EVERYDAY ENGINEERING MAGAZINE

April, 1920
Vol. 9 No. 1

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CONTENTS

Vol. 9 APRIL, 1920 No. 1

EVERYDAY ENGINEERING MAGAZINE

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MATHEMATICS AND SCIENCE.

IT was once "proven" mathematically that it was impossible to fly. Langley battered this theory to death. James Clark Maxwell brought forth a mathematical treatment called the Electromagnetic Theory of Light. Twenty-two years later, the brilliant young Hertz of Karlsruhe proved experimentally that Maxwell was right. In the first case higher mathematics were wrong; in the second case they were right.

IT requires a great intellect to theorize in mathematics as Maxwell did, and few men are capable of doing it. The man or men whose mathematics told them that flying was impossible were probably incapable of handling such an involved problem.

THE value of mathematics to science depends largely upon the men who use mathematics in a scientific way. The mathematics of such men as Newton, Maxwell, Lodge, Kelvin, Euclid and Arrhenius have been of tremendous value to the world. A scientist wandering around in the upper regions of mathematics must be sure of his step else he makes a mistake and misinforms the world on some subject of vital importance. This would do more harm than good.

MATHEMATICS is the backbone of science. Without the higher expressions in mathematics there would be no science in a strict sense of the term. This means, then, that progress is dependent upon mathematics.

THE wrong use of figures may bring about great catastrophes. It may cause a liner to sink at sea, an elevator to drop, a building to collapse, a train to be wrecked or a city to be flooded.

MATHEMATICS stand guard over human knowledge. Mathematics prevent theory from running amuck. Mathematics analyze things. Few things are of greater importance to the world.

THE science of figures has made possible great things. The difference between rule-of-thumb procedure and real science is mathematics. It would be impossible to build a Brooklyn Bridge, a Woolworth Building or an Empire State Express without the science of figures.

MATHEMATICS lead into infinity. The science is as vast and endless as space itself. One can never hope to get to the end. The "bottom-bottom" of mathematics is as beclouded with mystery as any one of the great cosmological problems.

RAYMOND FRANCIS YATES, Editor.

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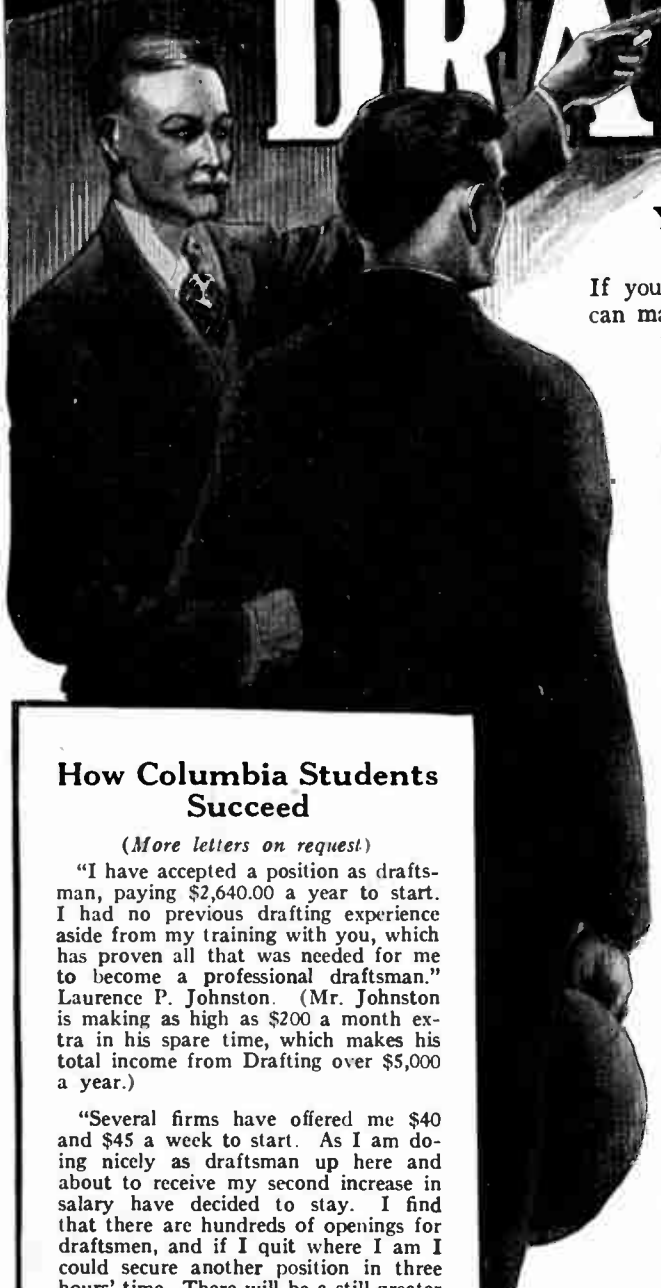

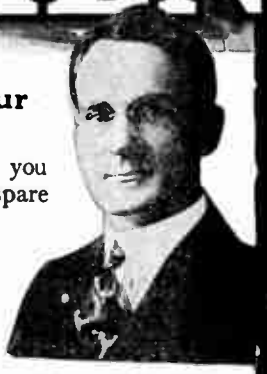

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LET'S have a little chat about getting ahead—you and I. My name is Pelton. Lots of people call me "The Man Who Makes Men Rich." I don't deny it. I've done it for thousands of people—lifted them up from poverty to riches.

I'm no genius—far from it. I'm just a plain, everyday, unassuming sort of man. I know what poverty is. I've looked black despair in the eye—had failure stalk me around and hoodoo everything I did. I've known the bitterest kind of want.

But today all is different. I have money and all of the things that money will buy. I am rich also in the things that money won't buy—health, happiness and friendship. Few people have more of the blessings of the world than I.

IT was a simple thing that jumped me up from poverty to riches. As I've said, I'm no genius. But I had the good fortune to know a genius. One day this man told me a "secret." It had to do with getting ahead and growing rich. He had used it himself with remarkable results. He said that every wealthy man knew this "secret,"—that is why he was rich.

I used the "secret." It surely had a good test. At that time I was flat broke. Worse than that, for I was several thousand dollars in the hole. I had about given up hope when I put the "secret" to work.

At first I couldn't believe my sudden change in fortune. Money actually flowed in on me. I was thrilled with a new sense of power. Things I couldn't do before became as easy for me to do as opening a door. My business boomed and continued to leap ahead at a rate that startled me. Prosperity became my partner. Since that day I've never known what it is to want for money, friendship, happiness, health or any of the good things of life.

That "secret" surely made me rich in every sense of the word.

MY sudden rise to riches naturally surprised others. One by one people came to me and asked me how I did it. I told them. And it worked for them as well as it did for me.

Some of the things this "secret has done for people are astounding. I would hardly believe them if I hadn't seen them with my own eyes. Adding ten, twenty, thirty or forty dollars a week to a man's income is a mere nothing. That's merely playing at it. In one case I took a rank failure and in a few weeks had him earning as high as $2,000.00 a week. Listen to this:

A young man in the East had an article for which there was a nation-wide demand. For twelve years he "puttered around" with it, barely eking out a living. Today this young man is worth $200,000. He is building a $25,000 home—and paying cash for it. He has three automobiles. His children go to private schools. He goes hunting, fishing, traveling whenever the mood strikes him. His income is over a thousand dollars a week.

In a little town in New York lives a man who two years ago was pitied by all who knew him. From the time he was 14 he had worked and slaved—and at sixty he was looked upon as a failure. Without work—in debt to his charitable friends, with an invalid son to support, the outlook was pitchy black.

Then he learned the "secret." In two weeks he was in business for himself. In three months his plant was working night and day to fill orders. During 1916 the profits were $20,000. During 1917 the profits ran close to $40,000. And this genial 64-year-young man is enjoying pleasures and comforts he little dreamed would ever be his.

I COULD tell you thousands of similar instances. But there's no need to do this as I'm willing to tell you the "secret" itself. Then you can put it to work and see what it will do for you.

I don't claim I can make you rich over night. Maybe I can—maybe I can't. Sometimes I have failures—everyone has. But I do claim that I can help 90 out of every 100 people if they will let me.

The point of it all, my friend, is that you are using only about one-tenth of that wonderful brain of yours. That's why you haven't won greater success. Throw the unused nine-tenths of your brain into action and you'll be amazed at the almost instantaneous results.

The Will is the motive power of the brain. Without a highly trained, inflexible will, a man has about as much chance of attaining success in life as a railway engine has of crossing the continent without steam. The biggest ideas have no value without will-power to "put them over." Yet the will, altho heretofore entirely neglected, can be trained into wonderful power like the brain or memory and by the very same method—intelligent exercise and use.

If you held your arm in a sling for two years it would become powerless to lift a feather, from lack of use. The same is true of the Will—it becomes useless from lack of practice. Because we don't use our Wills—because we continually bow to circumstance—we become unable to assert ourselves. What our wills need is practice.

Develop your will-power and money will flow in on you. Rich opportunities will open up for you. Driving energy you never dreamed you had will manifest itself. You will thrill with a new power—a power that nothing can resist. You'll have an influence over people that you never thought possible. Success—in whatever form you want it—will come as easy as failure came before. And those are only a few of the things the "secret" will do for you. The "secret" is fully explained in the wonderful book "Power of Will."

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PRACTICAL MECHANICS FOR EVERYDAY MEN

EVERYDAY ENGINEERING MAGAZINE

IT TELLS YOU HOW TO MAKE AND DO THINGS

VOLUME 9 APRIL, 1920 NUMBER 1

Steam Turbines and How They Work

By Raymond Francis Yates

While the average man generally understands the operating principles of the reciprocating steam engine, few thoroughly understand the operation of the steam turbine, which is really a far more interesting machine. This is probably due to the small amount of literature which treats of the steam tunrbine in a popular strain. Realizing this the author has attempted to set forth the principles of the turbine in an "everyday" way. The subject of the steam turbine is full of interest for the man who "likes to understand things".

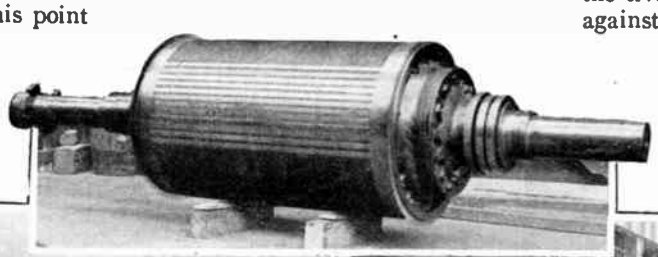
ABOUT eighteen hundred years have rolled by since the first steam turbine was made. History credits Heron as being the inventor of the first "steam-motor" which was really a reaction turbine. Although the steam turbine had its inception long before the reciprocating engine, and as a prime mover is far more efficient than the latter, it did not reach a point in its development where it could be applied in the work-a-day world until the early 80's. Today the whirling, hissing steam turbine is proving its worth in the power stations of the world; it has come into its own.

The ordinary reciprocating steam engine is inefficient for several reasons. When matter is set in motion, force is required to overcome this motion, before the body can be brought to rest. When steam delivers an impulse to a piston in an engine cylinder, the piston is forced to the opposite end of the cylinder and when it reaches this point it must stop and its motion is reversed by the crankshaft. When the piston stops a certain amount of the force represented by the steam is used in overcoming its motion. The general efficiency of the steam engine is further added to by its great number of sliding surfaces. These cause part of the useful energy to be used in overcoming friction.

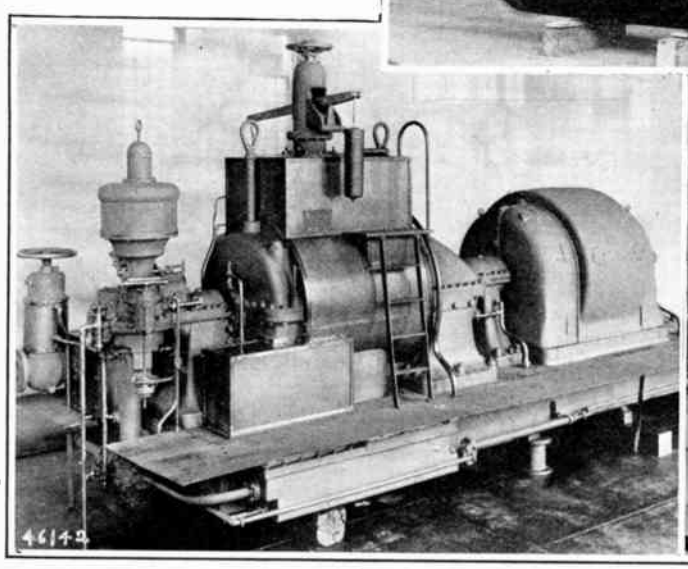
The steam turbine is far more efficient as a prime mover than the steam engine as it possesses no reciprocating parts. It has one moving member which is the rotor and this revolves in one direction only. The absence of a number of sliding surfaces also contributes to the general efficiency of the steam turbine. In most machines only two bearings are used.

The De Laval steam turbine first made its appearance in 1883. This machine is the A-B-C type of the turbine family. It consists simply of a single disc with lunette buckets arranged about its periphery. The steam is directed against these buckets by a number of nozzles which are mounted at an angle of from 15 to 20 degrees. The steam exhausts from the opposite side of the wheels into the atmosphere or condenser. The power produced by a turbine of the De Laval type is obtained entirely through the impact of the live steam delivered to the nozzles against the buckets.

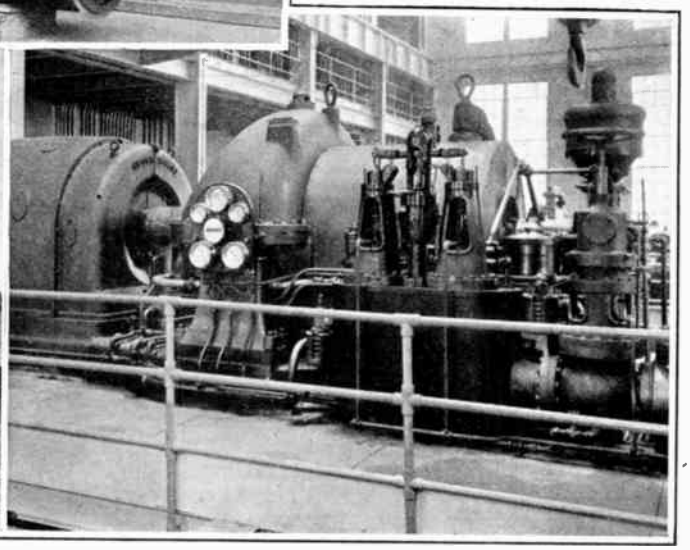
The steam ejected from the nozzles of the De Laval turbine reaches the almost unbe-



Rotor for a 7500 kva. turbo-generator



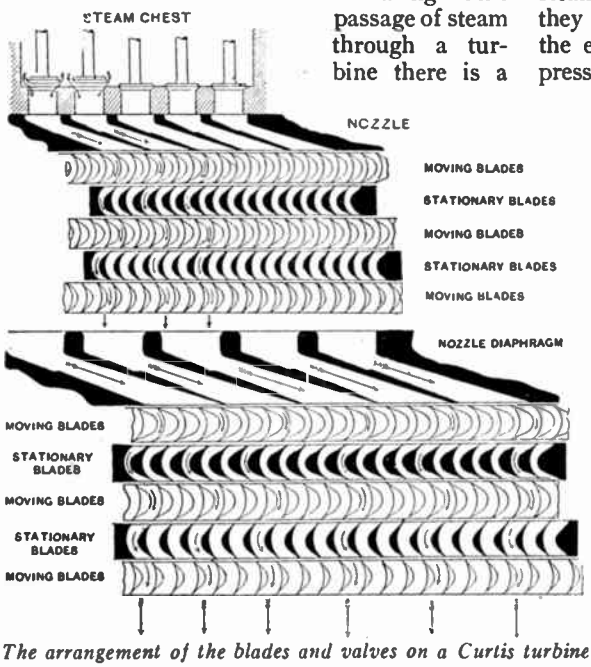
A Westinghouse automatic bleeder turbine, single flow, type 1200 R.P.M.



A 2500 kw. turbo-generator unit in operation

lievable velocity of from 2,000 to 4,000 feet per second. The latter figure is equivalent to a speed of over three-quarters of a mile per second. This steam velocity would theoretically produce a rotor surface velocity of from 90,000 to 120,000 feet per minute, which would involve a rotational speed as high as 80,000 R.P.M. with a wheel 6 in. in diameter. This tremendous speed is too excessive for practical application and the ordinary speeds of turbines of this type range from 30,000 for the smaller sizes to 9,000 for the larger types. Even these speeds are far too high for direct connection and the power is transmitted through a train of spiral gears which reduce the speed to the proper value. The speed is reduced to 1/10th of its original value by means of the gears.

The Parsons steam turbine was first introduced in the year 1884. This machine originally consisted of a number of discs mounted upon a single shaft revolving as a unit between stationary blades. Each disc has blades or buckets mounted upon its periphery. The method of sandwiching the stationary blades with the revolving blades is shown in the illustrations. It will be understood that the stationary blades are mounted on the inside of the turbine casing. The steam enters the turbine casing at high speed and pressure and sort of "elbows" its way through the spaces between the movable and stationary blades. By refering to the sketch it will be seen that the direction of the steam is altered as it passes from the stationary to the movable blades. A turbine with the blades arranged as described is said to be of the reaction type. In this type of machine the pressure of the steam is less on the exit side of the blades than on the entrance side. A reaction Parsons turbine has about three thousand blades compared to 300 for a De Laval turbine of the same size. The Parsons turbine, however, is by far the most efficient of the two.



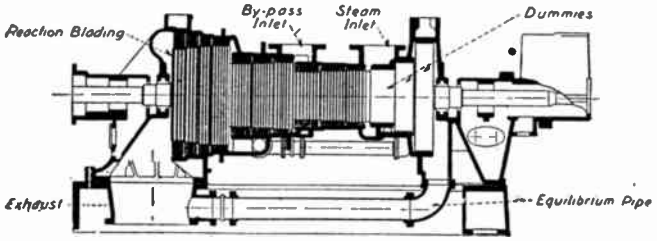
The arrangement of the blades and valves on a Curtis turbine

During the passage of steam through a turbine there is a considerable thrust. This thrust is overcome in the multistage machine by three balancing pistons on the opposite end of the rotor shaft. This arrangement will be noticed by refering to the sketches of the turbines. These balancing pistons are connected by passages to the different stages of the turbine so that as the steam is passing through each stage it will exert an equal and opposite pressure against the balancing piston. In this manner serious end thrust is eliminated. The balancing pistons never come into contact with the cylinder in which they revolve and there is little added friction to the motion of the rotor.

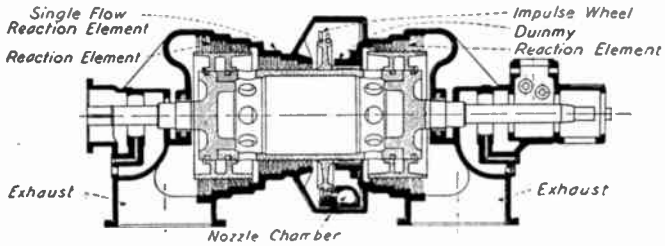
Steam turbines are made to operate on different pressures; high pressure, low pressure and mixed pressure. High pressure turbines operate at about the same initial pressure as triple expansion steam engines. Low pressure turbines generally operate on the exhaust steam of a reciprocating engine and they are generally interposed between the engine and the condenser. Mixed pressure turbines operate on the exhaust steam of engines which is supplemented with live steam for heavy loads.

Steam does not flow through high pressure turbines in one continuous stream, but rather in blasts or puffs at regular intervals. These puffs of steam are admitted by means of a cam on the governor, a spring-operated piston and a steam relay which causes about three impulses per second. The steam admissions are not throttled in proportion to the load and at full load the steam puffs merge into an almost continuous flow. On the larger machines an automatic cutoff is placed on the steam line which will cut off the supply if the speed of the turbine gets beyond a certain predetermined limit.

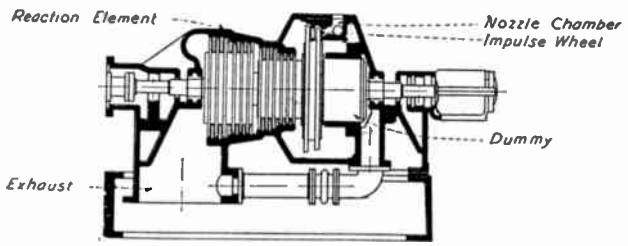
The Curtis type of steam turbine is assumed to be a combination of the principles of action of the De Laval and Parsons types, in that the first impact of the steam is from a series of several expanding nozzles in groups of two or three, at equal distances around the revolving wheel directly upon the revolving blades and from a reaction by a fixed blade disc, and in that a further impact occurs upon the second revolving wheel blades, the steam thus expanding through two or three stages and terminating in the condenser. The vertical arrangement of the shaft with the horizontal range of motion is one



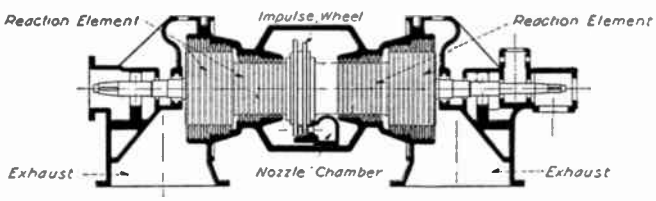
Section of a Parsons Type Single-Flow Turbine.



Section of a Combination Impulse and Reaction Single-Flow Turbine.



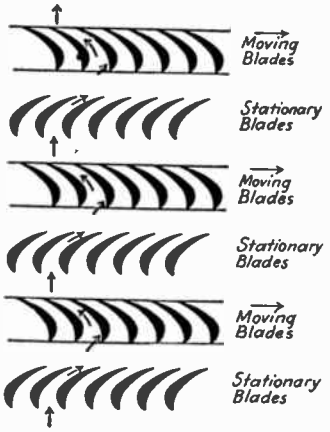
Section of a Double-Flow Turbine.



Section of a Double-Flow Turbine.

of the distinctive features of the Curtis type of steam turbine.

One of the drawings shows the arrangement of the steam chest valves and nozzles, and moving and stationary blades for a Curtis turbine. The most vital point in a steam turbine are the buckets since they, and the spaces between them, must be shaped exactly right to give the correct direction of flow and highest mechanical efficiency and also provide for the progressive ex-



The arrangement of the blades in a turbine

pansion of the steam. The buckets or blades for the Curtis turbine are cut out of the solid metal by a special bucket cutting machine.

In the following lines will be found a more detailed outline of the various turbines and their principles of action.

In the reaction turbine approximately one-half of the expansion in any one stage takes place in the stationary blades, imparting to the steam a velocity substantially equal to that of the moving blades so that it enters them without impact. The remainder of the expansion takes place in the moving blades, the spaces between which gradully grow smaller from the inlet to the exit side of the turbine forming a ring of moving nozzles. The velocity imparted to the steam by reason of the expansion occurring in the moving blades produces a reactive effort on these blades which turns the rotor of the turbine. This effect is very similar to that produced by water issuing from an ordinary hose nozzle.

In the turbines of the impulse type the complete expansion for any one stage takes place in the stationary blades or nozzles and the steam is delivered to the moving blades with a velocity somewhat more than double that of the blades. The passages between the moving blades are of uniform or even slightly increasing cross-section from inlet to outlet. The moving blades check and reverse the velocity of the steam current and the reluctance of the steam current to having its directions and velocity altered gives rise to a force against the blades which sets the rotor in motion.

Each of these two general classes of turbines has its partisans and doubtless always will have. The modern practice in turbine construction seems to be in the direction of a combination of the two types.

The use of a single impulse for the first stage of the expansion is desirable inasmuch as it replaces without any appreciable sacrifice of economy a considerable number of rows of reaction blading in the least efficient part of the reaction turbine, and makes possible a shorter and consequently stiffer rotor. For the intermediate and low-pressure sections, in which the volume of the steam is sufficient to require reasonably long blades moving at considerable velocities and extended experience confirms the belief that reaction blading has a decided economic advantage.

The all-impulse type necessitates a rotor built up of discs mounted on a shaft of smaller diameter in order that the circumferential clearance between the shaft and the diaphragms separating the pressure chambers may be as small as possible so that the considerable pressure drops between adjacent stages will not cause too much leakage

In the reaction type the pressure drops between adjacent stages are very much smaller and the body of the rotor may be built up in the form of a hollow drum. The drum construction is much stiffer than the shaft and disc design and it is believed much safer. When a disc is heated it develops internal strains that are impossible of calculation and which are liable to start cracks in the metal, resulting in many instances in complete rupture. On the other hand, in a rotor made up of a comparatively thin drum of considerable diameter and rings of large bore no such strains are encountered. Again the drum construction of rotor makes the turbine very much more accessible for examination and repairs. In most of the later designs of Westinghouse turbines the upper half of the cylinder can be lifted without interfering with the governor steam chest or pipe connections.

Bleeder turbines are for use in plants which are required to furnish not only power, but also considerable and varying quantities of low pressure steam for heating purposes. In these turbines a part of the steam after it has done work in the high pressure stages may be diverted to the heating system and the remainder expanded through the low pressure blading and exhausted into the condenser. In this way none of the energy of the heating system, due to the difference in pressure between the boiler and the heating system is wasted. On the other hand, if no steam is required for heating purposes, the turbine operates just as efficiently as though the bleeder feature was absent.

Steam turbines have been brought into use for the propulsion of ships. The real high speed of the turbine prevented its being adopted for this use for a long time. Finally a very efficient reducing gear was developed which made it possible to apply the turbine in this field. These reducing gears have been perfected to a point where they transmit 98½% of the power delivered to them. Turbines have been designed to operate on low pressure steam and these run on the exhaust steam from the engines. On the great steamship *Olympic* steam turbines are fed from the exhaust of the compound engines and a saving in fuel of from 12-15% is realized. The impossibility of reversing the turbine makes it necessary to install a separate unit when running astern.

TIN AMALGAM

TIN and mercury combine readily at ordinary temperatures. If 3 parts of mercury are brought into contact with 1 of tin, 6-sided crystals of tin amalgam are formed. Tin amalgam is used for silvering looking-glasses. When pulverized and rubbed on the polishing-stone it forms a kind of mosaic silver. Electric amalgam may be made by melting tin and zinc together in various portions in a porcelain crucible. The mixture is well stirred up, and when on the point of solidifying the mercury is added and worked into the mass. The whole is next transferred to the mortar warm enough to keep the amalgam soft, while it is well worked together, after which a piece of tallow or lard, not quite the equal in bulk to the mass, is kneaded in until the amalgam attains the proper consistency.

SILVER AMALGAM

THIS is best prepared by the use of pulverulent silver obtained by the reduction of silver solution. It may be prepared by bringing a solution of nitrate of silver in 10 to 15 parts of water into a bottle, adding a few small pieces of sheet zinc and vigorously shaking for a few minutes. The silver separating in the form of a very fine black-gray powder need only be washed and dried to be suitable for the preparation of amalgam. This finely divided powder may be directly dissolved in the mercury, though it requires some time. The object is more quickly attained by heating the mercury nearly to boiling in a crucible, then throwing in the pulverulent silver and quickly combining the mass by vigorous stirring with an iron rod.

WATCH

Watch for the announcement of a new contest which will appear in one of the early numbers of EVERYDAY ENGINEERING. This announcement will greatly interest all men who use tools. Several very substantial and worthwhile prizes are to be offered.

Model Car Trucks

Two-and-a-half Inch Gauge

By Henry Greenley

Associate Member Institute of Locomotive Engineers, England

QUITE recently the writer has been required to design and make patterns for some really satisfactory bogies for certain well finished "working" models of British Pullman cars. These trucks naturally embrace most of the characteristics common to American railroad practice and the accompanying drawings have been therefore rearranged in line with U. S. A. conditions and also slightly modified to suit amateur construction.

The trucks are of the over spring equalized type and as detailed in the drawings herewith require three patterns only viz: the side frames, stretcher or bolster, and the combined equalizer and axleboxes. It is advisable for the amateur to build the trucks from castings and make his own patterns even if a small number of trucks are required and all parts can be cast in gunmetal (bronze) thorughout if fine soft cast iron is not obtainable for the frames and bolster. With regard to the wheels, these may be in cast iron or turned from mild steel discs cut from the bar.

The chief feature of the trucks lies in the arrangement of the equalizer and axleboxes and in the attachment of the bolster to the car body. Although the wheels and equalizer can take up the position shown in an exaggerated degree in the sketch, Fig. 3. The bolster is provided with a half round transverse rib on its upper surface. This rib bears on a metal plate attached to the underside of the car transom beam and gives lateral stability to the truck, any direct side roll being taken up entirely by the equalizer springs. The truck is, however, quite free to rise and fall at the ends to accommodate itself to longitudinal waves in the track—i. e., such as are encountered at changes in gradient. The position taken up in Fig. 3 would therefore not be possible except in a slight degree, depending on the restraining action of the rubber washer fitted in the recess in the underside of the bolster casting under the head of the pivot screw or bolt.

The combination of the equalizer side springing with the "scale-beam" type of support for the bolster should provide for the roughest track and at the same time prevent the coach body from oscillating in a lateral direction. Nothing looks so bad as to see a model coach—and many do this—"dithering" and wobbling from side to side as it proceeds along the railroad.

To provide for the action indicated in the rough sketch, Fig. 3, rectangular holes in the side frames of the truck should be sufficiently free to allow the combined equalizer and axlebox to take up the position shown and to this end the sharp corners of the square boxes may be chamfered off to a substantial amount where they pass through the opening in the side plates of the truck.

Of course, separate boxes could be used but if the prospective maker of these bogie trucks is anxious to get say a train of four or five cars ready—this means 40 axleboxes—he will welcome anything in the nature of labor saving. With a view to the future use of the patterns one is always requiring bogie

This is the third installment of Mr. Henry Greenley's series on model railway engineering. During the past two years the Editor has received a multitude of inquiries relative to the construction of model car trucks and he hopes that this article sets forth all of the necessary information on the subject.—EDITOR.

trucks in the equipment of a model railway—and to obtaining clean castings metal patterns are recommended. For the side frames a piece of sheet brass ⅛ in. thick should be cut out to the shape required by detail drawing Fig. 5 allowing for sand "draw" and providing for shrinkage (3/16 in. to the foot, approximately). On this the three inside blocks may be silver soldered or soft soldered *and riveted.* The raised horn plates may then be cut out of 1/16 in. sheet and soft soldered on, the plates being further secured by countersunk screws driven from the back with their points which should be nicely rounded projecting through the front to indicate rivet or bolt heads in the final castings. The openings for the axleboxes should be arranged for in the pattern but enough metal should be provided for filing to size and "draw" on the sides of the hole should also be ample.

In soft soldering several parts to one base successive heats are necessary, and care should be taken not to oxidize or "burn" the surfaces and the solder by overheating. The temperature to which the metal is raised should be sufficient to just melt the solder. Parts fixed in the previous heats should be screwed or riveted to secure them in the succeeding ones. To hold several parts together during the soft soldering operation, strip steel clamps, as sketched in Fig. 4, will be found extremely useful. Cleanliness is necessary to successful soldering, and a certain amount of practice is required to produce a satisfactory pattern. When completed it should have nicely rounded corners and such fillets—which are essential to sound clean castings — may be obtained by floating soft solder wherever it is required to form a fillet. Another point to observe is that soft solder cannot follow silver soldering until the whole of the work is recleansed. To remove the burnt borax the object should be warmed (a black heat is sufficient) and immersed in a pickle of sulphuric acid and water, strength 1 to 20. The pattern for the equalizer may be made out of ¼ in. x ⅜ in. brass strip, the ends being silver soldered to plates made of 3/16 in. stuff. When shaped to dimensions (plus allowances for casting shrinkage) the axleboxes may be sweated on, also the small pieces forming the spring bearings. These additions are similar in shape to the pieces soldered to the side frames (see sketch Fig. 4) and may be sawed out of 7/16 in. sound bar brass. To retain the spiral springs in position the pattern should provide for the small spring pin shown in cross section drawing Fig. 6 and in Fig. 7.

If the latter course is adopted the casting may be of L section in the center to lighten it, although lightness in a model truck need not be studied. A little weight in wheels and trucks is to be desired. The side frames are attached to the bolster by three screws (3/32 in. diameter) on each side, but before the truck can be assembled the work to the wheels and axles must be completed, as the fixing of the side plates secures the whole of the parts of the bogie truck. It has been arranged in designing the truck to make the combined equalizer and axlebox (Fig. 7) quite flat at the back. These castings can then be quite easily finished by filing, machining or "band-grinding" the back and drilling 11/64 in. blind holes for the 5/32 in. axle journals. The rest of the casting, except for the sides of the axleboxes and the all-important rounding of the corners where the box passes through the side plate, only requires fettling up to provide a reasonably clean surface for the final painting.

The hole for the truck pivot bolt or screw in the bolster casting should be at least 1/32 in., if not 1/16 in. larger than the pivot itself. The rubber washer or disc will restrain the truck from any display of sloppiness due to the clearance between the hole and the screw or bolt, and at the same time the rubber will allow of the equalizer action of the

(*Continued on page* 88)

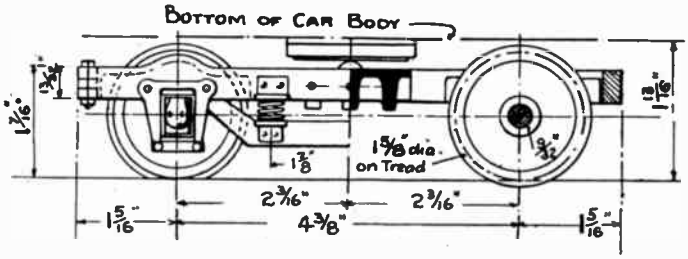


FIG. 1

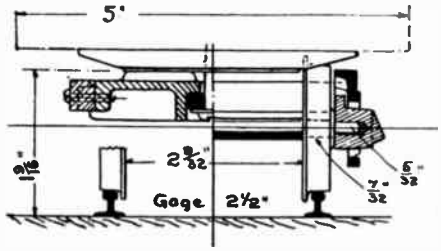


FIG. 2

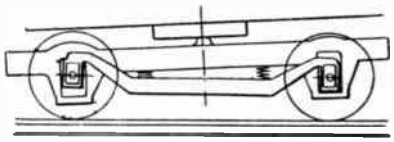


FIG. 3

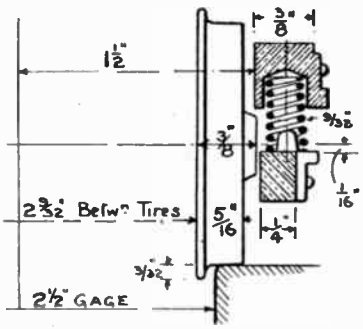


FIG. 6

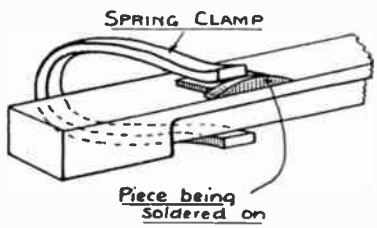


FIG. 4

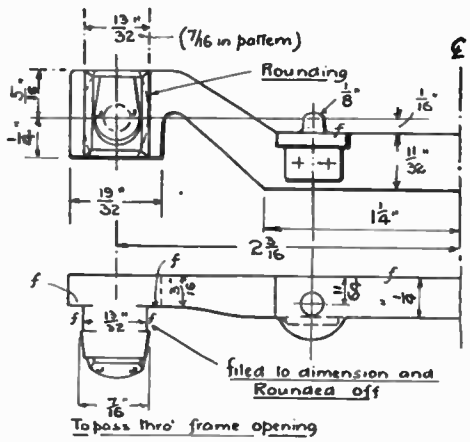


FIG. 7

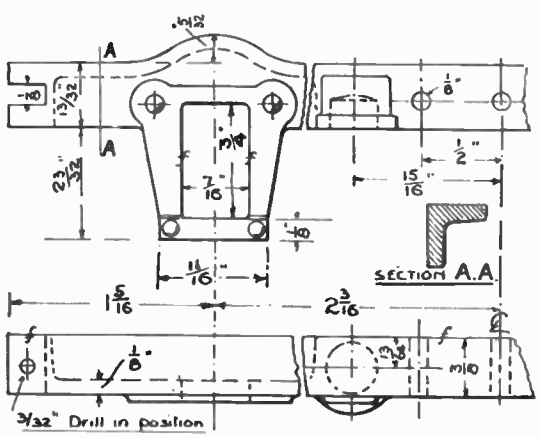


FIG. 5

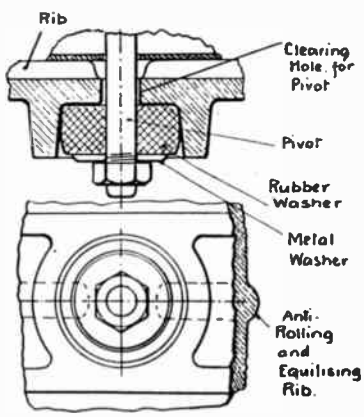


FIG. 8

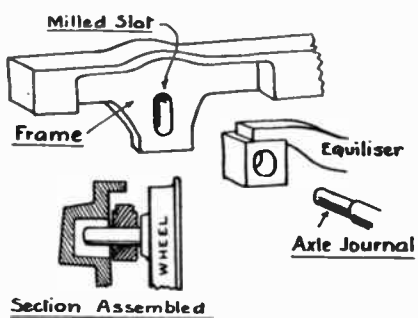


FIG. 10

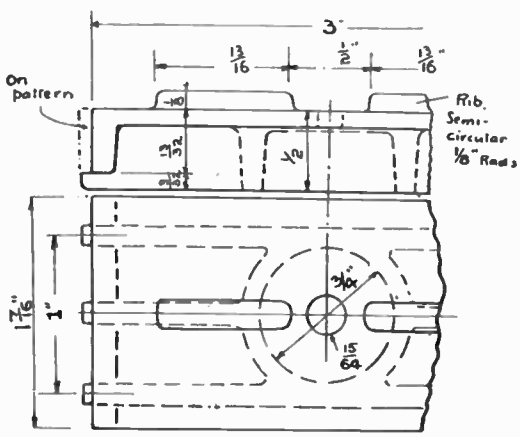


FIG. 9

Systematic Lubrication and Maintenance of Automobiles

An Exposition Dealing With the Importance of Giving an Automobile Regular Care, and How to Inspect the Mechanism in a Thorough Manner. The Necessity for Periodical Lubrication to Reduce Operating Expenses and Rapid Depreciation is also Made Clear

By Victor W. Pagé, M. S. A. E.

MORE automobiles come to an untimely end by abuse than are worn out by useful service and more parts of the mechanism become worn or broken by neglect than depreciate from normal use. The average motorist who looks after his own car is apt to be neglectful and keeps the car in operation as long as it will run. Even the cheapest of automobiles represents an investment of nearly a thousand dollars, yet their owners do not always take the care required to conserve the investment and lessen depreciation, which is apt to be abnormally high because no effort is made to give the mechanism the care it deserves.

This is not always the fault of the automobile owners, because in many cases they have no idea of what parts to inspect and what to look for even if they do carry on a more or less haphazard inspection of the power plant or chassis mechanism. The care that an automobile demands should not tax even the busy man, as several hours per week spent systematically will insure that the car will be properly oiled and that no serious defects will materialize without giving notice in advance. The instructions which follow are intended to help the automobilist in caring for the car in his charge and apply to most standard cars. The subject of lubrication is considered first, then that of logical and periodical inspection.

Car Lubrication Important

Without question the subject of lubrication is of more importance to an owner than any other subject, because proper lubrication contributes in no small degree to keeping a not inconsiderable investment from depreciating too rapidly. It does not suffice that the best of workmanship and highest grade materials are employed in manufacture. They cannot give the owner that service he has the right to expect if this feature is neglected. The best of material will not lubricate a bearing, and the finest workmanship will not keep a piece of machinery out of the scrap heap if wearing surfaces are not lubricated regularly. Even slight neglect, not in itself enough to destroy immediately, will have damaging effect upon wearing parts, and will cause not only increased depreciation but lost time, increased maintenance and operating cost, and a performance not at all in keeping with that which the automobile was designed and constructed to give.

The instructions which follow can be followed to advantage by drivers and owners of practically all standard makes of cars, though they will be subject to slight modifications as the arrangement of the mechanism dictates.

Motor Lubrication

The oil reservoir, when empty, will take two or three gallons of oil, depending on the size of the motor. The best oil to use depends on the type of motor and the recommendations of the manufacturer should be followed and only lubricant of the best quality used.

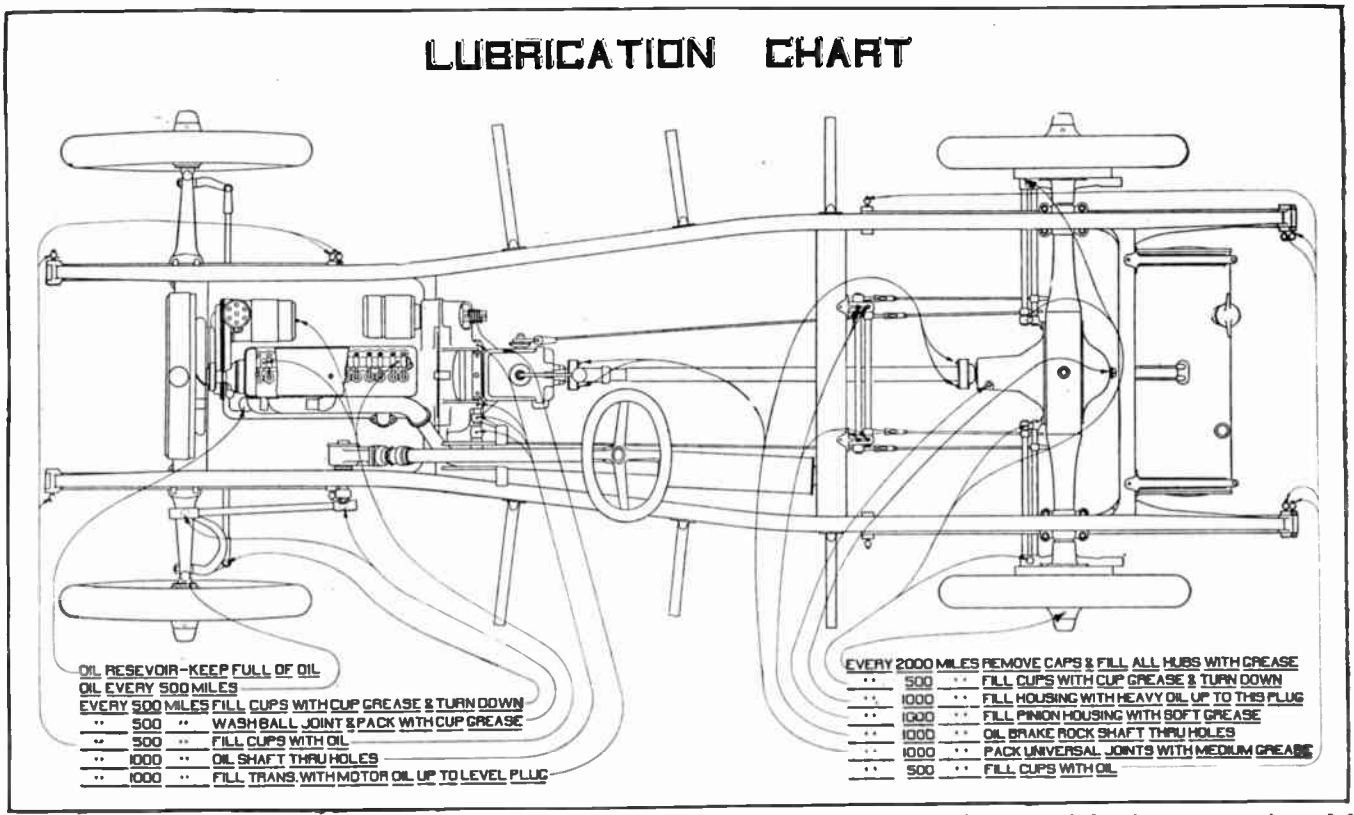


Chart showing location of oil and grease cups on a popular light car, the Oldsmobile Six, also giving the periods when attention is needed

The oil filler will be found located at forward end of the motor on the left side in most cars, though the location will vary. Care should be exercised at all times to see that the oil is kept between high and low marks on the gage usually found at rear end of motor. Watch oil circulation indicator on dash carefully, and should it not register when motor is running, investigate immediately, ascertaining if the oil line is stopped up, or if the reservoir is empty. The oil reservoir should be drained every five hundred miles through the plugs located at rear of reservoir in the starting and lighting system. One or two drops of three-in-one oil injected into the oil wells every thousand miles will be sufficient. One of these wells is located on the top of the distributor housing, oiling the armature ball bearing, the distributor plain bearing and the oil wick in the timing lever body. The other oil well will be found on the extension of the end plate at the driving coupling, and lubricates the ball bearing on that end of the magneto. Oil cups will also be found on the bearings of generator and motor of the starting and lighting system.

lubrication of the clutch is necessary if a dry plate or cone clutch is used except that the clutch throw-out bearing should receive regular lubrication. This is generally provided for by a large grease cup located on the floor board, which should be given one turn every morning or noon.

Oil cups are provided on the steering gear, and they should be kept filled with a good grade of light oil. At each end of the drag link is a socket in which the ball of the steering arm operates, as well as the arm on the knuckle arm. These should be thoroughly greased at least

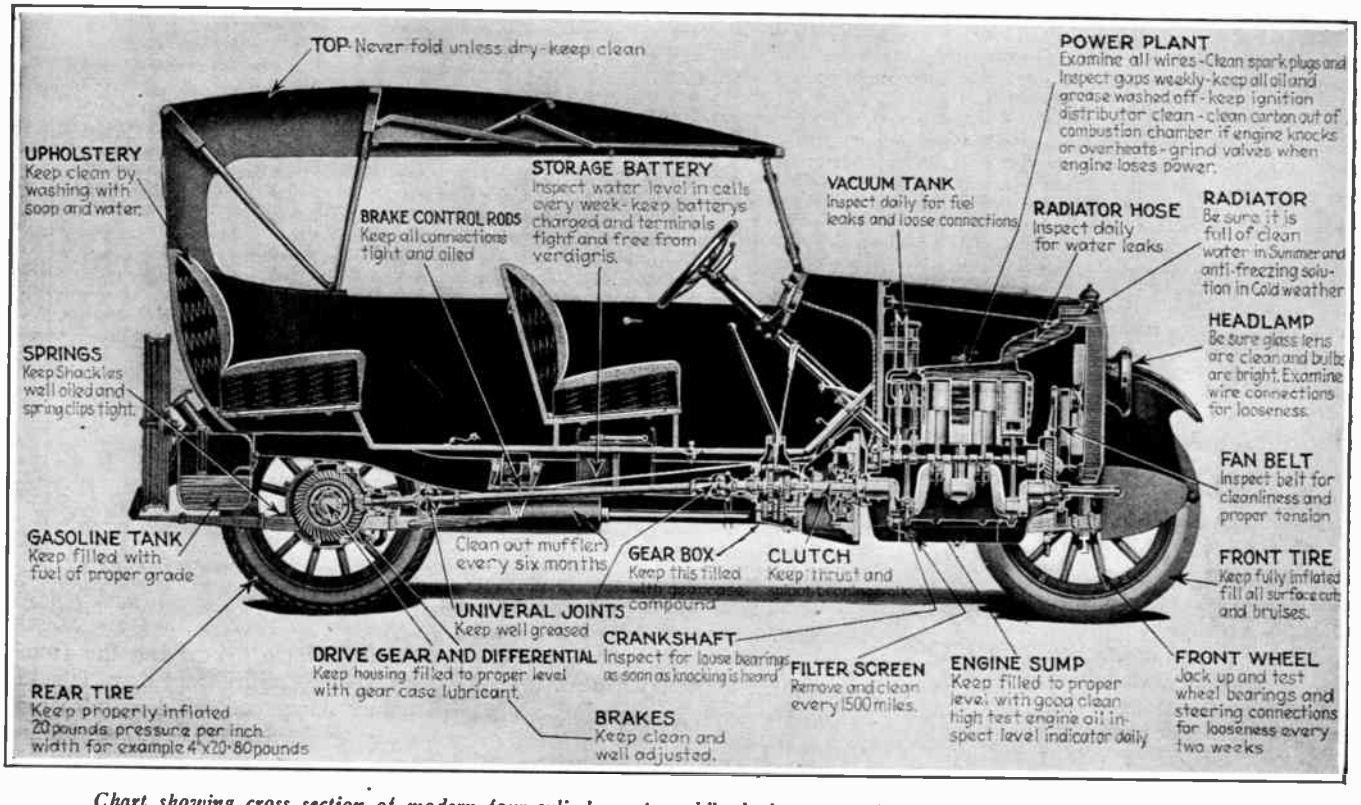


Chart showing cross section of modern four-cylinder automobile depicts parts of mechanism that need regular inspection

bottom of crank case, and refilled with fresh oil. The reason for this is obvious; the grade of gasoline that is being sold at the present time is such that perfect carburetion is impossible until the motor warms up, resulting in considerable raw gasoline finding its way into the oil reservoir, which gradually thins the oil until it ceases to be a perfect lubricant. For this reason, heavy-bodied cylinder oils are often recommended.

The oil system of modern automobiles is nearly always the force-feed type and pressure is maintained by a positive gear-driven pump located in the bottom of oil reservoir, generally to one side. There is an oil strainer surrounding the pump intake which should be cleaned occasionally. This can be easily removed for cleaning by simply taking out cap screws or unscrewing a plug. A grease cup is provided on the fan. Fill this with grease weekly and turn every day. Do not overoil the magneto or the dynamo and motor of the electric

Chassis Parts

Grease cups are usually provided at all points on the front axle where friction comes. Make sure that the grease cups are filled with a high-grade light grease free from acid and grit. Keep reserve supply of grease in a tightly covered can so that no grit or dust can get into it. If oil cups are used be sure to keep these filled with fluid oil.

The bearings on the front wheels of most cars are tapered roller forms and may be lubricated with any light grease or heavy oil if it is positively free from acid. Plugs are sometimes provided in the wheel for lubricating the bearings, and in addition the wheels should be removed periodically, the bearings thoroughly cleaned with kerosene and relubricated with light grease, using a clean wooden paddle for spreading.

The transmission should be filled in about 1½ inches above center line of the main shaft with a good grade of heavy transmission grease or oil. No

twice a month. Grease universal joints weekly with a good grade of cup grease, using grease gun, and once every three months joints should be completely taken down, thoroughly cleaned and repacked.

Oil cups on brake flanges and grease cups should be given attention once a week. These lubricate the internal brake cams of the rear axle. All external brake joints should be given a few drops of oil once a week. Fill differential gear-case one-third full of heavy oil or very light grease. Do not fill over one-third full.

