to be a form having square ends or it may be slightly tapering on its upper face and have a projection at its outer end by which it may be removed. Such a key is called a gib key. Key stock is procured in various standard sizes and is usually made smooth enough when manufactured so that no great amount of fitting is needed to insert it in the keyway.

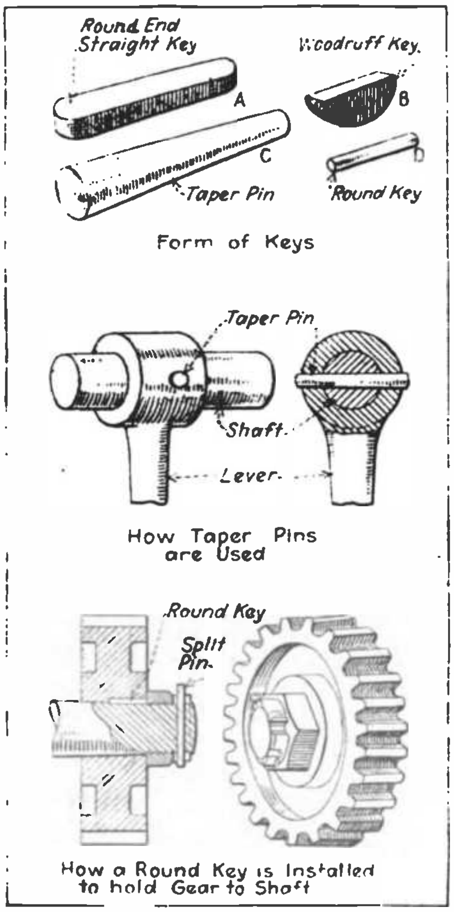


Fig. 1—Common forms of keys used in mechanical work

The key shown at B is known as the Woodruff key and is a very popular form in automobile and even in machinery construction. It is commonly used for securing such parts as gears, cams, and rocker arms to shafts. The taper pin shown at C is a favorite method of retaining brake actuating and control levers to the shaft operating them. The straight, round pin shown at D may be used in two ways; it may be driven entirely through a hole in the shaft and the hub of the lever and then headed over or it may be driven into a drilled hole which is made after the gear or piece it is to hold is in place on the shaft, the hole being drilled in such a way that half of it is in the gear and the other half in the shaft. The use of a taper pin is clearly shown while that of the round pin or key shown at D is also outlined. The half round keyway for the Woodruff key is shown in the taper end of the shaft outlined in Fig. 3 as is the method of making a template to obtain the radius of the Woodruff keyway when it is desired to fit a new Woodruff key or to determine the size of the keyway if the old key is lost.

The method of making the taper pin lock is a simple one. A straight hole is drilled through the boss of the lever and the shaft, the drill size being the same as that of the small end of the taper pin. Taper reamers may be obtained to conform to the taper of standard taper pins and these are employed to produce the correct taper in the straight hole in order that the corresponding taper pins may be a tight drive fit in both shaft and lever boss.

Laying Out a Keyway

The method of laying out a keyway when the rounded end key shown at Fig. 1 A, is to be placed in a shaft is shown at Fig. 2 A. The outline of the key is scribed on the shaft, care being taken to have the curved end a half circle whose radius is equal to half the width of the key. For example, if the key is supposed to be one-quarter inch wide and two inches long the first operation will be to describe a straight line along the shaft and to indicate thereon the useful length of the key, which is that of the straight portion, by center punch marks on the line. The dividers are then set to one-eighth inch radius and circles are drawn using the punch marks as centers. The sides of the circles are then joined by lines parallel to the center line. The next operation is to drill a series of holes into the shaft with a 7/32" drill as shown at Fig. 2 B. These are cut out by means of chisels such as shown at Fig. 2 C. The operation is started with a narrow chisel, followed through with the medium width chisels and finished off with the wide one which is accurately ground to the correct width of the keyways. A piece of quarter inch keystock is then obtained cut to the proper length and the ends rounded off with a file or on an emery wheel, to conform to the shape of the keyway. The method outlined is, of course, used only in a small shop where regular keyway cutting machinery is not available, as would be the case in an experimental or auto repair shop where milling machines or shapers are not included in the tool equipment. The method of making a keyway in the end of the shaft is similar to that for making one in the middle of the shaft except that it is much easier to chisel out the keyway with a cape chisel and finish it with a file as shown at Fig. 2 D.

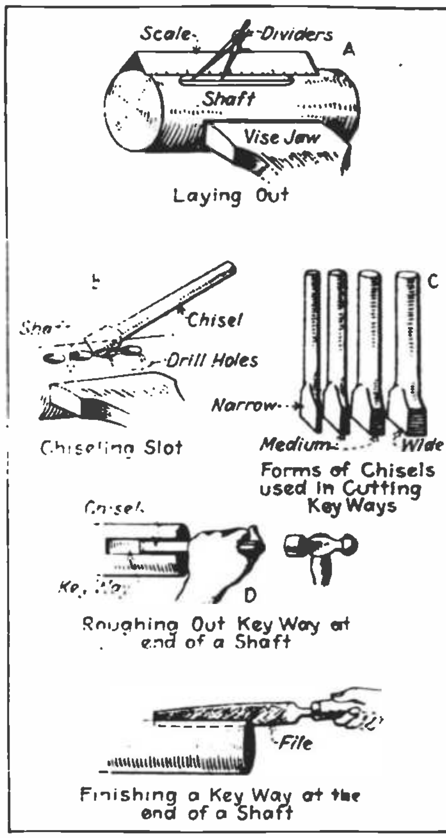


Fig. 2—How to lay out and cut a keyway without machinery

Woodruff Keying System

The Woodruff key may be obtained in a wide variety of sizes and in different materials. It is a very simple form to make if a key of the right size is not available. A very satisfactory Woodruff form key may be made from a bar of round stock of the desired material and radius as indicated at Fig. 4, in views A to F, inclusive. The first step is to saw into the end of the rod as shown at A, then to cut into the side of the rod with the saw as shown at B, this permits the piece of stock to break away as shown at C. Of course, the key is cut wider than the keyway it is to fit as well as longer than the regular size key. The operation of filing the sides and face to produce the finished key shown at F is easily accomplished.

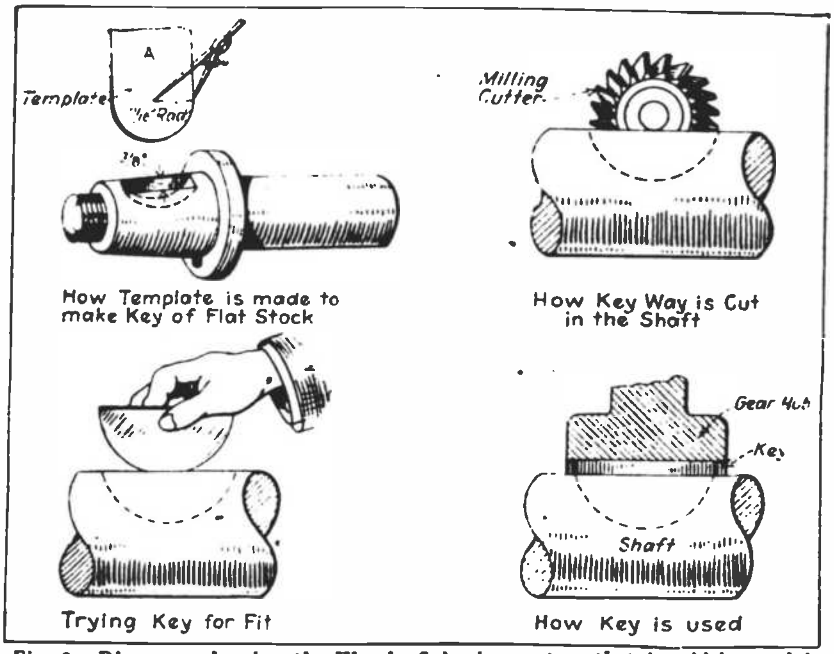


Fig. 3—Diagrams showing the Woodruff keying system that is widely used in automotive appliances

The keyway for a Woodruff key can be cut accurately only by a special milling cutter of the proper size made for the purpose. It is not necessary to have a milling machine to use this milling cutter as very satisfactory results can be obtained by putting it in a lathe or drill press chuck. The depth to which the cutter is fed into the shaft is outlined in an accompanying illustration. The key is then placed in the keyway and the hub of the part it is to retain is forced over the key and shaft as shown in the lower part of Fig. 3.

Care must be taken when fitting any form of retaining pin or key to have it a tight fit in its keyway because if keys are fitted so loosely that some degree of movement is permitted between them and the keyway there will be motion between the shaft and the part it drives and sufficient movement may develop so the key will be sheared off. This applies especially to keys subjected to variable or shock loads as in those employed for holding flywheels, driving wheel hubs, transmission system parts, gears, cams and similar components of machinery.

Each year sees the use of more and more Woodruff keys for fastening gears and similar parts to round shafts, for which reason the various sizes are of considerable interest. A table gives the various sizes which are referred to in the sketch above it, the letters in the table corresponding with those in the figure. There are 30 standard and many special sizes. These sizes vary from .5-inch diameter and .0625-inch thickness up to 1.5-inch diameter and .375-inch thickness. The general shape of the keys is that of a coin cut into halves, although to be exact the half is not complete, as the sketch shows. The key is set down into the shaft less than its full depth by almost the amount of its thickness, so that the portion projecting above the shaft and into the gear or other part is nearly square in section. One great advantage of this form over a square ended key is the ease of placing or removals, as a slight tapping on one end causes the semi-circular form to rock in its seat and one end to rise out of the key seat, until it projects enough to be picked out with a pair of pliers or the fingers.

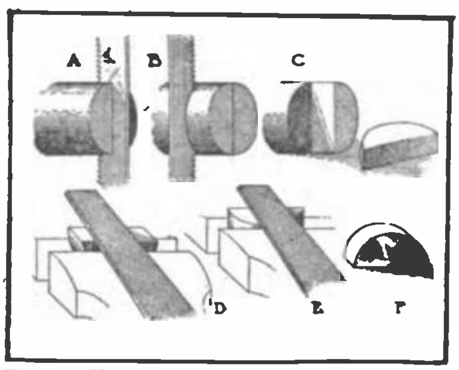


Fig. 4—How a Woodruff key may be cut from round bar stock

GERMAN METAL AIRPLANES

We have illustrated various types of metal airplanes in these columns, these being of German Junker design but there has been but very little information available about the salient points of construction. The technical department of the British Air Ministry has recently described two models which cannot fail to be of interest to those following aviation progress, an armored two-seater biplane, type J-1, and a single-seater pursuit monoplane, type D-1. Both are constructed entirely of metal and have cantilever wings. This firm has also produced a commercial six-seater cabin monoplane, which has been illustrated in a previous issue. Its construction is undoubtedly similar.

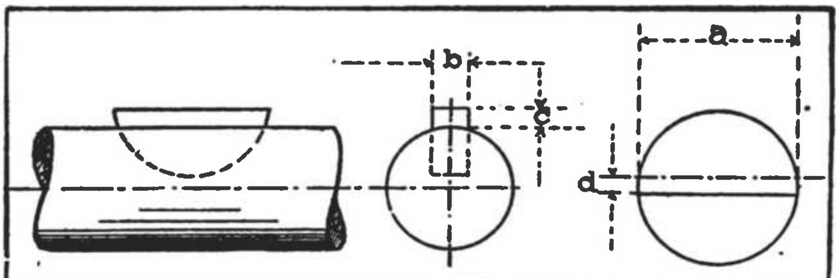
The wings have a deep section with a thick, round leading edge. This is also probably a "high lift" section. They do not have spars, as the term is generally understood, but have a rather large number of tubes running through the wing. In both types these tubes support the top and bottom surfaces. The biplane has ten such tubes in the upper wing and six in the lower. With the exception of two in each wing, they are arranged in pairs, that is to say, one under the top surface of the wing is directly over one on the lower surface. They are braced to each other within the wing by smaller tubes in such a way as to form a Warren truss between any two spar tubes. In the monoplane there are seven spar tubes, not in pairs, but evenly spaced when viewed from above but the bracing is the same. This construction is of sufficient strength to carry the bending moments due to the cantilever design. The fuselage of the biplane is made in two parts: an armor box containing the crew and engine, and a tail section built up of duralumin tubes in the form of a box girder and cloth covered. The pilot is under the center section and a square opening is cut in the upper wing for him to see through. The landing gear and center sections with their struts form a unit. The struts at the center section are the only ones on the machine. There is one pair on each side sloping outward and running from the lower wing roots to the upper center section. They are braced by another pair on each side, which cross to make an X and have the same fitting at the upper plane as the first pair. At their base they join the fuselage.

The metal used both for bracing and covering is duralumin. The covering of the wings is corrugated with the grooves running parallel to the line of flight. The sheet used for wing covering on the biplane is 0.015 in. thick and weighs 3.65 oz. per sq. ft. On the monoplane it is 0.014 in. thick. The bracing is of the same material, but steel is used generally for fittings.

The brief specifications of these two machines are:

D-1: Type, single-seater, pursuit monoplane; engine, 160 hp., Mercedes; span, 29 ft. 2 in.; length, overall, 22 ft.; total wing area, 158.8 sq. ft.; speed, 140 m.p.h.

J-1: Type, two-seater, armored biplane; engine, 230-hp., Benz; span, top 55 ft., bottom 35 ft. 7 in.; length, overall, 29 ft. 8 in.; height, overall, 11 ft. 9 in.; weight, empty 3724 lbs.; useful load, 845 lbs.; wing loading 8.5 lbs. per sq. ft.; power loading 19.9 lbs. per hp.



No. of Key	Diameter	Thickness	Depth in Gear	Less than ½ Diameter
	a	b	c	d
1	.500	.0625	.0312	.0468
2	.500	.0937	.0468	.0468
3	.500	.1250	.0625	.0937
4	.625	.0937	.0468	.0625
5	.625	.1250	.0625	.0625
6	.625	.1562	.0781	.0625
7	.750	.1259	.0625	.0625
8	.750	.1562	.0781	.0625
9	.750	.1875	.0937	.0625
10	.875	.1562	.0781	.0625
11	.875	.1875	.0937	.0625
12	.875	.2187	.1094	.0625
A	.875	.2500	.1250	.0625
13	1.000	.1875	.0937	.0625
14	1.000	.2187	.1094	.0625
15	1.000	.2500	.1250	.0625
B	1.000	.3125	.1562	.0625
16	1.125	.1875	.0937	.0781
17	1.125	.2187	.1094	.0781
18	1.125	.2500	.1250	.0781
C	1.125	.3125	.1562	.0781
19	1.250	.1875	.0937	.0781
20	1.250	.2187	.1094	.0781
21	1.250	.2500	.1250	.0781
D	1.250	.3125	.1562	.0781
E	1.250	.3750	.1875	.0781
22	1.375	.2500	.1250	.0937
23	1.375	.3125	.1562	.0937
F	1.375	.3750	.1875	.0937
24	1.500	.2500	.1250	.1094
25	1.500	.3125	.1562	.1094
G	1.500	.3750	.1875	.1094

Table of Woodruff key sizes and standard dimensions

CAUSE OF RACING CAR FAILURES

IN *La Vie Automobile,* Robert Faroux presents some interesting figures on the defects resulting in the failure or withdrawal of racing automobiles in the past decade. The article gives the results of a careful study of failures of cars in 84 tests and 1,000 cases of withdrawal from races and trials. The engine was the offender in a majority of the cases, while tires, which are often considered the weak spot of a car in severe road tests, had a remarkably low record of failures.

A study of these figures reveals some rather unexpected causes of trouble. While the treatment to which the valves are subjected is severe and it is not surprising that they should be responsible for nearly 12 per cent of the failures, the breakdowns resulting from the cylinders themselves is unexpected. This is accounted for in the author's opinion by defects in the casting or the modification of working conditions by the high temperature which occurs in the interior of the cylinder. Steel cylinders are not responsible for a single retirement. Another interesting point is the low percentage of retirements caused by tire trouble. Even at speeds in excess of 70 miles per hr. they were responsible for less than 3 per cent of the retirements or less than the clutch or the rear axle.

The causes of trouble as tabulated by Mr. Faroux are given as follows:

Engine

Valves	119
Cylinders	105
Connecting-rods	83
Cooling system	65
Crankshaft	57
Ignition	47
Lubrication	19
Camshaft	17
Carburetor	13
Distribution gear	7
Crankcase	7
Flywheel	5
Total	544

Transmission

Clutch	34
Gearbox	32
Transmission	24
Torque Tube	17
Universal Joints	14
Differential	9
Rear axle	57
Total	187

Chassis

Steering	45
Springs	25
Chassis	17
Wheels	63
Brakes	9
Tires and rims	27
Fuel Tank	27
Oil tank	5
Total	218

From the foregoing it will be evident that much of value can be learned from racing cars and that the experience gained by their builders can be applied to good advantage in constructing cars for commercial purposes because a single race may show up defective design or material that severe testing on the road under ordinary conditions would not make evident in a reasonable length of time.

IODINE AND BROMINE

Iodine and bromine are important elements and have extensive uses in pharmacy and technology. The great proportion of iodine has come from the nitrate deposits of Chile and its extraction from sea-weed was an important French industry, which is menaced by the obtaining of iodine from mineral sources, and also by the use of kelp and sea-weed as a fertilizer, which deprives the manufacturer of that source. Much interest is developing in the direct chemical treatment of sea-weed for the extraction of these elements because preliminary burning or incineration of sea-weed involves loss. The object is to extract the mineral elements, potassium salts, iodine, and bromine without destroying the organic matter. In California, by application of fermentation, acetic, propionic and butyric acids, acetone and ethylic ether have been produced. It has been proposed also, to make horse feed out of it. Dry distillation can be used to get tar, formic and acetic acids.

The Bienvenu Heater

MANY are the combustibles which have been proposed to take care of the coal crisis, and still more numerous the systems of heating apparatus which have seen the light of day since the war. Peat, lignite and various artificial fuels have supplied our stoves and furnaces, and their more extended and rational use has helped in the crisis which confronted all of us, but more especially nations like France and Italy. This coal shortage crisis has by no means been disposed of, and there is every reason to still search for palliatives for the evil which is sure to last some time.

To supplement illuminating gas, on which many people have depended, and which is unobtainable in many places, a very simple little apparatus has been invented in France, "The Bienvenu Heater," adapted to all kinds of stoves, cooking ranges, boilers, etc. Supplied with heavy petroleum or kerosene this heater produces the gas which it burns, giving a blue flame free from carbon and producing neither smoke nor dust. It burns a mixture of 80 per cent of air and 20 per cent of oil. It is easy enough to get fuel oil, wherever one may be, whereas other combustibles are not always easy to obtain. The heater has no delicate or incumbering parts and is easy to transport. It has the advantage over some petroleum furnaces now in use of giving an intense heat, due to the special spreading plates which are fixed in the path of the flames, as shown in accompanying illustration at Fig. 2.

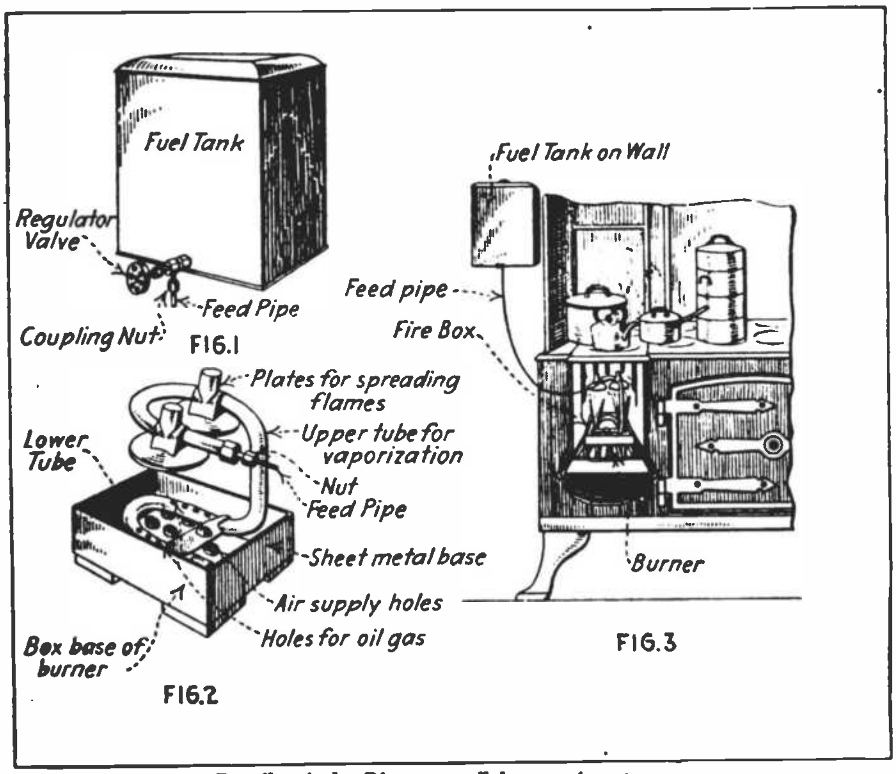
The expenditure of the fuel is slight, if we realize that it only burns 4½ quarts of oil in ten or twelve hours, according to the intensity of the heat, and that it is capable of boiling 135 quarts of water in 20 minutes.

It is composed of two parts: the oil tank and the burner proper. The reservoir, Fig. 1, has a capacity of about five quarts, it is provided with a regulator cock placed at its lowest part. A supply pipe effects the communication with the heater by means of screw couplings.

The burner, Fig. 2, is a hollow casting, a sort of rectangular box, covered with asbestos, and whose bottom is perforated with ventilating openings. This recipient measures 6 inches to 8 inches long and 4 inches wide and 2 inches deep. It contains a U-tube communicating with another tube of the same shape placed above it. The upper or vaporization tube carries two movable plates, designed to spread the flame and heat the vaporizing tubes, the lower tube is provided with two small orifices for the gas to escape through.

The very simple installation takes hardly three minutes. The heater having been placed in the fire box of the stove, Fig. 3, or under the boiler to be heated, the oil font is attached to the wall at a certain height. If it is placed at about five feet above the level of the heater, the pressure giving the maximum of heat will be obtained. The font and burner are connected by the supply pipe, the couplings are carefully screwed up with a wrench to avoid any leakage of oil. Next the font is filled with filtered oil, the base cock being closed. To light it a little wood alcohol or gasoline is poured into the burner casing and is lighted. This heats the upper tube to a high temperature. When this is effected a turn is given the regulating cock on the font which is at once shut off. A small quantity of oil escapes, which is vaporized in its passage through the heated tube and begins to escape by the orifices in the lower tube in the form of gas. Next the cock is opened to let the oil run down, and the gas is lighted, taking care to place the plates directly above the flames which they have to spread. These plates being adjustable, make it possible to direct the flame on the hearth, on the furnace or for the heating of water.

Before using the apparatus one must test the openings with a pin to see if they are obstructed, which would give an irregular and flickering flame. The burner must also be placed exactly level in the stove. When through with the heater and before it cools to any extent, a little cold water may be poured over it, which is all the cleaning it needs. The Bienvenu Heater is made in different sizes, according to the use to be made of it, whether for home use or for industrial purposes. The smaller sizes, such as we describe here, suffices for daily requirements in private houses, cooking meals, heating an apartment, a garage, heating the radiators of automobiles, etc. They will be of great use in country houses, on the farm, on motor boats and numerous other uses.



Details of the Bienvenu oil burner for stoves

LARGEST STEAM TURBINE

THE largest steam turbine ever built, developing 100,000 horsepower, has been installed in a street railway power house at New York City. It is said to be the first three-cylinder cross-compound unit in America. Superheated steam at 250-lb. pressure enters the high-pressure element and exhausts into the two low-pressure elements in parallel, condensing at 29-inch vacuum. At full load, the unit takes 826,000 pounds of steam an hour. All the elements which in an emergency can be used independently, run at 1,500 r.p.m. driving 25-cycle three-phase generators of 20,000 kw. each at 11,000 volts. The three generators combined have a two-hour overload capacity of 70,000 kw. The installation occupies a floor space 52 by 50 feet.

The production of nitric acid by synthesis from air has hitherto been very low in economy, as low as 2½% efficiency. Mr. Ferdinand Gros has endeavored to increase the economy of the process by drying the air perfectly, enriching it with oxygen and by these methods apparently is succeeding materially in perfecting the process.

ELECTRICAL PROGRESS DIGEST

ELECTRIC DRY-TYPE GLUE POT

THE Westinghouse Electric & Manufacturing Company has placed upon the market as an addition to its line an electrically heated dry-type glue pot, in a two-quart size. This glue pot is solidly constructed, consisting of a glue vessel of copper contained inside of a steel case. The glue pot may be easily removed for cleaning. This vessel fits snugly, making a perfect thermal contact with the heating element. There are many points of advantage and improvement of this line of dry-type glue pot over all other forms of heating glue. Among the most important are:

Westinghouse electric dry-type glue pot

The water bath is eliminated. With the old wet-type there was always danger of the water evaporating and burning the glue and the heater burning out. With the dry-type glue pot the current can be applied continuously without any danger of the heater burning out or the glue becoming overheated. The single-heat constant in-put heater gives the correct working temperature to the glue for continuous operation of the dry-type glue pot. The necessity of continuous additions of water and the inconvenience and sloppiness of the water bath are entirely eliminated. The new dry-type glue pot is more efficient because the glue is heated directly and none of the energy is required to heat a water bath.

There is a great saving in time because the glue is heated directly and held at the proper temperature without attention.

AN ELECTRIC ATOMIZER

THERE has recently been placed on the market an electric atomizer which is suitable for use in hospitals, schools, sickrooms, and in a variety of other places. It is suitable for sweetening cellars or ice boxes when formaldehyde is added to the water in the atomizer. The atomizer consists of a small brass bowl which contains a heating element imbedded in insulating material. The apparatus is mounted on a wooden base and is supplied with a cord and suitable attachment plug. In use, the bowl is filled with water and a few drops of perfume or disinfectant are added as desired. The boiling of the water drives off the liquid in the form of vapor, thus humidifying, perfuming or disinfecting the room.

LONG DISTANCE TRANSMISSION LINES

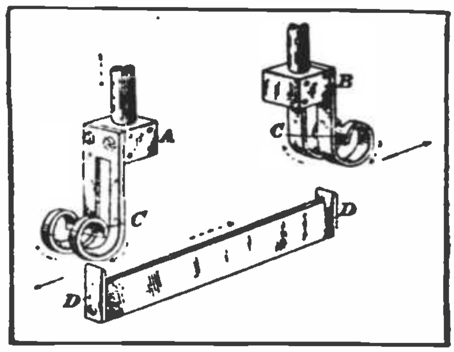
ACCORDING to a French engineer, writing in *Revue Generale de l'Electricité*, distances of 400 to 500 miles can be spanned with a transmission line by making use of the so-called "quarter-wave" construction. Such a line has the usual two conductors for single phase and three for three-phase, but frequency, capacity and inductance have such values that at no load the line is in resonance. The current must be maintained nearly constant at the generating end, and constant voltage will be received at the other, with reasonable regulation, efficiency and conductor cost.

ELECTROLYTIC IRON

WE have had occasion to speak several times of electrolytic iron. Another application of it for automobile repair work was carried out successfully during the war. It was found possible to deposit a layer of iron, up to about one-twelfth of an inch in thickness, on any cylindrical surface of wrought iron or steel. The metal adheres so that it cannot be chipped off. It can be subjected to red heat without apparent deterioration and can be carbonized and hardened in the regular methods of heat treatment. It enables many minor parts to be reclaimed. The greatest limitation to its use lies in the fact that it cannot be deposited satisfactorily on cast iron or aluminum. The best solution was found to be ferrous ammonium sulphate, seventy-five grams to the liter, with a one-tenth ampere current per 30 square c.m.'s of surface. The anode was made up of Swedish iron wire, woven into a sort of basket, so as to surround the work as nearly concentrically as possible. It was carried on a rocker arm and kept in motion, and to it were attached two celluloid cones so as to produce constant circulation of the solution. Constant renewal of the electrolyte in the vicinity of the surface of the work was thus ensured.

NON-ARCING OIL SWITCH

AN ingenious oil switch for blowing up the arc is illustrated here. The current from the terminals A and B divides into two parts, being conducted by the double conductors to the plate C,



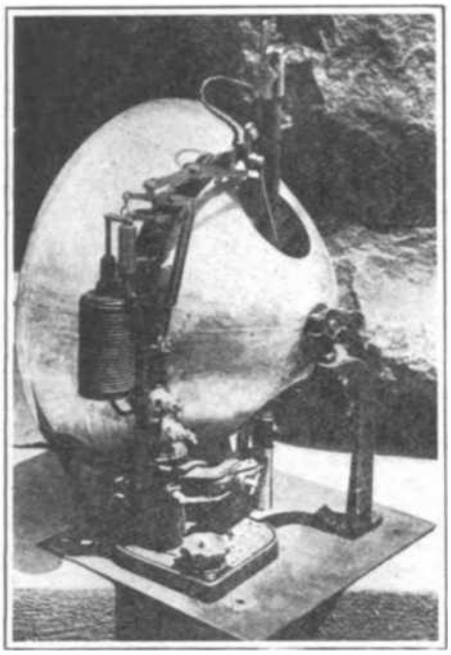
Non-arcing oil switch

uniting the lower ends of the two conductors between which the current divides itself. The plates C C coming in contact with D in the oil bath close the circuit. The conductors are curved onto a sort of solenoid and this creates a field designed to blow out any arc which may form on breaking the contact.

Aqueous emulsions containing 25 per cent of mineral oil have been found to be excellent lubricators. It is quite an interesting thing because of the high expense of lubricating oils, which constantly continues to, or threatens, to increase.

The well known singing or musical flame is being applied for the detection of fire-damp in mines. A flame contained in a tube is adjusted so as to be almost a singing flame, to be, as it may be expressed, on the edge of giving a note. A very small amount of marsh gas or fire-damp in the air will so alter the flame as to start it to sing, giving a very audible warning of danger.

At the Republican National Convention in Chicago locomotive headlights of the electric arc type with a parabolic reflector were used and made possible the taking of motion pictures there. To diffuse the light the plate glass in front



Modified locomotive headlight used to illuminate convention hall

of the reflectors was oiled and ground and the light in the great hall is described as approximating to white daylight. As a test of the reflector the sun's rays reflected therefrom burned a hole through a three-inch plank in four minutes.

Considerable attention has been given to experiments with wired-wireless transmission. It is partly a practical question in the line of supply. Thus in the year 1918 the United States were only good for eight thousand miles of twisted insulated wire per month. Under the conditions of the war this was far too little. The bare wire used in wired-wireless not only disposes of the necessity for braiding and insulation, but also occupies a very much less space in trains and ships holds. It works across rivers and underground and the general lines of wireless transmission are followed with it and frequency as high as one million cycles per second has been employed. It has been successfully used across the Potomac River. The best Atlantic cable of today is only good for a frequency of ten cycles per second, and for fifty to eighty volts potential.

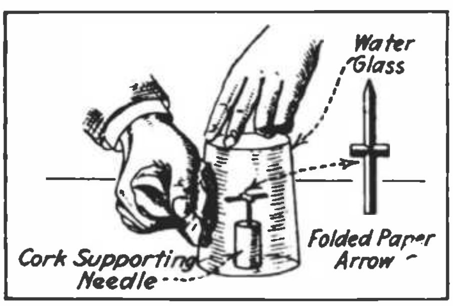
. Albert Hall in London, which occupies somewhat the same place in London life that the Madison Square Garden does in New York City, has changed its lighting system from arc lights to one thousand watt Mazda lamps.

In the United States one hundred and eighty-three millions of incandescent lamps were produced in 1919, three million less than in the preceding year. In 1918, 11 per cent of the lamps made had carbon filaments and in 1919 only 7 per cent have them. Twenty-seven million gas filled lamps were produced in 1919 and twenty-three million in 1918. The average candle power is on the increase.

A company with over $20,000,000.00 capital is being organized in England for the fixation of nitrogen. They will probably use a modified Haber process and propose to start off with a daily production of one hundred tons of ammonia salts and ultimately to produce as high as four hundred and fifty thousand tons of ammonium sulphate per annum. Ammonia products are oxidized, if desired, to give nitrates and they have very important use as such for explosives.

