EVERYDAY ENGINEERING MAGAZINE

November 1920
Vol. 10 No. 2

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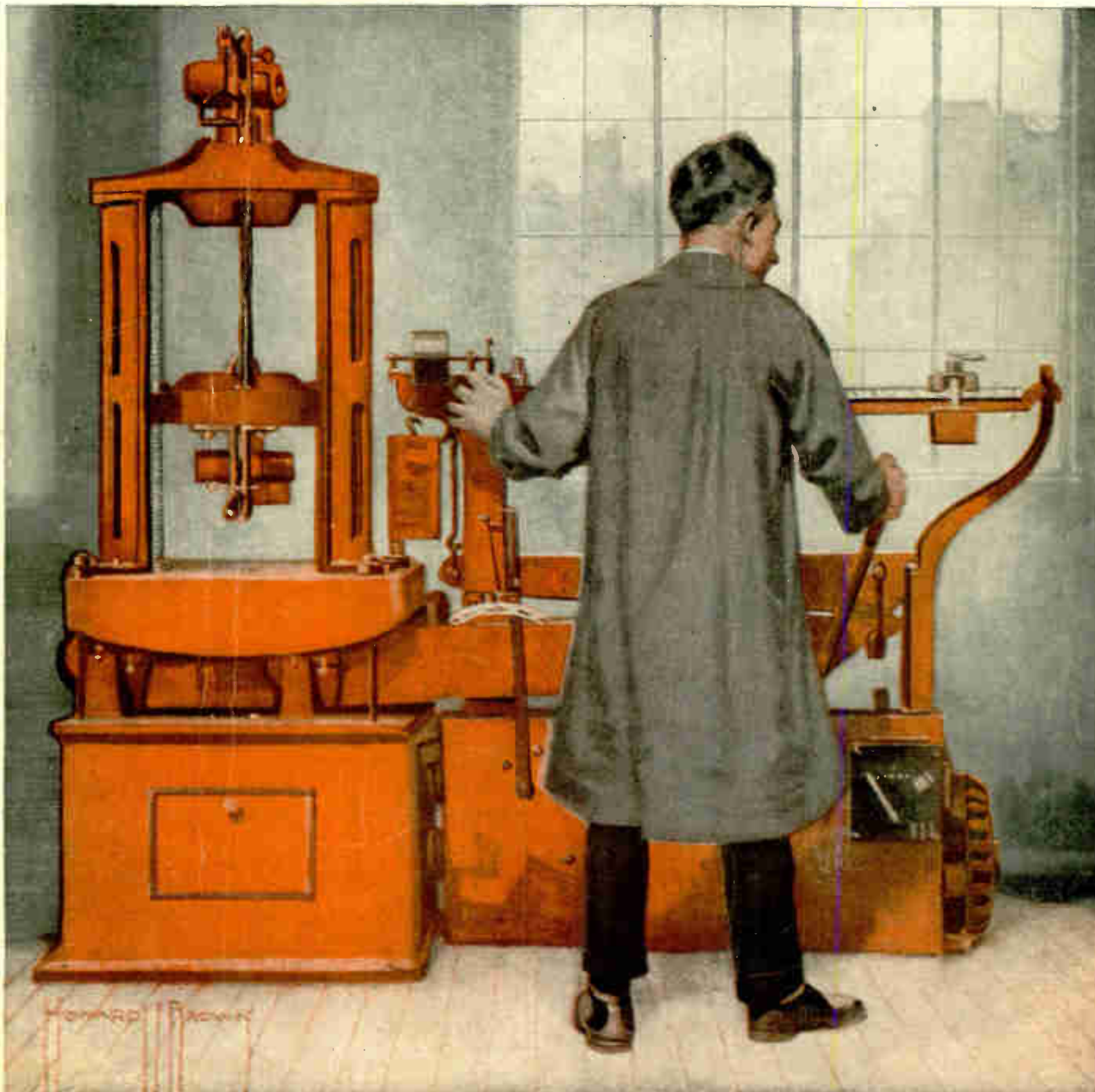

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VOL. 10 NOVEMBER, 1920 NO. 2

EVERYDAY ENGINEERING MAGAZINE

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A Dependable, Instructive Digest of Current Mechanical, Scientific, Automotive and Radio Progress.

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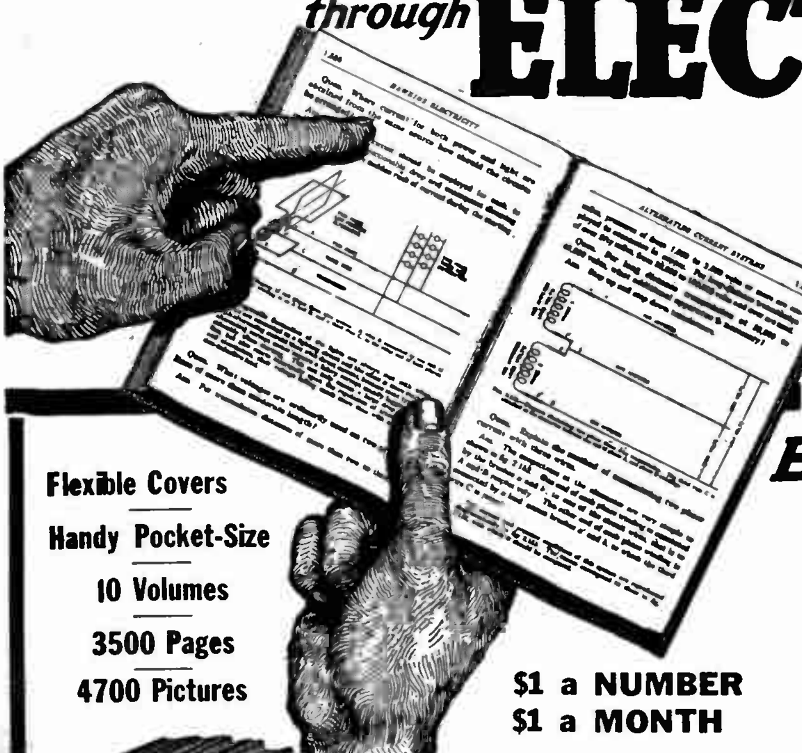

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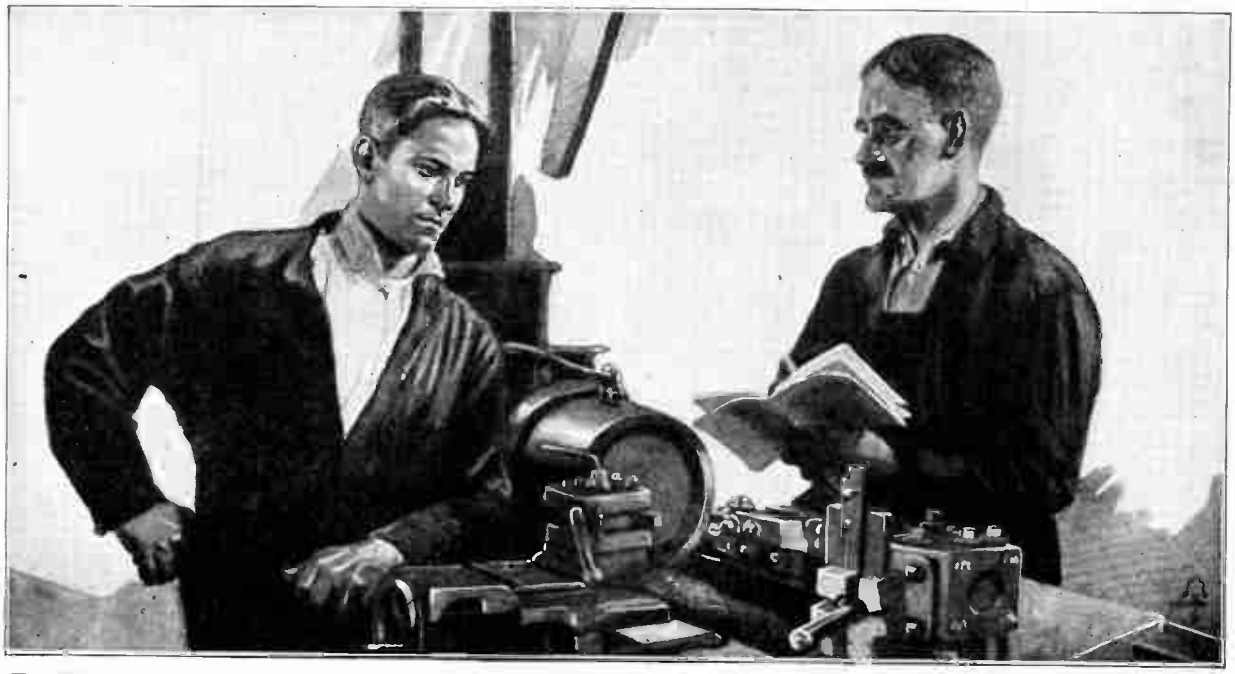

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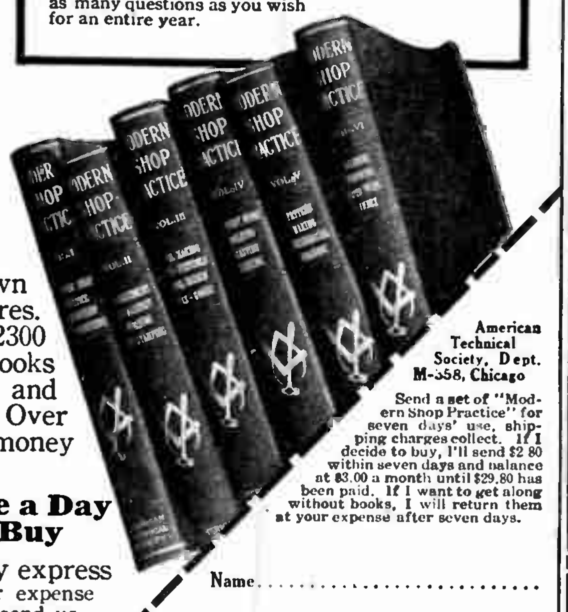

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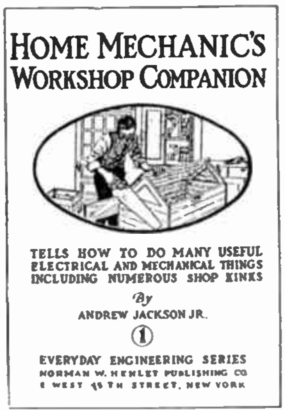

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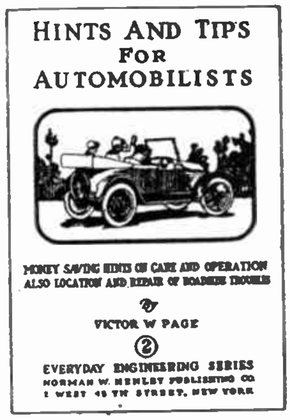

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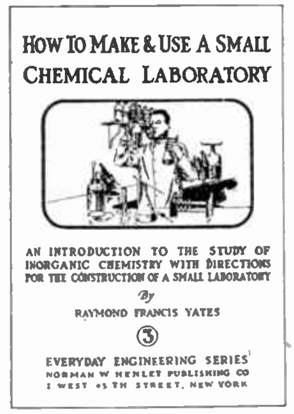

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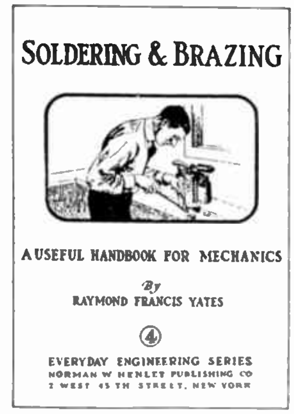

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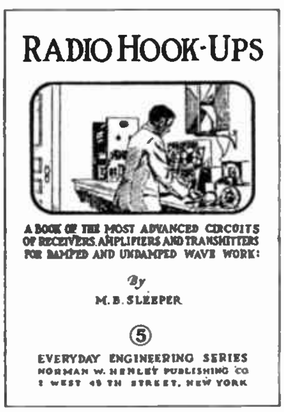

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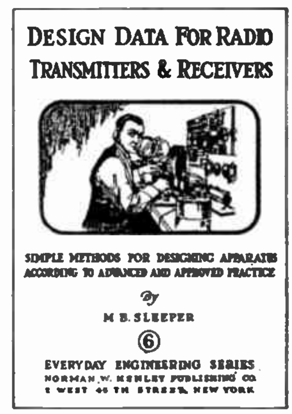

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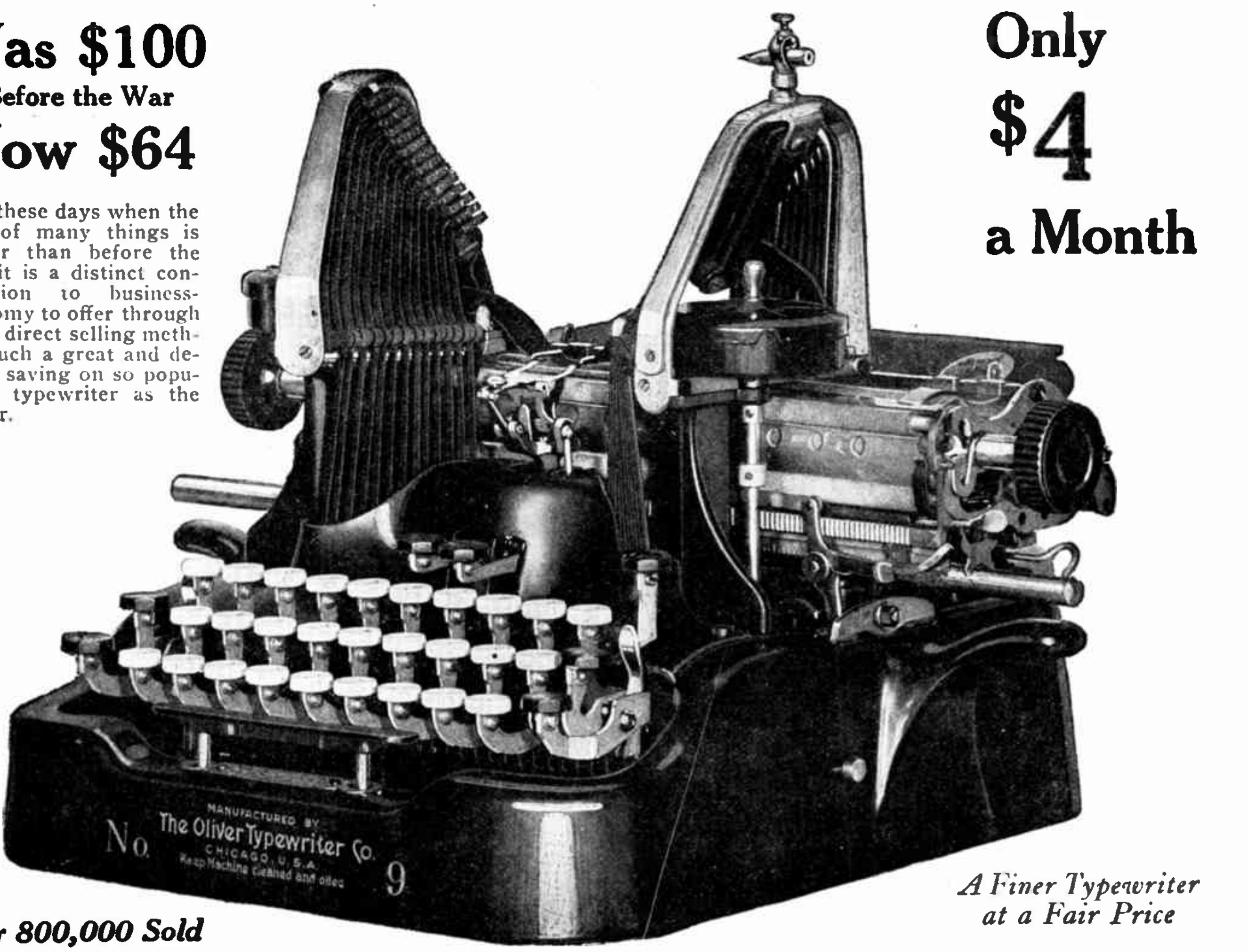

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VOLUME 10 NOVEMBER, 1920 NUMBER 2

Modern Testing Machines and Their Use

An Instructive, Non-technical Outline of the Various Stresses Materials Are Subjected to When Incorporated in Machinery and Other Structures and Special Appliances Developed to Determine Their Resisting Power to Tensile, Compression and Torsional Stress

By Victor W. Pagé, M. S. A. E.

PART I

TO permit a reduction in weight of automobile, aircraft and machinery parts subjected to severe stresses we are naturally led to use so-called special steels in preference to ordinary carbon steels because of their greater strength and elastic limit, weight for weight when suitably heat treated, combined with a safe degree of ductility. The selection of the steel to be used for each part and of the heat treatment that it should receive must depend upon the nature and intensity of the stresses to which that part will be subjected and upon the wear to which it will be exposed. The subject of heat treatment of alloy steels has been fully considered in these columns, so an outline of some of the testing machines developed for determining the characteristics of various metals will be of interest to our readers. Stresses may be divided into static and dynamic stresses. The former include gradually applied, tensile, compressive, bending, torsional and shearing stresses while dynamic stresses are those created by suddenly applied loads, viz., by shocks.

Stress Definitions

The different ways in which a stress may be applied leads us moreover to consider, first, constant stresses as when a part is subjected to a tension, compression, etc., of constant magnitude; second, progressive stresses, i.e., stresses varying in a progressive manner as, for instance, a tensile stress increasing from zero to the maximum, then decreasing to zero to again reach the maximum and so forth; three, repeated stresses which are suddenly removed to be again applied, and four, alternate stresses when the nature of the stress changes as, for instance, tension followed by compression then again by tension, etc. Repeated and alternate stresses, sometimes called fatigue stresses, if continued long enough lead to the eventual rupture of the parts by stresses remaining inferior to the apparent elastic limit of the metal.

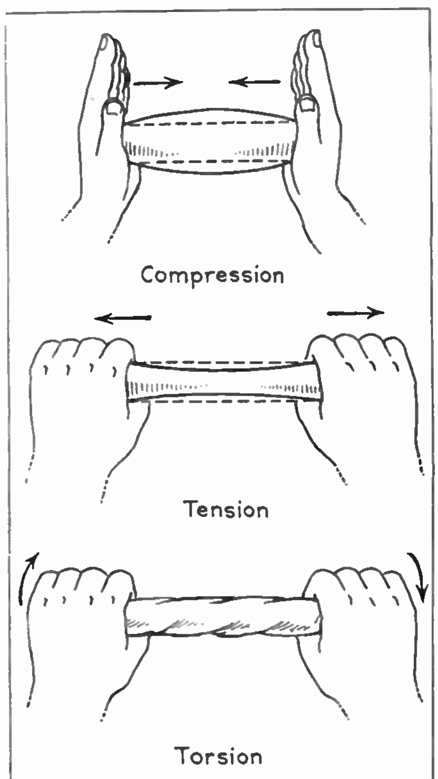


Fig. 1—Diagrams showing meaning of terms used in article when referring to stresses materials are subjected to

The main forms of stresses to which parts of machines are subjected can be easily understood by examining the accompanying illustration, Fig. 1, in which a bar of rubber is manipulated by a pair of hands. In brief, a tensile stress means pulling apart, a compression stress means effort expended to compress the piece, and torsional stress means twisting it. Testing machines, as ordinarily made, are strongly built devices capable of stressing metal pieces and fitted with gauges, weighing beams, etc., for recording or indicating the amount of stress required to produce a certain strain.