Every six months take out drain cup in the bottom of case and thoroughly rinse out old lubricant with kerosene by pouring it in at top cap. After rinsing out with kerosene, then fill with lubricant as above instructed. Rear hub bearings on full floating axles can be given sufficient grease by simply removing hub cap and filling this with grease, then screwing back in position.

This should be done about every three months. Every six months the springs should be taken apart and lubricated with a good grade of grease mixed with graphite. Spring-bolt bearings are provided with oil cups and should be oiled daily. There are numerous other points of friction such as control rods, cross rods, rocker shafts, etc., not mentioned, where a drop of oil occasionally will materially benefit.

Daily Maintenance Routine

Engine: Examine all wiring terminals for tightness. Clean magneto or ignition distributor externally. Note tension of fan belt. Inspect oil supply in engine crank case. Inspect oil pump for performing its proper function. Inspect radiator water supply. Inspect hose connection for leaks. Inspect gasoline tanks for proper fuel supply. Inspect fuel pipe line and all connections for leaks.

Brakes: Inspect for undue wear or looseness and tighten if necessary. Inspect for proper operation.

General: Inspect and thoroughly clean all lamps. Inspect tires for air pressure, cuts or damage. Make sure spare tires are properly inflated. Tighten all loose bolts and nuts.

Weekly Maintenance Routine

Engine: Inspect all wires for proper support and freedom from damage. Thoroughly clean engine externally. Inspect all pump connections for oil leaks. Inspect all water connections for leaks. Inspect carbureter control connections. Do not attempt to alter carburetor adjustment unless this is shown to be necessary when the truck is in service.

Remove magneto or battery system distributor cover and clean with gasoline and a clean cloth. Operate engine at low speed and, with one wire at a time separated from the spark plug inspect the spark given for length and apparent hotness. Keep engine free from carbon; inject tablespoonful of kerosene into each cylinder, through pet cock or spark plug holes. This should be injected when the motor is hot and allowed to stand over night. Remove, clean and adjust all spark plugs.

Brakes: Inspect and thoroughly clean and oil all brake connections. Adjust if necessary.

Springs: Inspect center bolt of spring and spring clips for apparent tightness.

Wheels: Inspect front wheels for alignment with rear wheels. Inspect tires for undue damage and wear. Jack up wheels and inspect bearing adjustment. Inspect spindles and spindle bolts. Inspect the steering rod adjustment and all rod ends of the steering linkage.

Clutch: Inspect entire clutch mechanism.

Transmission: Clean and inspect all control connections.

Universal Joint: Inspect universal joint for undue looseness and wear. Clean and refill universal joint with grease.

Differential: Inspect differential and propeller shaft bearing adjustment.

Body and Equipment: Inspect body bolts, hood fasteners and all similar bolts for apparent tightness. Inspect tool equipment for completeness.

Monthly Maintenance Routine

Engine: Determine if carbon is present in quantity in the engine. Examine and inspect engine for loose parts, leaks, noises. Clean oil pump screen. Grind valves if necessary.

Ignition: Clean magneto or distributor head, polish and adjust breaker points. Inspect magneto or timer cam for correct advance.

Clutch: Inspect clutch hub grease tube. Inspect clutch operation. Inspect clutch alignment.

Transmission: Clean externally and inspect for leaks, particularly the drain plug and the rear bearing.

Springs: Thoroughly inspect and clean spring shackle connections. Inspect springs to ascertain damage, if any.

Differential: Clean and inspect differential housing for oil leaks. Inspect brake arms and equalizers on differential housing.

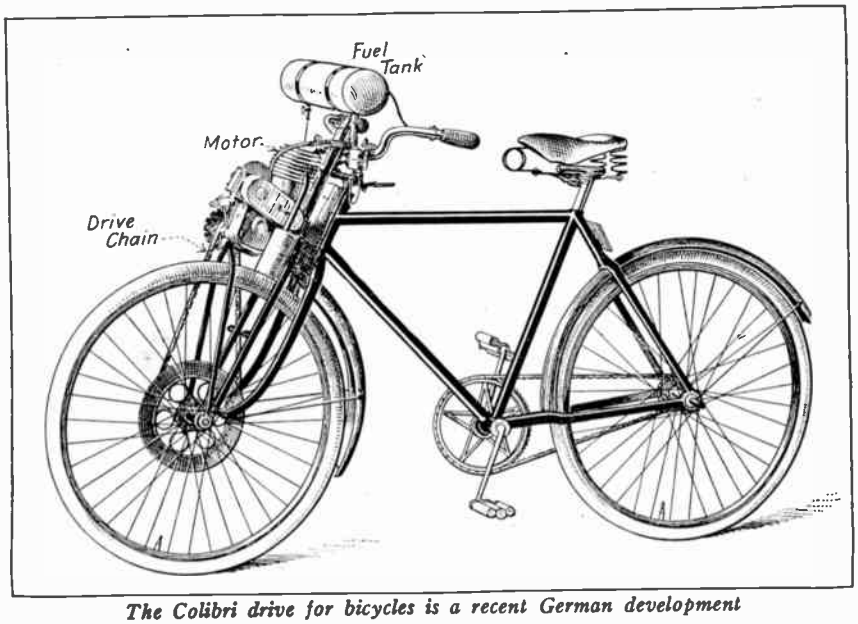
Wheels: Remove hub caps and inspect for proper lubrication. Inspect condition of bearings.

Universal Joint: Inspect universal joint ring and yokes. Inspect housing bolts inside joint housing.

General: Inspect transmission arm bolts. Inspect front motor support bolts. Inspect oil pan and transmission bolts. Inspect steering gear for lost motion and lubrication. Inspect speedometer drive.

ENGINE DRIVE FOR BICYCLES

AN easily installed gasoline engine drive for bicycles is not a novelty in the United States, but those of domestic design follow other principles than those of a new German design which is shown herewith. The power plant is mounted on the front fork and pulls the bicycle by driving the front wheel. The Colibri front drive is said to reduce dangerous skidding, also the weight will be less. It consists of an air-cooled, four-cycle, single cylinder engine of 1½ H.P., mounted on a fork frame of steel tubes. This is intended to be attached beside the front fork of the bicycle and is connected to the bicycle frame by spring joints. The vibrations of the engine are insulated from the bicycle frame, which could not stand such detrimental strains for a long period owing to its light construction.



The Colibri drive for bicycles is a recent German development

The engine drives a secondary shaft through a short chain, this crankshaft contains the clutching device and, from this shaft, the chain wheel at the front hub of the bicycle is driven with a longer chain.

By releasing the clutch the bicycle can be driven with pedals. The motor has a high-tension magneto and jet carburetor. The fuel tank is mounted at the steering bar and from the handles of this bar the throttle and clutch are controlled by Bowden wire. To prevent splashing of oil on the rider, the back and top side of the fly wheel is covered with a sheet metal guard. The weight of the complete Colibri motor

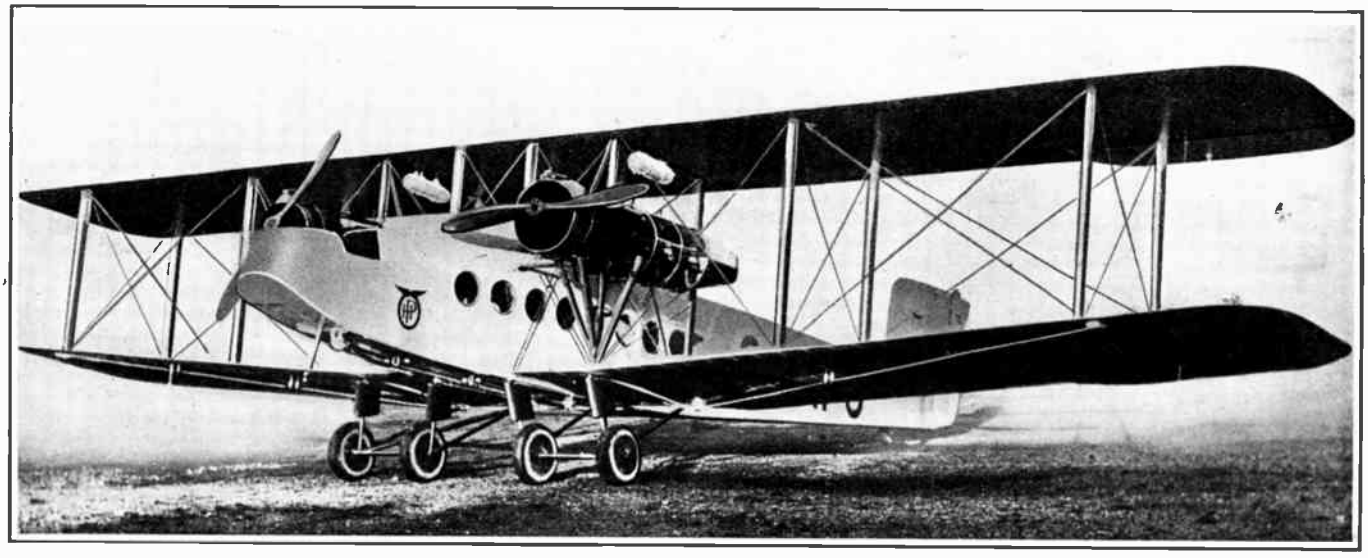
drive is 36.2 lbs. (16.5 kg.), the speed ranging from 18 to 25 m.p.h. with small fuel consumption that could be expected from a low powered engine. This is an interesting revival of the Clement motor, a French design of over fifteen years ago.

MORE COMFORT FOR THE AVIATOR

THE pilot's and navigator's cockpit in a recently devised machine intended for long flights is fitted with Triplex glass side windows and a floor window in front of the pilot. Normally the seat placing allows the crew to sit with their heads just clear of the cockpit, but the design is such that the cockpit may be converted into an enclosed cabin. The seats are fitted with clips which permit them both to drop about a foot, and sliding doors are pulled across the openings to close in the cockpit. Some of the side windows are made to open, and a pipe running from the front of the radiator supplies fresh air to the cockpit interior. Dual control is provided, and the pilot has two rudder bars one above the other, for the two seat positions. There is a system of pull-out tables for charts and slots for instruments. The circular opening for the pilot's head is fitted with an aluminum beading which is graduated off into degrees for use with a sextant. In the rear of the navigator are cupboards for food.

It would seem quite possible even in small single-engined machines to design a cockpit providing every facility for piloting and navigation, which will be thoroughly comfortable and livable for the pilot as well as the passengers. The accompanying illustration shows the thorough enclosure of the passengers' cabin in the Handley Page London-Paris flyer, and shows how well protected the passengers can be and how luxurious the furnishings of air liners can be made. The complete machine is also shown and the size of the fuselage necessary to accommodate the twelve passengers is clearly shown. Illustrations of an earlier design have been published previously in this magazine, but the latest type is particularly interesting in view of the improvements that have been made and the luxurious appointments of the "Pullman" body provided for the accommodations of the passengers who use the London-Paris air route.

Luxuriously appointed cabin of Handley-Page passenger-carrying airplane



The Handley-Page twin-motored airplane is a converted bomber with a well-appointed cabin for passengers

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The effect of temperature on the duration of incandescent lamps has been the subject of recent experiment. At 392° F. lamps were used up in 40 hours, while at 36° F. the duration was normal or better. This explains the short life of lamps in luminous signs, where being crowded together they are kept at a high temperature.

A mixture of sodium silicate (water-glass) baked in a kiln, forms a solid bonding material, with a tensile strength of over 2,000 pounds to the square inch. It is said to be used for abrasive wheels.

LEAD BURNING

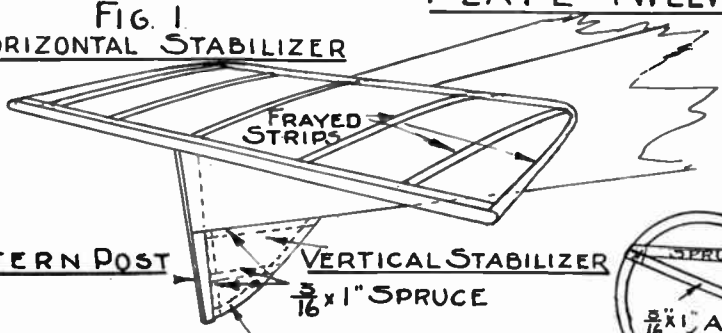
LEAD burning consists in melting the metals and causing the parts to flow together and become joined without the aid of solder. It requires considerably more skill than any other form of brazing or soldering. A long step toward success may be taken by the proper arrangement of the work. It is usual to provide something which may serve as a mold or guide for the melted metal. For example, if two lead sheets are to be united by soldering, they are laid on a sheet of some non-heat-conducting substance, such as brick or asbestos. The work in the immediate neighborhood of the joint is carefully scraped so as to remove all oxide or scale which would tend to bind the melted lead and prevent it from flowing freely. The metal at the seam is heated by a very hot bit or the flame from a blowpipe so that there is a uniform flow of lead across the seam. It is sometimes necessary to add more lead to the seam by melting a strip held in the hand. A flame of some sort is the most satisfactory source of heat for the average lead burning job, because not only is the heat more uniform, but also more intense, and the lead melts at the desired point before the surrounding metal becomes sufficiently hot to soften. There are several types of blowpipe for this purpose on the market. Some employ an alcohol flame, while others make use of mixed hydrogen and air. The flame is usually small, sharp-pointed, and very intense. Lead burning is absolutely necessary, and is insisted upon in certain classes of work, for instance, in lining tanks with lead for chemical solutions, or for joining the grids and lugs of storage batteries.

DETAILS OF TWO SEATER SEA-PLANE

Designed By C.E.MULLER M.A.E.

PLATE TWELVE

FIG. 1
HORIZONTAL STABILIZER



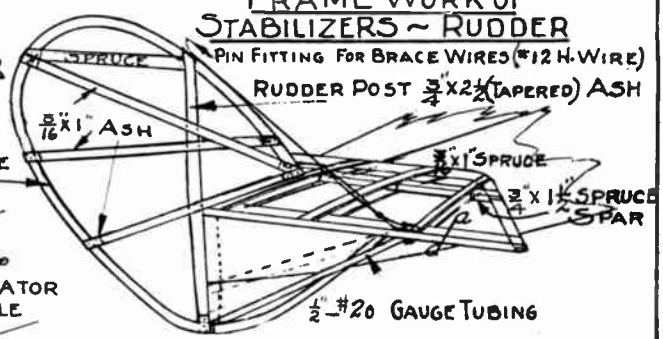
STERN POST — VERTICAL STABILIZER 5/16 x 1" SPRUCE

EDGEING OF 1/4" X 1 1/2" LAMINATED SPRUCE

SECTION OF STABILIZER TRAILING EDGE
5/16 x 1 1/4 SPRUCE FALSE RIBS

FIG. 3.

FIG. 2.
FRAME WORK OF STABILIZERS ~ RUDDER



PIN FITTING FOR BRACE WIRES (#12 H. WIRE)
RUDDER POST 3/4" X 2 1/2" (TAPERED) ASH
1/2" - #20 GAUGE TUBING

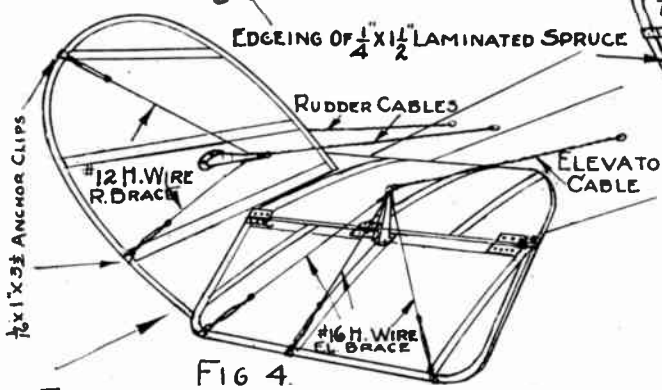


FIG 4.
EMPENNAGE ASSEMBLY

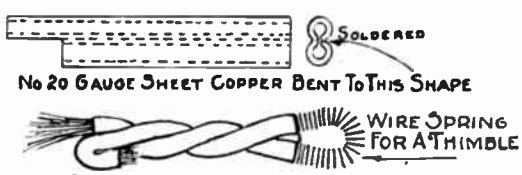
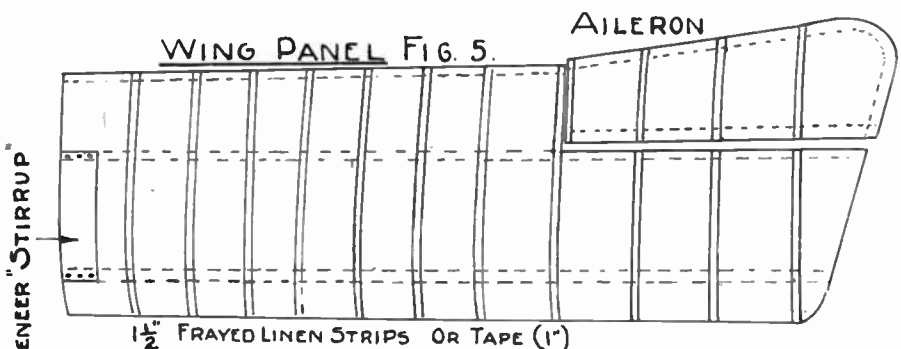


FIG. 6 CABLE TERMINAL

WING PANEL FIG. 5.



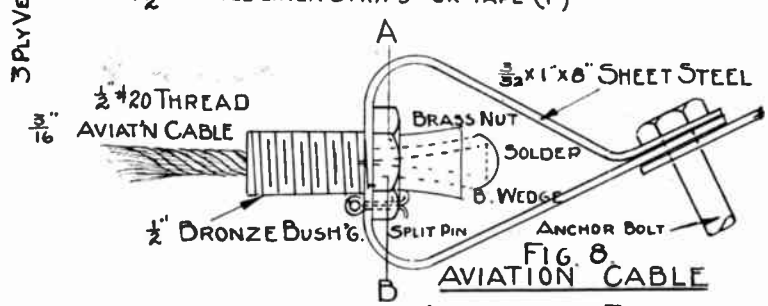
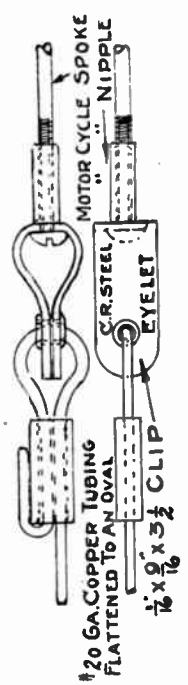


FIG. 8.
AVIATION CABLE ANCHORAGE TURNBUCKLE

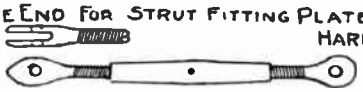
SECT A-B



HARDWIRE TURNBUCKLE
FIG. 7.

ALL STEEL NIEUPORT TURNBUCKLE
BARREL 4 5/8 LONG. TENSILE STRENGTH 11,000 lbs

YOKE END FOR STRUT FITTING PLATE



ENGLISH TYPE BRONZE BARREL

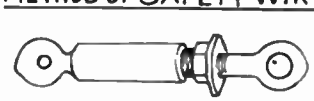
HARD WIRE — SOFT COPPER WIRE

METHOD OF SAFETY WIRING

BINET TURNBUCKLE
LARGEST BARREL 5/8" LONG T.S. 22,000 lbs
SMALLEST " 1 3/8" " T.S. 4001 bs

BINET FORGED STEMS

LEFT HAND EYE WITH CABLE THIMBLE
RIGHT " " TO TAKE A PIN



NAIN-GEANT FRENCH TURNBUCKLE
RIGHT AND LEFT HAND THREADED TUBING

Building A Two-Passenger Seaplane

By Charles E. Muller, M.A.E.

Consulting Aeronautical Engineer

PART EIGHT

FABRIC COVERING AND ASSEMBLING OF MACHINE

THE covering of airplane surfaces has undergone decided changes, principally in the improvement of the material itself and the methods of applying and doping the fabric. This is far from being standardized. Each manufacturer has his own method. Up to about 1912 cotton and silk, oiled or varnished, and some of the various rubberized fabrics then used for balloons were experimented with. The principal objections with these were the difficulty in getting them sufficiently taut, and the rapid deterioration by the oil and gasoline from the motors. Also they were weakened by the coating processes then used. Cotton fabrics weigh from 1½ to 4 ozs. per sq. yd. with a tensile strength of 25 to 80 lbs. per inch, depending on the weight.

Linen Widely Used

Closely woven linen, weighing from 3 to 4¾ ounces per sq. yd. with an approximate tensile strength of 75 lbs. per inch in the warp lengthwise of the material to about 100 lbs. per inch in the weft (crosswise of the material), is now almost universally used. This is carefully fitted, and smoothly but not too tightly stretched over the frame work. From 3 to 5 coats of cellulose dope is then applied and finished with a coat of spar varnish. On the large airplanes the fabric is applied so that the warp and the weft run diagonally and tacked or sewed on to the cap strips top and bottom of each rib. This tends to assist in stopping and ripping or tearing of the fabric. On the small machines, the fabric is lengthwise of the wings with the seams, if any, near the trailing edge. It may be tacked along the rear wing bar by placing filling-in-strips between the rib cap strips. The edge of the overlapping seam to face the rear so that the air in the slip stream cannot get under it. A brief explanation of some of the characteristics of fabrics that have been used may help the amateur to select a substitute, a cheaper covering.

Substitute Covering Materials

Cotton muslins and percales are comparatively strong and inexpensive. Careful selection of the very best quality of closely woven unsized and unbleached grades, should test from 40 to 60 lbs. per inch. Sea Island and Egyptian goods are the best cottons in strength and durability. I believe these are used exclusively in pneumatic tires in which the stresses are literally terrific. Cottons are susceptible to rapid deterioration by the elements especially moisture, therefore must be waterproofed by a "dope" explained later and spar varnished.

Rubberized cotton balloon fabric 36" to 50" wide, weighing 2¾ to 4 ozs. per sq. yd., formerly sold for 90 cents to $1.50 per yd. It is now seldom used.

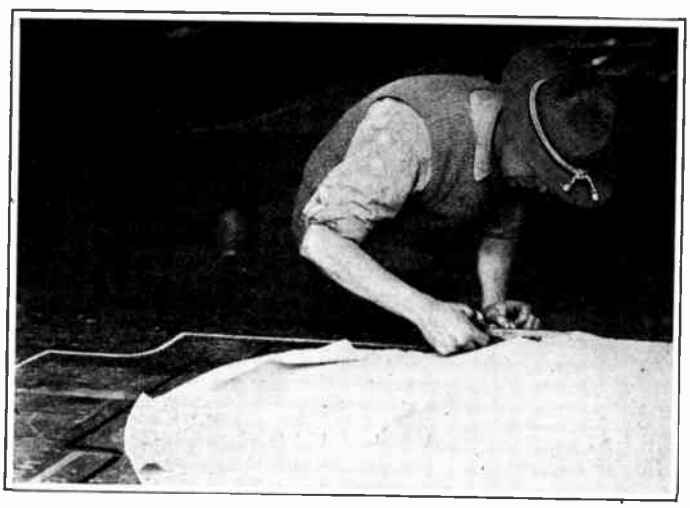
The fabric on an airplane sustains an average load at the C. P. (center of pressure) of approximately 20 lbs. per sq. ft. at seventy miles per hour. About 75% of this is exerted on the upper surface of the wings so it is therefore essential that this surface be properly fastened to the frame structure by copper tacks closely spaced or sewed to the cap strips by copper wire or flax cord after the 2nd or 3rd coat of dope is applied. Tape or frayed strips are then cemented with dope or varnish over the rows of tacks or stitches.

Dopes Used for Treating Cloth

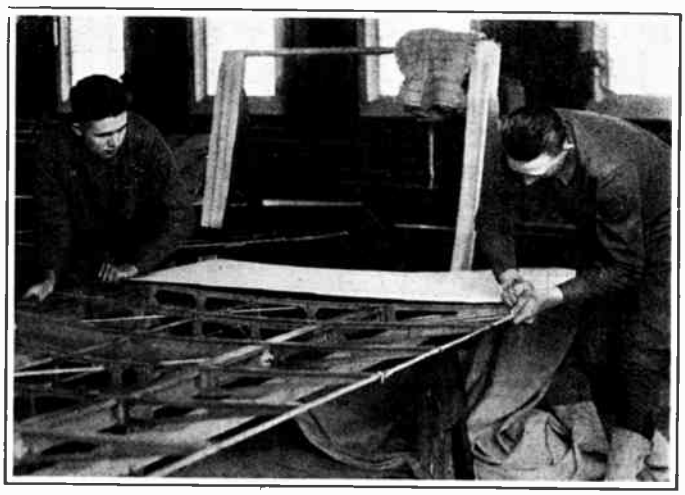
The history of the development of dopes is an interesting one, but a few pertinent facts will suffice for the needs of the amateur. Those in use today may be divided into two classes, namely; those made from a base of cellulose nitrate or pyroxylin and those manufactured with a cellulose acetate base. Both are dissolved in a suitable solvent more or less a trade secret, probably either alcohol or acetone. Sometimes, other substances are added to preserve its flexibility or to modify the shrinkage.

The chief advantage of the acetate dopes over the nitrates or pyroxylin is the reduced inflammability of the former. This will probably be appreciated to a greater extent for commercial machines, although the initial cost of cellulose acetate dope is greater. Some manufacturers apply three coats of the pyroxylin followed by two or three coats of the acetate. This gives a fire-resisting surface even though the doping is not non-inflammable all the way through.

The writer built a Farman type machine in 1911 that was covered with a single surfaced six-ounce cotton duck. It was stretched tightly over the framework with a pocket for each rib and wing bar. One coat of hot paraffine was applied with a stiff brush as rapidly as possible, then ironed with hot irons top and bottom. This machine was considered fairly efficient in the pioneer days. This method is purely experimental but may be worthy of further exploiting.

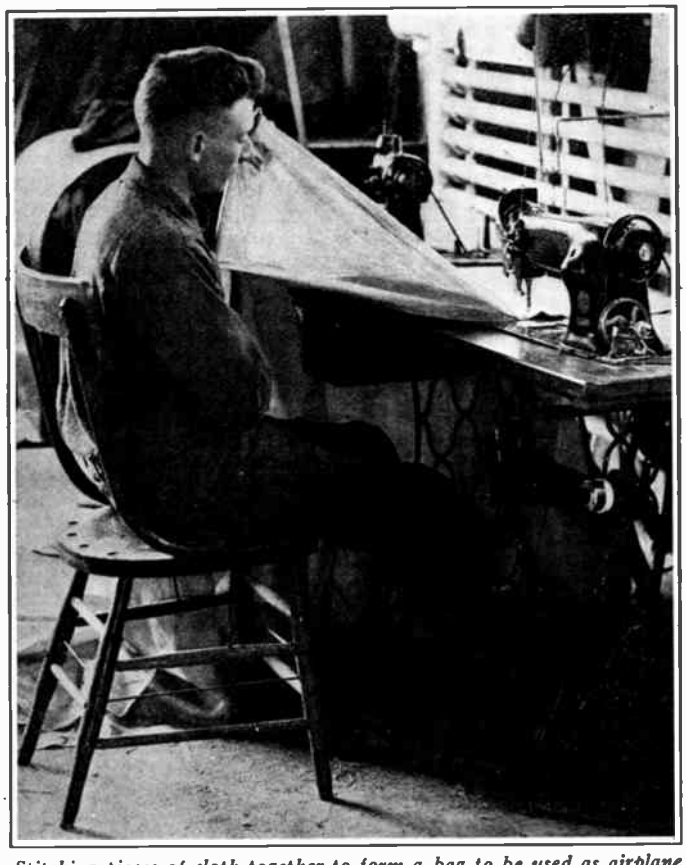


How cloth is cut on the pattern table to fit wing frames



Slipping cloth covering made in the form of a bag over wing frame

Some engineers recommend stretching the fabric on the frame as tightly as possible, then use a dope of slight shrinkage power, others stretch the fabric less taut and depend on the dope to shrink the fabric taut. Personally I favor an intermediate course especially for this seaplane. The frame construction of this plane was consistently designed so far as practical to eliminate the sewing of the fabrics and the easy attachment thereof.



Stitching pieces of cloth together to form a bag to be used as airplane wing covering

Securing Fabric to Frame

On the main wings the fabric may be tacked to the entering and trailing edges, and along the rear wing bar, where cut out for the ailerons. The aileron stabilizers and elevators are covered and tacked on the trailing edges. The rudder covering is made in the form of a bag and slipped over the frame and tacked to the rudder post and under the part that extends over the stabilizer.

The fuselage and the turtle back cover may be covered with an inferior grade of material and tacked where convenient, then doped, similar to the other surfaces.

Smooth Surfaces Important

The importance of a smooth aerofoil surface is of far greater aero-dynamical importance than most practical men realize. This has been empirically demonstrated by wind tunnel tests made by Zahm, Libbous, and others. The desirable properties of a good wing surface may be summed up as follows: It should be taut, smooth, water- and fireproof with dope adhering well to the fabric.

The fabric should then be well doped, the first coat should be well brushed in especially along the edges and the cap strips. It should be carefully rubbed down with No. 0 sand paper and well dusted. The last coat may be heavier than the others or may be a spar varnish of a grade that is recommended for seaplanes.

The tape or frayed strips should be applied after the third coat. If any patching is necessary the spar varnish must be removed with mineral wool and the doped surface well washed with the proper solvent. The patch is then well doped, two coats or more then applied. The dope will then act as a cement. After the dope has set, varnish may be applied to the patched area to protect it.

ASSEMBLING

When assembling we may divide the airplane in three units, firstly, the fuselage, with or without the motor, usually with the landing gear in position, the tail placed on a wooden horse so that the upper longerons are horizontal (level); secondly, the wings or cellulose in two sections (right and left); thirdly, the empennage or tail surfaces including the elevators and the horizontal stabilizer vertical fin, and the rudder. The rudder and vertical fin are usually left attached to the fuselage when transporting or storing the airplane but they are considered a part of the empennage. The next installment will explain the common method of truing up the fuselage, empennage and cellule.

The horizontal stabilizer is fastened on the longerons by 2 3/16 inch U bolts at the leading edge and braced by two light ½ inch No. 20 gauge steel tubing members from the trailing edge to the stern post and from the entering edge to the longeron.

The vertical fin is then attached to the stern post and to the horizontal strut by 20 gauge steel plates. The rudder and elevators are then hinged. Ordinary 10 penny nails make excellent hinge pins if kept well greased. A 1/16 inch hole must be drilled in one end to lock wire, or cotter pin it securely in position.

In the larger planes the cellule or wings are usually assembled by standing the entering edge of the panels, on pads, fitting the struts in their respective sockets and attaching the wires. In this type it is advisable to sling up the upper wing panel to the ceiling. Then have the lower wing panels on horses or blocks in their relative flying position, that is its proper dihedral and angle of incidence, then fit the struts in their sockets. It will be necessary to note the margin of take-up of the particular size turnbuckle that is used for each size wire as they vary according to size of wire from 1⅜ to 5⅛ inches in the length of barrel and therefore in their adjustment. Now measure the length of the wire cables (the cable is used instead of hard wire for flying and landing wire because it shows broken strands before failure and is therefore more reliable). Allowance must be made for loops and take-up. The stems must be turned in the barrel at least twice their diameter.

Novel Wire Terminals

Figure 6 shows an easily made cable terminal of 20 gauge sheet copper that is bent over a form of drill stock, then soldered. The cable is slipped through the short side, then a piece of wire spring, then returned through the long side and bent over, then placed in a vise and twisted as shown.

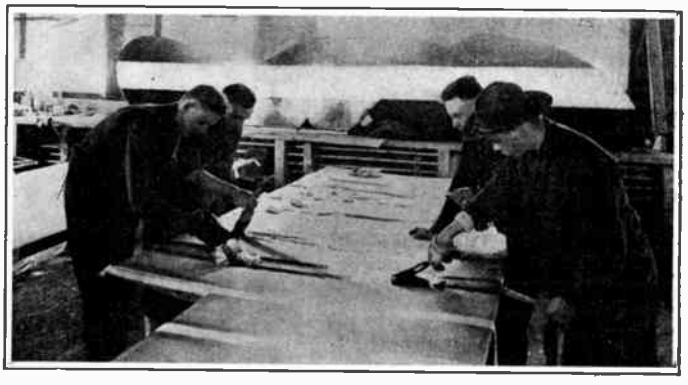
Figure 7 shows the adaption of the bicycle and motorcycle spoke and nipple for a take-up for hard wires. It may do very well for the fuselage tail wires or if cleverly done, the fitting eye bolts may suffice for a take-up.

Figure 8 suggests a possibility for an adjustment for cables. The nut is to take up the slack and also is used for

wedging the soldered cable end firmly. The bronze or brass bushing may be a piece of tubing about 2 inches long threaded for 1½ inches, with sufficiently thick walls to take an 18 to 20 thread. The opposite end may be reamed tapering or expanded to fit a wedge (brass is best for soldering) this is driven into the core of the wire cable, then soldered over the bushing and cable. A hole must be drilled through the nut and clip to lock it in position.

Of course these substitutes are not recommended if the regular turnbuckles are procurable but are suggestions to the ingenious. The stagger wires (some times called incidence wires) are made of cable and sometimes of hard wire. These are the wires that brace the wings in a fore and aft direction. The alignment of the airplane showing several methods of checking up the dihedral and incidence together with some practical flying instructions as taught in the U. S. Army during the war will conclude the series in the next issue.

Doping covered airplane wing frame at left. Large brushes are used to save time



Method of applying doped frayed strips to cover tacks or cord stitching shown above

CONCRETE HOUSES

QUITE a number of methods are employed in the construction of concrete houses. At Brighton, England, an experiment has been carried out with concrete slabs. Briefly, the system known as the "Doric" is as follows: A skeleton framework of lath is put up first, and then, both outside and inside, slabs or panels of a patented composition of weather-proofed cement and asbestos are attached. These slabs form the surfaces of both sides of the wall and between them is poured the concrete, making, when it sets, an unbroken, unjointed wall faced inside and out with asbestos covering. The outside is finished with rough cast. The building will be completed on traditional lines, but the time required for the erection of the shell is only about one-third that required for brickwork, and the cost approximately two-thirds. Concrete, as such, can be made more quickly and cheaply than brick, but it is found in practice that the process of rendering it waterproof makes its ultimate cost greater than that of brickwork. It is claimed for the new method that that extra cost is avoided.

A NATIONAL FUEL FOR FRANCE

ARRANGEMENTS are being made in France for putting on the market what will be known as the national fuel. This will be composed of a mixture of benzole and alcohol. At the present time experiments are being carried out, although it is difficult to understand what new data can be desired, for the Paris General Omnibus Co. used a benzole-alcohol mixture for several years with complete satisfaction, and only abolished it on account of the fluctuations in the price of alcohol. Actually all of the taxicabs and motorbuses in Paris are running on benzole exclusively. This is being imported from England and America. This fuel is adopted because of its lower price and also because the drivers refuse to run on anything else. As is generally known, there is a local tax on all motor fuel brought into the city of Paris; this tax is 20 centimes per litre of petrol and 15 centimes on benzole. As drivers buy their own fuel, they naturally refuse to accept the one bearing the higher tax.

DELIVERING A BUILDING BY TRUCK

THE development of motor truck transportation is shown in the recent delivery at Milwaukee of an all-steel building, 90 x 80 feet. This was made by a Youngstown, Ohio, plant on order of a large automobile manufacturer, and as it was urgently needed motor trucks were used to expedite delivery. The building, in parts, was transported on two large trucks in three days, much faster than would have been possible by freight; besides, two handlings of the material were saved, as it was possible to load the material on the trucks at the plant and unload it at the building site.

FUEL EFFICIENCY OF ENGINES

THE question of fuel economy is of vital interest to the users of cars both because of its affecting, as it does, the pocketbook, and the ability of the car to cover great distances on a moderate load of fuel. A survey of the field by this authority shows that the brake thermal-efficiencies of the various types of engines places the automobile motor in a "fairly satisfactory position". In the class of steam engines, the locomotive stands at the bottom with an average efficiency of 6 per cent, followed by the compound non-condensing engine, 10 per cent, the compound condensing engine, including boiler, 13 per cent and the Parsons turbine, including the boiler, 17 per cent. When we come to the internal combustion engine, there is a decided jump. The automobile motor is credited with 23 per cent, the airplane motor with 27 per cent, the coal gas stationary engine with 30 per cent, and the average Diesel engine with 34 per cent. On reaching that modern development in which the internal combustion and the steam engine are combined, we get for the Still engine an efficiency (actually obtained) of 41 per cent, and Dr. Dawson sets down the probable future efficiency of the Still-Diesel combination at 44.5 per cent.—*Scientific American.*

WHEN GARAGE PLANNING

IN planning the home garage, remember that for a single car the minimum floor space will be 12 ft. by 20 ft., if you purpose doing any work on the vehicle in its shelter. Also these dimensions do not allow room for either a work bench or for storage space; they are simply irreducible minimum for the man who intends to take care of his car.

The cement mills of the United States in 1918 saved from their waste 1,429 tons of potassium oxide. Of course, it was not recovered in this form, but the savings are calculated on the basis of the oxide. The amount recovered in 1917 represented 5 per cent. of the total production of this country.

Adapting Engines to the use of Available Fuels

By J. G. Vincent, M.S.A.E.

PROBABLY the most absorbing topic today in the automotive engineering world is the fuel question. This is as it should be, for it is essential that we design engines which will utilize not only the fuel that is being sold today but also the fuel which will be on the market two or more years hence. It is time that we devise some system which will insure the realization of the entire useful life of the cars we are designing today, rather than have them discarded or run under adverse conditions when the quality of the fuel deteriorates. The petroleum resources of the country are already taxed to the limit to supply sufficient gasoline for the cars now in use, and the only apparent way in which this fuel supply can be materially increased is by utilizing some of the heavier fractions which at the present time are not considered fit for automotive use.

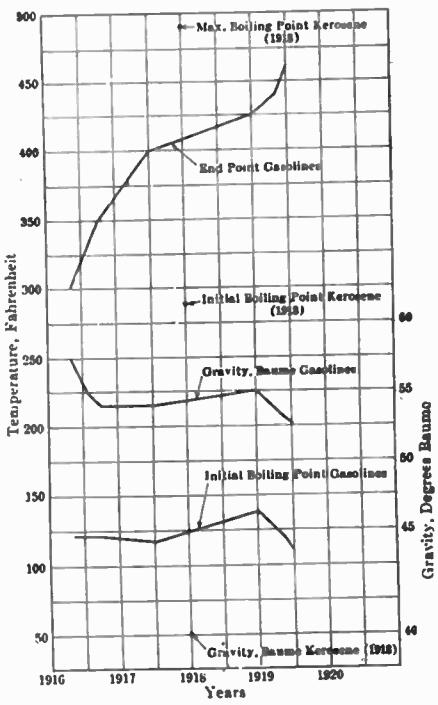
The accompanying curves are intended to bring out some of the salient facts in regard to the character of the fuel marketed in the past few years. Only three characteristics which are of special interest have therefore been plotted, although many additional considerations are to be borne in mind. It will be noted that the end-point of the average gasoline has been rapidly ascending in the last four years and is now but little less than the end-point of the kerosene of today. The gravity, Baumé, readings are slowly descending but the initial boiling point has not undergone much change. As long as this latter condition holds we shall not have much trouble in starting engines in cold weather.

Meeting the Fuel Problem

Let us now examine various methods of meeting the fuel problem. There was a time when we pointed with pride to the frost on a bare aluminum intake header, considering this a very desirable symptom indicating perfect vaporization. This applied when we were dealing with fuels of about 80°, Baumé, which vaporized under the conditions obtaining in the manifold at ordinary temperatures. The low temperatures produced by this vaporization increased the volumetric efficiency of engines very materially and cold headers were therefore looked on with favor. Thus we have repeatedly demonstrated on Liberty engines that 500 h.p. or more can be developed by one of these engines, which normally will give about 420 h.p., by using high-test gasoline and getting the mixture into the cylinders cold enough. But nowadays we are dealing with fuels which refuse to vaporize at ordinary temperatures in the

The paper from which the accompanying article is condensed was presented at the annual meeting of the Society of Automotive Engineers. Col. Vincent is one of the designers of the Liberty motor and Vice-President in charge of engineering of the Packard Motor Car Co. of Detroit, Mich., so his description of a new vaporizing device should be of interest to our readers following internal combustion or automotive engineering progress.

header. In the course of some experiments with glass manifolds I found that when using 56° Baumé gasoline it is necessary to put the mixture into the cylinders at about 180° Fahr. to secure a perfectly dry mixture. Of course, this is going to the extreme, and for all practical purposes the mixture



can be somewhat wet and yet the engine will function properly. We will therefore assume that a mixture temperature of 120° Fahr. is the minimum to be used.

I would like to state some of the reasons why the mixture should be introduced in as dry a condition as possible. From the standpoint of the driver the item first in importance is that of spark-plug fouling.

Second in importance to the driver is the question of performance with a cold engine. During the past few years we have used thermostats, water-jacketed headers, hot-spots and heated air intakes. All these, of course, help the situation somewhat, but I believe that with the fuel getting worse more rapidly than the engine is improving the winter operation of cars is becoming less satisfactory each year.

The third item in order of importance, insofar as the owner is concerned, is the contamination of the lubricating oil by fuel which passes the pistons. This is a serious problem, for few owners will go to the trouble of draining off the oil at comparatively short intervals in winter. In consequence the lubricating system soon becomes filled with a mixture of fuel and oil of little or no lubricating value.

There are many minor questions involved when we try to distribute and burn a wet mixture. Many have tried numerous types of intake headers to find which insures the nearest approach to equally proportioning the air and gasoline to each of the various cylinders. We are often using gas velocities in the intake header exceeding 100 m.p.h. and it is therefore to be expected that the liquid gasoline will separate from the air stream, due to its greater inertia. Of course, when the gasoline is turned into a dry gas it behaves just like air and takes the turns nicely along with the air. The failure to obtain prompt response when opening the throttle quickly when using a wet mixture is also undoubtedly due to the fact that the air will accelerate more quickly than the liquid gasoline particles, with the result that the engine either "lies down" or spits back. When a dry mixture is used we can step on the throttle and get instant response. The more finely divided the gasoline, the better the engine responds.

Securing a Dry Fuel Mixture

I take it that we are now all agreed that a dry mixture is desired. There remain to be examined the various methods of obtaining this result. The commonest one now employed is to utilize some of the heat contained in the exhaust gases, and since there is expelled in the exhaust from 20 to 40 per cent. of the heat units contained in

the original gasoline, depending upon the engine speed and other considerations, it would appear that this is the most practical and economical way to obtain the result. Theoretically it undoubtedly is, but practically, in some cases, the method presents serious objections. If we assume that the intake and exhaust manifolds are in some manner constructed integrally, it is obvious that the temperature of the intake walls will vary in proportion to that of the exhaust walls. This, of course, means that at high speed and under heavy load the walls will be very much hotter than at low speeds and light loads. It is therefore obvious that if the intake header is sufficiently hot to do the job at low speeds and light loads, it will be altogether too hot at high speeds and heavy loads to obtain the maximum volumetric efficiency of the engine. Of course, there are many cases where a high volumetric efficiency under heavy loads or at high speeds is not essential, so that this solution gives pretty fair results. We are all, however, striving to get the most power possible out of the least engine, and it certainly hurts to cut 10 or 20 per cent off the maximum output of the engine to insure a dry mixture at low throttle and light loads.

Then again there are various compromise schemes most of which are based on the theory that it is possible to locate a very hot spot at such a point that the heavy particles of the fuel will be thrown against this surface and vaporized, whereas the air and the lighter particles will be diverted from the hot-spot by the particular design of the header. This would be fine if it were possible to get the hot-spot hot enough under low throttle conditions. It is undoubtedly a good compromise scheme and does not detract from the volumetric efficiency of the engine to the extent that the regular exhaust-jacketed job does.

Another Solution of the Problem

It was these various considerations that led me to look elsewhere for a solution of the problem. It appeared desirable to evolve some simple inherently automatic method of supplying the heat, not possessing any of the disadvantages cited above. It was shown that about 4,574 B.t.u. per hr. would represent an average requirement. Assuming that there are 19,000 B.t.u. in 1 lb. of gasoline, it will be seen that we could secure the necessary heat from the complete combustion of 0.24 lb. of gasoline per hr., providing we could attain a 100 per cent heat transfer. We do not, of course, obtain 100 per cent efficiency with the scheme I am going to describe, but I believe that from a thermal standpoint you will agree that it is a very efficient arrangement or one representing but very small heat losses. The principle of this device is to take advantage of the difference in pressure existing on either side of the carbureter butterfly-valve and cause a small amount of the combustible mixture to pass through a passage which is in parallel with the main carbureter passage, burn this mixture in a suitable burner and then allow the burnt gases to mix with the incoming main supply to the engine above the throttle. It was evident immediately that this general scheme would be at its maximum efficiency under low throttle and light load conditions; an intense heat is generated very promptly under these conditions, which are obtained when starting up and idling. On the other hand, under wide-open throttle conditions, when we wish to maintain the volumetric efficiency of the engine as high as possible, but very little mixture passes through this "shunt" passage and a negligible amount of heat is produced in the burner. Of course, the reason that the mixture needs to be heated for wide-open throttle conditions is that combustion is largely assisted by the increased turbulence, increased compression pressures and naturally higher jacket-water temperature.

There are four main units which combine to give the desired result. They are briefly as follows:

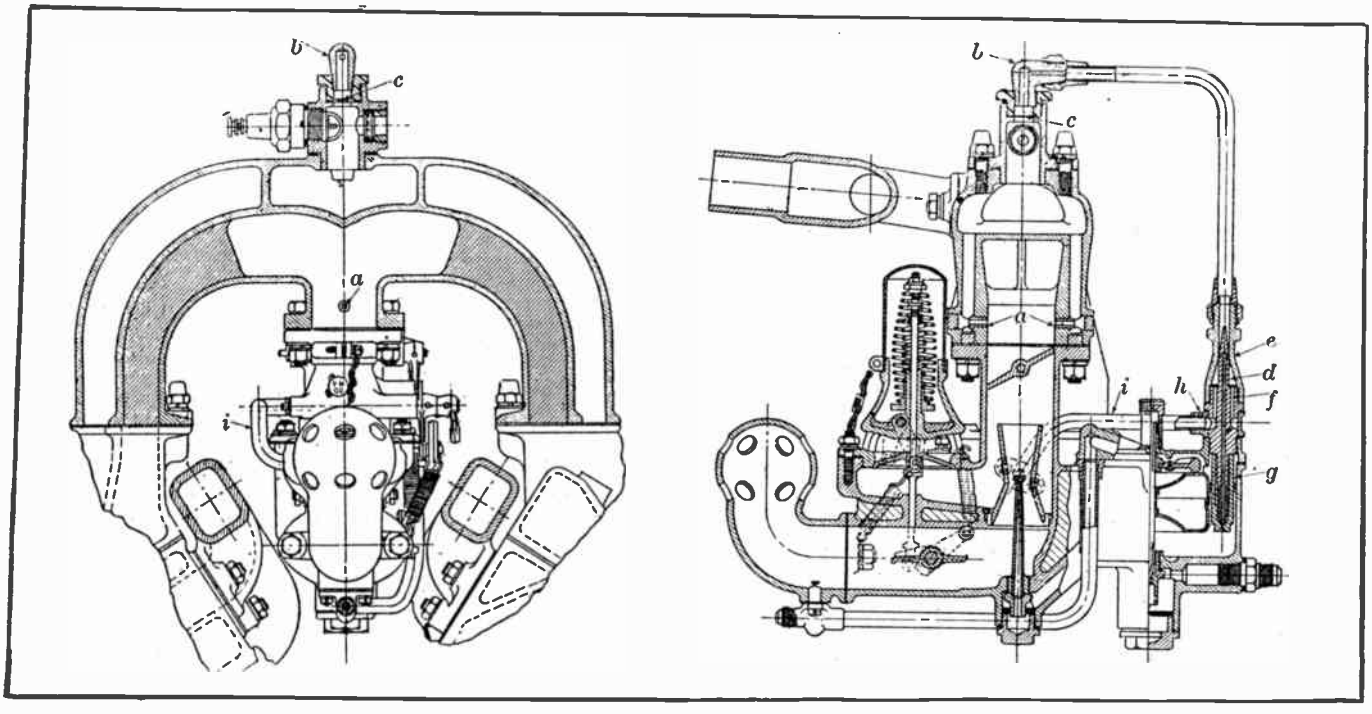
(1) A special inlet manifold which has a water-jacket as well as a combustion jacket.

(2) A burner which is attached to the combustion jacket.

(3) A vaporizer or miniature carbureter which is used to furnish the mixture for the burner.

(4) An auxiliary ignition breaker and coil which is used to furnish the spark for the burner spark-plug.

The manifold as shown on the accompanying drawing is of the conventional construction except for the additional jacket used for the hot gas which communicates with the main intake passage through the two hollow "suction" plugs shown at *a*. The burnt gas joins the main mixture after coming through these holes and the proportions are such that at no time does the burnt gas come into contact with the new mixture at a sufficiently high temperature to pre-ignite the mixture.



Sectional views showing construction of new vaporizing device to handle low volatility fuel in cold weather

The burner body is fastened to the manifold by the two-bolt flange shown, and in the burner body there is formed a combustion chamber into which a spark-plug fitted with a wide gap is inserted, as well as an observation window of heat-resisting glass which permits the action of the burner to be observed at all times. The mixture from the vaporizer is supplied by a ⅜-in. copper pipe and enters the combustion chamber after passing through a calibrated hole in the elbow shown at *b* on top of the burner and a screen *c*. The purpose of the latter is to assist in the atomization and even distribution of the incoming mixture. The mixture is supplied by the vaporizer shown at *d*, which is composed of four main parts, the choke *e*, the jet *f*, the jet sleeve *g* and the air intake *h*. This vaporizer is intended to function as a carbureter through a limited range of depressions. It is constructed on the general principles embodied in several different types of plain-tube carbureters and relies on the fact that a submerged jet exposed to atmospheric pressure will feed a fixed quantity of fuel, and that by suitable control of the depression over this jet the flow of fuel can be accelerated in just the degree required for an increasing suction and supply of air. Accordingly the level of gasoline in the sleeve *g* rises and falls as the suction in the venturi *e* decreases or increases. Control of the mixture supplied by this miniature carbureter to meet various temperature changes and starting conditions is attained by the simple means of coupling the air intake *h* to a pipe *i* which takes its air from the auxiliary air supply of the carbureter, as shown.

In connection with the air-valve type of carbureter around which this device has been designed there is a dash adjustment that permits the driver to control the depression existing in the auxiliary air supply passage so that when starting out on a cold day both the main and the auxiliary carbureters can be made to supply a richer mixture simultaneously by means of the dash adjustment.

The high-tension current for the burner spark-plug is supplied by an independent ignition coil, the primary circuit of which is wired in parallel with the regular ignition circuit; the extra coil is controlled by a separate contact-breaker. The latter is operated by the same cam as the regular engine ignition contact-breaker. It will thus be seen that the burner spark-plug is operating whenever the engine ignition is operating, and in the case of the twelve-cylinder engine there are three sparks in the burner per revolution of the engine. I have not found it advisable to cut off this spark or control it in any way, since except for the small amount of current used by the extra coil there appears to be no disadvantage in allowing it to operate continuously.