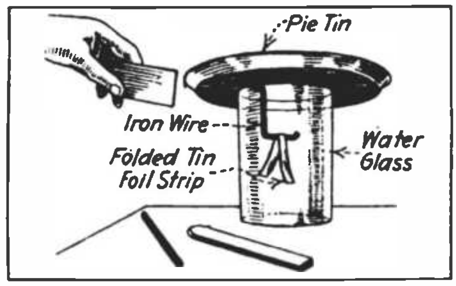
From the far East there are numerous reports of the development of electric power. In Japan some thousand miles of high voltage transmission lines are to be built within the next two years, presumably of the steel tower construction and possibly using aluminum conductors. From Korea and from Cochin, China reports of extensive electric installations in prospect are also given.

Some experiments with simple apparatus are shown in our cuts. In the first one a needle is thrust into a cork and on the cork is poised a paper arrow of the shape and folding shown on the right of the cut. When in position the least thing will cause the arrow to turn and its delicacy may be tested by a stick of sealing wax, which,



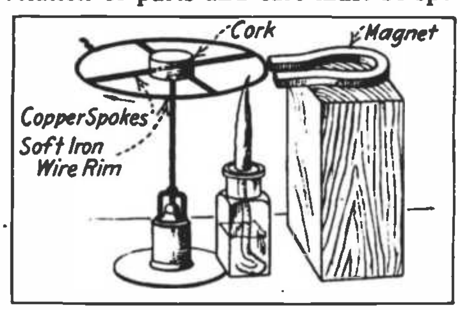
rubbed against the coat sleeve, will become electrified and will attract the point of the arrow when held near to it. Next a tumbler is inverted over the poised arrow and the glass of the tumbler is electrified by rubbing it with a silk handkerchief or a piece of fur. This electrification is local, and the arrow will turn so that its longest end points to the electrified portion of the glass, and by turning the glass around the arrow will also rotate.

The next cut shows a simple electroscope. A strip of tinfoil is suspended on a bent iron wire within a glass, as shown, and a pie tin is placed over the mouth of the glass, holding the wire in place. If an electrified object, such as a stick of sealing wax which has been rubbed with silk, wool or any animal substance, is touched to the plate, the latter will become electrified, as will also the strip of tinfoil and the ends of the latter will diverge. This



illustrates the principle of the electroscope, and the reader can refine the construction by using Dutch foil, or even gold leaf, for the strip and a neater suspending arrangement than that shown. The wire may go through the center of a block of wood, preferably parafined, which should fit the mouth of the glass.

The fact that hot iron is not magnetic is used in the next experiment to produce rotation of a wheel. The hub of the wheel is of cork, spokes are of copper wire and the rim is of soft iron. It is carried by a needle whose lower end rests on a plate of glass and is kept in position by a glass bead stuck to the glass plate with a little shellac or sealing wax. Care must be taken that none of this cement penetrates within the hole of the bead. A little metal brace keeps the needle vertical, and the greatest care must be taken to so adjust the wheel that it shall be in as nearly perfect balance as possible. A permanent magnet is placed on a block of wood in the position indicated as shown and a spirit lamp heats the wire as near the magnet as possible. Some experimenting will have to be done to determine the exact relation of parts and care must be spe-



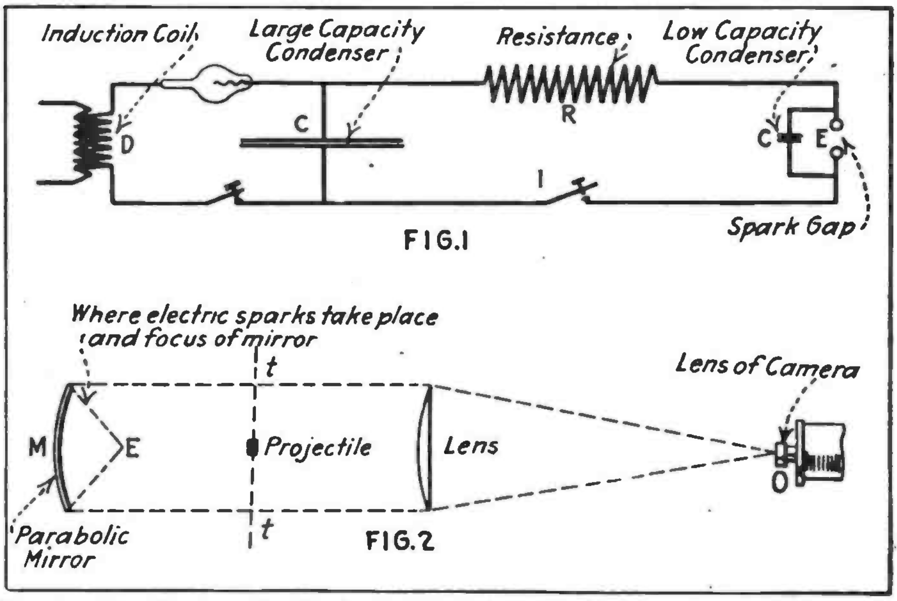
cially taken not to heat the permanent magnet. The heat of the lamp depolarizes the rim of the wheel in front of the magnet so that it is no longer attracted, but the more distant part of the rim, which has not yet been heated, is attracted, so that the wheel turns in the direction indicated by the arrows.

Photographing Projectiles in Motion

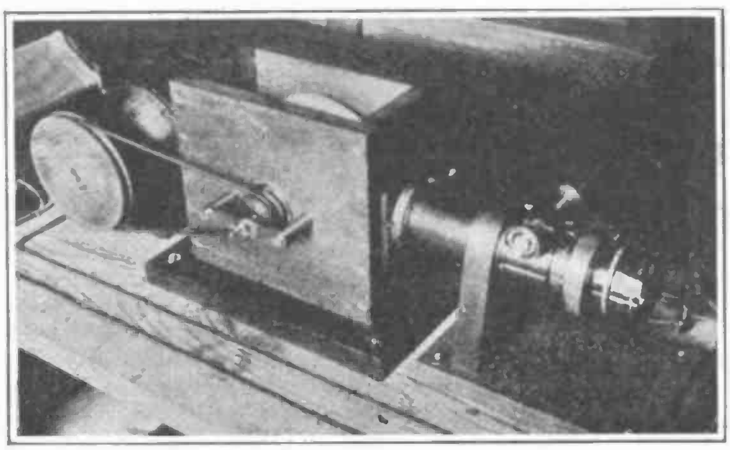
THE death in 1904 of Etienne Jules Marey, the eminent French photographer, removed from the stage an investigator who had done more to advance the development of instantaneous photography in the scientific field than any of his predcessors. After Maybiedge's very elaborate work Marey's great advance came as a direct simplification and not only that but he gave far superior results. In Paris today the Marey Institute is largely devoted to the class of work which it is fair to say originated with Marey.

Our illustrations show the apparatus and equipment for photographing projectiles in flight. We have already had occasion in our columns to speak of induction coil and Leyden jar spark photography which gives an incredible number of exposures in a unit of time. The standard speed of motion picture work may be taken at 16 exposures per second. In the work on the flight of projectiles as many as 15,000 photographs per second are taken, nearly 1,000 times as many. Thus it will be seen that if the projectile had a velocity of even 3,000 feet per second, which is very high, there would be 5 exposures given for each foot of its progress.

The diagram Fig. 1 shows the electric apparatus for producing the cascade of sparks. B is an induction coil, C is a large capacity condenser, E is the spark gap in parallel with a small capacity condenser C'. At I is indicated a switch. Referring now to Fig. 2, in which the optical system is shown, the spark gap is located at E in the focus of a parabolic mirror. This mirror reflects a parallel sheaf of rays to the condensing lens which converges them upon the objective O of the camera. The path of the projectile is indicated by the dotted line *t t* and P represents the projectile. It will be seen that the camera can photograph the projectile at any point within the diameter of the cylindrical beam of light reflected from the mirror M. A blast of air impinges upon the spark gap so as to prevent the formation of an arc. The diameter of the mirror M is 16 ins. By a simple inertia apparatus operated by the recoil of the



Figs. 1 and 2—Diagrams showing how it is possible to make 15,000 exposures per second



Electric motor-driven camera

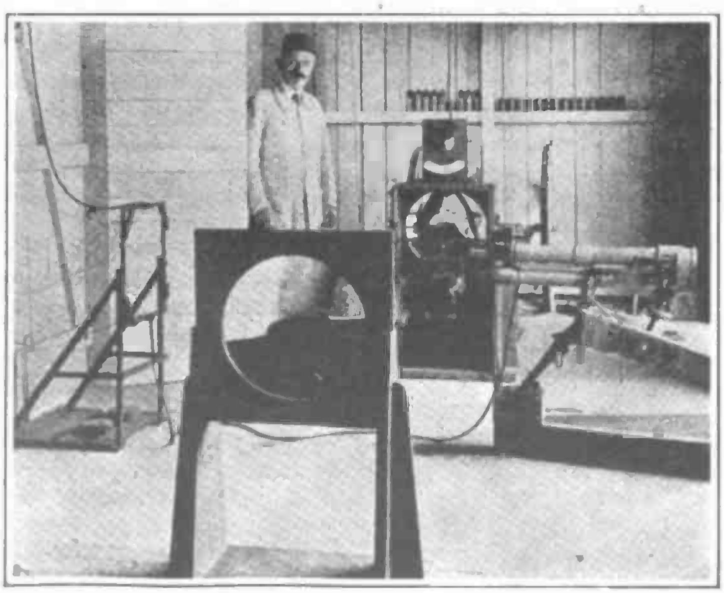


Fig. 4—Apparatus set up for photographing bullets in flight

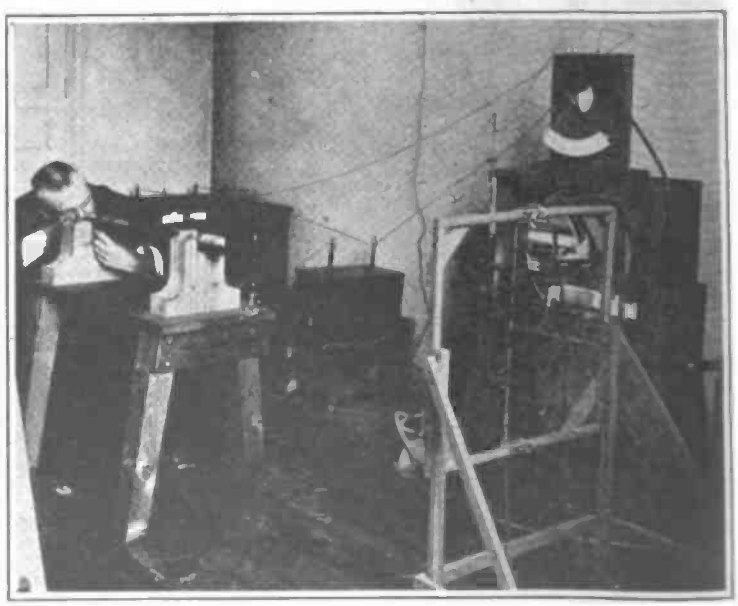


Fig. 5—Observer preparing to fire bullet across field of camera

piece discharged, pistol, rifle, or cannon, a film of paper is pierced and a contact made which closes the electric circuit and starts the stream of sparks. After the bullet has passed across the sheaf of rays it will have been photographed many times. Finally it cuts a wire, thus opening the circuit for stopping the sparks.

Within the camera K there is a light cylinder of duraluminum which rotates 12,000 turns a minute and a cinematograph film is wound upon this cylinder, whose speed of travel exceeds 300 feet per second. This film, it will be observed, can give from 5,000 to 25,000 images a second. Thus in studying the projectile fired from a 37 mm. gun, a frequency of 5,000 exposures per second was employed. The motor-driven camera and cylinder carrying the film are shown in Fig. 3, and the general apparatus with which the sub-director, Dr. L. Bull, photographed bullets in flight is shown in Fig. 4. The photograph at Fig. 6 shows the projectile of a 37 millimeter gun as it leaves the muzzle of the gun for the first few inches of the flight. Fig. 5 shows the observer preparing to fire a rifle bullet across the field that it may be photographed.

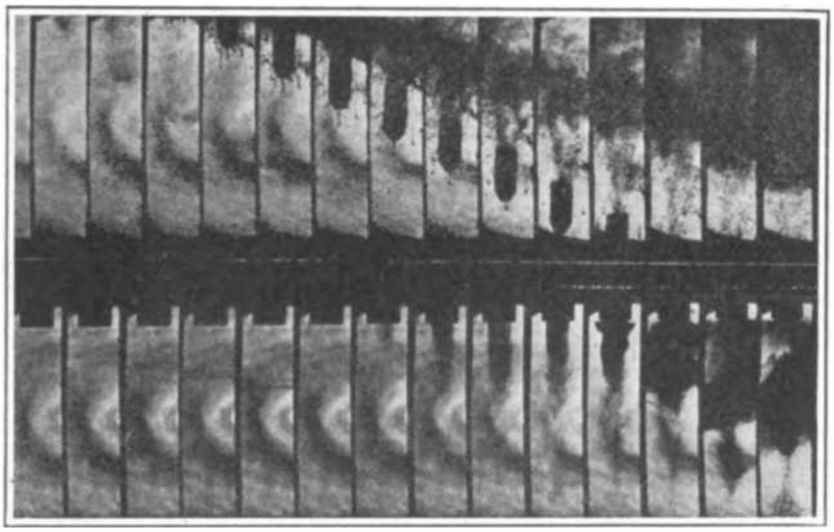


Fig. 6—Series of photographs showing bullet as it leaves muzzle of gun and escaping gases from powder explosion

THE WIMPERIS ACCELEROMETER

A DIAGRAMMATIC representation of the mechanism of the instrument is shown in the illustration. To make a measurement of the tractive effort necessary to overcome the resistance to motion, the instrument is leveled on the floor of the car by means of the adjustable leg, and then when the car is coasting the indication of the needle gives the reading in pounds per ton. The general nature of the internal mechanism may be described as a lopsided copper disc, mounted on a vertical axis and controlled in its rotation by a coiled spring. Any acceleration causes the heavier side of the disc to lag behind and so partially wind up the spring. The degree to which the spring is wound up measures the acceleration. Any tendency of the disc to oscillate is checked by a magnetic field at right angles to the plane of the disc. Besides these parts there is what is called "the compensating balance" which causes the instrument to record absolutely correctly, even when traveling around railway curves, or when on a road heavily cambered to one side or the other. The copper disc is shown at D; it has a hole cut in it near the circumference which has the effect of throwing the center of gravity slightly out of the center of the figure. On the pivot of the disc is fastened a spur wheel which gears in with another equal spur wheel, mounted on a parallel axis and carrying the pointer N. This pointer moves over a scale, not shown in the diagram. It will be seen that there is a small permanent magnet placed so as to damp the motions of the copper disc without having any of the sticking qualities which accompany frictional damping. The spring, which is called up by the rotation of the disc, is not shown, but lies in the horizontal plane just above the disc. In later forms of the instrument the arrangement described above has been varied slightly, but not so as to effect in any way the general principle of working. It had not been possible to include in the paper a description of more than a few of the tests which have been carried out, but the general conclusions which have been so far reached may be set out as follows:

(1) By the use of the accelerometer the road resistance of different kinds of roads or tracks, under various weather conditions, can be measured and compared;

(2) The amount of air resistance due to various forms of vehicle can be at once determined;

(3) The mechanical and thermal efficiency of the engine at various speeds can be obtained under real working conditions;

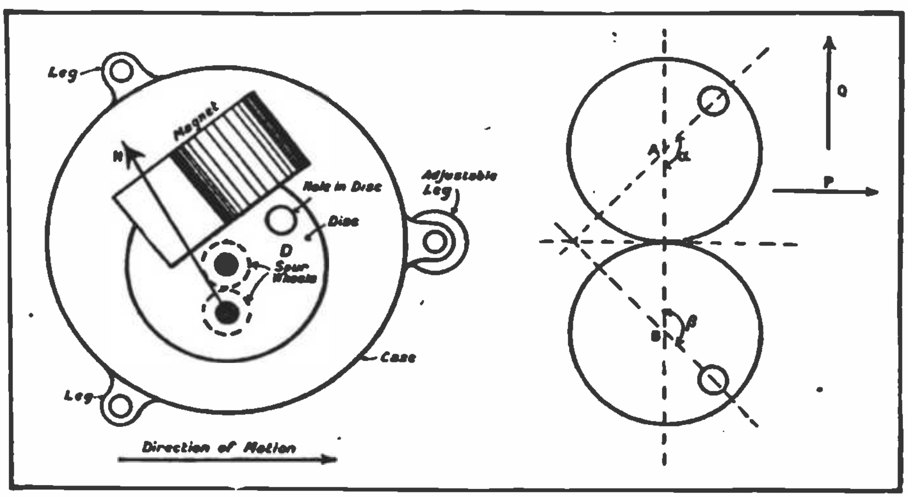
(4) The brake horsepower exerted by the engine when running at various speeds on the road can be easily obtained;

(5) It is possible to trace step by step the losses of power in transmission;

(6) It is possible to make a definite allowance for motor vehicles which are specified to show a given fuel economy (such as gross-ton-miles per gallon of fuel), and which may have to run their tests on exceptionally heavy roads;

(7) Lastly, the use of the accelerometer enables a useful interpretation to be given to speed and efficiency tests which are carried out on specially prepared motor tracts, having characteristics different from those of the ordinary highway at unrestricted speeds.

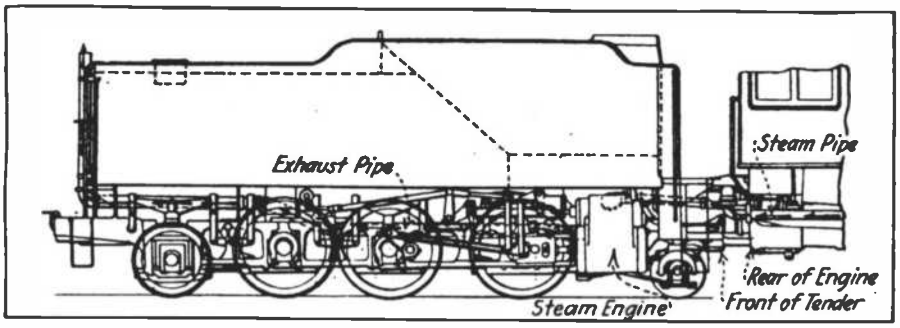
An English contemporary speaks of a ship's cooking range, fired by heavy fuel oil. It very appropriately is on an oil tanker, the *Narragansett*. Its small size six feet long and two feet wide with a single burner supplied by means of compressed air at a pressure of 45 lbs. to the square inch, indicates its efficiency, at it proved capable of preparing meals for 100 people. There is a special air pressure pump or compressor for the range.



Details of the Wimperis Accelerometer

DUPLEX LOCOMOTIVES

WE have already had occasion to mention a recent modification in locomotive practice in which an old engine and underbody was placed under the tender to be supplied with steam from the regular engine boiler, and we illustrate in the present issue such a locomotive. The underbody (or what in the automobile is called the chassis) of a locomotive engine is coupled back of the main engine and the steam chests are connected with the main steam supply. On this underbody is mounted the body of a regular tender, carrying the supply of water and coal. While it makes a big draught on the boiler, it is found that the duplex engine can be run for nearly an hour without pulling down the steam pressure unduly. In practice the tender-engine is cut off or throttled down when not needed, but in ascending heavy grades the pulling power of the engine can be greatly increased until the grade is surmounted. The writer has gone up a grade on the Canadian Pacific Railroad where as many as five locomotives were required to get the train up the incline. On one road a three-inch pipe supplies steam for the tender, taking it directly from a superheater. American engines are so often seen blowing off steam from their safety valves that they at least suggest a steaming capacity in excess of the requirements of the engine. In these cases it is evident that the extra engine under the tender can be taken care of as regards its steam supply. For the present most of this work has been done with old engines which may be in reasonably good condition but are too light for modern practice. If the system wins sufficient approval, there is little doubt that new engines will be built on this system.



Drawing showing arrangement of steam cylinders for driving tender

NEW AIRPLANE WING RIB

EXTREME altitudes—the objective of Major R. W. Schroeder and aviators of like ambitions—are not to overshadow another problem of aeronautics, that of multiplying the speed range of airplanes. A new type of airplane rib developed by the U. S. Bureau of Standards, by varying the angle of attack, is capable of making greater speed than hitherto possible with the prevailing wings and was reported recently by S. R. Winters in the *Scientific American.*

Described as the Parker variable-camber wing, the newly designed equipment recognizes the principle of construction that if the angle of attack can be efficiently varied from a very small to a very large angle, a wide range of speeds is possible. The properties of the type of wing usually seen are held responsible for the restricted speed of airplanes.

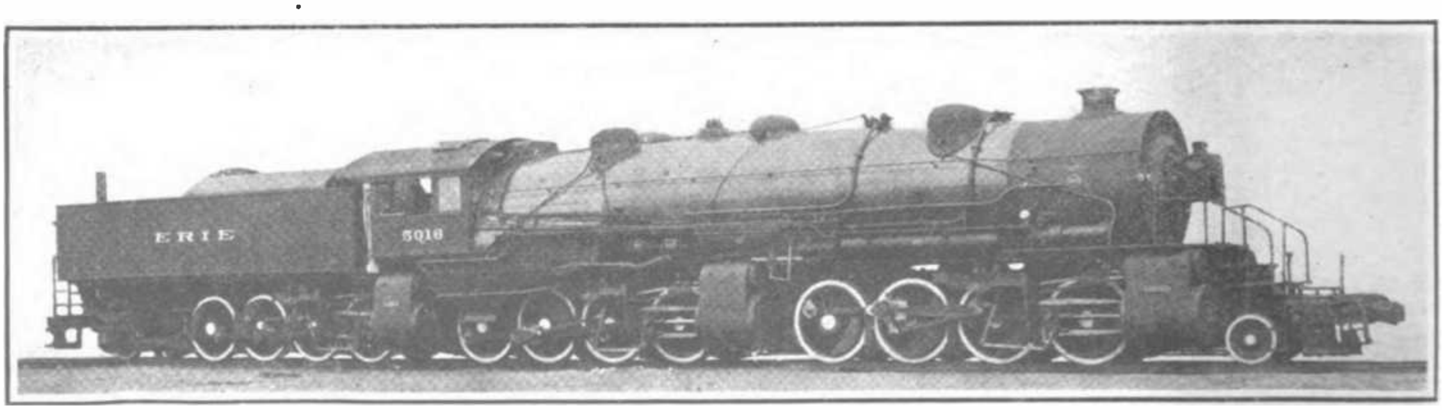
Among the features of the rib structure of the Parker variable-camber wing are: Deformation regularly with the load up to the unit flying load, then remains rigid under further applications of weight, being strong enough to stand up under several times its normal load without failure. Simple, fool-proof and easily manufactured are the virtues claimed for the wing. Metal construction is necessary in the new type of rib; other portions of the machine, such as spars, bracing wires and struts, are not altered. The essential parts of the new wing are: Channel shaped strips forming upper and lower surfaces of the rib between the spars; compression links are of channel section, also, and fixed to outer channels by pins, allowing necessary angular motion between links and strips; the tension links are flat strips of steel attached to the same pins which carry the compression links.

A radical departure from the prevailing type of wings, these links in streamline position carry no load, but in a lifting attitude they straighten out and make a truss of the rib, thus preventing further deformation under loads. The links in the first two and last two panels are slotted to permit of the insertion of reserve links. A tail piece is fixed in shape, riveted to the upper strip and constructed to slide over the rear spar. A spring is placed between the rear spar and the tail piece, this spring being used as a tension attachment to the rear spar and the front compression member of the tail piece.

A NEW ITALIAN AIRSHIP

ACCORDING to the Italian *Gazzetta de l'Aviazione* of recent date, the new Italian semi-rigid T34, known as "Roma", has given excellent results on test flights at Campiano. The ship. due to Comm. Useulli, has a capacity of 34,000 cu. m. (nearly 1,200,000 cu. ft.), is 128 m. (422 ft.) long, and has a maximum overall height of 27.5 m. (90 ft.). She is powered by six Ansaldo-San Giorgio twelve-cylinder V engines of 500 h.p. each, or may be fitted with an alternative power plant of 12 S. P. A. engines of 250 h.p.

Cruising with two engines (1,000 h.p.) the speed is said to be 85 km. h., and with the full 3,000 h.p. a speed in the neighborhood of 130 km. h. is expected. The disposable load is stated to be approximately 19 tons. Depending upon the length of the journey to be undertaken, the "Roma" can carry from 50 to 100 passengers.



Massive steam locomotive used on the Erie Railroad has three sets of drivers and engines, a pair of engines being used to drive the tender

Heat Treating Alloy Steels

A Series of Simplified Articles Detailing the Various Methods of Heat Treating Modern Alloy Steels. This Installment Explains the Critical Range and Why It Varies in Steels of Different Carbon Content

By Victor W. Pagé, M. S. A. E.

PART 5

Meaning of Critical Points

IF we heat up simple steel pieces of any composition containing less than .40 carbon, three points are observed, even though the piece is allowed to remain in the furnace where the temperature of the steel does not change for a few minutes.

These are the critical points of heating and are indicated on temperature chart as Ac_1, Ac_2, and Ac_3. On cooling the piece it will be found that there are three similar points, where the temperature of the steel does not become less, or it may even appear to rise. These are the recalescent points and are indicated as Ar_3, Ar_2, and Ar_1. These points are about 70 degrees Fahrenheit lower than the ascending points indicated by Ac, which are known as the decalescent points. This variation in temperature results from a certain amount of lag, which is due to the time consumed in the molecular change which takes place in the internal structure of the steel and which critical point represents alterations in the internal molecular arrangement of the steel, which are now well known to heat-treating experts.

These critical points may be understood by considering the case of water, which when heated to 212 degrees Fahrenheit, does not become any higher in temperature even though the heating process is continued until it is all steam, still at 212 degrees Fahrenheit. After this point, the rise continues, but in the process 760 B. t. u. of heat have been consumed on account of the structural change in the water, during which it changes from liquid to a vapor. In steel that has more than .40 carbon, for example, steel containing .90 carbon, which may be considered as the saturation point, we find that three critical points have combined into one and in particularly high carbon steels we note that there are two critical points.

To explain the reason for the various critical points occuring in steel of different carbon contents, the reader would be led into a discussion of the allotropic theory of iron-carbon alloys, which is not within the scope of a series of simplified discussions of this nature as it cannot be explained without the use of technical terminology. In simple language, the phenomena producing the critical points may be explained as follows:

When low carbon steel is heated to about 735 degrees Centigrade, or 1,355 degrees Fahrenheit, the pearlite in steel changes and absorbs heat and becomes a micro-constituent called austenite. The ferrite or iron is slower to transform, but by continuing the heating process it eventually changes into austenite also. For example, in a .67 carbon steel with about 25% ferrite, this micro-constituent is not transformed to austenite until a temperature of 1,415 degrees Fahrenheit is reached. The lower the proportion of carbon in the steel, the higher we find this latter temperature.

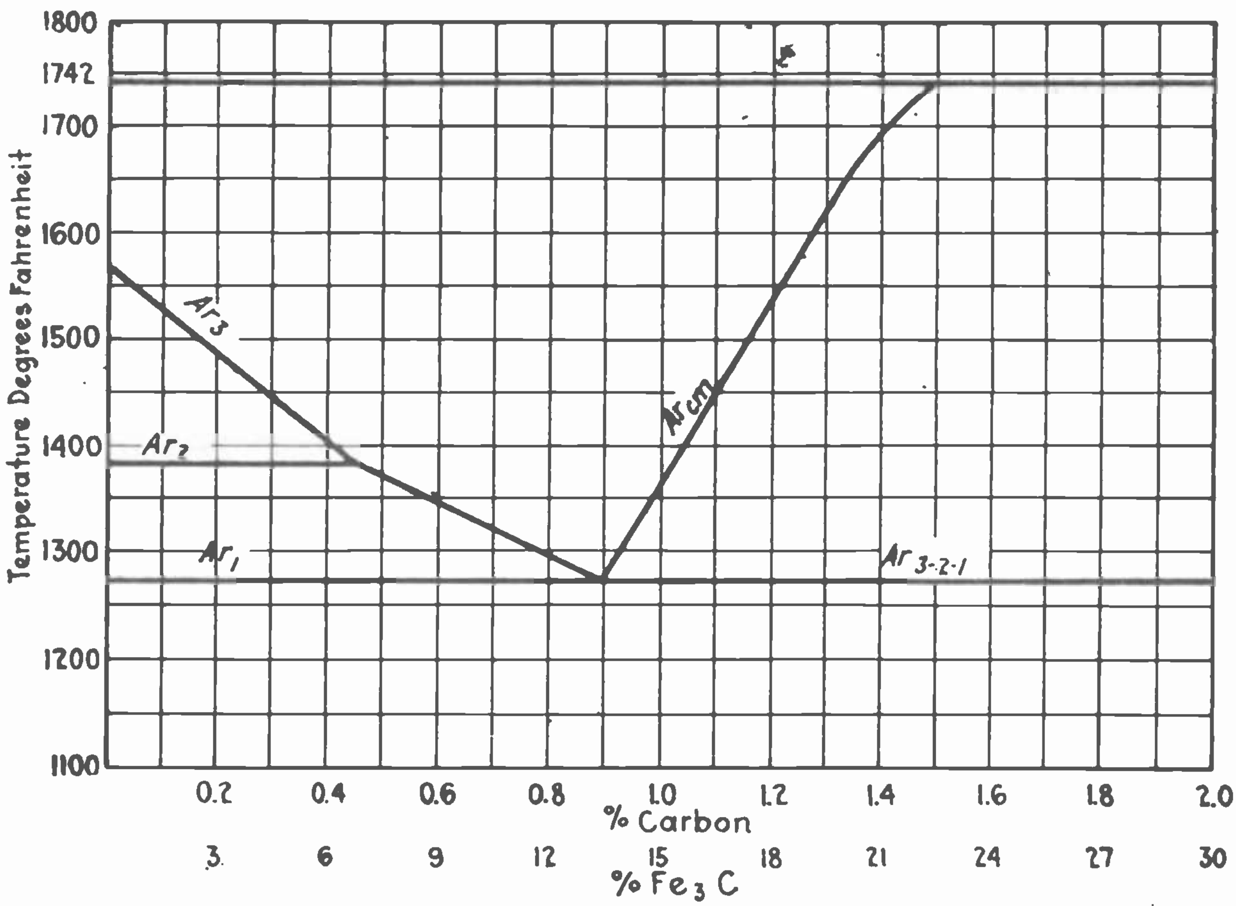


Diagram showing the approximate position of critical points of cooling for steels of varying carbon content. These are known as recalescent points, while change points on the rising heat are known as decalescent points

When pearlite only is present, as in .90 carbon steel, the change is completed with the transformation of pearlite at a temperature in the neighborhood of 1,350 degrees Fahrenheit. When the carbon content is higher than this, the pearlite first changes at about 1,350 degrees and the free cementite present, much later. In 1.50% carbon steel, the transformation does not take place until a temperature of 1,690 degrees Fahrenheit is reached.

It may seem to the non-technical reader, that the matter of critical points has been stressed unduly in this series of discussions, but it is believed that when the facts are fully appreciated, that the importance of treating steels of various compositions, at most suitable temperatures will be fully recognized. To use a homely simile, if a housewife removes a loaf of cake or bread from the oven before it is cooked through, the interior of this loaf will be found to be a paste or dough, which does not have any of the qualities of the outer, cooked skin. The same thing applies to steel, as really heat treating is merely a process of cooking the material in order to effect certain internal and surface structural changes. These structural changes in the molecular arrangement of the micro-constituents are produced by heat and as we have seen, different changes in the molecular arrangement take place at different degrees of heat.