To determine the value of a new process or method of making steel or the value of a certain heat treatment, it is essential to have means whereby tests may be made to determine its physical characteristics of quality. Testing machines, so well known to the metallurgist and steel treaters, were first developed in this country about fifty years ago and during the past fifty years several hundred types and sizes of testing machines have been developed, keeping pace with the advance in the art of steel making and steel treating. To the efficient testing machines of Olsen and Riehle, the metallurgist and heat treater owes to a large extent the great advance and rapid strides that have been made in the last few years in providing a quick means of accurately determining the results of his labor and also a means of checking up materials and keeping the quality up to a desired known standard of excellence.

Olsen Testing Machine

The Universal testing machine is the most popular one as this type of machine is made in sizes ranging from 10,000 lbs. to 1,500,000 lbs. in capacity and such machines are built of several types and many degrees of completeness, all depending on the particular use to which they are to be put and the material to be tested. The illustration at Fig. 2 is the Olsen Automatic and Autographic testing machine of the three screw type and this complete machine is exceedingly new in the design and arrangement of the recording attachment. The testing machine proper is built on the three screw principle of gearing in which the diameters of the gears and screws as well as the pitches of the screws vary in proportion to the lengths of the side of the isosceles triangle formed by them.

This type of machine is designed to give a great clearance for the operator in the direction of the scale beam with a minimum amount of clearance at right angles thereto so that the operator can, with ease, reach over to the center of the machine and adjust his specimen. The screws, and consequently the straining crosshead, is driven directly down by rotating nuts below the base of the machine thereby eliminating all bending and twisting moments in the machine. The screws and columns are placed on the beam side of the machine thereby protecting both the scale beam and the operator from falling or flying pieces of the test specimen as caused by rupture of the specimen from time to time.

The automatic and autographic attachment of this machine is novel in that it will record in either tension, compression or transverse at any point in the travel of the crosshead or measure extension or compression between any two points along the entire range of the machine without the use of any auxiliary apparatus. The scale beams of these machines are provided with multiple poises so that autographic records may be taken in various magnitudes and the curve from a small test specimen thus secured just as large as would be secured in making a test of a large specimen. The magnification of the extension or compression is ten times and the chart measure 10 x 20 inches in size so that a very highly magnified diagram is at all times obtainable.

With a Universal testing machine as illustrated it is also possible to make various other special tests such as torsion of small specimens, bending, shearing, Brinell hardness, ductility and gauge tests, etc., by using special attachments.

Extensometer Types

In connection with tension tests it is often required to use an Extensometer to secure the elastic limit or data from which the modulus may be computed. The main objection of the use of an Extensometer has been the time required in applying same and while this objection was well taken in the past it no longer exists, as the Extensometer shown in inset at Fig. 2 is what may be termed a one-piece instrument and can be applied to the standard .505 in. diameter test specimen in a second's time and the greatest accuracy and sensitiveness readily secured by its use. This Extensometer is known as the Lewis-Hayes type, and while it is designed primarily for the standard .505 in. diameter test specimen it can also be secured to meet other requirements. It is needless to add that this Extensometer reads directly to a ten-thousandth part of an inch and is for use up to the elastic limit only.

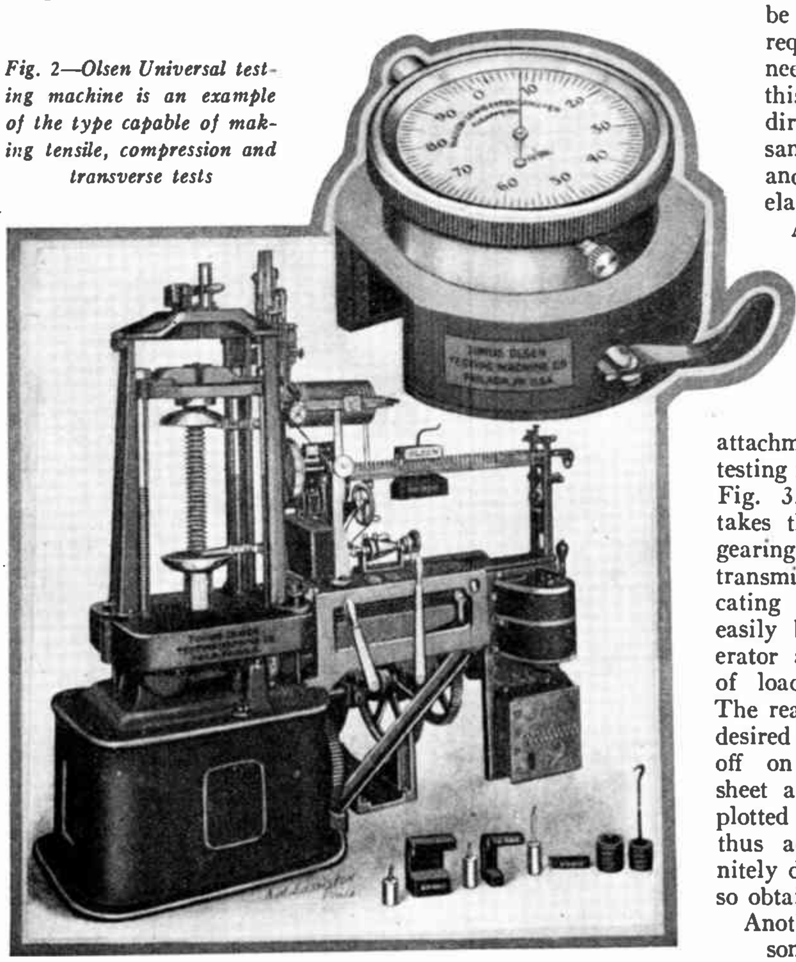
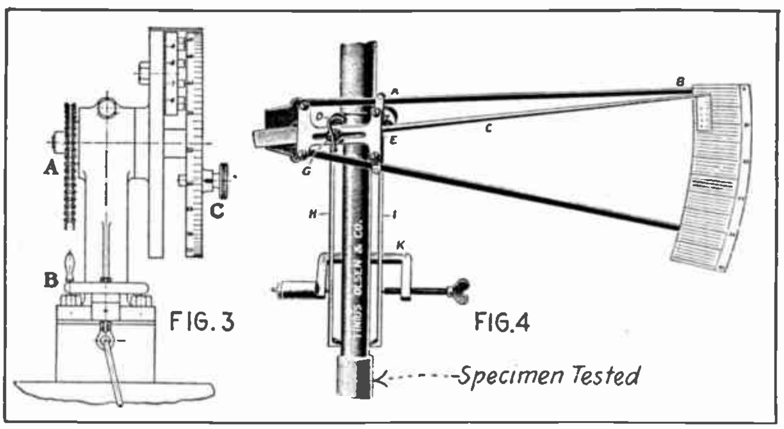


Fig. 2—Olsen Universal testing machine is an example of the type capable of making tensile, compression and transverse tests

Another quick means of determining the elastic limit of threaded or headed end test specimen is the use of the Malysheff method and attachment to an Olsen testing machine as shown in Fig. 3. This attachment takes the motion from the gearing of the machine transmitting same to indicating dials which may easily be read by the operator at equal increments of load as test proceeds. The reading of the dials at desired loads is then marked off on cross-section data sheet and a curve quickly plotted and elastic limit thus accurately and definitely determined from data so obtained.



Figs. 3 and 4—Extensometers for determining the yield point of specimens tested in machine shown at Fig. 2

Another form of Extensometer for measuring extension of test pieces within the yield point is shown at Fig. 4. It is a light, correct and easily read instrument. Its dial with vernier reads to one ten-thousandth of an inch and is applicable to all sizes and forms of specimens within its maximum range, 1⅛ inches round, square or flat specimens; requires but little care and time in adjustment, and no double reading or calculation is necessary with it. As it is so easily applied, it forms a very ready means of observing elastic limit and yield point when correct determinations are required. In adjusting this instrument, the two points D E are separated just to straddle the specimen, and indicator finger C, secured by thumb screw G. In placing instrument on specimen, bar A B is placed horizontal as near as may be observed; indicator finger C to point to upper part of dial, as shown in illustration. The spacing bars H I, by using the clamp K, are placed against the instrument's main pivots D E and the specimen, thus holding the instrument in position. Thumb screw G is here removed and instrument ready for the test.

As shown in cut, instrument is set for compression test readings, and for tension or extension readings spacing bars should point up instead of down, as shown in cut. The instrument is furnished with four verniers, which are marked, the vernier having the mark corresponding to the size of the specimen to be used. Spacing bars for 8-inch length of specimen are furnished, if required, 2-inch, 4-inch, 6-inch or any other length of spacing bars can be supplied. With the clamp K, the instrument is adjusted to zero when in position after removing the thumb screw G. This instrument may be provided with a special attachment to make it applicable to fine wire tests. Made in either English or metric system.

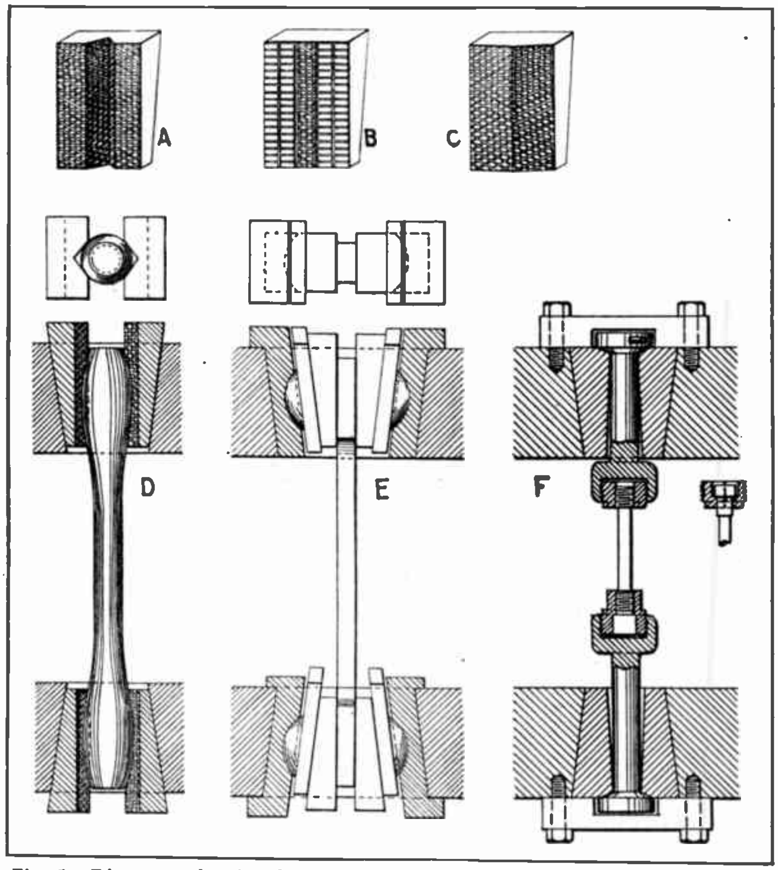


Fig. 5—Diagrams showing how specimens to be tested are held in the testing machine

Test Pieces and Fixtures

In order to obtain the best results from standard testing machines, certain fixtures are required and to secure any uniformity of results, the test pieces must be of standard forms. In holding specimens for tensile, or pulling apart tests, special gripping wedges are employed to hold the pieces to be tested if these are not provided with threads. The form of wedge grip for round or square specimens is shown at Fig. 5, A. The forms shown at B and C are for flat stock or plate specimens. The method of using the wedge grips is shown at Fig. 5, D and E. One set of wedges is carried by the machine frame, the other is placed in the movable crosshead of the machine.

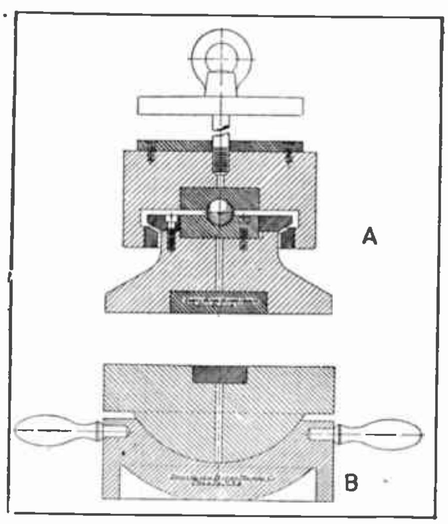


Fig. 6—Fittings used in making compression tests on Olsen Universal machine

The illustration at D shows the position of wedge grips in a testing machine. The crosshead holes should be lined up with liners depending on size specimen tested, so that on applying load the grips do not extend much beyond faces of crossheads. If wedge grips pull far below they are liable to break and the crosshead holes spread. The specimen should also be given as full a bearing on the wedge grips as possible. Illustration E shows a form of ball socket liners which may be secured if desired as additional equipment for testing machines. These liners are not essential with proper alignment of crosshead holes. To use such liners provision must be made in crossheads on purchase of testing machines.

The standard form of holder for gripping either threaded or headed forms of the .505 in. diameter test specimen are shown at F. Tool steel bushings are supplied to grip the specimen and are easily replaced when worn out. The self-aligning feature of the spherical seated specimen holders to insure a straight pull can be readily noted.

In making compression tests it is just as important to insure proper placing of the piece to be squeezed as it is in locating the piece to be pulled apart centrally. The illustration at Fig. 6, A, is a suspended ball bearing compression block arranged to fit in the lower crosshead of the Olsen Universal testing machine is recommended by both the A. S. C. E. and the A. S. T. M. This block is provided with a hardened and ground tool steel center with circles scribed for the purpose of centering specimen. This block can be made of any size to fit any specification and to fit in any capacity of testing machine. The illustration at Fig. 6, B, is of the latest Olsen spherical compression blocks for use on weighing table of a Universal testing machine. The center of the ball is in the face of the block, which is considered essential. The face is fitted with a hardened and ground tool steel center and scribed with circles for centering the specimen. Handles are provided with the heavier blocks for ease in handling. The specimen to be tested is placed between two such blocks, one above and the other below it.

(*Continued on page* 116)

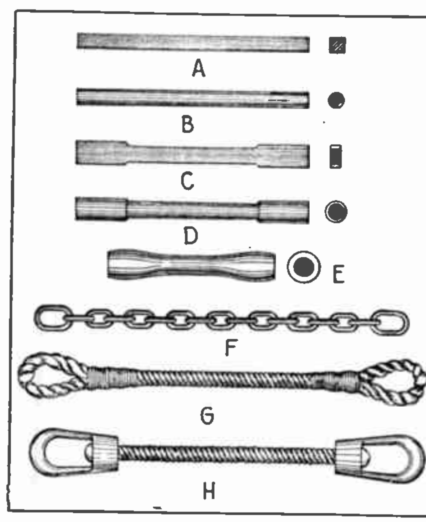


Fig. 7—How specimens are prepared for making tensile tests

EXPERIMENTAL CHEMISTRY

Crystallo-Chemical Analysis

By Theodore S. Silouianoff

THE purpose of this paper is to call the attention of experimenters to one of the most wonderful branches of analytical chemistry—quantitative and qualitative analysis with the aid of the microscope. As it would be impossible, for obvious reasons, to discuss in full the methods of crystallo-chemical analysis on the pages of this magazine in one article, the writer decided to limit the subject of this paper to the presentation of few examples, which, he trusts, will give the reader a fair idea of the crystallo-chemical analysis and its advantages over ordinary, or wet methods for certain classes of work.

Photograph No. 1

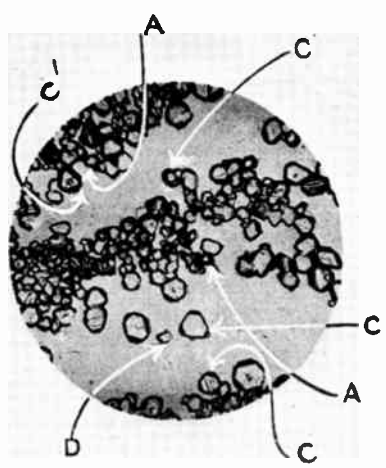
Photograph No. 2

Photograph No. 3

These photographs show the crystals of sodium phosphates as they appear in the field of the microscope

Advantages offered by the crystallo-chemical analysis are numerous and self-evident: where hours are required by the ordinary methods, only minutes are necessary to obtain the same results when following the microscopic methods for detection of elements in their compounds; where comparatively large volumes of reagents are necessary in the ordinary analysis, only minute particles of both substance under investigation and reagents are required, when the microscope is being called to assistance. While ordinary methods involve such operations as repeated precipitations, continuous washing of precipitates, or evaporation (condensation) of the filtrates—which generally takes much time and usually very greatly retards the progress of the investigation—the expenditure of time for the analogous operations when employing the microscope is almost negligible. The reason for this lies in the quantity of the material used, which is extremely small if the analysis is conducted with the aid of the microscope.

All that is required, is a *drop* of the solution of the substance to be tested, from 3 to 5 millimeters in diameter, and about 1 mm. deep, and a few particles, not over the size of a pinhead, of the reagents, which are far from being so numerous as in the case of ordinary analysis.



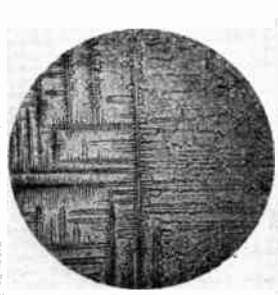
Photograph 6—Alum crystal

"Five grams of each reagent should last a life-time," said Prof. Chamot, an authority on chemical microscopy, in one of his addresses before the American Chemical Society.

As a very good example, showing some of the many advantages offered by the crystallo-chemical analysis, the following one may be given:

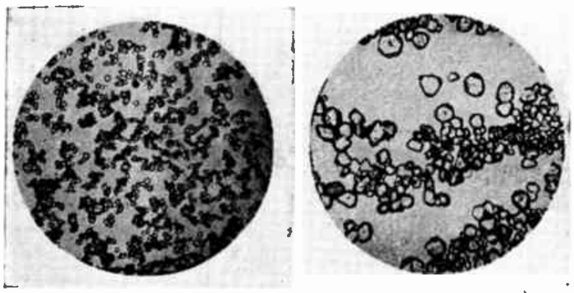
Let us assume that the qualitative analysis of a certain substance has given us the evidence of the presence of both and only Sodium (Na) and Phosphoric Acid (PO_4). Evidently we have the Sodium Phosphate. But the question, whether we have in our possession MONO —, Bi — or TRI — Sodium salt (as phosphoric acid is trivalent) will remain unsettled, until the phosphate is analyzed quantitatively for the amounts of Na and PO_4 present, which procedure will require an additional expenditure of several hours.

The microscope if brought to the aid in this or similar occasions, would greatly simplify matters. A small fragment of the salt in question is dissolved in a droplet of water, then placed on the microscopic slide to rest for a few moments in order to obtain the crystals of the salt by spontaneous evaporation. This being done, and crystalline phase having separated, the slide is placed on the stage of the microscope, the latter focussed sharply on the preparation. Just a glance into the microscope rewards the investigator with the complete solution of his problem, as all the three phosphates yield



Photographs 7, 8 and 9 show appearance of a film of alum solution in the field of the microscope the crystals belonging to the three different crystallo-graphic systems, and assume different, easily recognizable geometrical forms.