How the Device Operates

In actual operation, when the engine is idling, combustion takes place in the burner silently and continuously and a bluish-green flame completely fills the combustion chamber. This flame diminishes in intensity as the throttle is opened and the depression in the main intake header is thereby decreased, the general result being that for ordinary driving conditions up to 25 m.p.h. a mixture temperature of 150° to 180° Fahr. is maintained, giving perfect distribution, excellent acceleration, absence of spark-plug fouling and elimination of dilution of the lubricant in the crankcase. At higher speeds and wider throttle opening the influence of the combustion heater gradually decreases until at wide-open throttle it is practically out of action, which is exactly the condition desired. This combination has permitted the running of a twelve-cylinder engine on kerosene at moderate driving speeds with practically the same results as when using gasoline, but when using kerosene there are critical temperatures below which we cannot go without considerable spark knock. The problem of burning kerosene is, of course, something that we do not yet face, but the design of this heater can be modified to permit any shape of temperature-load curve desired. The combustion heater as at present constructed does not permit us to start on kerosene, but simple modifications would permit this to be accomplished.

One question that naturally arises is: What effect has the combustion heater on gasoline economy? I have conducted a great many experiments in an endeavor to answer this question. A series of tests was made on the dynamometer, the results of which are shown in the accompanying table. In these tests the gasoline consumption of the engine and of the burner were measured separately. It will be noted that the consumption of the burner, when idling, was 0.066 gal. per hr. This is slightly over ½ pint per hr. It will also be noted that under average driving conditions the engine fitted with a combustion heater may consume approximately 3 per cent. more than one without the heater, but it is possible to save a considerable amount of gasoline under such driving conditions as call for frequent accelerating, owing to the improved performance obtained with a dry mixture. In cold weather and even in hot weather it is possible to run with a much leaner mixture when the mixture is dry, and this will more than offset the slight amount of gasoline which the burner uses. I believe that taking an average over city and country mileage there will be little, if any, difference in the matter of gasoline consumption in moderate weather between a car fitted with a combustion heater and one not so equipped, but that there will be a noteworthy saving in cold weather.

Gasoline Consumption of a 3 by 5-inch Twelve-Cylinder Engine Using Combustion Heater

Engine Speed, r.p.m.	Equivalent Car Speed, m.p.h.	Brake Horsepower	Gas Consumption, Gal. per hr.		Burner Consumption	Engine Consumption	Temperature of Manifold, deg. fahr.
			Engine	Burner			
350	Idle	.....	1.02	0.066	0.064		218
400*	9.5	2.33	1.32	0.054	0.041		210
800*	19.1	5.07	1.80	0.054	0.030		200
1,200*	28.6	10.00	2.40	0.066	0.027		187
1,600*	38.2	16.53	3.30	0.114	0.035		156
1,600	38.2	32.00	4.27	0.102	0.024		150
1,600	38.2	63.00	7.20	0.060	0.008		146

*Assumed average driving conditions.

In conclusion, I would say that it has been demonstrated that, in addition to its other advantages, this device will appeal to both the careless driver who omits to change the engine oil frequently in winter and the careful driver who has hitherto taken this necessary precaution. In the first case it will serve to prevent damage to the engine, which is the result of the poor lubricating qualities of a mixture of fuel and oil, and in the second case it will materially reduce cost of operation.

GROWTH OF GERMAN AIR FORCE

DURING a recent celebration in Berlin to commemorate the death of Boelke, the great German airman and leading ace of their air service, the Aero Club of Berlin published some interesting figures showing the growth of the air forces in Germany during the world war. The figures are very interesting and show how the air service developed during the four years in an effort to keep up with the ever growing allied aerial forces. They go to show, also, how hopeless Germany's efforts to dominate the air were after the aircraft production abilities of America were organized.

	Aug. 1914	*Nov.* 1918
Machines (fighting, bombing, scouting)	246	4,050
Escadrilles for defending interior	18	108
Pilots at the front.....	500	5,000
Personnel in the interior..	500	80,000
Monthly consumption of fuel in litres.....	600,000	7,000,000
Machines fitted with cameras	100	2,000

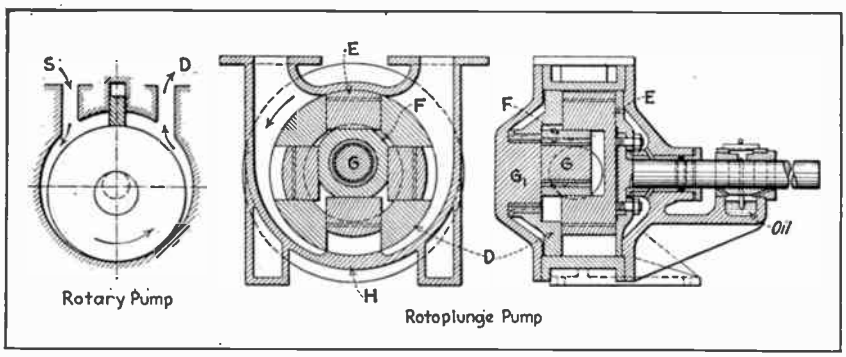
The above figures do not count the airplanes used in training pilots in the large aviation schools maintained for that purpose and it is reasonable to assume that at least 2,000 planes were used for that purpose.

ROTARY PUMPS

CONSIDERABLE attention is being given to rotary pumps; modern machinery methods, surface grinding and the like have resulted in the production of higher efficiency in this class of appliances, by the reduction of the back-leakage. Especially does this apply to air pumps or blowers. We illustrate in the cuts two systems of construction of interest, which are of English origin.

The first one, Fig. 1, is the Avonmore pump. This is simplicity itself in design. A cylindrical casing contains a smaller cylinder, which latter, in the operation of the pump, is caused to roll around the inner periphery of the larger containing cylinder. This rolling action is the all essential feature. It will be seen that in this rolling motion a different element of the inner cylinder will be in contact with the outer one as the rolling motion goes on. In the cut the arrow indicates the direction of motion. The inner cylinder at the moment rests on the bottom of the outer cylinder, but as the motion continues it will touch more and more to the right, in each rotation touching successively all parts of the outer one in regular succession. Immediately above the center of the structure is a sliding diaphragm, which rests upon the inner rotating or rather rolling cylinder, rising and falling in its recessed seat. This divides the inner space into two parts; the space on the right communicates with the outlet, the space on the left with the intake. The diaphragm cuts off these divisions, absolutely, one from the other. If now the motion of the rolling cylinder be pictured, it will be seen that the water on the outlet side as the cylinder rolls on will be squeezed out through the outlet pipe; at the same time water will be drawn in through the intake; the latter will in turn be forced out, and other water will be drawn in. This goes on as long as the rolling motion is maintained.

The cuts, Figs. 2 and 3, show a four-cylinder rotary pump, the Rotoplunge. A cylindrical driving member, D, is bored for four pistons. It rotates eccentrically in a casing. A separating diaphragm, H, in constant contact with the rotating cylinder, D, at the top and bottom of the casing, divides the space between the casing and rotating cylinder into two divisions. As the cylinder, D, turns, it carries with it the four pistons, E, and a fixed eccentric, G, moves the pistons radially in and out. As they pass the line of the diaphragm, H, the lower one is at its extreme inward stroke, and the upper one is at its extreme outward stroke. The other two have intermediate positions, the one on the right moving outward, the one on the left moving inward. Thus suction takes place on one side of the diaphragm and delivery on the other side. There are no valves and no complication. The pistons in their reciprocations force the water out of the right hand compartment and draw it into the left hand one.



Figs. 1, 2, 3—Rotary pump designs. That at left is the Avonmore, the other sections show the Rotoplunge form.

Both pumps present the feature of division into two compartments, a suction and a delivery division appearing in both. One feature of the rolling motion utilized in the first described pump, is that solid objects, if not too large, can be carried through it. A wire nail passes without difficulty.

MARKING FLUID FOR BLUE-PRINTS

THE following recipe for marking fluid for blue-prints has given me satisfaction. The fluid is composed of potassium oxalate, 1 ounce; gum arabic, 1 dram (60 grains); water, 6 ounces; cobalt-blue to color.

Italy has started working the iron mines on the island of Elba, Napoleon's transitory home. The expense is increasing as they are carried under the sea. Iron has also been found near the French frontier, and electric reduction furnaces have been started there. Coal is still a desideratum in Italy, and the iron deposits are of relatively small extent.

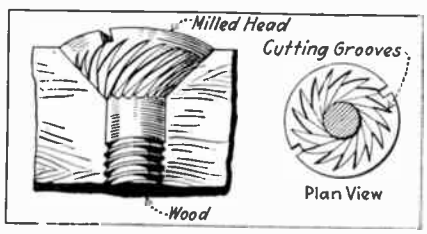
Under the sanitary laws and regulations for the prevention of phthisis in Africa, the Transvaal mines have to be washed down with streams of water to suppress dust. The water is found to carry gold, which is taken out and saved, so that not only is a revenue obtained, but a suggestion is given to do the same in other mines to save gold, which otherwise would be lost.

COAL RICH IN OIL

FOR many years lignite mined near Ione, California, has been used as fuel, though it contains a large quantity of moisture and therefore does not burn very well. Recently, however, on account of its resemblance to some oil shales that are apparently similar to cannel coals, this lignite has been tested by the United States Geological Survey. Department of the Interior, to determine whether it would not yield oil on destructive distillation. The results of the tests show that the best of the lignite, when destructively distilled, will yield 62 gallons of oil to the ton and, as a by-product, at least 18 pounds of ammonium sulphate, which is a valuable fertilizer. This lignite is remarkably "fat". Although it contains 46 per cent of moisture, analysis made by the Bureau of Mines shows that it contains also 31 per cent of volatile matter and 16 per cent of fixed carbon. The ash amounts to only 7 per cent, and the heating value is 6,060 British thermal units. Although the bed containing this lignite does not appear to underlie a large territory, it is doubtless destined to receive attention sooner or later as a possible source of oil and gasoline.

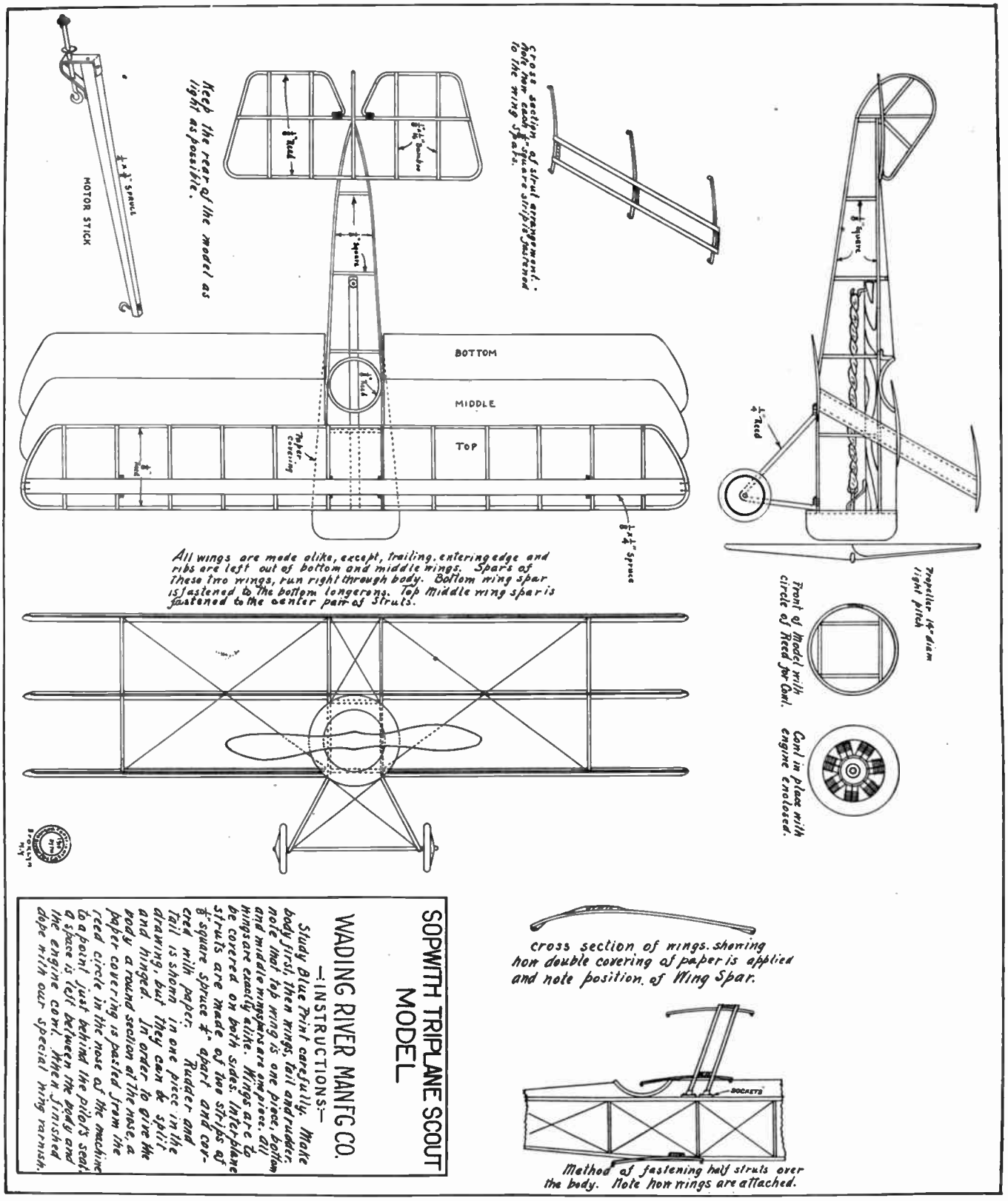
A SELF-COUNTERSINKING WOODSCREW HEAD

THERE is always a certain amount of extra work that goes with the use of flat-head woodscrews; for, as is obvious and well known, every hole has to be countersunk, to accommodate the head if the screw is of any size. It has remained for an American inventor to patent a uniquely designed woodscrew which countersinks itself. As will be noted in the accompanying illustration, this screw is made with a series of ribs or cutting teeth on the lower side, so that as the screw is driven into the wood these cutting teeth remove sufficient material to seat the head properly.



Woodscrew with countersinking head

Broken taps of large enough size can be often removed from the holes in which they are held by the use of the arc welder. The arc is directed on the top of the tap, not on the side of the hole, and little by little metal is melted on the broken tap until the surface is reached. Then a nut is welded on by the arc and when the whole has cooled off the tap can generally be backed out. It is important not to let the arc touch the side of the hole; it should be concentrated on the tap.



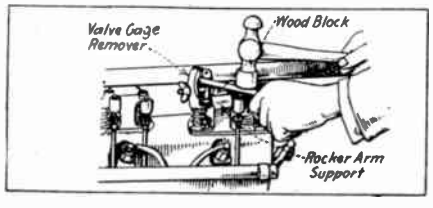
SOPWITH TRIPLANE DETAILS

THE full size Sopwith triplane is a single seat scout plane powered with either a 110 H. P. or 130 H. P. Clerget motor and is very fast. The span of all wings is the same, or 26 feet 6 inches, and the chord of all supporting surfaces is 3 feet 3 inches. The incidence of all planes is 2 degrees. The amount of stagger of the intermediate main planes is 18 inches and the total stagger, measured by dropping a plumb line from the leading edge of the top plane and measuring from the line to the leading edge of the bottom plane with machine in normal flying position is 36 inches. All planes are given a dihedral angle of 2½ degrees. The overall length is about 20 feet, the overall height is 10 feet 6 inches. The tail plane is given an incidence, when in normal position of 1½ degrees. The wheel track is 5 feet 6 inches. Ailerons are fitted to all three sets of wings. The model shown in accompanying drawings is not a difficult type to build and is a very pretty model when completed. No detail dimensions are given as the model maker can make his machine any proportionate size of the full size machine he desires. The material sizes specified in the drawing apply to a 3-foot model, which is about ⅛ the size of a large machine.

EVERYDAY MOTORIST

VALVE CAGE REMOVER

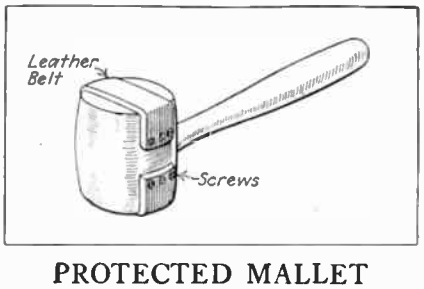
IN engines using overhead valves set in cages, such as the Buick, it is not always an easy matter to remove the valve cage, especially if it has not been taken out of the engine for some time. As it is necessary to remove the valve and cage unit to grind the valves to a



new seating, a simple clamp member which will grip the valve spring and collar at the end of the valve stem, as illustrated, is of value. A block of wood is placed between the rocker arm bearing pin supporting casting and a small pry bar used as indicated will remove the cage without damaging it or the valve.

WATER ON FORD COMMUTATOR COVER

BEWARE of water on commutator cover. It can get there from a leaky radiator, or it can get there when you are hosing the van when washing it. Water at that point can throw your firing all out of timing, so that when you next turn the starting handle you will get a backfire of the worst sort. One of the most juzzling cases of hard starting combined with backfiring arose in my own experience from this very cause. The reason is, of course, that the low-tension current gets conducted by the water to the wrong terminal on the commutator cover, so that the wrong cylinder fires—and it necessarily fires at the wrong time—before its piston gets anywhere near the top of its travel. The piston is thus driven hard back—against your cranking.

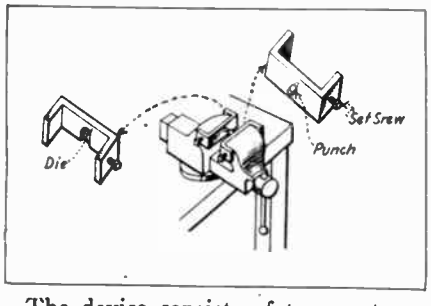


PROTECTED MALLET

IN straightening sheet metal parts or driving out threaded pieces a heavy, tempered blow is required. That struck by a wooden mallet has the right quality, but is liable to injure the finish because of the hard wood used for the ordinary mallet head. By attaching a thick piece of leather or felt over the head of the mallet, the force of the blow is softened and finished parts may be removed without injury. If the protecting material is attached by screws it may be taken off when it is desired to use the mallet in the usual manner.

PUNCH FOR USE IN VISE

THERE is a use in many small shops for a sheet metal punch for small size holes, and any handy garage men can make their own sheet metal punch in a short while from scrap ends of steel bars.

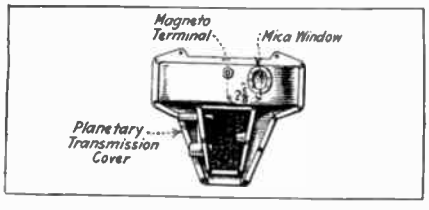


The device consists of two parts, as shown. Both of these are made from ¾ x 2-inch stock bent U shape to fit the vise jaws, and each piece is provided with a set screw to clamp it to the jaw. The die hole is drilled in one part and a slot cut on the back for the punched metal to drop through. The other part has a punch in it as indicated set in the center. The punch is of hardened steel and has a shoulder to hold it in place. The die hole is hardened and the device will punch holes in 3/16 sheet stock very easily with the aid of the vise screw.

Small size punches and bushings can be made to go as attachments for punching various sizes of holes as required.

INSPECTION WINDOW OF MICA

A MOTORIST had trouble because of stoppage of the oil tube which runs from the transmission case of the Ford engine to the front for conveying the oil, and devised the scheme shown in the accompanying illustration for making a quick inspection. A small inspection window two inches in diameter was inserted in the transmission case as shown. This window is made 3 inches in diameter, but as it is held in place by a steel ring 1/32 inch thick and about ½ inch wide, the effective opening of the window is but two inches. The ring is secured by 10/32 round-head screws. A felt or shellacked cardboard gasket is placed between the mica and the transmission cover, and the upper side of the mica is spread with shellac when it comes in contact with the retaining ring.

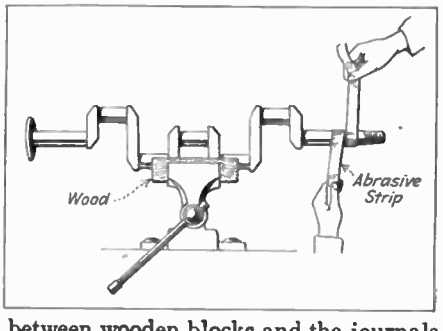


WRAP UP GOOD TOOLS

IT is an admirable idea to wrap good tools such as polished pliers, wrenches, etc., in oiled cloths before storing them away in the tool compartment, as the oiled cloths prevent them from becoming rusty or marred, which is quite likely to happen if the brightly finished surfaces are exposed any length of time. Files should be wrapped to protect the cutting teeth, for if they are allowed to rattle around they not only injure other tools but are injured themselves. Polished tools should never be carried in a tool compartment adjacent to a storage battery because the acid fumes will cause rusting of the polished surfaces.

TRUING CRANKSHAFT

THE method of holding a crankshaft when it is desired to true the crank-pin journal shown is a very practical one and is followed by a number of mechanics when overhauling an engine. The journals are often not sufficiently scored or roughed up to warrant dressing them down in a lathe so the crankshaft may be securely clamped in a vise

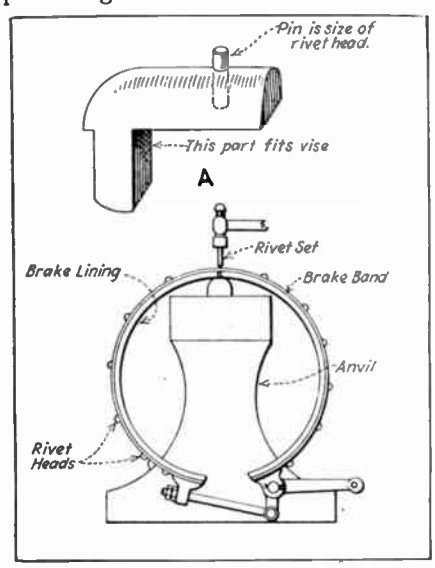


between wooden blocks and the journals dressed down with strips of emery cloth or with a leather belt or strap covered with oil and abrasive material, this be-

ing given one turn around the crank-pin and pulled up and down and back and forth to produce the requisite smoothness.

REPLACING BRAKE LINING

IF the brake lining is worn it should be removed by chipping off the rivets and driving them out of the hole in the brake band. A piece of new lining is cut to the proper length and holes are drilled through it to coincide with those in the brake bands. The best method is to drill only two holes at a time and fit the lining carefully to one end of the brake band, then drilling in the next two rivet holes and after the lining is securely fastened in place to go on to the next rivets. It is



important to use copper rivets having reasonably large heads that will not pull through the material and to countersink the material enough so the rivet heads will be firmly embedded below the surface so as not to come in contact with the brake drums. Some cases of slipping brakes have been traced to projecting rivet heads which did not permit the friction lining to come into contact with the brake drums.

A simple fitting which can be placed in an ordinary bench vise for riveting against is an ordinary steel drift having a flat point of the same size as the rivet head. The fitting shown at A in accompanying illustration may be placed in a common vise or may be formed to fit the pritchell hole in an anvil. This piece may be made of mild steel, though the punch H which is the same size as the rivet head can be made of tool steel. The body of the tool is flattened out on the under side where it rests on the anvil or bench vise top and is left oval on the top. A ⅜-inch hole is drilled in the top and tool steel punches of the form shown at H may be driven in place, some arrangement being made by which the punch may be driven out and replaced by a new one if it becomes broken or by one of smaller size if different rivets are used. A hammer and an ordinary rivet set are used to set the rivets as shown in the lower portion of the illustration. Copper rivets are easily headed up and neat heads may be formed without trouble. Never use iron or steel rivets for holding brake linings in place as projecting heads may wear grooves in the brake drums. The only remedy for grooved brake drums or members that have worn thin is replacement with new ones.

DRAIN OUT AUTO ENGINE BASE OFTEN

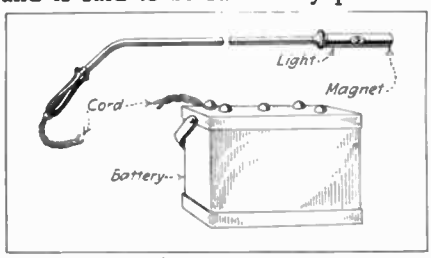
A CAMPAIGN to call attention to the necessity of changing oil in motors every so many hundred miles is being advocated. It is pointed out that there is so much kerosene in gasoline today that it has a tendency to run down past the pistons, get into the lubricating oil and thin it. The kerosene cuts the thin film of oil on the wearing surfaces of the pistons, piston rings and cylinder walls. With the film of oil on the wearing parts of the motor broken, friction, the bugbear of motor efficiency, starts in. The pistons work up and down through broken films of oil in a lubricating substance that has lost considerable of its richness and thickness.

There is little chance of changing the quality of the gasoline. Therefore, to prolong the life of the motor the only thing to do is to change the lubricating oil frequently, possibly every 500 to 1,000 miles. An experiment is instanced as proof that it is the non-lubricating qualities of the oil that damages motors.

A motor was brought into a shop with almost .015 inches wear. The motor was ground to .020 inches oversize, fitted with new pistons, put on the block and filled with good, clean oil. The motor was then run continuously for 60 hours and during this time the oil was changed three times. When the motor was taken down it showed no wear. The motor was again put together, oil was taken from an old motor truck and the motor put through the same 60-hour test without any change of oil. It showed .005 inch wear, indicating that it is the non-lubricating qualities of the oil resulting from the kerosene working past the pistons and mixing with it that causes the deterioration of motors.

ILLUMINATED MAGNET

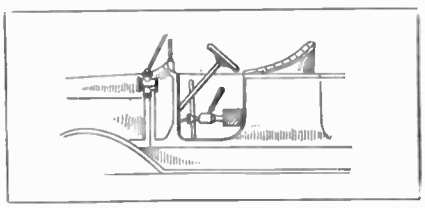
AN electric searchlight and electromagnet should prove a useful tool in the private garage and the repair shop. It consists of a handle on one end of which the magnet is placed while below the latter is an electric bulb which sends light through two windows as shown in accompanying illustration. A flexible cord passes through the instrument and is attached to a storage battery of the usual six-volt type or to dry cells. The magnet is utilized to pick up nuts, bolts or pieces of metal that may drop into the crankcase or other places not easily reached by hand, and is said to be sufficiently powerful



to attract a good-sized wrench. The light facilitates finding the parts, may be used to ascertain the amount of gasoline in the fuel tank or lubricant in the crankcase and to inspect other places. In addition to being handy in the garage it could be included in the tool equipment of a car and used in connection with roadside repairs. As most of the nuts and bolts are of magnetic material, the device will be very useful in many ways.

ADJUSTING BRAKES

AUTOMOBILE owners often neglect the adjustment of foot brakes because it usually takes two men to adjust the brakes successfully. One applies the pedal and sits in the seat



while the other turns the wheels to insure even braking power after they are jacked up. One man may adjust the brakes by using a jack, as shown in the illustration. The jack with a plank back of it, to protect the heel board, is placed between the seat and the brake pedal. The jack is applied to bring any pressure needed on the brake pedal, and the proper adjustments can then be made to make sure that the brake bands will be in contact with the drums at all points on the drum circumference.

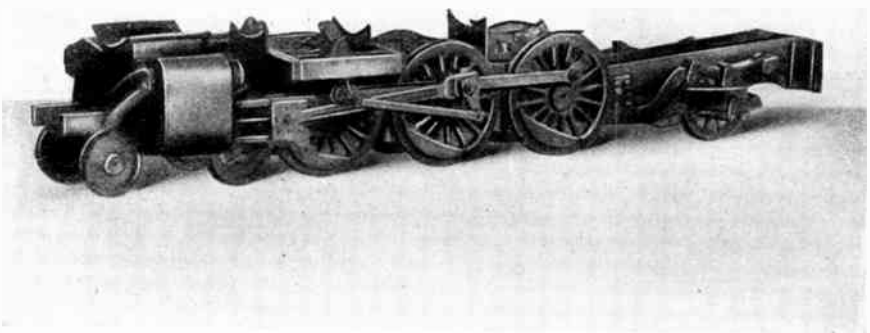
GREASE ON BRAKES

A FAULTY condition that is the result of warm weather is the leakage of grease from rear axle interiors and the attendent excessive deposits of that material on the brake drums, especially on the inner periphery against which the emergency or internal brake bands act. This reduces braking efficiency to a considerable degree and wherever such deposits are found, they should be removed by cleaning the parts thoroughly with gasoline, even if this should necessitate removing the wheels to gain access to the brake drum interior. The leakage is usually caused by the thinning out of the grease.

An Electrically Operated Model Locomotive

By Frank S. Collins

IN planning the construction of the model locomotive described in this article, the writer was confronted at the outset by the great difficulty of obtaining small castings, under wartime conditions. It was decided therefore, to dispense with castings as far as possible and with the exception of the driving wheels, none has been used in what may be termed the "chassis" of the locomotive. This condition involves a great deal more work than would be necessary were castings obtainable, but the results, in the writer's opinion, fully justify the additional time and labor. Small parts made from steel bar or plate are clean, strong and of good appearance, whereas iron castings of the small cross-section and often complicated design required for this class of work, would be expensive to



The finished chassis of the locomotive

mold, would almost inevitably be chilled, and impossible to produce cleanly unless die-cast. Die-casting, of course, would be out of the question unless large numbers were required.

The frames of the locomotive, which is on a scale of ½ in. = 1 ft., are sawed from flat cold-rolled steel bar, the annular spaces being drilled out and filed to finish. The cross frames or bracings which also form the boiler saddles, the guide bars, hangers, spring rigging, etc., are all cut from steel plate or bar.

In making these parts, the writer uses the following plan: A tracing of the piece required is made upon vellum, from the drawing, the tracing then being cut out to form a template and fastened to the steel plate with a little shellac. The piece is then sawn out to the form of the template, and centers of holes, etc., punched as located on the template. This is a great improvement upon the method of marking out with a scriber direct upon the plate, as the contrast of the India ink into lines upon the white paper template to the usual easily blurred scratches upon the steel, has to be experienced to be appreciated. Particular attention has been given to the spring rigging of the model, for apart from the matter of appearance, the locomotive ability to keep the track depends almost entirely upon all wheels being properly hung. In this particular case, the arrangement used in the prototype has been faithfully followed. The fixed suspension points are located at the front of the leading drivers and at the rear of the trailing wheels, all vertical motion between these points being transmitted through the rocking arms by which the springs are connected end to end, while a cross-compensator is supplied at the rear of the last two driving wheels in order to balance unequal stresses on either side of the locomotive.

This arrangement is of particular value in damping out any rocking motion which might otherwise reach dangerous proportions. The springs themselves are built up of clock spring steel arranged in laminæ, making a good practical spring as well as being a faithful reproduction of the prototype.

The cylinders and valve chests, which in an electrically operated model are naturally on the order of camouflage, are built up of steel plates. The coupling and connecting rods are cut from 5/32 in. steel bar, the connecting rods having split brasses with wedge adjustment.

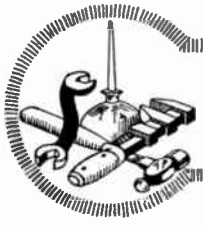
The trailing truck frame is made from ½ in. angle iron, trimmed down to size as required and bent hot. The driving wheels are, as previously stated, the only castings used, the leading and trailing wheels being turned from the bar. All wheels except trailers are pressed on to the axles and secured by a threaded circular key. The pattern for the driving wheels was made from hard rubber fibre, and the writer would take this opportunity to urge the superiority of this material over wood for such purposes. Wooden patterns for this order of work frequently give trouble by warping, splitting and cracking, especially when, as in this instance, spokes have to be cut across the grain. Hard rubber has no grain, and is equally strong in practically any direction. It is tough and will stand very hard treatment. It is readily worked with either machine or hand tools designed for use with metal. It can be threaded with tap, die or in the lathe and takes a clean, sound thread. A pattern once made from this material, however light and apparently fragile, can be used almost indefinitely. The engine will be driven by a series-wound direct current motor, designed to fit inside the boiler shell, which experience has shown to be the best possible arrangement for small locomotives. The motor field will be a cylindrical casting with its axis horizontal, while the armature will be vertical and connected through a suitable machine-cut reduction gear to one driving axle. The coupling rods will transmit the torque to the four remaining driving wheels, and thus the adhesion of all six will be available as in the prototype. In addition, the driving wheels carry practically the entire weight of the motor, which is considerable, and the adhesion is thus increased again. A special device will be provided and located in the tender, by means of which it is practicable to reverse either a series, shunt or compound motor by merely reversing the polarity of the third and return rails. This greatly adds to the realistic effect of these models, as all their movements can be controlled without the operator approaching the track.

The writer makes no apology for presenting the description of this model while in an incomplete state, his personal experience having been that it is during construction that such work is of most interest to model builders.

Blue Print Paper

A BLUE print paper which gives good results, and is not difficult to make, is prepared in this manner:

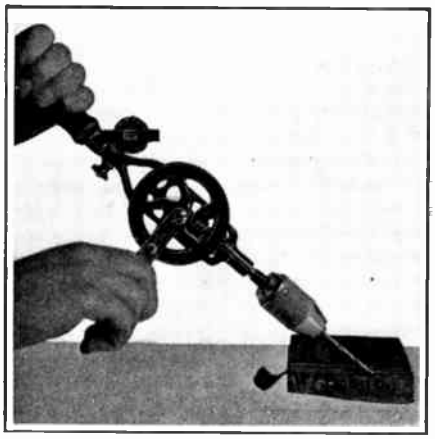
Mix 12 grains of Ferric Ammonium Citrate and 50 cubic centimeters of water in one container and 12 grains of Potassium ferricyanide and 50 cubic centimeters of water in another container. Mix equal parts of each solution in a third container and apply a brush.



SHOP PRACTICE

A LEVEL ATTACHMENT FOR HAND DRILLS

THERE has recently appeared on the market a little device which will be of great service to mechanics and experimenters who are not in possession of drill presses. This is a level that can be attached to any small hand-tool so that the operator is able to keep the drill at any desired level. These levels are being made in several styles and sizes according to the class of drill on which they are to be used. In all lines where hand-operated drills are used, the level enables the operator to drill a hole at the angle or position desired. If the angle is stated, the level tube is set at that degree. If the operator desires to drill at a chosen angle or the most convenient position,



A drill with level attachment in use

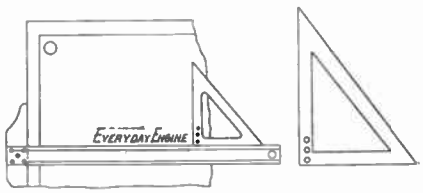
the tube is leveled to that position. If desiring to drill overhead, the level can be read from the bottom as the tube is cut away. This level will be a great aid to amateur experimenters; in a great many cases better and more encouraging results would be had if holes could be more accurately drilled. The average experimenter's shop is not equipped with a drill press, when drilling is to be done someone is called to tell one how to hold the drill, as desired.

Where it is not convenient to locate the level through the stock of the drill a small block is located, having a hole and a set-screw, which holds the leg of the protractor plate which is bent at a right angle. In all cases the level is easily removed from the drill, which prevents breaking if the drill is placed among other tools.

A DRAFTING IDEA

TO draw in the guide lines for lettering on drawings the writer devised the simple stunt shown on the accompanying sketch.

Taking a sharp knitting needle, and heating it slightly, he burned three small holes through the triangle as shown.



First of all, the holes were laid out the correct distance apart.

The rest is simple. The triangle was placed on the T square, and putting a pencil point through the holes, the triangle was drawn horizontally along the T square, which makes guide lines even and all the correct distance apart.—J. H. MOORE.

TWO WAYS OF ANNEALING STEEL

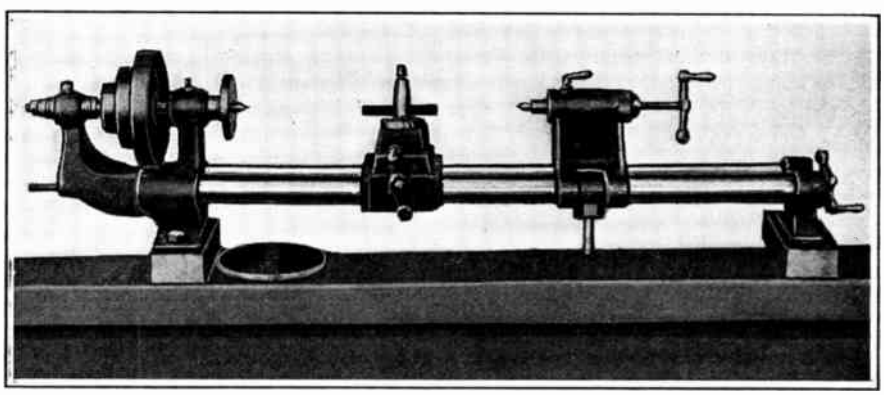
IT may be heated to a dull red heat, covered with dry, warm sand and left to cool slowly; or heat and cover it up in a forge fire, and leave it there until the fire is out and all is cold. The other method is to heat the steel red hot; heat gradually, let it "soak" as the smiths say, until it is evenly heated, then remove it from the fire and take it to some dark place. Let the steel cool until you lose sight of the dull red in the dark; then cool off in cold water. A good "dark place" may be made by throwing your coat over a barrel, leaving just room enough to look in at the iron. This method is called "water anneal", and is based upon the theory that steel softens when cooled at a certain temperature.

There are many other methods of annealing steel but most of them require apparatus and experience that are not usually possessed by the amateur.

A New Amateur Lathe

A new amateur lathe designed along the general lines of the Henry Greenley lathe described in the May, 1918, issue of EVERYDAY ENGINEERING has recently been brought out to supply the wants of those who are unable to purchase more expensive machines. The lathe shown sells complete with back gears for less than a hundred dollars.

To reduce the cost of manufacture and yet provide a workable, serviceable lathe, the bed of the machine is formed by the use of two large rods of cold-rolled steel. The work on the lathe of the bed is really limited to the drilling of holes. The lathe is also equipped with babbitted bearings, which add greatly to its accuracy and "longlivity." The motion of the slide rest is brought about by means of a long screw operated by a handle at the end of the machine. The cross feed is operated in the usual manner. The tail stock can be clamped to any position on the lathe bed.



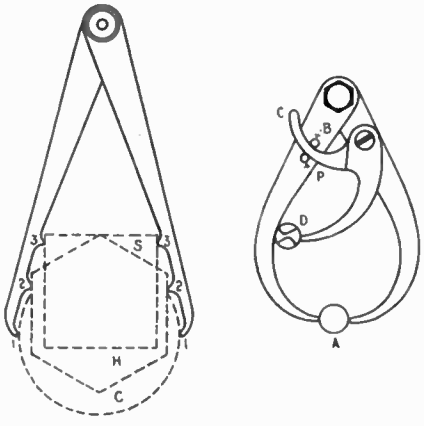
A well-built amateurs' lathe with two cold roll steel rods for a bed

The lathe shown is a stock article with the exception of the bed being made longer in this particular instance to suit the needs of a customer. The castings and parts for this well-designed little tool are also available.

TWO NEW CALIPERS

THE new caliper shown on the left gives the minimum diameter of circular stock material from which square or hexagon pieces can be made without unnecessary waste of material and can also be used as an ordinary caliper.

For square stock the points of the caliper 3-3 are set to the distance across the flat sides. The distance between

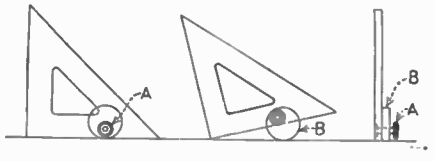


points 1-1 will be equal to the distance across the corners. For hexagon stock, the points are set to the distance (2-2) across the flat sides. The distance between points 1-1 will equal the distance across the corners.

By the use of the caliper shown at the right one is able to select at once the right size drill to suit bolt and pipe taps to cut as near a full thread as is practical for one tap without breaking it. When the diameter of the bolt or pipe is calipered as at A, the diameter of the drill to be used is given at D, for bolts when the arm C is in contact with pin B and, for pipe when C is in contact with P. The calipers can also be used for ordinary purposes.

AN ADJUSTABLE TRIANGLE

AN ordinary wooden or celluloid triangle can be so fixed that it is adjustable to various angles by the addition of a small hardwood eccentric as illustrated in the sketch. The wooden



eccentric is held to the triangle by means of a small screw and knurled nut, which, when tightened, will hold the eccentric in any position. A small piece of round hard rubber would make a very good substitute for the hardwood piece. When the eccentric is not in use it can be placed in a position where it will not be in the way.—J. H. MOORE.

TABLE OF STANDARD GAGES AND SCALES FOR MODEL RAILROADS AS EXISTING BEFORE THE WAR

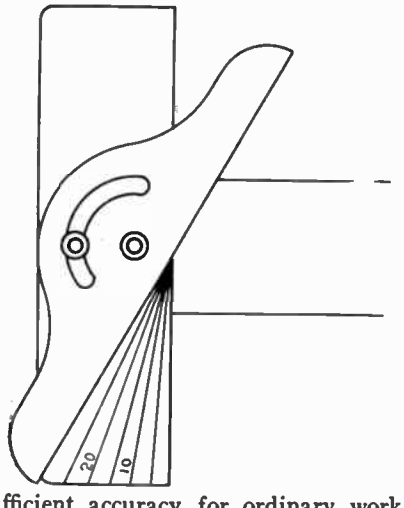
Prepared by Henry Greenley

Gage		Scale	
Toy Gages	No. 0 1¼ in.	7mm—1 foot (about 1/44th)	Quite suitable for indoor railroads where space is limited and for portable systems. Locos. driven by clock-work or electricity. Steam models not entirely satisfactory if not scale proportions.
	No. 1 1¾ ins.	10mm—1 foot (about 1/30th)	The best gage for indoor electrical steam or clock-work railroads for indoor use. The scale is a very convenient one.
	No. 2 2 ins.	11¼mm. or 1⅞ in. to 1 foot (about 1/27th)	Almost the same in characteristics as the No. 1 gage but too large for locomotives. Not being continued as a standard.
For Amateur Construction	2½ in. gage	½ in. to 1 foot (so-called half inch scale)	The most popular size for amateur construction and the smallest outdoor gage. Steam locos. may be fired by alcohol, kerosene or solid fuel.
	3¼ in. 3½ in.	¼ in. to 1 foot ¾ in. to 1 foot	Common gages for amateur working models, outdoor use and for exhibition models.
	4¾ in.	1 in. to 1 foot	Ditto. This is the smallest passenger-carrying gage. A 2-mile non-stop run has been obtained with two passengers by locomotive of this size.
For Private Garden Use	7¼ in. gage	1½ in. to 1 foot (⅛th size)	The 7¼-inch is the most convenient, smallest gage that can be recommended for garden railways and passenger carrying. The construction is within the scope of the amateur model maker.
	9½ ins.	2 ins. to 1 foot (1/6th size)	
Estate and Miniature Railroads	15 in. gage	3 in. or 3.25 in. to 1 foot (about ¼ in. size)	One of the standard sizes for miniature railroad locomotives in parks and estates, in Great Britain. It is not subject to British Board of Trade rules and jurisdiction.

A T-SQUARE PROTRACTOR

TO get away from the use of the protractor, the writer arranged his T-square as shown on the sketch. The head was marked with lines as shown, so that one can easily set the square to any angle without using a protractor at all.

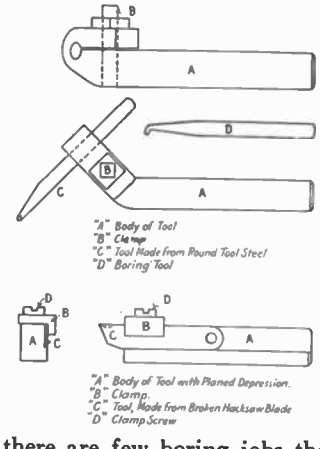
This method gives the angles with



sufficient accuracy for ordinary work. The head is really marked on both sides, but only one side is shown for illustrative purposes. These lines are 1 deg. apart, on the sketch they show 5 deg. apart, but this is in order to demonstrate the idea clearly.

TWO GOOD LATHE TOOLS

THE boring tool shown in the sketch is a very handy device with which many different operations can be done. The holder is the most difficult part of the tool and this can be made at a local blacksmith shop unless one is well able to handle forging jobs at home. When this holder is provided with a number of differently pointed



tools there are few boring jobs that do not come within its scope.

Those who have trouble with their parting tools breaking off will welcome the little suggestion illustrated at the bottom of the drawing. This is really a holder made to accommodate a small piece of a broken hack-saw blade.

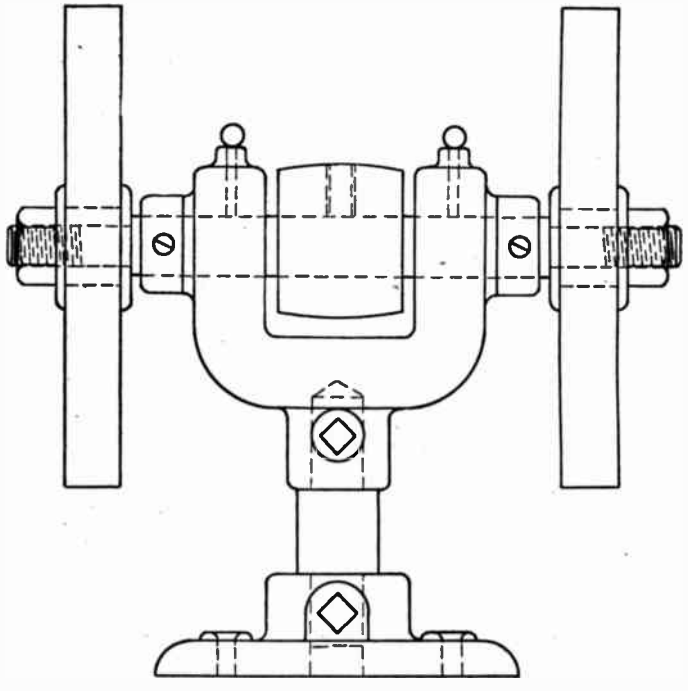
A Design for a Small Grinding Head

By Joseph Dante, Jr.

EVERY workshop should be equipped with a small power-driven grinding head. A hand driven machine is very inconvenient when it becomes necessary to use both hands during a grinding operation. The little grinder pictured is so easily constructed that no mechanic who sees it can have an excuse for going without such a machine in his home shop.

One of the few patterns needed in the construction of the machine is that for the base which is very simple. This particular pattern may be turned up on the lathe. Three holding-down bolt holes are drilled in the casting when it is received from the foundry. A 5/8 in. hole is drilled in the center to receive the standard which is a piece of cold rolled steel. This is held in place by a set screw.

The body or bearing casting must be drilled very carefully to insure a workable accuracy. The author first drilled a 3/4-in. hole through both the bearings. This operation was done on the lathe. This accomplished, a 3/4-in. steel rod was placed through the hole. The drilling of the hole in the bottom of the casting for the standard was done by allowing the ends of the 3/4-in. rod to rest in two vee-blocks. A 3/8-in. hole is then drilled and tapped out in the casting to accomodate a square-headed set screw which holds the bearing casting to the standard.



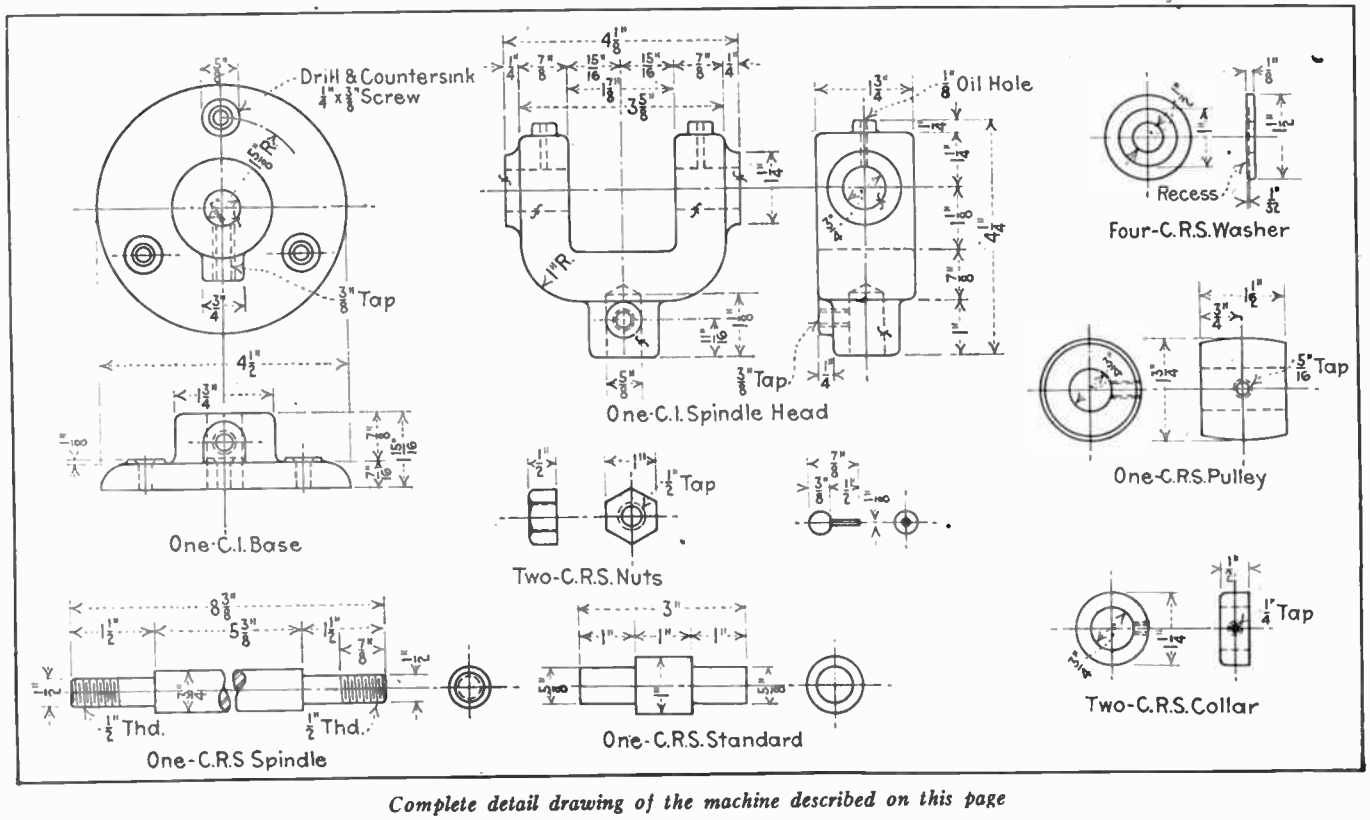
Grinding Head

The collar bearing ends are turned up from solid cold rolled stock. This work was done on a mandrel. The pieces are nicely polished before they are taken from the mandrel.