The purpose of cooling the steel more or less rapidly is to fix the desired internal structure so that it will remain a characteristic of the piece after heat treating; just as the object of baking dough into bread is to turn a soft, pasty substance that is not eatable, into one that is harder and that has been changed chemically so that it can be assimilated by the digestic organs. The object of heat treating steel is to take material that may be soft and easily worked on machines in its annealed condition and by proper heat treatment, change it into a strong and hard material on which further machining processes or changes of form would be difficult. It is easier to mold dough into the form of loaves before it is baked than after it has undergone the heating process. For the same reason, it is easier to machine steel while it is soft than after it has been hardened by any of the heat treating processes described in a preceding installment.

A study of the foregoing will show that improvement in the quality or physical proportions of any alloy steel, can only be brought about by heating the steel to, or beyond the critical point, at which the molecular change takes place and then quenching it in brine water or oil, depending on the degree of hardness desired and the chemical composition of the alloy.

If steel is heated to a temperature below the critical point and then quenched in any cooling medium, it will be found that the structure of the steel will not be what is desired, nor will the grain be properly refined. If steel is heated to temperatures higher than those determined to be the change point, and then quenched, we find that this will result in hardening the steel, but it will have a much coarser grain than if the quenching had been done at the top of the critical range.

Even the old-time rule-of-thumb steel hardener recognized that the finer the grain of the steel, the stronger it was and it is understood that to obtain the maximum refinement of grain, the heating and cooling qualities of any special grade of steel must be determined by scientific means and the treatment or heating operation confined as closely as possible with respect to the critical range of temperatures. The reader will see that careless heat treatment will impair the quality of the treated parts. There is no use of paying the high prices asked for alloy steels unless one will follow the heat treatments that will bring out the superior qualities of these alloys.

It is not only necessary to heat the steel to the proper temperature, but it is also important that the heating be performed uniformly. A loaf of bread cannot be baked by throwing it into a hot fire, it must be placed in an oven and the temperature of the oven maintained at a certain heat for a certain period to complete the baking process. It is exactly the same with steel. If a cold piece of steel is thrown into a raging hot furnace, the temperature of which is above the critical range, the transformation of the pearlite and ferrite, or later, the cementite into austenite is rushed beyond the capacity of steel to withstand it, and this condition is more critical, the higher the carbon content of the alloy.

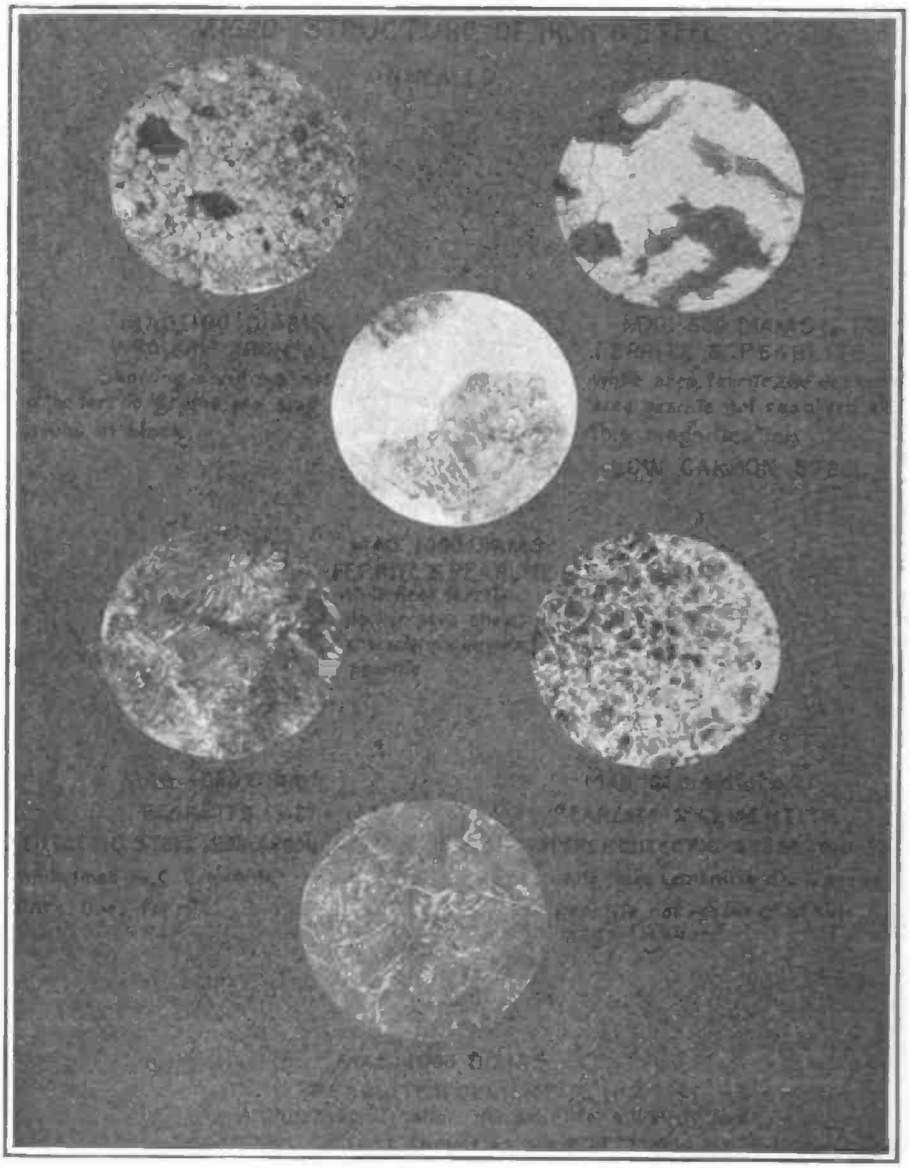


Photo-micrographs showing the microstructure of annealed iron and steel

The molecular expansion which occurs may be so rapid as to cause cracking or fracture of the steel pieces. Then again, if the flame or source of heat acts directly upon the work, the transformation will take place on the surface long before it takes place at the core, inasmuch as this will produce a core having certain characteristics and the skin having widely different ones. It is apparent that cracking or warping of the piece must ensue as a result.

This explains why muffle furnaces and lead or salt baths give better hardening results than heating the steel in a forge fire or an unprotected blast flame would. Then again, in a lead or salt bath, upon the introduction of a piece of cold work, the salt or metal solidifies to a degree about the surface of the work and melts away from it slowly as the piece becomes heated throughout, and in this way serves to help in slowing down the transformation period.

It is found advisable to pre-heat certain grades of steel to a medium temperature before they are inserted in the hardening furnace, as this assists in having the steel pass through this critical range without damage. While cracking or fracture due to improper heat treatment may not be a serious matter in the case of a simple tool or an inexpensive automobile part, it will be apparent that it is a matter of considerable moment and a source of great expense if it takes place on a die, for example, used in drop-forging, or metal stamping, on which a month or more of a skilled mechanic's time has been expended.

The changes of structure in steel brought about by heat treatment have been summarized by Brinnell as follows:

Changes of Structure Brought About by Heat Treatment

1. When a piece of steel, hardened or unhardened, is heated to the upper critical point, Ac_3, all previous crystallization, however coarse or however distorted by cold work, is obliterated and replaced by the finest structure which the metal is capable of assuming, the structure of burnt steel being the only exception, save that in steels of .2 carbon or lower a multiple treatment of some kind is often necessary (the ferrite, pearlite and cementite is changed to austenite).

2. When a piece of steel, hardened or unhardened, after being heated to Ac_3 is allowed to cool slowly it retains the fine structure which it had acquired at that temperature. It then possesses the finest structure which *unhardened* steel is capable of assuming. (The austenite reverts to the original pearlite and ferrite but the grains, however coarse originally, become now the finest and best distributed possible.)

3. When a piece of steel, hardened or unhardened, after being heated to Ac_3 is suddenly cooled by quenching in cold water; for instance, it is fully hardened and retains the fine grain acquired at that temperature. The metal then possesses the finest structure which *hardened* steel is capable of assuming. The austenite which tends to rapidly revert through several stages to pearlite, etc., is trapped before reaching the soft pearlite stage and the resulting structure, depending on the carbon content and the alloying chromium, nickel, manganese or other elements, is either composed of martensite, the hardest stage in steel, except cementite; and the condition of greatest volume, troostite, which is softer than martensite or sorbite, which is softer still. But in each of these conditions the structure is the finest possible.

4. When a piece of steel, hardened or unhardened, is heated to a temperature *above* Ac_3 and cooled slowly, the metal whose crystallization has been obliterated by its passage through Ac_3 crystallizes again, the crystals or grains increasing in size until Ar_1 is reached below which there is no further growth. If the steel is heated above Ac_3 and allowed to cool to Ac_3 again and there quenched, it will be fully hardened but its structure will be coarser than if it had been quenched from Ac_3 without having been heated higher.

5. The higher the temperature above Ac_3 from which the steel is cooled or quenched the coarser the grain.

6. The slower the cooling from above Ac_3, the coarser the grain.

7. When a piece of hardened steel is heated to a temperature below Ac_3 some of its cementite is changed spontaneously into pearlite and the metal is thereby softened. This tendency increases with the temperature and is greatest at Ac_1. This transformation, however, is not accompanied by a change in the dimensions of the grain.

Researches in which the writer took part and the recent work of Professors Howe and Zimmerschied have developed that:—

1. When a piece of steel, hardened and slowly cooled or unhardened is heated to the temperature Ac_1, the cementite existing in the pearlite structure is radically altered from the previous laminated form to the globular state and the resultant is thereby softened and rendered ductile, though the size of the grain is unchanged.

2. When a piece of steel previously heated to Ac_3 and then either hardened or allowed to cool slowly is thereupon heated to Ac_1 and allowed to cool slowly the resultant structure shows globular cementite and is the softest and most ductile that steel may assume, the size of the grain being the smallest possible.

Brief Review of Steel Composition

Steel is an alloy of iron and carbon in its simplest form and is not found in nature. Steel has been defined as iron which is malleable or that is capable of hardening by sudden cooling. This metal is a modified form of iron that has more carbon than malleable or wrought iron and considerably less than cast iron. This is not an exact statement of fact, because some of the modern so-called steels have as low a carbon content as wrought iron. The properties of the various forms of steel that have been adapted to industrial uses naturally vary according to amount and nature of the alloying elements. We have learned that low carbon or mild steel contains from five-hundredths of one per cent to three-tenths of one per cent carbon. This carbon content is too low to have the steel hardened by quenching after the steel has been brought to a cherry-red heat unless the steel is subjected to a carburizing process to increase the carbon content at the surface, and then, of course, only the surface hardens. Steel containing from three-tenths of one per cent to eight-tenths of one per cent carbon is known as "medium carbon" steel and may be hardened to some extent by the quenching process. If the carbon content is from eight-tenths of one per cent to two per cent, we have what is known as "high carbon" steel, which is capable of being rendered very hard and at the same time brittle by heating to the required temperature and cooling suddenly by quenching in oil, water or brine, depending upon the degree of hardness desired and the use for which the steel is intended. The harsher the action of the quenching medium, brine being the one used to obtain maximum hardness, the more brittle the steel becomes.

Alloy Steels

Alloy steels have now come into extensive use due to the great advances that have been made in the automotive industry. In the development of the automobile and aircraft it has been necessary for engineers to design parts that would be light in weight and yet possess much more strength than could be obtained by using ordinary commercial grades of steel and iron. Among some of the elements which have been used in combination with carbon and iron are found manganese, nickel, chromium, vanadium, tungsten and molybdenum. The use of these elements either alone or in combination is to produce qualities of strength and hardness combined with ductility. The various natural properties imparted by the alloying elements may be greatly increased by intelligent heat treatment or may be entirely nullified by improper heat treatment.

The ordinary grade of nickel steel contains about one-quarter of one per cent carbon and 3 to 3½ per cent of

(*Continued on page* 551)

European Sport Planes

Some Recently Developed Small Airplanes for the Individual Flier

By E. H. Lémonon

EUROPEAN builders of airplanes have built sport machines of several models, each one being very different from any of the others. All these planes are designed to meet the requirements of a quick get-away, a fast climb, and a high speed combined with a low landing speed, to ensure the greatest possible degree of safety. The design and construction embrace light weight and economical upkeep to the highest degree consistent with the above qualities. Our Paris correspondent has sent details and photographs that will be interesting to the readers of EVERYDAY ENGINEERING MAGAZINE who are following aeronautical developments.

A Clean-cut Monoplane

The French Morane-Saulnier, Parasol, A. R. Type, shown at Fig. 1, has a fuselage of a good streamline shape; the nose and front are covered with aluminium, doors in the side giving access to the engine, the remainder being covered with linen. This "Parasol" is a two-seater tandem, the pilot being in front the passenger and immediately behind the engine. The body tapers to a vertical strut at the rear, on which the rudder is hinged; the fuselage is simple and as lightly constructed as possible. The motor is an 80 h.p. Rhone provided with dual ignition. The landing gear is composed of a chassis of streamlined steel tubing welded by the oxy-acetylene process. Rubber shock absorbers bind the axle to the struts. The landing wheels have big tires to enable it to land on rough ground. The empennage is composed of a non-lifting fixed stabilizer, to which are fastened the elevator flaps. The ailerons are connected to the control-stick by rigid connecting rods, actuating shafts passing through the wings.

The Morane-Saulnier is very quick in answering to the controls, and capable of performing any "stunt". It flies at 153 kilometers (95.1 miles) an hour as a maximum speed, with a minimum of 80 kilometers (49.7 miles), and will climb to 6,000 meters. American pilots trained at Issoudoun will remember a modified form of this plane equipped with a 50 h.p. Gnome engine as a "rouleur" or penguin for preliminary training. The wing spread was reduced and the ailerons left off so the embryo pilot could not leave the ground.

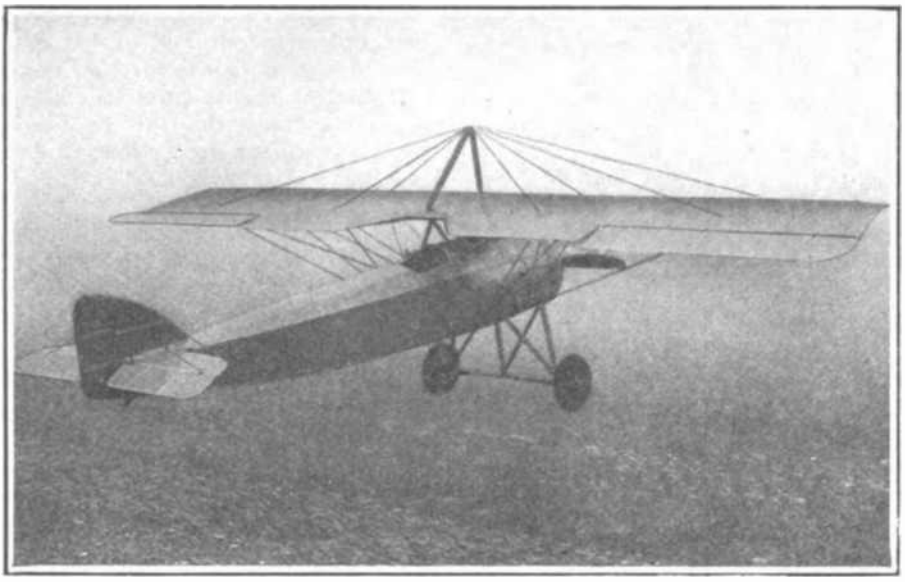


Fig. 1. The Morane-Saulnier Parasol A. R. Type Monoplane

The specifications are as follows:

Span	10 m. 565
Length	6 m. 767
Height	3 m. 405
Total area	21 + sq. meters
Weight of machine empty	400 kgs.
Weight of fuel	67 kgs.
Weight, useful	160 kgs.
Weight, total	627 kgs.
Load per sq. m.	28 kgs. 630
Engine	80 h.p. Rhone
Weight per h.p.	7 kgs. 840

The Dutch Spyker V. 3 Type

The well-known Dutch firm "Trompenburg" of Amsterdam, who built the famous "Spyker" car, is also building two models of planes, one of which is shown at Fig. 2. The manager is Henry Wynmalen, the pre-war aviator.

The latest model is illustrated and the specifications are as follows:

Span (upper and lower)	8 m. 10
Total length	6 m. 10
Height	2 m. 60
Total area	20 sq. m. 280
Weight empty	350 kgs.
Useful load	350 kgs.
Total weight	700 kgs.
Engine	Spyker 130 h.p.

Fig. 2. The Dutch Spyker V-3 Type Biplane

Maximum speed........190 km. hour
Minimum speed........ 80 km. hour
Duration .... 4 hours
Safety factor 8

The Spyker engine is a 9-cylinder rotary engine of French Clerget type, giving 135 h.p. at 1100/1200 revolutions per minute. The bore is of 120 mm. and the stroke of 160 mm. Valves are mechanically operated by push rods, one exhaust and one inlet valve being provided. The pistons are of aluminum alloy. Hollow connecting rods are used with fixed gudgeon pins floating in bronze bushings in the piston. Cylinders are all steel and integrally machined, including the flanges. The ignition is of dual type and the total weight is of 138 kilogrammes.

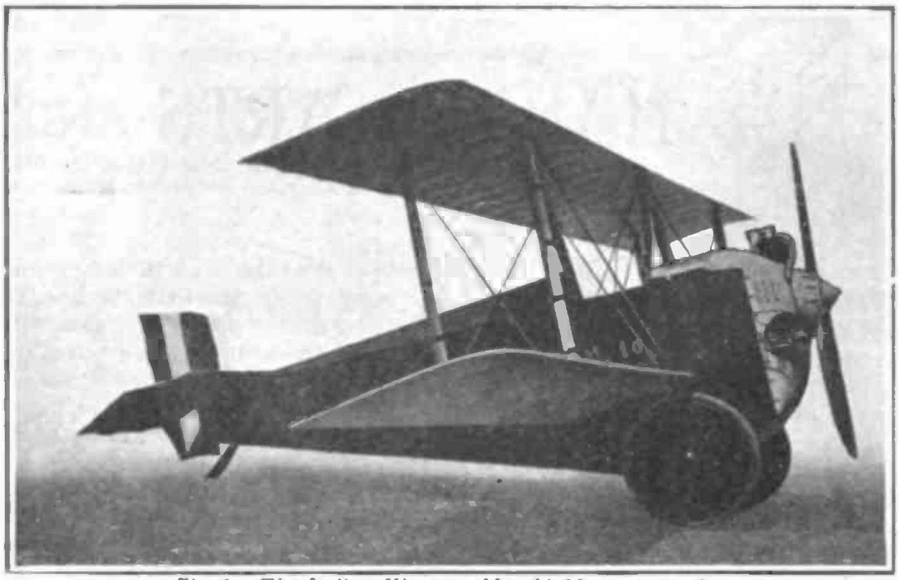


Fig. 3. The Italian Nieuport-Macchi M-16 sport plane

Fig. 4. The Nieuport-Macchi seaplane with two-cylinder motor

The Italian Nieuport-Macchi M. 16 Sport Plane

This is a single-seater with a biplane body, a pusher screw, and a monoplane tail. The smallness of its dimensions and the low power of the engine are so unusual that it has been called "the air motor-cycle". The upper wings are fixed to the double cabane, whereas the lower are attached to the fuselage, which is of rigid trellis construction, and though of a simple construction, is very strong. The fuselage itself is fitted with a comfortable cockpit for the pilot.

This compact craft, shown at Fig. 3, was originally built for sporting purposes, but it can be used for training cadets as it is inexpensive as well as for perfecting the already qualified pilots. The machine is said to be very manoeuvrable and is easily handled.

These are the specifications:
Span .... 6 m.
Total length .... 4 m. 20
Surface .... 12 s. m.
Engine ....30 h.p., 3 cylinder
Weight (empty) ....160 kgs.
Loading .... 95 kgs.
Air endurance .... 2 hours
Highest speed ......130 km. per hour
Climb at 1,800 m. in 26 min. 30 sec.

The Macchi Company has also built the M. 16 flying boat shown at Fig. 4. which is of absolutely the same type as the preceding one, except that a twin cylinder engine is used. The two floats can be easily substituted for the wheels of the landing gear shown on the land machine.

The Italian R. 6 40 H.P. Triplane

Ricci Bros. of Naples have built a single-seater sport plane that is very small, it is the "R. 6 40 h.p. triplane" and has also been called the "flivver" of the air. Its construction is shown (*Continued on page 533*)

Fig. 5. Italian Ricci 6 forty horsepower sporting triplane

MANUAL ARTS AND CRAFTS

PROJECTS FOR THE SCHOOL, HOME OR SHOP

SLAT FURNITURE

THIS method of construction is specially adaptable for boys that have that manly desire to create worthy projects for the home. It is excellent for beginners, as it trains the hand and the eye in a most skilful manner. For developing the ability to saw accurately, it has no equal, as a boy appreciates the fact that all his efforts count. Quick, concrete results stimulate the youth more than any other fact, therefore a boy just naturally glories in watching the growth of his own handiwork. The more one studies these problems from the educational as well as the practical aspect, the more it is appreciated that to keep a boy interested results in a development of skill, stamina and courage. Skill is acquired by diligent and intelligent practice, stamina from properly directed energy, courage is born of repeated successes.

These projects are especially designed to develop the art of sawing close to the line, thereby eliminating that tedious monotony of chopping, cutting, scraping and planing to the line. With a little concentration (called care) one can soon acquire the skill to saw within a sixteenth of an inch from the line. Begin by marking across the grain with a pencil sharpened flat similar to a knife, using the try square to guide the lines. Squaring around the stock so that the lines will remain parallel to the saw cut on all four surfaces is an excellent guide for all; even the expert uses this method when he is particular or wishes to eliminate any possible chance of a "slip up." Therefore it will surely repay the amateur to draw the lines on all four surfaces until he finds himself so skilful that he can saw both straight and square by sighting.

The design at Fig. 1 is an octagonal Taboret, very useful when used as a sewing basket, smoking stand, or plant pedestal. This project requires a little more than 5 square (board) feet: No. 1, 1 piece, ¾" x 12" x 33" to 36", and 1 piece, No. 2, ¾" x 12" x 36" long. Establish the working edge (standard edge so called) straight, smooth and square on No. 1 piece, then carefully gauge a line on both sides 1¾" from the working edge. In most cases with experienced workers, both edges are planed straight, square and smooth, then gauged from both edges. This saves a little time in the operation. Rip saw near the line, allowing not less than 1/16 of an inch, watching the lines on both sides.

Time may be saved by laying out the position of the shelves and cutting these pieces to length before cutting to width. Now lay out the octagon as indicated in Fig. 4. There are several ways to do this. This method is given because it may be done by the compass or the radius may be laid off by the rule on the sides of the square. First, establish the working edge, then lay out the square as large as the stock is wide,—that is, the width of board after truing up will determine the size of the square (shelves). Then draw diagonals as indicated, the distance from this intersection to the corner which equals the radius as shown in Fig. 4, rising all four corners of the square as centers of their respective arcs. The shelves may be laid out separately or one may be cut out, planed true, then used as a pattern to draw out the others. Care must be taken to have them match; that is, when

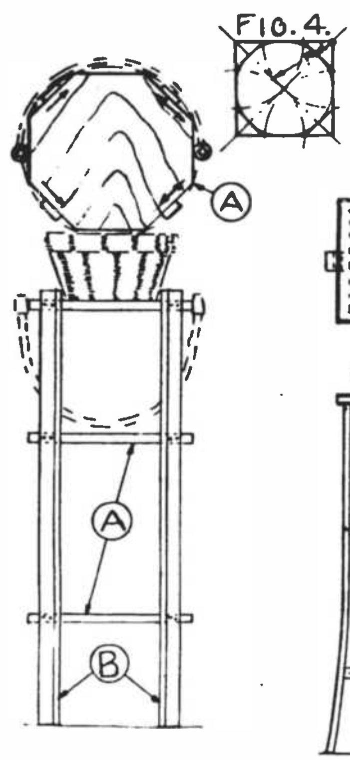


FIG. 1.
OCTAGONAL TABOURET

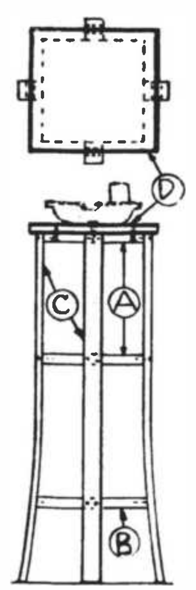


FIG. 2.
SQ. TOP STAND

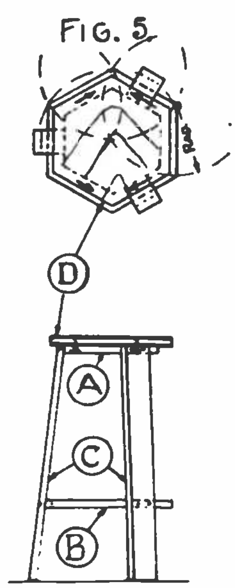


FIG. 3.
HEXAGONAL STOOL

ALL DIMENSIONS IN INCHES

SLAT FURNITURE
Designed For The Beginner By C. E. Mullerman
Manual Training Instructor N.Y. City Schools
LISTS OF MATERIAL

FIGURE 1
UTILITY TABOURET

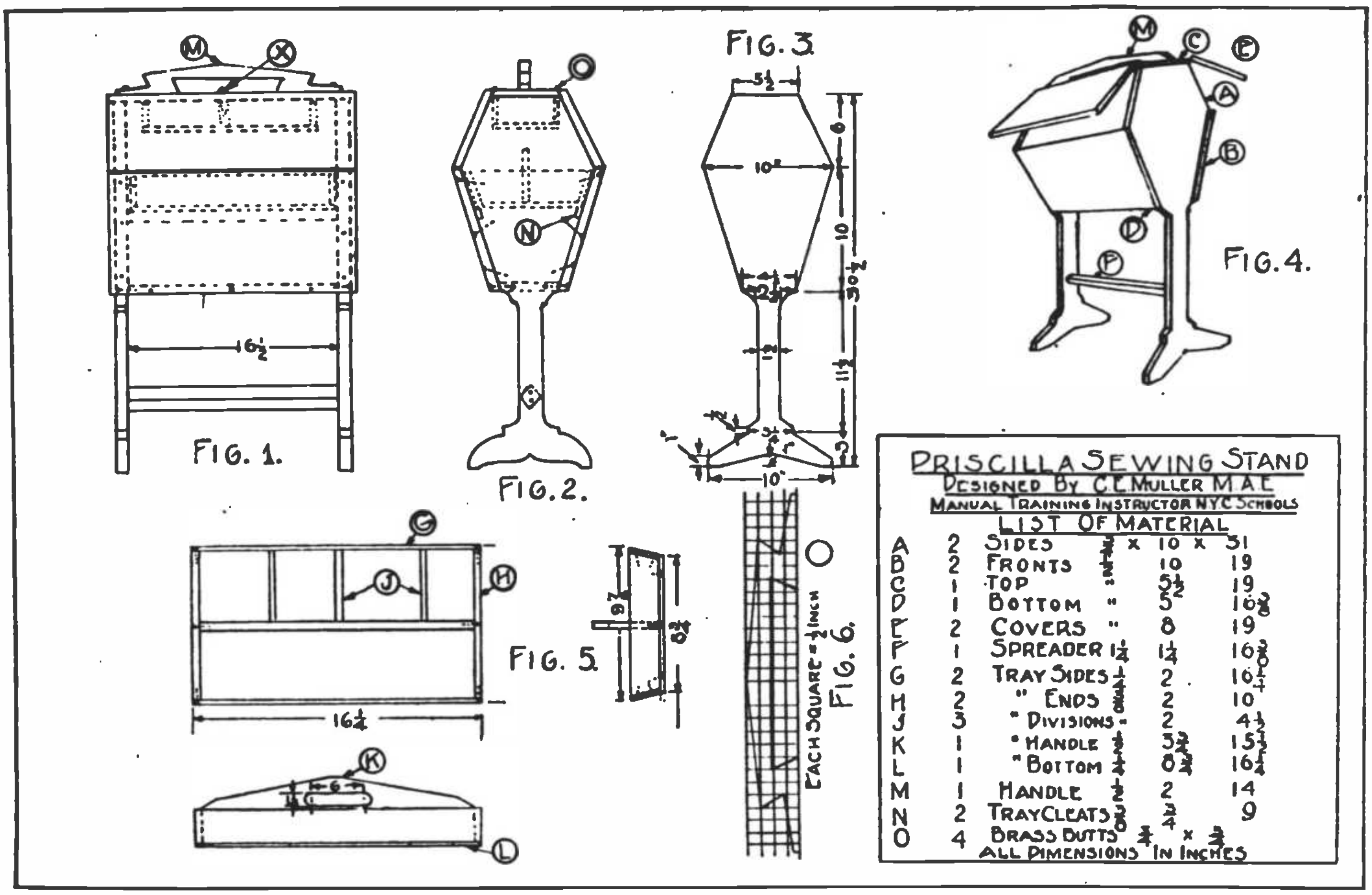
A	3	SHELVES	¾ x 12 x 12 (1¾ sq)
B	4	LEGS	¾ x 1¾ x 33

FIGURE 2
JARDINAIRE STAND

A	2	HEADERS	¾ x	7½ x	7½
B	1	SHELF	"	8½	8½
C	4	LEGS	"	1½	26
D	1	TOP	"	9½	9½

FIGURE 3
CONVENIENT STOOL

A	1	HEADER	¾ x	7 3/16 x	8¼
B	1	SHELF	"	9½	11
C	2	LEGS	=	2	18
D	1	TOP	=	8⅝	10



PRISCILLA SEWING STAND
DESIGNED BY C. E. MULLER M. A. E.
MANUAL TRAINING INSTRUCTOR N. Y. C. SCHOOLS
LIST OF MATERIAL

A	2	Sides	¾ x	10 x	31
B	2	Fronts	½	10	19
C	1	Top	"	5½	19
D	1	Bottom	"	5	16⅜
E	2	Covers	"	8	19
F	1	Spreader	1¼	1¼	16⅜
G	2	Tray Sides	¼	2	16¼
H	2	" Ends	⅜	2	10
J	3	" Divisions	-	2	4½
K	1	" Handle	½	3¾	15½
L	1	" Bottom	¼	8¾	16¼
M	1	Handle	½	2	14
N	2	Tray Cleats	⅜	¾	9
O	4	Brass Butts	¾	x ¾	

ALL DIMENSIONS IN INCHES

planed (temporarily nail them together and plane as one) they should be so marked that they remain in the same relation to one another. If this is not done the legs will not lay straight, but be slightly bowed. This may be done by marking the corresponding corner of each shelf. By sawing accurately to the line 90% of the work is accomplished. When sawing or planing be sure to go with the grain, especially at the corners as indicated by the small arrows, Figs. 4 and 5.

The legs are nailed on to the shelves with two 1¾" to 2" No. 16 wire brads. These should be lock nailed, as explained in the next project, at each place of contact. Care must be taken and trials made frequently to insure that the shelves set perfectly level (horizontal with the floor) as the project stands upright.

The designs at Figs. 2 and 3 are of practically the same construction and need but little additional instruction. The principal difference between Fig. 1 and Figs. 2 and 3 is that the legs do not project above the top but are nailed to a header which allows the top shelf to project. This gives a more finished appearance, also extra strength. The top shelf is fastened by wood screws that protrude upward through the header.

The lower shelf of Fig. 2 is bevelled to fit the flare of the legs. The header and lower shelf of Fig. 3 are bevelled likewise. This method permits chamfering the edges of the top shelf as described and diagramatically shown in the next issue. Set the brad heads in about 1/16 of an inch. Putty of the same color as the stain should fill the holes. Stain the project as desired. See the former issue for a number of home-made stains and methods of application. It may then be finished with 1 or 2 coats of shellac, wax or varnish as described in the August edition.

PRISCILLA SEWING STAND

THIS sewing stand is a very attractive and convenient receptacle for mother's or sister's fancy work and embroidery. The appreciation shown by them surely compensates for the little time and expense required in its construction. A handy person can produce one of these stands in an incredibly short time. One especially apt in woodwork can easily complete this project in 8 to 10 hours, including the staining. Chestnut wood is particularly recommended for this project, as it has very attractive grain and exemplifies the antique; also it is soft and easily planed and cut.

Select two pieces of stock ⅝" to ⅞" x 10" x 31", temporarily nail together, establish the working edge, then square the ends to length. If the sawing is accurately done, it need only be sand-papered with No. 2, then with fine sand-paper when the project is complete. If the design of Fig. 3 is used a cross-cut saw will suffice for the entire job, including the handle K of the tray, which may be made similar to M and then nailed or glued on the tray partition.