The three accompanying photographs, Nos. 1, 2 and 3, show the crystals of Mono, —, di — and tri-sodium phosphates respectively, as they appear in the field of the microscope. The forms of the crystals differ to such an extent that their recognition would not present any difficulties. In parallel with this, the presence of undesirable admixtures could be easily detected and thus the purity of the substance under investigation ascertained.



Photographs 4 and 5 show alum crystals

Outline of Procedure

The entire procedure of the analysis with the aid of the microscope in general, may be outlined, step by step, as follows:

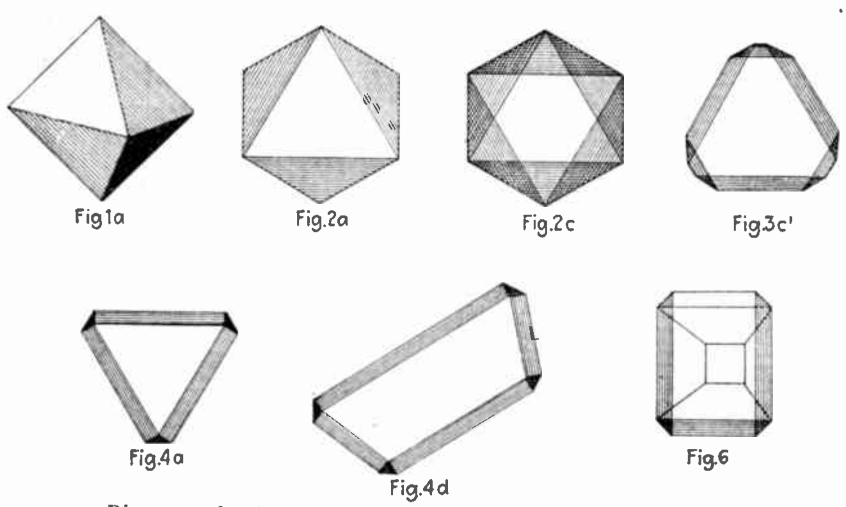
1. A solution of the substance to be analyzed is prepared.
2. A droplet of this solution is placed on the slide.
3. The slide with solution is transferred on the stage of the microscope and the preparation is brought in sharp focus.
4. The reagent is applied.
5. The formation of crystals, their development, forms, optical and other properties are observed and studied.
6. The conclusions as to the chemical constitution of the substance under investigation are made, the compound in question thus being identified.

Of course, in order to make possible the detection of elements with the aid of the microscope, it is necessary for the investigator to possess a thorough knowledge of the fundamental principles of chemical crystallography, as only then he will be in a position to make correct interpretation of the behavior of the crystals when subjected to different tests.

As to the crystallography and optical properties of the crystals, all the data necessary for the crystallo-chemical analysis may be readily obtained from tables and text-books. But in order not to be confused by apparent deviations from the laws he has thus learned, the investigator must be thoroughly familiar with so-called "habitus" of the compounds (for the explanation of the term see below). This knowledge must be acquired directly from practice. The student must perform all the characteristic micro-chemical reactions for every element, as he has already done when he was studying the methods of ordinary analysis, with which he is supposed to be quite familiar.

The expression "habitus of the compound" is undoubtedly new to the reader, so the author immediately proceeds to an explanation, taking the following example:

A moderately concentrated solution of ordinary alum ($KAl(SO_4)_2$) is prepared, one drop is placed on the microscopic slide and set aside until the alum has assumed crystalline form. The slide is then transferred to the stage of the microscope, and after bringing the preparation in sharp focus, the crystals resembling those shown on the photographs, Nos. 4, 5 and 6, will be seen.



Diagrams showing geometrical forms assumed by micro-crystals

A slight movement of the tube of the microscope permits a more close study of the form of the crystals obtained under the conditions stated above. By moving the tube slightly up and down, thus focussing alternately upon the upper and lower faces of the crystals, we will be able to ascertain their geometrical forms. As the faces of the crystals are in different planes, it was impossible to bring both upper and lower faces in sharp focus simultaneously. Therefore, the photographs Nos. 4, 5 and 6 show merely the character of crystals formed under given conditions. In such a case, the drawings would suit the purpose better than the photograph.

Photograph 10 shows another form of alum crystal growth

Referring to the set of drawings accompanying this article: Figure No. 1a (and No. 2a) shows one of the microcrystals of alum, resting on the slide, when growing, on its octahedral face. These crystals may be found on photograph No. 6 marked A and A' respectively. Figure No. 2c shows an equilateral triangle of the upper face and three octahedral faces sloping from this outward and downward. This crystal is resting on equilateral triangle when growing, which is placed symmetrically in reference to the upper triangular face. Crystals, answering this description, can be seen on the photograph No. 6 marked C—C. Figures 3c', 4a, and 4d represent the geometrical forms of micro-crystals of alum commonly found when the formation takes place under conditions given above. Figure 3c' represents the crystals on photograph No. 6 marked C'—C' and figure 4d the one marked D. Under exceptional conditions the crystals of alum may grow on cubical faces, as shown on the figure 6. Close examination of photographs Nos. 4, 5 and 6 will reveal many duplicates of the crystals already mentioned and described.

If the drop of the solution of the alum will be spread over the slide, so as to form a mere film of a solution, parallel growths, shown on photographs Nos. 7, 8 and 9, are formed instead of the crystals possessing definite geometrical focus, such as shown on photographs Nos. 4, 5 and 6. Occasionally, instead of parallel growths, the crystals assume another form, similar to parallel growths and shown on photograph No. 10. However, in both cases we can easily distinguish the octahedral endings of the branches, which fact establishes certain similarity of the crystals of alum shown on all photographs.

It is hardly necessary to mention that all these forms are so characteristic and peculiar in their appearance, that once seen, they will not offer any difficulty in their recognition.

Such distinct appearances of different crystals of one substance are designated as the HABITUS (or habit) of the same.

"Under like conditions of formation, crystalline compounds always separate not only in the same crystal system, but will assume each time some geometrical form; this characteristic form is called 'the habit' of the compound, and upon this property micro-chemical methods of analysis are based." (Chamot.)

The next point, to which the writer would like to call the reader's particular attention, is the extreme sensitiveness of the micro-chemical reactions. The following table will speak for itself:

With Caesium Chloride as a reagent, the following amounts of elements can be detected present in the solution subjected to the micro-tests:

0.005	of a milligram of Magnesium
0.001	of a milligram of Iron
0.0005	of a milligram of Cobalt
0.00002	of a milligram of Zinc

It will be well for the reader to compare these figures with the maximum sensitiveness that can be obtained using such reagents as hydrogen sulfide, etc., which he has to work with in the ordinary analysis.

The possibility of ascertaining the presence of elements and their compounds in a given substance with such degree of rapidity and accuracy, as the writer had endeavored to show in this article—renders the micro-methods of qualitative analysis indispensable for chemists in their everyday work.

Many of us chemists have been led to the enormous conclusions in our analytical work simply by the impurities we find in chemicals we use, even though marked C. P.

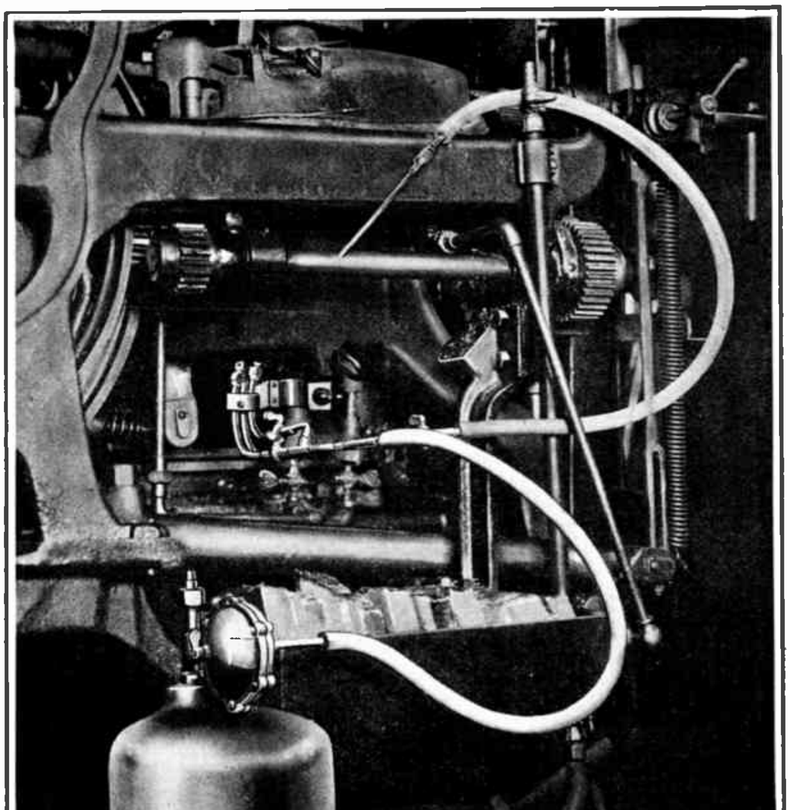
Micro-methods offer a splendid opportunity for an analytical chemist, as well as any other person using chemicals of every description for their work, —for solving one of the most serious problems confronting them, that of easy, quick, accurate and reliable means of controlling the product they use or manufacture. For experimenters, chemical analysis with the aid of the microscope offers an inexhaustive source of experiments, fascinating as well as instructive.

For the benefit of those who may be interested in this singular mode of chemical analysis, the author is preparing other articles on the same subject, in which he intends to present the methods of carrying on both qualitative and quantitative analyses of an unknown compound with the aid of microscope.

ACETYLENE FOR MELTING LINOTYPE METAL

THE use of acetylene gas as an auxiliary for the melting of linotype metal when the regular gas supply fails is becoming very general in newspaper plants and printing establishments. Most of the linotype machines were formerly equipped exclusively with city gas connections, and when the supply was cut off even temporarily it was a problem to keep going. In the case of the daily newspaper especially, an occasional delay of a few hours is a matter of serious consequence, as shutting down the type machines means holding up the presses and delaying the hour of issue, making local distribution late and sometimes resulting in the missing of mail trains. To-day the small Prest-O-Lite tank and acetylene torch are drafted into service. The auxiliary supply of acetylene, which is stored in dissolved form in cylinders, has been found to be the most satisfactory as well as the most economical way of keeping the machinery of publication moving in emergencies of this kind.

So far as is known, the first newspaper to resort to acetylene for tiding over a shut-off of the local gas supply was the Memphis (Tenn.) *Press.* The acetylene supply was obtained from a garage that happened to have a couple of extra Prest-O-Lite tanks, such as are used for automobile truck lighting. Quick thinking on the part of the linotype men and the easily obtained dissolved acetylene saved the day, and the paper went to press as usual. The nation-wide service of Prest-O-Lite, with its 22,000 stations, where empty tanks may be exchanged for filled tanks, has led newspapers in all parts of the country to avail themselves of this added safeguard against publication delays.



Emergency use of acetylene for heating linotype metal

The mode of connecting the acetylene to the melting pot on linotype machines and the simplicity of the equipment are shown in the illustration.

VANADIUM AS AN ALLOY

VANADIUM has become one of the vital factors in the steel trade, entering into the manufacture of automobiles very extensively. Four pounds of vanadium added to a ton of steel results in an increase of 45 per cent in its strength and at the same time produces an alloy steel which has satisfactory machining qualities.

A Quick-Change Variable Speed Gear Box

By H. H. Parker

Drawings by the Author

THE amateur machine shop owner who has a strong desire to "make something" will perhaps be interested in the small gear box illustrated herewith. Its construction offers good experience in fitting and lining up shafts and gears as well as the regular machine work necessary and when finished the apparatus will prove a valuable adjunct to his bench drill or speed lathe. A drill press is inherently a variable speed machine, for each sized drill has its individual driving speed for highest efficiency; yet when a stepped pulley is used the continual changing of belts becomes such a nuisance that it is seldom resorted to beyond a high and low speed, the whole range of drill sizes coming within these two speeds. A bench speed lathe labors under a similar, if less marked, disadvantage and it is in such cases that a quick-change gear box, allowing of four or more speed changes by merely shifting a handle, is applicable.

The device to be described is built up of two cast iron or steel end plates held together by spacing rods, to save making a complicated casting; and as the lining up of the two shafts with their gears might be a troublesome problem for the amateur with his limited equipment, the design calls for large cored holes in the end plates and thin bronze bearing bushings to fit the shafts. Then babbitt or type metal is poured into the cored openings with the shafting in place, thus holding them in position without resorting to accurate machine work. All the work may be done on an eight-inch lathe, not necessarily of the screw-cutting type, while the gears required are all carried in stock by various gear makers, though some may require boring out to slightly larger size. As described, the construction of the machine calls for a few castings, but if desired, steel plate may be used instead, in which case separate bearing boxes would have to be turned up and screwed into or flange riveted to the plates. The first point to be considered will be the

This is the first of a series of articles by Mr. Parker, who will describe the construction of various interesting machine tools and appliances suitable for the amateur's workshop that he can make with ordinary shop equipment.

Six Gears Required

Six spur gears will be required, four on the driven shaft and two on the tumbler. If more than four speed changes are required, other gear steps may be added, provided the tumbler shaft is made large enough to insure stiffness. This would of course call for longer spacing bars and if gears of larger diameter than shown in the design were used, the end plates would have to be slightly enlarged.

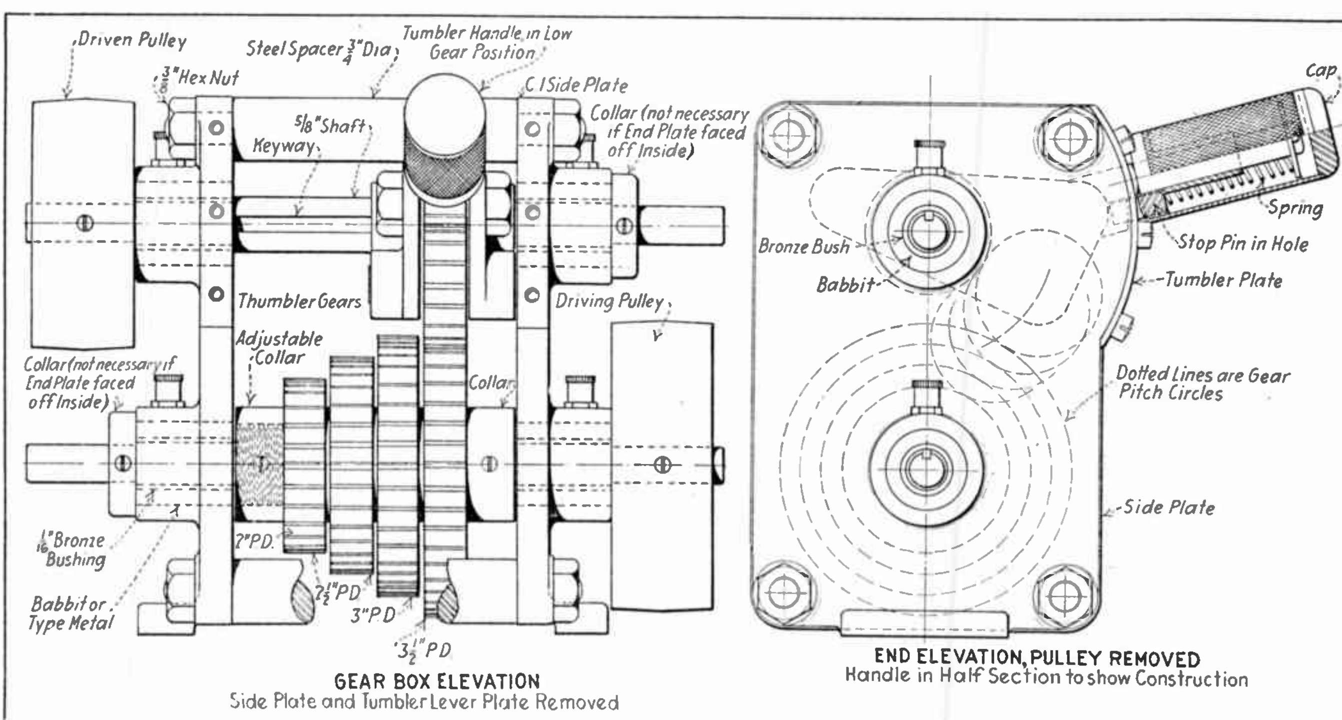
The gears used are of the cut teeth stock pattern carried by various manufacturers; for this design they were selected from the general catalog of the Philadelphia Gear Works, but there are a number of other makers carrying similar sizes in stock. These are cast iron gears; brass or steel cut, but not the cast (unfinished) tooth type, can be used, depending upon requirements. 16 Pitch was selected as about the most suited to average requirements and of this pitch the following gears are needed, all having a half-inch face and stock size holes:

Two, 1½ in. pitch diam., 18 teeth, 7/16 in. hole
One, 2 in. pitch diam., 24 teeth, ½ in. hole
One, 2½ in pitch diam., 30 teeth, ½ in. hole
One, 3 in. pitch diam., 36 teeth, ½ in. hole
One, 3½ in. pitch diam., 42 teeth, ½ in. hole

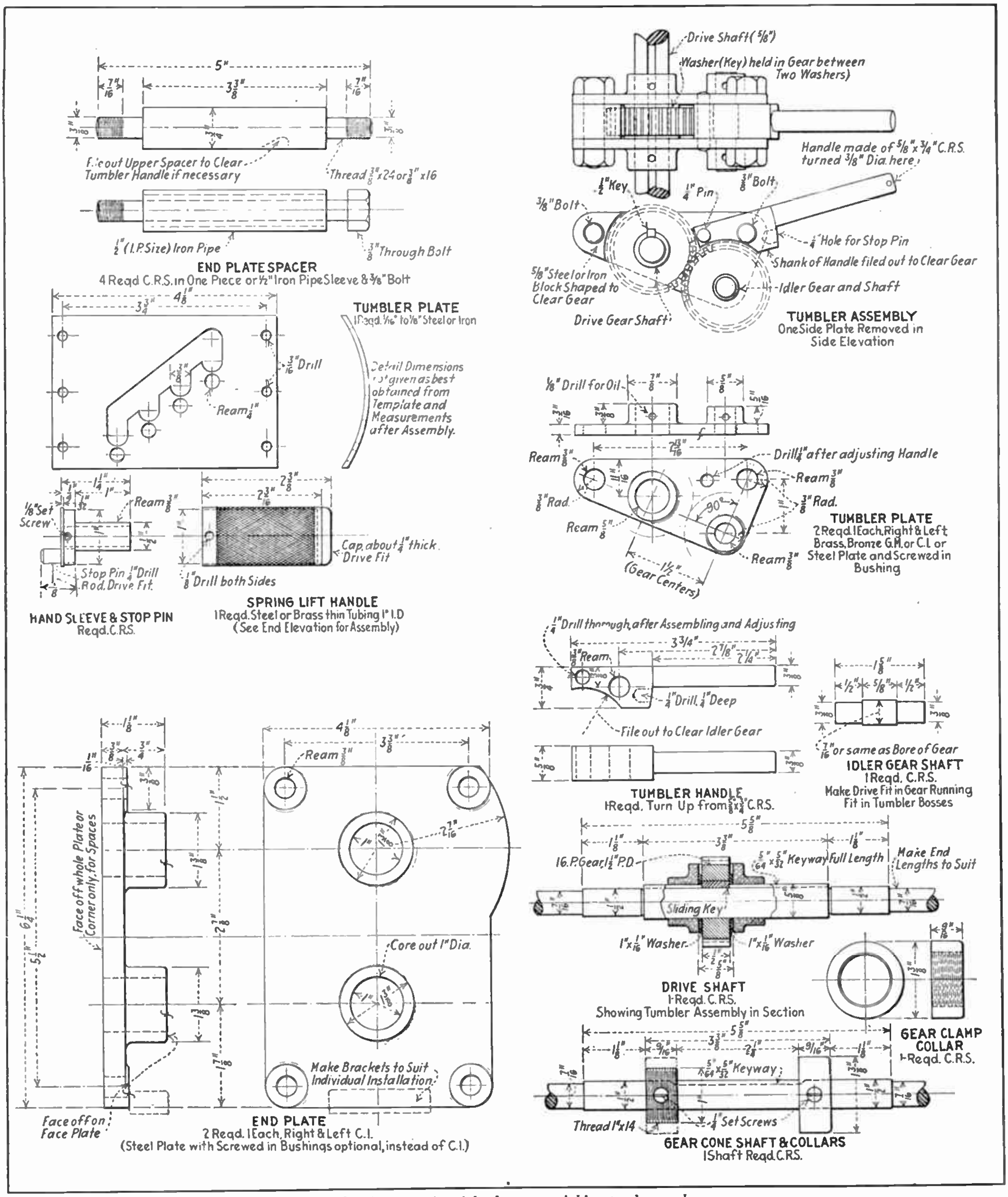
These dimensions, especially the holes, may vary slightly in different makes, but the above data will furnish a close guide. The larger the holes which can be obtained, the better; in fact the tumbler shaft gear must be bored out to five-eighths, due to the comparatively long, keywayed, unsupported shaft. The others may be left as they are, those on the step gear shaft being closely clamped together and thus strengthening that shaft.