Two 1/8-in. oil holes are drilled in the casting, one on each bearing. Two small round-headed pins are turned up. These are used to place in the oil holes to prevent dust and chips from getting in.

The pulley for the machine can be turned up from a solid piece of cold rolled stock or a pattern can be made. This will depend upon the builder. No great trouble will be had in turning the pulley up from a solid piece by the use of a mandrel. The spindle is turned from cold rolled stock to the dimensions shown.

Grinding wheels of the proper grit and grade and with the proper sized arbor can be purchased from most any large hardware store or by mail from manufacturers.



Complete detail drawing of the machine described on this page

Our Readers' Workshops Page

THE shops pictured this month belong to E. P. Bradbury, of Los Angeles, Cal., and H. C. Smith, of Chicago, Ill. One is a chemical laboratory and the other a mechanical workshop. Both are very well equipped along their respective lines.

Mr. Smith describes his laboratory in the following words:

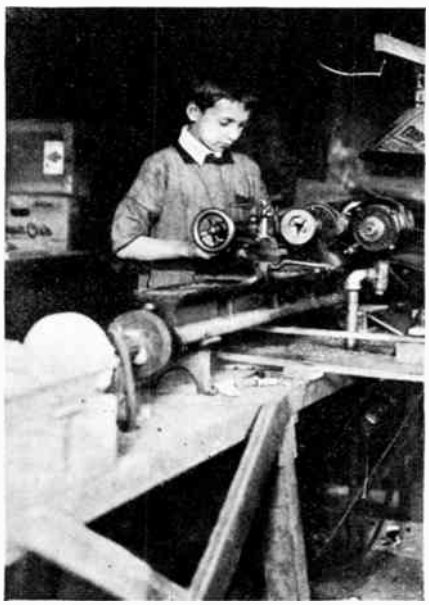
"My laboratory contains the following: Over 150 solid chemicals, including such metals as mercury, arsenic, antimony, etc., about 100 chemical solutions, including various acids such as nitric, sulphuric, hydrochloric, phosphoric, acetic, sulphurous, acetic anhyd., etc., and about 25 solutions, solids and stains for bacteriological work.

"My apparatus consists of the following (part of which is shown in the picture):

"Ringstand, rings for same, bunsen burners, tripods (for retorts), burette clamps, burettes, pippettes, various sizes of flasks, beakers, retorts, evaporating dishes, crucibles, watch glasses, graduated tubes, long chemical flasks, test tubes, filter pump, suction filter (heavy glass), filter paper, sterilized cotton, forceps, porcelain and glass mortars, graduates, test tubes with side outlet, hydrometers, chemical thermometers and an 'imported French microscope', also a balance and platinum inoculatory needle (for bacteriological work).

"My work in the laboratory consists of chemical analysis of various materials, such as food, iron and steel, oils, etc., also microscopical and bacteriological analysis ,and urinalysis. In conclusion I would like to say that my laboratory also contains a fine assortment of scientific books (mostly chemical) and I spend many profitable evenings and Sundays in my laboratory."

The workshop of Mr. Bradbury, illustrated at the top of the page, is described by him as follows:



The laboratory of Mr. Norris E. Bradbury, of Los Angeles, Cal. Mr. Bradbury is shown at work at his lathe

"Our workshop is located in a space of about ten by twelve feet. The equipment consists of a one-quarter horsepower motor, a nine-inch screw cutting-bench lathe, a circular saw with adjustable table, and a grinding and polishing stand holding ten-inch wheels. Space is left for a jig saw which is soon to be added to facilitate pattern making.

"The lathe is equipped with universal and independent chucks, drill chuck, etc. We have made, and added to the lathe, stops with micrometer adjustment for cross and longitudinal feeds, a thread pick up dial, a milling attachment with vise and a gear cutting attachment which is complete except the index plates which are still to be made. The grinding head and saw are home-made, the parts being cast from our own patterns. Even the saws were cut out of an old hand saw, drilled and filed. While they cut perfectly, the amount of work involved makes it cheaper to buy them. The line shaft runs along the floor to economize belting and the pulleys are made of thin boards nailed across grain and turned while in place. The soldering outfit consists of a special low voltage transformer which heats a soldering iron of very simple construction and also supplies sufficient current to sweat large surfaces together. In the absence of gas we chose electricity for its convenience and absence of fire risk.

"As for the purpose of the workshop, our activities are not confined to any particular line. We make play room furniture, transformers, drum controllers and accessories for miniature railroad, and are at present engaged in the construction of wireless apparatus, high frequency coil, etc. We intend in the near future to build a model steam engine. When we do we shall draw our plans, make our own patterns and cast them ourselves in brass, as we have a complete foundry outfit for small castings, except a brass furnace. Up to the present we have only used babbit for casting in sand. We have successfully cast in this metal grooved pulleys or sheave wheels from split patterns, a job that requires considerable care. Finally, we may add that our shop policy requires every piece of work to be as good as our skill will permit. No matter how small a piece of work it is it must be *right*."

Part of the chemical laboratory of Mr. H. C. Smith, of Chicago, Ill.

Another view of the laboratory of H. C. Smith

Aeromarine Limousine Flying Boat

A Well Appointed Type for Sporting and Commercial Use

PERHAPS the most interesting of the new peace models is the Aeromarine Limousine, a flying boat unique in the combining of safety, comfort, and service. This cabin boat is the principal feature of the large Aeromarine exhibit at the aeronautical exhibition in New York.

To explain why this model has been developed to so remarkable a point of refinement—when even the upholstery, carpet, and interior decorations have been the subject of much thought—it should be stated that on this flying boat was focused the care and attention of the staff and men of the entire Aeromarine plant. It was felt that this flying boat would be the first of a large number of similar "ships" to be used in pleasure flying in the United States. The Aeromarine company is devoting itself entirely to the production of air-and-water machines. This specialization aided in the time and effort which the plant could afford to put into one super-flying boat.

The Aeromarine limousine, known as the 50 B-2, is a three-passenger pusher flying boat with a speed of seventy-five miles an hour. The pilot sits in the bow and just behind him sit the two passengers, side by side. Over all three, in a graceful, stream-lined curve, rises the roof of the cabin. The roof is built as a solid part of the hull, and consists of transparent celluloid sheets set in strong frames, so that the view of the pilot and passengers is unobstructed.

A Well Finished Cabin

The hull or cabin is finished in blue leather and polished mahogany. Within the roomy compartment one gets the impression that one is seated in a beautiful sedan. As a matter of fact this is true, but instead of wheels this sedan has wings. The upholstery, the furnishings, the compartments and drawers lining the sides of the boat and also the bow, the many little comforts, are all specially planned to make the aerial tourist feel that in exchanging the road for the air he has gained not only speed and wonderful, ever-changing scenery, but luxury as well. The wide doors entering the cabin are watertight.

The merits of the cabin lie not only in its appointments, however. The roof not only shelters the passenger and pilot from the cold and rush of the wind, but also from spray, rain, and the noise of the powerful motor. These advantages make long trips possible without fatigue.

One of the many unique features of the limousine which deserves comment is the removal of the usual and heretofore necessary clutter of wires, pulleys, etc., from around the control wheel and rudder bar. A special Aeromarine invention replaces those about the wheel, which operates ailerons and elevators in the customary manner of the Deperdussin system, by a single tube. The rudder bar also, communicates its motion to a duplicate bar beneath the floor. This adds not only neatness to the interior of the cabin, but safety, for no wraps or other material can jam the controls. A self-starter is provided for the convenience of the pilot.

An eight-cylinder V type motor of 150 horsepower, every part of which is built in the Aeromarine factory and known as the B-8, furnishes the power. The motor is set between the wings some distance behind the cabin. A wind-driven pump lifts the gasoline from this tank to a smaller tank in the upper wing, whence it flows by gravity pressure to the motor. Forty gallons of gasoline may be carried, enough for about three and a half hours at full speed. This means a range of approximately 250 miles.

Specifications

The characteristics and specifications of the "50-B-2" are as follows:

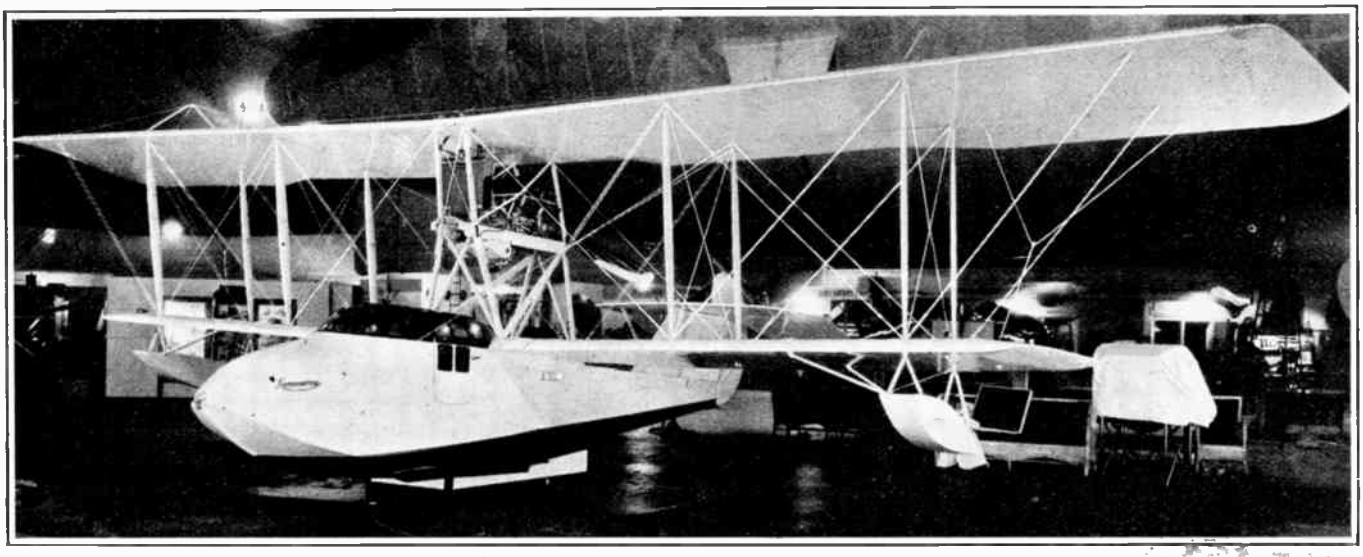
Overall length	28′ 11 5/16″
Overall heighth	12′ 7″
Weight (light load)	2280 lbs.
Weight (full load)	3225 lbs.
Useful load	945 lbs.
Span	48′ 6″
Total area	504 sq. ft.
Wing curve	R.A.F. No. 6
Maximum speed	75 MPH
Minimum speed	44 MPH
Climb in ten minutes	2200 ft.
Endurance in hours	3.4 hrs.

Upper Wing

Span	48′ 6″
Area	304 sq. ft.
Chord	6′ 3″
Angle of incidence	4′ 20″

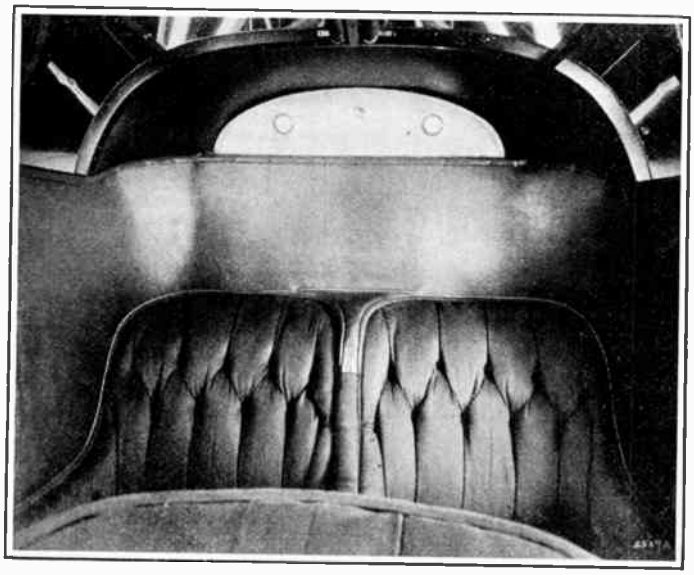
Lower Wing

Span	37′ 8″
Area	200 sq. ft.
Chord	6′ 3″
Angle of incidence	3°

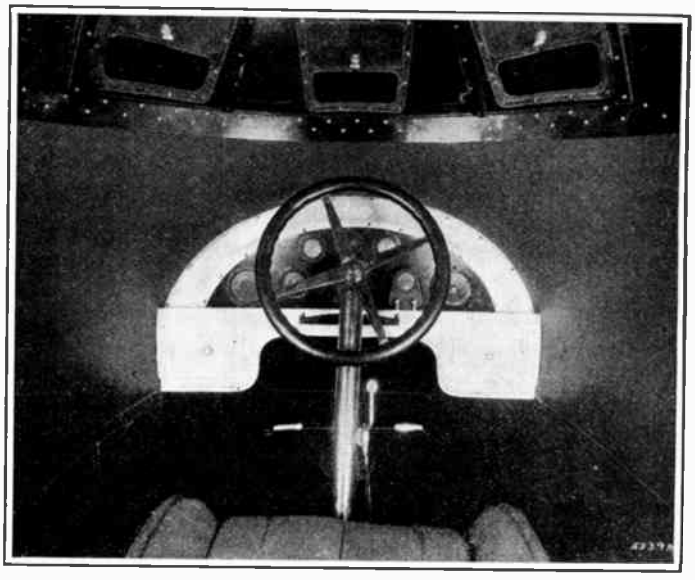


The aeromarine limousine flying boat, a new type intended to foster commercial aviation

Stagger	12″
Gap	6′ 6″
Sweepback	None
Decalage	1° 30′
Area of ailerons (2)	58 sq. ft.
Area of elevators (2)	25.6 sq. ft.
Area of rudder	17.5 sq. ft.
Area of stabilizer	39.0 sq. ft.
Area of fin	15.0 sq. ft.
Skid fins	None



The seating arrangement for the passengers in the aeromarine limousine flying boat



The pilot's seat and control wheel is at the front of the passenger compartment

Engine	45° "B" type
Horsepower	150
Tank capacity	58 gal.
Load per H.P.	23.8 lbs.
Load per sq. ft.	6.15 lbs.

For those who prefer to be snug inside a cabin in winter or bad weather and out in the air when summer breezes blow the Aeromarine company has devised another "ship" which may best be described by calling it the touring car of the air. The hull of this flying boat will also be exhibited at the show. In this type the pilot sits alone in a cockpit in the bow of the boat. In a larger opening behind him two passengers sit side by side. They are protected, like the pilot, by a windshield, but the cockpit may at any time be completely enclosed and made proof against wind and water by the use of a removable celluloid top. This plane, too, is most carefully finished as well as most carefully constructed. There is no roughness or crudity such as marked the first planes. An electric self-starter is also used on this model.

In reporting on the waste of natural gas in this country, the Bureau of Mines reports that the efficiency of gas used for cooking is as low as 13 per cent., for heating houses, 25 per cent., for hot water boilers, 10 per cent. In good practice these efficiencies should be trebled. It is calculated that there is a domestic waste of 80 per cent., certainly a good basis on which to establish better practice.

MOLYBDENUM STEEL IN AUTOMOTIVE PRODUCTS

ONE of the most significant sidelights of the Aeronautical Exposition is the appearance of the new super-steel, a molybdenum alloy, in parts of airplane motors. The timely evolution of molybdenum steel gave Liberty motors connecting rods and crank shafts of the toughest and lightest material ever turned out by steel mills. Incidentally, it also provided an armor plate for the Renault "baby" tanks far superior to the heavy, cast turrets that were in use before American experts succeeded in perfecting a uniform steel with the metallic element molybdenum as an alloy. The helmets of Yankee "doughboys" also were made lighter and safer protection from German gun-fire through molybdenum steel.

Airplane designers have been impressed by the fact that molybdenum steel makes possible a lighter finished product of the same strength than that produced by other alloy steels. The lightening of the aggregate weight of a plane, through the use of lighter parts, is now more than an engineer's dream because a material has been found with which to execute the most advanced structural ideas. Makers of automobiles, trucks, tractors, and accessories are even more interested in the new steel that war evolved. It is predicted that automobiles made of molybdenum steel will weigh from one-fourth to one-third less than today's models. Radical changes in the automotive industry, in fact, are pending because of molybdenum's growing part in realizing "the American light-weight car". The saving on gasoline, tires and wear in a car one-third lighter than those of today are obvious.

The United States has a practical monopoly on molybdenum, controlling about 80 per cent of the world's supply of the metal. The largest known deposits in the world were discovered in a mountain near Climax, Colorado, about the time of the outbreak of the World War. Airplane makers, with the entire automotive industry, view this situation with relief. It not only enables them to secure a steel alloy without the previous difficulties and delays attending importation of chromium, vanadium and other alloying elements, but it assures them certain continuance of steel manufacture in the remote event of a war that would cut off alloys now secured only outside the United States.

We have already spoken of the utilization of water-power of France, designed to reach the most remote parts of the country, and to be at the service of the farmer as well as of the great manufacturer. Now it is announced that on the river Rhone alone, two billion francs are to be expended; twenty power stations are to be established, giving 715,000 horsepower. For the work fifteen years are allowed and the work is to be paid for by bonds guaranteed by the state.

A pipe line across the ocean has been proposed. It is to be of flexible construction so as to be fed out as fast as constructed. The interior is to be rifled and water is to be fed in with the oil, as it rotates the centrifugal force throwing it to the outer portion of the tube, forms a sort of pipe of water, which reduces the friction of the oil in its motion. The novelty of the proposition is in its size and the difficulties to be overcome in putting it in position.

In the tidal waters of Canada, as at Halifax, much trouble has been experienced with concrete piling. Often with an atmospheric temperature of forty degrees below zero, while the sea water is above the freezing point, conditions destructive to concrete are established in the alternate freezing and thawing in the portions within the tidal range. It is proposed to protect the portion within the tidal range by wooden sheathing.

The Chemistry of the Common Metals

Part II. Potassium

By Henry L. Havens

THE history of potassium is very similar to that of sodium, which was covered in the last article of this series. Potassium is chemically very much like sodium and holds many properties in common with this element. Both elements are very abundant and each form a large part of the earth's crust. It has been found that potassium actually forms 2.49 per cent of the lithosphere. This percentage compares very favorably with sodium. Potassium is also found to some extent in sea water and the future supply of the world may come from this source. The giant kelp plants in the sea absorb potassium compounds to such an extent that it will some day be profitable to develop this source for commercial needs. At the present time other sources of the element are much less difficult to work.

Potassium, much like sodium in its appearance, is a silvery white metal which very quickly tarnishes upon exposure to the atmosphere. It melts at 62.5° and boils at 758°. The vapor of potassium is blue in color and has been found to have a molar weight which is identical with its combining weight—39.1. Like sodium, potassium is soluble in liquid ammonia. This produces a blue colored liquid which is an extremely good conductor of electricity. Potassium also forms an alloy or amalgam with mercury in much the same manner as sodium. In fact, this forms one of the methods of obtaining metallic potassium from its compounds. A solution of a potassium salt is electrolyzed with a mercury cathode. This method was explained in connection with the article on sodium which appeared in the previous number of this publication. This alloy of potassium and mercury decomposes water but acts more slowly than the pure metal in this respect.

Sodium and potassium can be made to form a very interesting alloy. If the alloy does not contain too much sodium, it will be a liquid at ordinary temperatures.

Potassium can be obtained by the electrolysis of the fused hydroxide. Owing to the fact that potassium oxidizes much more rapidly than sodium it is necessary to place a layer of oil over the surface to protect the metal.

Since sodium can be produced much more cheaply than potassium and since it will do everything that potassium will do in a chemical way, potassium is not produced to a very great extent in a commercial way.

The compounds of potassium are many and varied. This is another way in which it is very similar to sodium. In the following lines a description of the more important compounds of potassium will be found. The author has made no attempt to outline all of the compounds of this metal as it would require too much space.

Potassium chloride (KCl) is probably one of the best known of the compounds of the element. This substance is found in great abundance in the potassium deposits of Stassfurt and it has become known as sylvite. It is found as double salts with magnesium chloride ($KClMgCl_26HO$). In this form it is recognized as carnallite. The larger part of the potassium chloride used in commerce is obtained from this mineral.

Caustic potash or potassium hydroxide (KOH) is almost exactly the same as sodium hydroxide in regard to its chemical properties. It is prepared by the electrolysis of potassium chloride. It can also be prepared by acting upon a boiling solution of the carbonate with calcium hydroxide, calcium carbonate being precipitated. The potassium hydroxide is left in solution. The process of electrolysis first explained is by far the most popular method of producing the hydroxide. In the last named process the hydroxide crystallizes from the solution with various amounts of water forming $KOH\text{-}H_2O$, $KOH.2H_2O$, $KOH.4H_2O$, $2KOH.5H_2O$ and $2KOH.9H_2O$. In the process for producing KOH in a commercial way the solutions are evaporated until nothing but the molten hydroxide remains.

KOH is a very strong base but sodium hydroxide is generally used in preference whenever possible. Sodium has a very small combining weight and therefore less of it is required for a given amount of work. The hydroxide of sodium is also cheaper than that of potassium. KOH is used considerably in the soap industry and in the manufacture of oxalic acid.

Potassium can form two oxides, a monoxide (K_2O) and a peroxide (K_2O_4). The former dissolves in water to form potassium hydroxide and the second dissolves in water for the formation of the hydroxide, hydrogen peroxide and oxygen.

Potassium bromide ($KBrO_3$) is formed when bromine is dissolved in a solution of potassium hydroxide as: $6KOH+3Br_2=KBr+KBrO_3+3H_2O$. It will be seen that potassium bromate is also formed during the reaction. If the resulting solution is carefully heated and evaporated to dryness the bromate will decompose into bromide and oxygen. If pure bromide is desired it may be obtained by recrystallization.

Potassium bromide has a density of 2.7 and its melting point is 750°. Its solubility is much greater than the chloride of potassium.

Potassium iodide (KI) can be readily prepared by any of the methods used for the bromide. This substance has a density of 3.05 and crystallizes in anhydrous cubes with a melting point of 705°. One hundred grm. of water is capable of holding 148 grm. of KI in solution at 25°. Iodine has been found to be much more soluble in a solution of KI than in water and when brought in contact with it tends to form the salt KI_3.

Potassium chlorate ($KClO_3$) is the most important salts of potassium without question. It may be prepared by passing an excess of chlorine into a concentrated solution of KOH. The hypochlorite is first formed:

$$2KOH+Cl_2=KCl+KClO+H_2O$$

$$3KClO=2KCl+KClO_3$$

Owing to the fact that the chlorate is much less soluble than the chloride, the solution can be allowed to cool and concentrate, the chlorate gradually separating out with very little of the chloride. Potassium chlorate occurs in nature in large quantities and therefore

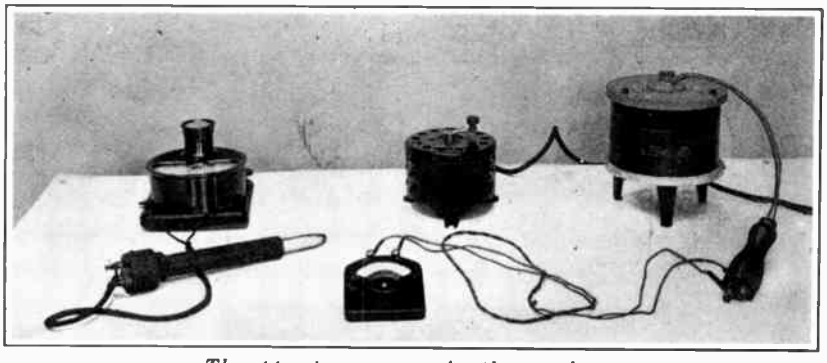
The Measurement of High Temperatures in the Laboratory

By E. P. Hurley

IN the experimenter's laboratory it is often desirable to have some method for the measurement of temperatures above those possible with the ordinary mercurial thermometer. The various devices now on the market for the determination of high temperatures are usually beyond the reach of the amateur experimenter. However, the author has made at a small cost an efficient instrument for the measuring of temperatures up to and including 1200° C.

The operation is based on the principle that the ends of two unlike metals welded together create when heated an electromotive force and if small rods or wires are used and the ends brought into contact with each other, will produce a small electric current. These wires are known as the "Fire End" or thermocouple. For temperatures as high as 1650° C. a thermocouple of one wire platinum and the other wire platinum 10% rhodium is generally used. This couple is very expensive and requires a very sensitive recorder as the electromotive force produced is but 18 millivolts at 1600° C., while that of the cheaper base metal couple or nickel alloy couples is approximately 80 millivolts at their highest temperatures. Where the maximum temperature does not exceed 900° C. the nickel alloy known as Constantan, which consists of about 41% nickel and 59% copper is used as a negative element against either copper, iron, or nickel chrome as a positive element. These couples produce very high electromotive force. The writer has used an alloy of chronium with nickel as a negative element and one of pure copper as a positive element. This makes an excellent couple.

This offers a big field for investigation and experimenting with the various metals and alloy wire to form couples. For each half of the couple use a wire 24 inches long with a cross section of 1/16 to ⅛ inch. The ends of the wire constituting the couple must now be welded together by oxy-acetylene flame or by an electric arc. The couple should now be annealed. This can be done in an electric resistance furnace or by other methods devised by the experimenter. Each wire of the couple should now be wrapped with a close spiral of asbestos cord to within one inch from the end. This can be done in a lathe or other rotating devices. Paint the asbestos cover with a paste consisting of 100 parts silica flour, 50 parts sodium silicate and 20 parts fire clay. Any other good heat insulating paint can be used. Heat the wires in a tube furnace until hard. Base metal couples used at high temperatures must be protected and a porcelain or fire clay tube can be obtained from pyrometer manufacturers for this purpose at a very small cost. The mounting can be turned from wood.



The apparatus necessary for the experiments

The quantity of energy available from a thermocouple is so small that a sensitive millivoltmeter must be employed for its measurement. The author has found the Weston Model No. 280 millivoltmeter reading from 0.75 millivolts an excellent instrument for this purpose.

Calibration of the Thermocouple

As the recorder or millivoltmeter measures the electromotive force produced in terms of millivolts in order to establish the connection between the reading and that of temperature, calibration is necessary. This is easily done by determining the melting points of a number of substances.

The following is a list of pure substances with the boiling and melting points:

Water	B. P.	100° C.
Tin	M. P.....	232° C.
Bismuth	B. P.	271° C.
Lead	M. P.....	327° C.
Zinc	M. P.....	419° C.
Sulphur	B. P.	445° C.
Antimony	M. P.....	630° C.
Silver	M. P.....	960° C.
Copper	M. P. (in air)	1083° C.

With the couple used by the writer the readings were as follows:

Temperature in degrees C.	*Millivolts*
100	4
200	11
400	27
600	43
800	58
1000	72

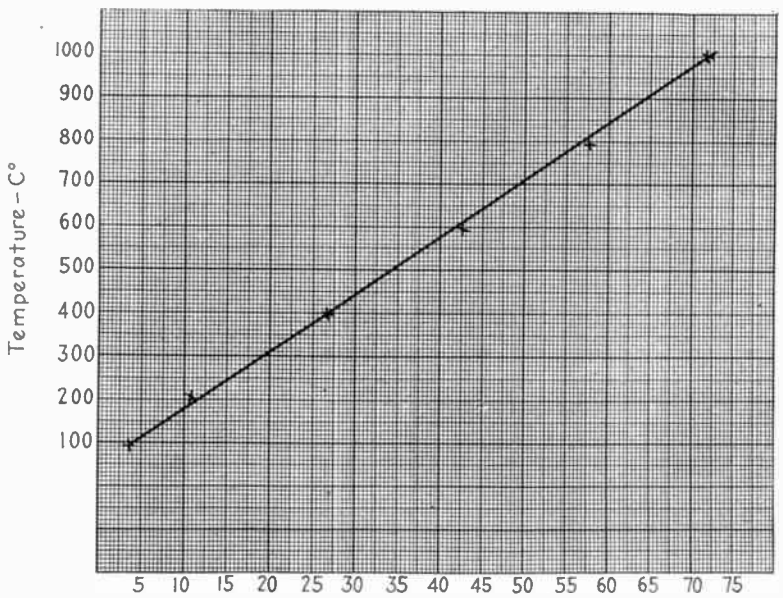


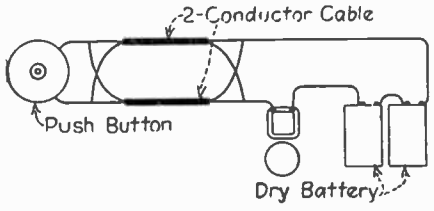
Fig. 1

The experimenter will find it a great assistance to plot a curve for the millivoltmeter readings. This can be referred to when desired and will not necessitate marking the degrees of temperature directly on the millivoltmeter scale. Fig. 1 shows a curve for the couple used in the above experiments. While it is not a straight line, yet sufficiently accurate for ordi-

(*Continued on page* 70)

A BURGLAR-PROOF ALARM CONNECTION

A DIAGRAM of connections for a perfectly burglar-proof electric alarm is given herewith. It will be seen that two independent circuits are made. If one is cut, the system will still be in



order as the other circuit will be left intact. This circuit can be employed in many cases where it is necessary to expose wires. The two circuits should, of course, be as far removed from one another as possible. No advantage would be derived from placing them together.

CHARLES DIEHL.

SIX USEFUL WRINKLES

A wood filler can be made with equal parts of wax (the kind that is used for sealing jars, etc.) and clear varnish. Mix well and leave the mixture to set. This wood filler is suitable for instrument bases, etc.

To remove paint from a window glass, rub it well with hot vinegar.

To frost a window, paint the glass with a strong solution of Epsom salts in hot water. This may be quickly washed off if clean glass is required afterwards.

An acetylene lamp will give a far more intense light if a little hydrogen peroxide is mixed with the water in the generator.

To know whether your telephone has rung while you are absent, place a piece of thin paper and a piece of carbon paper between the bell and the clapper. When the bell rings the clapper will make a mark.

Dip lamp wicks in vinegar and let them dry before using. They will not smoke if this is done.

JAMES A. UPTON.

TO ENGRAVE ALUMINIUM

ONE of the very interesting peculiarities of aluminium is its resistance to the direct action of the graver; the tool slips off like from a hard surface of glass. However, by using a varnish of 4 parts of oil of turpentine and 1 of stearin, mixed with 1 of rum, the graver penetrates the aluminium like pure copper.

Aluminium is also very difficult to drill. This can be partly overcome by using plain kerosene as a lubricant. Nothing has been discovered that is more suitable as a lubricant for this metal.

American Society of Experimental Engineers

WHO'S WHO IN THE A. S. E. E.
EUGENE LETSCH, M.E.

As a boy of 16 and released from high school, I had the choice between a "Mister Minister" and a school teacher, but my ideal was something in the direction of "Everyday". After a hard battle and many sleepless nights I left goal as a winner and a week after was hustling around a speed lathe as a mechanic apprentice boy. Contract was signed for four years; machinist helper first year, handy man second year, instructor mechanic third year, and testing laboratory fourth year.

Tools and dies for watches was an interesting field for me. Diesel and automobile practice held me for about two years. My father then insisted on sending me to the technical college for mechanical engineering, of which I am a graduate.

"Real money I'm going to make now," I told my father, and two weeks after was sailing for the country of my dream. Not mastering the English language, I was forced to work as machinist helper, but soon took advantage of the night school and the I. C. S Since that time a new road was open to me.

Analyzing all the possibilities within the range of scientific societies, the A. S. E. E. seems to have the basic spirit I was looking for. Experimental engineering is one of the most interesting occupations. It is an art where ability and knowledge are combined. As a hobby in general it is the reflex of intense interest in the things before us.

The A. S. E. E., with proper cooperation of the members, is qualified to create great things, and with the efficient board of directors we have now, it is an easy matter for every member to become prominent through the work and ability in experimental engineering. It is indeed a pleasure to state here that it is largely to the enthusiastic manner in which the board of directors, especially Mr. Raymond F. Yates, advocated the discussion of some of my matters in preparation for EVERYDAY.

E. LETSCH, M. E.

NEW MEMBERS

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Hum Chu Moon, 205 Albert St., Ottawa, Canada.
Joseph Mellon (no address).
John J. Barragar, 1227 9th St., Santa Monica, Cal.
Edward Kiefer, Northport, L. I., N. Y.
Herbert W. Hill, c/o Hill Logging Co., Bunker, Washington.

WHY NOT SEND FOR SOME APPLICATION BLANKS?

PROBABLY few members of the society realize what great good they can do by inducing their friends to join.

Members who feel that they can make good use of a few application blanks will be gladly furnished with them by addressing a post card to the offices of the society with this request.

ELECTRICAL PROGRESS DIGEST

A NEW DIRECT-CURRENT METER

A new single-pivot direct-current meter of the portable type is illustrated in the photograph. This instrument is hand calibrated and has an accuracy guaranteed to be within one-half of one per cent. This accuracy is maintained throughout the full scale value and the action is entirely dead-beat. The moving element is normally so damped that it almost immediately comes to rest at zero or in any deflected position.

This instrument, which is of the Rawson make, has its moving coil supported at the center of an iron sphere, thereby allowing it to oscillate freely in every direction without touching. The instrument has been designed so that it can be used successfully on ships, trains, blimps and airplanes. It can also be operated in proximity to heavy machinery. No leveling of the meter is necessary.

NEW APPLICATION OF THE X-RAY

THE X-ray has recently been applied to the testing of wood. The detection of knots, resin pockets, cracks and grub holes can be made in timbers up to 18 inches in thickness. Owing to the importance of obtaining perfect wood in the construction of airplanes, this method will prove invaluable. The use of X-ray apparatus has also been applied to the testing and examination of insulating materials. Electrical defects can be instantly detected by the use of X-rays. Small pieces of metal or other conducting material that has become accidentally mixed with the dielectric is very visible.

Communicating With Infra-Red Rays

DURING the war French scientists perfected a new method of communication by the use of infra-red rays and it is only recently that the details of this development have reached this country.

The infra-red ray transmitter of the new system is a very simple device, being merely a source of light rich with infra-rays. Both the visible and insible rays of the transmitter are concentrated and the invisible rays projected in a thin pencil in the direction of the receiver by means of a parabolic reflector. Before the rays leave the transmitter they are passed through a ray filter which effectively cuts off all visible rays and allows only the invisible rays to be projected. The filter consists of black manganese-dioxide glass or colored gelatine or cellophone. The electric arc has been used with great success as a source of infra-red rays.

The transmitting apparatus is provided with a quick-action shutter which breaks up the invisible light stream into the dots and dashes of the Morse code.

Infra-red rays possess all the properties common to heat waves and they are often referred to as heat waves owing to the fact that they heat all objects upon which they fall. Infra-red rays can be refracted, absorbed, polarized and diffracted.

The infra-red ray transmitter

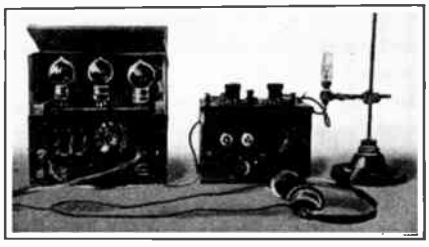
The infra-red rays are caused to fall upon a parabolic reflector at the receiving station where they are concentrated and made to fall upon a thermopile placed at the exact focal point of the reflector. The thermopile or electric thermocouple forms the sensitive part of a circuit containing several audions arranged for amplification. The concentrated infra-red rays falling upon the couple cause a temperature change which in turn alters the electrical resistance of the circuit. This change in resistance is further amplified by the audions and an audible signal is produced in the telephone receivers.

The new infra-red ray receiver in use

One of the most efficient thermocouples for this purpose is made by sealing a plate 0.01 mm. thick to a crystal of great thermo-electric power. The thickness of the plate and the diameter of the point of contact are as small as possible to obtain maximum sensitivity to the waves. The best results to date have been obtained with platinum as the metal and tellurium as the crystal.

By the aid of a powerful source of infra-red rays and with a very sensitive receiver communication has been carried on over a distance of several miles with very good results. It is said

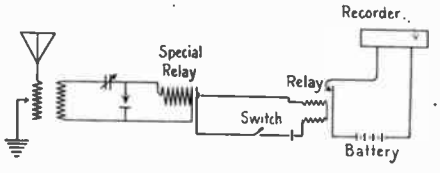
that the real value of this new apparatus lies in the fact that it is possible to carry on absolutely secret communication.



A non-electrical method of carrying on communication with infra-red rays has been devised. One of the illustrations show the use of this outfit. The rays are caused to fall upon a parabolic reflector where they are reflected to a special receiver in which they heat the air and cause a sound to be made.

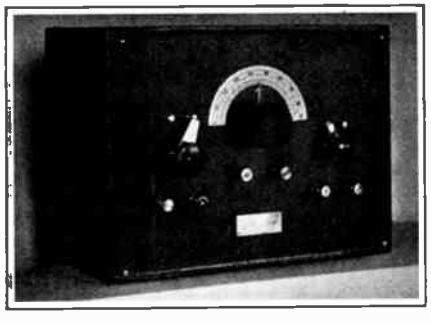
A RADIO RECORDING DEVICE

MR. WILLIAM G. H. FINCH, an Associate Member I. R. E. and Fellow Member of the American Society of Experimental Engineers, has recently perfected a radio device which will record wireless messages with an ordinary tape register similar to those employed on wire lines. This is made possible by



The wiring diagram

a super-sensivite relay which is designed and constructed along entirely new lines and which will function upon the receipt of extremely weak impulses. This sensitive relay closes the circuit of a second relay which controls a rather heavy current for the operation of the tape recorder or whatever device may



The cabinet containing the relay and its auxiliary apparatus

be connected in the circuit. It will be seen that lights can be lit, motors started, horns operated and bells rung by this system which is very simple.

An elementary wiring diagram is shown which will give the reader a general idea of just how the device works. The circuit is brought to a point of resonance in the customary manner by the use of variable inductances and capacities. A detector and a pair of head 'phones are used to tune the circuit. Both of these members may be switched out of the circuit when it has been brought to resonance. Maximum current will then flow through the special relay device which will in turn operate the second or heavy-current relay.

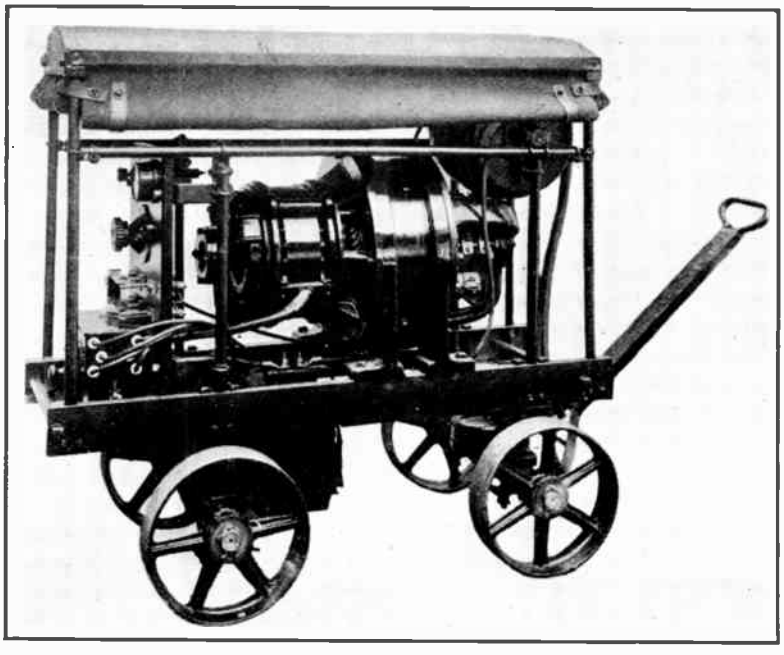
Under test this new relay worked perfectly over surprising distances and when used in conjunction with other efficient apparatus it can be depended upon to render very good service. It is simple and there are no extremely delicate parts exposed. By using the special relay in connection with at least one audion amplifier the distance over which it will operate can be increased considerably. With several stages of amplification the relay will operate over real long distances.

Radio engineers have long been endeavoring to perfect a device that would function on very weak currents and if the present development proves successful it will certainly receive a good welcome. It is said that the English engineers of the Marconi Co. recently perfected a device along these lines that will operate a bell upon the receipt of a radio distress signal at sea. This is to be employed for emergency use only and will not be used for ordinary communication. The fact that the Marconi Co. has been interested in this problem proves that its importance to the field is well recognized.

New Arc Welding Equipment

THE electric arc is being used more and more for purposes of welding. A very late and practical development along this line is shown in the illustration.

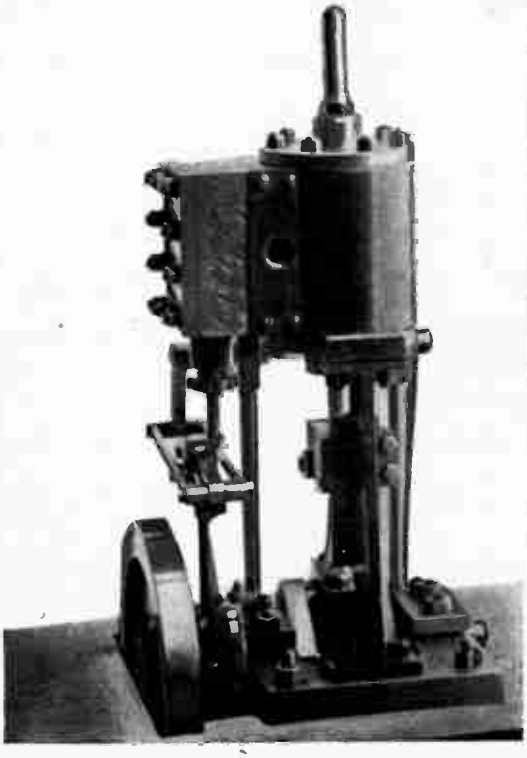
This is a motor generator outfit with absolutely automatic regulation. The

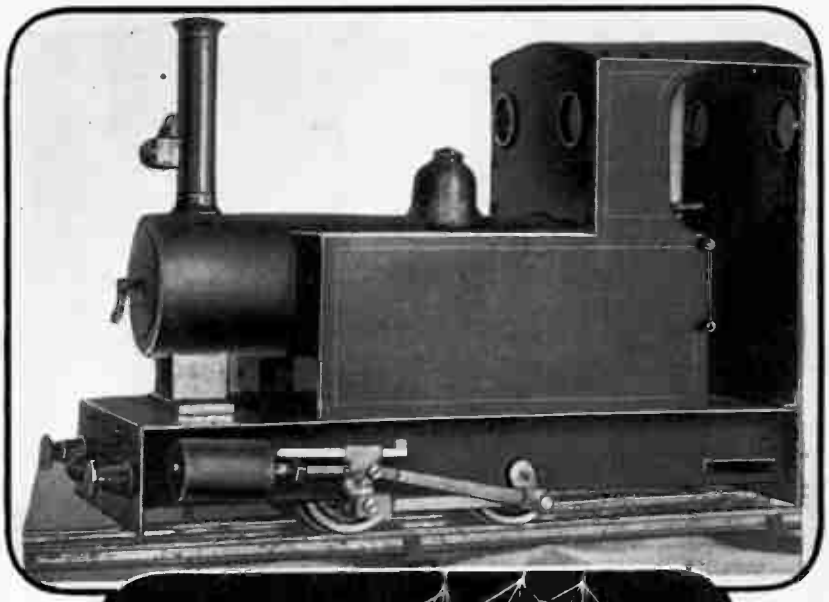


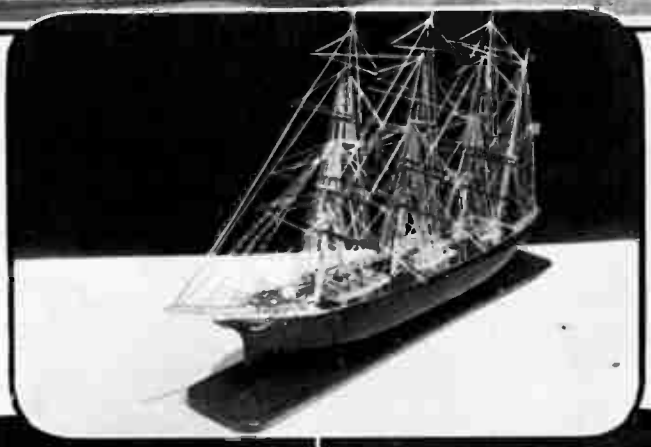
direct-current generator is a machine of exclusive design and is capable of delivering a current strength of 200 amperes at the voltage required for arc welding. This equipment is intended for the use of a single operator and unlike the old outfits does not need several men to take care of it during operation. A switch and meter panel, a motor generator, stabilizing reactor, electrode holder and face shield comprise the outfit. The entire outfit is mounted upon a small truck of rugged construction and readily portable without power.

To enable the operator to vary the current to meet his requirements, this arc welder is provided with both a voltage adjusting rheostat and a current-adjusting switch. The latter has four points giving, with slight variations of voltage and current desired, from 50 to 200 amperes. The voltage adjusting rheostat enables the operator to vary the open-circuit voltage from 35 to 65 volts. With an open-circuit voltage of 40 the approximate currents obtained with the different settings of the current adjusting switch are 65, 105, 150 and 200 amperes. The machine is equipped with well-built commutators and very liberally proportioned windings. The machine, although very complete, requires but little space.

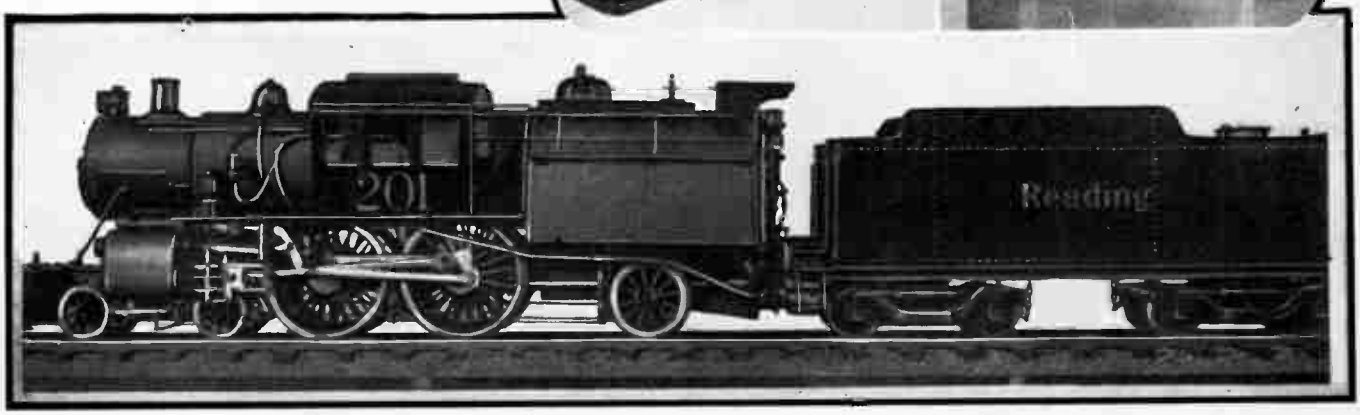
Models Made by Our Readers







SEVERAL very interesting models made by the readers of EVERYDAY ENGINEERING are shown on this page. The little donkey type of engine in the upper right hand corner is the work of Mr. Carlin, of Pittsburgh, Pa. The single-cylinder marine engine above is the handiwork of Mr. F. A. Wardlaw, of New York City. The splendid little four-masted bark "Star of Scotland" shown is the work of Mr. Edgar L. Brown. The execution of this model demanded a great amount of time, patience and labor from its builder. The "Reading" loco. at the bottom of the page was made by one of our Bloomfield, N. J., readers, who is too modest to have his name mentioned. This is one of the best model locos. that has come to our attention in some time.



New Things for the Automobilist

A VAST number of devices have been invented and have been marketed with a view of supplementing the regular equipment of the automobile or providing items to increase the comfort and safety of motoring that are not ordinarily supplied by the car manufacturers. Many of these devices have real merit, but an equally large number have no real reason for being and are of doubtful value. An automobilist who loads up his car with all kinds of junk he has little use for is making a mistake, not only because his money has not been expended wisely, but it takes gasoline to carry the added weight along. The task of selecting accessories of value from the mass of such material on the market is a difficult one for the novice motorist. The appliances shown in accompanying illustrations are of late development and should be useful to motorists.

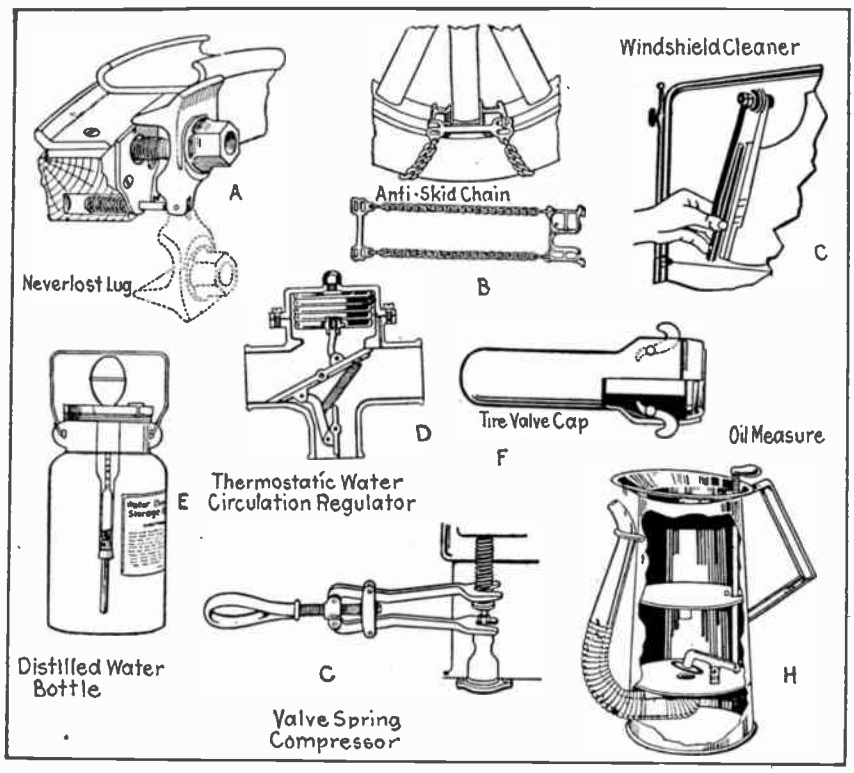


Fig. 1—Recently developed devices for the automobilist

There is one annoying point in connection with changing a demountable rim, and that is the liability of dropping the lugs into the mud or slush when they are removed from the bolts. The swiveling lug as shown at Fig. 1-A is designed so it can be easily removed from the rim retaining bolt and swung down out of the way without any danger of loss because it is securely held to the wheel felloe by a retention pin and spring in the manner indicated.

Quick detachable non-skid chains which are made in various sizes suited for both trucks and passenger cars are shown at B. This is a simple chain device consisting of a pair of cross-chains attached to a fastening device that attaches to the wheel spoke as indicated, permitting quick attachment and removal.