The fronts B and top C, Fig. 4, are made to extend beyond the sides A to give it the Colonial aspect and are lock nailed, as indicated in Fig. 2, with nine 1½- to 2-inch No. 16 wire brads set and puttied. The bottom D is a plain butt joint depending only on the nailing as indicated. The covers E are hinged at the top with two ¾" x ¾" brass butt hinges. Care must be taken to allow for the proper bevelling for the joint. The spreader F must be substantial, as it may be used as a foot rest. If this component is made diamond shape or even square, set with the diagonal vertical, it will add to its appearance. A strip ¾" by approximately 2" with chamfered corners will suffice. This also acts as a brace for the legs of the stand.

The tray, Fig. 5, is simply butt-jointed, then lock nailed with approximately 36 1¼-inch No. 16 wire brads. The partitions are in number and position to suit one's fancy and are usually used to hold the scissors, thread, needles, etc. Of course this tray is removable, allowing access to the space beneath that is used to hold the fancy work. When in a hurry, this fancy work may be placed on top of the tray. Two cleats running the full length of the tray should be glued or bradded to hold the tray in place, or four small blocks, approximately ⅜" x 1" x 1", may be glued in the corners in lieu of the cleats. Some folks prefer that the tray be minus the handle so that the

(*Continued on page 566*)

CHEMICAL NOTES, RECIPES AND FORMULAS

ACTIVE NITROGEN

NITROGEN may be described as one of the most peculiar of the elements. Under ordinary conditions, when it is isolated or in the elemental condition, it is quite difficult to make it combine with another element. But in its combinations it goes to both ends of the scale, forming ammonium compounds by combining with hydrogen and at the other end combining with oxygen. The alkali and alkaloids which it forms are very powerful basis and these are due to its hydrogen combinations; its oxygen combinations lead to nitric acid, one of the most powerful of the mineral acids. Recently an allotropic form of the nitrogen has been studied called active nitrogen. By passing the normally almost inert gas through a tube, in which a cascade of Lyden jar discharges are maintained, the gas glows and is said to be activated. The glow persists for a while. Ordinarily nitrogen gas forms a good atmosphere in which to preserve phosphorous, sulphur, selenium and other elements, but if the activated and glowing nitrogen as it leaves the part of the tube in which a spark is produced is caused to pass over many of the elements strong reactions occur which are not always understood. Ordinarily sulphur is a very inert substance as far as nitrogen is concerned, but it reacts with a blue flame or glow with active nitrogen and a green material is deposited on the sides of the tube. This is thought to be mainly nitrogen sulphide. Arsenic gives a green glow and produces arsenic nitride. If the glowing nitrogen is passed over metallic sodium the metal may be said to burn, forming the nitride, and similar results are maintained with other metals. Mercury, as might have been anticipated, produces an explosive compound. Nitric oxide acts in a most enigmatic manner forming, when mixed with active nitrogen, a higher oxide, the peroxide. There has been considerable controversy as to whether the nitrogen must be chemically pure to be capable of activation. Minute traces of oxygen seemed to have a favorable catalytic effect and a number of other gases in minute quantities increase the reaction and to produce it in any quantity about 1/10 of 1 per cent of one of the catalyzing gases must be present.

THE SMOKE PROBLEM OF SALT LAKE CITY

SALT LAKE CITY feels that its atmosphere is subject to contamination from smelters, the nearest of which is eight miles distant. Sulphur dioxide is discharged from these smelters throughout the year, and as it is a true gas it diffuses into the atmosphere. The United States Bureau of Mines is co-operating with the State of Utah in the City of Salt Lake in the investigation of the condition of its atmosphere with reference to this impurity. From the data obtained it appears that there is only about 0.1 part or less per million of the obnoxious gas in the air. It is believed that much of this is due to the chimneys of the city, which discharge at least fifteen tons of sulphurous acid into the air daily. Even with all this it leaves the air many times purer than the London, San Francisco or Berlin air. An interesting feature of the work was the collecting of samples of air at different high levels by the use of an aeroplane. These latter investigations were not so extensive as might have been desired, but they show great purity in the upper layers of the atmosphere. The general purity of the air so far as sulphurous acid is concerned was proved by all the tests.

CEMENT FOR FASTENING BRASS TO GLASS

FOR cementing brass to glass the following recipe will be found to answer very well: Take resin soap, made by boiling one part caustic soda and three parts of resin in five of water, and knead it into half the quantity of plaster of paris. This cement is used largely for fastening the brass tops on glass lamps. It is very strong, is not acted upon by petroleum, bears heat very well and hardens in one-half to three-quarters of an hour. By substituting zinc white, white lead or slacked lime for plaster of paris, it hardens more slowly. Water attacks only the surface of this cement. As it sets shortly after mixing, only as much as may be needed for immediate use should be made at one time.

FATS FOR SOLDERING

MANY workers who use the soldering iron to any extent prefer a soldering paste instead of the fluid. To them the following will be of interest:

1. Soldering fat or grease is commonly a mixture of resin and tallow with the addition of a small quantity of ammoniac. It is particularly adapted to the soldering of tinned ware, because it is easily wiped off the surface after the joint is made, whereas if resin were used alone the scraping might remove some of the tin and spoil the job.

2. The following is a well tried recipe for soldering grease: In a pot of sufficient size and over a slow fire melt together 500 parts of olive oil and 400 parts of tallow, then stir in slowly 250 parts of resin in powdered form and let the whole boil up once. Then let it cool and add 125 parts of saturated solution of sal ammoniac, stirring the while. When cool this preparation will be ready for use.

PLASTIC DRESSING FOR WOUNDS AND BURNS

INDUSTRIAL plants are now using the ambrine treatment for burns, scalds and all surface wounds which proved very successful for casualties incurred in the world war.

The dressing is a compound of wax and resin, and is solid when cold. It is heated to about 150 degrees Fahrenheit and applied by means of a special atomizer, or it can be gently daubed on with a soft brush. A plastic dressing, impervious to air, is thus formed, which does not adhere to the wound and which promotes the healing process without appreciable contraction. Disfigurement and scars are prevented to a greater extent than was possible under the old methods.

TO WELD SPRING STEEL

AN experienced blacksmith has used for years the following in welding steel springs: Just before the steel comes to a welding heat, he placed a small piece of Russian sheet iron—such as stove bodies are made of—on the joint; this melts and runs into the joint so that the weld is perfect. This Russian iron undoubtedly acts the same as welding plates which are made of iron wire mesh screen impregnated with a fluxing compound.

BELT CEMENT

PUT 15 pounds of best glue in a kettle and pour over it 5 gallons of cold water. Let it stand a few hours or over night in a cold room, after which dissolve by gentle heat. Stir in one pint of Venice turpentine and add one gallon of Martin's belt cement. Cook for four or five hours by gentle heat, being careful not to boil the mixture. A water or steam jacketed kettle should be used to avoid burning. If too thick, mix with water.

MARKING GRADUATED SURFACES

THE scale is varnished over with a little thin shellac varnish, so as to sink into all the cuts. When this is dry, a black varnish of lamp-black and shellac is spread on, so as to fill all the cuts. This is allowed to thoroughly dry. When hard, the work is driven in the lathe, and the superfluous varnish polished off with the fine flour emery cloth until only that in the cuts is left. This gives a very distinct marking and fine finish to scale.

A new way of determining the lead in copper is the placing of a small amount of it in a cavity in a positive graphite electrode of an arc. When a current is turned on the lead line is watched on the spectroscope and the time required for its disappearance gives the basis for the estimation. Fourteen to 227 seconds are cited as the time required for different amounts and the determination is accurate enough for factory work.

A direct way of determining mercury consists of suspending a coil of copper gauzes in the solution which is kept in motion until all the mercury is precipitated thereon. It is then washed and dried and weighed; it is then heated in an atmosphere of hydrogen and weighed for a second time. The loss is mercury; as little as one-tenth of a milligram of mercury can be thus detected.

The S. J. Peachy cold vulcanizing process for India rubber has attracted much attention. A solution of India rubber in benzole or naphtha is charged with sulphuretted hydrogen so as to be completely or partly saturated. In another vessel a solution of sulphurous oxide in the same solvent is prepared and the two are mixed. This forms a stiff jelly and on evaporation of the solvent fully vulcanized rubber is obtained. Its quality and degree of vulcanization are said to be perfect. It can be used to produce a leather substitute by mixing it with scraps of leather, and such material, used for the soles of shoes, is said to be more durable than true leather. It can be made to act as a cement so that it is quite possible to make such an article as a pair of shoes without a single stitch in them. It is very fully protected by patents.

EUROPEAN SPORT PLANES

(*Continued from page* 529)

at Fig. 5 and the specifications are:

Span (upper and lower)	3 m. 50
Total length	3 m. 75
Height	2 m. 30
Total area	11 s. m.
Weight empty	150 kgs.
Useful load	110 kgs.
Total weight	260 kgs.
Engine	Anzani 40 h.p.
Maximum speed	150 km. per hr.
Minimum speed	40 km. per hr.
Duration	3 hours
Safety	8

Fig. 6. The Austrian W.K.F. sport plane

The Austrian W.K.F. Sport Plane

The Wiener Karosserie und Flugzenfabrik of Vienna have built a sport plane which flies very well and was designed by Ober Ingenieur F. Gchieferl to meet the demand for a small single-seater aeroplane, the actual running costs of which would be reduced to the minimum. The engine is a German Fiero engine, 3 cylinders W. Type similar to the Anzani "Channel" type. The two valves (inlet and exhaust) of each cylinder are overhead, worked by a single rocker.

The fuselage has four longerons and is entirely covered with linen. The front stagger is very apparent, and gives good visibility to the pilot. The wings are braced with single strand wire; the ailerons are fitted on upper plane. Its specifications follow:

Span (upper plane)	5 m. 50
Span (lower plane)	5 m. 50
Length overall	4 m. 40
Height	2 m. 10
Total area	10 sq. m. 24
Engine	Hiero 33 h.p.
Weight empty	165 kgs.
Weight of load	175 kgs.
Total weight	340 kgs.
Load per sq. m.	33 kgs. 300
Load per h.p.	9 kgs. 710
Maximum speed	81 miles
Endurance	10 hours

Of the planes illustrated and described, the small Macchi-Nieuport seaplane would seem to be a type that could be easily made by the amateur mechanic and that would be an excellent type for any one who wishes to teach himself to fly with minimum danger.

POTEZ TYPE VIII BIPLANE

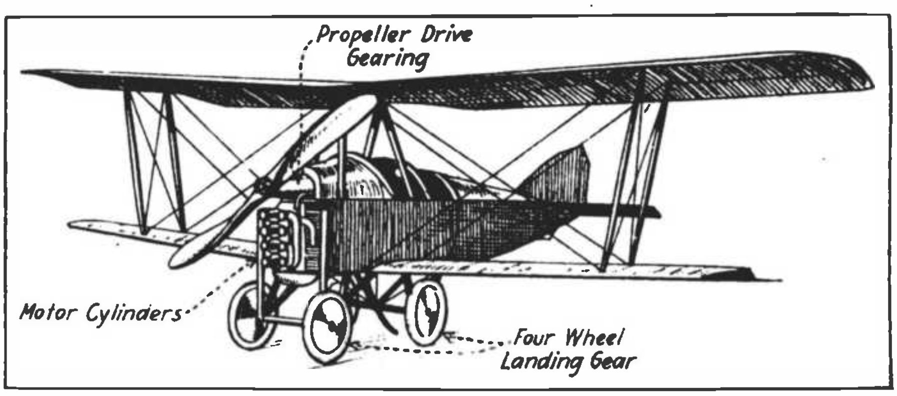
THIS is the little biplane which has been making a name for itself in France. It is a sport-type aeroplane, equipped with the Potez 4-cylinder, air-cooled engine of 50 horsepower. This aeroplane is all metal, the fuselage consisting of sections of duraluminum, secured to the longerons similar to the construction of a ship. It makes a very substantial and rigid construction and, of course, will not deteriorate. All the surfaces and wing frame work members are of duraluminum. The longerons are of U shape, forming the outline of the body. The fittings are of sheet steel. The landing gear has been designed for greatest factor of safety. The chassis has four wheels to reduce danger of turning over, and is constructed very strongly.

The unique arrangement of the engine, which is located vertically at the front of the fuselage, necessitates a gear transmission to the propeller shaft. A brake operated by the pilot permits a quick stop of the machine from rolling after landing. This machine lands at 25 miles per hour, and recently a landing was made at Le Bourget aerodrome, France, in which the plane came to a full stop in 33 feet. This machine carries two persons, the passenger seat being at the center of gravity so that the machine may be flown as a single-seater without disturbing its balance. It is equipped with dual controls.

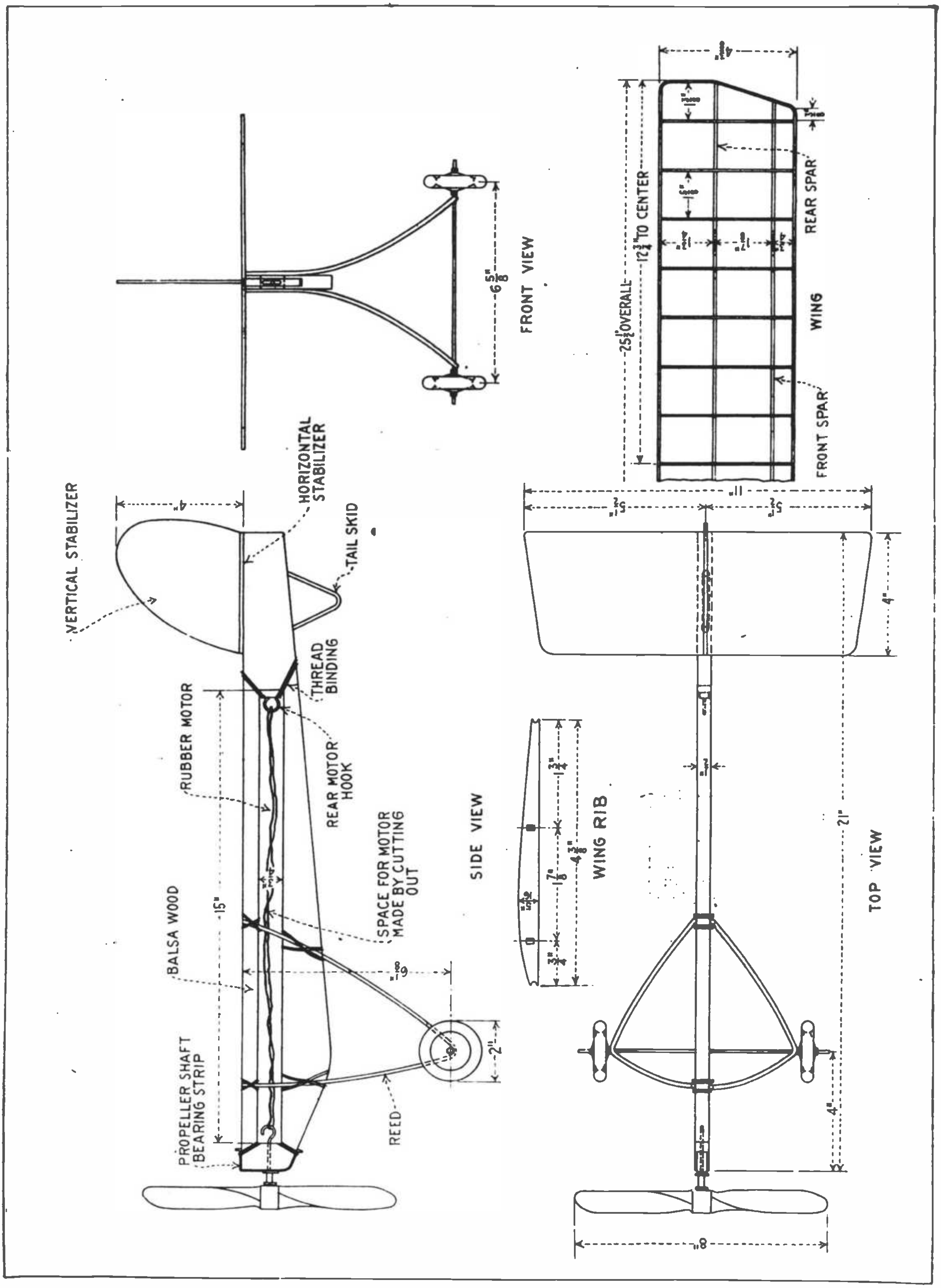
Specifications: Span, upper wing 26 feet; span, lower wing, 21 feet; length, total, 18 feet; area of wings, 204.7 square feet; weight, empty, 485 pounds; useful load, 440 pounds; weight, loaded, 925 pounds; weight per square foot, 4.5 pounds.

This aeroplane may be used by any sportsman as it is handled almost as easily as an automobile. It is extremely economical and will last a long time. Its construction permits use under all climate conditions, and it is much more enduring than any wood and fabric construction would be.

The Henry Potez Type A-4 motor used in this aeroplane is of very simple design and is strongly built. It is the first of its kind, being constructed similar to an automobile engine. It is a 4-cylinder type, air cooled and gives 50 horsepower. By its unusual location a uniform cooling is given each cylinder. The crankcase is vertical, the propeller shaft connecting at the top end with the crankshaft by gears. The weight of the engine is given as 220 pounds; r.p.m. of engine, normal, 2,200; r.p.m. of propeller, 1,100. Fuel consumption, 3.9 gallons per hour.



The Potez Type VIII biplane has an unconventional engine installation


VERTICAL STABILIZER
HORIZONTAL STABILIZER
TAIL SKID
THREAD BINDING
RUBBER MOTOR
REAR MOTOR HOOK
SPACE FOR MOTOR MADE BY CUTTING OUT
SIDE VIEW
BALSA WOOD
15"
2"
PROPELLER SHAFT BEARING STRIP
REED
FRONT VIEW
WING
REAR SPAR
FRONT SPAR
25½" OVERALL
12¾" TO CENTER
11"
4"
21"
WING RIB
TOP VIEW
8"

A 25-Inch Spread Monoplane

By H. C. Ellis

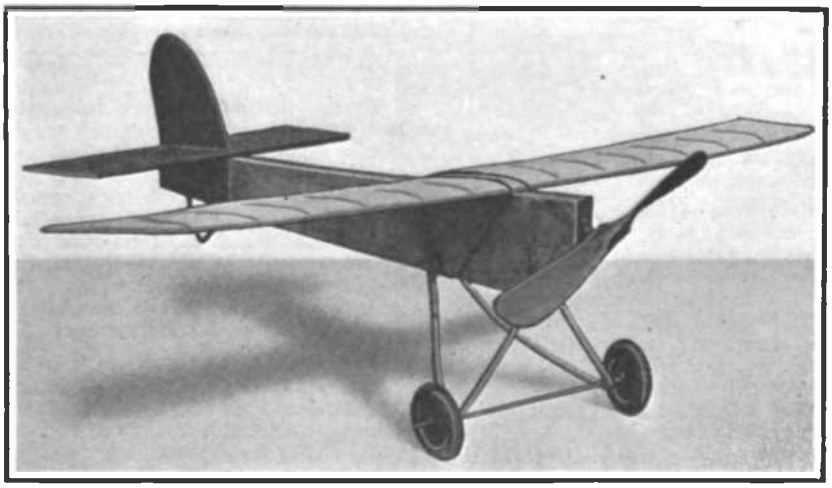
THE fuselage of this simple and easily made model is cut from a piece of Balsa 21 in. long, 3 in. wide and ½ in. in thickness. A portion of the fuselage is cut away as shown in the drawing to admit the rubber motor. This is best accomplished by using a sharp knife and care should be taken in cutting the Balsa or too much may be cut out, thereby weakening the fuselage.

The propeller is 8 in. in diameter and has a pitch of 22 in. Sheet brass, 1/16 in. thick, is used for a propeller hanger and is shaped and bound to the fuselage as shown in the drawing. A plain bearing propeller shaft is used as a mounting for the propeller. The rear rubber hook is of 1/16 in. steel rod which is bent to shape, and fastened to the rear of the fuselage by binding and gluing as shown in the drawing. Ten feet of ⅛ in. flat rubber is used for the motive power.

The landing gear is constructed of ⅛ in. reed and is shaped and bound to the fuselage at the points shown in the drawing. A 1/16 in. steel axle, threaded and fitted with nuts, is bound and glued to the landing gear. The wheels are 2 in. in diameter. There are several types of wheels on the market that may be used. The fuselage is drilled at the points shown to take the tail skid which is ⅛ in. reed.

The stabilizer and rudder are cut from ⅛ in. Balsa. Small nails or brads and glue are used to fasten them to the fuselage. Solid ribs of 1/16 in. spruce or Balsa are used in the construction of the main plane. Dowels ⅛ in. in diameter is used for the spars in the main plane. The edges of the main plane are of ⅛ in. reed. Care should be taken in assembling the main plane so as not to have it warped. The ribs should be glued to the spars and reed wing edges. After the glue is dry, cover the planes with paper which may be purchased from several of the model supply houses selling model aeroplane supplies. After the wing is covered the dope should be applied. The main plane is fastened to the fuselage by a rubber band, a simple and secure method of fastening that has the advantage of economy and yet that permits the main plane to be shifted to secure correct balance.

After the rubber motor has been placed on the motor and propeller hooks, the sides of the fuselage may be covered over with bamboo paper, which is doped or varnished, to seal the opening in which the rubber motor is placed and obtain a smooth, unbroken fuselage with minimum air resistance.



The completed model of the simple 25-inch spread monoplane

STATISTICS SHOW FLYING IS SAFE

THE airplane is the fastest machine man has ever built, but fast as it is, it has not yet caught up with its reputation for danger. That reputation was acquired when the plane was in its infancy, when man was just beginning to master the air, and in the mind of the average man it has not yet been downed. One reason why this belief in the danger of aviation persists, is that man has clung to the earth for ages untold and it does not seem quite natural to him suddenly to take to the air.

Just as people a few years ago regarded airmen, so prehistoric races must have regarded the first men to venture on water in coracles. The average busy man has no time to read of the exact science of aeronautics which now has made the airplane safe. He sees in the papers occasionally a story of an airplane accident and reads it, not stopping to think of the thousands of miles safely flown that day by other planes. But he probably skips a few briefer accounts of accidents to automobiles because these are too common to interest him.

In substantiating this statement that airplanes are safe we find our best argument in statistics collected here and abroad by governments. It should be borne in mind that these figures deal principally with land machines, and that flying boats are admittedly safer than airplanes. The reason for this is that flying boats can always land on water while airplanes are dependent on landing fields which, at the present time, are far from numerous. The flying boat is not compelled to fly high for safety's sake. It can skim along two or three feet above water for hours when fog or low clouds make high flying hazardous. The boat can always land safely if the fog descends to the water or becomes too thick, while the airplane is not so fortunate.

The British Air Ministery, to get back to the subject, collected statistics on all commercial flying in that country for the last seven months of 1919. The results amazed even pilots and engineers who had long regarded the risk in flying as negligible. The figures covered 35,330 flights by 403 machines of a total time in the air of 8,368 hours, during which time 593,000 miles were traveled. In all this flying in good weather and bad, one passenger was killed in every 16,666 passenger hours in the air. To put it differently a single passenger might expect to fly about 1,180,000 miles—47 times around the world—before becoming the victim of a fatal crash. That sounds utterly absurd to the landsman, yet the British Government stands back of the figures.

The pilots, who tested experimental planes, did stunt flying and ran other unnecessary risks, showed .48 deaths per thousand hours, as compared to the passenger rate of .06 per thousand hours.

Coming nearer home, figures compiled by the Post Office Department show to the end of 1919, 405,000 miles flown with the loss of three pilots. These pilots, of course, ran many risks, for they carried the mail through rain, snow, and fog that blinded them.

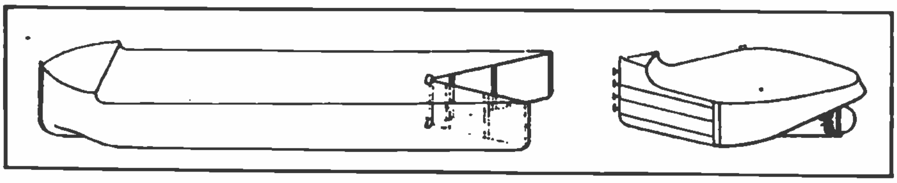
Even in training pilots the figures are exceedingly low. From the beginning of the war until the end of 1918, 17,690 men learned to fly in the U. S. Air Service. They spent 705,243 hours in the air. One man was killed in every 2,310 hours, or one to about every 160,000 miles. With these positive proofs of aviation's safety before us, American airplane manufacturers are going ahead building planes, confident that the realization will soon come everywhere that man can take care of himself as surely in the realm of the birds as in the realm of the fishes.

EVERYDAY SCIENCE NOTES

BY PROF. T. O'CONOR SLOANE

NEW SYSTEM OF PUSHING BARGES

AN interesting system has been developed for pushing barges. A substitute for the tug boat, the Constant pusher, is illustrated, as regards the principle of its operation herewith. The general principle is clear from the cut. The smaller part contains the engine and propeller. The securing of the two together is done by T-headed bolts which are indicated projecting from the head of the pusher. Four of them are shown. These bolts enter through a slot into a vertical channel at the apex of the reetrant angle



in the stern of the barge. When the two parts have been brought as close together as possible the T-bolts, whose heads hitherto have lain in the vertical plane and which passed through the slot into the channel, are turned through 90°, which brings the T-heads across the slot. The two sections of the boat are then drawn together, by nuts from the interior of the pusher, connecting the two units solidly together. The idea is that the pusher can be shifted around from one hull to another so as to keep one hull in motion and doing work while the other is being loaded or unloaded as the case may be. On the old Morris Canal in this country the canal boats used to be made in two sections bolted together, capable of rapid detachment from each other. They were pulled by animal power. On the Mississippi River in this country the pushing of cargo barges has been very extensively applied.

It has been found that the industrial production of helium for use in balloons at Fort Worth and Petrolia, Texas, is so expensive as to be impractical. It cost more to manufacture the gas than to build the airship. Six millions of dollars have already been spent on the plants.

Coke ovens are subject to several kinds of corrosion due to impurities in the coke. Sodium chloride and sodium sulphate have generally to be looked for and as they volatilize owing to the heat of the charge penetrate and this integrates the brick lining. Iron oxide has been found in the bricks, probably due to the volatilization of the iron in the coal as iron chloride by reaction with the sodium chloride. This also is a source of injury. Silica bricks have been found to measurably solve the problem.

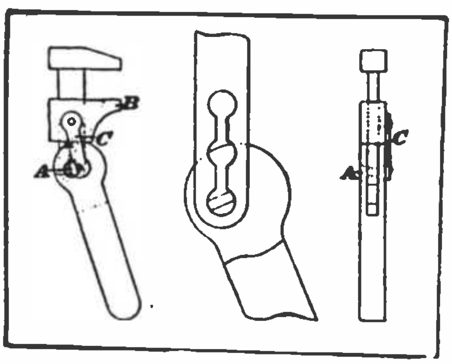
Considerable attention is now given to the shaking or beating of cement bags to recover the cement ordinarily adhering to them after emptying. By a recent concrete road contractor in Wisconsin one million cement sacks were cleaned and thereby two hundred barrels of cement were recovered. The sacks were reduced in weght to one-half or one-third their weight before cleaning so that the freight on the return bags was reduced.

The Germans, during the war-time scarcity of coal, have employed unburned bricks in building. It is claimed that five or six weeks of drying of bricks made with the proper color of clay will give material adapted for ordinary house construction. It is exciting considerable attention in England. Of course, such bricks are very much cheaper than the burned bricks. Plaster adheres to them perfectly and they are not found to be objectionable from dampness.

A red coloring matter used by the Chinese in coloring food products, notably cheese, has long been kept a secret. It is now found that it is produced by the cultivation on rice of microscopic fungus. This fungus attacks the grains of rice, and penetrates them, so that when they are ground up an effectual and innocuous red coloring material is produced. As far as the investigation has gone the secret of the preparation is in the conditions of temperature and humidity required for the successful cultivation of the fungus.

ADJUSTABLE WRENCH

THE spanner or wrench which we illustrate has its jaw, B, pushed up against the nut or bolt which may be between it and the upper jaw by the movement of the handle, which has a cam-shaped end. The



link, C, is an auxiliary for drawing back the jaw, B, when the handle is pulled in the other direction. There are several holes in the shaft of the wrench so that the handle, A, can be shifted up and down to accommodate different sized objects.

The Minister of Public Works of Buenos Ayres has been presented with a report of experience with a gliding boat on the Lambert system. It is understood that the report is very favorable and that the adoption of this system is recommended for river use on many rivers of the Argentine. It is proposed to construct the boats in government shops, importing the machinery only.

Lignite briquettes are to be placed on the Canadian market, it is hoped, under the auspices of the Alberta Government. The Government experts are working on a method to extract tar from the oil-bearing sands of Alberta to use in the cementing of the briquettes.

A very curious coincidence, and it may eventually prove to be more, is that the magnetic elements, iron, nickel, and cobalt have nearly the same atomic weights, namely: 55.8, 58.7, and 59. Manganese is also slightly magnetic and its atomic weight is 54.9. A new magnetic copper-manganese-aluminum alloy has an average atomic weight of 56.3.

Electrolytic iron has been investigated by the chief research chemist of the British Ministry of Munitions. It is found that this iron is not so pure as it is generally supposed to be, and it may contain pin holes, lumps of included matter, cracks, developed and incipient. He thinks that these troubles can be largely eliminated, by control of the deposition process, but as at present produced it is not considered a safe iron from the engineering standpoint.

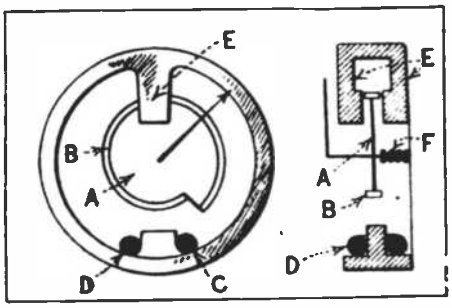
A question of pressure per unit area came up at a recent discussion at a meeting of the British Royal Institute. If the edges of two knife blades are pressed together the area in contact is so small that there is no trouble in producing a pressure of over 300 tons to the square inch. The same may be produced in a Brinnell hardness tester. The gas pressure in large calibre guns rarely exceeds 20 tons to the square inch, which is about 2,500 atmospheres. It is calculated that if a hole 56 miles deep were made in the earth the pressure at its lower point would be about 24,000 atmospheres and the pressure at the center of the earth is put at about 6,000 tons to the square inch. Pressures comparable to these and temperatures in the neighborhood of 17,000° have been momentarily obtained in making diamonds. It is evident that the sinking of the proposed 12-mile shaft for purposes of investigation may involve very serious problems.

From all parts of the world news is being received of the appraisal of available waterpower. In Brazil 148 waterpowers are reported which could supply 30 millions of horsepower. From Canada comes a report that the Government of Ontario proposes to spend 17 millions of dollars in waterpower development. In the State of Washington 100 miles from the city of Seattle, a 36,000-kilowatt power station for that region is being installed upon the Stagit River. The power line will work at 160,000,000 volts. From Iceland comes the estimate of 1,000 millions available horsepower and the Iceland Waterfall Commission may grant a concession to a Dano-Norwegian company for the utilization of waterpower for the production of nitrogen and for an electrification of the whole island. It is even proposed to construct a 200-kilometer electric railway running from the port of Reykjavik to the East through the agricultural district, which will be, when constructed, the first Icelandic railroad.

It is interesting to note that American Sperry gyroscopic compasses are to be installed in two steamships being built in Great Britain.

ELECTRICAL METER

AN apparatus for indicating the strength of an electric current whose construction is such that the indicating hand can rotate practically through 360° is illustrated in the cut. A disc made of soft iron is shown provided with an index hand. The flange B follows the spiral periphery of the



disc. The controlling magnet has a pole C whose windings are indicated by D and opposite there is a double pole EE. Between its parts the periphery of the disc and its flange rotates. A spiral spring F pulls the disc in one direction so as to make the index hand indicate 0 when no current is passing, but when the current passes the magnet pulls against the pull of the spring and the whole is calibrated so that the movements of the index hand gives the amperage.