Shafting

This requires little comment. All journals are half inch in diameter and



Elevations of a quick-change variable speed gear box showing relation of parts comprising the assembly



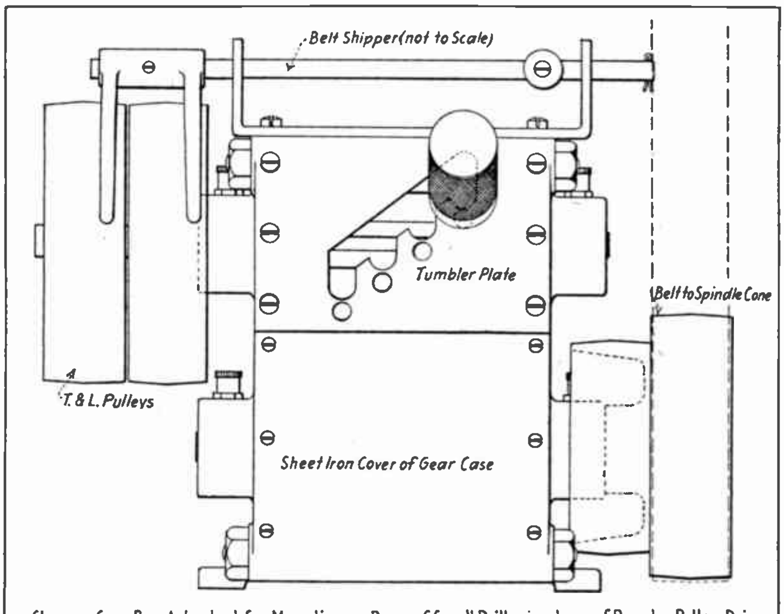
Details of parts of quick-change variable speed gear box

the ends reduced to seven-sixteenths where the pulleys are attached in order to prevent marring the bearings. The keyway in the tumbler shaft may be cut in the lathe by setting a cutting tool over on its side and working the carriage back and forth by hand; not a formidable job on a small shaft like this one. There are various methods of securing the step gears on the lower shaft, the one shown being the use of two collars; one set screwed or taper pinned and the other in two parts, the inner collar being set screwed while the outer one screws on over it and clamps the cluster of gears tightly together. A full length keyway may be cut and all the gears keyed, or one may be keyed and all four secured by long through bolts. In any event the gears should be spaced about a sixteenth of an inch apart by means of accurately turned washers. The tumbler idler gear is forced on a short shaft which runs in bearings provided in the tumbler side plates.

End Plates

As shown, two cast iron end plates are used, right and left. The holes may be "green sand" cored or core prints and standard round cores used, or they may be cast solid and the holes drilled out. Each end plate is to be mounted on the face plate in the lathe and the four spacing bar outside bosses faced off. The bearing boss ends may be faced also; this would be of assistance when pouring the bearings later. The best way to machine the inside surface would be to face off the whole of it, though a fair job could be performed by only facing the corners to clear the spacer bars. But if the whole is machined, a good bearing for the shaft collars inside is furnished, making unnecessary the use of outside collars. If the bearing bosses are cored out these openings do not require machining. Feet or brackets may be cast on the end plates to suit the taste of the builder, or to make convenient the attaching of the gear box to some special machine.

bearing bosses. Thin bronze sleeves may be inserted to act as renewable bearing bushings if desired. A block of steel or brass, five-eighths thick, is filed up to act as a spacer for the inside end of the tumbler and another piece turned up and filed to serve as a handle as well as spacer. After machining the inside surfaces of the tumbler plates, these are clamped together and the bearing holes drilled and reamed, as well as the bolt holes. Then the end blocks are inserted and drilled for the three-eighths clamp bolts, though the final pinning of the handle is postponed until the machine is assembled and lined up. When the correct position of the handle is finally determined, a hole is drilled for a quarter-inch pin, or preferably a taper pin. Great care should be taken in drilling the bearing holes that these are correctly spaced, so that the gears will run without binding and with but a barely perceptible amount of backlash. The tumbler shaft gear is keywayed and a short key fitted which is held between two steel washers a sixteenth of an inch thick. The shaft should be an easy sliding fit through the tumbler gear and its bearings.



Change Gear Box Adopted for Mounting on Base of Small Driller in place of Regular Pulley Drive

Spacing Bars

Two methods of making these four pieces are shown, the easiest being to cut and face up four pieces of half-inch (nominal size) iron pipe and use three-eight-inch bolts to hold the end plates together. The more workman-like way would be to machine the bar out of a piece of three-quarter-inch cold-rolled or machine steel and thread the ends for hexagon nuts.

Tumbler Assembly

This is the most important part of the machine for the success of the gear box depends upon the accuracy of its construction and fitting together. Two side plates are used between which the two inch and a half P. D. gears work. The tumbler rotates about its shaft as a pivot and is actuated by a handle on the outside of the case. It is moved up or down to mesh with any one of the gears of the lower cluster, each combination giving a different speed to the driving shaft. These side plates can be made of cast iron, brass, bronze or gun metal, or steel plate with inserted

Tumbler Plate

A drawing is shown of this but only the general dimensions are given, for it is best first to make a cardboard or tin template, fit it over the assembled gear box and mark off and cut out the openings, altering these until the handle can be accurately shifted to mesh the tumbler with any one of the gears. Then the plate may be laid off and cut to shape by using the template as a pattern.

Locking Handle

The drawings probably make the mechanism sufficiently clear without further description. The locking pin must be firmly driven into the handle flange and is best made of hardened and tempered drill rod. It should fit the quarter-inch holes in the tumbler plate without shake or binding. Knurling the handle is not necessary but adds to the appearance and furnishes a good grip. A thin tube of this kind is best knurled by inserting a brass bar or a cylinder of very hardwood such as maple and then driving this out after the knurling is completed.

Assembling

The gear cluster is assembled and clamped together permanently upon the shaft; the tumbler assembly is also pushed over the upper shaft and both shafts slipped through the cored out bearing bosses and the end plates secured together by means of the spacing bars. Then four bronze bearing sleeves, an inch and an eighth long and a thirty-second thick, are placed on the shaft journals. The shafts are then temporarily jacked up and adjusted until exactly parallel, with the idler gear meshing perfectly at all positions. Then the openings are dammed up with putty or clay and babbitt or type metal run in between bearing, sleeves and bosses. It would be a good plan to later fit steel washers inside of the shafts to take any end thrust, unless outside collars are used. A template is then fitted as described above and the tumbler plate made and screwed to the end plates. A sheet iron cover is then cut out and bent around the end plates, the ends meeting above and below the tumbler plate. This cover is screwed to the end plates and if a thin leather or flannel gasket is placed between, thick oil or grease may be poured into the lower part of the box for lubrication.

For lead burning, hydrogen gas generated on the spot has been quite expensively used, although it is more convenient now to buy it in cylinders. The gas generated by the operative from zinc and sulphuric acid is apt to contain arsenic. It is very bad for the lead burner's health. An electric lead burner for use especially on storage battery work is being introduced. It is only adapted for alternating currents. It has a single carbon electrode, the material to be treated forming the other one. An automatic transformer permits the current to be regulated. If properly handled no arc is formed and the instant the carbon electrode touches the metal the heat is produced. The joints made by it are said to be of the very best quality.

The railways to be electrified in Italy are said to represent 2,600 miles of road-bed, and the electrification will involve, it is said, a saving of 1,786,000 tons of coal.

MODERN TESTING MACHINES AND THEIR USE

(*Continued from page* 109)

Preparing Test Specimens

In preparing materials for tensile tests, a number of standard forms have been evolved, as shown at Fig. 7. A is the method of preparing a specimen of rolled, square or flat bar. B is used for rolled round bars. The specimen shown at C is the U. S. Government and American C. E. standard shape for specimens cut from plates, the ends not to be over 3 inches wide. The standard shape for specimens turned down in the middle is shown at D. A good shape for cast iron specimens to fit wedge grips is shown at E, the area of the reduced portion to be one square inch. The method of preparing chain by providing forged loops larger than the links is shown at F. The method of serving loops in hemp rope and fastening pieces on wire rope is shown at G and H. Holding material of this nature is relatively easy, as metal rods are thrust through the loops, one being above the top frame, the other below the movable crosshead of the machine.

The Riehle Brothers Testing Machine Company has just completed for the United States Government what is claimed to be the largest vertical screw testing machine in the world (1,000,000 pounds capacity) to be installed at the Forest Products Laboratory, Madison, Wis. This is clearly shown at Fig. 8. This machine is arranged to test columns 30 feet or less in compression and will take specimens 10 feet long or less in transverse. When arranged for tensile specimens the maximum travel of the pulling head is approximately 29 feet. For tensile testing the top or weighing head can be secured at four different elevations, according to length of specimens to be tested, and is held in place by two keys which pass through openings in the weighing columns. The weighing mechanism is entirely independent of the power mechanism.

The machine weighs approximately 150,000 pounds, is 45 feet over all height, 37 feet above floor line, when table is level with floor, 15 feet long and 10 feet wide. The tensile grips will hold specimens up to 12 ins. x 4 ins. The weighing beam is of the micrometer dial screw type; the dial is graduated by 100-pound marks to 10,000 pounds and the beam readings are by 10,000 pounds to 1,000,000 pounds. A needle beam is provided to magnify the swing of the weighing beam. A one-tenth poise is also furnished to be used for light loads. The machine has four speeds, 10 in. per minute for adjusting the pulling head and pulling speeds of 2 in., ½ in., 1/10 in. per minute.

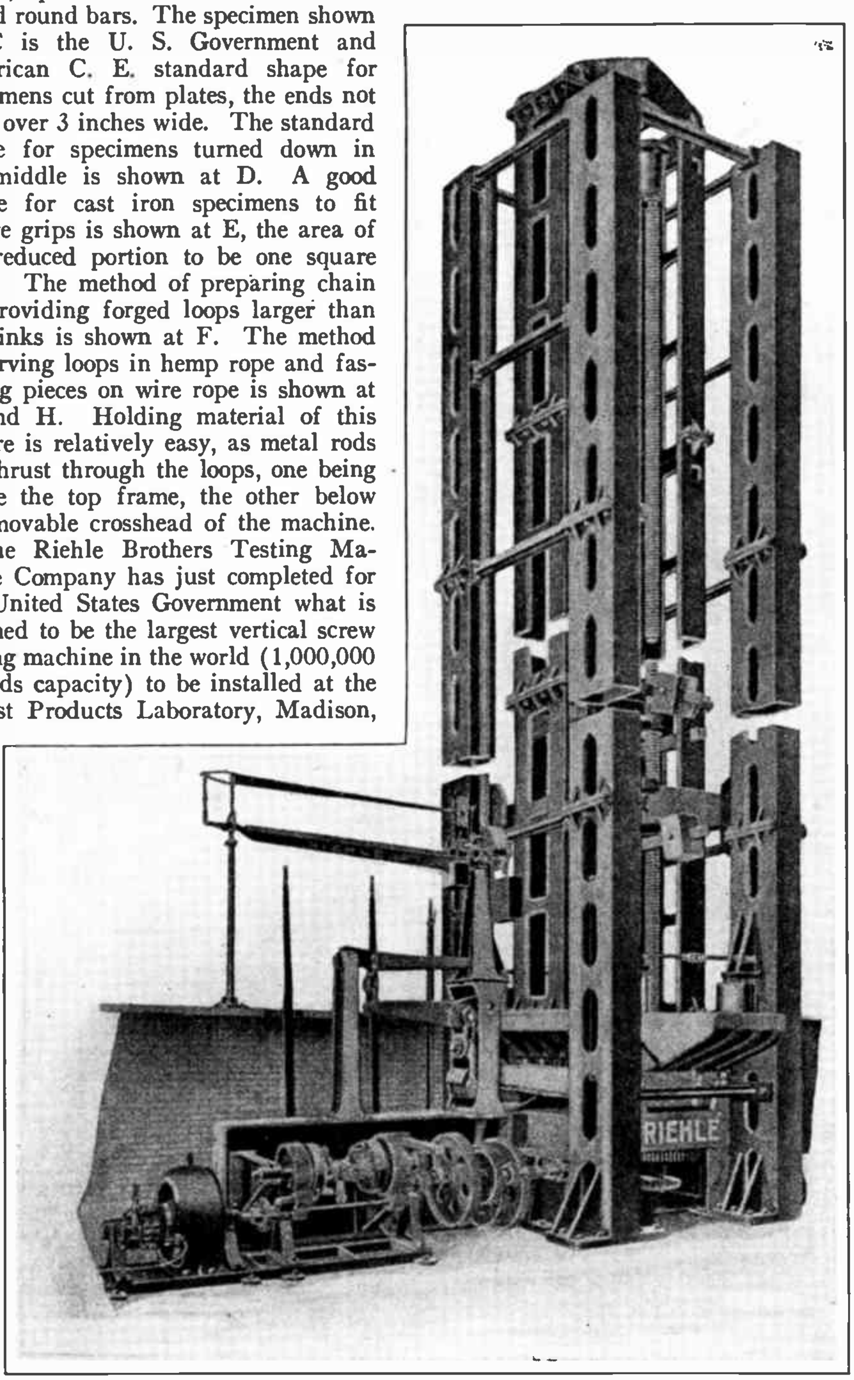


Fig. 8—Riehle Brothers 1,000,000 *pounds capacity testing machine installed in the Forest Products Laboratory, Madison, Wis.*

Machine for Torsion Tests

The torsion test is fast becoming an exceedingly important one, as it is not only used to test the strength and quality of the material, but also the strength and quality of finished products and even as a proof test in many cases, such as of universal joints, axles, clutches, etc. To make a standard torsion test, the machine should be preferably automatic and autographic, arranged to make large curves in various magnitudes, depending on the type of test to be made. The illustration at Fig. 10 is of a 60,000 inch lbs. capacity Olsen automatic and autographic torsion testing machine, No. 1, which will grip rounds up to 1½ in. diameter and of length up to 4 ft. 6 in. The scale beam is provided with three poises, one reading to full capacity, one to half capacity and the third to one-tenth full capacity for use in light tests.

The angular distortion may be recorded in two magnitudes, the one for use in determining the elastic curve and for highly magnified readings of the elastic limit and the second or lower magnification where it is desired to trace a curve up to the rupture point of the specimen. It may thus readily be seen that with this torsion testing machine curves may be made in six different combinations, depending upon the type of specimen tested and the wishes of the operator. This size of torsion testing machine, with a longer bed, is the one universally used by all the large universal joint manufacturers and automobile manufacturers who proof test their own universal joints and similar parts.

The metallurgist and heat treater has in the last few years so improved the quality of steel entering into the crankshafts, axles and kindred parts that for torsion tests, in which the stress varies as the cube of the diameter, a much larger and heavier torsion testing machine is required, and where a machine of 230,000 inch lbs. capacity would twist off a 2½ inch or even larger shafts, now it will hardly test a 1¾ inch or 1 15/16 inch heat treated chrome vanadium bar. For automobile steel testing it has thus been found necessary by the automobile manufacturers and the steel makers to secure machines of 230,000 inch lbs. capacity. It is needless to go into details as to this machine, as it is similar in construction to the machine just described, varying only in details. It may be interesting to note that torsion testing machines may be secured adapted to testing the very finest wire and also up to the heaviest and largest bar or tube made and in capacities ranging from 25 in. lbs. up to that of 2,000,000 inch lbs.

Ed. Note: The writer desires to acknowledge the assistance rendered by Mr. Thorsten Y. Olsen of the Tinius Olsen Testing Machine Co. and also the Riehle Brothers Testing Machine Co., both of Philadelphia, in preparing this series of articles. The next installment will consider other types of testing machines for making Brinell, impact, alternate stress and other tests.

(To be continued)

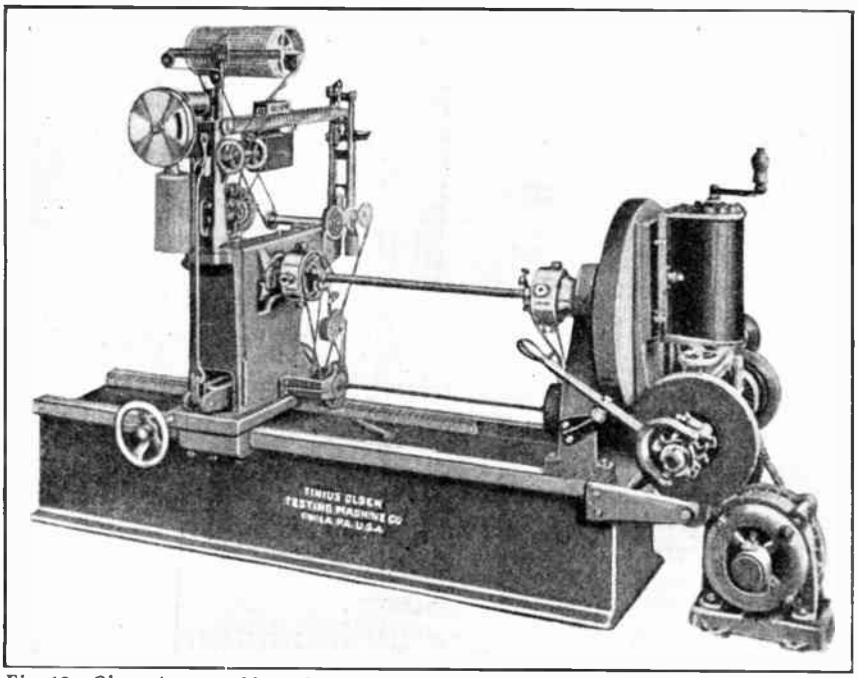


Fig. 10—Olsen Autographic and automatic torsion testing machine used for determining power transmission ability of shafting

BROKEN VALVE STEMS EASILY REPAIRED

TO repair a broken valve stem the fittings should be removed and the stem slipped back in the tube. Now make a small hole in the tube a short distance from the valve stem, bring the valve out again through this hole, and in so doing the fabric in the original valve hole will not be injured. The small cut formerly occupied by the valve stem can be vulcanized easily. If the valve is battered so that no fittings can be removed, the valve can be sawed off across to the cut with a hacksaw and the nut can then be easily taken off.