When driving in rainy or snowy weather, the windshield becomes covered with moisture or ice and is hard to see through. The cleaner shown at C is made in two forms, one to be attached to the windshield frame, another that is installed by boring a hole in the windshield glass as illustrated. The cleaners are made of chemically treated felt.

The motor thermostat shown in section at D is very useful in these days of low-grade fuel, because it allows the motor to "warm up" quickly in cold weather by regulating the circulation of water through the cylinder block. When the motor attains its efficient operating temperature promptly, the pistons and rings expand to their proper fit and the escape of raw gasoline past the pistons into the crank case where it will dilute the oil is minimized.

One of the important points in connection with the care of the storage battery is the periodical replenishing of the water evaporated from the electrolyte. It is also necessary to test the specific gravity of the solution from time to time to make sure the battery is properly charged. The combination shown at E is very useful, as it consists of a jar to hold distilled water, provided with a cover that keeps foreign matter out of the liquid and also serves to hold the hydrometer syringe that is so useful in testing electrolyte or introducing water into the battery cell jars.

Many motorists run their cars without putting the dust caps on the tire valves because of the time it takes to screw the cap down and remove it when it is necessary to gain access to the valve for inflating the tire. This practice results in dust working into the valve and causing air leakage or rusting and damage of the valve parts. The quick action dust cap shown at Fig. 1-F is designed to offer all the protection afforded by the threaded style and offers the added advantage of quick application and removal. To install, the cap is simply pushed down over the valve stem and the spring-actuated pawls catch in the thread and hold the cap in place. To release, the spring pawls are pressed out of engagement by pushing in their exposed ends with the fingers and the cap is easily lifted off.

A new valve lifter, which is shown at G, will prove useful to the automobile mechanic or to the motorist who enjoys taking care of his own car. As the ends that spread apart to compress the valve spring are actuated by a thread and inclined plane arrangement, the stiffest valve spring may be compressed with ease and the valve spring collar retention key may be easily removed or inserted, as the case may be. The lifter will keep the spring compressed as long as necessary and enables the operator to use both hands in removing the valve.

The oil filler openings of automobile engines are not always located in accessible places and it is often difficult to pour the oil in with the ordinary measure or funnel. The combined funnel and measure shown at H is a recently devised accessory that is equally valuable to the car owner or garage proprietor. The spout is made of flexible tubing and the delivery opening is controlled by a valve so only the desired quantity of oil may be supplied. This valve is easily controlled by a lever close to the handle of the measure. All the oil passing out of the measure is screened by a wire gauze baffle plate through which it must pass. With the valve closed, the measure may be used in the ordinary way and oil poured out of the top.

Unless a storage battery is kept properly charged during the winter season,

especially if a car is operated very little owing to the severity of our northern climate, there is apt to be a marked decrease in battery capacity due to sulphation of the plates, and besides the electrolyte of a depleted battery is apt to freeze if the car is kept in an unheated garage. The rectifier shown at Fig. 2-A is the product of a large producer of electrical appliances and permits the motorist who has only alternating current available to give his storage battery a "boosting" or conditioning charge whenever necessary and thus keep the battery in condition even if the car is not used for extended periods.

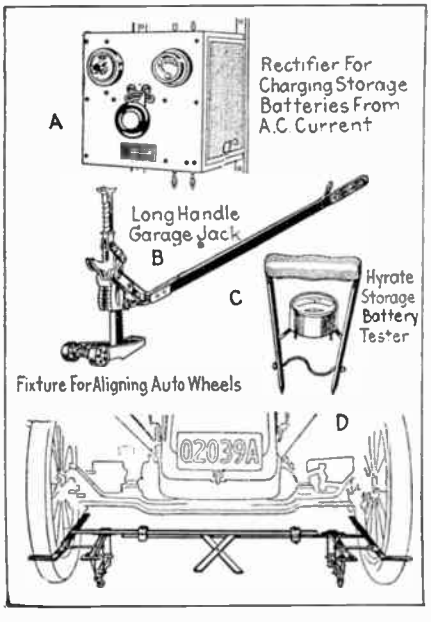


Fig. 2—Useful devices for the garage

The extension-handle jack shown at B is a very strong appliance intended for garage or service station use and is a quick-acting jack for heavy duty. The operating lever or handle is five feet long and makes it easy to lift heavy cars. The length of the handle makes it possible to place the jack under the axles or other hard-to-reach places.

The storage battery cell tester shown at C is a device that consists of a recording meter and a special nichrome wire resistance which connects the prods. The sharp pointed steel prods establish a suitable connection with the lead cell terminals or connection bars, and the cell voltage is indicated on the special voltmeter.

One of the factors that promotes tire depreciation is improper adjustment of the front wheels and their alignment with the normal path of car travel. A gage that makes it possible to line up the automobile wheels very accurately and secure easy steering as well as lessening tire wear is shown at Fig. 2-D, which also outlines the method of using it.

POWER SAVED BY DIFFERENTIAL

SOME figures regarding the loss of power which results when a vehicle is operated with its two driving gears solidly locked together, that is, without a differential gear, were given in a paper by C. G. Conradi, read before the Institute of Mechanical Engineers.

Tests were made with a ¾ ton Electromobile truck. The vehicle during the tests was run over the same course by the same driver, and under the same weather conditions. It was designed for a speed of 15 m. p. h., and weighed, complete with battery, 3,400 lbs. The electrical equipment consisted of a 60-cell A. 4 Edison battery supplying current to a double commutator motor and with a modified series parallel system of control. The chassis was arranged with an all-gear drive, the motor driving the live axle through double reductions, double helical gear, while a bevel differential of normal type was fitted. The differential was securely locked when required, by the insertion of brass blocks between the pinions and meshing with the same movement being then possible. The current consumed was measured by a Sangamo ampere-hour meter, and showed current as charged to the battery, not battery output as is more generally the case.

Condition of Differential	*Load*	*Miles*	*Ampere Hours*	*Ampere Hours per mile*	*Saving per cent.*
Locked	Light	18.1	100	5.52	..
Free	Light	18.1	93	5.13	7
Locked	11 Cwt.	18.1	125	6.90	..
Free	11 Cwt.	18.1	110	6.08	12

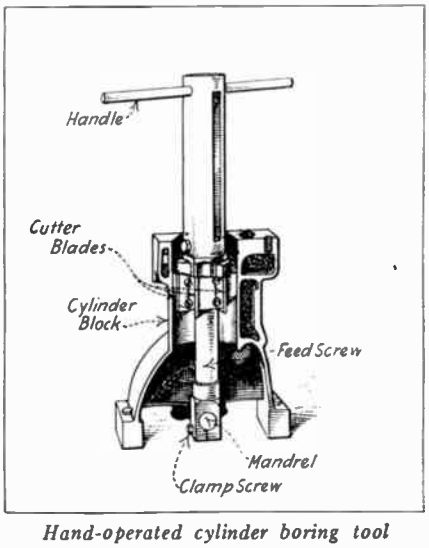
It will be observed from the tabulated results that both light and loaded consumption of current is greater when the differential is out of action, the percentage difference increasing with increase of load. This is to be expected, as with increased load the tires will grip the road better and more power be required to cause one wheel to slip when traveling on a curve.

SIMPLE MIXTURE INSURES CLEAR VISION

TO maintain a clear vision through the windshield in rainy weather when the glass usually clouds up is vitally important to the safety of the motor car and its occupants. A variety of rubber wipers that scrape off the accumulated moisture are used to keep the glass clear in wet weather, but many believe that the old-fashioned alcohol and glycerine solution, which is carried in a small bottle and rubbed on the glass as needed, is best. If the bottle containing the mixture is wrapped in a cloth and stored away in the side pocket it will always be ready for use and a cloth to apply it will also be handy when needed.

A NEW CYLINDER REBORER

A NEW cylinder reboring apparatus is being placed on the market and is shown in accompanying illustration. It is said that this tool will bore an



Hand-operated cylinder boring tool

absolutely straight, round smooth hole. The reamer used with this tool has a wide adjustment and is said to run true at all adjustments. Another advantage is that the cutters can be sharpened by anyone on an ordinary grinder.

By referring to the illustration it will be seen that the fixture which guides and feeds the reamer uniformly consists of a screw, which occupies a central position in the cylinder, and is clamped to a short shaft which in turn is secured in two crankshaft bearings and suitable bushings provided to fit any particular bearing. The reamer can be turned by hand or power as desired.

USING UP OLD COMMUTATOR WIRES

WHEN the commutator wires of a Ford get oily at the lower end and are electrically leaky, turn them bottom upward—that is to say, put the commutator terminals on to the low-tension binding-posts on dash, and the upper (dash) terminals on to the commutator binding-posts (seeing, of course, that you do not shuffle them). There is little tendency for electricity to leak at the dash end, because there is little metal there to short-circuit it and the wires are spread further apart, whereas, at the commutator end there is metal everywhere.

The Construction of a Chanute Glider

By Percy Pierce

Late First Lieutenant, U. S. Air Service

PART II.

The struts are of next importance. These are oval or of streamline form, 1 in. by 9/16 in. in section and 3 ft. 11 in. long. Sixteen are required, and they should all be of carefully picked stuff, quite straight grained, without knots of any description. For attaching the struts to the planes, I have decided, after experience with several other methods, that nothing can be more simple or conducive to sound construction than the cast aluminum or aluminum alloy socket, and for glider work I have just designed a socket which requires no eyebolts or lugs for bolting down. This is shown in Fig. 7, which sketch gives detailed measurements, while Fig. 8 shows the socket in perspective. A single black iron carriage bolt only is required to secure the socket to the spar, which bolt passes through a hole in the base, the head being inside underneath the strut. The socket is prevented from turning by the tension of the wires. There are four lugs provided to take the bracing wires, but in the majority of places on the glider only three of these will be required, the fourth being cut off with a hack-saw and the metal filed smooth. It will be noted that the socket is so designed with the base at an angle to the vertical center line that it fits on the dipping edges or camber of the plane; thus the same pattern suffices for the sockets at both top and bottom of the struts. The positions of the lugs are such that the wires make a direct pull through them to the bolt.

Fig. 6—Sketch showing method of fitting the steel wire for trailing edges of aerofoils and method of bracing end rib by short strut. Fig. 8 —the strut socket in perspective shown at right

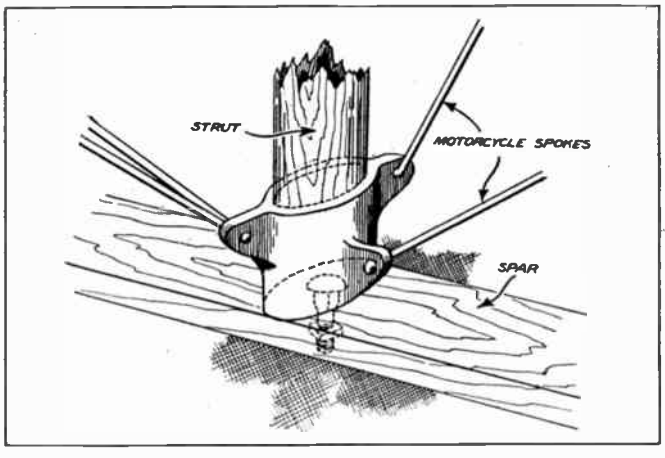
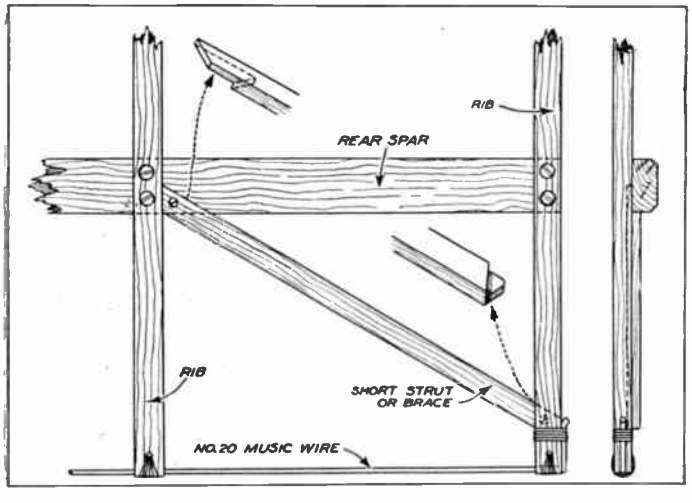
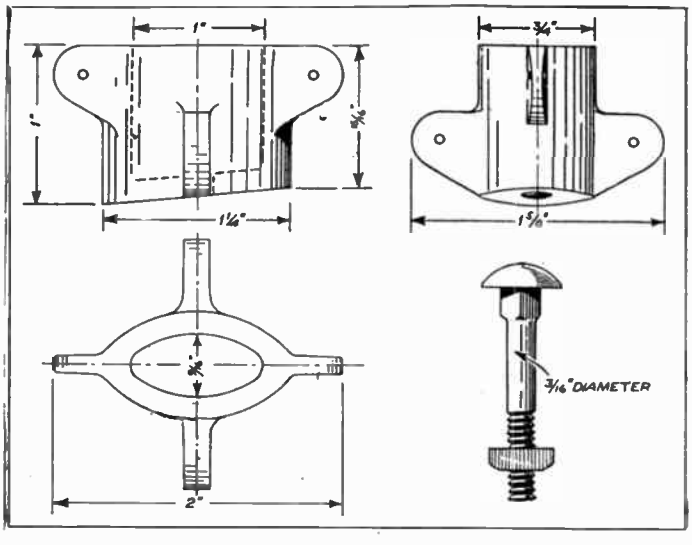


Fig. 7 — Dimensioned drawings showing details of cast aluminum strut socket which may be cast from a simple, easily made pattern. The carriage bolt by which the socket is attached to spar is also shown





The ailerons or flaps are shown in plan in Fig. 9. The ribs are here figured as though they were of equal thickness from back to front, but they may very well taper slightly from the main spar to the trailing edge. The pivots on which the flaps hang are to be of No. 18 gauge cold rolled steel and are shown in detail in Fig. 10.

Bolster and Crossbar

In Fig. 11, I have shown a perspective sketch of one of the bolsters and front end of the outrigger; it also shows the manner in which the outrigger, and the additional piece running parallel with the outriggers and bridging across between the struts to help carry the bolsters, are lashed to the struts. The struts—that is to say, the four center ones—should be prepared to receive these by having additional pieces of wood glued on each side of them; these pieces are then notched to a depth of about ¼ in., and the lashing, which may be either of strong fine cord or fine tinned iron wire, is then put on.

The crossbar in front should also be lashed in as shown. This bar must be of ash or birch, in order that an easy steamed bend may be obtained. I ought to mention that, if tinned wire is used for binding, it is a good plan to pass the soldering iron over the whole of the wire; this converts the lashing into what is practically a jointless metal band.

The bolsters or arm nests may, if the pilot is not very keen on personal comfort, take the form of a plain round piece of wood, but it will be found well

worth the trouble to pad them with millpuff and cover with strong cloth, leather or any other suitable material. A section of the bolster and outrigger are shown in Fig. 12.

into the top hems the outriggers are passed, and into the bottom ones the bent wood strips. The lacing is then done tightly, to keep the cloth in place. The cloth should, of course, be turned

sary only half the number of copper terminating tubes or ferrels that would otherwise be required. The spokes may be used just as they are, and the head with the turned over end makes quite

Fig. 9—Dimensioned drawing below shows the details of frame for aileron flaps

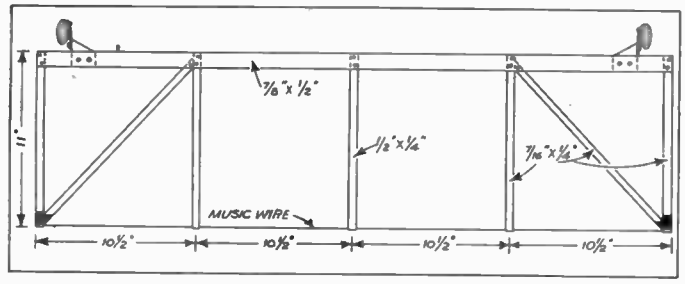
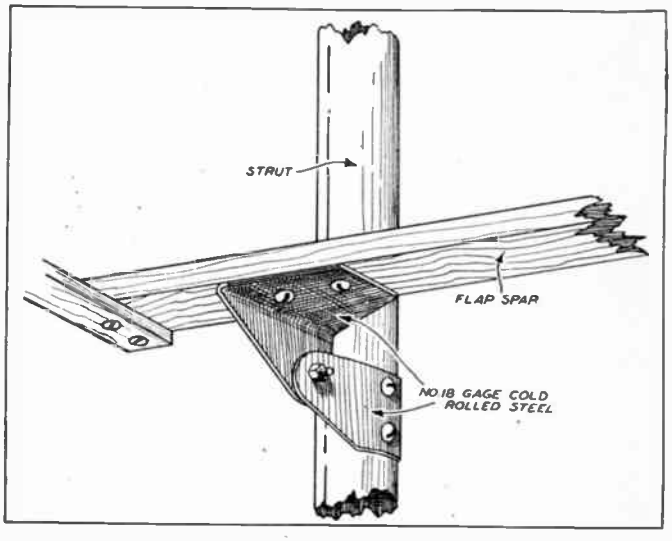


Fig. 10—Perspective sketch at right shows how easily the bearings for the aileron flaps are made



Tail Plane Construction

The tail plane can next be made. As it is clearly shown in the plan view, Fig. 3, no special sketch is needed. Ribs measuring ½ in. by ⅜ in. will be screwed to the spars, and wired at the trailing edge in the same way as the main planes. No steaming of the ribs will be required, since there is no camber, the tail being quite flat and acting only as a stabilizer to steady the glider longitudinally in flight. The main spars are clamped to the outriggers with four V-bolts, as shown in detail in Fig. 13. As shown in the perspective view of the glider (Fig. 2), there are two

over and stitched along the front and back edges, a part of the lacing cord or wire being also sewn in. Three or four screws with countersunk heads are then passed through the skids into the bent wood strip. A sketch of the short strut which requires to be placed in the fork of the outriggers and skids is given in Fig. 14. The drawing shows plates of brass of about No. 20 or 22 gauge secured to the outrigger by wire binding; the wire may well be soldered to the plates as additional security against slipping.

Spokes and Nipples for Turnbuckles

With the object of lessening the cost

a simple attachment on the lugs of the aluminum sockets. A steel plate, shaped as shown in Fig. 15, is needed for each brace to take the wire and spoke nipple. To stiffen this plate and also to act as a bearing surface when tightening the spoke—a piece of No. 20 gauge brass between the steel and the nipple head is used.

In the sketches, Fig. 16, I have endeavored to illustrate the method of attaching the spokes to the outriggers, at the points shown in the side elevation (Fig. 3). The binding here is of wire, and soldered.

With regard to the fabric of this ma-

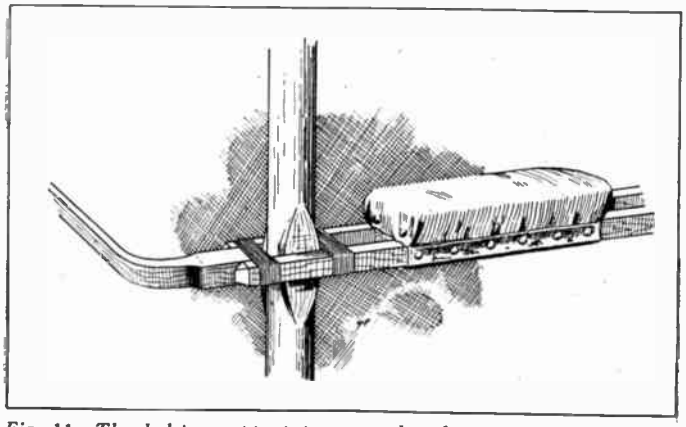


Fig. 11—The bolster support to go under the arms of the pilot is well padded

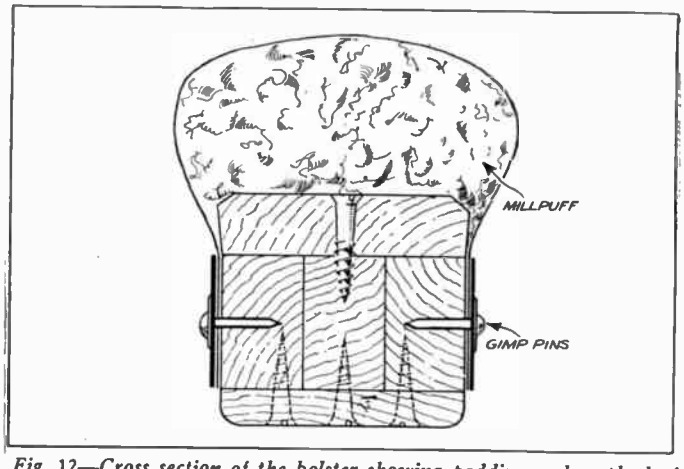


Fig. 12—Cross section of the bolster showing padding and method of attachment

vertical directional vanes or fins underneath the tail plane. The method of securing these is indicated in Fig. 3, namely by lacing with fine cord to the outriggers and a strip of bent wood screwed to the trailing skids. The fabric is carefully cut to shape after the skids are bent, and a deep hem sewn along the top and bottom;

of this glider, I have shown no turnbuckles of the right and left-hand screw type, with the exception of those two which are used to regulate the angle of the tail. Instead, I suggest the use of motorcycle spokes and nipples. This will not only save the cost of the barrel turnbuckles, but will also render neces-

chine, almost any light cloth is suitable, from calico to oilcloth. Proofed cloth, such as oilcloth, for gliders, especially when the planes are single-surfaced, is not at all necessary and a good strong unbleached muslin can be obtained at less than a quarter a yard, 38 in. wide, weighing somewhere in

the neighborhood of 2 ozs. to the square yard, the cloth is fastened to the ribs with waterproof glue (ordinary glue containing linseed oil), the edges where the fabric is turned over the entering edge or over the wire at the trailing edge being cut into a few gores. An overlap of about two inches should be allowed. The cloth should run with the warp across the plane, so that the width will be just sufficient to stretch over three ribs with, at the ends, an allowance for turning over on to the sides of the ribs. Glue and brads will be used on the ribs where one piece of cloth overlaps another. The fabric is, of course, applied on the underside of the planes.

The normal angle of incidence of the sustaining surfaces will be about 1 in 8 or 7°, so that the tail plane, being non-lifting, will be set at this angle to the main planes.

How to Use a Glider

The art of using a glider is an important point to consider. Two methods confront us, namely,—towed and free flight. For one who has never flown a glider, the latter is by far the best and safest. Locate a hill with a gradual slope of about 1 in 8 and with the aid of two assistants you can readily be launched into the air. For free flight it is necessary to have a wind of from 10 to 15 miles an hour blowing. The pilot takes his position in the center of the machine, supporting its weight. The assistants grasp the ends of the glider to steady and when the signal is given all three start running downhill in the face of the breeze, the pilot keeping the glider at a negative angle as much as possible until ready to soar, when by pulling the nose of the machine up a bit, he will soon find himself dangling in the air. The assistants should release the glider as soon as they feel it tugging. Towed flight is carried out in about the same manner, except that ropes are securely tied to the lower, front sockets next to the end struts and by these ropes two or three assistants on each, tow the glides in flight. The speed or pull of the helpers in this case merely substitutes for the wind in free flight. An automobile or motor boat can be resorted to for towed flight, but it is advisable to first master free and hand-towed flights before attempting something of greater power.

The weight of the glider, which I have described, should come out at between 50 to 55 lbs., the latter figure being the maximum permissible for a glider of this size.

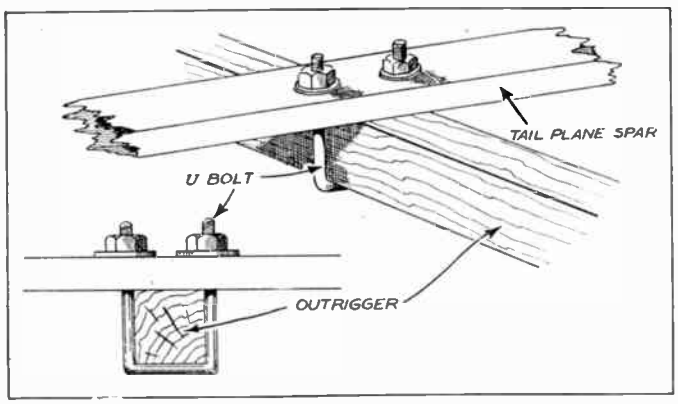


Fig. 13—Details of the clamps used to attach the outrigger to the main tail spars

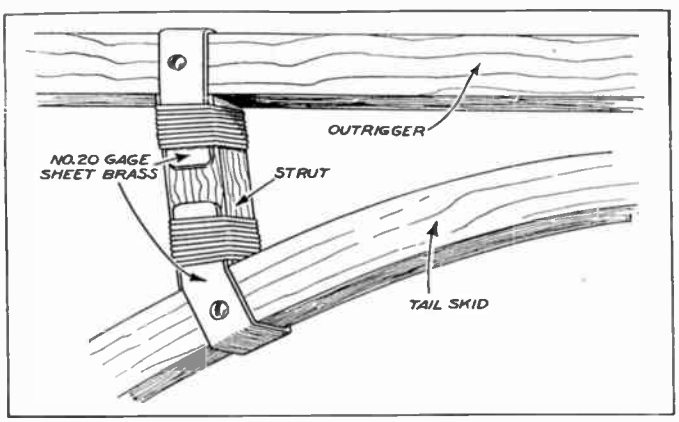


Fig. 14—Details of attachment of the strut between outrigger and skid

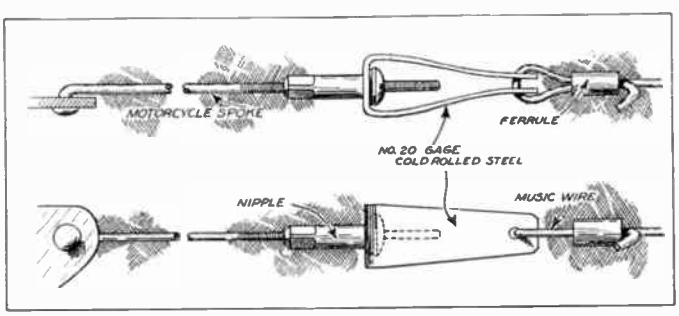


Fig. 15—A simple improvised turnbuckle shown above made of a motorcycle spoke

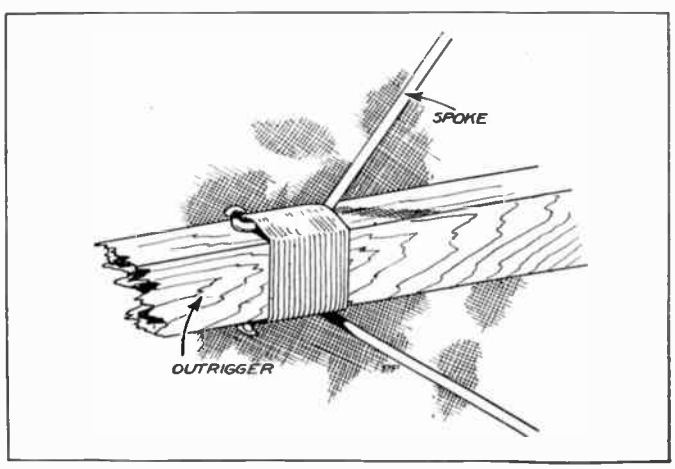


Fig. 16—Detail at right shows how spoke ends are wired to outriggers

By using two megaphones, one at each end of a base line twelve feet long, the position of an aeroplane can be located within a few tenths of a degree by the sound of its exhaust.

TECHNICAL TERMINOLOGY—

THE old engineer, says an exchange, had become tired of the deeply technical talk he heard from various young engineering students he met at his club who liked to air their newly acquired knowledge to their non-technical friends. One evening he began: "This morning I went over to see a new machine we've got at our place, and it's astonishing how it works." "And how does it work?" asked one. "Well," was the reply, "by means of a pedal attachment a fulcrumed lever converts a vertical reciprocating motion into a circular movement. The principal part of the machine is a huge disk that revolves in a vertical plane. Power is applied through the axis of the disk, and work is done on the periphery, and the hardest steel by mere contact may be reduced to any shape." "What is this wonderful machine?" was asked. "A grindstone," was the reply. This brings out very well the weakness of most technical writers, the effort seems to be to make easy things hard instead of the most desired end to attain, that of making difficult things understandable.

It is now claimed as the result of experiments that cyanamide has a toxic effect on corn; it does not decompose into urea and so gives no useful nitrogen to plants.

The Berliner Gyrocopter

A Man Carrying Flying Machine Without Wings That Works

THE gyrocopter illustrated herewith, Henry A. Berliner's new adaptation of the old helicopter principle, when tilted forward will fly horizontally, the tilting being accomplished by changing the center of lifting pressure. The weight of the machine is given as 620 pounds and the lifting power is over 900 pounds. The lifting propellers are 13 feet in diameter and revolve on a horizontal plane. They are driven by an 80 H.P. La Rhone motor.

It is believed by the inventor that this principle could be applied to an airplane and enable it to rise from a small area or descend in a small field, a very desirable feature. The propellers are driven by bevel gears, and turn in opposite directions and at the same speed. The driving gearing is housed in an oil-tight casing at the bottom of the vertical bearing member that serves as a housing for the propeller shafts, the inner one telescoping into the outer one. The inner or longer shaft drives the upper propeller, the lower propeller is driven by the outer and shorter one.

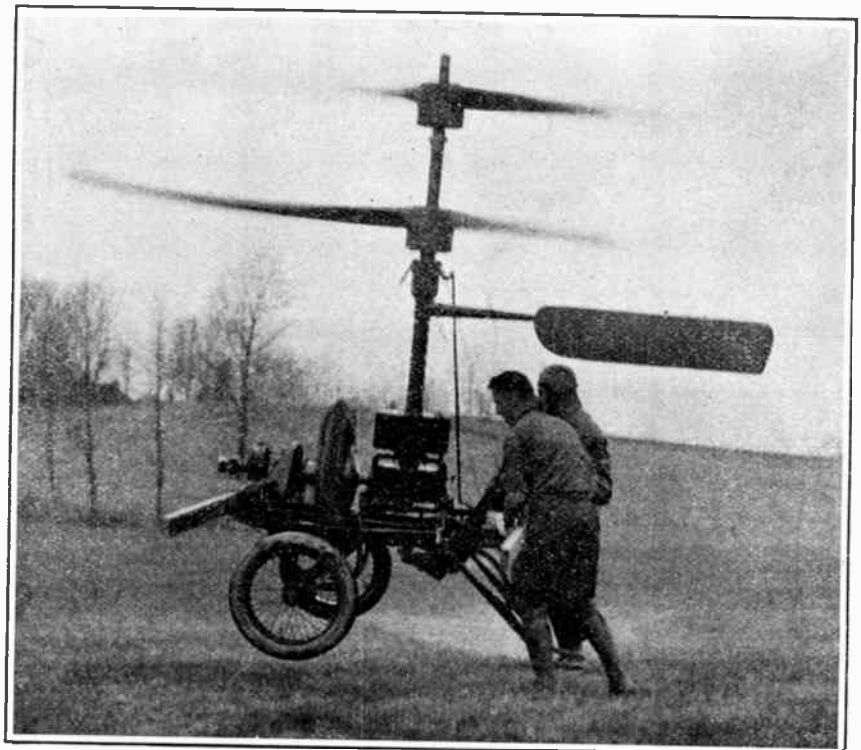
The fuel and oil tanks are disposed around the central mast, which also carries a rearwardly extending vane member presumably to steer the machine to the right and left. The construction of the machine is very simple, and not only the lifting force but that resulting in forward motion is derived from the large propellers. The reason the propellers turn in opposite directions is that this neutralizes the forces tending to rotate the machine around its vertical axis, as would be the case if both propellers turned in the same direction.

The machine illustrated is the result of years of development by the father of the present experimenter, Mr. Emile Berliner, and the basic principles of this class of aircraft were known several decades ago. The formerly existing lack of light power plants retarded development of such apparatus, as more thrust is required for flight than is needed to take an airplane of the same weight off the ground. The photograph of the machine herewith is a particularly interesting one because it shows the wheels and rear skids clear of the ground and that the pilot is seated in the frame so the machine has lifted his weight as well as that of the machine. The efforts of two assistants are needed to hold the machine down and keep it from screwing its way through the air.

No extended flights have been made to date with this type of aircraft so the efficiency of the methods of controlling its flights can only be conjectured. A drawback of the machine as at present built is that there seems to be no safety devices to prevent rapid descent in event of the engine stopping in mid-air. Some adherents of this principle have stated that in such an emergency, the large propellers will act as a windmill and as they rotate, they will prevent rapid falling of the apparatus. It is also claimed that a parachute will safeguard the aviator in such an event.

These devices are yet in the experimental stage, but considerable progress has been made in the practical application of theoretical principles that have long been held workable by experts. Multi-engine helicopters may be developed in the future that will provide safe and rapid aerial transportation, but at the present time the other types of aircraft using the sustaining power of gas or the litfing effort of the air under inclined aerofoils fixed to a rapidly moving central fuselage are the most practical for aerial navigation.

Other helicopter types have been devised, some having a third propeller for imparting horizontal thrust and secure forward motion without having to tilt the apparatus and have the lifting screws exert an angular thrust instead of a purely vertical lifting effort. It is recognized by its inventor that considerable experimental work will be required in perfecting the machine so it will be readily controllable. It was the intention of the originator of this form of aircraft, Mr. Emile Berliner, to try his experiments over water with a machine equipped with floats and fly low so even if the engine did stop during the preliminary experiments, it would be attended by no more serious effects than ducking the operator and wetting the machine. While considerable development work is yet to be done, this machine offers interesting possibilities for the future.



Photograph showing the Berliner gyrocopter lifting its weight and that of the pilot clear of the ground by its own power

TO REMOVE GREASE FROM MERCURY

TO cleanse mercury, first put a ten per cent solution of nitric acid in an iron ladle, and then the mercury to be cleaned; place same over a blacksmith's forge until the nitric acid boils. The dirt will then rise to the top, and leave the mercury perfectly clean in the bottom. Care must be used not to let the mercury boil, as the fumes are very poisonous.

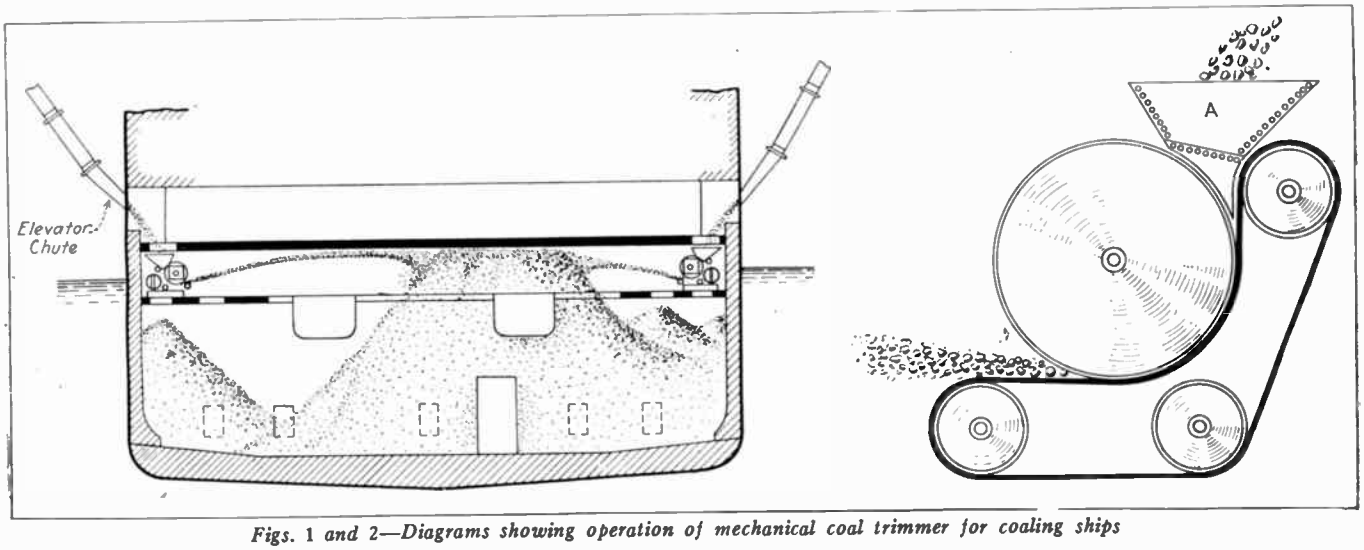
The formation of iron ore by bacteria has been investigated by E. C. Harden of the U. S. Geological Survey. He found "iron bacteria" actively engaged at considerable depths below the surface. Laboratory cultures were successfully made for investigation.

EVERYDAY SCIENCE NOTES

BY PROF. T. O'CONOR SLOANE

A MECHANICAL COAL TRIMMER

The hand-trimming of coal in loading a ship or in filling her coal-bunkers is at once an expensive and anything but a sanitary operation. The work is done shovelful by shovelful, by a large gang of men in an atmosphere charged with coal dust. The illustrations show an apparatus for trimming by power, and thereby dispensing with hand labor. The machine is comparatively simple and compact, and lends itself to the present system of coaling. In Fig. 1 the details of the appliance are shown. The coal is delivered by spout or any other type of conveyor to the hopper A. The large drum shown in section is some thirty inches in length, and the belt is 27 inches wide. The drum is grooved. The belt travels at high speed, varying with the work it has to do—3,500 feet a minute is a speed adapted for mixed coal. A thirty horse-power electric motor does the driving. The speed is varied by a controller. As the coal falls into the space between the belt and the drum it is driven through at high speed, and flies out at the other side to any desired distance, and can be directed to any part of the bunkers. The relation of machine to the ship is shown in Fig. 2. The coal is shown arriving in the ordinary way through tubes. As it falls from the ends of the spouts, instead of being trimmed back by hand to the remote corners of the bunkers, it is seized between drum and belt and projected, as indicated, clear across the bunkers to the back upper corners, so as to fill them in the most complete manner, certainly more thoroughly than would be possible with shovel-trimming. The operator at the controller regulates the speed of the motor from 900 to 1,200 revolutions per minute, according to requirements.



Figs. 1 and 2—Diagrams showing operation of mechanical coal trimmer for coaling ships

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In England efforts or experiments in the use of compressed gas for driving automobiles have not ceased with the war. It is found that coal gas compressed to thirteen atmospheres is thirteen times as bulky as gasoline of the same propelling value. This feature alone is held to limit the use of gas to a radius of action of only ten or twelve miles.

A new high-speed steel, with vanadium and molybdenum instead of tungsten is reported as having given excellent results. Ingots of molybdenum steel are liable to show cracks and tools made from it are erratic in behaviour. The use of vanadium is said to overcome these troubles. Another steel containing cobalt and chromium is reported as holding its volume, when hardened, so that it is adapted for standard taps and dies. Stainless steel, with about 13 per cent. of chromium has been hardened from a temperature of 1740° to 1830° F., which are very high hardening temperatures. The same steel has to be drawn at a low temperature. Among its uses it proved to be very good for the exhaust valves of aeroplane engines.

There has been much difficulty in England in bringing the manufacturers to work to a uniform gauge system. The English manufacturer is individualistic, but during the war limit gauges had to be worked up to, and it seemed as if the old system had been disposed of, but it is said that it is reasserting itself, and some factories, it is said, never did reform their methods. Just before the armistice, 10,000 inspection gauges per week were being turned out. Limit gauges, one too large and one too small, were made so much of a size as to exact an accuracy many times that employed in the standard English engineering practice.

The annual report of the Panama Canal Sanitation Department shows that the mosquito is not so completely disposed of as had been believed. The insect can and does go further afield from his breeding place than was formerly believed. He travels over a mile, which implies that the drainage must be more extensive than was formerly believed necessary. The sanitation of the Isthmus is not so perfect, but that the recommendation is made that the staff should be away for two months every year. A curious note is to the effect that it is important to keep cattle away from dwellings, because their deep foot-prints fill with water and form breeding places for the mosquito. It is definitely known that the mosquito is the disseminator of fevers.

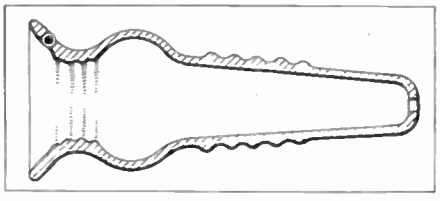
Australia has long been afflicted with a rabbit plague. Now a new trouble is making itself felt; this time it is prickly pear plague. These annoying and almost useless plants are invading vast areas of country. To kill them, various forms of arsenical poison are employed and the government in Queensland is taking a part in the work of extermination. It costs about 50 shillings an acre to kill the plants, so it is of poor economy to do it except on valuable land. Potassium compounds can be made by the aid of the ashes, but the expense of transportation makes this process of little value. The ashes are 10 per cent. of the weight of the dried plants, and they give about half their weight of the potassium salt. The plants have covered 22 million acres in Queensland, and are spreading over an area of a million acres annually. Some alcohol can be made from them, but in small percentage only; it has proved to be of little use for paper-making; attempts to use it as a reserve food for cattle have had a measure of success.

England is expressing some anxiety about the gasoline supply. The consumption is in the neighborhood of three thousand millions of gallons per annum. Potatoes may be made a source of alcohol, as a gasoline substitute, but the yield is only twenty gallons per ton. The mahua tree flowers which grow in India do much better, giving ninety gallons per ton of dried flowers. The cost of a ton of the flowers is put at thirty shillings sterling. Cheap denaturing is a problem not yet solved in Great Britain. It costs about six pence a gallon. There are hopes that benzol and the distillates from shales may help to solve the problem. In Norfolk, England, wells are evolving natural gas, and hopes are entertained that oil may yet be obtained there.

Froth separation, or oil separation, long in use for certain ores by floating them in a sort of oily foam, is being extended to other minerals, and is being developed to cover a larger range of minerals. Its applications promise to become far more numerous than hitherto in the near future.

THE BI-JET WATER HOSE NOZZLE

The cut shows a new hose-nozzle, recently introduced in England, to be used for washing automobiles and other purposes, which gives as desired a strong jet of water or a distributed and soft stream. The jet is formed by the round aperture in the inner end of the nozzle. As long as it is left un-



disturbed the strong jet, once started, continues. But if the hand is placed over the larger open end of the jet for an instant the effect is to break up the stream, and, on removing the hand the soft and distributed stream continues to flow indefinitely. To restore the strong jet, all that is necessary is to give the nozzle a sweeping transverse jerk. The nozzle then returns to its old function and a continuous strong defined jet is again produced.

As a lubricant for wood the use of graphite, rubbed off from a lead pencil, of talc powder or of paraffin wav from a candle, is recommended in preference to the much used soap. The latter sinks into the wood and is therefore not permanent. The above recommendation was made especially to photographers for lubrication of shutters where wooden surfaces come in contact.

The vibrations of a reinforced concrete chimney in Saganoski, Japan, have been measured. The chimney is 750 feet high and 26 feet 3 inches internal diameter at the top. In a 50-mile gale it vibrated less than one inch; in a 78-mile gale the vibrations had a range of 7.32 inches. It is calculated that with a wind velocity of 110 miles per hour, the vibrations would extend to 15 inches. Such winds are to be anticipated in that locality. The period of vibration was practically constant, 2.52 to 2.56 seconds. The maximum amplitude of vibration was curiously enough at right angles to the direction of the wind.

A gas well in California recently caught fire. It is thought that the friction of sand carried up with the rush of gas heated the upper two feet of the pipe red hot and effected the ignition. Dynamite and streams of carbon tetrachloride were used to put it out. The dynamite proved successful. On the explosion taking place, a deep red glow appeared, followed by a black puff and the fire was out.

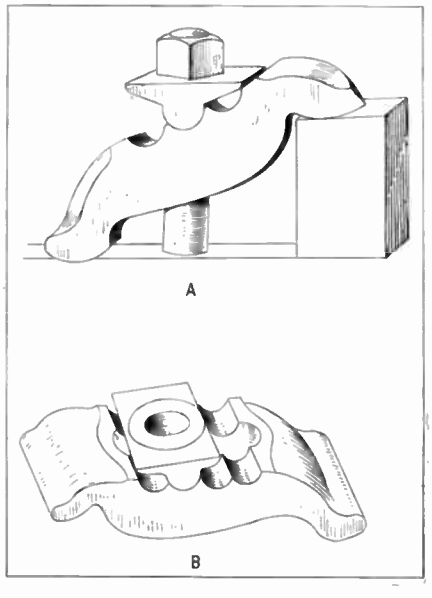
A recent investigation of the failure of the Ridgeway storage dam in Tasmania brought out the interesting fact that the sand used in making the concrete contained considerable magnesia and that this accounted for the failure. It is seldom that it occurs to an engineer to have sand analyzed, although the cement may be subjected to the most rigorous requirements.

In West Virginia near Fairmont and Clarksburg there are wells which reached a depth of 7,579 and 7,386 feet, respectively. They were bored to reach the Clinton sands for oil. At Czuchow, Germany, there is a 7,348-foot well, and near MacDonald, Pa., there is one 7,248 feet deep. These are said to be the deepest wells in the world. The deepest metal mine is said to be at St. John del Ray, Brazil. It is 6,326 feet deep and increases 1° F. in temperature for each 120 feet of depth. Some of the workings are as hot as 110° F. It is a gold mine, and is 80 years old.

A rapid and approximate analysis of air to determine the percentage of carbon dioxide present is effected by drawing it at the rate of two litres per hour, through a solution of barium hydrate in water. It is calculated that the formation of a precipitate in two minutes will indicate the presence of 4 volumes of carbon dioxide to 1,000 volumes of air. If twenty minutes are required to show a precipitate the proportion is only 5 parts is 10,000 parts of air. Interpolation will give the results for intermediate periods. Carbon monoxide is oxidized by passing the effluent from the above test through a tube electrically heated, the air being mixed with or acted on by iodic acid. The reaction precipitates iodine, which may be determined by titration, and the percentage of carbon monoxide calculated therefrom. As a check the air after this treatment may be passed through baryta water, just as before, for the carbon monoxide has now been converted into carbon dioxide. Silver nitrate solution will absorb and precipitate sulphuretted hydrogen and sulphur dioxide is absorbed by potassium permanganate. The two last named impurities can be determined in the two solutions by the regular methods.

THE AUTOSET CLAMP

A clamp or dog for holding work on the tables of drill-presses and other machine tools is shown in the cut. Its construction is so simple that a description is hardly needed. A single bolt holds it down, clamping the work upon the bed plate of any machine tool with a slotted table. The

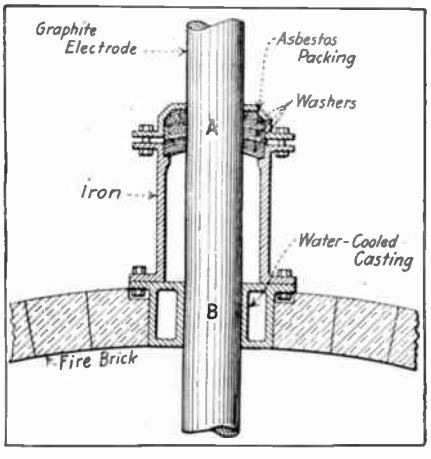


distinguishing feature is the peculiar shape, which has been studied out, so as to make the clamp self adjusting. The semicircular grooves receive a washer with a semi-cylindrical base, and through this washer the holding-down bolt passes. The shape of the washer fitting the groove gives the feature of self-adjusting. The general contour of the clamp carries out this feature still further. The holding-down bolt passes through a slot, and the washer can be bedded in any one of several transverse grooves. The bolt stays vertical in all conditions, and a three-groove clamp will hold work varying from ⅜ to 1½ inches in thickness. A four-notch clamp will hold work up to 2¾ inches in thickness.

A step in the direction of decimalization of standards is a bill for the consideration of the British Parliament, Lord Southwark's bill, to divide the sovereign into 1,000 mills, instead of the 960 farthings it now contains.

PROTECTING FURNACE ELECTRODE

In an interesting paper on electric steel furnaces, by Victor Stobie, what would seem a minor difficulty with electric arc furnaces was spoken of. The trouble, really a very serious one, is the difficulty in saving the electrode from wasting away where it passed through the top arch of the furnace.



The joint there cannot be a tight one and the carbon electrode burns away and makes the leakage greater than ever. The cut shows how this trouble has been overcome. An iron tube, 24 inches long, surrounds the electrode resting upon a water-cooled bushing, and is considerably larger in diameter. At the top there is a reasonably tight joint. As the part of the electrode which passes through this joint is far enough from the furnace to be comparatively cold, it does not burn away, there is no leakage of gases through it, and there is no trouble in keeping it in good working order. When as in former practice the joint was at B, there was endless trouble. It was calculated that 75 per cent of the waste of electrodes was due to burning at the upper ends. The securing of a tight joint and the coolness of the electrode end makes the use of water cooled heavy bronze connections unnecessary, and makes the top of the furnaces more accessible to the workmen on account of the reduced heat.

The area, whose drainage is generally assumed to be effected by some river, is termed the river's watershed. Thus the Mississippi is accredited with an enormous watershed or drainage area, in extent equal to the area of many states. Now it has been calculated that the water flowing in the bed of the Father of Waters as it passes St. Louis is only equal in amount to the rain which falls over the area of the one state of Mississippi. The rest of the rain which falls over the vast watershed disappears by evaporation. The extent of the influence of evaporation on the delivery of water from or by open conduits is taken very full cognizance of by irrigation engineers; they use open channels and wooden trough conduits in their work; and allow a large loss for evaporation. Were it not for the enormous evaporation from the Great Lakes the volume of water pouring over the falls of Niagara would be incalculably large. Besides this loss there is also the evaporation in the land areas before the water of the rainfalls reaches the lakes. The total annual rainfall of the United States has been calculated at six thousand billion tons.

In Derbyshire, England, the government has sunk wells in the neighborhood of 4,000 feet deep in search of oil. Success is thought quite probable. One well has yielded oil for over four months.

New French Aviation Engines

Some Unusual Designs Shown at the Recent French Aero Show

A CAREFUL examination of the engines shown at the Paris Aero Show shows that the aviation engine of the future will probably be of the fixed cylinder water-cooled type with more than six cylinders. This does not imply that the air-cooled engine has been abandoned, but, as power in a single unit is rising, the advantage is more and more with the water-cooled type. Units are being built with 600 to 1200 h.p. and the fixed cylinder, water-cooled type only can be used when high power engines of this type are contemplated. There is a revival of small aviation engines, developing from 30 to 60 h.p., all of the air-cooled type, some having only two cylinders placed horizontally.