The Germans have developed great ingenuity in the production of substitutions ("Ersatz"), and one of their patents proposes the making of artificial silk from muscular tissue of animals. The flesh is macerated in a particular solution which separates the muscular fabrics by dissolving the material which cements them together. This gives filaments, short and flexible, which are transferred to a liquid which straightens them as if by a species of tanning. The fibers which are several inches long have been made into artificial silk. They can be impregnated with india rubber so as to make a fabric impervious to water. The artificial silk thus prepared can be used for the manufacture of insulating fibre, balloon cloth and the like. It is said that it can be made quite cheaply.

In a recent lecture before the London Chemical Society the fact was noted that it would be possible to produce 10,500,000 cubic feet of helium per annum at Calgary, Can. The cost of the plant would be less than five million dollars and the gas would be produced at not more than $0.04 a cubic foot. This, of course, is the gas which will have to be used in dirigibles, sooner or later as it removes the risk of fire. In the valley of the Fraser River in Western British America, a flow of natural gas has been found containing 99% of nitrogen. This gives a raw material for the fixation of nitrogen which may eventually prove of great importance.

The Railway Committee of the American Railway Engineer Association in examining the tensile strength of old rails got as high a reading as 57,000 lbs. per square inch in the flange of an 85-lb. rail that had been in service some nineteen years. This indicates an absence of any flaws and shows that if the right material is put into rails and if rightly handled in the manufacturing process, flaws will not develop.

It has been found in San Francisco Harbor that while a creosoted pile would not be attacked by the teredo, yet if a piece of untreated wood is nailed to it the teredo will enter the untreated wood and will grow to the length of an inch or more and will then bore into the creosoted pile. The zone of greatest activity was where the pile emerges from the bottom and it rapidly decreases from that point upward. The teredo never enters it below the mud.

Ninety-five per cent of the total known vanadium in the world is in a mine in Peru, known as Minas Raga on the eastern slope of the Andes not far from the great Cerro de Pasco mine. There is supposed to be in sight in this mine ore enough to supply eighteen thousand tons of metal. The ore averages about 19 per cent vanadium.

It is stated that lightning strikes loamy soil twenty-two times where it strikes a chalk soil, such as exists in the South of England, one time. A sandy soil has an intermediate liability to lightning stroke.

There has naturally been a great increase in India rubber plantations, so much so that the question of what to do with the seeds of the tree has come up. It is found that the kernels of the seeds of the Para rubber tree are rich in oil, resembling linseed oil, and the oil cake left after the extraction of the oil is a good food for cattle.

In Iceland there has been reported a very violent earthquake affecting the port of Reykjabik. Iceland has undoubtedly suffered more from volcanic and seismic disturbances than any other equal area of the earth's surface. The volcanoes have had a way of pouring out vast quantities of gravel, ruining the arable land which at the best is limited there. Recently Iceland has been attracting considerable attention as a possible field for the exploration of water power, the perpetual ice and snow deposits on its mountains offering great possibilities in this direction.

In Canada there has been published a table of the durability of furs, which originated with a Cornell University professor. Twenty-three different furs are cited, the sea and land otters and the wolverine, the fierce rodent called the glutton, being most durable. These three are taken as having a durability of 100%. At the other end of the line is the rabbit skin with only one-half of 1% durability attributed to it. In other words, the much used rabbit skin is 200 times inferior in resisting wear to the three furs named above. Other much used skins are seal skin 80%, martin and skunk both 70%, sable 65%, muskrat 45%, ermine 25%.

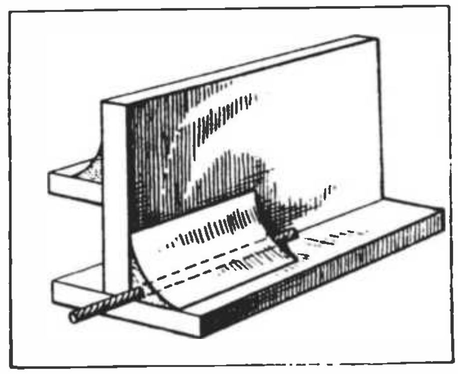
The remains of a fossil elephant have been found in the Chagny sands near Lyons, France. The bones are almost complete and the elephant was over 13 ft. high, with tusks slightly curved only and nearly 8 ft. long.

In France it has been found that the laundresses are very subject to consumption and that tuberculosis is responsible for half their deaths. This is attributed to infection from clothes, which have been worn by consumptives, bedclothes from their beds and the like. It is recommended that such articles should be at once plunged into disinfecting solutions before going to the laundress.

A curiosity in freezing occurred in Philadelphia. A cast iron column supporting an elevated sidewalk gradually filled with water from rain. In the cold weather it started to freeze and in its expansion the ice was extruded from the bottom of the column which was lifted up together with the sidewalk, which it supported, through a distance of about eight inches. No harm was done. On the restoration of the column to its proper position by melting out the ice, the the top was made water-tight, so as to prevent the recurrence of the accident.

IMPROVED FILLET

THE very simple improvement in flexible or wax fillet for pattern makers has been deemed worth a patent. It will be



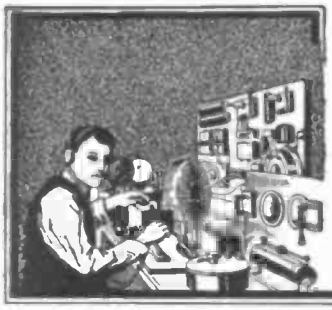
seen that by having a cord located in the heart of the fillet, O, as shown, the manipulation, the fastening and the strength of the fillet will be materially increased.

The American Locomotive Co. has been building locomotive engines at Schenectady for the Italian State Railways. Each is fitted with an apparatus for burning pulverized fuel, similar to those installed on the Lehigh Valley Railroad, where mixtures of anthracite and soft coal are in use. In Italy lignite is to be used and its analysis in round numbers is, ash 10%, volatile matter 40%, fixed carbon 30%, and water 20%. This analysis brings out the poor quality of lignite as a fuel, but Italy has little or no coal of her own.

The Rolls-Royce Automobile Works, at Derby, England, have recently been visited by the English Institute of Automobile Engineers. The works cover an area of between twenty and thirty acres. The output is about thirty-five cars per week. This is a great contrast to the American quantity production of cars, which runs up to thousands in a week in a single factory. This is actually a hand-made car and the comment on the methods by an English authority is to the effect that it is built up of machine parts finished manually, and that much of the labor in this connection seems to be superfluous, and the same is said about a number of refinements which the car embodies.

The erosion of guns has been studied during the war and an approach has been made to the cause. During firing a hardening of the surface of the bore takes place, especially on the driving surface of the lands but which effects lands and grooves alike and spreads to the powder chamber. This induces the formation of small cracks, which marks the beginning of the erosion. Even a few rounds bring about this damaging hardening of the metal of the bore. The getting rid of it can be done only, as far as known, by the use of steel which will not be so effected.

In petroleum wells where the air lift is used, it is said that the inflow of water is increased and that an emulsion is produced with heavy oils. If the water present is between 5% and 20%, it separates with much difficulty. In one case, however, the separation of the water was effected by giving an additional 20% of water which made the breaking up of the emulsion easy.



RADIO
TELEPHONE AND TELEGRAPH APPARATUS

A Short Wave Regenerative Receiver

Easily Made Is This 150- to 600-Meter Set, Fitted With a Tickler Coil for Amplification

By M. B. Sleeper

Illustrations by the Author

NOW that the experimenters are getting on the scratch line for the long distance, short wave work for which everyone is preparing, every man wants a regenerative set. There is a certain amount of choice between various circuits in use at present, but if the majority favors the type using no condenser in the secondary, it is probably because the manufacturers have specialized on it.

While we are on the subject of the variometer-tuned secondary set, it might be well to clear up a question that seems to lurk unspoken in the minds of many experimenters—a sort of skeleton in the closet question, ignorance of which no one wants to admit. "What does the secondary variometer do? How can it tune the circuit to a given wavelength, when there is no capacity in the circuit?" Yet the variometer does tune, and very sharply.

The answer is simply this: The condenser effect between the grid and filament furnishes the capacity, a small amount, about 0.00002 mfd., but enough to make the secondary circuit oscillatory. To tune to 300 meters with such a capacity, requires only 1.3 mh. inductance.

Because the tube is depended upon to furnish the capacity, a large variation in inductance is required to cover any considerable wavelength range. Since only a part of the inductance is adjustable, the balance acting as the coupling coil, the variation of the inductance and, consequently, the wavelength range, is quite limited.

Therefore, to make the set of wider utility, the equipment described in this article is designed to operate with a 0.0005 mfd. variable condenser in the secondary circuit.

Again, a straight tickler coil is employed instead of a tuned plate circuit. The reason is a constructional one. A tickler is much easier to make than a variometer.

General Description

Figs. 1 and 2 show the front and rear of the receiver, mounted on a panel 5 by 10 by 3/16 ins., with a complete circuit in Fig. 3. In the primary, the thirteen taps give a wavelength range, with a 0.0003 mfd. antenna, up to 600 meters. On the first secondary tap, a 0.0005 mfd. condenser will give a range of approximately 150 to 450 meters, and on the second tap, 250 to 700 meters. Thus the set is adapted not only to 200-meter work, but to the reception of 600-meter commercial stations as well.

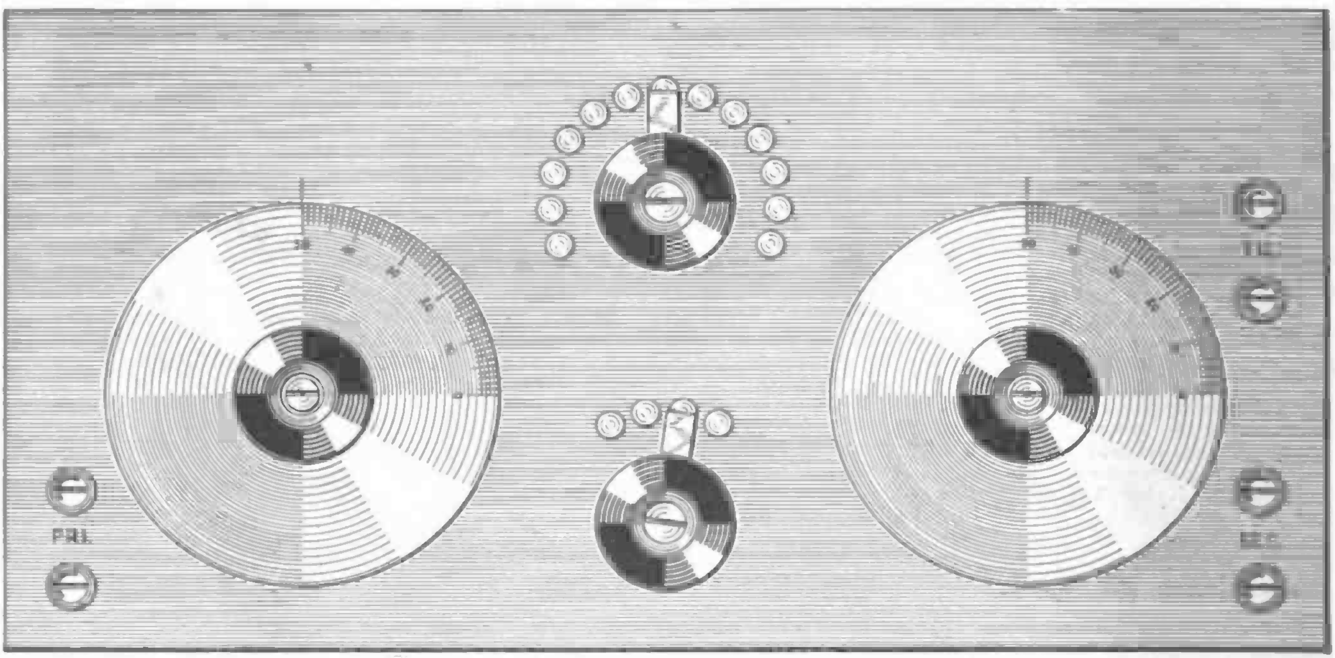


Fig 1. A regenerative receiver mounted on a 5- by 10-in. panel

In the plate circuit of the audion the tickler is connected, preferably with a 0.001 mfd. fixed condenser around the telephones and B battery, although this is not shown.

The Primary Coil

A tube 3½ ins. in diameter and 2¼ ins. long is needed for the primary coil. This is wound for 1.7 ins. with 20 No.

38 high frequency cable, giving 38 turns per inch, or a total of 65 turns. These are tapped as follows:

Tap 1..15th turn	Tap 8..40th turn
Tap 2..18th turn	Tap 9..45th turn
Tap 3..21st turn	Tap 10..50th turn
Tap 4..24th turn	Tap 11..55th turn
Tap 5..27th turn	Tap 12..60th turn
Tap 6..30th turn	Tap 13..65th turn
Tap 7..35th turn	

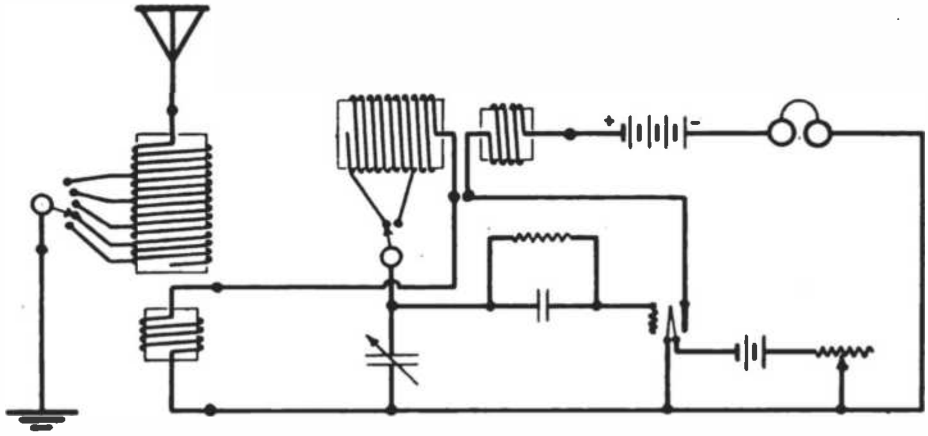


Fig. 3. Connections for the regenerative receiver

Two methods of tapping can be employed. One is to wind the coils without taps. Then mark with ink where the taps should be. Unwind the wire, scrape at each marked point, and solder on leads. The other way is to bring out a loop for each tap, and tie a knot in the loop. This holds the wire securely at the tapping point while the coil is being wound. When the work is completed, the loops are cut to the proper length and soldered to the switch points. A better method is to make short loops, and use No. 14 bare copper wire leads to the points and other connections.

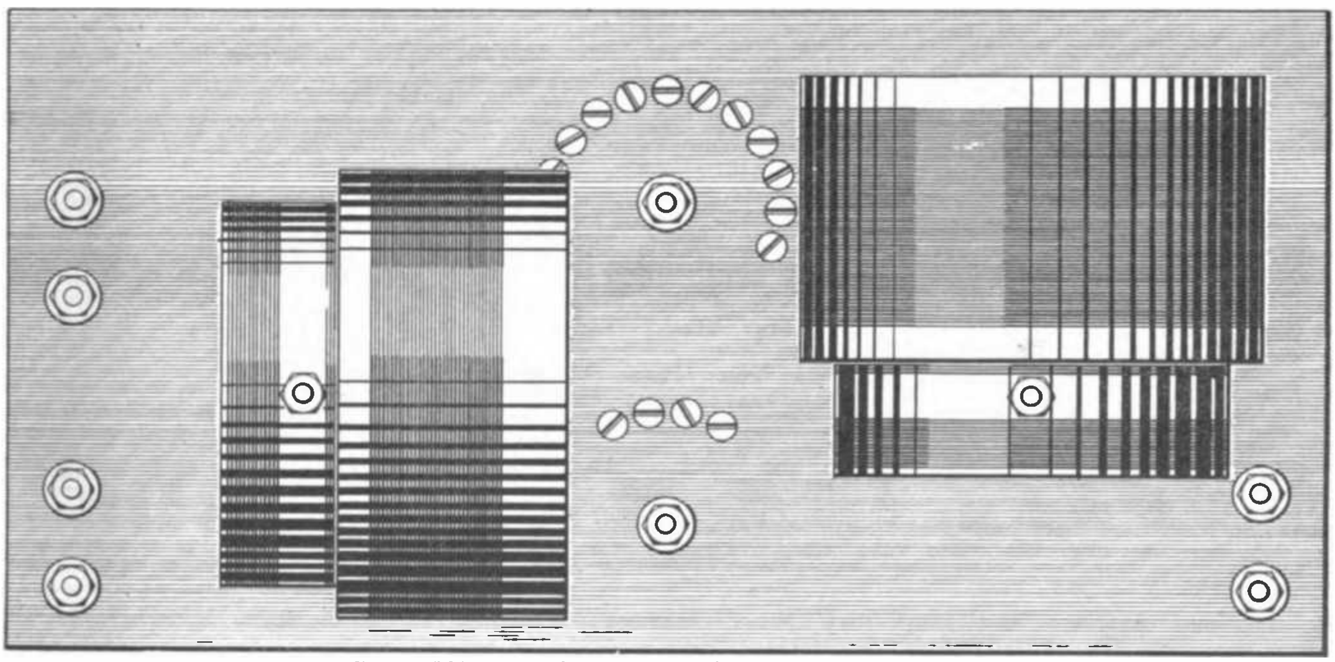


Fig. 2. This shows the mounted coils on the rear of the panel

Short, threaded brass pillars or angles of 3/8- by 1/16-in. brass strip can be used to mount the primary tube. This must be accurately and securely fixed. Otherwise, because of the small clearance, the secondary coil will touch the primary tube.

The Secondary Coupling Coil and Tickler Coil

The construction of the secondary coupling coil and tickler are identical, both as to the method of mounting and the size of the coils. The tubes are 3 ins. in diameter, and 1¼ ins. long, wound with 20 No. 38 high frequency cable. Each section is 3/8 in. long, with a separation of 3/8 in. between them.

If the bearing at the panel is carefully made, no rear support will be required for the shaft of either the coupling or tickler coil. For each coil, two brass washers, ¾ in. in diameter and 3/16 in. thick are cut and threaded at the center with an 8-32 tap. The brass shaft, of 3/16 in. rod, is threaded at one end for a distance great enough to take one washer, the adjusting knob, and a nut to clamp the handle against the washer. Then, from the other end, the rod is threaded to within the thickness of the panel from the other threads. The washer under the handle bears against the front of the panel, while the other washer bears against the rear, leaving the unthreaded part of the rod to run in the hole in the panel. A lock nut holds the rear washer in place, and maintans a small amount of friction.

Two sets of nuts hold the coil in position on the shaft. Leads, run in Empire or soft rubber tubing, can be wound around the shaft and brought off to the terminals.

Secondary Loading Coil

The secondary loading coil, in series with the coupling coil, provided coupling to the tickler, independent of the primary-secondary coupling. The tube is 1¾ ins. long by 3½ ins. in diameter, wound for 1 in. with 20 No. 38 cable. Starting at the rear end near the tickler, a tap is taken off at the tenth turn, and connected to the first point of the secondary switch, as can be seen in Fig. 3.

This coil should be mounted in a manner similar to that used for the primary. With this coil completed and in place, and the set carefully connected with No. 14 bare copper wire, all joints soldered, the set is ready for use. A condenser, mounted as shown in some of the preceding articles, and a vacuum tube mounting, complete the set. If 5- by 5-in. panels are used for the audion and condenser, the set can be made up neatly with the 5- by 10-in. panel below, and the two smaller ones above.

(Continued on page 547)

English Radio Equipment

Details of Radio Apparatus from Marconi's Wireless Telegraph Company, Ltd.

AMERICAN opinions of English radio equipment vary between the conviction that they are far behind the times to beliefs that they are considerably in the lead. Mr. Philip R. Coursey of London has been kind enough to furnish EVERYDAY ENGINEERING with photographs, circuits, and data on some of the apparatus built by Marconi's Wireless Telegraph Company, Ltd. This article, and others to follow, will show the American experimenters and engineers just what is going on across the ocean.

The ½ and 1½ k. w. tube transmitters have been selected for the first article, as there is now such interest in this type of equipment. These sets are shown in Figs. 1 and 2, with diagram of connections for the ½ k. w. set in Fig. 3.

The first striking feature of construction is the cabinet style of mounting. When the set is not in use, the operating table is turned up, completely enclosing the apparatus. A door is also provided to cover the vacuum tube section, to keep the brilliant light from the eyes of the operator.

It will be seen that the ½ k. w. set has three panels, one at the left carrying the transmitter controls and antenna current meter, the center panel for the tubes, and the right hand panel for the receiving set and six-step amplifier.

Upon going over the circuit in Fig. 3, it will be found that there are points of similarity as well as difference between this set and the conventional types employed by American manufacturers. Starting at the input side, the potential on which the set operates is 85 volts at 150 cycles. The primaries and secondaries of the filament lighting transformers, 13 and 12, and 26 and 25 are designed to step down the 85 volts to 10 volts. The practice of operating filaments on a. c. is not new, but seldom used here.

Through transformer 28, 27, 500 volts are applied to the plates of the oscillating tube, 8, and the modulating tube, 11. In this circuit a single rectifier, 24, is placed. Because of the high frequency, 150 cycles, of the supply current, it is only necessary to use one rectifier. Condensers 21 and 23, of 0.25 to 0.5 mfd., shunt out any alternating current component, and the modulation choke coil, of about 1.5 henries, also smooths out the intermittent rectified current.

The modulation tube, 11, connected in the usual manner, can be controlled by a telephone transmitter, 16, or, for modulated telegraph sending, a buzzer, 17, according to the position of switch, 18. A key, 19, is used with the buzzer. When, however, the set is operating on undamped wave telegraphy, the sending is done by key 20, which, during telephone or buzzer modulation, is kept closed.

A plate current ammeter, indicating the current through the oscillator tube, 8, is connected between the plates. The air-core high frequency choke coil, 9, prevents the high frequency current in the oscillating circuit from backing up into supply circuit.

Distinctly different from American practice are the antenna and oscillation circuits. The lack of variable condensers is particularly noticeable. Direct coupling to the antenna is obtained by the switch from the plate lead, in which condenser, 7, of about 0.01 mfd., is connected. This prevents the short circuiting of the direct current to the

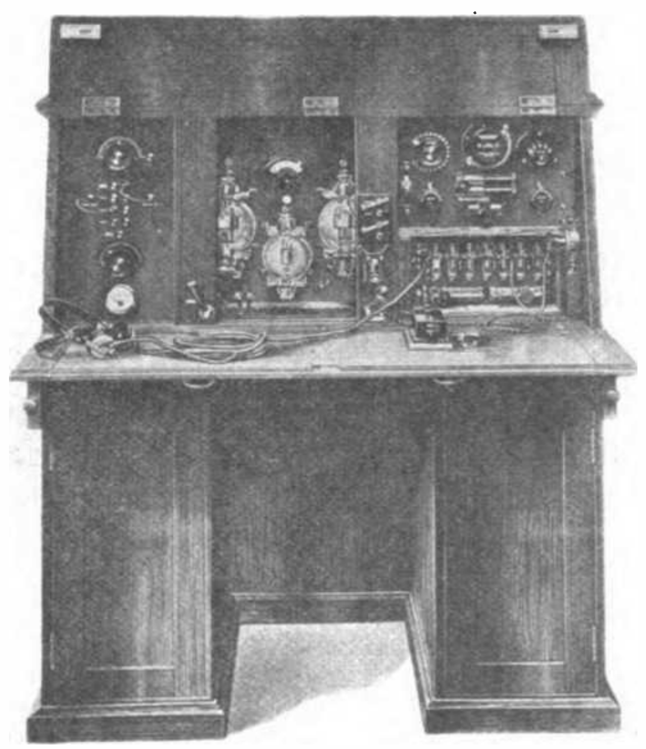


Fig. 1 The ½ k. w. installation looks quite different from the American sets

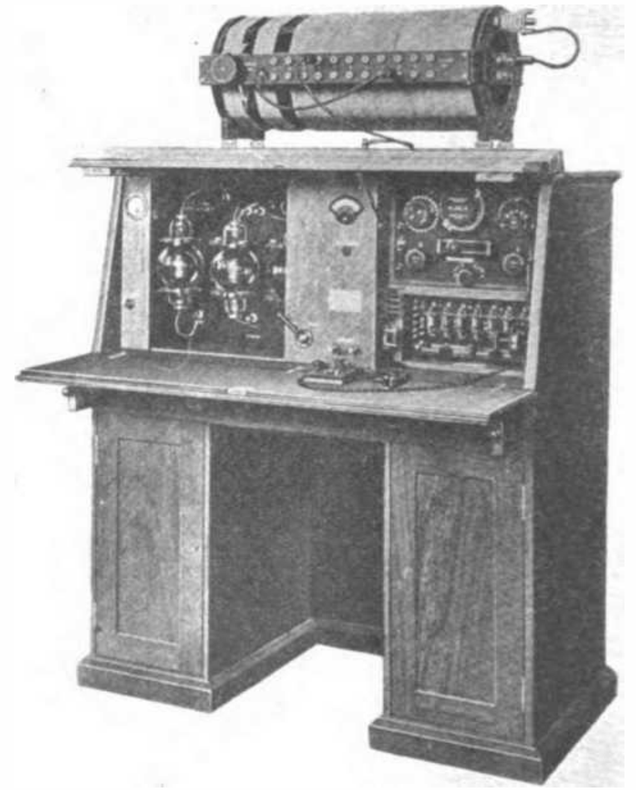


Fig. 2. A 1½ k. w. set which can be depended upon to cover 500 nautical miles

ground, but passes the high frequency current. Coupling to the grid is obtained by coil 3 in the grid circuit. The condenser 6 and the resistance 5 constitute a leak circuit. A plug switch gives a rough adjustment of the antenna wavelength, and a variometer, 1, a fine control.

In the ground circuit, a few turns of wire, 4, are coupled to a coil which is in series with the radiation ammeter.

The tuning adjustments can be seen operates the modulation buzzer. When the change-over switch, mounted at the left of the center panel, is put on receive, the transmitting instruments are disconnected from the supply line, but a considerable charge is retained in the smoothing out condensers. Therefore, an insulated discharge button is provided, between the center and right hand panels, to short circuit the condensers. This does away with the possibility of being shocked if any of the ometer is used, but rough and fine taps, one at the end, and the other at the front. The plate coupling plug is also inserted at these taps. The grid coupling coil is at the left hand end.

An interesting refinement is the modulation transformer. The primary coil has a center tap which acts as a common return for the transmitter, connected at one end, and the buzzer, with the key in series, at the other end of the primary winding. A battery is in-

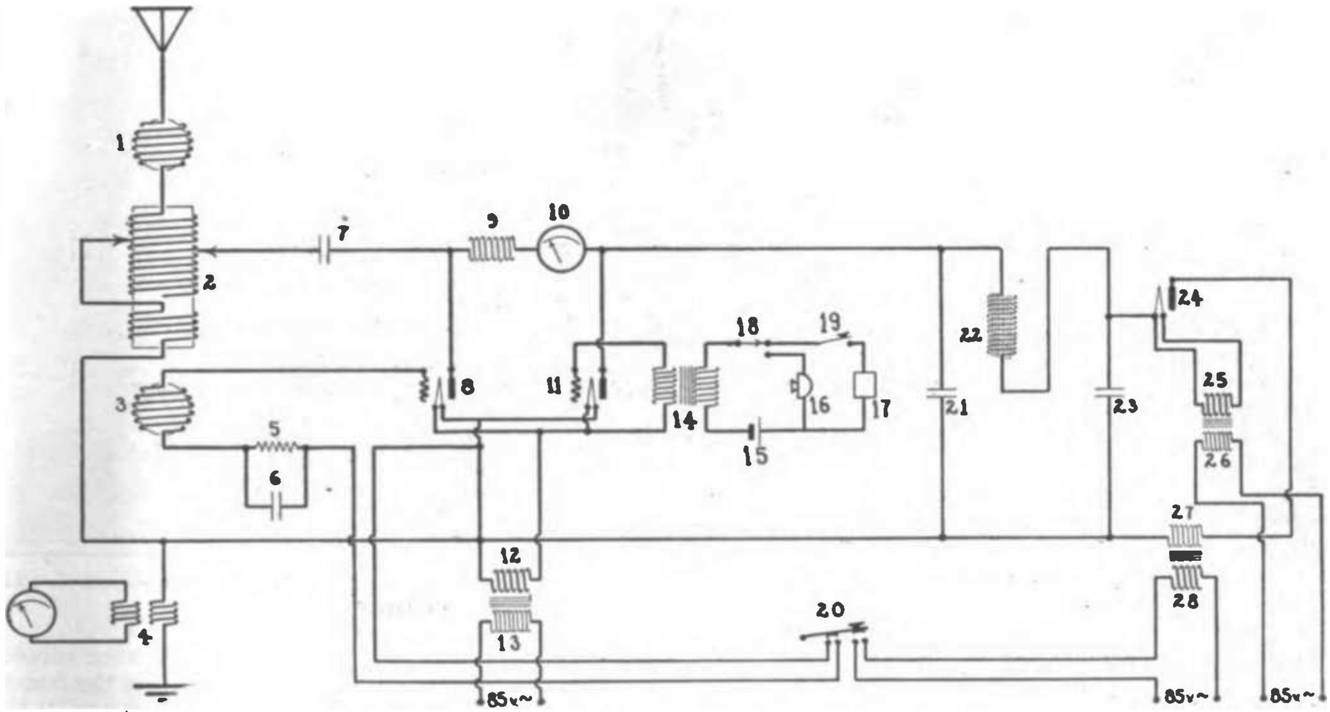


Fig. 3. Complete diagram of the ½ k. w. tube transmitter. This varies from the circuit of the 1½ k. w. set only in small details

in Fig. 1, on the left hand panel. At the top is the antenna variometer, with the two plugs, for the antenna and plate connections, and 9 jacks, while below are the grid coil and radiation meter. On the center panel, the transmitting tubes are mounted at the outside, with the rectifier at the center, and, above, the plate current meter. Changes from buzzer to telephone modulation are effected by the upper two-pole switch, just at the right of the tube panel.

Two keys are furnished for the telegraph sending. The larger is for undamped wave work, while the smaller live parts are touched just after transmitting.

The transmitting range, on 1,000 to 2,000 meters, is conservatively estimated by the manufacturers as 100, 130, and 300 nautical miles for telephone, buzzer, and undamped wave sending, when an antenna 220 ft. long by 100 ft. high, having a natural period of at least 360 meters, is employed.

Essentially, the 1.5 k. w. set is similar to the 0.5 k. w. type just described. As shown in Fig. 2, the inductance is outside the cabinet. No antenna variserted in the common return. Therefore, no switch is needed to change from telephone to buzzer modulation.

This set, operating at 1,200 to 3,000 meters on an antenna having a natural period of about 400 meters, is rated at 250, 350, and 500 nautical miles for telephone, buzzer modulated, and undamped wave transmitting respectively.

In the succeeding articles, British amplifiers, receivers, airplane apparatus, and other transmitting sets will be described and illustrated.

RESISTANCE BOXES

THERE are many uses in the laboratory for small resistance boxes such as shown in the accompanying illustration. While this one is of a manufactured type, they can be made easily and inexpensively.

For resistances up to 10 ohms, if only a small current-carrying capacity is required, No. 30 Advance wire can be used. It is only necessary to make a small loop for each 1-ohm step, soldering the ends to the switch points underneath the panel. Such a winding, if the sides of the loops are close together, is practically non-inductive.

When larger wire or more resistance per step is needed, the wire can be wound in the usual non-inductive manner on a small thin piece of bakelite. Fibre should not be used as it absorbs moisture.

These little boxes are adaptable to antenna resistance measurements if a small vacuum tube generator is used to excite the antenna.

It is not necessary to make them non-inductive if only direct-current measurements are to be made. Then the wire may be wound on short lengths of hard rubber or bakelite rod.