RELINERS AND INSIDE PROTECTORS

RELINERS, if made of flexible material and well designed, are a good thing in old tires; that is, tires showing separation and breaks in the fabric, and which would not ordinarily be serviceable. Under such circumstances reliners reinforce the tire, protect the tube from being pinched in the fabric and often make it possible to secure a great deal of additional mileage. It is not, however, advisable to use reliners in new tires, on account of the creeping, chafing and heating occasioned and the interference with the normal action of the tire.

COUNTERSINKING BRAKE-BAND LINING

THE repair man frequently experiences the difficulty of having the drill or countersinking tool with which he is countersinking the brake lining for the rivet heads going either too deeply or completely through the lining. This annoying trouble can be easily avoided by placing the material to be countersunk on an old spring leaf. It is best to fasten the two together with a clamp, although it is not absolutely necessary. Then, when drilling, the point of the drill will stop when it comes in contact with the spring leaf, thus leaving a countersunk hole of the proper depth to suit the average condition.

SPARE YOUR SPARE TIRES

AUTOMOBILE tires are wrapped in paper by the manufacturer because tire makers know that sunlight and air sap the strength of the rubber. They should be protected until they actually go on the rim for road service. Statistics prove that a tire good for an average of 6,000 miles when it leaves the factory will lose approximately 2,000 miles of its life by being carried unprotected as a spare for one year. A tire cover, made of rubberized coated fabric, will outlast many tires. It will cost less than the 2,000 lost mileage on one unprotected spare. Neatly covered spares look much better hanging on the back of the machine than do bare tires. The covers are water-proof and can be washed without injury as often as the car is washed. They can be purchased in colors to match the body finish of the car. Therefore, both from the standpoint of appearance and economy, "cover your tires to spare your spares" is good, sound advice.

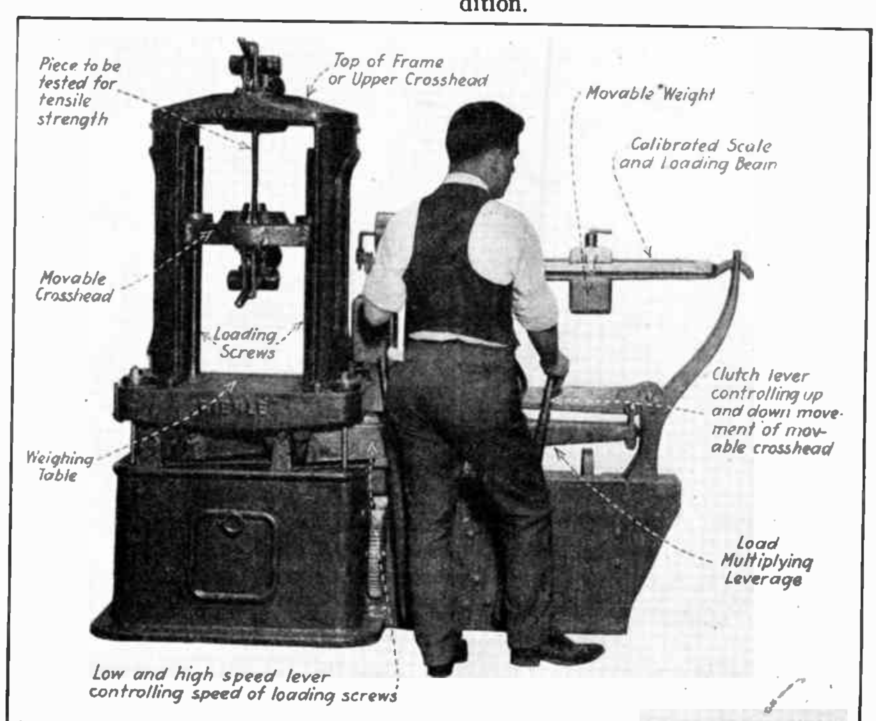


Fig. 9—How to test specimen for elastic limit, elongation or ultimate tensile strength in Riehle machine

Stop Cocks and Their Uses

By F. C. Heylman, A. S. M. E.

STOP cocks of different kinds and sizes are in use in all parts of the world. Their advantage over the ordinary gate or globe valve is readily seen by studying stop cocks in use. On account of its peculiar construction a stop cock is easier to operate than gate or globe valves. For loading racks or fire hydrants, where valves must be opened with a very short movement, the stop cock is particularly suited. A one-inch gate valve required about four turns to open or close, while a stop cock requires only a quarter of a turn to completely open it.

Another feature of the stop cock is its reliability. The wear on them is equal on all surfaces instead of wearing out in places. Also stop cocks last for a very long time without the need of repair, depending, of course, upon the kind of liquid handled. This is a very good feature, the importance of which should not be overlooked, especially when used in places where supervision is slight. A stop cock does not call for much space—not so much as other types of valves. It can be put in places where there would not be sufficient room for a gate valve.

When a stop cock is used as a drain for tanks, reservoirs, etc., containing dirt, scale, sediment and other foreign substances it very seldom happens that the valve cannot be closed after using, as the sharp edges of the hole in the plug cut off these foreign substances. But this is not the case when a globe or gate valve is used. The inability to close valves often occurs when valves have to be lifted from the seat and this results in delay and other unpleasant features.

Stop cocks last longer, because the plug is made of one substantial piece and protected all around. Take for example a stop cock to be used in a sulphuric acid line. We all know that this liquid is very wearing on any valve. With the gate type of valve, the wedge must be lifted in opening and lowered in closing. When the gate is in a closed position, there is no chance for the acid to go through, but the moment the wedge is lifted from the seat, the acid, being under pressure, will go around and over the wedge, until it reaches the stuffing box and the lower part of the stem. From there the acid will go through the stuffing box and get in contact with moisture in the air, with the result that a weak acid is formed, and in a very short time the stuffing box is out of order, and the packing rings are gone. This trouble is eliminated by using stop cocks for sulphuric acid. The suitability of the particular stop cock for the purpose intended must of course be considered.

In general, it is found that the ordinary stop cock causes trouble by sticking. (See Cecil H. Peabody's book, "Steamboilers," who writes in regard to blow-off cocks: "A cock has the disadvantage that it may give trouble by sticking; a valve may leak and the leak may not be detected."

This sticking is the reason stop cocks have not been used as much as they would have been otherwise and some ways of overcoming this evil have been tried.

One of the oldest types of stop cocks is shown in Figure 1, the so-called Service Cock, which is used for low pressure liquid. Both ends of the body are open and the plug projects through the body, being held in place by a nut and washer. When this plug sticks, it can be loosened by tapping the bottom end, which, however, ruins the thread and causes distortion. It is easily understood that when a stop cock of this type is under pressure and the plug has to be loosened by tapping, the liquid will flow out at both ends of the body. To overcome this, the plug must be tapped again and will stick just as before with the same result.

When this stop cock is used for oil, cold water or any other harmless liquid, there is no danger, except that there is a loss of the liquid, but when sulphuric acid, caustic soda, steam hot oil or hot water are discharged the operator, of course, is in danger. For that reason the kind of stop cock shown in Figure 1 is not permitted to be used in Europe on boilers or in steamlines—and for very good reasons.

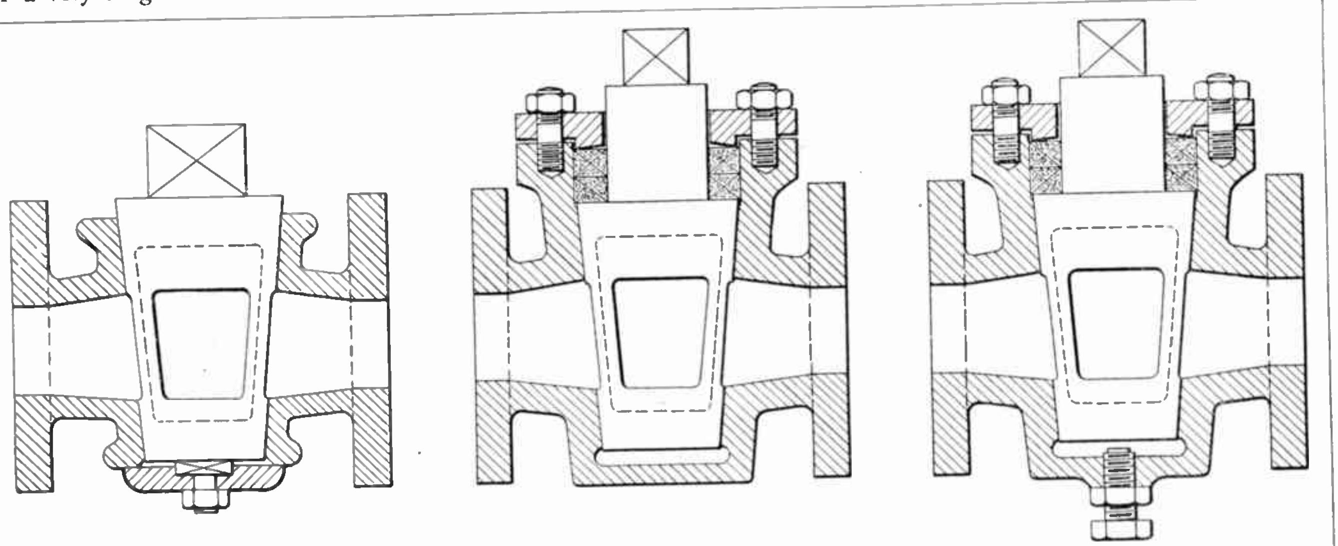


FIG. 1 FIG. 2 FIG. 3

This type of stop cock, however, has one very good feature, namely that both ends are open. The body can be inspected or scraped in case of regrinding, and it can be very easily repaired. After grinding the body must be thoroughly cleaned and this is possible only when both ends are open. The easiest way to clean the body is during grinding at the bench with a piece of rag soaked in kerosene, and this is a big time saving. To remove high spots or grooves from the surface inside the body, a good light is necessary, and with the bottom of the body closed a light cannot be held inside during the light cannot be held inside during the scraping, with the result that poor work is done, causing a leaky stop cock and loss of liquid. For low pressure this stop cock will give sufficiently good results, but is unreliable, as once it starts to leak, or the plug has to be lifted during sticking the cock cannot be used again without complete overhauling.

The illustration at Figure 2 shows a stop cock in which the plug is held in a body closed at the lower end. At the top there is a gland engaging the lower end of the plug and holding it in place and the end of the plug is packed. When a plug of this type sticks, it is sometimes possible to free it by tapping the plug or the body with a hammer; failing this, the stop cock must be taken apart at first opportunity, and when used as a drain valve for tanks

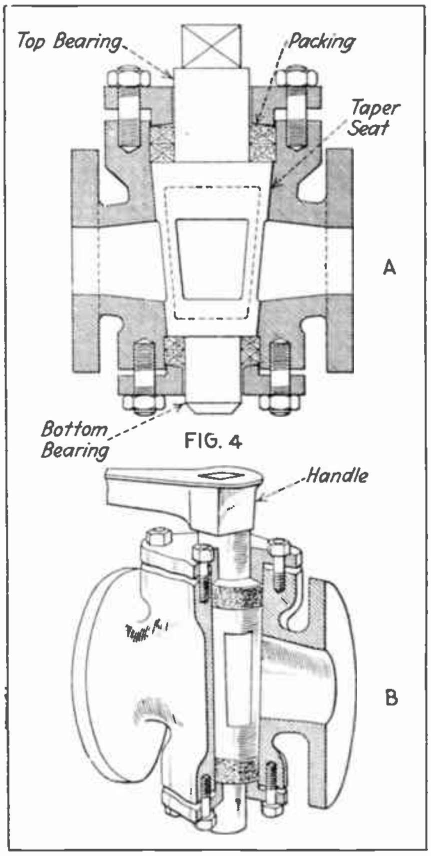


FIG. 4

or in pipe lines or on boilers, a loss in contents results and in addition the use of a hammer causes distortion of the parts and leakage.

In many cases, in trying to open this type of cock, the square end of the plug has broken and the valve was put entirely out of order. The fact that one end of the body is closed makes overhauling very difficult—particularly grinding. There is also the danger of a repairman forgetting to ascertain how far the plug sinks into the body, and in many cases where this matter was overlooked, the lower end of the plug rested on the bottom of the body instead of being tight around the opening.

This type of stop cock is also unreliable, as it will stick, and is therefore not suitable as a blow-off valve on boilers. The single gland on the top of the body, which holds the plug in place, does not guarantee that the plug will not blow out, and this will happen in case one of the stud-bolts breaks. As stated before, the closed bottom will make it very difficult to grind this type of valve.

The cut in Figure 3 shows the same stop cock as in Figure 2, with the exception that in order to prevent the sticking of the plug the botom of he body is provided wih a lift-screw. When the plug sticks in the body, the bolt has to be screwed in, in order to lift the plug, but after continuous usage and the extra strain of tightening the counter nut on the body, the thread becomes worn, leaving the bolt loose in the thread, and there is a leakage. In case one forgot to screw the bolt down again and to tighten the top gland of the plug, the plug would rest on the bolt instead of shutting off the opening in the body.

The drawing at Figure 4 shows a double packed stop cock for low pressure, designed for general use. One can see from the sketch that this type is the simplest possible combination of the types shown in Figures 1 and 2. This stop cock will stick, just as the other types, but there is a way to overcome the sticking without damaging the parts or losing the liquid.

As a rule a plug should turn around two or three times in the body in order to prevent the excessive wearing of one side. For stop cocks the use of a ratchet wrench is advisable. This reduces the cost of repairs, such as grinding, to a great extent. This stop cock has only a slight tendency to stick, but should it turn with difficuly, by loosening the top gland and tightening the bottom gland, the trouble will be eliminated at once. When the top gland is tightened to the extent that the plug turns with difficulty, the bottom gland should be drawn tight enough *to release part of the pressure on the plug.* The plug will then turn smoothly and evenly.

It is not advisable to lift a plug, if too tight, as there is a great possibility of admitting dirt, sand, scale, etc., between the two surfaces i. e., plug and body which may cause cutting of the surfaces followed by the customary leaking.

As may be seen from the sketch the plug is provided with an upper and lower stem. The end of the lower stem is beveled under 45°, so that in case of emergency, a hammer can be used against the lower stem without causing any damage. The packing at each end of the plug does away with leaking, and makes it unnecessary to drive the plug in place, thereby lessening the tendency to stick.

The stop cocks already described and numbered in Figures 1, 2 and 3 are not fitted for blow-off valves and should never be used for steam pressure, on account of the fact that there is a chance that one of the stud bolts might break, or that the nut and washer of the type shown in Figure 1 might give away with serious consequences.

A blow-off valve for boilers, or for steam pressure in general, should have a guard on the top to prevent the plug from blowing out. The stop cock shown in Figure 5 is such a valve and can be safely used as a blow-off valve.

It is a well-known fact that a blow-off stop cock sticks more or less when opened, this being due to increased temperature of the plug, while the body is still cold. This may be overcome by building a jacket around the body to keep it warm, but it will be found that the difference in expansion between plug and body is very much in favor of the blow-off valve.

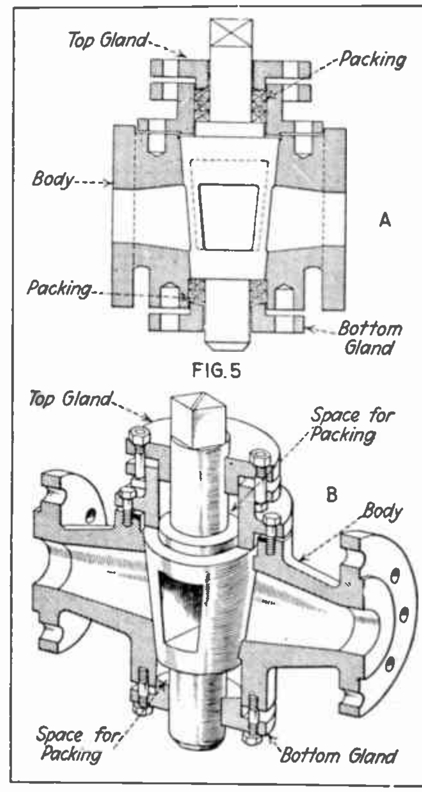


FIG. 5

With reference to the operation of blow-off valves in general, we find in "Boiler Room Orders," published by the Hartford Steam Boiler & Inspection & Insurance Company, in paragraph No. O, under the heading "Routine Use of the Blow Off," the following rule:

"To remove sediment from the bottom of the boilers, open the blow-off valve in the morning, or before the circulation has started up. The valve should be open wide for a few moments, but it should be opened and closed slowly so as to avoid shocks from water hammer action."

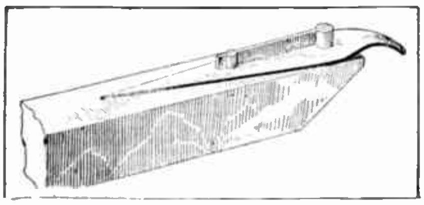
When using two blow-off valves in succession, first open the valve nearest the boiler very slowly. This valve will always operate easily. Then open the outside valve very slowly until it sticks. Wait a few seconds until the body of this valve gets warm, and then throw the valve wide open. The valve will

(*Continued on page* 135)

SHOP PRACTICE

INDICATOR FOR TRUING UP WORK ON LATHE

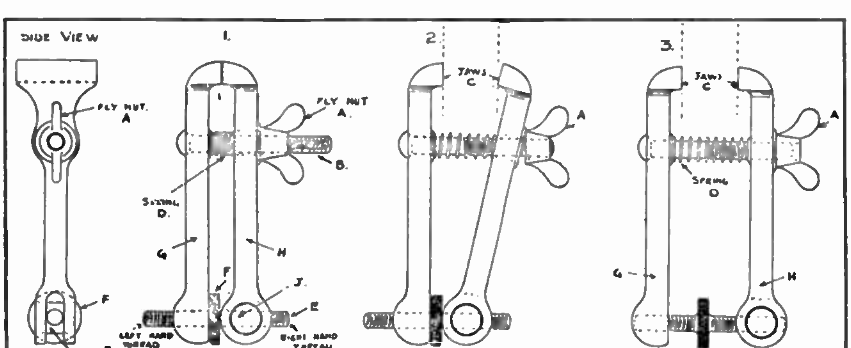
THE illustration shows an indicator described by Adolph Grimm in the *American Machinist*, such as is used for centering lathe work. It can be made by any mechanic and if the work is carefully done, the tool will be quite accurate. The indicator is held in the toolpost and applied to the work to be centered in the usual manner. It is very simple in construction, consisting of a swinging indicator made from sheet steel which swings on a pivot pin inserted in the body of the device. This pin is slotted and carries a piece of steel spring which extends to the smaller slotted pin riveted to the indicator pointer. This spring serves to keep the pointer of the device centered and returns it to position when the indicator is deflected by a piece running out of true. The motion of the short arm is magnified about four or five to one.