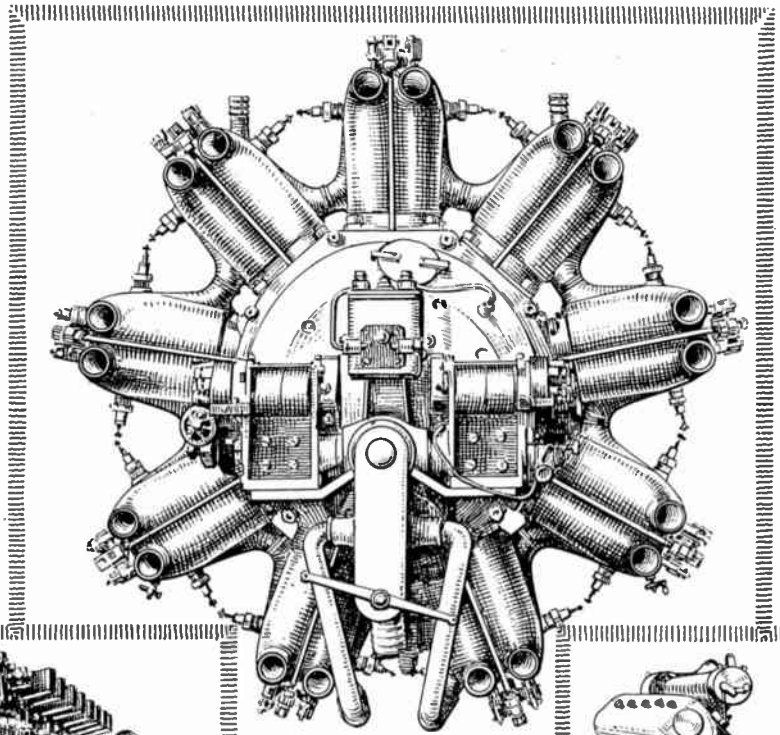
The trend of design is discussed by the foreign correspondent of "Automotive Industries" in a lengthy article from which the following notes have been taken. Engines with geared down propellers are on the increase. As a consequence, piston speed is being increased and higher efficiency is being obtained. At present, piston speed is not high compared with automobile racing practice. The most advanced aviation engines are limited to 2500 r.p.m., giving a piston speed of a little more than 40 ft. per second compared with 70 ft. for racing practice. During the war, engineers were not encouraged to increase engine speed, most of those in authority being prejudiced against and afraid of high-speed engines. Many of the earlier engines, too, developed trouble with reducing gears, and such defects could not be eliminated owing to lack of time.

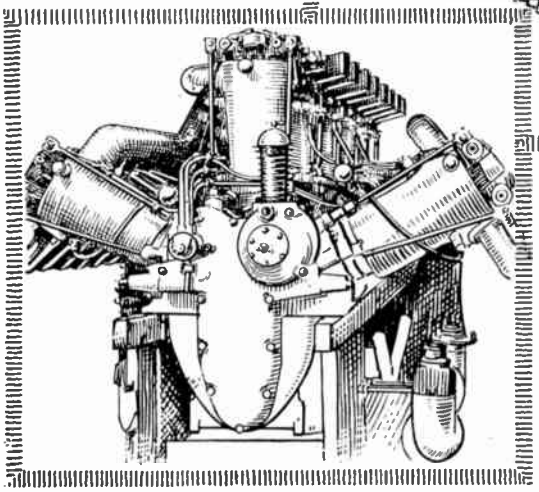
Large Lorraine Engine

The largest engine in the show was the Lorraine-Dietrich 24-cylinder W-type. It has separately forged steel cylinders of 126 by 200 mm., with a sheet steel water jacket common to a pair of cylinders. The four valves are in the head, but are operated from a crankcase camshaft and push rods. The engine is of a direct propeller type and is shown at Fig. 1. It was designed toward the end of the war for use on the big 1919 bombers which were rendered unnecessary by the Armistice, but is now being produced for commercial purposes.

F. I. A. T. Radial or Star Engine

As an indication of the tendency in Europe, the F. I. A. T. has been built in the water-cooled star type shown at Fig. 2, somewhat like the Salmson engine which gave such a good account of itself during the war. This engine has nine cylinders, measuring 130 by 150 mm. and are steel forgings with sheet steel welded-on jackets, mounted around a circular aluminum crankcase. One of the features of this engine is the ingenious manner in which all the intake pipes are put inside. The carburetor is bolted direct to the lowest portion of the front of the crankcase and delivers its mixture to a distributing chamber cast with the case. The intake pipes are steel tubes welded in position when the cylinders are built up and before the sheet steel water jacket is put on. With this arrangement, the intake pipes are entirely inside the water space and the mixture is uniformly heated on the whole of its passage.





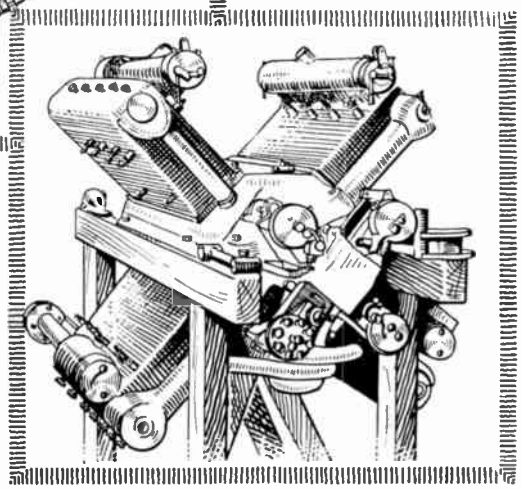


Fig. 1—the Lorraine-Dietrich 24-cylinder engine has three banks of eight cylinders. Fig. 2—The new F. I. A. T. radial or star engine. Fig. 3—The Peugeot 16-cylinder power plant

New Peugeot Motor

A novel Peugeot design, depicted at Fig. 3, is an entirely different type. Sixteen cylinders, in four groups of four, form an X and have rods connecting up to a four-row, three-bearing crankshaft. This is the only X type engine in the Show; the idea, however, is not entirely new, having been adopted by Gobron and others in the

early days of aeronautical science.

In this construction, the cylinders are steel forgings, each group of four being welded to a base plate, and a sheet aluminum water jacket fitted round the group. The heads, which are cast iron and welded in position, also serve to unite the four. There are four valves per cylinder, slightly inclined in the head and operated by an enclosed overhead crankshaft, with a single rocker arm for each pair of valves. Cylinder dimensions are 130 by 170 mm. and the power developed is 500 at 1400 r.p.m.

This engine has a center crankshaft ball bearing and plain bearings for the ends. The tubular connecting rod consists of one master rod, mounted direct on the crankpin and three auxiliary rods, one being in the prolongation of the master, and the two others at 180 deg. to it. Camshaft drive is by bevel gearing and an enclosed vertical shaft for each group of four cylinders. From the camshaft drive gear the magnetos are operated, there being one for each group of four cylinders. The water pump, mounted immediately below the magnetos, is common to the entire engine.

Small Clerget Engine

So far as Continental makers are concerned, there has been considerably less development in air-cooled engines than in the water-cooled variety. Gnome, Clerget and Anzani have remained true to the air variety and have adopted improvements. There appears to be a demand for small engines for single seater runabouts, and here, of course, the air-cooled engine is supreme. One of the smallest is a twin-cylinder horizontal built by Clerget, and illustrated at Fig. 4.

The cylinders, which are only 85 by 100 mm., are steel forgings with machined fins and valves in the head operated by push-rods and rockers. It is stated to develop 16 h.p. It has roller bearings for both the crankshaft and the connecting rods, aluminum alloy pistons, and forced lubrication. The weight is only 48½ lbs.

Gnome has a new low-powered machine, the Z-9, rated at 60 h.p. with cylinders of 84 by 106 mm. The valve in the piston head has given way to a mechanically operated valve in the cylinder head. The internal lock ring holding the cylinders to the crankcase is replaced by studs and nuts. The crankshaft is hollow, but this is used only to cool the internal parts of the engine. The carburetor delivers its mixture to the intake valves by external intake pipes, and in many respects the engine resembles the La Rhone more than it does the Gnome, with which Aviation enthusiasts are familiar.

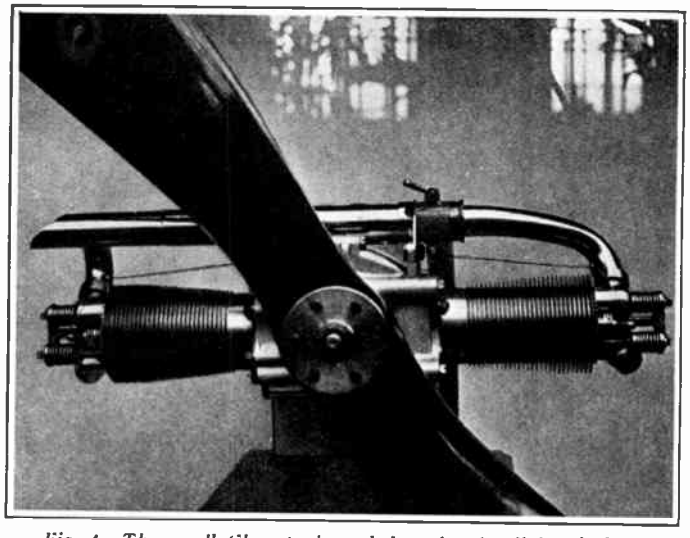


Fig. 4—The small Clerget air-cooled engine for light airplanes

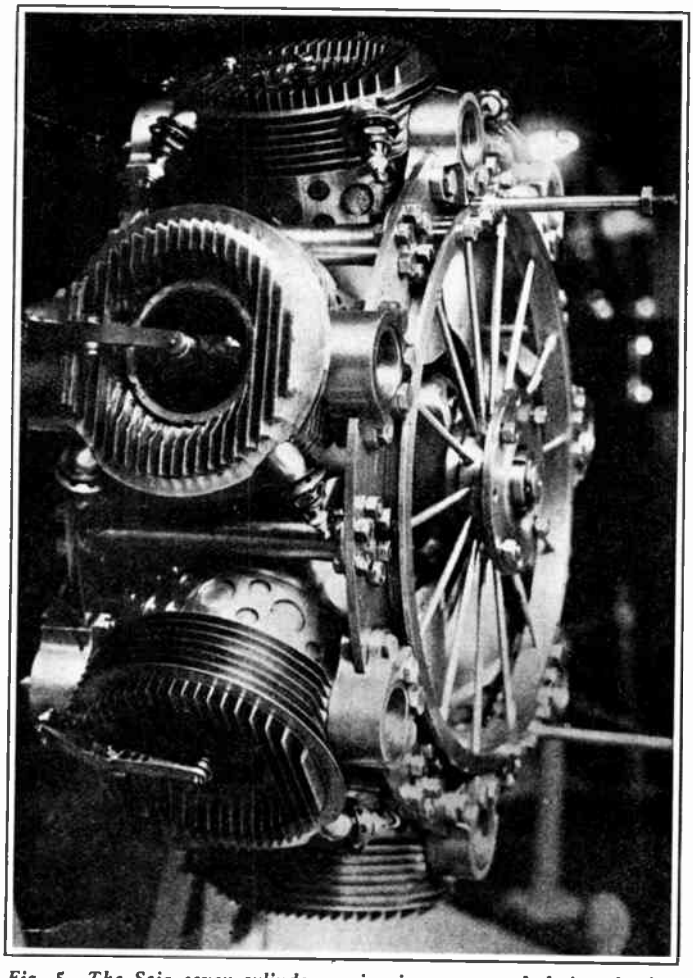


Fig. 5—The Seja seven-cylinder engine is an unusual design, having oscillating cylinders supported by trunnions

Seja is an Unusual Design

The Seja, while a rotary air-cooled type, has distinctive features. The connecting rods are rigidly connected to the aluminum piston, without the use of a wrist pin. The cylinders, however, can oscillate, for they are hung in trunnions, near their head, between a couple of heavy steel rings forming the frame work of the engine. These rings or hoops, have a hub, connected by spokes to the former, and it is in the hub that the single-throw crankshaft is carried. The crankcase is open and the cylinder barrels are cut short, so that at the end of the stroke the greater portion of the piston skirts is uncovered. One valve is mounted in the head and the other is placed horizontally. Cylinder dimensions of this engine are unusual, being 186 by 130 mm. It does not appear that this engine has been in service.

INSPECT WHEELS FREQUENTLY

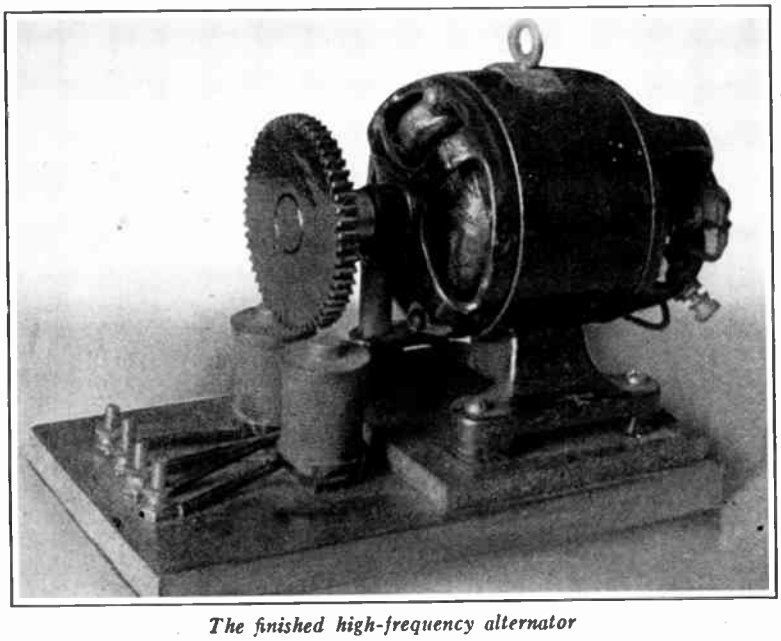
ON all cars having the rear wheels secured to tapered shafts, and most of the popular cars use this construction, care should be taken that the hubs are kept seated tightly on the taper end of the axle by means of the clamping nuts. The rear hub caps should be taken off and the lock nuts screwed up as much as possible without injuring the threads. If this is not done the hub may work loose on the shaft and by knocking against the key will certainly spread the key-way in a comparatively short time. The car should be jacked up when the wheels are tested because a wheel may apparently be tight if the car weight rests on it and yet be loose when relieved of its load. Wire wheels are usually installed over master hubs and locked in position by lock nuts. It is good practice to inspect these lock nuts frequently and tighten same. If a wheel becomes loose on the inner hub it will creak and wear the hub.

THE JUNIOR EXPERIMENTER

A Small High-Frequency Alternator

By Joseph Jordon

THE little machine illustrated in the photograph is easily made and many very interesting experiments can be performed by its use. All that is needed for its construction is a small battery motor, an old gear wheel and a pair of magnets. The motor can generally be found about the junior experimenter's laboratory and the gear wheel can be obtained for the asking at some local garage. The magnets can be wound at home, although those shown on the machine are sold at all large electrical supply houses.



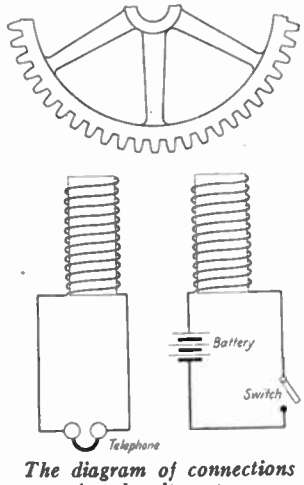
The finished high-frequency alternator

The gear wheel is mounted upon the shaft of the motor. If the hole in the center of the wheel is too large it can be plugged up with a piece of soft brass and drilled out again so that it will fit upon the shaft of the motor. It can be made a tight fit or it can be held to the shaft of the motor with a small set screw. Although the builder should try to make the gear run as truely as possible on the shaft just as a matter of neatness and good workmanship this is not necessary to the working of the device. The size of the gear wheel is not of great importance, but the builder should try to obtain one between the diameters of 2½ and 3 inches. A small battery motor will not drive one beyond this diameter with sufficient speed. Of course, if a larger and more powerful motor is used for this purpose a larger gear can be employed. If the gear is hardened it should be heated to redness and allowed to cool slowly. This process will anneal it and make it more efficient for the use to which it is to be put.

The gear wheel or rotor of the high-frequency alternator should be mounted on the motor shaft so that it revolves over the two magnets which are mounted on the motor base. It should be so mounted that its teeth will come as closely to the poles of the magnets as possible without touching them when it is revolved at high speed.

The connections for the generator are shown in the sketch. When the gear wheel on the shaft of the motor is revolved each one of the teeth on it will act as a pole and these poles will be alternately arranged—one North and the following one will be South. The one magnet of the generator is connected to a direct source of current such as a few dry cells. This sets up a uniform magnetic field and the rotating wheel sets an alternating current in the opposite magnet. This alternating current field will be indicated in a telephone receiver by a hum which will vary in frequency with the speed of the motor. If a rheostat is used in connection with the motor practically any frequency can be obtained. The frequency of the current produced will depend entirely upon the number of teeth in the gear wheel and the speed of the wheel. The intensity of the current will depend upon the winding. The winding of the magnets should be done with very fine wire. No. 28 single cotton covered will be found most suitable. This will produce just about the right E.M.F. in the second circuit which contains the 'phones. The current strength will be very small.

This little machine is an inexpensive experimental device with which many very entertaining experiments can be conducted. Aside from this it can also be used for a very practical purpose in connection with a wireless telegraph outfit. In this work it can be used to replace the conventional buzzer test with which the detector is brought to a



The diagram of connections for the alternator

(*Continued on page* 90)

A Few Facts About Patents

An Explanation of Some of the Fundamentals of the Patent Law

THE patent system is the outgrowth of a very odious system of monopolies which were originally granted by the English Crown in the form of an open letter, from which comes our expression "Letters Patent". This was an open letter under the seal of the Crown, conferring the exclusive right to practice some business in the Realm. These monopolies became particularly objectionable during the reign of Queen Elizabeth, and not long after her reign they were abolished. A statute of James I contained a provision against monopolies being granted excepting to those who introduced new manufactures into the Realm, and this theory still survives in England in the patent of importation, or "communication".

In this country the patent law is based on a clause of the Constitution of the United States which gives Congress the right to grant to inventors, for limited periods of time, the exclusive right to enjoy the fruits of their inventions. A patent, therefore, is a Federal thing, that is, a thing of the Federal Government and not of the States. It is a grant of the exclusive right to make, use, and sell a certain invention for a certain period of time. An infringement consists in the making, using, or selling of the thing concerning which the grant was made, by some other person without authority. Patents are granted by the Government of the United States, under the seal of the Patent Office, and, of course, in accordance with the Statutes of the United States, and the Patent Law is a Statute Law. A patent is a creature of these statutes, and can only be considered with reference to them.

In this country an ordinary patent runs from seventeen years from the date of issue, not from the date of filing the application.

The following paragraph is Section 4886 of the Revised Statutes of the United States, as now amended. It is the fundamental basis of our patent law, and is worthy of careful reading, as every word means something.

"Any person who has invented or discovered any new useful art, machine, manufacture, or composition of matter, or any new and useful improvements thereof, not known or used by others in this country, before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceeding had, obtain a patent therefor."

Considering the separate phrases, we have, first—"Any person who has invented or discovered." This means that the application must be made by the inventor; no one else can make it; otherwise it is void. If two persons jointly invent, and one files a sole application, or if two file a joint application, on an invention made by one of them, no valid patent can issue on that application. So the person who furnishes the money, or a mere assignee, cannot make the application—it must be made by the inventor.

Next in the statute are the words: "Any new and useful". Of course a thing must be new, for this is the fundamental idea of a patent.

If a thing is not "useful", no patent should be granted, but on the other hand, a small degree of utility will support a patent. If a thing is really harmful, the patent is void. For example, a device for perpetrating fraud on the public would be void.

There was a case in Connecticut of a patent on a process for producing tobacco in imitation of certain high-grade Cuban tobacco. It was found at one time, that in a certain district in Cuba there was a parasite or fly which by biting the leaves of the tobacco plant caused little white spots to appear, and the public got into the habit of looking for these spots and recognizing them as the mark of the tobacco of this particular district. This man in Connecticut conceived the idea of going out in his tobacco fields and spraying a certain solution on the leaves, and thus reproducing these white spots. He got a patent on this, though with considerable difficulty, as the Patent Office held that it was a fradulent thing.

He stated, however, that this invention made the cigars more free-burning, and on that ground a patent was granted. He prospered in this business for some time, until some other man decided that he would try it also. This brought up litigation, and the judge without hesitation held the patent invalid, resting his decision on the grounds of lack of utility. He said that there was no proof that the cigars really were more free-burning, though he seemed inclined to rest his decision on the broader ground of the essentially fraudulent nature of the business.

What constitutes novelty? "Not known or used by others in this country before his invention or discovery." If used in a foreign country, it does not affect an American patent, unless it can be shown that it is an idea brought home by the inventor, in which case the patent is void. If a man goes abroad and seeing something over there that seems to him meritorious, comes home and patents it, obviously he has not invented it. If, however, a man in this country invents a thing in good faith, the fact that it was used abroad is no bar to the patent, provided the thing was not "patented or described in any printed publication in this or any foreign country before his invention or discovery thereof." This relates to the date of his invention and not to the date of his patent. To grant to a man a patent on a thing that has been described in a printed publication before his discovery of it would be bad practice, because he might have read that publication, and in any event it would not be new, for the world would be in possession of the invention. But if he had invented it in good faith before this publication was issued, he could file his application in this country within two years of that publication; otherwise it would be void.

Referring again to the statute we find the phrase: "Not in public use or on sale in this country for more than two years prior to his application." This means that a man cannot make an invention and allow his device to go into use or to be sold to the public for an indefinite period, and then obtain a patent; he must file his application within two years from the time such public use begins. The question is, what constitutes public use, and this question is a very difficult one.

For example, in the case where a pavement has been laid for six years on a toll road near Boston, it was held not to be in public use. The reason for this decision was that the pavement was held to be experimental, having been put down to determine whether it was serviceable. It was placed in front of a toll-gate, where the horses had to stop and start, and where the work on the pavement was the heaviest. Every few days the inventor would examine the pavement, would discuss it with the men, and find out every detail regarding it. He was held to have been experimenting, but that was an extreme case.

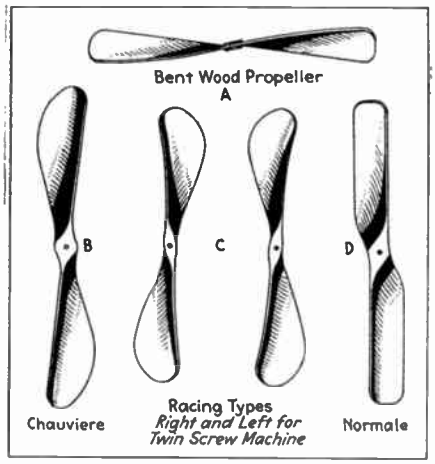
When a man has finished with his invention when he is satisfied the thing is good, although capable of further improvements, then the use becomes public use under the statutes. Ordinarily, when he begins to derive profit, it constitutes public use.

How to Make a Small Propeller

By Paul F. Wilber

TO make an air propelled ice boat, wind wagon, canoe, or possibly a light aeroplane to fly with a motorcycle engine; it will be almost necessary to make your own propeller. It will take a very small amount of wood, but some time and patience. If you are successful the first time, you will feel well paid for your work.

There is very much experimenting going on with propellers today, and for



Forms of model propellers

an engineer to design a propeller, figure the different stresses, and estimate what it will do when completed, he will have to use as many different formulae and mathematical rules that would fill a real large text book.

In designing this propeller we will use a lot of guess work, just plain every day figures, and some good common sense. For an example, we will take a propeller seven feet in diameter, six feet pitch, a blade eight inches wide, and a hub four and three-eighths inches thick. After studying this closely you should be able to design a propeller with whatever dimensions you would think best for your needs, and no doubt it will work as good as any propeller you would purchase.

Small propellers can be made of white pine or spruce, but for a motor of fifty horsepower or more, it should be of some heavier wood, as mahogany, walnut, ash or gum. We will use spruce; five boards seven feet long, eight inches wide, and three-fourths of an inch thick.

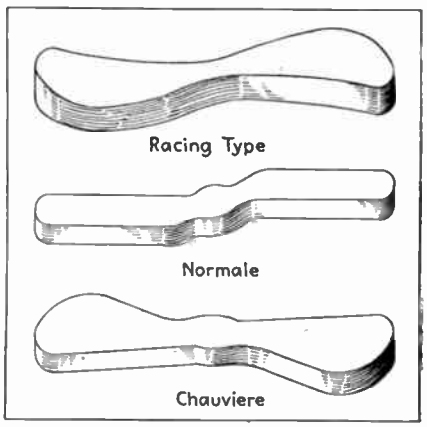
If you have no clamps, Fig. 5 shows how to make seven clamps that will answer the purpose very well. All you need is fourteen pieces of some hard wood, twelve inches long, four inches wide and two inches thick. Bore holes for half inch bolts one inch from the end. Also fourteen carriage bolts eight and one half inches long and a good wrench to draw them down.

The propeller should be glued up in a warm room with hot glue and the clamps screwed down until the glue comes out between all the layers of wood.

After it is glued up as in Fig. 1, lay out the shape as in Fig. 2. This will be called the face side of the propeller. The hub is five inches in diameter. Square a line through the center, down the side, and across the back, to get a center on the edge. Draw the line L through the center. The lines E come to the edge of the hub. The radius H and I to be what ever looks good to the eye. After sawing this out on the band saw, you have a block as in Fig. 3.

Now we will explain the pitch and how it is figured that anyone with a small knowledge of arithmetic can arrive at intelligent conclusions.

The pitch of a propeller is the number of feet or inches it moves ahead in one revolution *without any slip*. In



Blanks for small model propellers

other words, the blades of a propeller, with a pitch of six feet, are placed on such an angle as to screw it through the air six feet in one revolution, providing it was revolving in a solid medium, but as air is yielding there will be slip. A propeller is not efficient unles there is a slip. Too much slip and a propeller would be inefficient and also too little slip and it would also be inefficient. Some air must be

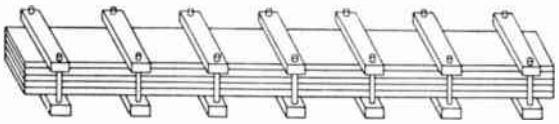
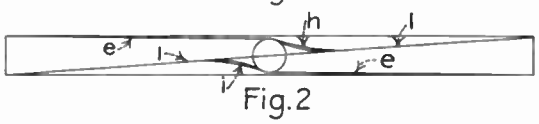
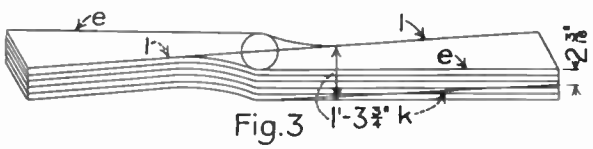
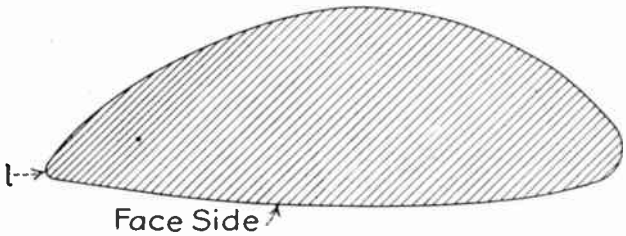
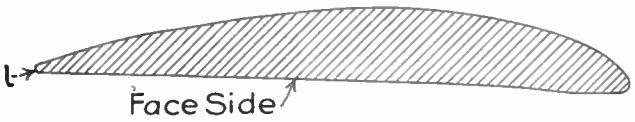


Fig. 5









Diagrams showing steps in constructing small air screw described in accompanying article

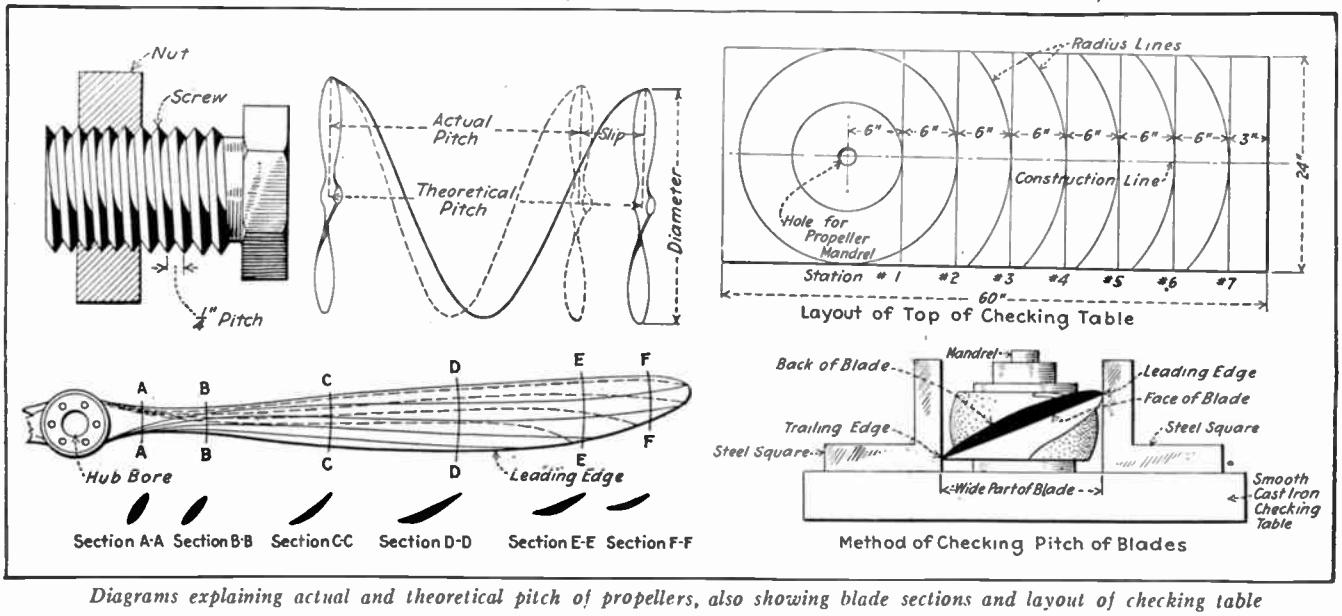
piled up back of the propeller to produce a reaction on the volume of air driven back. A slip of ten to twenty per cent is most efficient, although some propellers are very efficient at twenty-five per cent. Anything over this would be very poor. Therefore, an efficient propeller should have a slip of not more than twenty-five per cent.

The efficiency of a propeller begins to fall off at about fifteen hundred revolutions per minute, some at a lower speed than this; about twelve or thirteen hundred revolutions. Most aerial propellers run at about fourteen hundred revolutions. You should judge your pitch according to the speed of your motor and the speed you expect to make with your machine. A simple formula in plain figures to find the pitch follows:

The diameter in inches, times 3.1416, divided by the width of the blade in inches, times the angle of the blade in inches. This gives the pitch of the propeller in inches, but the next step in making the propeller is to find the angle of the blade in inches. The pitch in our case is six feet.

First multiply the diameter in inches, which is eighty-four, by 3.1416 to get the circumference, which will be two hundred and sixty-four inches. Divide by eight (the width of the blade in inches), which will give thirty-three. The pitch in inches is seventy-two, divided by thirty-three, is two and three-sixteenths. The angle of the blade in inches, or the difference between the leaving edge of the propeller, which is the line L, and the entering edge, which is the line K. Measure two and three-sixteenths inches down from the face side of the block, as in Figure 3, which will be one of the points for the line K, and the entering edge of the propeller when finished.

A propeller should have the same



Diagrams explaining actual and theoretical pitch of propellers, also showing blade sections and layout of checking table

The illustration at the right depicts the method of weighing and balancing the small propellers used for models. The use of a jig saw in cutting out laminated blanks is shown below

After model propeller blanks are roughed out they are worked down to approximate size and blade form with a draw knife and are finished on a small sanding wheel before varnish is applied

pitch near the hub as at the end of the blade, but as it does not move as fast at this point as at the end, the angle of the blade will have to be greater, so we will go through the same formula as we used to find the blade angle at the end of the blade to find the blade angle one foot from the hub, making the other point for the line K.

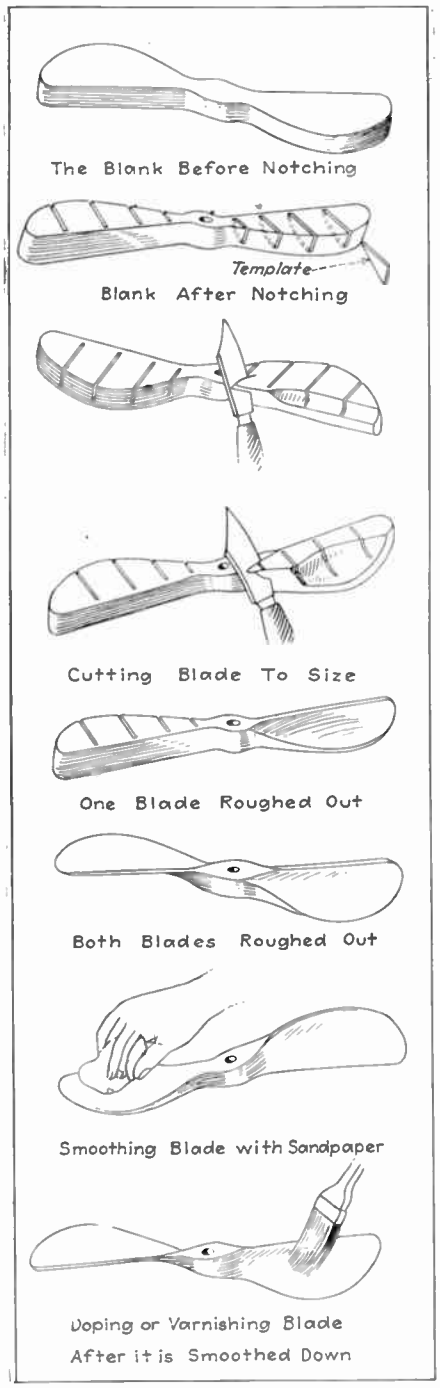


Diagram showing steps in working down small model propeller blank to finished product with ordinary knife

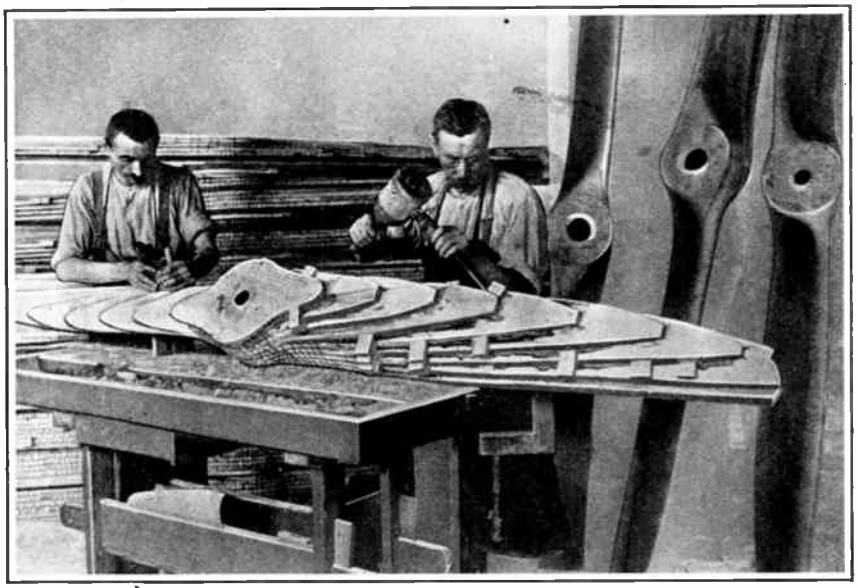
One foot from the center of the hub will be circumference of two feet, or twenty-four inches, times 3.1416 will be seventy-five and one-half inches, divided by the width of the blade at this point, which is four inches, = nineteen. The pitch (seventy-two inches) divided by nineteen = three and three-fourths inches. The angle of the blade in inches at this point.

Measure down the face side one foot from the hub three and three-fourths inches, making the other point for the line K. By laying a straight edge on the two points and drawing a line, will give the pitch line or the line to cut to. Now cut the face side down, cutting from the line L to the line K with a draw knife, gouge, or paring chisel. When nearly to size use a spoke shave or block plane. This side will be the face side or front of the propeller when finished and should be slightly concaved, about an eighth of an inch, but close to the hub it will round out the shape of the hub. Fig. 6 shows a cross section of the blade one foot from the hub and Fig. 7 shows a cross section near the end of the blade.

Make a pattern as in Fig. 4 of some heavy paper; mark the shape out on the finished side of the propeller, afterward cutting the shape out on the band saw.

The back is easy and one is more liable to get it too thick than too thin. By using a pair of calipers and calipering each blade at different places you can get them about the same thickness. Some of the manufactured propellers have a variation of three-sixteenths of an inch.

The entering edge should be rounding, about one-quarter of an inch, but the leaving edge should taper to almost nothing. In shaping the hub, use the eye entirely. It will be very easy, as it tapers off quickly into the blade.



In making large airplane propellers skilled workmen work them the laminated blanks down with plane and chisel

The blades must be balanced, by driving a nail in each center and resting the propeller on two sticks. Take off the back of the blade that is the heaviest.

The whole propeller should be well sanded with first coarse and then fine sandpaper, then given two coats of shellac and one coat of varnish. Be sure and get it on smooth, as two coats on one blade and one on the other will throw it very much out of balance.

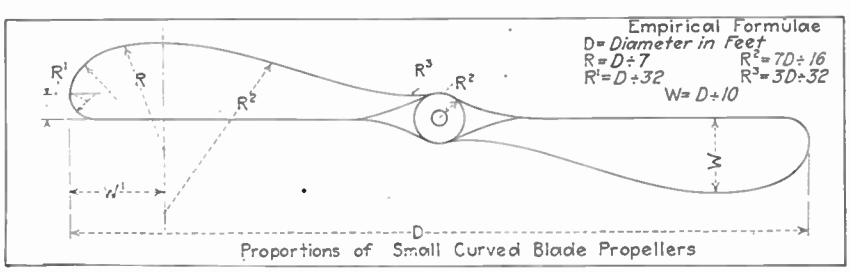


Chart showing empirical formulae for proportions of small propellers

If you use a motor running from fifteen hundred to two thousand revolutions, it should be geared to the propeller, so the propeller will make from one thousand to twelve hundred revolutions.

If the motor is to run one thousand revolutions and the propeller is too large for it, so as to lower the speed of the motor, cut off the ends of the propeller inch by inch until the motor develops its full power.

If the propeller runs ten hundred and fifty revolutions and has five-foot pitch, it will travel 5,250 feet in one minute, less fifteen per cent slip, will be 4,464 feet, or fifty miles per hour.

If your machine only makes thirty miles, the propeller has too much pitch and cannot be changed, so make a new propeller and give it less pitch and more blade area.

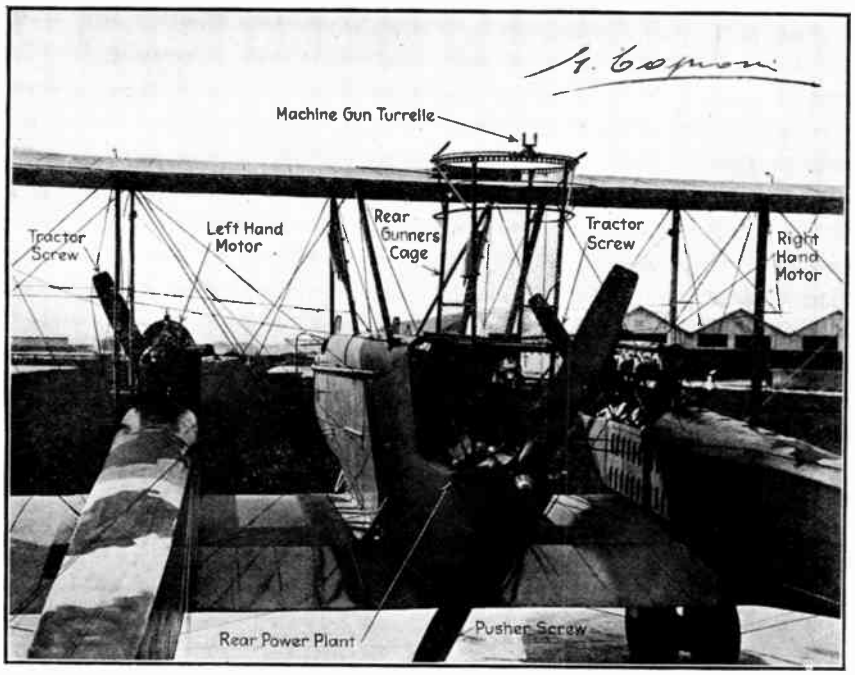
WHAT THE U. S. AIR SERVICE DID

ON the declaration of war the United States had 55 training airplanes, of which 51 were classified as obsolete and the other 4 as obsolescent. When we entered the war the allies made the designs of their planes available to us and before the end of hostilities furnished us from their own manufacture 3,800 planes.

Aviation schools in the United States graduated 8,602 men from elementary courses. More than 5,000 pilots and observers were sent overseas. The total personnel of the Air Service, officers, students and enlisted men, increased from 1,200 at the outbreak of the war to nearly 200,000 at its close.

There were produced in the United States to November 30, 1918 more than 8,000 training planes and more than 16,000 training engines. The DeHaviland-4 observation and daybombing plane was the only plane the United States put into quantity production. Before the armistice was signed, 3,227 had been completed and 1,885 shipped overseas. The plane was successfully used at the front for three months.

The production of the 12-cylinder Liberty engine was America's chief contribution to aviation. Before the armistice 13,574 had been completed, 4,435 shipped to the expeditionary forces, and 1,025 delivered to the allies.



When three motors are used, as in the Caproni design shown, the propellers are preferably placed so one will not be forced to revolve in the slip stream of the others, as indicated

COLLOIDAL FUEL

WITHIN the last year and a half attention of the fuel engineers has been called to a new kind of fuel called colloidal fuel. This fuel consists of a mixture of powdered coal and fuel oil. The making of this colloidal fuel consists of a certain process which keeps the powdered coal in suspension in the oil so that the coal does not settle to the bottom of a tank supplying the furnaces with fuel. Numerous demonstration tests were made, which showed that there is a possibility of using such fuel successfully. However, the writer does not know of any test on a large practical scale showing that success with this fuel has been already attained and it is therefore difficult to foretell what may possibly happen in future along this line. The main advantage of the colloidal fuel seems to lie in the fact that the process would increase the effective supply of the available fuel oil by 40 to 50 per cent. Colloidal fuel appears to have the same advantages in burning as the fuel oil alone.

TO PRESERVE SCREWS

SOME toolmakers and experimenters like to save their small screws, nuts, etc., the common practice being to keep them in small tin boxes where they soon become rusty and unfit for use. A good way to keep such scrap or new screws of various size, is to keep them in small large-neck bottles, each provided with a cork and labelled if desired. In this way one can always see instantly just what they have and how many of each and the pieces never get rusty.

STARTING FROM COLD ON ALCOHOL

THE problem of starting internal combustion engines on alcohol without application of internal heat is said to have been solved by Ralph McKay in experimental work for the Australian Institute of Science and Industry. The compression of the engine was reduced by controlling the admission of air and it was found that the engine fired regularly with initial compression pressures of from 35 down to 25 pounds per square inch. With a leather disk, punctured to allow enough air to be drawn to provide the correct mixture, placed over the air intake on the carburetor a 25 horse-power car was started without difficulty on methylated spirit. It is reported that another engine was started from cold without fail on the first attempt on 70 consecutive mornings.

FRICTION AND ENERGY

THE effect of friction is to convert energy into heat. Small bodies manifest the effect of heat more quickly than large bodies because they are not capable of absorbing the heat generated. The parallel is made of course in reference to the same expenditure of energy in both bodies.

The specific heat of iron is 0.0038 B.t.u. per lb. per °F. rise in temperature or lb. X. deg. X 10.1138 = B.t.u. absorbed, and each B.t.u. equals 778 ft.-lb.; therefore, each pound of iron heated 1° F. has absorbed 0.1138 × 778 = 88.5 ft.-lb. of energy.

The co-efficient of friction means the proportion of the pounds pull (or push) to the pounds (weight) being moved over a given horizontal surface. For instance, wood on wood without lubricant may have a co-efficient of 0.5; that is, it will require a ½-lb. pull to move a pound along slowly. In plain language, the co-efficient of friction represents the ratio of force required to slide a body along a horizontal plane surface to the weight of the body.

Quite an extensive business is done in Birmingham in the renewal of burned out or rejected tungsten lamps. The filament is replaced, the bulb having been previously cleaned of internal stains, and the lamp is restored to a perfect condition. It is all done through a hole in the apex, which hole is only a quarter of an inch in diameter. It is claimed that the renewed lamps last longer than new ones. About fifteen cents are saved on a lamp.

Molybdenum has been used with success as the characteristic element in high speed steel. At first results incident to its use were uncertain, sometimes the steel would be good at other times it would be unsatisfactory. At last it has been found that cobalt acts as a stabilizer to secure an even product.

The following is given as the composition of duralumin. Copper 3.5 to 4 per cent; Magnesium, 0.5 per cent; Manganese, 0.5 to 1 per cent; the rest is aluminum.

RADIO
TELEPHONE AND TELEGRAPH APPARATUS

Some Ideas for a Crystal Receiver

New Instruments, Made by the Standardized Panel Method, Combined into a Crystal Receiving Set

By M. B. Sleeper

THE versatility of the standardized panel system of building radio instruments is shown by the set illustrated in detail by the photographs accompanying this article.

In addition to the regular 5- by 5-in. panels, there are four panels 5 by 2½ ins. These save considerable space as well as expense where full size panels are not actually necessary.

The set is of the closely coupled type, designed for wavelengths from 200 to 2,000 meters, the B-C range. Adjustments are made by the three-point inductance switch and the 0.0006 mfd. condenser.

Figs. 1 and 2 show the arrangement of the controls, and the layout of the instruments. Across the top are the galena detector, adjustable telephone condenser, 'phone connectors, and buzzer test. The inductance, tuning condenser, and buzzer practice key are at the bottom. The usual single-slide tuner circuit is used, except that the switch replaces the slider.

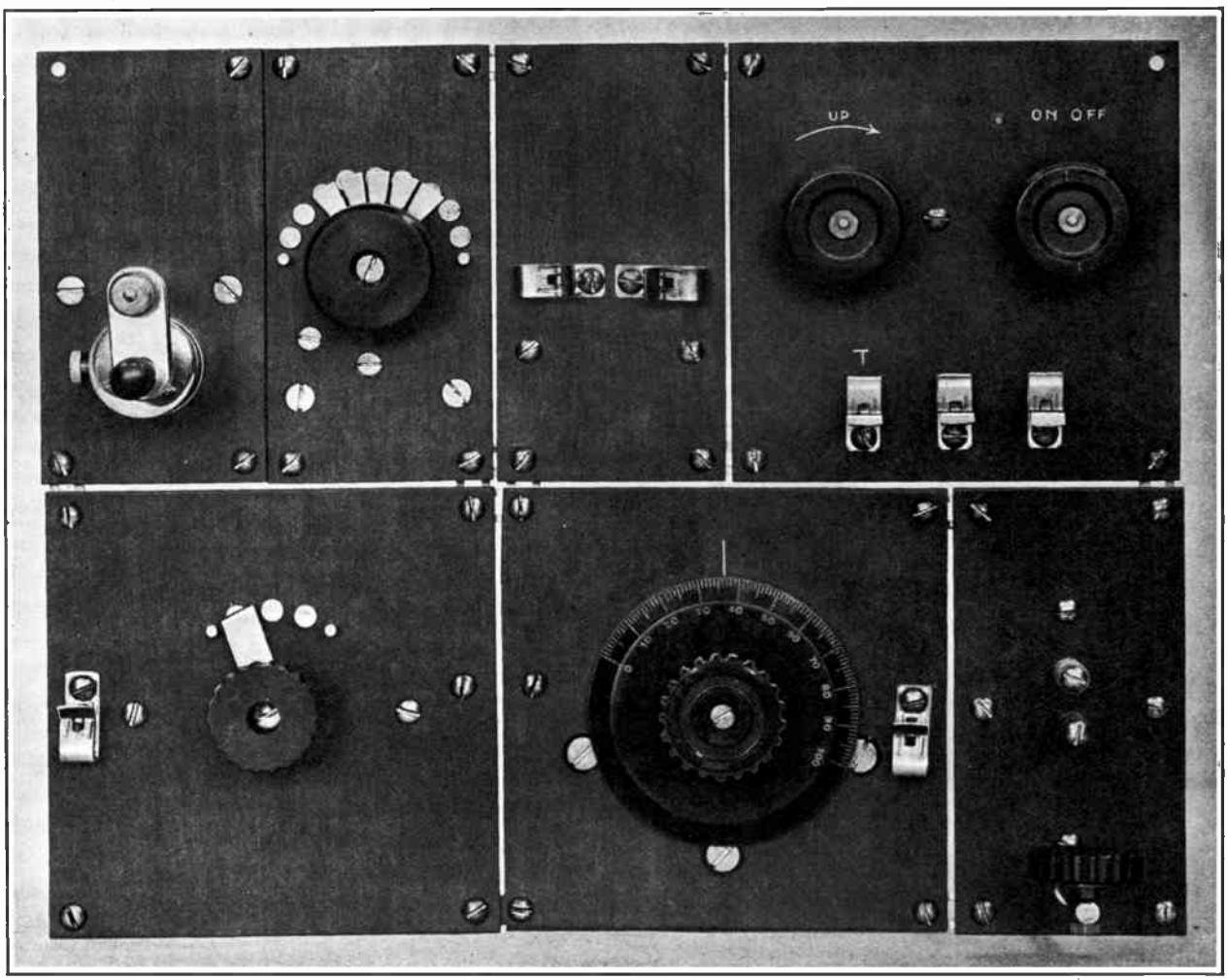


Fig. 1. The instruments assembled, ready to wire

Tuning Inductance

Complete details for the tuning inductance were given in the March issue of Everyday Engineering. It is, in short, a three-bank coil of 3 x 16 No. 38 high frequency cable, with three taps brought out to the switch.

Sufficient overlap is allowed that, with a Short Range antenna, the set will tune as follows:

Tap 1, 179 to 473 meters.
Tap 2, 377 to 997 meters.
Tap 3, 800 to 2,116 meters.