Precision Radio Measuring Instruments

Instruments from the General Radio Company Which Combine Utility with Great Accuracy

THE General Radio Company, specializing on laboratory equipment of high precision, has recently brought out three instruments of special interest to experimenters. From the photographs and description a number of excellent ideas can be obtained also for the construction in the experimenter's shop of equipment for his own work.

Standards of Inductance.

In Fig. 1 is shown the standard inductance made with values of 0.05, 0.20, 1.0, and 5.0 mhs.

The design of this standard by means of which extreme accuracy is obtained is quite interesting. Those who have attempted to build cylindrical coils of exact values appreciate the difficulties attaining to construction of standards of that type. Moreover such coils have large outside magnetic fields, a factor which introduces considerable errors into measurements.

Both of these difficulties have been overcome in the General Radio inductance standards. As can be seen from Fig. 1, two D-shaped coils are used one of which is mounted below the main supporting plate and the other on a circular bakelite plate. High frequency cable is of course employed to give a low high frequency resistance. The shape of these coils produces a very small external field. The form of winding is referred to as astatic.

Practically no metal is in the field of the coils with the exception of the necessary non-magnetic screws and nuts. The formwound coils are bound with tape to prevent any change in their shape and are firmly secured to the bakelite plates.

When the instrument is assembled a final adjustment of the inductance is necessary to give the accuracy which is not obtainable by ordinary manufacturing methods. This is obtained by varying the mutual inductance between the coils. For this purpose the four screws which hold the upper-round bakelite plate are loosened and the plate rotated until an exact value is obtained. The accuracy of this adjustment gives a value of inductance having less than one tenth of 1% error.

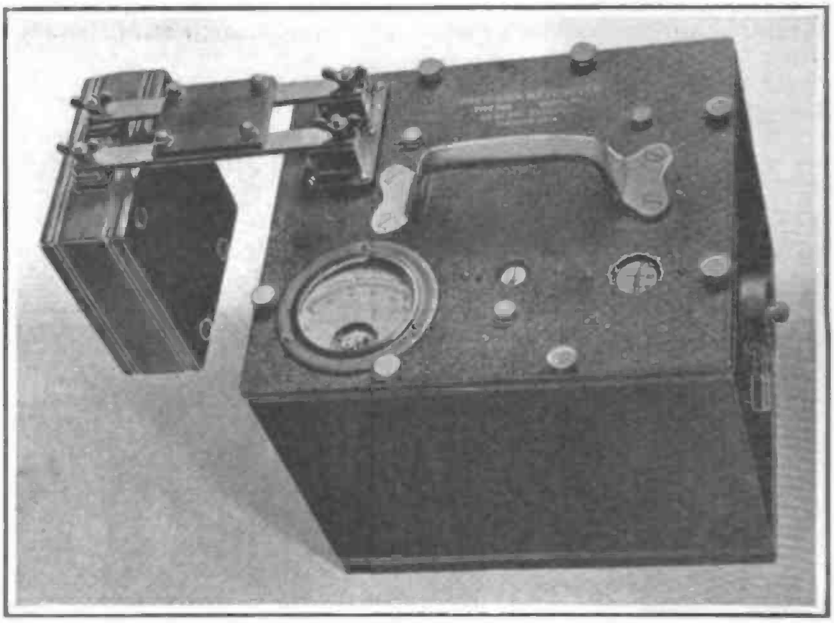


Fig. 3. The simplest circuit, with the fewest instruments, is employed for this wavemeter

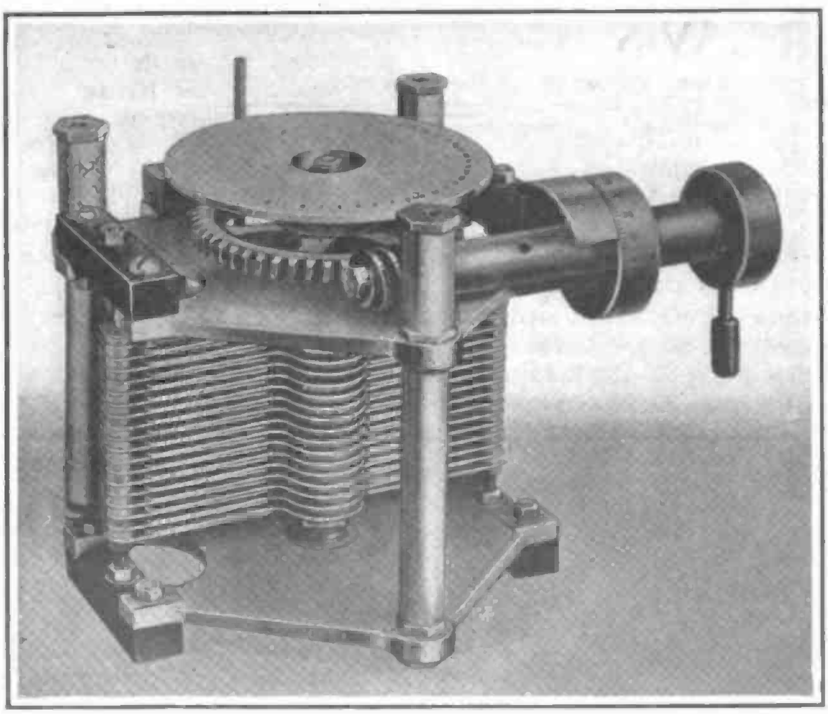


Fig. 2. The design of this condenser, giving great strength and low losses, is quite unusual

The continuous capacity of the two small sizes is 2.5 amps., the 1.0 mh. coil, 2 amps., and 5.0 mhs. coils, 1 amp.

A Precision Condenser.

For laboratory measurements the ordinary condensers show losses and variations in adjustment which are not in evidence when the condenser is used for ordinary receiving work. Not only must the bearings be absolutely accurate to insure an unchangeable calibration but a vernier adjustment is necessary, and losses through insulation between the fixed and movable plates must be negligible to give the lowest possible phase difference.

The General Radio condenser is constructed to attain the ultimate in these respects. Heavy aluminum plates widely spaced are the first steps toward permanence of adjustment. The supporting pillars as shown in Fig. 2 gives a strength to assure the calibration against variation from jars and hard use. Aluminum end plates are provided but the insulation between them and the rotating plates is not located at the bearings according to usual practice, but at points in a weak dielectric field. As little insulating material as possible is used to keep down losses from this source. Conical brass bearings with a steel shaft tend to reduce wearing.

An interesting feature is the worm adjustment of the rotating plates. At first thought it might appear that considerable play would be present between the worm and gear, either from inaccuracies of manufacture or wear under use. Such an occurrence is guarded against by using a spring tension to hold the worm against the gear. This method is similar to that employed in the precision dividing engines.

The scale on the main shaft covers 180% but it is divided into twenty-five equal parts. On the worm shaft is a second scale of one hundred equal divisions. Since a rotation of the worm moves the variable plates one division on the large scale, the setting of the condenser can be read to one part in twenty-five hundred of a semicircle.

The copper lined mahogany case in which the condenser is mounted provides perfect shielding. This case fits into a strong carrying box furnished with a handle and lock.

As a result of the care employed in the design and construction of the precision condenser it can be seen for purposes of measurement that the condenser is equivalent to twc parallel condensers, one fixed, containing all the losses and the other a perfect variable condenser. Potentials of one thousand volts can be employed without danger of a breakdown. A calibration curve made from twenty-six points readable with an accuracy of one tenth of 1% is supplied with the variable condenser.

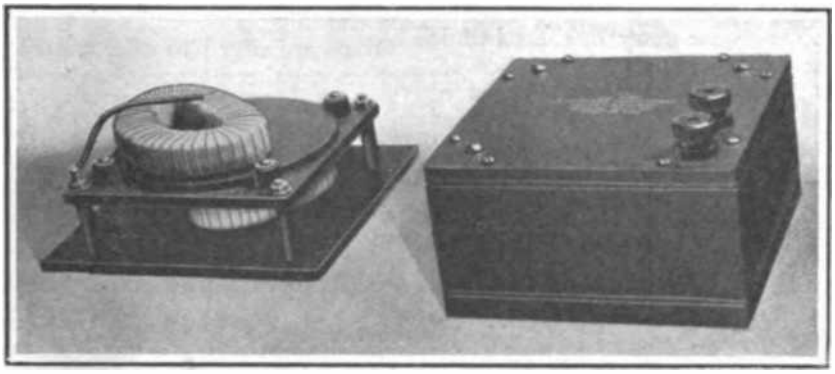


Fig. 1. An exact value of inductance is obtained by adjusting the mutual inductance between the upper and lower coils

The Precision Wavemeter.

This wavemeter, to eliminate errors and variations due to elaborate circuits, contains only a condenser, of the type just described, a type 425 Weston thermogalvanometer, and the inductance coil. With five coils a range of 75 to 24,000 meters can be obtained. No exciting means is furnished, for, in accurate work, such excitation is not required. The use of a buzzer calls for a special calibration, when it is in use, and at best causes errors of too great a magnitude for such a precision instrument.

By the elimination of losses in the condenser and wiring, and by winding the inductance coils with high frequency cable in a manner to make the distributed capacity minimum, an accuracy is obtained which permits the determination of the resonance point for undamped waves to less than one-half a division on the vernier scale, which is equivalent in wavelength to 1 part in 10,000.

The wavemeter is carried in a mahogany case, fitting in a strong whitewood carrying box which also holds the coils and calibration data. Mahogany boxes, with bakelite ends, are used to mount the inductances. The general design of the instrument is intended to combine strength with accuracy of reading.

The wavelength calibration is made at 24 points for each coil, and a capacity calibration at 26 points on the condenser is also furnished.

BOOK REVIEWS

Wireless Telegraphy and Telephony. By H. M. Dowsett, M.I.E.E. 331 pages, 305 illustrations, cloth bound, 8½ by 5½ ins. Published by The Wireless Press, Ltd., American representatives, The Wireless Press, Inc., New York City.

The sub-title of this book, "first principles, present practice, and testing", summarizes the contents, for, in a practical and useful way, these phases of radio are treated, making it a valuable book for experimenters in general and operators in particular.

In the first two chapters, electrical phenomena are discussed, serving as an introduction to the three following chapters which take up spark discharge apparatus, continuous wave generators, and the vacuum tube. The sixth chapter is devoted to high speed communication methods.

Ten chapters, constituting the balance of the valume, describe the principles involved, and various methods employed to measure current and electromotive force, resistance, capacity, inductance, frequency, dielectric strength, decrement, and the direction, distance, and strength of received signals.

The value of this book lies not in new material presented, but in the practical nature of the treatment.

An Electron Tube Transmitter of Completely Modulated Waves. Scientific Papers of the Bureau of Standards No. 381. By Lewis M. Hull, Associate Physicist. 13 pages, 9 illustrations, paper cover, 10 by 7 ins. Sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5c.

Of interest to experimenters, as well as engineers, is this new paper from the Bureau, for it describes a vacuum tube set which uses 500-cycle alternating current for the plate voltage supply. In this way, complete modulation is obtained, and no control tube is required. Although capacity, direct, or inductive coupling can be used from the generating circuit, inductive coupling was used for this set. An efficiency from the plate voltage step-up transformer to the antenna of 35% was obtained. Constants and dimensions for the instruments are given.

It is interesting to note that heterodyne reception is required in connection with this transmitter.

Wireless Transmission of Photographs, second edition. By Marcus S. Martin. 143 pages, 77 illustrations, cloth bound, 8½ by 5½ ins. Published by The Wireless Press, Ltd., American representatives, The Wireless Press, Inc., New York City.

To Mr. Martin's unique book on the transmission of photographs by radio has been added, in the second edition, a discussion of the Nernst lamp, data on films, and enlarging, and notes on optical lenses which enhance considerably the value of the original manuscript.

While no practical use has been made of photograph transmission, Mr. Martin sets forth the details of what he and others have accomplished, and opens to experimenters and inventors a most fascinating field of work. Moreover, a solution of the problem, capable of commercial application, would be of great value to newspapers, as it would enable them to reproduce photographs and news, from distant sources, simultaneously.

NOTICE

Do not fail to read the announcement of the Transatlantic Sending Tests on page 544. If you are not in a position to participate in these tests yourself, you can at least assist another man who wants to try. The accomplishment of this feat will be the greatest achievement of experimental radio communication.

If you can't assist in one way, you can in another. Get in on it somehow.

Experimental Transatlantic Sending Tests

The Next Long Distance Record for a 200-Meter Set Will be Transmitting Across the Atlantic. "Everyday Engineering" is Making Arrangements for the Tests

TO cross the Atlantic ocean, by one means or another, has called forth the greatest skill and daring in several lines of engineering work. Columbus in his sailing ship, Fickett in his steam propeller vessel, Marconi with his radio signals, Read piloting a flying boat, Alcock and Brown in a land machine, and, last of all, the crew of the British dirigible, have made their marks in the history of the pioneers, as well as in engineering accomplishments.

It is hoped that, during the coming winter, the next transatlantic conquest will be recorded, that is, the transmission, from a 200-meter, 1 k. w. experimental station, of radio messages to England.

At first thought, there might seem to be no real purpose for this work, and no useful result attained by it. The same judgment might be rendered of the Olympic contests. There is always the desire in the heart of every man to do something first. But of more importance than that is the fact of being first to attain the degree of efficiency or proficiency required for the task.

The first experimenter to transmit across the Atlantic will set a new standard for 200-meter sets. His name will never be forgotten as long as there are radio experimenters.

Of real benefit to everyone engaged in the work, however, will be the publicity thus obtained through the newspapers all over the country. The increased interest in the work of the experimenters, and the respect which they will command will greatly strengthen their position.

This is the reason that EVERYDAY ENGINEERING is making the first proposal for the attempt, and is working out plans which will insure the co-operation of English receiving stations.

Announcement is made now to give everyone sufficient time to prepare for the tests, which will start on February 1, 1921. The elements of the contest are as follows:

1. Any man, or group of men, can enter. In the latter case, credit will be given to the man who engineers the work. Those connected with radio companies may enter if they carry on as individuals apart from the organizations in which they are employed.

2. The only limits on the transmitter are that the input, measured at the source of power supply, shall not exceed 1 k. w., and the wavelength shall not exceed 200 meters.

3. Those wishing to enter the contest must communicate with the Radio Editor, EVERYDAY ENGINEERING MAGAZINE, in order to be allotted places in the schedule, the details of which will be announced later.

4. Names for entry in the schedule will be accepted up to November 15, 1920. Suggestions for the method of conducting the tests will be entertained until October 15, 1920. Complete details of the schedule will appear in the January, 1921, issue of EVERYDAY, in circulation on the first of December. This allows two months before the tests are made. News of the preparations will be published as fast as they are completed.

5. Prizes to be awarded by individuals and manufacturers, and the conditions under which they are to be given, will also be published.

CAN YOU ENTER THE COMPETITION?

Special efforts of this sort are necessarily expensive. There are experimenters who will not be dismayed by the cost of fitting up and carrying out tests to obtain the high degree of efficiency required. Others may feel that their present equipment is sufficient.

So many times, however, contests are won by those who work with limited facilities, who do their utmost with what they have. There will be some contestants who will apply to friends to help them. In some towns, civic pride will prompt contributions in an effort to bring the honor of achievement to that locality.

As is true in all engineering efforts, the man with the greatest energy and resourcefulness will win.

REGISTRY FOR THE CONTESTS

Individuals, groups of workers, and clubs should send in their names as soon as possible so that there will not be any confusion near the closing date. The following information must be given:

1. Name of contestant, individuals comprising group and man supervising the work.

2. Address and call of station, if already in operation.

3. Longest transmission ever accomplished on 200 meters with 1 k. w. by operator.

4. Type of transmitter to be used. (An answer to this question is requested but not required.)

As fast as they are received, names of entrants will be published in EVERYDAY. The January, 1921, issue will contain a complete list of the contestants.

PRIZES

To promote the interest in this contest, individuals, clubs and manufacturers are urged to offer prizes to the winner, either unconditionally or under such circumstances as may be set forth by the donor. Many manufacturers will undoubtedly wish to create interest in their products by offering prizes if some of their products are used by the successful contestant.

POSSIBILITIES OF ACCOMPLISHMENT

When it is considered that commercial transatlantic stations use several hundred kilowatts to transmit across the ocean, it may seem that the proposal to use only 1 k. w. is rather far fetched.

In 1901, Marconi did it with 25 k. w. To be sure, it was on a long wavelength. and at the shortest separation between this continent and England. Nevertheless, the English experimenters who will co-operate with us have wonderfully sensitive receiving apparatus.

Mr. Philip R. Coursey, of the *Radio Review* and *Wireless World*, whose aid has been requested in handling the receiving arrangements, will have no difficulty in enlisting the most able English operators and the best equipped stations.

BOOK REVIEW

PRACTICAL AMATEUR WIRELESS STATIONS. Compiled by the Editor of *The Wireless Age*. 136 pages, profusely illustrated, paper cover, 9 by 6 ins. Published by The Wireless Press, Inc., New York City.

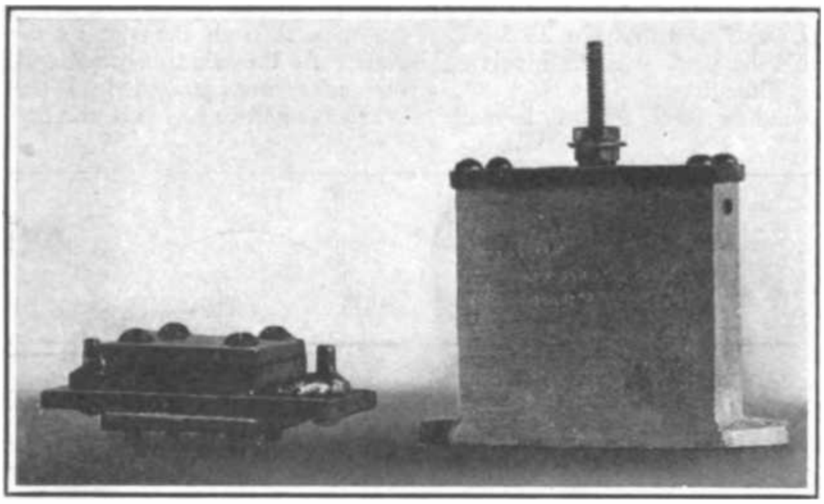
Mr. J. Andrew White, who selected the material for this volume, calls it an "experience book", containing the best ideas of thirty-three experimenters. Each of the forty-seven chapters takes up a separate problem, giving instructions and illustrations of the methods required. No special sequence is followed, as in a text book, for this is simply a collection of helpful and interesting ideas, most of which concern the actual construction of radio apparatus.

There are chapters on regenerative receivers, long wave sets, different types of panel receivers, amplifiers, detector construction, instrument details, and installation notes in the first half of the book. The second half deals with sending equipment such as panel transmitters, transformer design, vacuum tube transmitters, spark gaps, keys, and other instruments.

SMALL DUBILIER MICA CONDENSERS

TWO types of small mica condensers, distributed by the Pacent Electric Company, are shown in the accompanying illustration. The open type, at the left, is made in various sizes for use in receiving circuits and vacuum tube transmitters. In transmitting sets, they are useful to shunt around the grid leak, to keep the high-voltage plate potential out of the antenna tuning inductance, and for similar purposes.

The larger condenser, enclosed in an aluminum case, is for smoothing out direct current or rectified alternating current. The capacity is 0.25 mfd. One terminal of the condenser is grounded to the case, while the other is connected to the protruding screw in the bakelite top. Lugs on the base are drilled so that it can be fastened down readily on the table or inside a cabinet.



BOOK REVIEW

EMERGENCY WAR TRAINING FOR RADIO MECHANICS AND RADIO OPERATORS. Issued by the Federal Board for Vocational Training, C. A. Prosser, Director. 75 pages, 8 illustrations, paper cover, 9 by 6 ins. Published at the Government Printing Office, Washington, D. C.

Written in 1918 for the purpose of training men who were waiting to be called into the army, to prepare them for radio work, this book has completed the work for which it was intended. However, it is still valuable to those, particularly, who are learning the code, or teaching others.

It contains twenty-four pages of operating exercises, carrying the lessons from simple words to complete messages in the form of army communications, in a quantity which precludes the possibility of memorization from continued use.

The questions on theory and operating will be found helpful to those preparing for examinations.

Instruments for Undamped Wave Transmitting Sets

FOR some time articles have been published, papers written, and arguments put forth concerning interference on short waves. The conclusion is invariably that interference will be remedied through the general adoption of undamped waves transmitting sets. But, with the articles, papers, and arguments, the reduction of Q R M stops, because of the difficulty in buying equipment at reasonable prices which cannot be made in the ordinary experimenter's shop. This same difficulty is responsible for the limited use of the radio telephone.

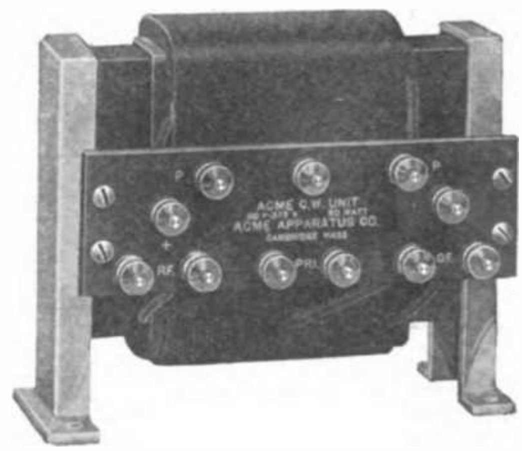
The number of possible circuits for tube transmitters is running a close race with the methods of copying P O Z with one bulb.

Experimenters who have listened on a particularly good night and have experienced the painful process of copying long distance through the beehive of broadly tuned 200-meter stations are looking forward for the ray of hope which will light the way to the grave of Q R M.

More than that, we all want to speak as well as buzz, but there is the stone wall of high voltage plate potential.

Tubes can be purchased at reasonable prices as well as the other parts of the set, but a motor generator, if it can be obtained at all, represents a small fortune. To surmount this difficulty is like making a boy with a spark understand that, when he is going, the other stations must call it a day.

Now, however, a new instrument, from the Acme Apparatus Company, is on the market which makes it possible, to use the words of the manufacturer, to change the common ordinary garden variety of 110-volt, 60 cycle current, to high voltage direct current of the correct value to supply the plate potential for vacuum tubes. Furthermore, the cost of device is even within the reach of those who haven't a wage earner in the family. The new instrument, a transformer, is shown in the accompanying illustration. The primary is wound for 110 volts, and the secondary to give two voltages each of 550 for the 200-watt tubes and 325 volts for the 50-watt tubes. The secondary winding is connected to two rectifying tubes utilizing both sides of the cycle.



The pulsating direct current is then smoothed out by means of a condenser and series choke coils of one and one-half henries.

This transformer has in addition two other windings which give 12 volts each, one for lighting the filaments of the rectifying tubes and the other for lighting the filaments of the power tubes. Both of these windings are provided with center taps. The rectifying tube filament winding is tapped so that the plate current is distributed to both halves of the filament, thereby preventing one-half of the filament there being overheated by this additional current. The power winding is tapped in the center so that the grid circuit will not become alternately positive and negative. Thus the oscillations in the transmitter are not modulated at any low multiple of the alternating current supply frequency. The manufacturers of this transformer also build supplementary equipment, including large choke coils, telephone modulation transformers, and separate filament heating transformers, the last being used where it is desirable to heat the filaments from 110 volts a. c. instead of a low voltage direct current supply.

A system of wireless telegraphy for press messages is shortly to be established between Helsingfor and Copenhagen. Though the Danish arrangements are now complete, the Finnish military authorities have not yet given their consent to the use of the Finnish wireless stations.

Variometer or Coupling Coils

Small, Pancake Coils Are Used on this Variometer to Replace the Usual Ball Types

THE design of the coils for the variometer described in this article is not greatly superior to the ball and hollow winding types but it offers some new thoughts for the experimenters and a different method of making a simple variometer where winding forms for the usual sort are not available. Actually this variometer is a modification of the figure 8 windings, in that the two halves of the figure 8 coils are replaced by two circular coils wound in opposite directions.

Fig. 1 shows the front of the completed instrument and, at the right, sectional views of the device employed in winding the pancake coils. Fig. 2 illustrates the appearance of the rear and side of the instrument, while in Fig. 3 there is a wiring diagram.

Essentially, the variometer is made up of a set of stationary coils in front of which another set is rotated. For experimental purposes, a 360-degree scale was used, divided into 200 parts. However, only one-half a revolution is needed to pass from minimum to maximum, so that a scale of 100 divisions, 180 degrees, is sufficient.

The coils are the most interesting and the only difficult part of the instrument. A number of experiments were made at the Everyday Engineering Laboratory on windings of this sort to determine first, if it was possible to make up a small pancake coil which would be self-supporting and would not be damaged during work of assembling the parts, and, second, how small wire could be without rendering the coil too secure. The latter factor is important for the size of the coils is limited and it is necessary to use small wire in order to obtain a fair amount of inductance. Otherwise, with too small an inductance, this type of winding would not be practical. As a matter of fact it was found that No. 26 S.S.C. wire could be used without involving any great difficulties.

The winding form, Fig. 1, is made in two parts, a main section which is put in the chuck of the lathe, and an end plate held by a center in the tail stock, and pinned to the other section. The form used for this work was cut from brass rod 1¾ ins. in diameter. The face of the main section was first turned true and smooth. Then it was cut back the thickness of the wire and turned down to three-fourths of an inch. The slight ledge on which the wire was wound was turned at an angle of 45 degrees to the face, and the protruding face was slightly counter bored and a saw cut made as shown in the cross-sectional views. The end plate is merely a washer with a slot cut in five-eighths of an inch. This work done the two parts were put together with the slot of one opposite the saw cut in the other, and a hole drilled just inside the circumference of the protruding face. A pin was then driven into the end plate and the hole in the main section drilled out so that the pin slipped in easily when the parts were assembled

To wind the coil, the main section was fitted in the chuck. The end plate, with its pin in place, set against the face, and the tail stock moved up so that the end plate was held firmly against the main section. Then a fine wire was held in the saw cut and the winding started by putting the end of the wire through the slot in the end plate. As the winding progressed, the fine wire was pushed into the cut. When the groove was full, the fine wire was brought around and twisted so that the coils could not unwind. Cutting off the wire and bending the end backward completed the coil.

The next step was to push back the tail stock and withdraw the end plate. Just a touch on the binding wire and the coil slipped off the face of the main section. Finally the coil was dipped in very hot beeswax. After cooling, it was found that the coil, though wound with No. 26 wire, was quite strong and firm.

The next step in constructing the variometer was to cut out a bakelite strip 5 ins. long and ¾ in. wide, to act as the support of the stationary coils and a bearing for the shaft which controlled the moveable coils. The strip was drilled, as shown in Fig. 2, for the screws, the shaft, and the holes through which threads were passed to bind the coils in place. Four more holes were drilled to take the terminals of the coils. They were made fairly large to

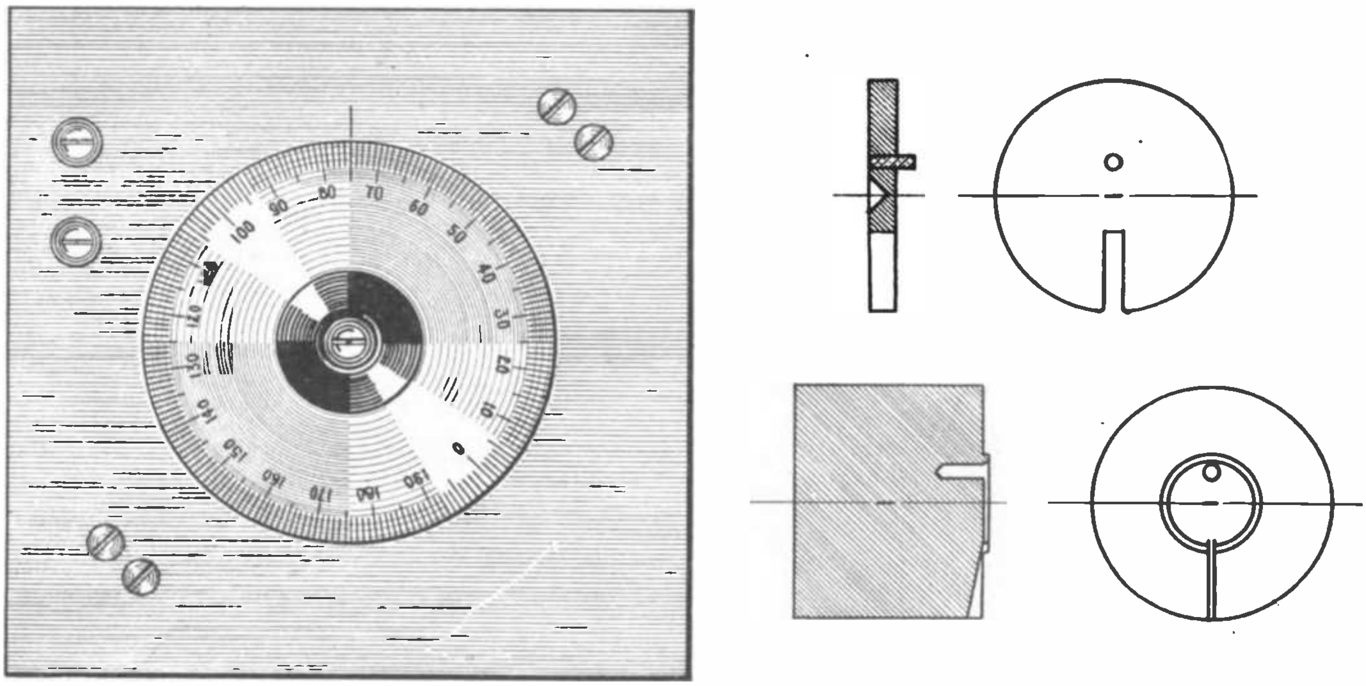


Fig. 1, left. The front of the panel of the completed variometer. Right. Cross sectional views of the form used for winding the coils allow for variations in the position of the terminals. It will be seen that the ends of the coils are bent back squarely. This was done by holding the coil with a pair of parallel jaw pliers while the wire is being bent. Otherwise, the turns would have come loose. The coils were 2¼ ins. apart, center to center. Another strip four and one-eighth inches long and three-fourth inch wide was cut out to carry the moveable coils. These were fastened on in the same way.

At this point, flexible leads were soldered to the terminals of the coils. It will be readily understood that considerable caution was necessary to prevent the coil from coming apart during the soldering process. It was found, however, that since the binding threads were near the terminal points, they held the wires well enough so that, although the beeswax became soft, the turns did not come apart. A very hot soldering iron was used, so that just a touch was necessary to make the joint.

Details of the assembly are given in Figs. 1 and 2. The bakelite strip for the rotating coils is held by a nut against a ⅜ in. length of ½ in. round rod, which is, in turn, locked by a second nut. Two washers were put on at the rear nut to act as spacers, so that the moveable coils were held 1/16 in. from the stationary coils. A washer and lock nuts on the end of the shaft kept the moveable section in place.

It will be noted that a 360 degrees scale divided into 200 parts is employed at the front. This is not necessary because only a half-revolution is required to pass from a maximum negative mutual inductance to a maximum positive mutual. The panel measures 5 x 5 ins. and, to insure sufficient strength, should be 3/16 or ¼ in. thick.

This type of variometer can be used as a coupling coil by connecting the windings as shown in Fig. 3. Then four binding posts will be necessary, two for the coils acting as a primary coupling inductance, and two for the other set of coils serving as the secondary coupling inductance. Again, this can be used as a secondary coupling and tickler coil.