Indicator for truing up work on lathe

PARALLEL JAW HAND VISE

THE hand vise illustrated is a very useful tool for machinists, model makers and others who have to handle small pieces of work that cannot be gripped very well in an ordinary bench vise. It has the valuable feature of providing a parallel grip throughout its range of adjustment, providing the turnbuckle at the lower end is properly manipulated. The sketch at 1 shows the vise in a closed position, that at 2 indicates what happens if the bottom adjustment is not properly worked and view at 3 shows the device at its maximum opening with parallel jaws when both upper and lower adjustments are properly made.



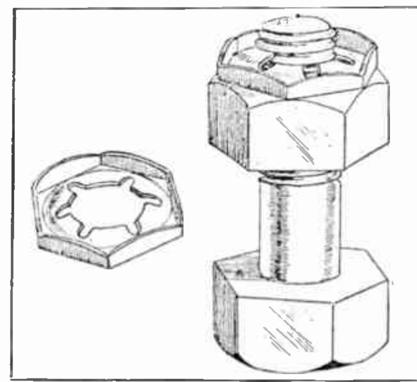
Parallel jaw hand vise in various positions

TO CUT GLASS WITHOUT A DIAMOND

MANY times it is necessary to cut a large pane of glass and one is not always provided with a diamond for doing this work. In this case lay the glass on a straight flat surface; make a mark on the glass at either end, where you wish to cut the glass. Heat a piece of wide thin iron, perfectly straight or in a curve if desired, and place it on the glass at the marks made. The heated iron will cause the glass to expand on the upper surface sufficiently to crack the glass on the heated part, the crack extending clear through.

FIGURING IN QUINTILLIONS

WHAT is the biggest figure you ever saw? Here is the one which beats all previous records we have on measuring combinations. A European mathematician has compiled the number of possible combinations with a No. 11 Set (103 blocks) which is the Metric Set of Johansson Standard Gages as 10,141,204,801,825,835,211,-973,625,643,007; or, in other words, oven ten quintillions. For example, when it is considered that the number of combinations obtained up to 200 m/m is about 200,000 it is easier to understand the great many different ways each measurement can be made up. Of course, this number should not be confused with the number of possible measurements which can be made with a full set of Standard Gages which, in the cases of the No. 1 Set (81 blocks) is about 260,000. When you begin to figure how many times each one of these 260,000 measurements can be made up by different combinations, then it is not so difficult to realize how this tremendous number is obtained.



New nut locking device

NEW NUT LOCK

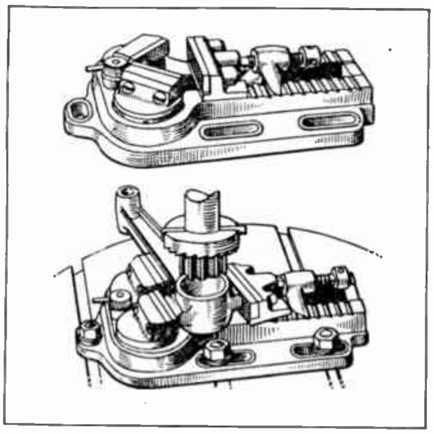
THE "Palnut" Locking Device consists of a spring steel stamping of hexagonal shape and internally provided with projecting tongues bent up to fit the pitch of the bolt whereas the nut is fitted. It is simply screwed down tight above the nut when the spring of the tongues gives a grip sufficient to lock the nut proper, the tongues springing out and engaging the threads as indicated. The spring lock thus provided prevents the nut from becoming loose due to vibration or other causes.

RELATION OF HAMMER SIZE TO PUNCHES AND CHISELS

IN all cases there must be some relation between the size of the tool and the weight of the blow struck, and to use, say, a 7 lb. hammer on a 3/8 in. punch or chisel would mean the smashing up of the tool with very little effective result in the way of work. It may be shown as a ready example of this that while you can drive a 16-gauge 2 in. wire nail into an ordinary brick until its head is flush, if you use a 4 oz. to 6 oz. hammer, yet if you use a 2 lb. hammer the nail will not enter, but simply collapse; in effect this is the same with all percussion tools. If you have a big-bodied chisel or punch you can use a sledge hammer on it, but if you have a small-bodied tool only a small hammer can be effectively used, and for the usual 1/2 in. to 5/8 in. hexagon steel punches and chisels more work can be done with a ¾ lb. to 1 lb. hammer than with one of larger size, owing to more of the force being utilized.

THREE JAW MACHINE VISE

THE vise shown in the accompanying illustrations is intended for holding pieces of irregular shapes while machining, being adapted to both toolroom and quantity production work. Many pieces ordinarily requiring jigs may be held for drilling or milling. All three jaws can be swiveled, each independently of the others, and can be fixed in the positions required. The sliding jaw is held down by means of a T-head



Three jaw machine vise

bolt and is not secured to its screw, which can be shifted along the body and readily engaged. In place of the usual stationary jaw there are two swiveling jaws, which can be swung to form a V-block having an angle of 90 deg. or more for holding cams or circular work. For holding irregularly shaped pieces, such as a connecting rod, as shown in the lower view, the jaws may be swung to accommodate themselves to the form of the work. They can be locked in position by the nut between them, the turning of which tightens a cone against the flanges of the circular bases of the jaws. The jaws are fitted with loose grip-plates, which tend to draw the work down on the body of the vise when pressure is applied by means of a screw. Smooth, soft plates can be furnished if desired.

The body of the vise is made of steel alloy and the remaining parts of mild steel, casehardened where necessary. The bearing surfaces are hand-scraped The vise is made in sizes, having maximum openings betwen the jaws of 4, 6, 9, 12 and 18 in. For the smallest and the largest sizes the depths of the jaws are, respectively, 1¼ and 2½ in.; the widths of the sliding jaws, 3 and 8 in.; the widths of the swiveling jaws, 2½ and 5 in.; and the over-all sizes 12 x 6½ in. and 34½ x 13 inches.

MAKING PHOSPHOR-BRONZE

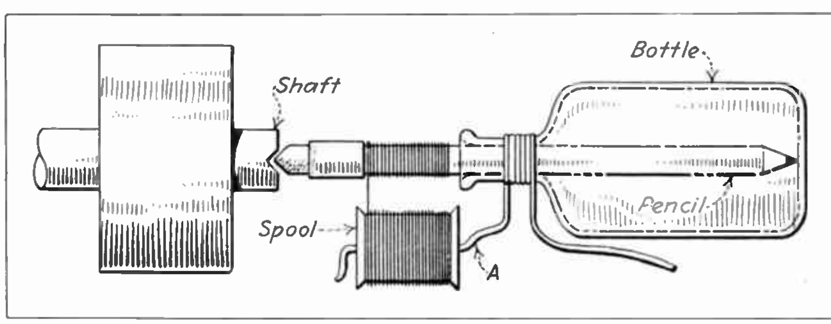
WHERE possible, the use of phosphor-tin is usually the method used for adding the phosphorus in this alloy, but where this tin alloy is not available the phorphorus has to be added to the copper first, and then the required amount of tin is alloyed in, it being very inadvisable to make the Cu-Sn alloy first and then add the phosphorus. The copper should be melted and lifted from the fire and, after skimming, the phosphorus should be pushed under the surface with a proper plunger. Then as soon as reaction ceases the tin should be alloyed in and the metal poured.

TO FILE CAST IRON

FREQUENTLY it is necessary to file a piece of cast iron that has been subjected to friction and has acquired a glaze or skin. The best way to get through this skin is to use the edges of an old file. If a new file is used on this sort of surface it may be ruined.

A QUICKLY MADE SPEED INDICATOR.

WHEN necessary to ascertain the speed of a shaft and no way is known without a speed indicator, and none is at hand, the job of taking the speed may be accomplished with a lead pencil, a bottle, a spool of thread and piece of wire. Hole the bottle and wire in one hand and wind wire on neck of bottle with other, leaving an end which



A quickly made speed indicator

bend with pliers at short angles when spool is to be held on.

Trim the rubber of lead pencil to fit center drilled shaft end and cut small niche in pencil to attach end of thread. Hold bottle in right hand and press pencil rubber against end of revolving shaft and hold finger on edge of spool so as it will not spin when the pencil rubber is released from shaft. Hold on for ten seconds or quarter of minute and by counting wraps of thread on pencil will determine speed of shaft for time held on. To rewind thread on spool hold edge of spool on shaft or edge of pulley or belt until rewound.

GEO. G. MCVICKER.

ALUMINUM ALLOY FOR FORGING

MUCH progress has been made of late in the development of new aluminum alloys, especially for use in the automotive industry. The most sensational step, according to a leading authority on this subject, is the evolution of a forging alloy which promises to accomplish much in automobile engine design, in the way of cutting down the reciprocating weight, and in reducing rotating masses and bearing pressures. The physical properties which have so far been secured in the forging alloy are said to be 55,000 to 65,000 pounds per square inch tensile strength with 18 to 22 per cent elongation and 38 to 40 per cent reduction in area.

CEMENT FOR FASTENING LEATHER ON PAPER TO PULLEYS

SOAK six pounds of carriage glue over night, then heat thoroughly till dissolved and add six pounds of white lead ground in oil. Reduce the mixture with oil until it is of a free working consistency. Add one ounce of nitric acid and stir till thoroughly mixed. The pulley surface should be made thoroughly clean and should be warmed to about 125 degrees Fahrenheit. Then apply the cement and clamp on the leather and let stand 12 hours before using. If the job is done right, it is claimed the leather will have to be turned off in a lathe in order to remove it.

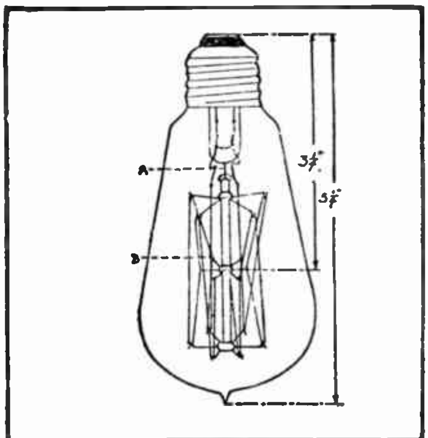
SIMPLE CASE HARDENING

HEAT the article to be case-hardened to a bright red; sprinkle over powdered rosin till thoroughly coated and plunge into clear water. This works fine on any wrought iron work. For cast iron use prussiated potash or common lye, or even the muriate of potash is good. Use same method as with wrought iron. Another method for hardening cast iron is to pulverize and mix together equal weights of saltpetre, prussiate of potash and ½ ounce salammoniac. Heat the cast iron pieces till red hot, roll them in the powder, and then plunge them into the liquid.

ELECTRICAL PROGRESS DIGEST

MILL-TYPE GAS-FILLED LAMP

IN order to secure a lamp that would combine the shock resisting qualities of the carbon lamp with the efficiency and brilliancy of the modern gas-filled lamp, the mill-type was produced. This lamp is similar in appearance to the ordinary vacuum type B lamp, but instead of the entire stem being of one piece, a flexible, shock-absorbing steel spring shank is inserted



Mill type gas fitted lamp

between the arbor and the glass which surrounds the lead-in wires as shown at A in the accompanying drawing. This construction enables the arbor and filament to vibrate freely in all directions without displacing the anchors or short-circuiting the filament loops.

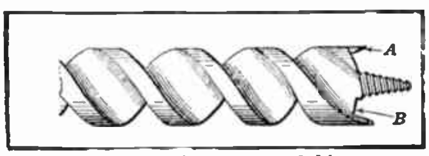
Another important feature of the mill-type lamp is the method of anchoring the filament. Instead of the usual top and bottom anchors, an additional set of anchors is supplied at the center of the arbor, as shown at B. By lacing the filament to this extra set of anchors, it is prevented from becoming tangled when subjected to severe jolts or sudden shocks.

INTENSITY OF WIRELESS SIGNALS

A METHOD of measuring and comparing the intensities of signals received by a radio station has been worked out in France with good results. This method, which can be employed only for undamped waves, essentially consists in comparing the intensities of reception of the signal and of the sound produced by a local source of oscillations, of the same frequency and form, constituted by an ordinary heterodyne. By modifying the intensity of the action of the auxiliary oscillation-generating device upon, say, the antenna, a rough equalization is first obtained; afterwards by maneuvering convenient shunts to the telephone an absolute equality of intensities is obtained. The ratio of intensities is proportional to the shunt resistances. Moreover, by inserting a thermo-galvanometer in the antenna the absolute value of the intensity of the auxiliary signals can be obtained. The error in the practical use of this method is from 5 to 10 per cent.

SHARPENING WOOD BITS

ONE way to sharpen wood bits easily is to use a fine file in the following manner. The scoring nibs, which are the two prongs which stick downward on either side of the gimlet point, are filed from the inside. If they are filed from the outside, they will eventually score a circle too small for the top portion of the bit to pass through. The cutting lips are filed on the underside while the bit is held in the hand, chuck end down. Referring to the accompanying diagram: At A is shown the scoring edge and at B the cutting edge. Use a fine file and take light cuts on the inside edge of A. If



How to sharpen wood bits

they were taken on the outside, the diameter of the bit would be made smaller at this point. The cutting edges (B) are also sharpened in the same way, care being taken to do the filing on the upper side of the cuting edge.

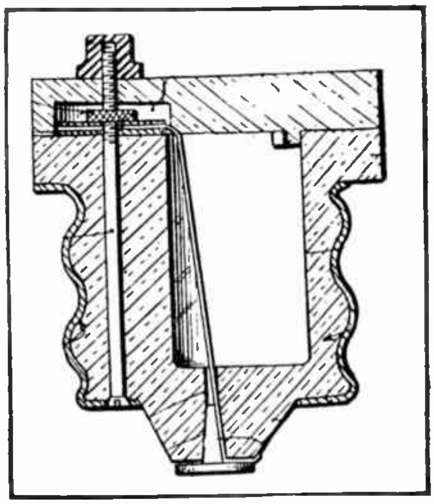
Some interesting figures giving the percentage of houses using electricity in different parts of the British Empire have been published. The following table gives the number of houses in 100 using the electric supply:

In British Possessions

Australia	11.2
Bermuda	14.6
Egypt	0.2
New Zealand	14.3
South Africa	3.3
United Kingdom	16.8

RENEWABLE PLUG FUSE

THE accompanying illustration shows a renewable plug fuse that has features of some merit. The fuse wire runs diagonally through the plug, being held between washers at the top where it is secured by a nut, while at the bottom a wedge button does the clamping. To make the renewal, the fiber top is unscrewed and the brass nut loosened sufficiently to remove the end



Renewable plug fuse

of the burned-out fuse. The bottom end of the old fuse is removed by simply taking out the wedge button. Inserting new fuse wire is the next step and then the brass nut is tightened once more and the wedge button inserted again. The fiber top is screwed on and the plug is ready for use without further adjustment.

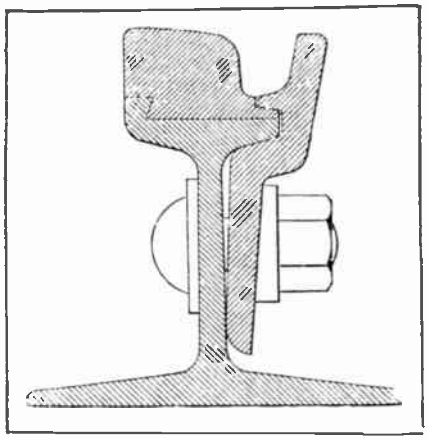
ELECTRO-PNEUMATIC WELDING MACHINE

IN operating spot-welding machines of the usual type the pressure required for the weld is produced by a foot pedal. This is tiring to the operator, especially as he may have to make 15,000 welds per day. The electro-pneumatic welding machines now being built in Germany are equipped with a compressed air cylinder controlled by a foot pedal, which requires very small effort to depress. The motion may also be regulated by a small motor that actuates the mechanism a given number of times at the required intervals. By this device the capacity of the welding machine may be increased by 50 per cent.

EVERYDAY SCIENCE NOTES

NEW TRAMWAY RAIL

A sectional view of a tramway or trolley rail recently invented is given here. It will be seen that the portion of the rail on



which the wheel travels is susceptible of renewal, so that the entire rail may not be replaced, but only the portion subject to wear.

In the roasting of coffee, soot is produced and now it is suggested that this should be carefully saved as it contains caffeine and can be used as a source for the production of this alkaloid. It may contain as little as 0.8% or as much as 22% of caffeine. Simple sublimation from the soot evolves the alkaloid. The chaff of coffee contains so little as to be of negligible value and should not be allowed to mix with the soot if the latter is to be used for producing the alkaloid.

It is calculated that the wave power on the Japanese coast represents some five millions horse power, but the really successful wave motor has not yet been invented.

The absorption of carbon mono-oxide by gas masks is quite a problem. If the air containing it is dry, the following formula is efficacious: Manganese dioxide 50 parts, copper oxide 30 parts, cobalt seng oxide 15 parts, silver oxide 5 parts.

Thermostatic metal for opening and closing ventilators and for similar purposes operated by changes in temperature, has been put on the market in England. It is based on the attachment to each other of two metals of different coefficients of expansion by heat. It is really a variation on the compound bar which has been long in use as a demonstration or for practical purposes. Compound metal is supplied in different thicknesses from .015 to .25 inches in thickness.

The hardness of electrolytic iron has been commented on. It has been found that long annealing is required to soften it. Ten minutes at 660° C. reduced iron from 164 Brinell to 161, while at 10500. C. The same iron reduced to 88 Brinell. A full hour brought the two samples to 159, and to 83 Brinell respectively. The final deduction from the tests was that for complete annealing two hours at 950° C. or one hour at 1050° C. are required.

The Platt Fuguerė lighthouse in the sea off the northeast coast of Guernsey is operated by a submarine cable a mile and one-quarter in length. It lies a mile from the shore and nobody resides in the lighthouse. Its cost is about one-eighth of the sum which would have been required had a lighthouse force been provided for. The light is acetylene turned on and off by clock work. There is a compressed air fog signal and by a microphone this rings a bell on shore so that the engineers may be sure that the signal is sounded. There is a pressure gauge on shore which gives warning when there is only two weeks' supply of acetylene in the tank. There is also a telephone which, if the sea permits access, is for the use of pilots. These are the principal features of the ingenious installation, which might be copied elsewhere.

Considerable success has been attained on the Swedish State railways with ball bearings for car axles. After four years' experience it is found that the starting resistance is very much less than with the plain bearings, that there has been no heating, and that the length of trains can be increased from 15% to 38%. It is not said whether there was any trouble from broken balls, cups or races, which in such heavy service might properly be anticipated.