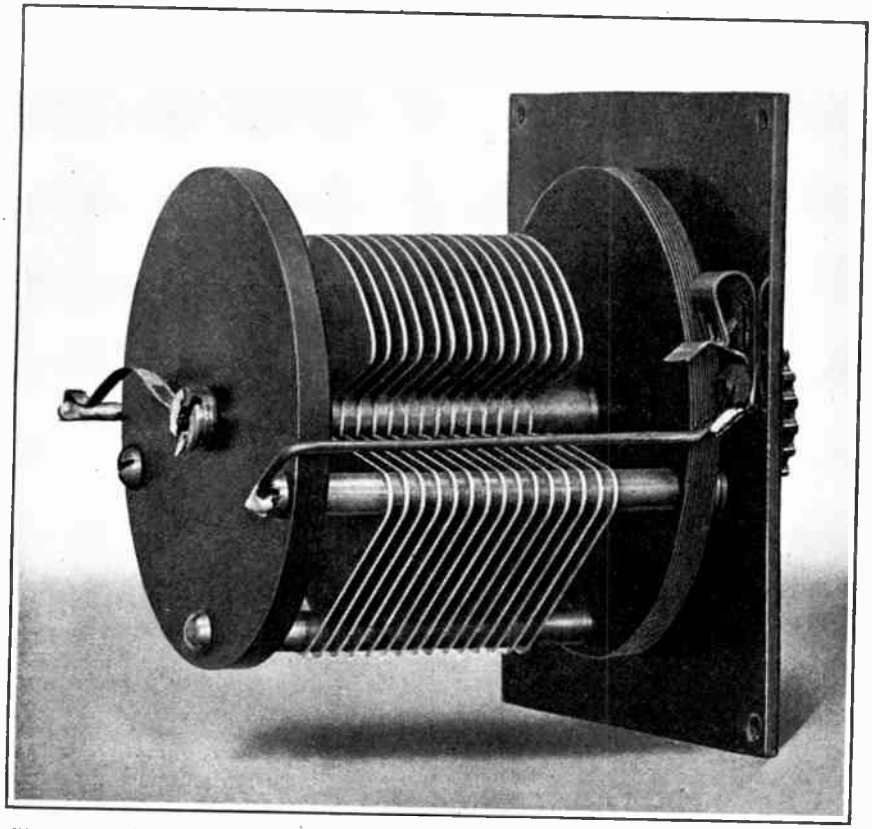


Fig. 3. A close view of the tuning condenser. The method of connecting is shown clearly

If a greater range of wavelength is required, a loading coil may be added to the set.

Loading Coil

To increase the wavelength range of this set or the one described in the March, 1920, issue, the panels must be changed around. The buzzer might be left out, or the key and telephone connection panel removed and replaced by a 5- by 5-in. panel to carry a loading coil. This is not shown, but the construction is simple.

The coil to be described will include the D range, giving a latitude of 200 to 6,000 meters. A tube 3½ ins. in diameter and 6 ins. long is needed. The winding is of three banks of 10 No. 38 high frequency cable, a size which is more economical of space than the heavy cable, and gives much better results than solid wire. Moreover, at the lower frequencies, the 10 No. 38 is practically as good as the other.

The winding is started ⅜ in. from one end of the tube, and is continued for 1.7 ins., in which space there should be 230 turns, allowing 45 turns per inch of this wire. The inductance at this point will be 5,200,000 cms. Then more wire is put on until the coil is 4.5 ins. long, giving a total of 607

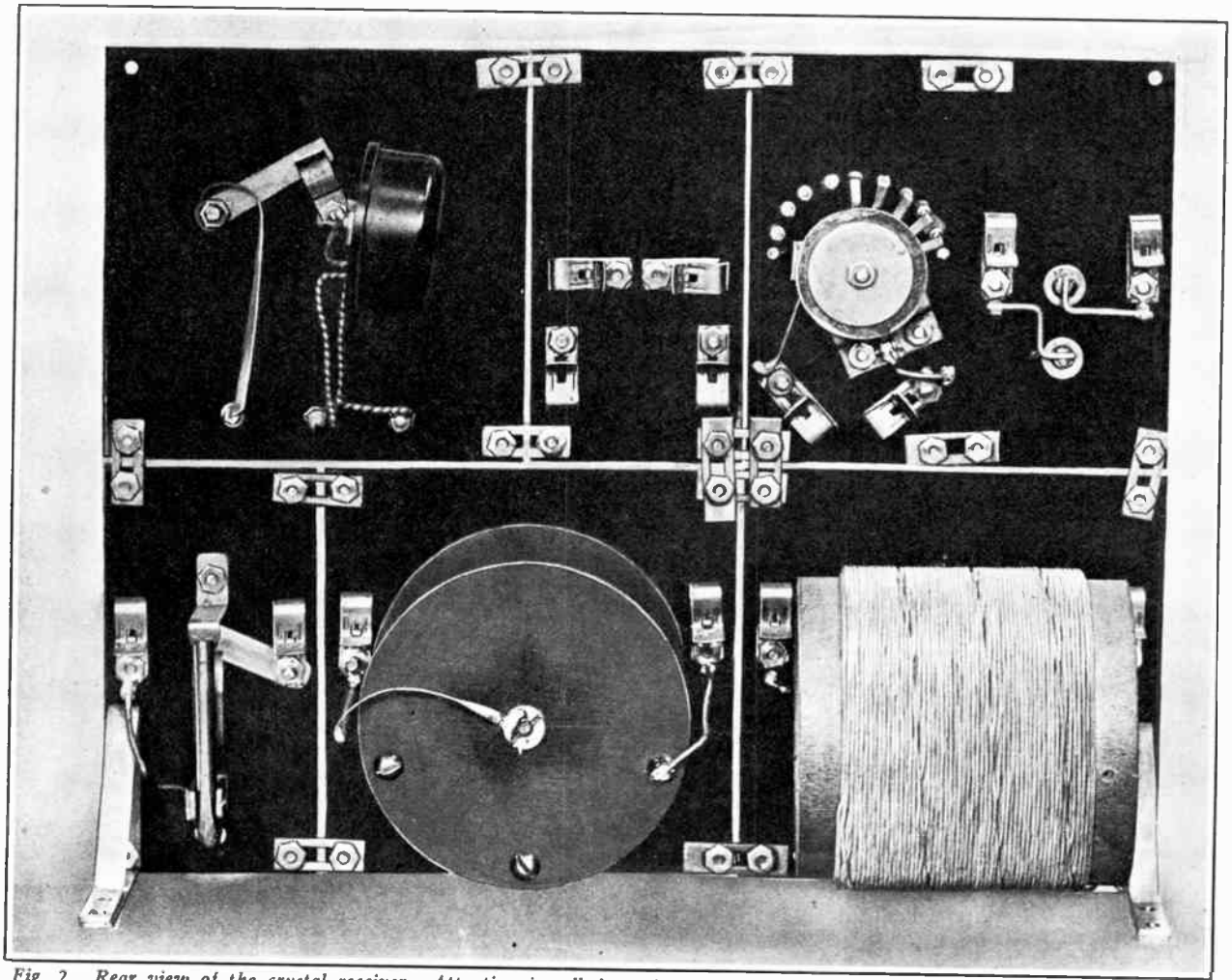


Fig. 2. Rear view of the crystal receiver. Attention is called to the buzzer, mounted at right angles to the panel, so that the vibrator contact screw can be adjusted from the front

turns. If these dimensions are adhered to closely, the inductance of the entire coil will be 18,200,000 cms.

Three points are needed on the switch that controls this coil. When connected in series with the other, the wavelength ranges are:

Tap 1, coil cut out.
Tap 2, 1,577 to 4,172 meters
Tap 3, 2,665 to 7,052 meters.

Sufficient space is allowed at the end of the tube that it can be mounted on legs, with the axis of the coil perpendicular to the panel. This makes the coils at right angles, so that there is no mutual inductance between them.

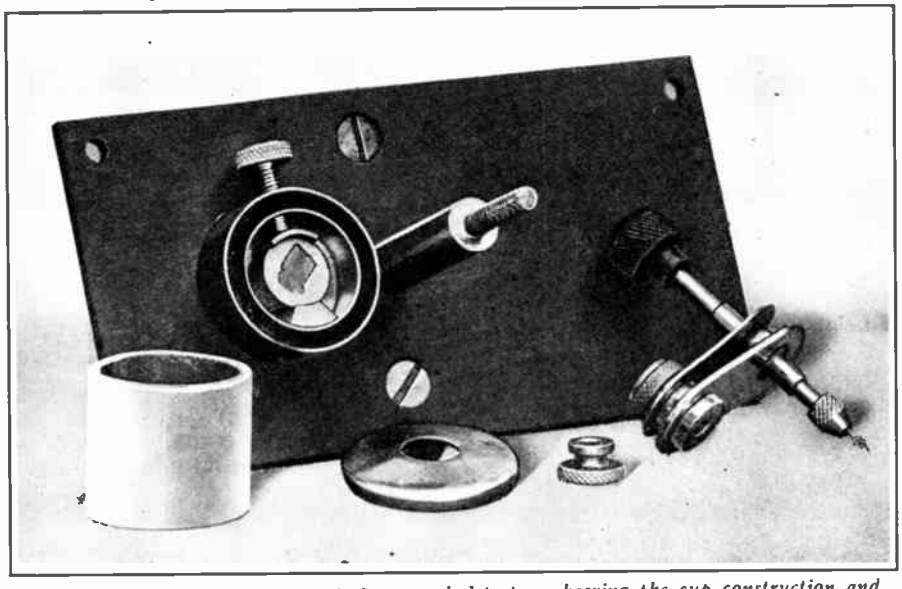


Fig. 4. A disassembled view of the crystal detector, showing the cup construction and universal joint

Tuning Condenser

This instrument was described in the last issue. It is made up of a G. A. Standardized condenser, 0.00001 to 0.0006 mfd. The condenser was mounted by removing the three screws which hold the upper bakelite plate to the fixed plates, and putting them through the front panel, as is shown in Fig. 3. Two washers on each screw hold the condenser end plate and the panel a slight distance apart. The previous issue explained the method used to secure the A. H. Corwin dial to the shaft.

Galena Detector

The detector, shown disassembled in Fig. 4, is from the Wireless Improvement Company. This type, so widely used on Government equipment, provides protection against dust, and allows a universal adjustment of the contact point.

The crystal cup carries a thumbscrew and clamping piece by means of which the crystal is held in place and contact is established. Around the edge of the cup, there is a felt ring, on which the glass tube fits tightly. When the thumbscrew is turned down on the upright post, the arm which carries the contact presses down on the cover at the top of the glass tube.

Adjustable Telephone Condenser

Fig. 5 shows the telephone shunt condenser. This is of the Dubilier mica construction, supplied by the Pacent Electric Company. It is made in five steps, each of 0.0001 mfd., giving a total capacity of 0.0005 mfd.

The condenser comes all mounted on a brass piece which is secured to the panel by a 6-32 machine screw. Although nine switch points are on the panel, only five are connected with the condenser. The other four are put in to carry over the fan switch.

No. 24 spring brass sheet is used for the fan. After the small holes are drilled, the fan is put in a vise with a piece of wood behind it. With this backing the slots can be cut with a backscrew.

Buzzer Practice Key

Rather unusual construction is used for the key, although its simplicity should appeal to experimenters. The key lever is of ¼ in. brass rod, bent as shown in Fig. 6. At the rear a U-shaped piece of ⅜ by 1/16 in. brass strip carries a ⅛ in. rod which passes through the lever.

Underneath the U piece is put a No. 24 sheet brass spring, bent so as to come over a tension adjusting screw threaded into the panel.

The movement is regulated by another screw against which the lever strikes when the key knob is pressed. Movement in the other direction is stopped by a brass strip bent at the end.

Connections are taken from the U piece and from a brass strip into which the upper adjusting screw is threaded.

While this key cannot be used to break heavy currents, it is quite satisfactory to operate the buzzer test.

Buzzer Test

This panel has been illustrated before, in conjunction with a short wave set. An excellent feature of the instrument is that the shaft of the left hand knob is threaded into the regular contact adjusting screw. A drop of solder holds the rod in place. The

(*Concluded on page 67*)

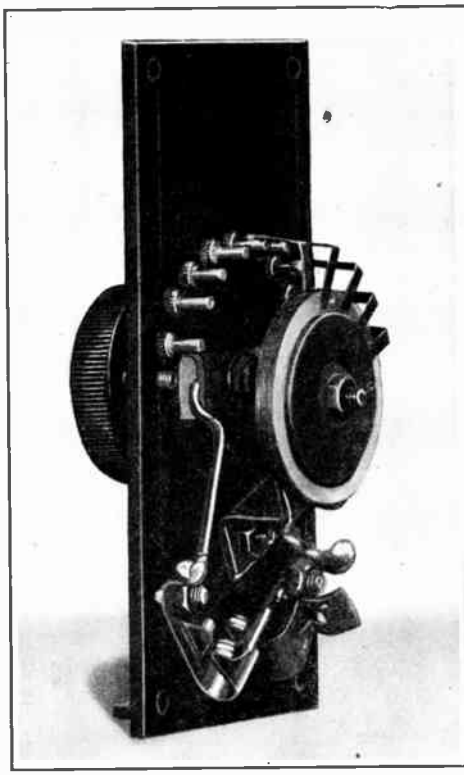


Fig. 5. The condenser is made of discs of mica and copper foil

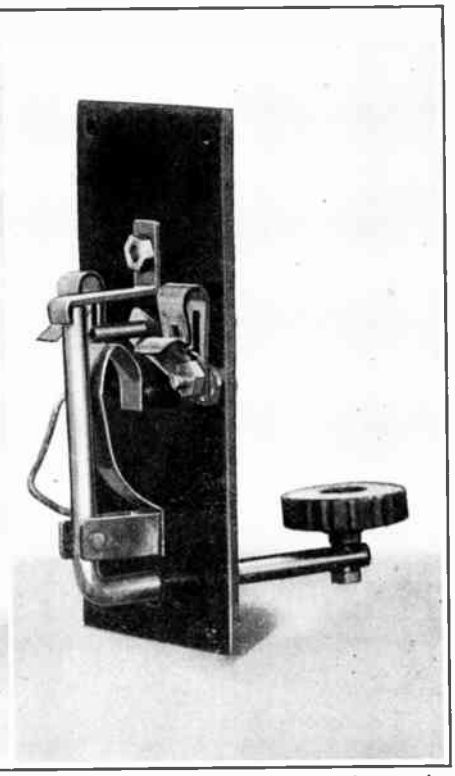


Fig. 6. Both the tension and stopping screws can be seen in this view

Comparative Efficiency of High and Low Spark Frequencies

Actual data obtained on tests, and an explanation of the results

IN the March issue of EVERYDAY ENGINEERING, mention was made of the current discussion of high and low spark frequencies, and their relation to transmitting ranges.

Very interesting light has been thrown upon the subject by Mr. C. F. Cairns, Chief Engineer of the Acme Apparatus Company, who supplied that data presented in this article.

Many of the "long distance" experimenters have discovered that, by lowering their spark frequencies, that is, slowing down their rotary gaps, their signals were heard over greater distances. The natural conclusion was that, with greater energy per wave train, longer distances could be covered.

As is shown in the following paragraphs, however, there are a number of effects to consider.

The usual, and one might say old fashioned, type of amateur radio transformer is known as the loose coupled resonant type which, when used with a particular condenser value and at a given frequency, produces a secondary voltage on open circuit greater than given by multiplying the primary voltage by the ratio of transformation. This phenomenon is known as resonance rise, and is due to a considerable leakage inductance, in the transformer, being balanced by a small condenser across the secondary terminals, and is specifically the production of a large series of forces by the application of a small series of forces at the correct time intervals.

A mechanical analogy of this phenomenon is the well known stunt that many of us have tried, namely, standing on the back platform of the street car whose wheels are in the middle, and by bringing our weight to bear at the proper time intervals get the car oscillating with the hopes of removing it from its beaten path. We found that the forces which we applied in this way were cumulative and that after a time the oscillations of the car were of such magnitude as to attract the attention of the conductor and give the motorman a ride in a different plane than was his custom.

Nevertheless, it took time to bring about the large forces which had to be built up to make the car oscillate at such amplitude. Just so in an electrical circuit, such as a radio transformer with a suitable condenser for resonance, the voltage on the condenser does not reach its final large value on immediate closure of the primary switch, but takes a definite time, and may under certain conditions take more than 1/120th of a second or the time of ½ cycle of the usual 60 cycle source of current. This phase of resonance phenomenon is known as transient effect and has been dealth with, for all circuits, by Steinmetz.

When operating a resonance type of radio transformer with a rotary spark gap, the condenser is periodically charged and discharged and the amount of energy drawn from the line is

$0.5\ CV^2N$, plus the losses in the transformer,

where C=capacity in mfds.
V=voltage in kilovolts.
N=frequency in cycles.

With high spark frequencies and the resonance type of transformer, the transient effect is of such magnitude that the voltage on the condenser does not have a chance to rise before the spark gap discharges the condenser and although the value of N is large, the voltage is consequently small. Therefore, with the resonance type of transformer, a *slower* gap speed produces better results as *more time is allowed for the condenser voltage to rise* before the rotary gap discharges the condenser, and more power is drawn from the line.

The reason, therefore, that the above mentioned amateurs got their signals further was not due to the low spark frequencies, but *because they were putting more power into the transformer and antenna.* If low spark frequencies were more efficient, 500 cycle sets would not be used so widely.

As further evidence of the efficiency of the higher gap speeds, it is a well known fact that the human ear is most sensitive to frequencies in the neighborhood of 1000 cycles per second and also that audio tuning is sharper at this frequency than at lower ones.

Recognizing these facts, the Acme Apparatus Company has designed their radio transformers to draw their rated power when used with a rotary gap operating at from 700 to 800 sparks per second. These transformers are reasonably close coupled and do not depend for their secondary voltage on the phenomenon of resonance. The transient effect is small and the condenser can therefore become sufficiently charged during the interval between gap discharges, although they occur at the rapid rate of 700 to 800 times per second.

As evidence of this fact the 1 k.w. Acme transformer has a rating of 15,000 R.M.S. over 20,000 peak voltage, and, when used with condensers of 20,000 volt rating, breaks them down, showing that even with high gap speeds the voltage gets on the condenser. With an Acme transformer, the power input is reduced with a reduction in gap speed as one would expect from the formula $0.5\ CV^2N$, when C and V remain the same and N is decreased.

It now rests with some interested amateur to get voltmeter, ammeter and wattmeter in the primary circuit of a resonance type of transformer, and then a non resonance type, and measure the radiation in amperes in the antenna at different gas speeds. At the same time an observer should be at a receiving station with an audibility meter or shunt box to measure the strength of the received signals under the different conditions.

Such tests would undoubtedly show that with the same watts input, the higher spark frequencies will carry much further than the low, not because of the medium or the amplifier, but because the human ear is affected more by the given amount of energy at 700 to 800 cycles than at 200 to 300 cycles.

Some recent experiments on ¼ KW Acme close coupled transformer and a ¼ KVA resonance type of transformer, of a well known make, showed the following results at 110 volts, 60 cycles, with a condenser of .007 mfd. and a rotary gap running at 800 sparks per second, on the usual operating conditions of an amateur station:

	Primary Current	*Watts Input*	*Secondary Current*	*Secondary R.M.S. Voltage*	*Power Factor*	*Efficiency*	*Watts Delivered*
Open Circuit							
ACME (close coupled)	1.00	50	.020	5875			
——— (resonance) ...	.52	60	.032	8860	(gap removed)		
Operating Condition							
ACME (close coupled)	2.55	275	.047	4830	.930	82%	226
——— (resonance) ...	3.45	215	.040	3450	.537	64.2%	138

The above figures bear out the facts given in this article. It will be noted that the amount of energy delivered by each transformer is:

ACME (close coupled) .047x4830=227 watts
——— (resonance) .040x3450=138 watts

If we take $0.5\ CV^2N$ for each transformer, it is not proper to use the secondary voltage as given either R.M.S. or peak, as the voltmeter integrates

the various values over a given time. During spark discharges the voltmeter is partially short circuited and between spark discharges its voltage should rise to that given on condenser load. Therefore, it can be seen that as the duration of partial short circuit is practically the same in both cases, the integrated value of the voltage in the case of the Acme shows that between gap discharges the voltage on the condenser is high and in the case of the resonance transformer is held down by the transient effect.

Using Concentrated Inductances

Methods for Mounting and Special Applications of the Coils

THERE are two types of concentrated inductances in use, one the De Forest plug-mounted type, and the other, unmounted. Both offer disadvantages to the man who makes his own instruments because the former must be used in a plug receptacle, while the other is not provided with any sort of mounting facilities.

A very efficient and good looking mounting for the plain coils is shown here. The three coils constitute the primary, secondary, and tickler, looking from right to left. A small wooden core is fitted in each coil, and drilled to take two 3/16-in. brass rods. The wires from the coils are connected to screws in the cores, from which flexible leads run to binding posts on the base.

One of the best methods is to have a three-coil mounting to furnish primary-secondary and tickler coupling, and additional loading coils mounted as shown below:

PRI., 11 mh. SEC., 100 mh. PRI., 20 mh. PRI., 40 mh. PRI., 100 mh.

The coupling coils should be arranged like this:

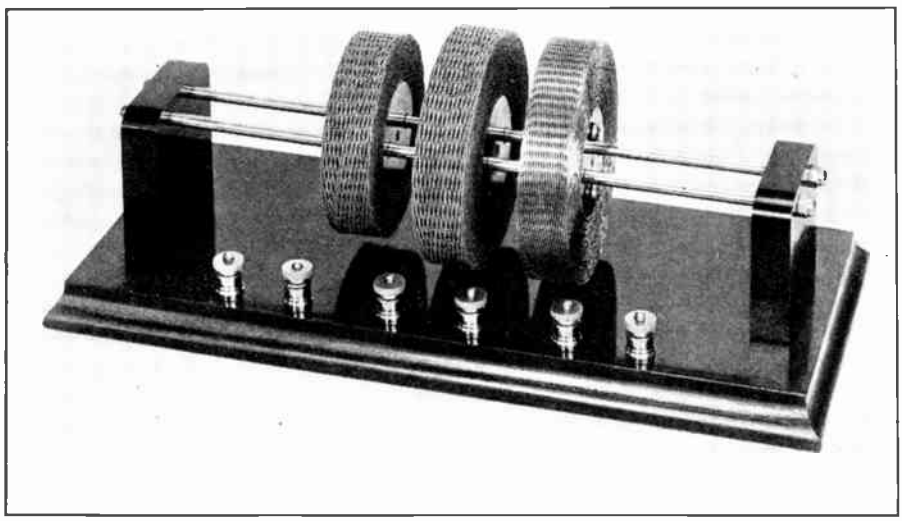
PRI., 4.5 mh. SEC., 11 mh. TIC., 4.5 mh.

With 0.001 mfd. maximum condensers in both primary and secondary circuits, in shunt, the wavelength range, using a Long Range Antenna of 0.0004 mfd., will be:

PRIMARY	
L	λ
4.5 mh.	2,850 to 4,750 meters
11.0 mh.	4,400 to 7,450 meters
20.0 mh.	6,000 to 10,000 meters
40.0 mh.	8,400 to 14,200 meters
100.0 mh.	13,400 to 22,400 meters

SECONDARY	
L	λ
11.0 mh.	2,000 to 6,300 meters
100.0 mh.	6,000 to 19,000 meters

These values were obtained by considering the condenser capacity as 0.0001 to 0.001 mfd. As a matter of fact, most condensers go both lower and higher than these values, giving an overlap of wavelengths sufficient to compensate for small variations in antenna capacity above or below 0.0004 mfd.. the figure used to obtain the ranges given in the table.



A Radisco mounting for concentrated inductances

In operation, the secondary coil is left at the center, and the tickler coupling and primary-secondary coupling are varied by moving the outer coils.

For a long wave tuner, using a set of coils such as is supplied by the Atlantic Radio Company, this type of instrument is very good. The disadvantage is that the coils cannot be changed for tuning to short waves.

The A. T. Hovey Company gets around this by having a rod supported at only one end, so that coils can be slipped on or off quickly. Even these, however, it is necessary to change connections.

Of course, with the De Forest three-coil mounting, coils can be plugged in very quickly, but that is not as good as a simple switch.

An oscillating circuit is often useful, particularly for an undamped wave receiver. The simplest type is that using a coil tapped at the center. In the case of the concentrated inductances, where no taps are provided, it is best to mount two coils so that one can be moved toward or away from the other. The windings must be in the same direction, as if they were a single coil.

Then one end of one coil goes to the grid, the point at which the coils are connected together runs to the filament, and the other end of the second coil to the B battery and on to the plate. A 0.001 mfd. variable condenser is put across the grid and plate leads from the coils. To facilitate coupling, a small coil should be connected in series with the others, and mounted in place of the tickler coil.

Then an ordinary damped wave circuit is employed at the receiver. The oscillations in the coupled coil produce beats with the undamped waves.

For this purpose, an 11 mh. coil should be used for coupling, and two 40 mh. coils for the main inductance. They give a wavelength range of 6,000 to 20,000 meters.

A complete circuit for this type of oscillator was given on page 104 of the November-December, 1919, issue.

INDUCTANCE STANDARDS

MANY times the experimenter needs coils of given inductances Here is a table showing the length and turns for different coils, all wound with No. 28 single silk covered wire. If made carefully, the inductance values will be accurate within 5 per cent.

Coils 3 ins. in Diameter

L cms.	*Total No. of turns*	*Length of Coil in ins.*
50,000	18	0.28
100,000	27	0.42
200,000	42	0.64
300,000	53	0.82
400,000	64	0.98
500,000	73	1.13
600,000	83	1.27
700,000	92	1.42
800,000	101	1.55
900,000	110	1.70
1,000,000	119	1.83

Coils 5 ins. in Diameter

500,000	47	0.73
1,000,000	72	1.10
1,500,000	94	1.44
2,000,000	113	1.74
2,500,000	130	2.00
3,000,000	147	2.26
3,500,000	164	2.52
4,000,000	180	2.76
4,500,000	195	3.00
5,000,000	210	3.24

Remember that 1,000,000 cms. equals one 1 millihenry.

A Long Wave Receiver

The Grebe Regenerative Set for 500 to 20,000 Meters

THE CR-7 set from the A. H. Grebe Company is one of a very few long wave receivers which have been offered to radio experimenters. In fact, long wave sets have not been prominent in the great number of new radio catalogs, principally because, with the long single-layer inductances tabooed, the problems of large inductance in small space have not been solved satisfactorily by many companies.

Electrical circuits and mechanical design have been carried out on the CR-7 set in a way which will meet the unqualified approval of the most exacting experimenter. The design of the primary and secondary inductances, described farther on, is an unusually clever piece of work, representing an amount of thought seldom shown by other apparatus.

Fig. 1 illustrates the bakelite panel, 12 by 21¼ ins., with the various controls. An oak cabinet carries the panel on which all the instruments are mounted. A hinged cover permits the examination of the set.

Across the top, from left to right, are the primary-secondary coupling, primary inductance switch, opening for the insertion of the audion bulb, secondary inductance switch, and tickler coupling, while at the bottom are the primary condenser, antenna compensating inductance switch, rheostat, bridging condenser, secondary condenser, and telephone jack.

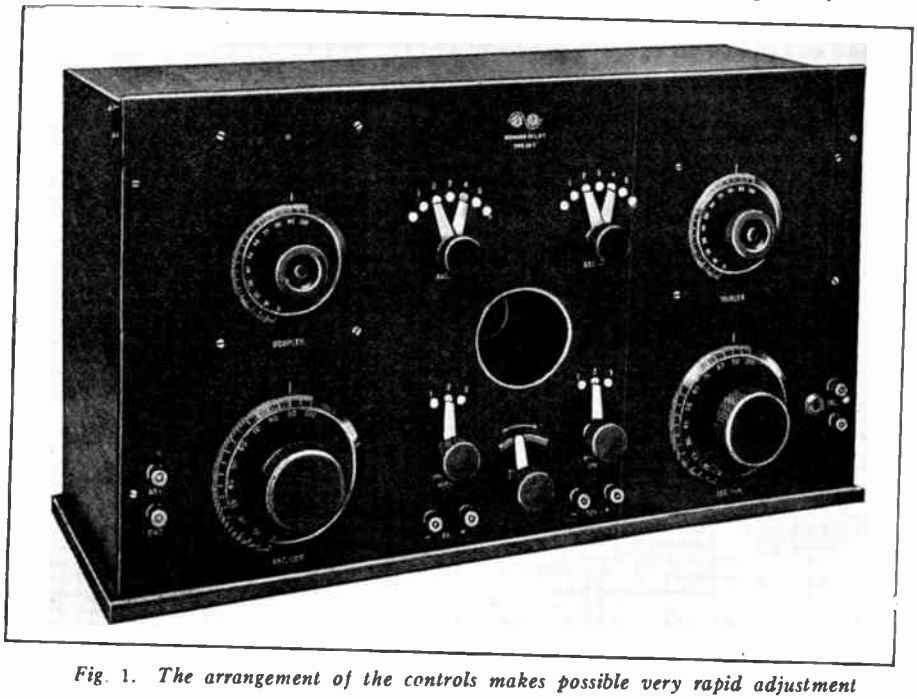


Fig. 1. The arrangement of the controls makes possible very rapid adjustment

In the rear view, Fig. 2, the primary condenser and inductance are at the right hand end of the panel. The tube at the center carries the audion socket. Dust is, in this way, kept out of the set.

Three small bridging condensers are located at the left of the socket tube,

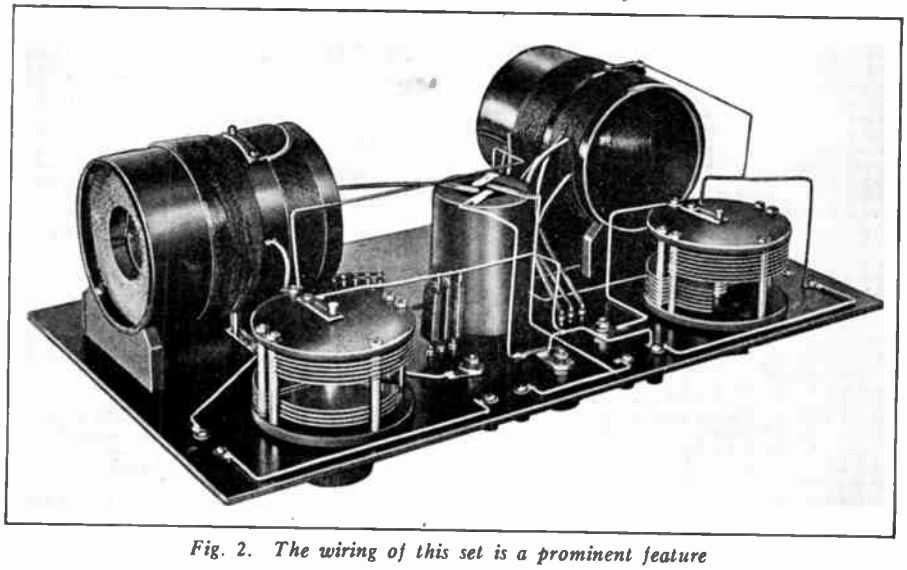


Fig. 2. The wiring of this set is a prominent feature

any one of which can be cut in by the three-point switch.

Primary Inductances

Fig. 3 shows, in the primary circuit, four concentrated inductances and a divided tubular coil wound with two banks of high frequency cable. The appearance of the assembled coils can be seen in Fig. 2.

The concentrated coils, instead of having the same inside diameters, have the same outside diameters, so that they fit snugly inside a tube on the end of which are the divided coils. The purpose of dividing the coils is to allow for the shaft of the secondary coupling coil.

The end section of the banked coil is tapped at three points, and is used to compensate for variations in the capacities of different antennas. By setting this switch at the proper point, determined experimentally, corresponding adjustments of the primary and secondary condensers and inductances give very nearly the same wavelengths in both circuits.

Two contacts, are employed on the inductance switch to short circuit the two sections ahead of the last one in use, a method of cutting down dead-end losses which is quite effective.

Primary Condenser

A 26-plate balanced condenser, having a maximum capacity of 0.0008 mfd., is connected in series with the ground. The method of establishing connection to the rotating plates is interesting. A short strip of brass, drilled and slotted at one end, clamps the end of the shaft tightly enough to give a low resistance contact.

Secondary Inductances

Fig. 2 shows clearly the coil assembly, similar to that of the primary. It is mounted at right angles to the other, to prevent any coupling effect. Here the tickler coil is mounted at the end of the tube. One part of the tickler is wound on the tube, and the other on the variometer ball. The coupling from the straight part of the tickler is

not great enough, however, to cause any noticeable feed-back effect when the adjustable section is at 0.

Secondary Coupling Coil

In Fig. 3 this coil is marked COUP. It can be seen at the end of the primary coils. The ends of the coil are soldered to the shaft, which is made in two pieces. Slotted brass strips are fastened to the tube and one to the panel, clamp on the shafts and make connections. These can be seen more readily on the tickler coil.

Secondary Condenser.

An 18-plate balanced condenser is provided for tuning the secondary circuit. At maximum, the capacity is 0.0004 mfd. Tuning is made sharper when a small condenser is employed in the secondary circuit.

Fig. 4 shows the wavelength of the secondary circuit at various settings. These curves are approximately correct for the primary circuit when the compensating coil is adjusted according to the antenna capacity.

Dial Setting	*Reception*
0	Damped waves (not amplified).
0–40	Damped waves (amplified by regeneration).
40–100	Undamped waves (set oscillating locally).

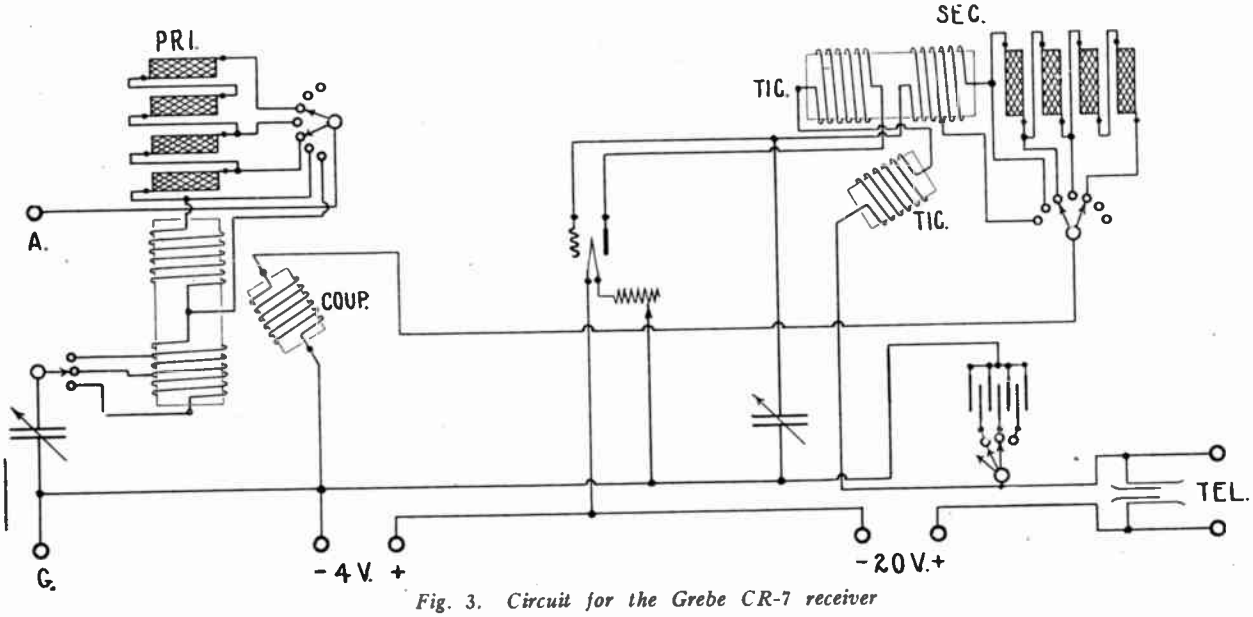


Fig. 3. Circuit for the Grebe CR-7 receiver

Tickler Coil

Energy from the plate circuit is fed back to the grid by means of a tickler coil. This method gives the best control, particularly on a long wave set.

At 0 coupling, spark stations come in the usual manner. As the coupling is increased, regenerative and finally oscillating effects occur. The table above shows the dial settings.

Audion Circuits

No grid leak or condenser is used with this set, as provision is made for a constant negative grid potential. Particularly on undamped waves, this is an advantage, as reception is better without a grid condenser.

Fig. 3 shows the connections of the by-pass condenser which shunts the telephones and batteries. The adjust-

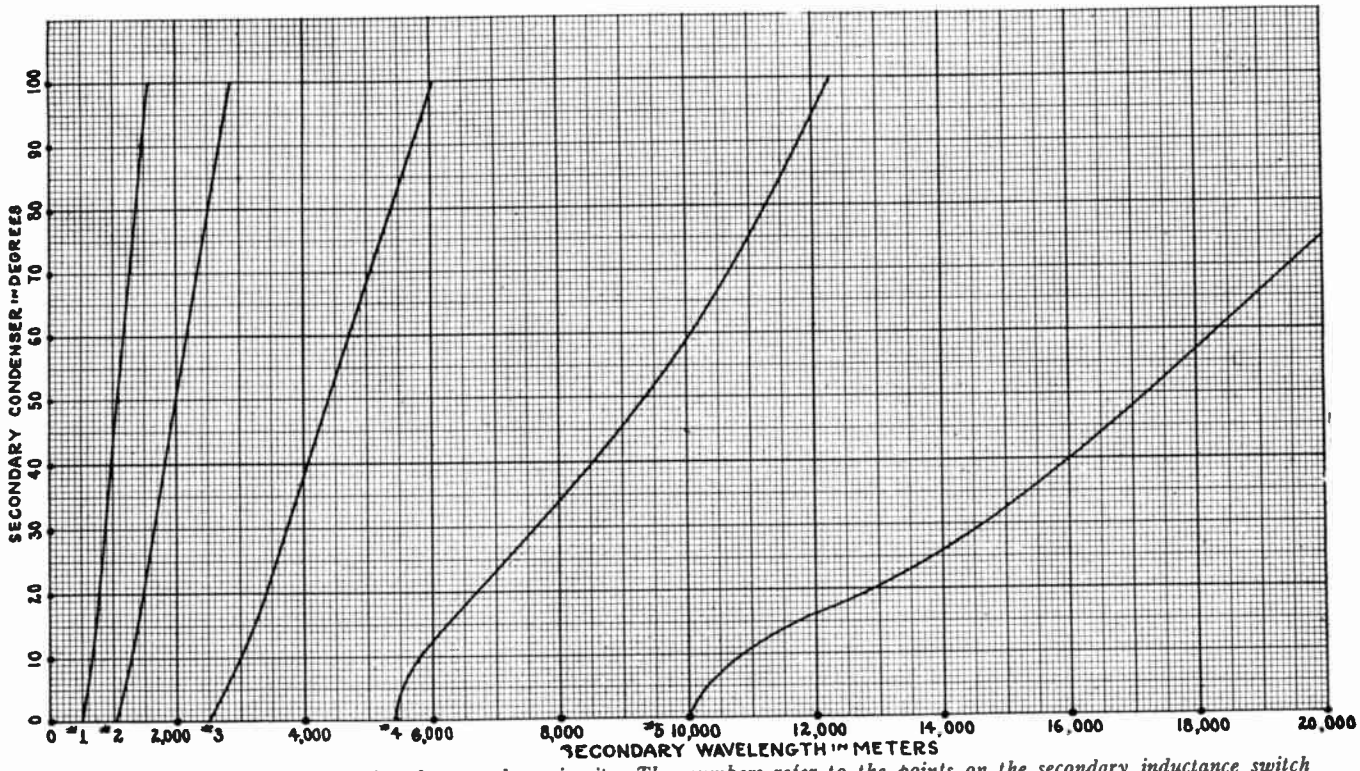


Fig. 4. Wavelength calibration for the secondary circuit. The numbers refer to the points on the secondary inductance switch

ment of this condenser has quite an appreciable effect on long wave signals.

A 4-volt battery is required for the audion filament, and a 20- or 22.5-volt battery for the plate.

Operation

The CR-7 is extremely simple to operate and, as the elements are all connected with heavy bus wire, the circuits are easy to follow.

To tune to a given wavelength, consult the wavelength curve and set the secondary condenser and switch to the positions corresponding to the desired wavelength. Next adjust the primary circuit to the same settings, making final adjustment for maximum signal strength when the signals are received.

For regeneration or amplification of spark signals, the tickler dial is turned towards the 100 mark until the signals have increased to the maximum, just below the point where a mushy and distorted note is obtained; for continuous wave reception, the tickler is increased to the oscillating point, and the proper beat obtained by adjustment of either the primary or secondary condensers.

RAVENSWOOD RADIO ASSOCIATION

THE Ravenswood Radio Association which, up to the present time, has restricted its membership to commercial licensed men only, has now formed a Junior Division which makes no restrictions on the applicants other than that they be sufficiently interested in radio and be of such character as to meet with the approval of the Board of Directors.

The Senior Division of this association, consisting of twenty-two commercial licensed operators, will without a doubt prove a great benefit to the junior members, and the valuable discussions and talks given at the weekly meetings will go a long way toward raising the standard of the radio amateurs and the elimination of local interference. It will also mean the promotion of good fellowship among the amateurs, an issue of vital importance to the systematic handling of amateur radio traffic.

A very reasonable fee is assessed the Junior Members and a membership certificate has been issued of which any radio men may be proud.

Further information may be obtained by either calling or writing the Secretary, Mr. N. E. Wunderlich, 4533 No. Sawyer Avenue, Chicago, Ill.

THE ARMOUR VILLA RADIO ASSOCIATION

THE Armour Villa Radio Association now has a code practice table and code practice is held every Friday evening. At every other meeting we are reading one part of an elementary course in radio telegraphy.

Last December we received a charter from the American Radio Relay League, and are now an affiliated association. We are trying out a new idea for QRM control. We offered to tune every amateur's transmitter, whether a member or not, free of charge. This is done by a Technical Committee member, and when he goes to the station he gives the owner a few points about unnecessary sending and proper operation of a transmitter, that is, on the communication part.

If an amateur persists in using a directly connected transmitter we shall notify the Radio Inspector. Clubs should not feel that they are unsportsmanlike when they do this. If a station after repeated warnings still continues to use a directly connected transmitter it is for the good of amateur radio that this station be shut down.

All communications should be addressed to Walter Remy, Secretary, Bronxville, N. Y.

Can you read this message from P. S. 37?

AN IDEA FOR RADIO CLUBS

THE members of the Radio Club of Public School 37 Bronx, N. Y., are selling post cards, bearing the design reproduced here, to raise money for apparatus.

By holding the magazine in the correct position, the reader will find a message, clearly readable, from P. S. 37. This message may be hard to find, but, looking at it from the correct angle, it is perfectly plain.

The postal was sent in by Dr. Herman V. Bucher, formerly Commissioner of Education in Argentina, and one of the most enthusiastic promoters of experimental radio work in the country.

LOST

INFORMATION is wanted concerning the whereabouts of Harold C. Sever, 9DN, of Valpariso, Ind., who left home for Chicago, Ill., Feb. 17, 1920, to test out some wireless apparatus, intending to return on a midnight train, and has not been heard from since.

He is 5 feet 6 inches tall, brown hair, blue eyes, weight 130 pounds, thumbs slightly crooked. Left in civilian clothes; mixed grey suit; dark gray overcoat; American Legion pin in coat lapel; green felt hat; navy shoes; name on all his clothes. Carried brown suitcase containing receiving set and a black bag with tools and working clothes.

His wife and mother will appreciate any word concerning him. For this purpose address Mrs. H. C. Sever, Box 226, Pleasant Plains, Ill.

THE PHILADELPHIA RADIO AMATEUR ASSOCIATION

PHILADELPHIA amateurs are invited to the meetings of the Philadelphia Radio Amateur Association which are held the second and fourth Mondays of each month at 1611 Columbia Ave. Live talks are given on practical amateur subjects, ideas interchanged, papers read and discussed, etc. Like other A. R. R. L. clubs, the P. R. A. A. is enjoying a healthy growth, but has room for every amateur in Philadelphia and vicinity.

THE ELECTRIC CITY RADIO CLUB

A NEW club has been organized at Scranton, Pa., The Electric City Radio Club. The officers are: President, R. C. Ehrhardt; Vice-President, Frank Tarbox; Secretary, P. D. McFarland, 802 Woodlawn St., and Treasurer, D. G. Shotton. Meetings are held every Tuesday evening at the Erie Railroad Apprentice School, and amateurs in the vicinity are cordially invited to visit and join. The present membership is about thirty. The club has a wave meter and will tune membership stations.

The Problems of Vacuum Tube Circuits

An Introduction to the Problems Encountered in the Design of Detectors, Amplifiers, and Undamped and Modulated Telephone and Telegraph Transmitters, Part VIII.

By L. M. Clement

DETECTION WITH A GRID CONDENSER

IF a condenser is connected in series with the grid of the tube the action of the tube as a detector is somewhat different from the case just discussed.

Detection results not only from the non-linear characteristic of the tube but from other effects also. The action is quite complex and involves not only the detector effect (due to the curved E_c 1_b curve), but the blocking action due to the grid condenser as well. No attempt will be made to explain the action in detail.

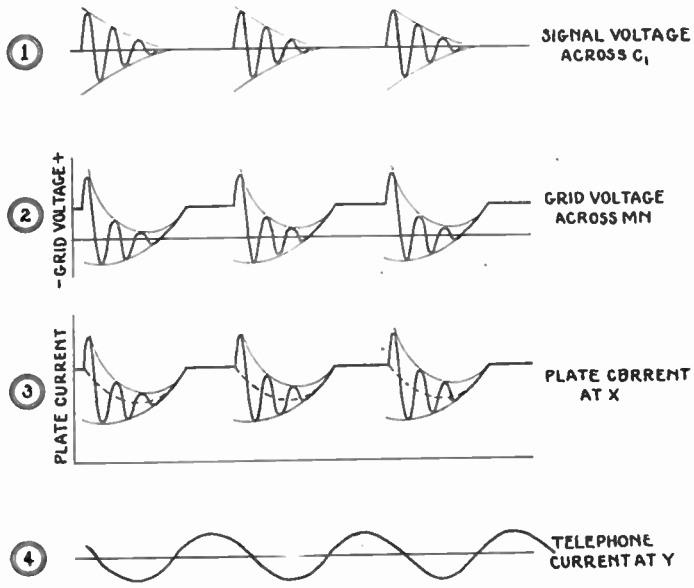


Fig. 42. Action in the audion circuits in the grid condenser

Let us consider the case of a tube of the high vacuum type similar to those made by the General Electric or Western Electric Companies. The grid-filament circuit has an almost infinite resistance when the grid is negative with respect to the filament due to the lack of carriers of electricity. In a gas tube this resistance may be relatively small due to the presence of positive ions of the gas molecules.

If the condenser has no leakage across its terminals the grid will be isolated from the rest of the circuit and will assume some charge with respect to the filament and plate. Upon the application of an alternating voltage to the circuit, current will flow during the positive half cycle only, from the grid to the filament and no current will flow during the negative half cycle. This is another way of saying that during the positive half cycle electrons are attached to the grid and during the negative half cycle this supply of electrons cannot leak off and in this way the grid receives negative charge each oscillation. This change of charge or voltage on the grid changes the plate current as it should, and for an impressed signal voltage has the effect of sliding the point of operation down the E_c 1_b curve, as shown at 2 in Fig. 42.

In most detector circuits there are small leakages in the condenser and other portions of the circuit which allow the charge to dissipate off slowly.

For good operation an artificial leak resistance is shunted between grid and filament to allow the accumulated charge to leak off rapidly enough so that blocking of the tube will not result.

The gas tube, due to the conduction between the grid and the filament, in general does not need an external resistance leak for proper operation.

Let us consider just what happens when an alternating current signal is applied to the grid circuit of a tube through a grid condenser. Fig. 43 illustrates a typical detector circuit with a grid condenser.

Suppose this signal is in the form of a series of damped oscillations as at 1 in Fig. 42. As we have already seen, when this voltage is applied to the grid circuit, the voltage between the grid and the filament falls due to the unilateral conductivity of the grid. The effect is equivalent to the superimposition of the radio frequency signal on a continuously changing point on the grid potential-plate current curve of the tube, and appears as shown on 2 of Fig. 42.

The plate circuit is very similar to the grid voltage except where detection due to the curve portion of the E_c 1_b curve distorts the signal current. The shape of the plate current is illustrated in 3 of Fig. 42.

If the leakage path were of high enough resistance, and the impressed voltage were large enough, the negative charge on the grid would finally become of such a value that the plate current would be reduced to zero. When this occurs, the tube would momentarily cease to operate. It is for the purpose of preventing this effect that an artificial external leak resistance R is employed. It has been found that for weak signals maximum detection is obtained for very high values of this leak resistance. The resistance should be such that the grid voltage is restored to its original value before the beginning of the second wave train in the group. This is illustrated at 2 of Fig. 42.

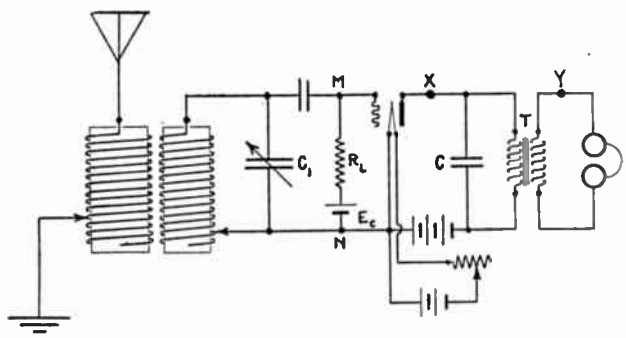


Fig. 43. The circuit on which the curves in Fig. 42 were obtained

By the application of the proper grid voltage, it is possible to start this action at any point of the grid voltage grid current curve.

For best detection, the point of maximum curvature should be selected. The location of this point differs for different tubes and should be determined experimentally if maximum detection is desired.

By observation of Fig. 42 it is seen that the grid leak resistance is of such a value that the accumulated charge is allowed to leak off before the arrival of the next wave train.

The telephone current is similar to the dotted line curve of 3 in Fig. 42, which follows the center point of each individual oscillation.

The wave form in the output circuit of the vacuum tube among other things can be resolved into a series of high

frequencies, a direct current and an audio frequency or signal current.

The condenser C, Fig. 43, bypasses these high frequency terms which prevents them from being amplified and causing disturbances or blocking of the ensuing stages of amplification.

The direct current passes through the primary winding of the transformer T while the audio frequency is transformed by it and delivered to the telephones.

If this output impedance of the tube is Ro and the impedance receivers at the signal frequency, usually between 800 and 1,000 cycles per second, is Z then in order to obtain maximum power in the telephones the transformer should have an impedance ratio of $\frac{Ro}{Z}$. This is equivalent to a turn ratio of $\sqrt{\frac{Ro}{Z}}$

The detection of a tube with a grid condenser, if the condenser and resistance are properly proportioned, is, in general, slightly better than the detection due to the detector effect described in the last installment of these articles for damped wave signals. This type of circuit, due to the grid leak resistance and grid currents which flow, produce some losses in the receiving circuit which manifest themselves by an increase of the decrement of the circuits.

For heterodyn reception it has been found that the ordinary detector circuit without a grid condenser gives best operation.

SOME IDEAS FOR A CRYSTAL RECEIVER

(*Continued from page* 60)

cover is slotted at the side allowing it to be slipped on over the rod.

When the tone of the buzzer becomes irregular, it can be quickly adjusted from the panel, without the necessity of removing the cover.