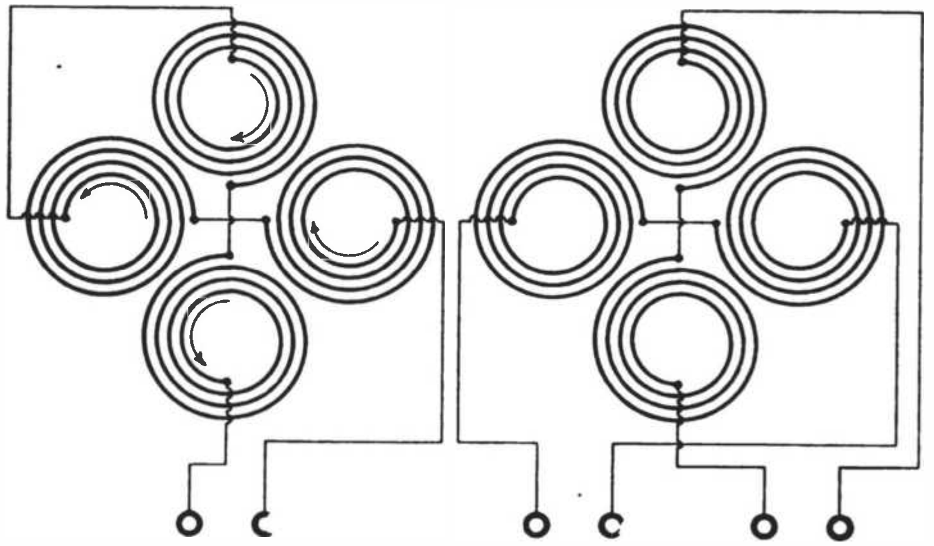


Fig. 3. At the left, the connections for a variometer. On the right, a diagram for coupling coils

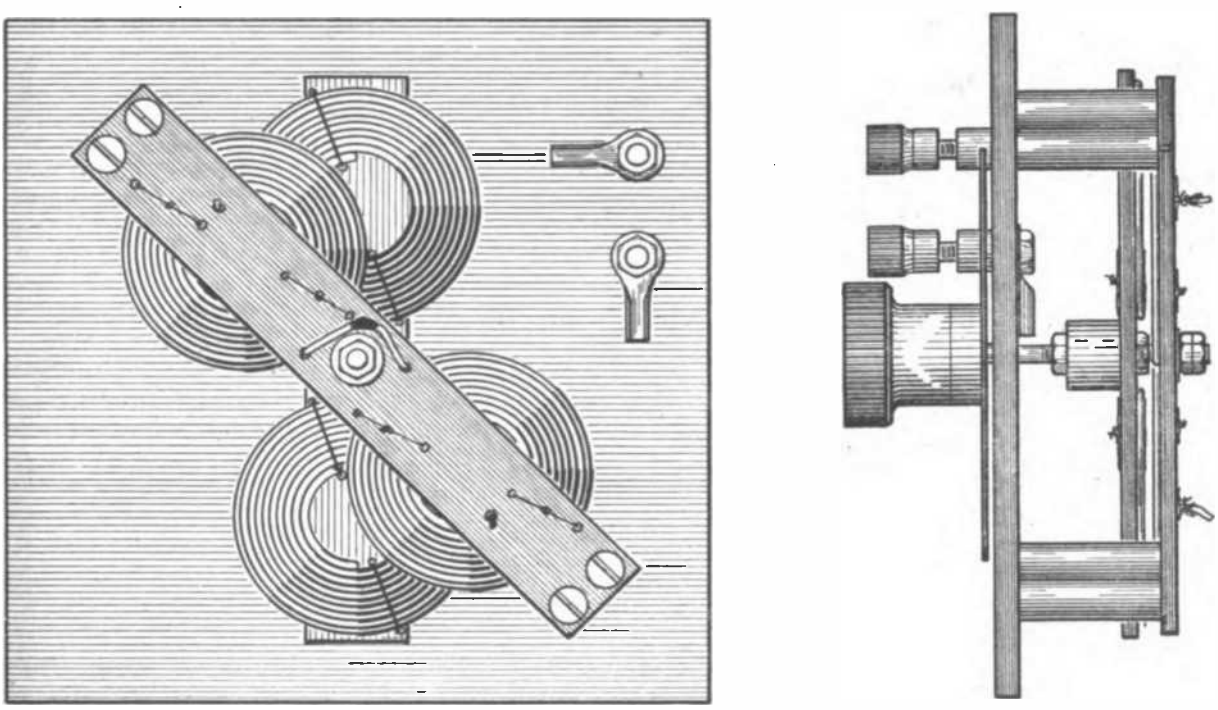


Fig. 2. Rear and side views of the instrument as it appears when finished, except for the connecting wires

REGENERATIVE RECEIVER

(*Continued from page* 539)

Operation

Tuning in the primary circuit, accomplished by the 13-point switch, will be found quite sharp. The secondary condenser, giving a facile control over a considerable range, saves just the amount of time which, with a receiver less easy to handle, causes the loss of a call. The coupling to the primary is usually made tight for listening-in, and loosened for sharp tuning.

If the tickler leads are of the correct polarity, regeneration can be readily adjusted, and will need practically no changing from 200 to 600 meters, another advantage over the tuned plate circuit which must be fixed for each signal.

Complaints about poor operation can often be traced to wornout B batteries. When anything goes wrong, the plate batteries should be examined first of all.

The Radio Department

A Discussion of Current Topics of Interest to Experimenters and Manufacturers

ONCE more experimental radio is having its preliminary yawn and stretch portending the resumption of activities. The demand for antenna wire and insulators is starting on the up-grade, which precedes a steep curve, to be followed by a flattening that operators will recognize by the saturation of the ether.

Just now, several thousand minds are formulating plans for the "real transmitter" or the "real receiver" which several thousand pairs of hands will make this winter. The accompanying pairs of ears are close to the ground, and pairs of eyes are carefully searching for the signs of the times which will indicate the optimum course leading to the paragon of efficiency.

This is the season at which the wiseacre, who has something so radically excellent that he won't let anyone see it, first makes his appearance. He should be carefully avoided as an undesirable denizen of the radio woods. New things never come from such men. If they have any ideas, they are always borrowed from someone who is not so selfish as to be secretive.

But to return to the "paragon sets." For sending, we shall have with us the spark coil and transformer, as always, and a new crop of vacuum tube transmitters. However, vacuum tube sets are now split up into several classes, namely, undamped wave, telephone, buzzer modulated, and a newcomer, the a.c. plate voltage type.

Since few of us can have everything, we must decide how we can get the most for what we have to give. The telephone is all very well for its intended purpose, but those who are out for distance will not select it. Undamped waves are too difficult to handle at the receiving end. Thus we find the choice lying between the buzzer modulated and the a.c. plate voltage types.

Buzzer modulation, if the set is operated on 110 volts a.c., calls for a step-up transformer for the plates, a step-down transformer for the filaments, smoothing-out coils and condensers, rectifier tubes, a modulation transformer, and a large choke coil. And there will be many to use them, too.

However, the man who wants most for least will have, instead of all the instruments just listed, a step-up transformer to change 110 volts a.c. to about 350 or 500, and a step-down transformer to give eight or ten volts for the filaments. Then he will apply the high voltage to the plates of as many tubes as he can get, connected in parallel, wire them to an oscillating circuit, and transmit on a 200-meter wave, modulated at 60 cycles or whatever is the frequency of his a.c. supply.

The note, to be sure, will be low, but the tuning extremely sharp, and the distance greater than that accomplished with the same tubes in a buzzer modulated circuit.

Experiments are now being conducted in the EVERYDAY ENGINEERING Laboratory, on a set of this sort, equipped with a step-up transformer which also doubles the frequency. The work has not progressed to a point at which the success of the frequency doubler is assured, but a very interesting article on a set using alternating current on the plate will appear in the October number.

Mr. A. H. Wood, Jr., has written an article for those who prefer the buzzer modulated and telephone set which will also appear in the October issue.

The regenerative receiver, for short wave work, will be even more popular this winter. Among the more advanced experimenters the Armstrong short wave radio frequency amplifier is promised wider use. Although it has been described in various periodicals, it has not received the favor which it merits. An article on this type of set is under way, and will probably be found in the October issue.

As for the man who is looking forward to Transatlantic work: If he wants the best, he will have a separate oscillator for undamped wave reception, and, perhaps, a few steps of radio frequency amplification, augmented by two or three stages of audio frequency amplifiers.

Designs for the tuning instruments and amplifiers will appear in EVERYDAY in the last issues of 1920.

THOSE who attempt the Transatlantic sending tests will have enough to keep them busy up to the first of February, 1921. The suggestion regarding a.c. plate supply offers a new possibility for long distance work.

Experimenters are urged to send in their ideas as to the way the schedule should be arranged and the winner selected, for it is desired that all experimenters share in the decisions as to the conduct of the tests, since they are open to all experimenters.

THERE are two things which every radio man should do as soon as he has his antenna up—he should measure the capacity of his antenna, and, if he is going to send, the resistance at 200 meters. It is impossible to design a receiver without knowing the capacity, just as it is meaningless to talk about two amperes or ten amperes in the antenna when the resistance is unknown. Also, it is desirable to measure the natural period so that the set can be operated at as little as possible above the natural period of the antenna.

Without this data, no experimenter can talk intelligently about his station. These three measurements, and simple ways of making them have been taken up in recent issues of EVERYDAY.

The man who talks and writes of antenna capacity and watts in the antenna has progressed a long way past the experimenter who looks blank when these terms are used.

RADIO experimenters as a whole are strictly practical, putting to their own use the efforts and products of others. From this great group of boys and men there are being and will be developed a few real scientists, men who seek knowledge because it is useful, in contrast to the many who confine their interests to useful knowledge.

A note of appreciation and understanding of such men is sounded in the conclusion of a booklet published by The American Telephone Company and The Western Electric Company, supplementing an exhibit prepared by them to reproduce the fundamental discoveries of the nineteenth and twentieth centuries which paved the way for the successful development of the wireless telephone.

"The efforts of the host of practical scientists throughout the world who are advancing the wireless art by the invention and development of better radio devices are manifested by the state of the art itself, but the work of the pioneer scientists, which has been of equal and perhaps greater value, is not so obvious. Indeed, the work of these pioneers is often overlooked by the very people, the public, who benefit most by their work. For instance, it is not very apparent that a Henry seeking to understand the laws of the electro-magnet, or a Faraday absorbed in the transformation which a beam of light undergoes in traversing a magnetic field, or a Maxwell, who, with paper and pencil, is making guesses as to the structure of the ether, is doing a work without which there could be no wireless telephone. This is a fact we cannot bear too much in mind. The number of Henrys and Faradays and Maxwells of whom the world is in possession at any one time is very limited, and because their labors, if not immediately, are certain eventually to find many applications, they should be given every aid and encouragement. Of this principle, the history of the wireless telephone is merely typical. By altering a few names and statements of fact, and in no wise changing the underlying thought, any one of many practical applications and processes might be substituted above for the wireless telephone. Take, for example, the incandescent lamp, the X-ray, radium, antiseptics and antitoxins, the fixation of nitrogen, and the modern methods of soil fertilization,—in every case we would find the evidence pointing to the conclusion that the abstract scientist and the reclusive philosopher of one generation are preparing the way for the technician of the next; that the scientific laboratory of one generation becomes the workshop of the next, that the "useless" theory of one is the practice of the next; in a word, that for guiding all research there is no higher principle than this,—'Know the truth, and the truth shall make you free.'"

THE RADIO CLUB OF BROOKLYN

THE Radio Club of Brooklyn, Inc., is an organization composed entirely of radio amateurs. All full members have first grade commercial licenses and all have more or less complete sets of apparatus. During the past winter several lectures have been given in the meetings by authorities on amateur radio telegraphy and telephony. Mr. Hewitt has been kind enough to describe his old set at Albany, with which he worked thirty-nine States in the Union, and gave various valuable hints on efficient rigs of all kinds; also, Mr. Earle Dannals, Chief Radio Electrician, U.S.N., has given some highly interesting and eye-opening talks on "Amateur Radio Telephones, Frequency Tuners, and the Theory of the Action of the Vacuum Tube, and on how to adjust Radio Spark Transmitters."

The members of the Brooklyn Radio Club have access to one of the best General Radio Wavemeters obtainable. There is a committee composed of some of the more experienced members of the club, which is at the service of any member should his transmitter need tuning. This committee is in communication with the Radio Inspector and it is its business to see that all the transmitters of members are adjusted in accordance with the law and at the highest point of efficiency.

One of the primary purposes of the Radio Club is to raise the standards of its members in their ability as operators, and in the operation of their stations.

Meetings are held every other Friday night in the rooms kindly loaned by Mr. Warren S. Benson at No. 4 Fuller Place, Brooklyn. All amateurs interested are advised and invited to come any meeting night, or communicate with the Secretary, Mr. Lloyd Jacquet, at 478-A 16th Street, Brooklyn. Telephone South 5649-W.

THE RADIO ASSOCIATION OF WESTERN NEW YORK

THE Radio Association of Western New York, with headquarters in Buffalo, held its semi-monthly meeting recently at its new rooms, at 389 High Street, corner Jefferson. This Radio Club has a large number of members who live in surrounding towns and who attend meetings regularly. The new impetus given radio work since the war has enabled the club to expand, both financially and in membership. The constitution and by-laws of this club are worked out in a clear and efficient manner and the club will be glad to mail a copy upon written request to any amateurs desiring the same for organization purposes. Any other radio club granting the same privilege to this club will be gratefully thanked.

The constitution calls for the suspension of meetings during the summer months, but the members have decided to continue meetings for the purpose of a summer campaign for members. It is planned to have every radio enthusiast enrolled in the club before the fall relay work starts, so that Buffalo will again be on the radio relay map.

Plans were laid to hold a luncheon and to invite and interest the prospective members in the organization. Any one wishing to do any long-distance work is bound to give full co-operation in order to reduce to a minimum the troublesome interference of the past. This club is desirous of subscribing to a club directory giving the name of club, location of same and the name and address of the secretary. All other radio clubs please write to the editor of this magazine and make a similar request.

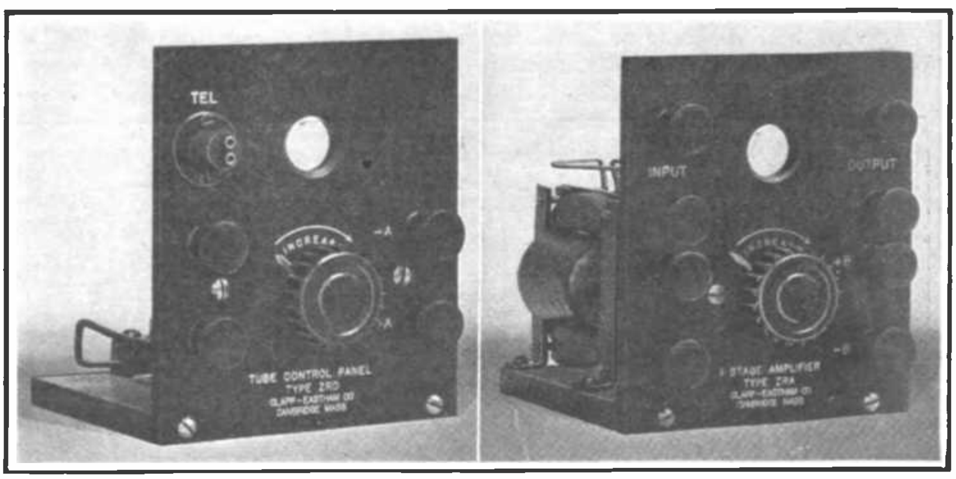
Address communications to John G. Rieger, President, 15 Fairview Place, or Elmer H. Kumpf, Secretary, 41 Amsterdam Avenue, Buffalo, N. Y.

We are informed by a Danish reader that the wireless station at Lyngby (near Copenhagen) transmits press to CQ at 11 a. m. G. M. T. on a wave-length of 4,100 metres C. W. and Meteorological reports at 7.50 a. m., 1.50 p. m. and 6.50 p. m. G. M. T. on 5,000 metres C. W.

Between the hours of 9 a. m. and 1 p. m., and 9 p. m. and 1 a. m. G. M. T., this station works with Stonehaven on 3,400 metres.

Detector and Amplifier Units

THE Clapp-Eastham Company, always on the watch for new apparatus in keeping with the demands of the experimenters, has brought out the detector and amplifier units shown in the accompanying illustrations. It is understood that a regenerative receiver, of a design conforming with these units, will be ready for the fall.



Both instruments are mounted on bakelite panels 4¼ by 5½ by ¼ in. Binding posts are arranged so that jumpers from one panel to another can be used, thus simplifying the wiring at the front of the set. At the rear, regular bus wiring, with Empire cloth tubing, is employed. This feature and the arrangement of the instruments makes the rear of the set as attractive as the front.

Quite original is the method of connecting the telephones to the detector. A small jack is provided into which the cord tips can be pushed. This does away with a special plug to which the leads would have to be soldered, and leaves the tips so that they can be used for any other methods of connection.

Another feature of these units is a new back-mounted rheostat by which the filament brilliancy is controlled. Binding posts are arranged so that either series or parallel connections can be used for the detector and one or more stages of amplification.

Small Dirigible for Commercial Use

THE small airship which is shown in the accompanying drawing has the distinction of being the first commercial airship to be sold in the United States. It is known as the Pony Blimp. The builders had in view the need for small, efficient, inexpensive airships, which might be used for commercial service or for purposes of sport. In the tests which have been carried on it has demonstrated its worthiness showing a quick response to the propeller and the controls, and decided economy in operation.

The Blimp is 95 feet long, has a maximum diameter of 28 feet and a height of 40 feet. Its volume is 35,000 cubic feet. The car, which is 12 feet in length can accommodate a crew of two people. Driven by its 40 horsepower engine, it has a maximum speed of 40 miles per hour, and a range, at full speed, of 400 miles, with a ceiling at 6,000 feet. This means that with two men aboard, and at an elevation of 6,000 feet, it can travel some 400 miles at a speed in still air of 40 miles per hour. Of course, by taking advantage of favorable winds, with the motor idle, the fuel may be conserved and the total range under such conditions may be increased considerably over 400 miles. For landing, the Blimp is equipped with mooring harness and anchors which permit ground stops to be made when desired for the replenishment of gas and supplies. The useful lift was 935 pounds, this including passengers, ballast, anchor, drag rope, parachutes and fuel.

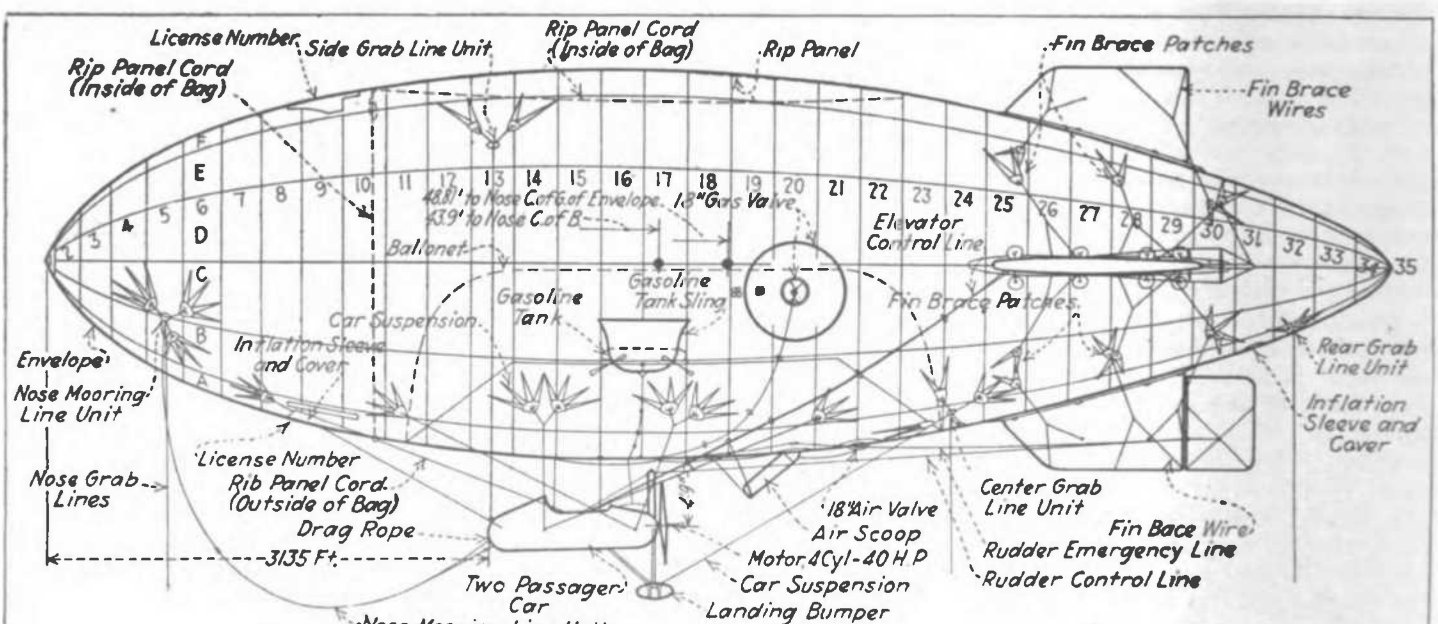
The 40 h.p. Ace engine (modified for airship use) consumed approximately 24 lbs. (nearly 4 gal.) of fuel per hour when running full out (about 2,000 r.p.m.) It throttles down nicely and runs with very little vibration. The fuselage is a wood veneer construction, light but substantial, normally holding two persons, but wide enough to accommodate a third passenger in the rear seat. There is plenty of space for wireless and other small apparatus. The drag rope is carried in a box in the nose. A small pontoon bumper which fits the single skid may be carried or not, as desired. A small size harpoon anchor has been developed for this ship on the same principle as has been successful in larger airships.

A new design of fuel pump is for pumping gasoline from the car up to the tanks. The same pump may be used for pumping fuel up a hose when towing the balloon. For oversea use a sea anchor is recommended consisting of one flexible unit of the Goodyear design. A rubber shock-absorber is used with either a sea or land anchor.

This airship is in no sense a toy. Although no larger than a medium size spherical and not as large as a standard type R kite balloon, this little airship carries a power plant large enough and efficient means of control to give it perfect freedom of motion in any ordinary wind, and in cruising radius it is in a class with ships many times its size. In the trials the ship handled very easily and conveniently, there being no appreciable troubles developed. The quick maneuvering qualities were particularly noticeable, it being possible to make sharp turns An angle of ascent of 42 degrees was obtained, and an angle of descent of 35 degrees. Landing the ship was exceptionally easy, it being handled on one occasion in a light breeze, by a ground crew of only two men.

AIRPLANE ECONOMY

ALTHOUGH a great deal has been heard of the efficiency of the aero engine, yet it is not so generally realized that the latter can vie with a car engine, even on the score of miles per gallon. A fair average petrol consumption for a stationary water-cooled engine would be about six pints per brake horsepower per hour. This means that a 30 h.p. engine would consume 2¼ gallons per hour. A single-seater aeroplane with this engine would be capable of anything from 70 to 90 m.p.h., and at the lower figure the mileage per gallon works out at 31. In actual practice results equal to this have been obtained, for in a non-stop flight from London to Turin, a distance of 650 miles, made by Mr. B. Hinkler. in nine and a half hours, on a Baby Avro fitted with a 30 h.p. Green engine and Zenith carburetor, the total petrol consumption was 20 gallons. giving a mileage per gallon of 32½, at an average speed of 68.4 m.p.h. This particular journey was the first of a series which totalled a distance of 2,250 miles covered in 34½ hours for a total petrol consumption of 75 gallons, the average distance per gallon being thirty miles, and the average speed 65 m.p.h. It is interesting to note that the four-cylinder 30 h.p. Green engine used on this flight was built in 1910, and was used in an early Avro triplane and later in the first Avro tractor biplane. Since its original appearance it has been fitted with aluminum pistons and a special camshaft.



Outline Drawing of the Goodyear Pony Blimp

HEAT TREATING ALLOY STEELS

PART 5

(*Continued from page* 527)

nickel. The steel has a high tensile strength, a high limit of elasticity and great hardness and because of this, battleship armor is made of it. It is also popular for automobile driving shafts.

A manganese steel may contain as high as 12 per cent manganese and 1½ carbon. This steel is too hard to be machined by ordinary edge-cutting tools. At the same time, it possesses great ductility and strength.

Chrome steel has a chromium content varying from 1 to 2 per cent and a carbon content ranging from eight-tenths of one per cent to 2 per cent. Nickel is often introduced, making what is known as a chrome nickel steel which is widely used in the manufacture of automobile and other machinery parts, such as crankshafts, transmission gears, etc. When this steel is hardened by sudden cooling and then tempered it has great hardness without being brittle.

A steel containing from 3 per cent to 20 per cent of tungsten and from one-half of one per cent to 2 per cent of carbon is known as a "tungsten" steel. This has great magnetic retentivity and for this reason is widely used for permanent magnets in various forms of electrical appliances. Another good quality of tungsten steel is that it will retain its temper even at a red heat and for this reason it is capable of wide application for lathe, shaper and planer tools or for machining highly resisting alloy steel that would turn the edge of the ordinary carbon steel tool.

Molybdenum steel has about the same properties as tungsten steel, but less alloying element is required to obtain the same result. One per cent of molybdenum has the same effect as twice the amount of tungsten.

Vanadium is also used in alloy steel and it imparts the quality of making the steel practically fatigue-proof, i. e., parts made of vanadium steel have many of the good qualities found in chrome steel, with the additional one of being greatly resistant to vibratory stresses.

It is not the purpose of this series to go deeply into the metallurgy of steel, but it has been necessary to consider the subject briefly in order that the reader interested in heat treating may appreciate the many varieties of steel that he may be called upon to handle and so that he will realize that a method of treatment that will be very effective with one form may be detrimental to good results in working with another steel alloy of different character.

(*To be continued*)

WHY BEARINGS HEAT

One of the most annoying and disconcerting things that can happen to an engineer, or others in charge of machinery, is an experience with a bearing on an important piece of machinery which is heating.

If a bearing on a new piece of machinery persists in heating and the operator is satisfied that the oil he is using is not too light or too heavy, then the bearing may be out of line, or perhaps it has been designed with insufficient clearance. Overheating may also result when the clearance is too great. and trouble may follow because the bearing has high and low spots upon its surface. A very frequent cause of bearings running hot is foreign matter which may owe its presence in the bearing to any number of causes.

Faulty oil distribution is probably the cause of overheating as frequently as anything else. The oil may be fed into the bearing at the wrong point, or perhaps the grooves do not convey the oil to all parts of the bearing. Again, the feed pipe may not be of sufficient size to supply the bearing with an adequate amount of oil or the oil reservoir may be too small to permit of proper cooling. We have known many cases where a hot bearing was caused through an obstruction in the oil supply pipe restricting the flow of oil.

Unsuitable bearing materials and bearings which are not large enough to carry the loads brought upon them are often the cause of heating, and all the more annoying because they do not readily suggest themselves as the root of the trouble.

The sudden heating of an erstwhile well-behaved bearing may be due to recent rebabbitting or readjustment; that is, the clearance may be set carelessly, the interior surface may be imperfectly finished or the oil grooves may be improperly cut. A reduction in the amount of oil supplied to a bearing such as that brought about by a partially plugged feed line, the lowering of the oil level in a crankcase or reservoir of a ring-oiled bearing or the glazing of a lubricating pad may also cause a bearing to heat.

When the supply of oil is completely interrupted, overheating will prove especially serious and rapid. The supply of oil may be cut off through a feed pipe becoming plugged or through the oil reservoir running dry. Broken ring oilers, glazed pads, pads which have fallen away from the journal and the congealing of the oil in a system also cut off the oil supply. Dirt suddenly entering the bearing with the oil or from outside sources usually results in overheating. The more abrasive materials cause heating because they roughen the journal and bearing, but the softer materials are usually found to have plugged the oil grooves and cut off the oil supply.

If the proper oil in sufficient quantities is being fed to the bearing, overheating must be due to mechanical disarrangements. For example, a bearing may have become knocked out of line or the bearing cap may have worked loose. Overheating may result from the bearing having become badly worn due to the above causes. Excessive loads are a common cause of hot bearings. A tightened belt or a shaft which has been sprung through dirt building up between the teeth of gears might be mentioned in this connection. Excessive loads may be thrown on the main bearings of the steam engine through insufficient cushioning in the steam cylinder, and too high compression in the internal-combustion engine has been known to bring about the same result.

The only way to obviate the continued heating of a bearing is to correct the underlying mechanical faults to which it is due. If sudden and unexpected heating occurs, any imperfections in the lubricating system should be set right, and when it is due to mechanical troubles, these should be corrected at once. Do not try to "manage somehow" with a heated bearing. Many preparations and devices have been recommended for reducing the temperatures of hot bearings, but these makeshifts are as ineffective as medicines given to cure a broken leg. If a suitable oil will not keep a bearing cool, it is time to make some repairs.—*Lubrication.*

BAKELITE USED FOR AIRPLANE PROPELLERS

A SERIES of tests with Bakelite propellers has recently been completed by the Army Air Service. The results are reported to have been satisfactory. Several designs of propellers were used, but the micarta construction was more serviceable. These propellers were made by coating sheets of duck with Bakelite, then pressing five or six of these sheets tightly together to form a board that is sawed out in the shape of a propeller lamination just as wood laminations are cut. The Bakelite is then molded to an exact angle in a special mold under pressure at 350 degrees F.

The advantages discovered in the army tests are: Uniformity of texture, strength, absence of warping, elasticity, absence of metal hub, uniformity of all propellers made from the same mold, proof against abrasion, proof against moisture, including oil; freedom from checking and splitting, adjustable pitch feature resulting partly from elasticity, ease and rapidity of manufacture once the molds are completed.

COMPARING MAGNETO AND BATTERY IGNITION

CONSIDERABLE interest has often been expressed by engineers as to the relative power output of engines equipped with magneto and battery ignition, respectively. This question came up in the work of the Bureau of Aircraft Production, and in connection with it a test was made at McCook Field, Dayton, Ohio, for the purpose of determining the performance of a 180-h.p. Hispano-Suiza engine when equipped with Dixie magneto and when equipped with special Delco battery ignition. The difference in performance was so slight that only one power curve was plotted. (Engine Report No. 155, page 6.) This is in line with previous comparative tests made at McCook Field with both battery and magneto ignition; it was found that battery ignition and magneto ignition would give practically the same power on the same engine. The gasoline consumption also was found to be practically the same.

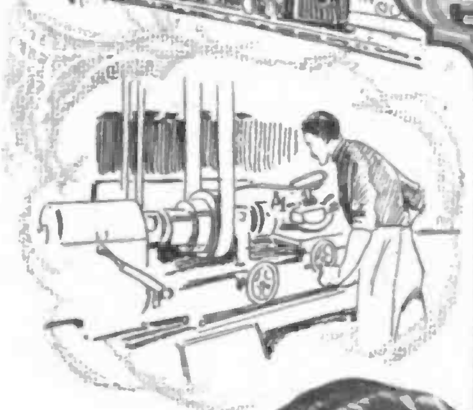
As regards weight, two magnetos, each weighing 14½ pounds, one starting magneto of 6 pounds and one switch of 1 pound, make a total of 36 pounds, while for the Delco battery ignition, two Delco units, including distributors, breakers, coils, etc., weigh together 30 pounds, ignition battery 10 pounds and switch and regulator 2 pounds, giving a total for battery ignition of 42 pounds, or 6 pounds in favor of the magneto.