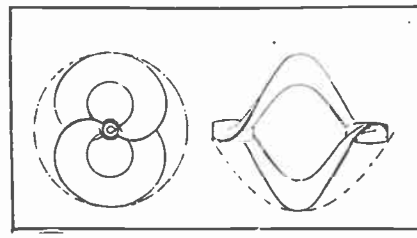
The English technical journals make quite a point of describing old engines, stationary or locomotive. In the case of stationary engines they are generally beam engines, and recently the demolishing of a beam engine built by the famous James Watt in 1821 and which ceased its virtual century of work on May 4th of this year is noted. As far as known, the engine needed important repairs twice only during that period and for the last twelve years it averaged 120 hours duty practically every week. The cylinder was 24 inches in diameter by 6 feet stroke, the flywheel was 16 feet in diameter built up in segments, the piston rod was kept in line by the old fashioned parallel motion. It is estimated that if 250 pounds sterling had been spent on the engine it might have been run for another century.

Reinforced concrete pipes are made by the centrifugal process in South Africa. Reinforcement is made out of the wires of old cables which are woven into cylindrical cages. These are placed in the molds. A sufficient quantity of the cement for the pipe is then poured in and the mold is turned rapidly and as it speeds up it causes the material to be evenly distributed for the entire length of the mold. Water is also driven out. Eight to twenty minutes' rotation are required according to the size of the pipe; the latter period suffices for five-foot diameter pipe. When subject to destructive pressure the pipes open up and become porous, but seem not to break like a cast iron pipe.

In the Ontario, Can., mines many rare metals have been recovered, including platinum and palladium. Nearly 20,000 tons of Bessmer matte from the International Nickel Company of Ontario were treated in Bayonne, N. J., from which were recovered platinum, palladium, rhodium, osmium, iridium, and ruthenium.

UNUSUAL SCREW PROPELLER

From the celebrated Thorneycroft works comes the screw propeller whose construction is perfectly clear from the diagram. The idea is to produce a propeller which will ride over an obstruction as if it meets



an obstacle it will worm its way over it. The construction suggests great strength as there are no unsupported radial blades.

The world moves. Two cities of the orient, Calcutta and Bombay, have expanded so rapidly in recent years, that the introduction of underground railroads is being discussed and it is even proposed that a tube at Calcutta should be run under the Hooghley River.

The State of Colorado proposes to construct three tunnels fourteen miles in length through the mountains of the Continental Divide. The maximum grade will be about half the present one and the new tunnels will have a maximum altitude of 1,000 to 2,000 feet less than that of the present surface railroad. It is proposed to utilize the tunnels for automobiles by making special provision for putting the automobiles on trucks for passage through them.

An odd point was brought out at a paper recently read in Glasgow on the casting of steel ingots. The point was that in pouring the steel from the ladle a uniform rate of delivery should be maintained. It is thought that this might be effected if the pouring is done by tilting the ladle and pouring through an open spout on its margin. When, however, it is poured from a nozzle in the bottom of the ladle, as is almost the universal custom, the delivery gets slower and slower as the head of metal is lowered. The fireclay nozzle grows larger during the pouring, but it does not solve the problem as its change of cross-sectional area depends on factors that have no relation to the head of metal.

Considerable trouble is experienced in condensers on ocean vessels from the leakage into them of salt water. An ingenious apparatus for indicating such leakage has been devised. Two primary cells are supplied with condensed steam. One from the steam before it enters the condenser and the latter with condenser effluent. They are balanced against each other electrically. If salt gets into the condenser it will make its appearance in the second cell, thereby increasing its voltage and throwing the two cells out of balance so as to close a relay and light a signal lamp. The apparatus is even provided with a switch by turning, whose balance can be restored and the degrees through which the switch is turned gives the percentage of salt.

Construction of Model Electric Cars and Locomotives

By Edward E. DeLancey

PART I—THE MOTOR-DRIVEN TRUCK

THERE are hundreds of men and boys who are interested in model making. Unfortunately very few of these enthusiastic amateurs can afford a well equipped workshop and must therefore content themselves with a few ordinary tools, and still fewer special ones. On the other hand, the lucky ones who can afford a lathe and other machine tools are less likely to develop the resourcefulness of their less fortunate fellows.

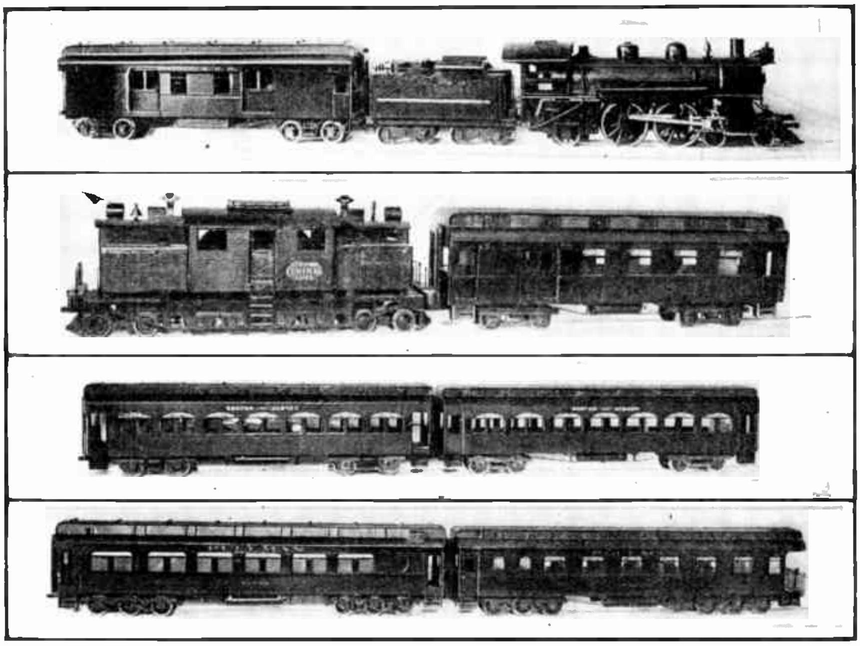
As an example of what can be accomplished along these lines, the writer desires to call the reader's attention to the accompanying series of illustrations which show some of the electric cars and locomotives constructed by the writer and his son. A few words of explanation will suffice to describe these interesting models.

An "Atlantic type" locomotive and baggage car is shown at the top of cut. This locomotive is a "fakir" because it has a Porter No. 2 motor concealed in the "fire box" and geared to rear driving axle. It is equipped with reversing switch, operated by usual lever in cab, and has electric headlight. It runs fast, but has not much tractive effort.

The baggage car has a controller (a circuit breaker) and a reversing switch in the front vestibule. The rear end has a "dummy" platform. The motor in this car is a specially rewound Porter No. 2, and will *start* the whole train! Without load this car will run at the equivalent of seventy miles per hour!

An electric locomotive of the Grand Central Terminal type is shown below the Atlantic type engine. It has *two* motors, reversing switch and electric headlights. Although it runs powerfully, I regard it as yet in the experiment stage. The car is a trailer of the "commuter's car" type.

Two day coaches are shown. The one on the left is a motor car with 2 3/16-inch wheels. The trucks are in a general way like those described, but with a swing bolster like that shown in drawings. It has no sprocket rigging and therefore slips in starting. Nevertheless it will ultimately get up good speed with two trailers. The controller and reversing switch are in the front vestibule. The coach on the right is a trailer. Of the two Pullmans, the one on the left is a sleeper, and that on the right is an observation parlor car. Special pains have been taken with the six-wheel trucks, so that the cars roll smoothly, and with the characteristic triple "click" of that type of truck.



An interesting outfit of locomotives and cars built by Edward E. DeLancey. Atlantic type locomotive at top. Grand Central type electric locomotive shown below it. Day coaches and Pullmans are also illustrated.

This entire outfit is of 3" gauge and equipped throughout with "Miller type" automatic couplers worked by the usual lever in the vestibules. In the case of the "Geneva," the coupler is worked by a brass crank handle attached to the rail of the observation platform. The "face plates" of the "Lucia" have springs and "accordion" action.

The two "Pullmans" and the two eight-wheeled trailers have sliding brass journal boxes, equalizers and equalizer springs. The two motor cars have no equalizers, but have super-springs above the swing bolsters. The latter are visible on the "Boston and Albany" motor car. The two "Boston and Albany" coaches are not quite complete — still lacking "grab irons" and other minor details. The fact that they are not yet varnished has caused them to photograph better than the other stock. All cars have glass windows, but no attempt has been made to reproduce any interior finish whatsoever.

In the following article the writer is addressing himself more particularly to those whose "hobby" it is to make realistic models of railway rolling stock under the handicap of a limited equipment. The accompanying photographs indicate the results which he has been able to attain under such a handicap, and he believes them to be attractive enough to justify him in "passing along" the main feature, viz.: the design of a truck operated by a "stock" motor, which is applied in such a way that its presence cannot be detected by the casual observer. We have assumed that the constructor will be compelled to purchase his wheels, already set to gauge on the axles, as well as his motor and gears. The gears are assumed to be slipped loosely over the axles before the wheels are set thereon. For the rest an inexpensive supply of stock brass, tin, black sheet iron, thin wood, paint and glass form the principal items. A few scraps of sheet zinc are desirable and we shall add that practically all of the sheet metal required can be obtained from scraps.

Tools and Supplies Needed

As for tools the following short list comprises the indispensable ones—a gear drill stock with at least every third size of drill from No. 1 to No. 51. A drill gauge, a hacksaw, a dozen scroll saw blades and frame, a pair of snips, some small files (flat, three-cornered and rat-tail), an assortment of round-nosed and square-nosed pincers, wire cutters, etc. If a set of small taps and dies can be added, so much the better, but an adjustable tap wrench is essential for the machine screw taps. A *good* vise with 2½" jaws is needed. Ordinary wood-working tools are assumed.

As for supplies the following machine screws, with taps to fit, will be necessary — a half gross of round-headed 5/64" x ½". Also two dozen 1¼" x ⅛". Both these lengths will be found too long for some purposes, but it is better to cut off the excess than to load up with several lengths. Some small brass escutcheon pins for making rivets will be convenient. The small wood screws, brads, etc., can be purchased as needed, and also a few feet of insulated copper wire. Some of these articles are for body work. The list of stock brass for the truck will be found further on.

Description of Motor Truck

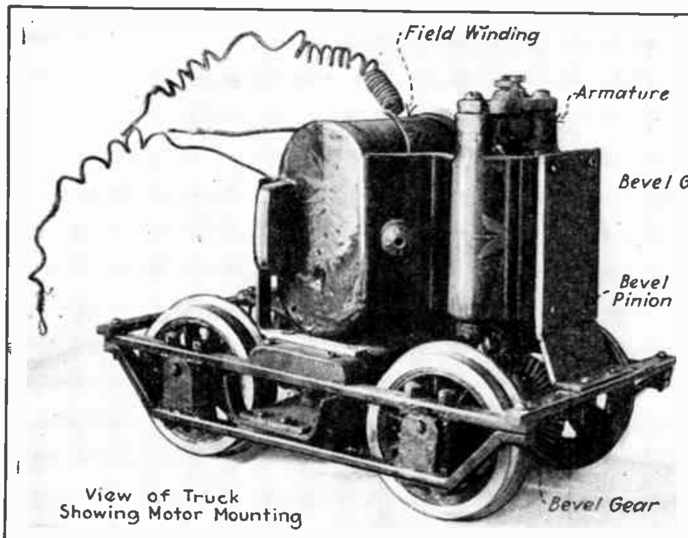
The motor truck, shown in the accompanying photographs, is made for a 3" gauge, but essentially it is similar to the locomotive truck under discussion, which is to be 2½" gauge, as per the drawings. The main difference lies in the design of the swing bolster. Careful construction is the keynote of success, and therefore be *patient* and *deliberate*. The design is so simple that it will be grasped immediately, but a few time-saving hints will be of service. These relate mainly to the gearing and journal boxes.

The motor must be a Porter K. and D. No. 2. This can be purchased of any of the larger dealers in electrical supplies. In order to assure the right combination of gears we shall violate the ethics of technical writing by naming a dealer. On page 11 of the Montgomery & Co. catalogue will be found a table of brass *bevel* gears, and on page 22, a similar table of sprocket wheels and chains. From the first table select G 484 1½" x ½", 48 x 16 teeth, axle hole, ¼" (or 3/16"). From the second table select G 819, pitch diameter ¾", 8 teeth, axle hole 3/16". Two sprocket wheels will be required, and one foot of chain to fit. We prefer the bicycle type of chain, because it is more readily reconnected than the steel wire ones by substituting a 5/64" machine screw for the original pin. All of these gears and sprockets will fit a 3/16" axle, but we deem that size rather light and would prefer to rebore such gears as require it to fit the ¼" axle shown in the drawings.

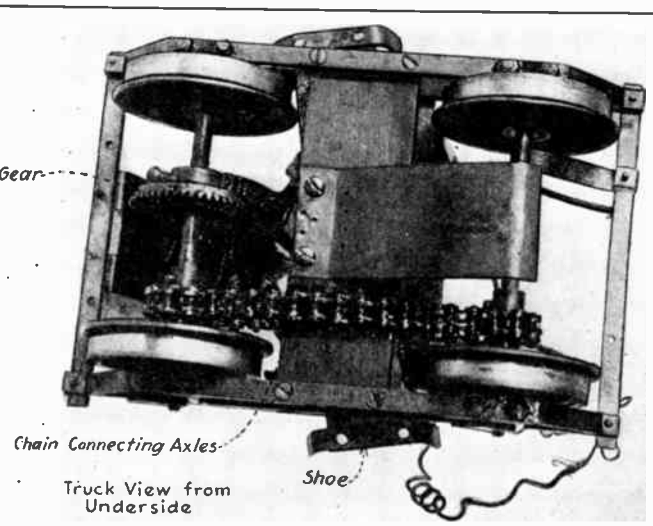
The sprocket wheels and chain are necessary only if it is desired to have both pairs of wheels function as drivers. One pair will suffice for light loads, but are sure to slip considerably in starting. It will be found that the hole in the smaller of the two bevel gears is too small. Ascertain the size of the motor shaft with the drill gauge and use the indicated size of drill for reboring. It will be wise to purchase the motor, gears, sprockets and chain *first*. Then take the gears and sprockets to the machine shop where the four pairs of running wheels are to be made and have them slipped over axles. The fit should be just free enough to allow shifting along the axle until the time comes for tightening up the set-screws. See that the journals of the running wheels are each 1/32" longer than the thickness of the journal boxes. This enables the box lids — when screwed tightly—to act as end stops and prevents the wheel bosses from rubbing against the boxes. The drawing at Fig. 1 is a front view with practically all of the wooden end piece cut away, so as to show the position of the gears and sprockets. It should be noted that the motor comes equipped with a grooved pulley, but this should be removed so that the small gear will be brought as close to the motor shaft bearing as possible. Care should be exercised in its removal as it is on "for keeps."

The cut at Fig. 2 is a cross section through the center pin (a round-headed screw), showing the springs and method of supporting the body of the locomotive. The shoes, for either side or center contact, are also shown. In the latter case an end view is seen, and its shape and method of attachment is indicated by the dotted line in Fig. 3. We prefer a center contact as being both cheaper and simpler. If a side contact is used the "third rail" must be bent downward at least a quarter of an inch at each end to prevent the shoe from catching at the various breaks and shifts from one side to the other which are inseparable from a side contact system.

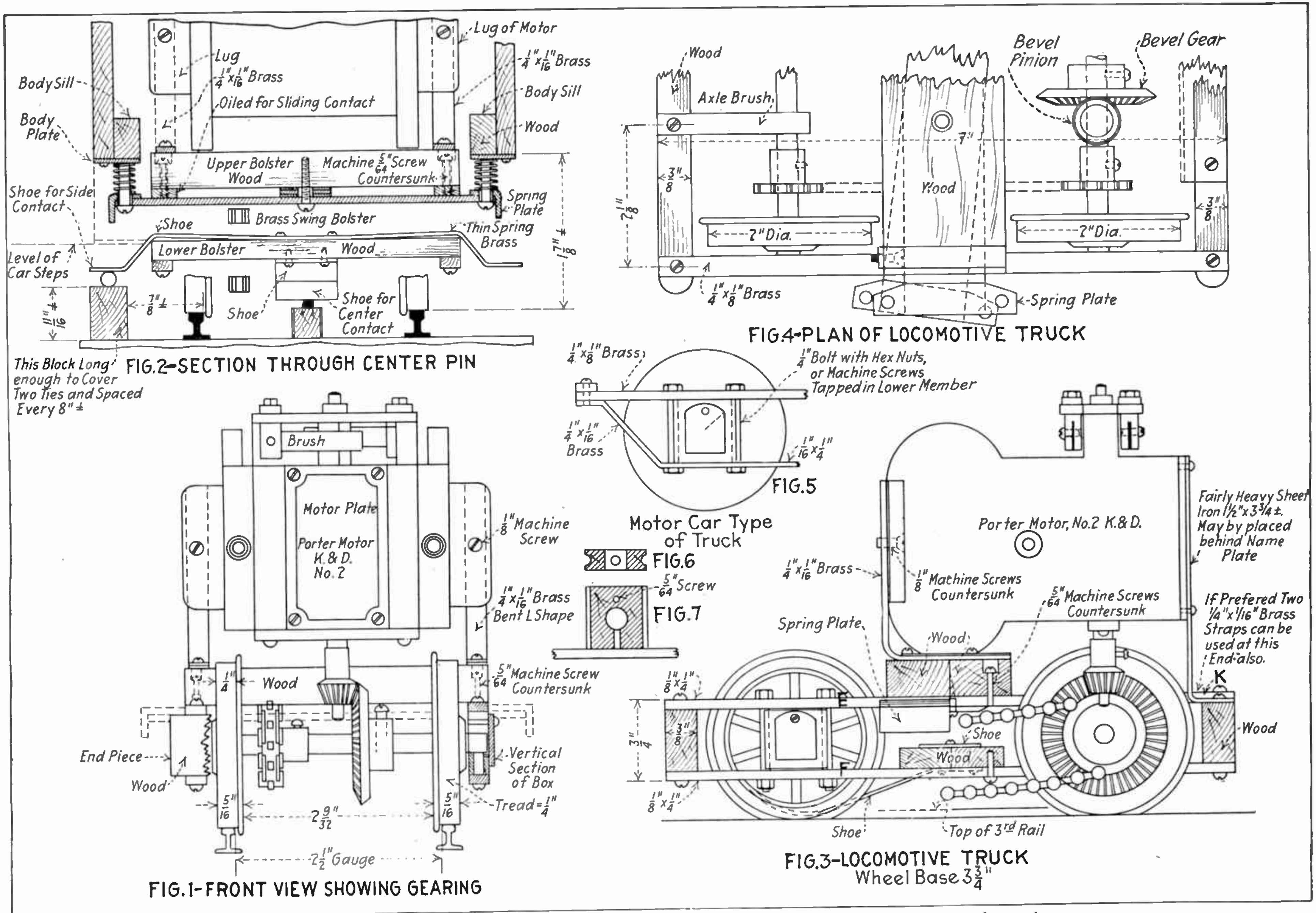
The illustration at Fig. 3 is a side view and longitudinal section showing the gearing, sprockets and chain and the method of attaching the motor to the truck. Other methods will of course suggest themselves, but this one interferes least with the circulation of air about the motor. Fig. 4 shows a three-quarter plan. The broken lines show the position of the swing bolster and spring plates, both when normal and when the locomotive is traversing a curve. The axle brush which returns the current to the running rails is also shown. Fig. 5 is an alternative end finish for the truck frames. It is slightly more difficult to make,



Electric motor-driven truck of the baggage car which is shown in accompanying photograph. This shows original form of swing bolster and spring plate, now superseded by type shown in drawings.