Assembly

The extreme simplicity of these instruments coupled with their excellent appearance, should appeal to the experimenters. All that is needed in the way of tools to build this apparatus are a set of drills, taps, files, a hacksaw, and a soldering iron.

Several methods can be employed to mount the panels. If another set of brackets is put on to support the top corners, the panels are sufficiently rigid for all purposes. Another way is to fit the set into a cabinet. This can be accomplished by putting small brass angles inside the cabinet, to which the corner screws can be secured.

Where connections are made at the front of the panels, wires can be run from the rear through the separations between the panels.

The Radio Department

WHAT'S the trouble with experimental radio work? The answer will depend upon the individual. Offhand, you may say that there doesn't seem to be anything wrong; in fact, you believe things are quite all right, at least considering some of the past trials of the experimenters.

If you are an A. R. R. L. man, you will probably complain of the Q R M. According to reports which are heard from the mid-west as well as from both coasts, the complaint would be justified. Some men tell of broad tuning, and others of non-regulation wavelengths.

It is to be hoped that the amount of trouble from indifference and wilfullness is small. The balance must be charged to the account of ignorance.

A great number of radio men are not interested in communication as much as in laboratory experimenting. Their cry is, "Give us data!"

THE article in this number, on high and low spark frequencies, is the first of a series which will give accurate data on transmitting equipment, with the idea of presenting information of value to the long distance operators.

Next month there will be some interesting facts about the Amrad quenched gap and spark coil. Mr. F. F. Pickslay, Sandusky, Ohio, is working on a radio telephone set, the details of which will be given to the readers of Everyday. This is a high powered equipment, employing a new type of circuit. An interesting feature is that no variable condensers will be used.

Mr. Clement is going to postpone the audion article which should be in the next issue, and is preparing, in its place some exceptionally valuable data on high frequency resistance measurements, accompanied by curves showing the resistance of different types of coils, at varying frequencies.

As a companion article, there will be complete details of a non-inductive resistance box, used with the circuits described by Mr. Clement. Various methods for measuring high frequency resistance have been used, but they had the disadvantage of requiring exceedingly careful shielding and special resistance bridges.

The system to be presented in the May issue does away with shielding troubles, and only calls for a resistance box and milliammeter.

UNDAMPED waves offer a broad field for experimental work, and a practical 200-meter outfit would be welcomed by the operators. The difficulty is in tuning undamped waves of such high frequency. There are ways to get around this trouble, one of which will be described shortly in Everyday.

One of the best methods of communicating on undamped waves is to use a buzzer or other type of modulator to call; then change over to the pure undamped waves. This gives a rather broad wave for calling, and a very sharp one for sending the messages.

HAVE you ever used a heterodyne wavemeter? This instrument, although not new, is not well known or understood by experimenters. It is nothing more than a calibrated audion oscillator, with a pair of telephones in the plate circuit. No buzzer exciter or detector is needed.

Wavelength, inductance or capacity can be measured, by means of the heterodyne wavemeter, with an accuracy which cannot be approached by the older type of instrument.

One of these meters is under construction in the Everyday laboratory, and will be described in detail as soon as it is ready, possibly in the May number.

ANOTHER matter of importance, on which experiments are being made, is the wave filter. It is easy to show on paper that series or shunt circuits can be employed to by-pass all but a given frequency, or to admit only a certain band of frequencies, but it is entirely different to operate such circuits advantageously under operating conditions.

Results obtained so far indicate that those circuits applied to radio receivers, are of little value except as paper inventions. Of course, they are used on wire telephone systems, but that is a different matter. We hope to have some data very soon which will show whether or not filter circuits really aid in the reduction of interference.

IT is gratifying to find that so many new radio clubs are being formed. The idea of giving code practice and tuning transmitters is particularly commendable. Moreover, the co-operation established in this way between experimenters allows an exchange of ideas which is not possible in casual conversations.

Quite a number of the local clubs have joined the A. R. R. L. thus building up the chain of relay stations which is already doing such good work.

Everyday is glad to publish announcements from all clubs, and also reports of conditions in different cities. If your club has succeeded in reducing the local Q R M, send in an account of the means which were used. This will give other clubs helpful suggestions for their own difficulties.

Design Features of the S. C. R. 112

Notes on the Loop Transmitter and Receiver from the Simon Company

IT is unfortunate that, with the end of the past emergency, the intensive development of radio equipment for the Army and Navy practically ceased. So many things which promised great successes never had the chance to prove themselves.

This is particularly true of the S. C. R. 112 set, which was to have been built in great quantities for communication between battalion and regiment posts of command or, in special cases, between battalions and companies. Operating on the ground or in dugouts, the range of this set is over four miles, using a loop of 3 turns, 1 meter square. The weight of this set, a matter of very great importance, is only 28 pounds.

Electrical details will not be discussed in this article, other than to say that the transmitter is of the buzzer type with an input of 60 to 85 watts at 10 volts, while the receiver is of the audion type, employing a condenser in shunt with the inductance of the loop for tuning. Adjustments are provided for transmitting wavelengths of 110, 123, and 140 meters. Some of the various instruments will be taken up in a subsequent article. We are concerned here with the exceptionally clever mechanical features.

Hidden away in the specifications for this set are the statements: "The box shall be capable of being dropped, with the instruments assembled within, five times the distance of 30 ins. on the earth without damage. It shall be sufficiently waterproof to operate when set upon the ground in a driving rain."

It took some time for the Signal Corps and the manufacturers to realize that apparatus in the field was subjected to such use. Possibly the thoughts of the beautiful skies and the smooth roads of France were too firmly implanted in the minds of the designers.

The influence of European methods can be seen in the canvas-covered carrying case a practical solution for waterproofness which, although it is not as handsome as bakelite or finished wood, gives a rugged appearance. This canvas covering also protects the wooden case from mechanical injury. Canvas flaps are also provided to guard the controls.

Figs. 2 and 4 show the flush construction of the switch handles and telegraph key. Instead of outstanding knobs to be knocked off and to strike against the legs of the man carrying the set, straight handles, easy to grip, turn in recesses. The top of the handle, flush with the side of the case, is marked with a line to read against the scale.

Indications for transmitting are filled with red pigment and for receiving, with white.

The spare parts are fitted in a section below the part of the case which carries the radio instruments. Thus, while no appreciable weight or size is added to the set, the disadvantage of a separate spare part box is overcome.

A very human consideration is introduced in the design of the filament switch, shown in Fig. 2, just beside the folding key lever. The switch mechanism is mounted on an asbestos panel, while the front plate is of aluminum. Between the asbestos sheet and the front plate are two Ward-Leonard resistances.

At the 4-volt position of the switch, the smaller resistance of 1.15 ohms is cut in, or at the 10-volt position, the 6.2 ohm resistance permitting the use of a 4- or 10-volt battery on the filament of the audion. The heat from these resistances is radiated by the aluminum front plate, giving the operator a chance to warm his fingers when the weather is cold. The flap at the end of the case can be let down to enhance this effect. Very little heat is conducted into the set because of the asbestos plate at the rear of the resistances.

The telegraph key is unusual in that

(*Continued on page* 86)

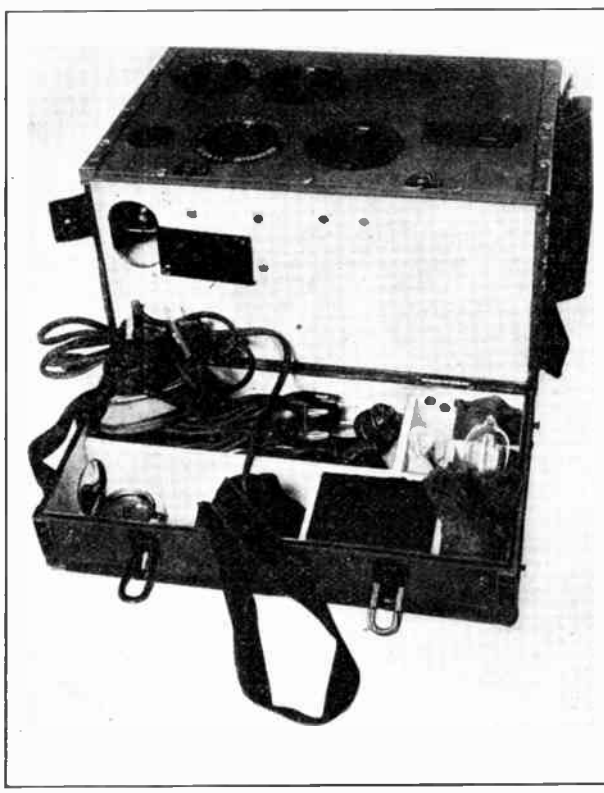


Fig. 1. The top section turned back to show the spare part box

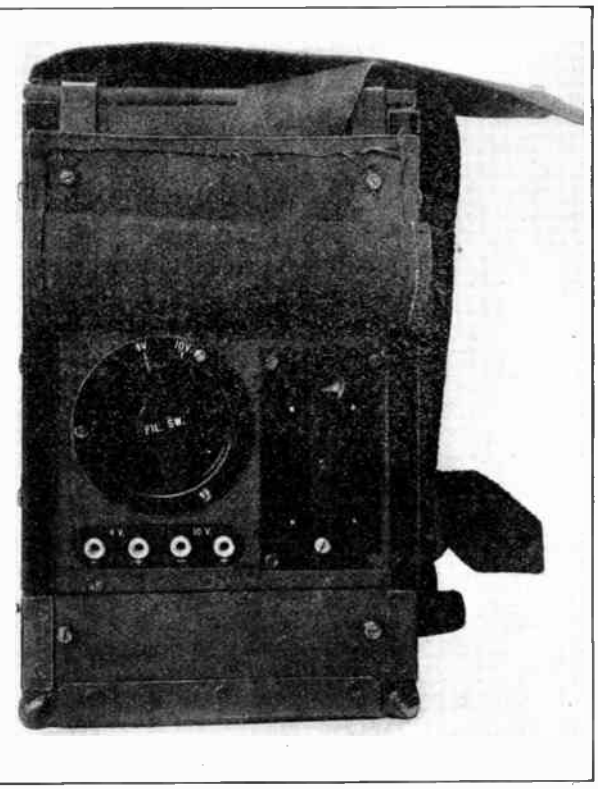


Fig. 2. Illustrating the key, in closed position, and the filament switch

MEASUREMENT OF HIGH TEMPERATURES IN THE LABORATORY

(*Continued from page 37*)

nary work. All readings were checked with an Englehardt millivoltmeter and a platinum rhodium thermocouple which the writer has recently added to his laboratory equipment.

For obtaining approximate results in calibrating, Seger cones can be purchased from chemical supply houses and can be used in an electric furnace having an arrangement for viewing the melting of the cones. The cones and couple to be calibrated are arranged in the furnace and the temperature gradually raised. As the cones fuse the reading in millivolts should be taken. With the fusing point of the Seger cones known a curve can be plotted showing temperature and millivoltmeter readings. The cones can be purchased in assorted lots and should be ordered by number. Following is a list of cones with numbers and fusing points·

Number	*Fusing Point—Degrees C.*
.022	590
.021	629
.020	650
.019	680
.018	710
.017	740
.016	770
.015	800
.014	830
.013	860
.012	890
.011	920
.010	950
.09	970
.08	990
.07	1010
.06	1030
.05	1050
.04	1070

The electromotive force developed by a thermocouple depends upon the difference between the hot and cold junctions and for precise work one junction of the couple should be kept at constant temperature. A convenient arrangement is to have the ends of the couple pass through a cork into a thermo bottle, which has previously been filled with cracked ice. However, as the couple was primarily designed and made for the heat treatment of tool steel no cold junction need be made for these determinations.

The apparatus described herewith should appeal strongly to the amateur mechanic and model maker. Various tool steels fail to give the length of service expected due to insufficient hardness or lack of uniformity of hardness and a calibrated couple with a millivoltmeter offer a simple method for determining the proper temperature to which high carbon tool steel should be heated before quenching.

When iron and steel pass through certain of its transformation points the hardness and coarseness of the grain are considerably altered. These properties may be made permanent by sudden quenching.

(*Continued on page 72*)

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(*Continued from page* 70)

The sample to be tested is prepared by counterboring a hole in the piece of steel and the bare end of the thermocouple inserted. Another method is to clamp over the bare end of the couple two pieces of the steel to be tested. These pieces should be at least one inch long and not less than three-quarters of an inch wide. The sample is now placed in a furnace and the furnace gradually heated. Fig. — shows the arrangement as used by the writer. A rheostat should be used to control the temperature. Allow the furnace to reach 600° C. At a certain point variable with the carbon content of steel the indicator on the millivoltmeter will be motionless for several seconds due to the readjustment of the steel structure and the changing conditions caused by the application of heat. This point is known as the decalescent point. The temperature of the millivoltmeter reading at this pause indicates the proper quenching temperature. The tool or sample to be tested is generally heated slightly higher than necessary to allow for the loss of heat from the furnace to the quenching bath.

The serious investigator, with the apparatus described in this paper, should have no difficulty to acquire the principles of thermoelectric pyrometry and particularly the pyrometric phenomena attending the critical quenching temperature of steel.

CHEMISTRY OF THE COMMON METALS

(*Continued from page* 36)

does not have a very great commercial value.

Potassium perchlorate is formed when the chlorate is heated very gently. This substance is a white crystalline one which is not very soluble in water. It can also be formed when perchloric acid is added to a solution of a potassium salt. At higher temperatures the perchlorate decomposes into the chloride and oxygen.

Potassium nitrate (KNO_3) is a very important compound. It is commonly known as saltpeter and is found in great quantities in nature. The present method of making the salt is by bringing together equivalent quantities of sodium nitrate, potassium chloride and water. When this mixture is heated to a fairly high temperature a large amount of the sodium chloride separates. The solution is filtered while hot and allowed to cool when potassium nitrate and a little sodium chloride crystallizes out.

Potassium nitrate (KNO_2) is made in the same manner as the corresponding sodium salt. As it is much more difficult to purify and as it can be replaced in every case by the salt of sodium, it is not largely used.

(*Continued on page* 75)

(*Continued from page 72*)

Potassium carbonate (K_2CO_3) is now obtained from potassium sulfate by a modification of the Le Blonc process for the preparation of soda. It is also obtained by the use of potassium chloride by taking advantage of the fact that when carbon dioxide under pressure is forced into a potassium chloride solution, containing magnesium carbonate in suspension, a double salt having the formula $KHCO_3$ $M_2CO_24H_2O$ is deposited. This salt is readily decomposed by hot water, producing M_2CO_3 which is preciptated. Carbon dioxide passes out of the solution and a solution of potassium carbonate remains from which the salt is obtained.

Potassium bicarbonate ($KHCO_3$) or potassium acid carbonate may be prepared by passing carbon dioxide through a very strong solution of the carbonate. The solution of this substance is slightly alkaline. It can be partially decomposed into CO_2 and the carbonate by boiling. At a temperature of 190° the salt is entirely decomposed into the carbonate, carbon dioxide and water.

Potassium sulfate (K_2SO_4) occurs largely in nature. It is present in schoenite and it is obtained from this substance by adding potassium chloride and a little water. When heated potassium sulfate crystallizes out, leaving magnesium chloride in the solution.

Potassium cyanide (KCN) is manufactured by heating potassium ferrocyanide with potassium carbonate. The following reaction then occurs:

$$K_4Fe(CN)_6+K_2CO_3=5KCN+KCNO+CO_2+Fe$$

Potassium cyanide is used in large quantities in gold mining and the processes of silver and electroplating.

A PRACTICAL SAFETY DEVICE

Emery wheels, rotary cutting machines, etc., are a constant source of danger to the workman's eyes. With "safety first" being preached by trained organizations of safety men in all big industrial estabishments, any device designed to protect the worker's eyes from injury is of general interest.

Goggles and glass shields have proven fairly satisfactory, but not entirely so, because of the liability of the glass to become broken.

Recently safety glass and transparent sheeting (the same material used for lights in auto curtains) have been tried with great success.

The safety glass is made either by laying in it a coarse mesh of fine wire or by employing hydraulic pressure to weld a piece of the transparent sheeting between two sheets of glass.

However, for goggles or shields over emery wheels, the transparent sheeting alone is very effective. It is cheaper and lighter than any form of glass.

EVERYDAY SCIENCE NOTES

The banana has been recommended as a source of alcohol; the Germans left vast plantations in Africa. Referred to the area cultivated it gives double the yield of sugar beets. An acre gives from its quota of 800 trees some 100,000 lbs. of fruit and the yield of alcohol is from 1,000 to 1,200 gallons per acre. In the Philippines, the Nipa palm is a possible source of alcohol; it is tapped like the sugar maple. A liquor for use by the natives is now made from it.

A bottle with a message from the aviator Hawker, who came down in the ocean last May in his attempt to cross to England, has been picked up off the southwest coast of Norway. It was found on November 20th. It was thrown out by Hawker on May 17th or 18th, so that it had been afloat some six months.

The following welding compositions are from a French contemporary.

A

Iron filings	6	parts by weight
Ammonium chloride	14	" "
Potassium ferrocyanide	14	" "
Borax	100	" "

B

Rosin	30	parts by weight
Salt	10	" "
Borax	300	" "
Alum	30	" "
Ammonium chloride	150	" "
Zinc sulphate	20	" "

A wooden boiler has been recently described. It was in use in the Philadelphia pumping station a century ago. It worked at a pressure of only 2½ lbs. to the square inch. It was made of 5-inch white pine braced with 10-inch oak beams; it was rectangular in shape, 9 by 14 feet area and 9 feet deep. It had an iron fire box and flue with a return flue above. The trouble on rceord is that it did not do well above the water line. The water seemed to keep the lower part in order, but the steam did not take care of the upper portions.

The Colonial Belgium Office is to try out motor tractors for use in Africa to burn palm oil and similar vegetable oils. They are to be used for ploughing and general hauling and traction.

A wood-screw is being placed on the market which has no slot, but in place of it has a square hole in its top, to receive a special square ended screw-driver. It is somewhat in the line of the safety set-screws for belt wheels on shafting.

It has been found that electric line poles give away and decay 20 inches below the surface and a little way above the surface of the ground. To save them they are dug around so as to expose a yard or less; if there is decay the rotten wood is scraped away, and a divided tank is put around the post and a preservative is put into it. Attempts to do this under pressure failed as the joints could not be adequately packed. After impregnation with the preservative eight vertical reinforcing pieces of steel are attached and concrete is applied to a thickness of three or four inches, extending a foot above the surface of the earth. When new poles are to be put into the places formerly occupied by old and decayed poles it is advantageous to use new and fresh earth as the old earth is filled with fungus germs and will quickly start decay.

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High Frequency Resistance Measurements; Construction of a Heterodyne Wavemeter; Use of the Quenched Spark Gap; 200-Meter Undamped Wave Transmitter.

These are some of the articles which will appear in EVERYDAY, the magazine that gives accurate construction data on instruments which do the work. If you miss a single issue, you will lose information you cannot find elsewhere.

EVERYDAY SCIENCE NOTES

The iron mines of Bill Island, Newfoundland, have been attracting some attention. There are two areas, one good for 700,000 tons per annum, the other for 600,000 tons. There is enough it is believed to keep the mines going for centuries. In Nova Scotia a 10,000,000-ton deposit is cited, lying near the coast.

From England comes the interesting intelligence that the manufacturers of automobiles are seriously turning their thoughts to the manufacture of air-cooled engines. Presumably it is the aeroplane that has awakened this interest, but to us in this country it is a very familiar subject, as we have several very successful cars of the type in question, and have been familiar with such for many years.

Exploration of the upper regions of the atmosphere by huge rockets, as our readers know, has been proposed. And now comes the suggestion that there might be danger in such attempts, the idea being that there may be hydrogen gas in the higher regions and that a rocket might bring about a catastrophy by igniting it. This is a very odd and fanciful idea.

It is calculated that on the Pennsylvania Railroad it takes 127 men to do the work formerly done by 100. This is supposed to have occurred in the last two years. In shop work the output per man has fallen to three-quarters on a ten-hour basis; if the eight-hour day be taken as the basis the decline is about 40 per cent., or it takes ten men to do the work formerly done by six men.

It was observed that piles in the Great Salt Lake lasted a long time. Now railroad sleepers are soaked in the water of the lake for a year before use; Oregon pine sleepers are greatly improved in durability by this system.

In Algeria truck drivers found that their trucks would give them electric shocks, during the siroccos or high winds of that region. They avoided them by attaching a dragging wire to the truck. This gave a ground and kept the chassis discharged. Otherwise the insulation afforded by the rubber tires kept them in a charged condition once the flying sand had so affected them.

Three of four instances of whales killed by the Allies' dirigibles in the war have been cited. They were mistaken for submarines and bombs were dropped with the idea of sinking the enemy craft, but it was the poor cetacean that suffered. The English submarines evolved a method of signaling by jets of water or sterm. This increased their resemblance to whales and it is said that one was mistaken for a whale by a friendly ship.

The porosity of porcelain telegraph and power line insulators has been lately carried out in New Zealand. They were subjected to a pressure of 2,000 lbs. to the square inch in a cavity in a steel block. The hole was 3 inches wide and 6½ inches deep and was closed with a plate an inch thick. A solution colored red was used to enable the penetration to be tested. Some showed no penetration and no relation between the specific gravity and porosity could be traced.

BOOK REVIEWS

COMPLETE PRACTICAL MACHINIST. By Joshua Rose, M.E. Published by the Henry Carey Baird Co., 2 West 45th Street, New York, N. Y. Size 5 x 7½, bound in cloth, contains 536 pages and 432 line drawings and halftones.

This book is a particularly complete treatment of general machine shop processes and machine operation. It seems to have been prepared with the aim to interest the student and workman rather than the advanced machine designer or engineer. The contents are written in a practical, straightforward manner easily digestible to the layman as well as to the experienced mechanic. All of the various machine shop subjects that it treats are well illustrated in a way that greatly facilitates proper understanding. As a home study book for the man desiring to advance himself where he is employed, few would be more useful.

The chapters cover the following subjects: Cutting Tools for Lathe and Planing Machines, Cutting Speed and Feed, Boring Tools for Lathe Work, Screw-cutting Tools, Lathe Dogs, Carriers or Drivers, Turning Eccentrics, Hand Turning, Drilling in the Lathe, Boring Brass, Slotting Machine Tools, Twist Drills, Tool Steel Taps and Dies, Vise Work—Tools, Fitting Connecting Rods, Milling Machine and Milling Tools, Grinding Stone and Tool Grinding, Lining or Marking Out Work, Machine Tools, Precision Lathe Attachments and Their Use, Fellows Gear Shaper and Its Operation, Miscellaneous Attachments and Machinery, To Calculate the Speed of Wheels, Pulleys, Etc., How to Set a Slide Valve and Pumps.

SELENIUM CELLS AND HOW THEY ARE MADE. By Samuel Wein. Published by Progress Publishing Co., 1812 Lexington Ave., New York City. Contains 30 pages, bound in paper and illustrated with halftones and line cuts.

This is one of the very few books that have been published on the interesting subject of selenium, its properties and use. Also includes a brief historical sketch of the element and the method of producing it on a commercial scale.

Probably the most interesting data in this booklet is the clear discourse given on each of the well known types of selenium cells. The Bell-Tainter, Fritts, Mercadier, Bidwell, Townsend, Gripenberg, Ruhmer, Hammer and other cells of note are treated in an understandable way. The latter part of the booklet is devoted to general constructional data. A very interesting table showing the sensitivity of Ruhmers cells at different distances and with different sources of light is given. Another very useful table is included which has to do with inertia.

(*Continued from page* 68)
the lever folds up flush with the case when not in use. Inside is the breaking mechanism and a small resistance, shunted across the key to prevent sparking and also to keep the buzzer interrupter in vibration between the dots and dashes. This idea might be applied to spark coils as well.

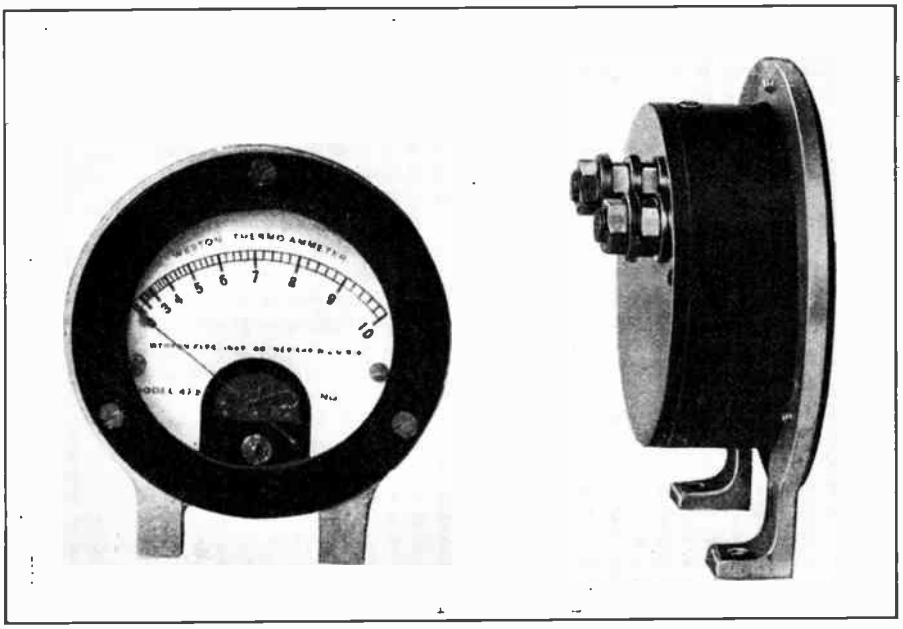


Fig. 3. Details of the thermo ammeter mounting

dows are provided behind the heavy wire mesh. Fig. 1 shows the opening through which the audion is removed.

Fig. 3 illustrates the method employed for mounting the Weston thermo ammeter. As it is not practical to use the ordinary flush mounting, a yoke was made to fit around the case, fastened to the flange by machine screws.

In this way the flush mounting effect was secured without actually putting the ammeter on the front panel.

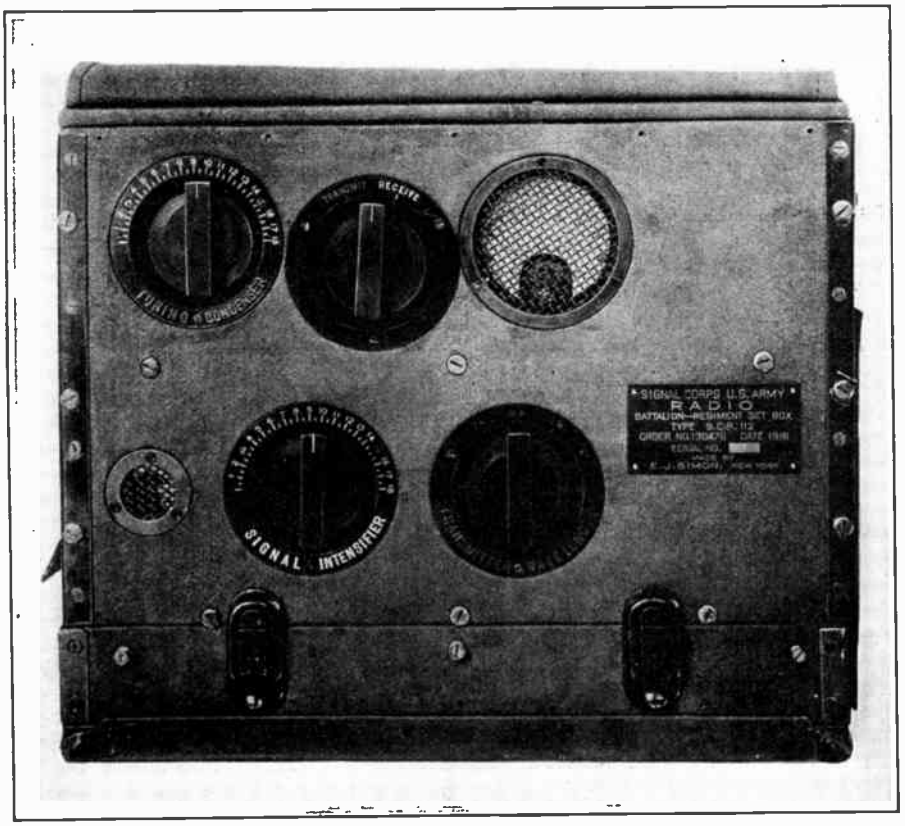


Fig. 4. Front of the case, showing the controls and location of the spare part box

Attention is also called to the protection provided for the ammeter and audion observation opening. To prevent the admission of dust, glass win-

THE RADIO INTELLIGENCE POST

The Radio Intelligence Post of the American Legion wishes to hear from former service men who were attached to the Radio Intelligence Section of the General Staff.

Membership in this Post should be interesting to these men for the opportunities it gives for exchange of experiences and social activity, as well as keeping abreast of radio developments.

The secretary is A. L. Bernhard, 1679 42nd Street, Brooklyn, N. Y.

ENGLISH RADIO ASSOCIATIONS

THE American radio clubs will undoubtedly find it of great interest to correspond with some of the newly established associations in England. An exchange of ideas and co-operation can be established in this way. Below are the names of some of the associations and their secretaries.

The Wireless Society of London. Hon. Secretary, Mr. H. L. McMichael, 32, Quex Road, West Hempstead, N.W. London, England.

The Manchester Wireless Club. Hon. Secretary, Mr. J. C. A. Reid, 16, Hawthorn Avenue, Monton, Eccles, Manchester, England.

The Derby Wireless Club. Hon. Secretary, Mr. S. G. Taylor, St. Mary's Gate, Derby, England.

North Middlesex Wireless Club. Hon. Secretary, Mr. E. M. Savage, Nithsdale, Eversley Park Road, Winchmore Hill, N. 21, North Middlesex, England.

There is a radio society in Belgium with which correspondence can be carried on in the English or French language.

Le Cercle Belge d'Etudes Radiotéléraphiques. The Secretary is M. Pierre Tollenaere, 209, Bd. Leopold 11, Brussels, Belgium.

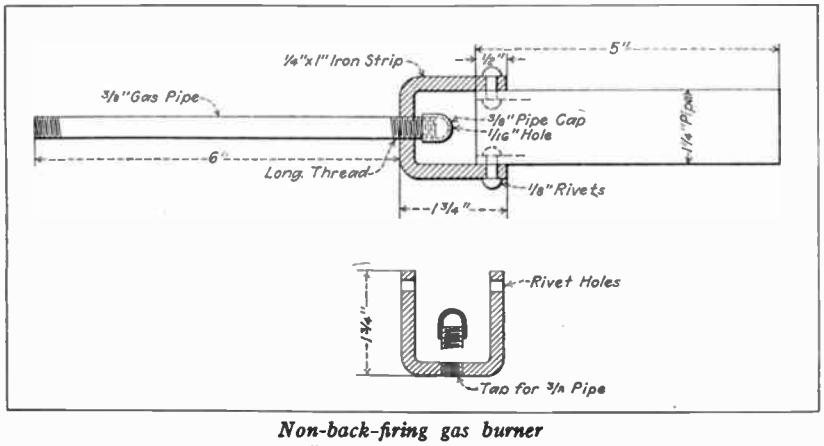
SOUTH JERSEY RADIO ASSOCIATION

THE South Jersey Radio Association has just elected new officers for the ensuing year. This organization has been in existence for some time. During the war it conducted a radio school and graduated many men who went into the service. It is now looking forward to a bright future and hopes to secure members from all parts of South Jersey. If the experimenters from this part of the country will cooperate with the Association we can make it a live, wide-awake one which will benefit everyone.

The meetings are held every third Thursday of the month at Collingswood, N. J. Communications should be addressed to Edward B. Patterson, West Walnut Avenue, Merchantville, N. J.

NON-BACK-FIRING GAS BURNER

THE sketch shows a cheap and easily constructed gas burner that gives a hot flame. All that is needed is a piece of 1¼" pipe, 5" long, and a piece of ⅜" pipe with long thread on one end, a piece of ¼" x 1" iron strip, and one ⅜" pipe cap. Screw the long thread of ⅜" pipe through the ¼ x 1" iron strip and then screw on ⅜" cap to the end of the pipe that projects through with 1/16" hole drilled in the center. This burner can be turned down to mere pilot light when not in use, and will not go out.—*Harry F. Mack.*



Non-back-firing gas burner

SODIUM FLUORIDE AS A WOOD PRESERVATIVE

TESTS made years ago at the Forest Products Laboratory indicated that sodium fluoride might be successfully used as a wood preservative, because it had high toxicity, was not injurious to metal, and was convenient to handle. Laboratory tests alone, however, are never sufficient to establish the value of any material as a wood preservative; actual service tests, even though they require years to complete, are also needed.

In order to obtain comparative durability records, the laboratory in 1914 placed sap-pine ties treated with sodium fluoride, together with ties treated with zinc chloride and creosote, in one of the mines of the Tennessee Coal, Iron and Railway Company, at Birmingham, Alabama. Similar service tests were also started at this time on red oak ties placed in the tracks of the Baltimore and Ohio Railway Company.

After five years of service the mine ties which were treated with sodium fluoride have been found in as good condition as those treated with zinc chloride, both showing very little deterioration. The creosoted mine ties apparently were in still better condition, while the untreated ones were in various advanced stages of decay. The red oak railway ties treated with sodium fluoride were practically all sound, as were those treated with zinc chloride, whereas a large percentage of the untreated oak ties had been removed.

Both of these tests, as well as others started later, must continue for a number of years, yet before the relative value of the sodium-fluoride treatment for ties and timbers is definitely known.

NOTES ON BEARINGS

THE projected area of a bearing is equal to the diameter of the shaft multiplied by the length of the bearing. Pressure per inch, therefore, may be arrived at by dividing the total pressure by the projected areas of the bearing. Required bearing area is the total pressure divided by the allowable pressures per square inch, giving the required projected area in square inches. Required bearing length is the total pressure divided by the desired pressure per square inch, and this again divided by the diameter of the shaft; or the projected area divided by the shaft's diameter.

Allowable pressure per square inch ranges from 10 to 30 lbs. for high-speed shafts in babbitted bearings, to 100 lbs. for large slow-speed shafts. Engine crankpins often sustain 1,000 to 3,000 lbs. the sq. in.

Speed of minimum friction is the ratio of motion at which, if varied from, either faster or slower, the friction of a bearing increases. With perfect lubrication it is believed to be between 100 and 150 ft. per minute.

A curious and not particularly valuable presentation of a hypothetical trip to the moon is given by one of our contemporaries. As there is no atmosphere for an aeroplane propellor to work in, above a certain altitude, the logical deduction is that the propelling motor would have to be of the reaction or rocket type. Then as gravity ceased, if the speed was uniform water would not pour, the operator would float about in his compartment, and a fictitious gravity effect would have to be created by having a constantly accelerated speed. As the efficiency of the reaction engine is very low a vast amount of explosive to operate it would have to be carried—a consumption of some 500 lbs. to the mile might be looked for. The physiology of the operation is not treated of by our authority—life in a vacuum is presumably beyond his planning. Finally he takes the view that there is enough energy for the transit locked up in an ounce of radium, but over 1700 years would be required to get it out.

MODEL CAR TRUCKS

(*Continued from page* 12)

truck on the roadbed. The sketch, Fig. 8, gives full particulars of the device natural size, and it will, as far as the writer is concerned, be considered as the American model railroad standard fixing for bogie trucks for all vehicles.

The beaming springs should be designed to take a load of about 16 oz. each with a deflection of about ⅛ in.. the unloaded length being about ⅝ in. As already mentioned, the coefficients of scale tonnage are:

1 lb. of model = 5.41 tons.

1 ton of original = 0.184 lbs. in the model.

Taking the car at an average of 40 tons, the weight on each spring would possible.

be 40 × 0.184 ÷ 8 = .92 lbs. Tempered springs should be obtained if

The spliced ends of the crossbars and side frames of the truck may be bolted together with 3/32 in. bolts, and where additional realism is desired safety chains—often used in real practice to limit the movement of a truck—may be attached to these bolts.

The transom of the car body may vary in design, but it is suggested that the dimension of its underside (including the metal rubbing plate) being ratined for all types of vehicle at 1 9/16 in. approximately, above rail level. A difference of 1/32 in. either way is of no account.

In view of the fact that a British firm has adopted a similar design to the above, for their ½ in. scale Pullman coaches, and readers can obtain castings, the points of difference, which are solely due to the manufacturing considerations, may be mentioned. The axleboxes and equalizer are cast in one. but instead of the boxes working in a slot in the side frame casting, the latter is milled out as shown in the sketch and the journal rides in this slot. The axlebox therefore provides for the vertical movement and control of the journal, while any longitudinal position of the journal is restrained by the milled slob. The sketches should make this clear.

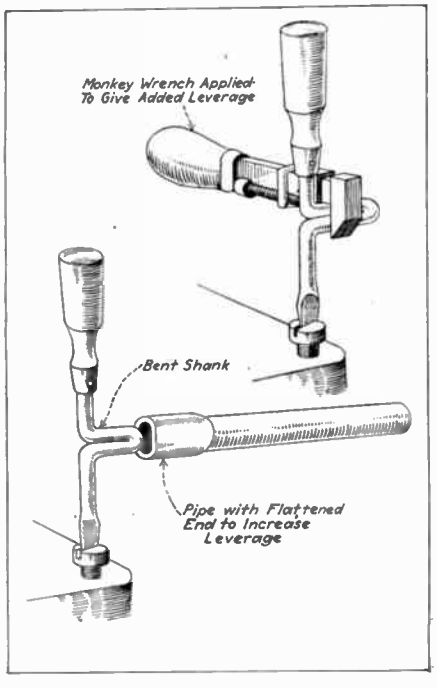
WHITE WRITING FLUID FOR BLUE-PRINTS

A FLUID which I find is as good as any I have ever used for writing white on blue-prints is made of equal parts of sal-soda and water. Another fluid, not as good, is made by mixing equal parts of borax and water. Both these fluids must be used with a fine-pointed pen; a pen with a blunt point will not work well.

It is proposed by French electricians to use what they term "denatured electricity" for heating purposes. This kind of electric power is supposed to be made unfit for anything but heating, and so is said to be "denatured". The current is periodically cut off or is purposely caused to fluctuate so as to be intolerable for lighting and to work badly for power. For heating such interruptions are of no account.

HEAVY DUTY SCREWDRIVER

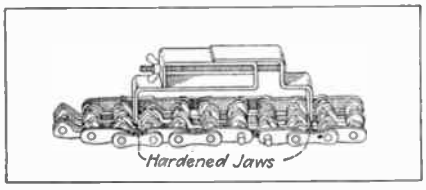
THE improved type of screwdriver shown in accompanying cut will be found useful for turning large or tight screws. Any long bladed driver may be altered by heating and bending it into the shape indicated. It can be



used with a piece of flattened pipe to provide increased leverage, or a monkey wrench can be applied. If the screwdriver is of good grade of steel, the most stubborn of screws ordinarily beyond its capacity if used in the regular way, can be easily turned.

SILENT CHAIN TOOL

REMOVAL or replacement of the lock link of silent motor chains is made easier by the use of a tool that will draw the chain together while doing the work. Such a tool comprises



two steel hooks made of strip stock that may be caught into the links at each side of the master or lock link and contracted by a thumbscrew and bolt. The steel jaws may be case-hardened to insure durability but this is not absolutely necessary.

The Siemens house is putting an inert dry cell on the market. Its exciting components are absolutely dry, so that it suffers no deterioration from standing for however long a period. Before using it water is added, and it at once becomes active.

A SMALL HIGH FREQUENCY ALTERNATOR

(*Continued from page 52*)

point of maximum sensitiveness. A buzzer used for this purpose often produces too heavy a current and many times burns the point of a detector crystal and renders it insensitive. The little high-frequency alternator described can be used successfully as a substitute for the buzzer and will be found much more efficient for this purpose. By the use of a rheostat inserted in the input circuit or in the circuit of the first buzzer, the amount of current flowing through the detector crystal can be controlled. The frequency of the machine can also be controlled nicely by adjusting the speed of the motor. By the use of a higher frequency it is possible to bring the detector to a higher point of sensitivity as the human ear is more sensitive to the higher vibrations. A buzzer is continuously getting out of adjustment and it is almost impossible to keep one in perfect order. This disadvantage is entirely overcome by the use of the high-frequency alternator. Once the motor speed is set, the frequency of the machine will not vary in the least and the machine can be run indefinitely. When the device is used for wireless work it can be controlled by push buttons in the same way a buzzer is controlled.

PAINTING IRONWORK

THERE are many positions where girders and other iron members are used which are not prominently in view, and often because metal work is not in immediate view it gets neglected. In putting in out-of-sight work it should be all cleaned thoroughly and have one or two coats of red lead and raw linseed oil paint, usually about 4 lbs. red and 1 lb. old white lead thoroughly ground together, forming the pigment, no driers or turpentine being used. The paint is made fresh as required, and is well worked in with stiff paint brushes, each coat being allowed to dry before a succeeding one is applied. After the work of building is finished all dirt should be cleaned off the ironwork, and if the paint has been removed or broken another coat should be applied. In places where stream and moisture is prevalent all concealed ironwork should be examined and, where necessary repainted at least once a year, but where exposed to view there is less need to specially hunt after paint defects, as they soon make themselves apparent.

Terrestial heat is believed to be profoundly influenced by the presence of radium in the crust of the earth. And now comes the theory that the heat encountered in driving the Simplon tunnel was in part at least due to radium. It is very obvious, as is stated, that if there had been enough radium it would have been impossible to construct the tunnel.

TESTING GLOVES FOR USE OF LINEMEN

SOME day when you are walking along a "main-traveled" road where traffic is piled back as far as one can see and linemen are repairing a broken wire, stop and watch them work. They are interesting artisans; the most interesting phase of their operations you will not see. The gloves they wear tell a unique story. Probably the line they are handling is "alive", and carrying electric current enough to cause instant death, yet they pick it up, twist it, splice it as nonchalantly as though handling fishing tackle. They are able to pick up the live wire because of the rubber gloves they wear. Did you know that these gloves are today made according to rigid specifications completely standardized, and that no purchasing agent dare buy rubber gloves until he has thoroughly tested them?

No glove can be marked with the manufacturer's name or with the size in such a manner as to injure it in any way. Every glove must be more than 14 inches long and the average thickness not less than 60 mils. They must have a tensile strength of 1,200 pounds per square inch and bear having two inches of their surface stretched to twelve without a rupture. The gloves shall be capable of withstanding the application of 18,000 volts without puncturing. The dielectric test is made by immersing the glove in a pan of water with the glove nearly full of water. The water inside and outside of the glove forms the electrodes. These are conveniently connected to the testing transformer by means of a chain suspended within the glove and by direct connection to the retaining vessel.

After the gloves are purchased, rigid inspection is insisted upon; they are subjected to periodic high voltage tests weekly or monthly, cleaned with soap and water and stored in cold, dark places. They are marked by serial numbers and their history kept. You understand that should one of the linemen you have been watching puncture his gloves, death may result. The perfection of linemen's rubber gloves is one of the silent romances of the electrical industry. They are as important in the day's work as the steel helmet in battle. Today line work is a hundred times safer than formerly, for now when a line is deadened the switch is usually of the modern safety enclosed type and no other person but the man on the line holds the key that locks the disconnected switch.

Melted quartz, now coming into many uses will not crack as glass does under sudden changes of temperature. An immersion heater is produced in England, in which the core on which the wire is wound as well as the enclosing tube are made of quartz.

ENGINE ROOM HINTS

LEAKY boiler settings may be made lastingly tight by soaking cheap waste or asbestos from old discarded pipe covering in thin fire clay and hammering the mixture into the cracks. Paint the brickwork with thin fire clay or cement.

In packing valve stems of piston rods, never use old packing that has been removed. It has lost its elasticity, and there is danger of its scoring the rods.

Frequently the sight feed glass of a lubricator fills with oil. If the oil is removed from the body of the cup and it is filled with water and started up in the usual way the water will float the oil out of the blast without further trouble.

DETECTING SULPHURIC ACID IN OIL

BROUGHT into contact with moisture, any acid present in the lubricant will cause corrosion. The presence of sulphuric acid may be detected by a solution of barium chloride in distilled water. Thin the oil by mixing it with an equal quantity of gasoline or benzine. Add a few drops of the barium chloride solution, and if the oil contains sulphuric acid, a whitish precipitate will be revealed. In the absence of moisture, sulphuric acid is not so active and may escape detection.

Dr. W. H. Eccles in a recent discussion before the British Association said that the three electrode vacuum tube was revolutionizing wireless telegraphy. One point made was that it can be used with small receptive antennae. By its use speech, he said, has been freely transmitted across the Atlantic. He thought it possible that it may yet be used in the field of electric power. In his laboratory he has detected currents due to 10-10 volts; at times a magnification of 20,000 was involved. He calculated that with a fifty-mile length of cable submerged on each side of the Atlantic with a 40-ampere current and a frequency of 20 to the second, telegraphic messages could be dispatched.

The production of tungsten has doubled during the war. Portugal, Spain, France and Great Britain are credited with 2,500 to 2,800 tons, North America with 6,000 tons. South America with 3,000 to 3,500 tons, India, Siam, Australia and the Malay States with 5,500 to 6,000 tons, and China, Japan and Indo-China with 800 to 1,200 tons. Although produced in such small tonnage, it is one of the most important metals in the world. In its use in incandescent electric lamps it has increased the efficiency of that type of lamp fourfold, and has brought about the manufacture of such high candle power lamps that they almost rival the arc lights in power.

From Canada comes the suggestion to use water transmission lines for the conveyance of voice messages by what is known as "wired wireless"; in this system a metallic line is used in connection with wireless transmission methods. to effect in some degree a limitation of transmission to one station.

EVERYDAY SCIENCE NOTES

The preparation of tungsten filaments for incandescent lamps is carried out in the general way as described here. The crude oxide is dissolved and reprecipitated and heated to expel any ammonium salts it may have retained from the precipitation. Some thorium nitrate is mixed with it and it is compressed into a prismatic shaped bar, eight inches long and a quarter of an inch square by hydraulic pressure. It is heated in a gas furnace until it sinters. The heating is then completed in a reducing atmosphere by passing an electric current through it. It is then drawn down into wire, graphite being used as the lubricant. The thorium must be in just the right proportions.

In welding operations on the large scale as in ship-building, it is found that arc welding is slower and takes more labor charge, but requires less power and a less expensive apparatus. Butt and spot welding are done by incandescence and plates three inches thick can be successfully spot-welded. For seams between plates to be joined arc-welding is much employed. Metallic electrodes are favored for arc work, and the skill of the workman counts for a great deal in the work.

It is claimed that by the use of wire of streamline section, rafwire, ten miles an hour have been added to the speed of an aeroplane. The designation "raf" stands for Royal Aircraft Factory.

If a machine in a factory breaks down it may be an affair of days to replace it. If it is a workman that is injured he can be replaced without delay. In Germany it is said there is a special insurance to cover the contingency of the breaking down of machines; in case of a machine failing the insurance company is held obliged to immediately replace it. It is obvious that this might be an impossibility, however.

As it begins to appear that the resources of the world in tungsten are limited, molybdenum comes in as a substitute for tungsten in high speed steel. This has already been noted in these notes. The production of molybdenum in Canada in 1918 was ten times what it was in 1914. If tungsten is to be scarce it is well to keep it for incandescent lamp filaments and to use the commoner metal, molybdenum, for steel.

According to some calculations at the present rate the petroleum resources of the United States will be expended by 1927. Other countries are searching for oil, the Argentine Confederacy and England among the most prominent.

A good deal of work is being done in the development of the production of electrolytic iron. Electrolytic copper has long had a place in commerce, and now a very pure iron is being precipitated by the electric current from the solution of the metal. A rotating cathode receives the deposit, which is stripped from it as a sheet from time to time. Hydrogen gas accumulates on the cathode and interferes to some extent with the progress of the operation. The iron produced is very soft. After fusion it can be cut with a knife like copper, and is as malleable as that metal. It is of special value for tubes and sheets. Under the microscope it shows a lamellar structure.

CLASSIFIED ADVERTISING COLUMNS

Advertisements in these columns 5c per word, average 7 words to the line. To insert advertisement under proper classification copy should reach us not later than the first of the month.

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VULCANIZE RUBBER without heat or tools. Whirlwind seller to every Auto Owner. Further particulars free. Muscatine Agency, E402, Muscatine, Iowa.

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TIRES—10,000 MILES GUARANTEED IN WRITING. (No seconds). At special Wholesale direct-to-you prices. Don't buy until you get our prices. Write Washington-McLean Tire Co., 2104 14th St., N. W., Washington, D. C.

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MIX your own airplane dope. Perfect results easy. Small cost. Guaranteed formula $1.00. Send stamp for sample. Planoloid, Box 309, Old Town, Me.

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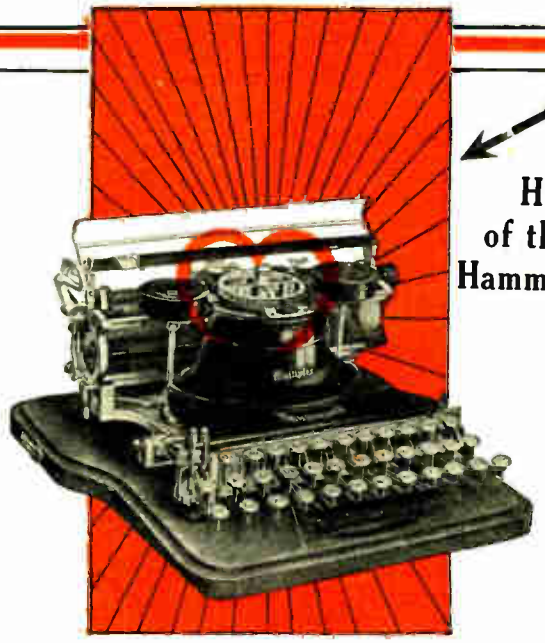

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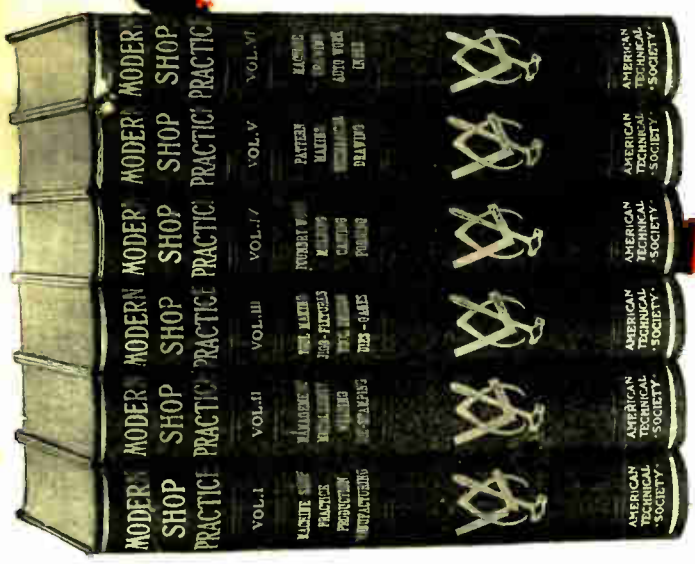

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