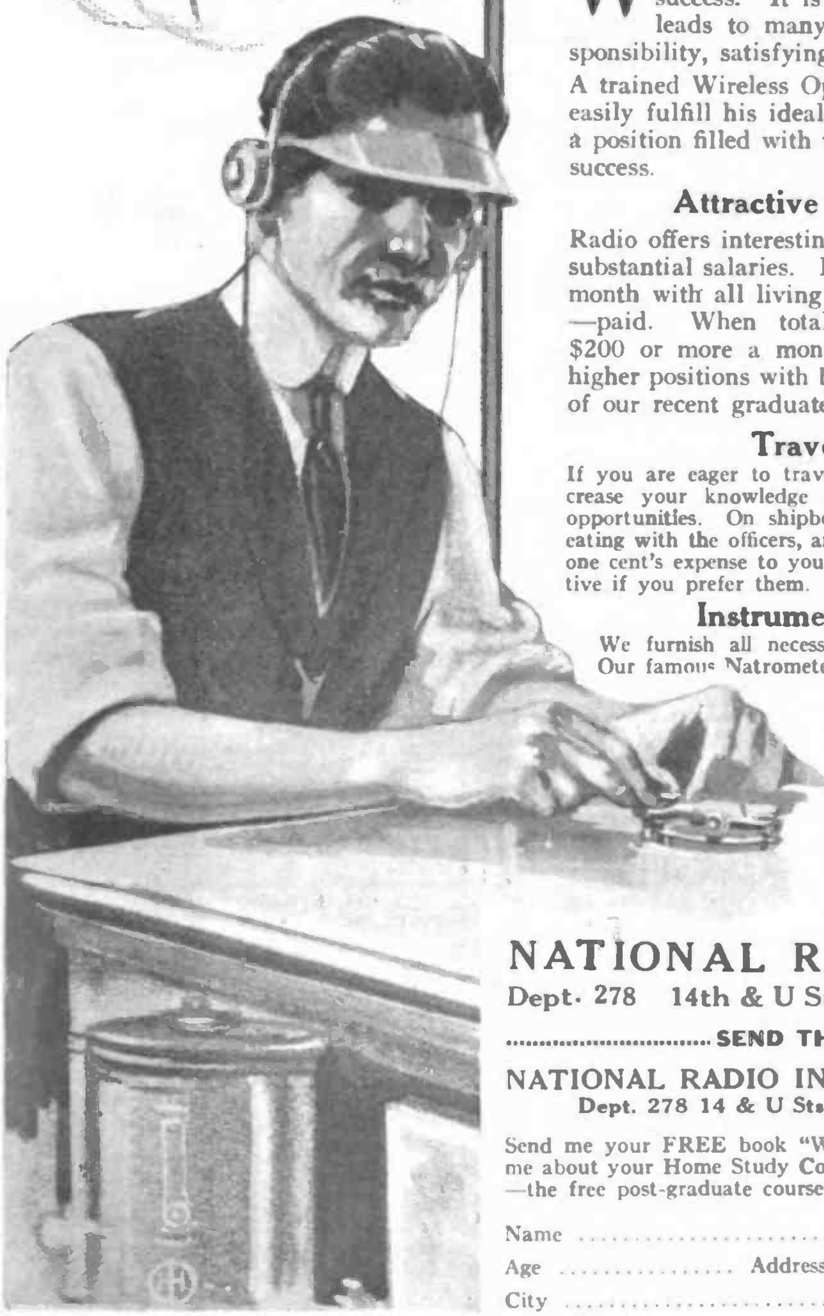
AIR SERVICE AERIAL AMBULANCE

THE new ambulance has a fuselage designed primarily for the transportation of the sick or wounded, providing space for two litter patients, a medical attendant and a pilot.

The basis for this new ambulance is the DH-4 aeroplane, with several modifications. The landing gear has been moved forward about twelve inches and the dihedral angle increased to 2.75 per cent. The wings have a 12-inch stagger and the angle of incidence is 3 degrees.

Necessary accommodations for the wounded are provided by increasing the depth of the fuselage behind the pilot's seat and dividing the space thus provided into an upper and lower compartment by means of a longitudinal partition. These compartments are reached through doors running their entire length, opening on the side of the fuselage. Each compartment is furnished with a Stokes litter, which can be securely fastened in its compartment and is easily handled by two men. Adequate light and ventilation is provided by means of windows in each compartment.





WHAT CALORIZING IS

SEVERAL years ago one of the large electric companies instituted a research for the development of some processes of treatment that would render metals more resistant to oxidation at high temperatures. At the present time the process has reached a stage where this company is using it regularly; it has been tried out in several other connections, notably that of soot-blowers already mentioned, and it seems so promising that a company has been formed for the sole purpose of commercializing it.

The process to which the name "calorizing" has been applied depends upon the high heat resistance of aluminum oxide. The parts to be treated are packed to a retort with an alumina mixture and other chemicals whose identity is not for the present divulged; hydrogen gas is introduced into the retort, and the temperature is then brought gradually up to 1,650 degrees Fahrenheit in the electric furnace. After holding the heat at this point for a proper time, the retort is allowed to cool slowly, the introduction of the hydrogen still continuing. When cold, the treated parts are withdrawn and cleaned. It is then found that the alumina has penetrated the surface metal of the treated parts to a greater or less degree, depending upon the time through which the process is allowed to extend. A homogeneous protective alloy is thus formed with the surface metal, not unlike an amalgam. This alloy shell is strongly resistant to the oxidizing influence of heat, and at the same time no physical change is apparent in the calorized portion of the metal, with the exception of the mild anneal resulting from the heating in the furnace. In particular, there is not the slightest tendency of the protective shell to strip or otherwise to behave as anything other than an integral part with the metal beneath it.

Where high temperatures in combustion are employed, ranging up to 1,800 degrees Fahrenheit, calorized metal is said to give most excellent results. The ideal temperatures for its use range from 1,100 to 1,750 degrees Fahrenheit, and at 1,800 degrees the resistance to oxidation from heat very slowly diminishes. Close-grained cast iron, black and wrought iron, steel, nickel, nickel-steel, brass, bronze and copper have been successfully calorized and a much longer life incorporated in their use in high temperatures. A large application is seen in relation to calorizing of annealing and carbonizing boxes, pyrometer protection-tubes, retorts, super-heaters, vaporizers, burner collars, pipe and tubing and a multitude of other uses among many industries. Calorizing is not a preventive of atmospheric oxidation or oxidation from moisture.

INDIA AND BRAZIL MICA

MICA commonly occurs in pegmatites, which consist of large crystals of feldspar and quartz, mica constituting but a small proportion of the total rock mined. Much of the feldspar thus thrown out during the process of mining is pure and of high quality, and the Bureau of Mines has suggested that much of it could be utilized for ceramic purposes. Encouragement is given to such utilization by the fact that several mines now worked for mica were formerly operated for the production of feldspar. Where mines are not readily accessible to railroads feldspar utilization might not be feasible, for it is a much lower priced product than mica and cannot, therefore, bear as heavy transportation expense. Where mines are located close to railroads, however, such utilization would tend to reduce the cost of mica mining and at the same time assist in the solution of the waste-disposal problem.

Methods of mining mica in India are very primitive. In place of using explosives, fires are built and water thrown on the heated rock surface. Iron wedges are driven into the cracks thus formed, and the rock masses reduced and removed. After separation from adhering rock, the mica "books" are taken from the pits by women or coolies, who carry them on their heads to the cobbing sheds. The cobbed and sorted mica is carried in baskets on bullock carts to the main offices, some of which are distant a seven-day trip from the mines. India mica is of very high quality, and, for the most part, the trimming and grading are done much more carefully than in America.

The principal mica deposits of Brazil are situated in the states of Bahia, Sao Paulo, Goyaz and Minas Gereas. Some of them are of wide extent and sufficiently rich in mica to render mining operations attractive. Production increased from 1,435 kilos, valued at $1,152, in 1910, to 15,348 kilos, valued at $12,964, in 1914, and to 53,743 kilos, valued at $55,859, in 1916. Exports from the state of Sao Paulo alone in 1917 amounted to 10,771 kilos and in 1918 to 11,604 kilos (1 kilo equals 2.2 pounds). The product is shipped to England, France, Germany, Italy and the United States.

The best product of Brazil is termed "ruby clear mica," which, according to some experts, compares favorably with India ruby mica. In view of the increasing demand for electrical mica, the quality of the Brazilian product justifies greater development, but the deposits are handicapped by poor transportation. Thus in 1912 the mica was worth only one-eighth to one-twelfth as much in the Sao Paulo market as when delivered in England.—U. S. Bureau of Mines.

WHAT IS NEW IN AVIATION

(*Continued from page* 505)

equal and a dihedral angle is given to the bottom plane only. The ailerons are constructed on the firm's patented system of balance which was first fitted to the large four-engine machine, with the result that this large machine can easily be controlled by one pilot without the use of servo motors or other contrivance. The overall span of the planes is 75 ft. and there is no stagger. It is proposed in a short time to fit the new high lift plane system which has been evolved by this firm. Experiments along these lines are proceeding.

The fuselage is devoted entirely to carrying the crew, passengers and for cargo. The pilot and engineer are seated on the extreme nose of the machine in a comfortable cockpit, in which all engine controls, instruments and other apparatus necessary for the working of the machine are arranged within easy reach of the pilot or engineer, as required. The dashboard carries a full set of instruments, and provision is made for Marconi wireless gear to be fitted if required. Both pilots and engineer's seats are comfortably upholstered, and the rudder bar is adjustable both as to height and distance from the pilot. A partition immediately to the rear of the pilot divides the forward cockpit from the main fuselage saloon or cargo space. This saloon occupies three complete bays of the fuselage and measures 4 ft. 6 ins. wide by 6 ft. high by 22 ft. long. The whole of this space is provided with flooring which is of a new type, considerably lighter and stronger than previously used. Adjustable Triplex Safety Glass windows are fitted in the sides of the fuselage, and seating accommodation provided for 15 passengers, each of the passengers having a window immediately next to him.

As previously mentioned, no struts or internal structure of any description occur throughout this saloon. A large side door is provided for access to the saloon, and steps are provided which can be adjusted to position from inside the saloon if necessary. For cargo purposes, trap doors can be arranged in the cargo space, as required. The fuselage is constructed in three sections. The front section comprises the pilot's cockpit, with all the instruments and controls. The second section contains the passenger saloon or cargo space, and the third and last section extends from the rear end of the saloon to the rudder post, either of these sections being easily changeable.

The engine nacelle framework is of steel tube, and is so arranged that the engine stands outside the wing hinges. The gasoline tanks are carried on the same framework but behind the en-

(*Continued on page* 563)

WHAT IS NEW IN AVIATION

(*Continued from page* 561)

gines, and a fireproof partition is arranged between the tank and the engine. No bracing wires or struts pass through the fuel tanks, and both the engine and tank are very readily removable when required. The oil tank is immediately behind the engine, and the radiator is of the nose type carried in front of the engine. The whole of the engine unit, tanks, etc., are covered with a stream-line aluminum cowling circular in cross section.

The undercarriage is similar in design to that used so successfully on the large four-engine Handley-Page machines, and consists of two entirely separate units, each unit having two wheels, one below the engine and the other near the fuselage, and all members are universally jointed so as to allow for any movement of either shock absorber. No portion of the undercarriage projects below the fuselage and thus any arrangement for dropping nails, etc., from the fuselage will not be interfered with. The tail skid is of the usual type, with the exception that it is kept almost entirely within the fuselage, thus considerably reducing head resistance.

A monoplane tail is fitted of ample size, and carries the usual elevators. The vertical surfaces consist of a monoplane fin and balanced rudder arranged on the center line of the fuselage. The elevators are unbalanced, but are carefully proportioned so as to reduce the load on the pilot's hand, and in addition, hand-adjusting gear is provided for the tail plane itself, whereby the pilot can alter the trim of the machine at any time during the flight.

Vickers Commercial and Amphibian

Since its first inception the Vimy-Commercial has been altered and improved in several respects. The large cabin with seating accommodation for 9-10 passengers, is built upon the famous Saunders "Consuta" principle with the layers of plywood sewn together, a form of construction which has proved very strong and durable. This construction also has the advantage that there is no internal cross bracing in the cabin, which is, therefore, particularly roomy and comfortable. There are eight wicker seats arranged along the sides of the cabin, and a ninth wooden seat is placed on the starboard side, opposite the entrance door.

The pilot's cockpit is entered through two doors in the forward bulkhead of the cabin, and below this is a space for cargo, mail or luggage. A separate door in the port side enables the cargo to be loaded or unloaded without inconveniencing the passengers in the slightest. For long non-stop flights two pilots

(*Continued on page* 564)

WHAT IS NEW IN AVIATION

(*Continued from page 563*)

may be carried, and dual control is fitted as standard.

Should it be desired to use the machine as a cargo carrier, this can easily be done by removing the seats, when the cabin affords a roomy space for goods and merchandise. The capacity of the Vimy-Commercial when thus fitted is 1½ tons. It will therefore be seen that quite a considerable cargo can be transported by air at the—comparatively—high speed of 100 m.p.h. The machine has an endurance of five hours, and the petrol consumption is 35 gallons per hour.

There is little doubt that the "Viking amphibian machine exhibited by Messrs. Vickers, Ltd., will cause considerable interest, not only on account of its combination landing gear, which allows it to alight on and start from either land or water, but also because as a flying-boat, this machine represents a departure from standard practice, its hull design being considerably out of the ordinary. The flying-boat hull of the "Viking" has a pronounced Vee bottom both forward and aft of the step. Two retractable land wheels are mounted one on each side of the boat. These are operated from the pilot's cockpit, and can be raised and lowered during flight. If, therefore, the machine is used, as it would be, chiefly over sea but has to make land going journeys, in the course of its duties, it is able, should necessity arise, of alighting safely on an ordinary aerodrome.

A "conservatory" roof is fitted over the top of the boat, inside which the three passengers and two pilots are comfortably housed. If it is desired to use the boat for cargo carrying, three of the seats can be removed, when a space of 76 cu. ft. is available for commercial load. The engine, a 560 hp. Rolls-Royce "Eagle," Mark VIII, is mounted high in the gap between the planes and drives a small diameter four-bladed air-screw (pusher). The "Viking" has an overall length of 32 ft. and a span of 46 ft. Fully loaded, in flying trim, the weight is 4,545 lbs.

(*Part 2 in October issue*)

For photographing on textile fabrics the following bath may be used: Alcohol, 95%, 500 parts; gum mastic 2½ parts, gum benzoin 5 parts, cadmium chloride 15 parts. The material is immersed in the bath for one minute, the excess removed between two pieces of blotting paper, and it is allowed to dry. It is sensitized by immersion in a 5% solution of silver nitrate, drained off after spreading on a plate of glass and allowed to dry in the dark room. The regular printing process is followed, but the printing is carried further than with paper as the strength of the image is reduced in the fixing. It is toned in the following bath: Gold chloride 1 part, sodium borate 30 parts, water 1,000 parts. It is fixed in a 10% solution of hyposulphite.

LAMP BULBS AS FIRE EXTINGUISHERS

BURNT-OUT electric lamp bulbs can be turned into cheap and effective fire extinguishers by filling them with some such solution as twenty parts of calcium chloride and five parts of salt in seventy-five parts of water or with carbon tetrachloride which is often sold under various trade names for filling small hand extinguishers. The bulbs are filled by immersing them in the solution and breaking off the tips with a pair of pliers. The air having been largely exhausted from them, they will fill quickly and stay filled. To use the filled lamp bulb is thrown forcibly to the base of the flame so it will be broken and thus liberate the gas-forming liquid. Carbon tetrachloride is much more effective than calcium chloride, salt and water, but is more expensive.

AIR-DRIED PEAT

AT a recent meeting in Toronto, a report was presented showing that the simple process of excavation, maceration and spreading peat, allowing the sun to do the drying and curing of the peat, produced the best results. The excavated peat contains about 88 per cent moisture, and none of this water need be removed mechanically. The peat is spread on the surface of the ground, usually on a part of the bog which has been cleared and drained. The drying and curing takes from two to four weeks to complete. Towards the end of this time the peat is turned over and a few days later is coned or stacked in hollow piles, and in a short time the peat is ready for marketing.

MEASURING CARBON CONTENT OF STEEL

THE Bureau of Standards, in Technologic Paper No. 141, entitled "An Electrolytic Resistance Method for Determining Carbon in Steel," described methods and apparatus for rapidly and accurately determining carbon in steel by absorbing in a solution of barium hydroxide the carbon dioxide resulting from direct combustion of the metal in oxygen and deducting the carbon content from the change in electrical resistance of the barium hydroxide solution.

Winnipeg, Canada, is in hopes that it will eventually become an ocean port by using the waters of the Red River. The mayor of that city has predicted that in twenty years' time seagoing ships will navigate the Red River and Winnipeg will become the Liverpool of Canada.

MANUAL ARTS AND CRAFTS

(*Continued from page 531*)

fancy work may be stored on top of the tray more conveniently. "Local option" may determine that.

An additional till may be made sufficiently short, approximately 15½" long x 5¼" outside dimensions and fastened in the center with a round-head wood screw as a pivot in the center division. This would take the place of the lower tray and therefore be more desirable for some. Another method that may be employed is to fasten one corner of the till by the foregoing method. This would give a little more accessibility. If you take a board representing the till, you may very easily ascertain the amount required for clearance to swing the till clear in either position.

The handle M, Fig. 6, is easily made, requiring only a saw of almost any description, by keeping the lines nearly straight, it will be more in keeping with the general design. It may be modified by slightly curving these lines concave or convex with a spoke-shave or knife. A block or smoothing plane will also do this if held askew, i. e., that is, the cutter being about 45 degrees to the cut. This project is stained in a weathered oak, or old English oak color, then polished with one or two applications of beeswax cut in turpentine, will give a finish very near to the old Colonial furniture so much sought for.

SHORTAGE OF MOTOR FUEL SERIOUS

THE gasoline shortage in the Pacific Northwest is rapidly becoming acute. For the past month it has been with difficulty that the three large oil companies operating in that territory have been able to provide sufficient gasoline for the most necessary of occupations. The rationing system has been in effect for a month and in general has limited trucks to purchases of ten gallons and pleasure cars to tankfuls of three gallons. Only vehicles operated by fire and police departments and doctors have been able to secure unlimited supplies. The Standard Oil Co., Shell Co. and Union Oil Co. do not offer any hope for permanent relief from the shortage until in the middle of the summer at the very earliest, with possibilities that strict economy will be necessary until next fall. The reasons ascribed to the shortage are insufficiency of supply of the oil obtainable in California oil fields. Besides affecting hundreds by shortage of the gasoline supply, the lack of fuel oil is also embarrassing a great many manufacturers in that, since they are equipped to burn fuel oil, it is with difficulty that they are able to rapidly make changes that will provide for this latter situation may be the substitution of powdered coal or producer gas.

HOW FAST CAN A YACHT SAIL?

GENERALLY speaking, the speed of yachts is over-rated, says the *Scientific American*, and you may safely take from 20 to 30 per cent off when your friend tells you that his craft has done so and so. On the other hand, there are some well-authenticated records of high speed made by racing yachts under favorable conditions, which show the best of them to be wonderful examples of the science and craft of shipbuilding. The maximum speed of a yacht, supposing that her model and the cut of her sails are correct, is dependent upon certain adventitious conditions, such as the right kind of wind, the sea and (above all) the skipper. The ideal conditions for speed are when a yacht is reaching in a smooth sea with the wind over the quarter—that is, well abaft the beam—and with everything set that she can carry, without an excessive angle of heel.

A well-known authority, Major B. Heckstall Smith, author of "The Complete Yachtsman," in answer to the question, "How fast can a racing yacht sail?" states that at full speed a racing schooner about 105 feet on the waterline can do about 15.8 knots. This would be in a strong breeze, with the wind on the quarter. Assuming that this speed is about right, as he believes, he tells us that with exactly the same breeze a 90-footer can go 14.2 knots; a 75-footer, 13.4 knots; a 60-footer, 12 knots; a 50-footer, 10.9 knots; a 36-footer, 9 knots, and a 20-foot boat, 7 knots.

SOAP FROM LIGNITE TAR OILS

EXPERIMENTS, which have been said to have a satisfactory result, have been carried out in the laboratory of the Siemens Works in Berlin, with a view to converting lignite tar oils into fatty acids by the action of ozone. Similar experiments, carried out on a large scale by a process introduced by the city of Wiesbaden, have led to equally satisfactory results.

IF YOU NEED SPECIAL INFORMATION WRITE OUR SERVICE DEPT., EVERYDAY ENGINEERING MAGAZINE

NEW BOOKS

ELECTRO-DEPOSITION OF METALS. By George Langbein. Translated with additions by William F. Brannt. 875 pages, 6¼ by 9¼ inches; 185 illustrations. Published by Henry Carey Baird & Co., Inc., 2 W. 45th St., New York City.

This is the eighth edition of the present work, which has been revised, enlarged and entirely reset. The book illustrates and describes processes and apparatus used in plating and finishing metals. It is written in simple language with special reference to the needs of the practical plater and metal finisher, and gives hundreds of tested formulas for solutions, many of which have heretofore been considered trade secrets. It discusses electro-plating, galvanizing, metal coloring, lacquering, and electrotyping, and covers the history and theory of electro-metallurgy. The translator has added considerable matter to the original work, particularly in the chapter on "Apparatus and Instruments" and in the section on "Useful Tables." The present volume describes new developments in machinery and apparatus for this work, such as the latest types of plating machines, ball bearing grinding and polishing lathes, sand-blast apparatus for cleaning, and lacquer spraying by compressed air. It also treats of the use of electrically heated japanning and lacquer baking ovens. In fact, a rather careful inspection of this work fails to disclose the lack of any information that an electro-plater or electrotyper should have in ascertaining the theory of his trade or carrying it out in a practical way. It may be fairly said that this work is a thorough and complete exposition of the modern theory and practice of electro-deposition of all metals.

BOOK ON BRASS MAKING

The Bridgeport Brass Company, Bridgeport, Conn., has issued a finely printed and profusely illustrated historical book extending to 80 pages, setting forth a brief history of the ancient art of brass making, and its early, and even recent, method of production, contrasted with that of the electric furnace process, a twentieth century achievement which has reached its culmination in the extensive works of the enterprising company. The record of the possibilities of the electric furnace from the bulk of the work, and the processes are minutely described. Of special interest is the section devoted to the Laboratory and Research department, an institution in itself, the scientific work of which makes it possible to control closely the properties

BOOK REVIEW

of the products passing through the plant. The publication of this work is a marked deviation from the traditions of the brass industry by making an open book of the practices and processes of brass making.

Organic Photographic Developers. By Samuel Wein. Two volumes in one, with indexes; 128 pages. Published by Forty-second Street Commercial Studio, New York, 1920.

The first and second chapters of this book treat of organic developers and dye sensitizers, giving specifications from patents and other sources of a large number of developers, French, German, etc. In several cases a description is given of how to prepare the developers and sensitizers.

The third chapter gives the chemical formulæ of organic developers in which bond diagrams are used and full chemical formulæ are given. Then there comes a list of the developers in three columns, the first column devoted to the trade names, the second to the chemical names and the third to the chemical formulæ.

The first volume has a table of contents and index; the second volume, divided into eight chapters, has no contents, but has its index. The following list of chapter headings gives the topics covered: Developing, Factorial Development, Bleaching and Intensification, Toning, The Diazotype Process, Recovery of Silver From the Hypo, Photographic Bronze and Plaster Plaques.

It is not necessary for us to review this part, as the titles clearly show the ground covered. It is not clear why so small a book should be divided into two volumes nor why the second volume has no contents table. The first volume has one. There are two indexes, one for each volume.

Shop Practice for Home Mechanics. By Raymond Francis Yates. 320 pages, 6 by 9 inches, 309 illustrations. Published by Norman W. Henley Publishing Co., 2 West 45th Street, New York City.

A thoroughly practical and helpful book prepared especially for those who have had little or no experience in shop work. The introduction is given over to an elementary explanation of the fundamentals of mechanical science. This is followed by several chapters on the use of small tools and mechanical measuring instruments. Elementary and more advanced lathe work is treated in detail and directions given for the construction of a number of useful show appliances. Drilling and reaming, heat treatment of tool steel, special lathe operations, pattern mak-

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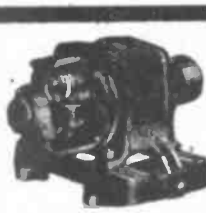

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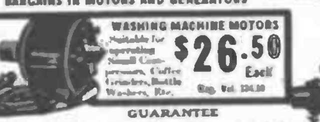

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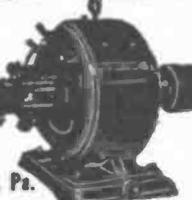

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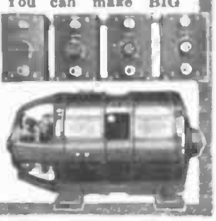

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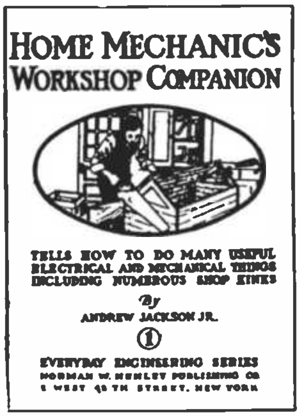

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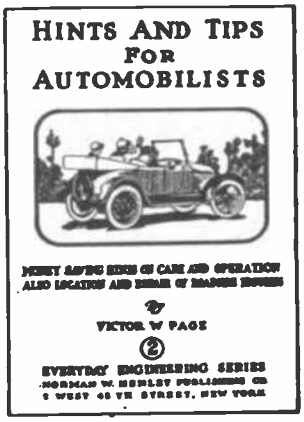

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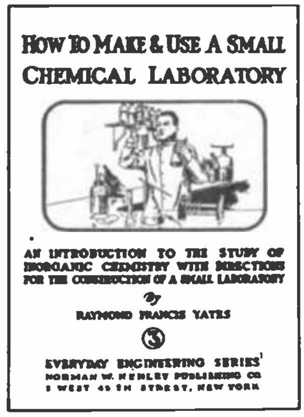

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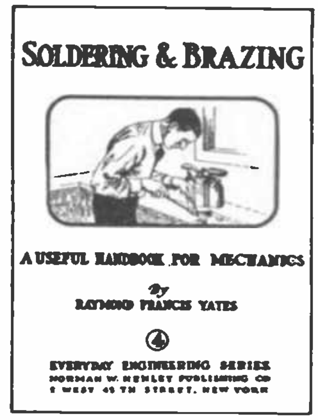

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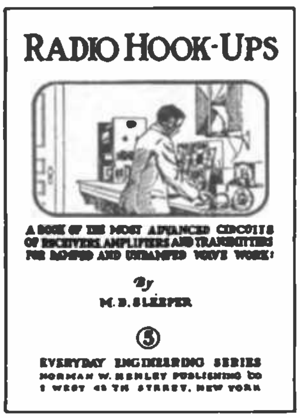

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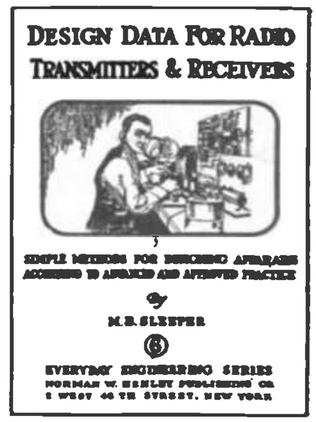

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BOOK REVIEW

(*Continued from page 569*)

ing, grinding, and grinding operations, home foundry work, etc., make up the rest of the volume. The book omits nothing that will be of use to those who use tools or to those who wish to learn the use of tools. The great number of clear engravings add much to the text matter and to the value of the volume as a visual instructor. This book tells how to do mechanical work in a way that everyone can understand and every mechanical experimenter, model maker, machinist apprentice or handy man will find much information of value by a careful perusal of its interesting text and illustrations.

INVENTIONS, THEIR PURCHASE AND SALE. By William E. Baff, Patent Attorney. 230 pages 5 by 8. Published by D. Van Nostrand Company, 25 Park Place, New York City.

This book is essentially a manual on the marketing of inventions and it views the subject from various angles. It is a book of business policy and is intended to enlighten inventors and others about plans by which inventions may be profitably exploited. It should be particularly valuable for busy people in every line desirous of understanding the nature of patent property in inventions. It will appeal to the capitalist or manufacturer as well as to the inventor. It gives information on how to gauge the value of an invention and how to exploit the patents to best advantage. As the author is a well-known specialist in patent law, the material is of a helpful, practical nature that appeals particularly to mechanical men.

USING ENGINE AS A BRAKE

THE motor-car driver should not forget that his car has three brakes. If he puts the gears in second speed and cuts off the spark, steep grades will have no terror for him. He should shut off the engine and slide into second as he rolls across the ridge, but should not drive in second. The spark can be shut off if the throttle will not close. Then with a six-cylinder car, six compression brakes are gained and the engine is cooling in the meantime. If necessary, a gentle touch of the service or emergency brake now and then generally will hold nicely. At times an abrupt or long drop will call for low instead of second in compression. On all but the steepest grades this will hold the car with but very little use of the brakes, and will keep the brakes in reserve for real emergencies.

Put hard soap on lag screws, wood screws or any screw for wood. It will surprise you how much easier they will go in.

FREEING A SEIZED ENGINE

OCCASIONALLY the repairer receives a call to start a seized engine that has resisted the best efforts of the owner of the car. At such times the repairer must exercise the utmost ingenuity, for the owner has generally tried all the easy and well-known methods before the repairer arrives.

In such cases the first thing to do is to make sure that it is the engine and not some other part of the transmission or rear axle that is at fault. The rear wheels should be jacked up and the emergency brake released and the gear shift lever placed in neutral The wheels should turn freely and there should be no binding in the rear axle system.

The spark plugs should be removed or the compression taps turned to relieve the compression. Then if the crank cannot be turned over by hand or by means of the starter, or by the two working together, the car may be towed with the gears in high and the clutch disengaged. As soon as the car has attained some momentum the clutch may be allowed to engage gently, care to be taken not to allow a sudden motion, which might strip the gears in the rear axle or even break a shaft.

If this does not free the engine, kerosene can be poured into the cylinders and allowed to remain for a couple of hours. This will have a tendency to dissolve any old oil which may have gummed the pistons to the cylinder walls. Then the car may be towed again and an attempt made to turn over the engine by engaging the high gear. The engine can be turned over more easily in high than in low gear because it does not have to revolve so rapidly.

After one has succeeded in turning over the engine the drain cock in the bottom of the crankcase should be opened and the mixture of kerosene and old oil drained out. Then the new oil should be added, the radiator should be filled with hot water in order to expand the cylinders and the spark plugs replaced. After starting the engine it should be run slowly under its own power for some little time. in order that the new oil may work to all parts of the engine and to allow the engine to work out some of its stiffness.

Sometimes water leaks into the cylinders and rusts the pistons fast to the cylinder walls. There is also a possibility of moisture condensing within the cylinders if the car is allowed to remain standing in a damp place without being used.

If the engine is fitted with a removable head, as is now used on many cars. it is often but the work of half an hour to remove the cylinder head and ascertain if the pistons are stuck in the cylinders. The movement, of course, will be very slight, but if the pistons are not rusted to the cylinder walls some slight movement should be obtainable.

If only one piston is tight, it may be possible to remove the lower half of the crankcase and take off the cap of the connecting rod of the tight piston. If there is sufficient room in the crankcase, the connecting rod can be tied to one side and the engine used to drive the car home on three cylinders. Or the tight piston may be driven out of the cylinder with a block of wood. The wire leading to the spark plug of the seized cylinder should be grounded when attempting to run the engine on three cylinders.

It is sometimes possible to rap each piston separately with a block of wood at the same time that the strain is applied to the starting crank, thus releasing the pistons from the cylinders and allowing a film of lubricating oil to penetrate between the parts.

On some cars the rim of the flywheel is exposed so that it may be gripped with a heavy wrench and the wrench used to assist in turning over the crankshaft. If one man lies on the bonnet over the engine and pulls up on the starting crank, at the same time that the car is being towed, the simultaneous strain at both ends of the crankshaft will often be enough to start the movement of the pistons in the cylinders.

When the car is in the garage and compressed air is available, this may be forced into the cylinders through an air valve made from a discarded tire, a valve and a broken spark plug. If an air pressure of 100 pounds a square inch is exerted over an area on the top of the piston of 15 square inches, this should be sufficient to start it. Of course, the poppet valves will have to be closed while the air is being admitted into the cylinder.—*Automobile Journal*.

DESCENT AT 450 MILES PER HOUR

LIEUT. WEISS of the French Army was attempting to establish a height record recently, but unexpectedly found his supply of oxygen virtually exhausted. The Paris correspondent of the *Morning Post* states that at the moment he was at 8,000 meters and his only chance of safety was to nose dive. For a certain number of seconds he achieved a speed of 450 miles per hour, and actually traversed 4,300 yards of descent in thirty seconds. The machine was injured as a result of the strain, and certain portions of the wings were torn off, while some supports also were broken before he was able to flatten out the machine for landing.

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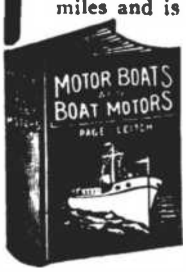

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