Inverted view of motor truck. This shows gearing and sprocket chain very distinctly. Also pick-up shoe and axle brush for return current. The action of the swing bolster is clearly indicated.

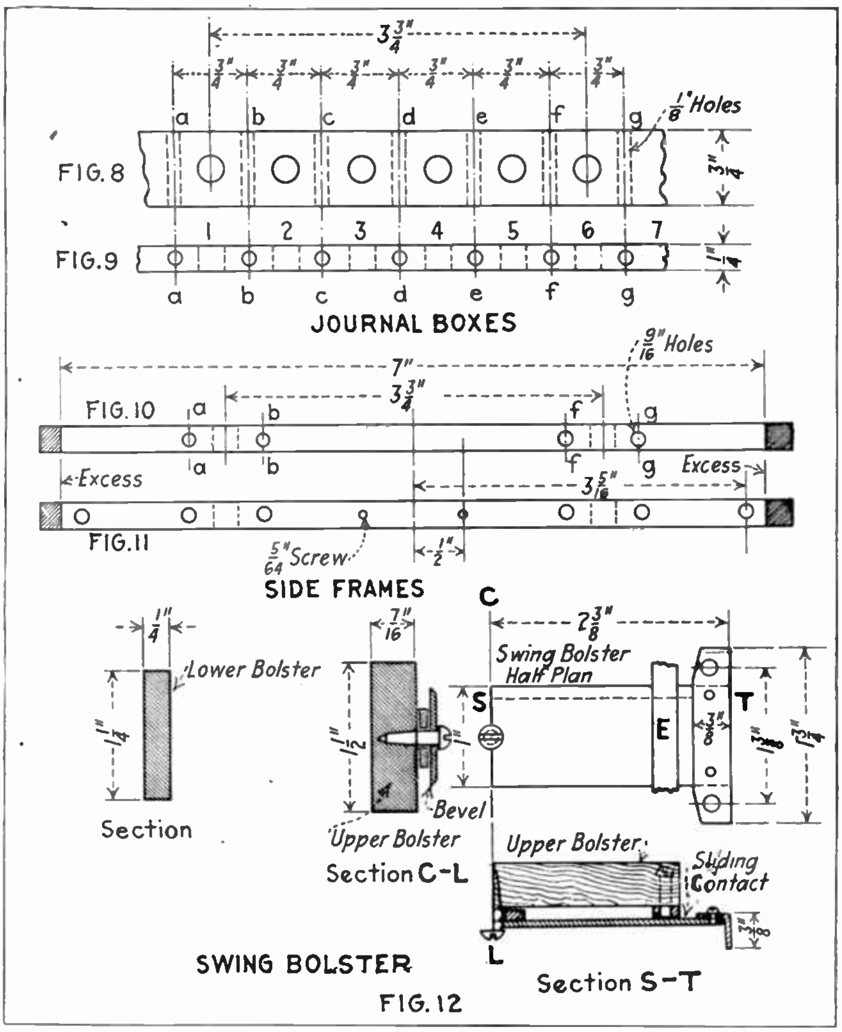


Detailed drawings showing construction of electric motor-driven truck suitable for model baggage car or locomotive.

and is more suitable for a motor car than for a locomotive. It will be noted that the lower frame in this type is half the thickness of the corresponding number in the locomotive truck. This is for greater ease in bending. Figs. 6 and 7 are respectively horizontal and vertical sections through the journal boxes. A cross section showing the journal is also seen at the right in Fig. 1. In Fig. 7 the small hole near the top is for the screw which holds the box lid. The vertical hole which communicates with the under side of the journal opening should be filled with cotton *before* the box is set in the frames. It will be noticed that the bottom of the journal opening has been enlarged a trifle with a rat-tail file in order to remove the burr at the intersection of the holes, and to offer a better contact between the cotton and the journal. This oiling refinement can be omitted altogether, but it involves very little additional labor.

The trailing truck is a duplicate of the motor truck minus the gearing and therefore the corresponding parts of the two can be made more conveniently in one job. The following list of stock brass is more than sufficient for both trucks.

These lengths are in excess of exact requirements to allow for waste, spoiled parts and desirable spare stock.



Details of journal boxes, side frames and swing bolster for motor truck.

Making the Journal Boxes

We shall begin with the journal boxes which can be made collectively if the following directions are accurately followed. If you have not machine tools it will again become necessary to fall back on a machine shop, but this will be the last time. Beginning about a quarter of an inch from one end of the stock piece, bore a series of 1/8" holes *exactly* 3/4" apart between centers, as shown in Figs. 8 and 9. These are the bolt holes. Then turn the work over on its broad side and bore a series of 1/4" holes each of which shall be *precisely* midway between the adjacent bolt holes. These are the journal holes, and may be bored for a 3/16" journal if desired. Lay out and bore as many boxes as the stock will permit because you may be tempted to make a second pair of trucks. While in the machine shop it might be worth while to bore the holes for the lid screws, and for the packing, but as this work can be done with a gear drill stock, we have not indicated these holes. All the bolt and journal holes must be accurately spaced along

For side frames	(L)	70", 1/4" x 1/8".
For journal boxes		20", 1/4" x 3/4".
For motor fastening		24", 1/4" x 1/16".
For spring plates		12", 3/8" x 3/8".
For swing bolster		12", 1" x 1/16".
For box lids		12", 1/2" x 1/16".
For shoes and axle brushes		12", thin spring brass 3/4" wide.
For springs		12", *open* spiral spring 1/4" diameter.

Angle, or "L" section. All of this stock must be true, straight and free from "twist".

the center lines of their respective sides of the stock and square therewith. The machine shop insures this, besides saving much labor.

With all the holes bored as shown in Figs. 8 and 9, and *BEFORE* separating the boxes along the lines a-a, b-b, etc., take note of a very important fact which makes it possible to use the still assembled boxes as a template for boring the bolt holes in the upper and lower members of the truck frame—E and F, Fig. 3. Remembering that the wheel base of the truck is 3 3/4", it will be found that the journal holes Nos. 1 and 6 are also 3 3/4" apart, and from this it follows that the bolt holes a-b and f-g must correspond with the bolt holes in both upper and lower members of the side frame. It is now permissible to cut off a section of the assembled boxes long enough to contain the eight which you are to use. To do this place the piece in the vise so that the ninth bolt hole is close enough to the jaws to help steady the hacksaw. With a square, mark the line of the center of the hole on the *outside* of the brass, and then cut *carefully* on this line. When you have finished, each piece should show an equal portion of the bolt hole. (Be as careful when the time comes to separate the remaining boxes.) The eight-box section is now ready for use as a template.

Making the Frame

Cut the eight side pieces from the first stock in the list, making each piece 1/2" longer than the required seven inches. With a square, scratch a line across one of the pieces precisely in the middle. Next clamp this piece and the narrow side of the eight-box section securely in the vise, in such a manner that the middle scratch on the former comes over the center of the fourth bolt hole in the latter (hole d-d, Fig. 8). See that both pieces coincide

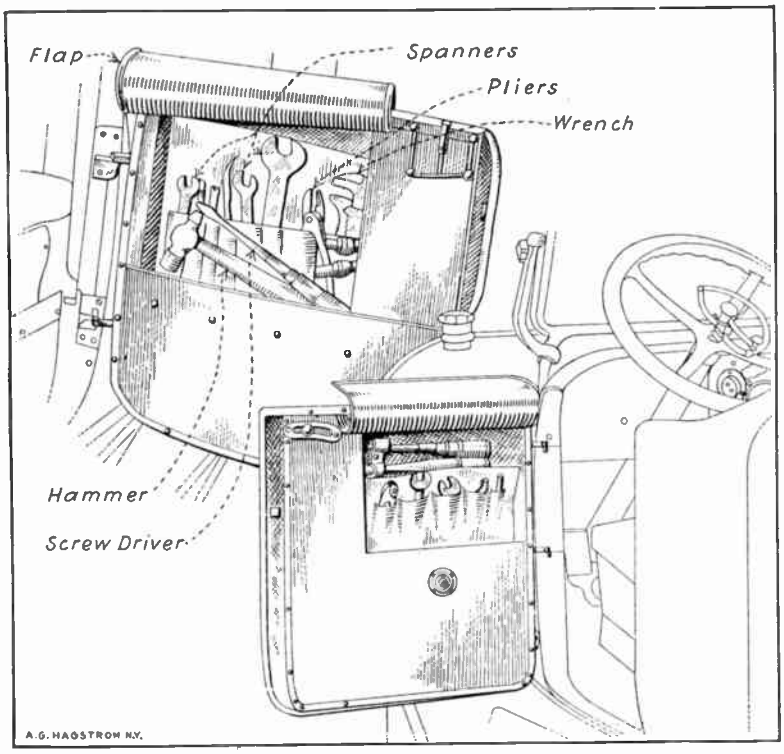
(Continued on page 159)

EVERYDAY MOTORIST

STORING TOOLS

THERE are certain tools of the motorist's kit that must be used more often than others. These include the common and useful ones, such as wrenches, screw-drivers, pliers, files, etc. Some of the 1920 model automobiles are equipped with special pockets in the front compartment doors in which tools are conveniently placed. Even if the car is not equipped, the handy man can easily make tool carriers that will fit in the spaces ordinarily wasted on the door, by making pockets in the carrier to hold the variout tools so that they will not rattle and providing a leather or canvas flap to cover the tools when not in use.

The accompanying illustration shows clearly how this may be done so further description seems unnecessary. The tool carrier may be made of imitation leather or heavy canvas and some times it is found feasible to fit a wooden block in the door frame in which spaces are hollowed out to receive the various tools.



A convenient method of storing tools ordinarily used for simple automobile repairs

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A good method of cleaning spark plugs that have become fouled with oil is to boil them up in a solution of washing soda and water.

LOOSE FAN BELTS

SOMETIMES an engine will overheat for no apparent reason. Occasionally a motorist will fuss with his power plant for some time before it is finally borne in upon him that the whole trouble lies in the fact that his fan belt is running too loose, causing the fan to run below its proper speed. If this condition is found, he should either tighten the fan belt himself or take the car to a garage and either have the adjustments tightened or the belt shortened.

USE CURRENT SPARINGLY IN WINTER

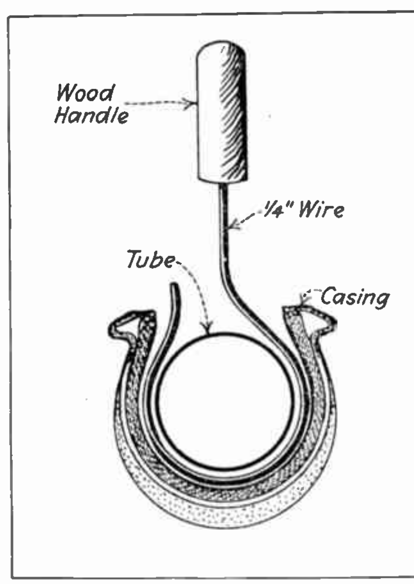
DO not connect additional apparatus, such as electrical horns, cigar lighters, etc., to the electrical system without taking the matter up with the factory. The surplus capacity of the usual system is large, but there is a limit to the amount of current which the generator can produce. Use the same judgment and reason in the operation of the electric lights on a car as you do those in your home or garage. When a car is running it is not necessary to burn all the lights, the two heads and the tail are all that are required or that are of any service. When the car is standing at night, use the side and tail lights only.

TOOL TO OPEN UP CASING AND PLACE TUBE

GEO. G. MCVICKER

IT is a tedious job to hold open an auto or truck casing and place a tube within and one which will usually smear one's clothes with talc powder if the job is done by hand in the usual way. I have made a tool for the purpose and it performs several jobs at once and does the tube inserting quickly. A piece of 1/4 in. steel wire is driven into a piece of round wood to serve as a handle and the other end bent into a loop, but not quite together when the return end of loop nears the main shank.

By partly inflating the tube, then squeeze it inside the loop and with casing standing on ground pull the loop around as casing is turned. This lays the tube smoothly and straightly in the casing. The wire loop distributes the tire powder around the inner side, and if a puncture had occurred it locates the nail or other sharp object if it happens to be sticking through the casing.



Tool to open up casing and place tube

DRIVE A NEW CAR CAREFULLY

MOTORISTS purchasing new cars should bear in mind a few simple rules that will tend to make their engines perform better and in time to come will save considerable expense and annoyance and the result will be a car that runs perfectly and gives the greatest efficiency. In breaking in a new engine always bear in mind that the parts are new, that the bearings are tightly adjusted, and necessarily stiff. An engine that is in this condition must be hauled with care for the first few hundred miles, otherwise troubles are bound to occur that will cause the owner many anxious moments and expense.

Always drive the new car slowly and cautiously until thoroughly familiar with its control mechanism and the methods of stopping it. When driving up grades on the higher gear ratios, if the engine shows any tendency to labor, shift back into a lower gear ratio, which has been provided by the manufacturer for that purpose. Many motorists believe that the best test of a car's ability is to rush all hills, or bad spots on the direct drive. It should be remembered that the lower speed ratios were provided for use at all times when employing the third or fourth speeds might cause strains in the engine.

One should never attempt to drive cars at high speeds unless the tire casings are in perfect condition and the road surfaces good. In driving on clay or muddy roads, or on wet asphalt, care must be taken in turning corners, and the car should always be driven cautiously to avoid dangerous side slipping or skidding.

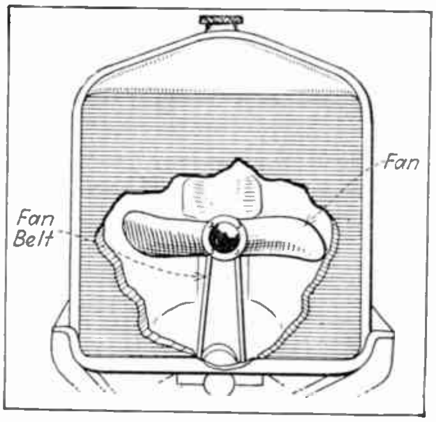
When driving on unfavorable highway surfaces, always keep one side of the car on firm ground if possible. The brakes should always be carefully applied, especially if the road surface is wet. An automobile should never be brought to a stop in mud, clay or sand, snow or slush if it can be avoided. Whenever road conditions are unfavorable, the smooth tread tires of the driving wheels should always be fitted with chain tire grips, to insure adequate traction.

BRAKE LUBRICATION

THE bands of automobile service brakes too often receive little or no attention. Then, glazed surface of the lining does not act quickly, nor is it dependable. The first step is to go over the lining with a squirt gun full of kerosene; while this is soaking well into the lining, go over the opposite brake also with kerosene, cleaning as well the connections for inspection and adjustment if required. Allow the kerosene a half hour at least to soak well into each lining, then giving a second application of kerosene if necessary. After this treatment, fill the squirt gun with clean engine oil and inject this into the bands, leaving it to soak into the open pores over night. In the morning wipe off the surplus oil, start the car and apply the brakes several times to get rid of any excess oil between the bands and the drums. This attention once each month or two will keep the brakes dependable and silent in operation.

PROPELLER-SHAPED COOLING FAN

THE efficiency of the usual form of fan blade used for drawing air through automobile radiators is very much lower than of the type used in airplane propellers because no attempt is made to secure a true pitch nor is there any pronounced increase in air movement due to aerofoil sections that



Propeller shaped cooling fan

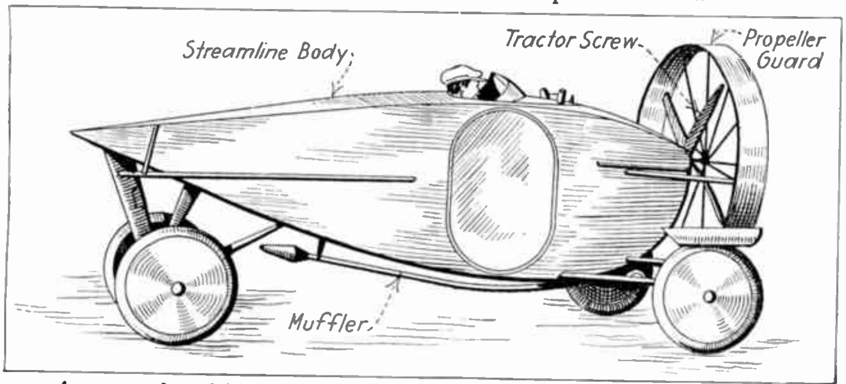
are now universally employed in aerial propellers. Flight attempts that were made with the early airplanes using propellers based on the ordinary electric fan design show that this form did not return much useful power in the form of thrust and for the energy expended. Naturally, if a propeller is efficient as a means of creating thrust for driving an airplane through the air, it will be equally useful in creating a draft of air through an automobile radiator.

The accompanying illustration shows a simple adaptation of a fan that is claimed to be considerably more efficient than the old four- or six-blade types. The fan is cast of aluminum and has a cone-shaped hub from which it is readily detached. The bearings operate in the hub interior, which also carries the fan-driving belt and the bearings are protected from dust and oil. The blades of the device are clearly shown in the illustration, a portion of the radiator being cut away to show how the fan is installed. The method of installation is a very simple one, as it is merely necessary to remove the old fan and replace it with the new and more efficient type.

THE HELICA

UNDER the above title a curiosity in the way of an automobile has made its appearance on the road. It is an automobile propelled by an air propeller. The automobile illustrated in the cut is the invention of a Frenchman, M. Leyat. Its driving machinery is of the simplest, a two-cylinder, V-type engine, air cooled and of only 8 h.p., is directly connected to the shaft of a 4-bladed propeller of 55 inches diameter. It is surrounded by a cylindrical safety guard. Everything is done in the construction of the body to avoid air resistance. The mud guards are horizontal and the rest of the mechanism is enclosed in a sort of streamline body. Wood enters into the construction of the body; there are two seats in tandem; the gasoline tank is in the rear, and driver, passenger and baggage has to reach the interior by a smooth-fitting door in the side.

As there is no transmission, properly speaking, in this car, and as this involves the doing away with a great deal of the weight inevitable in the regular type of construction, and also on account of the rational shape of the body, a speed of 50 miles an hour can be attained at an expenditure of some 15 miles to the gallon. As the wheels never skid, it should conserve the tires and even spare the road.



An unusual aerial screw propelled motor vehicle of French construction

The weight of the car is given as 450 pounds, the wheelbase 117 inches, the tread 56 inches and the tires 28 by 3 inches.

TO MAKE WOOD ACID PROOF

SOME storage batteries are carried in wooden battery boxes on cars and annoy the owners by leaking or slopping of the acid. To make the wood acid proof take six parts of wood tar and 12 parts rosin, and melt them together in an iron kettle, after which stir in 8 parts of finely powdered brick dust. The surface to be covered must be thoroughly cleaned and dried before painting with the warm preparation.

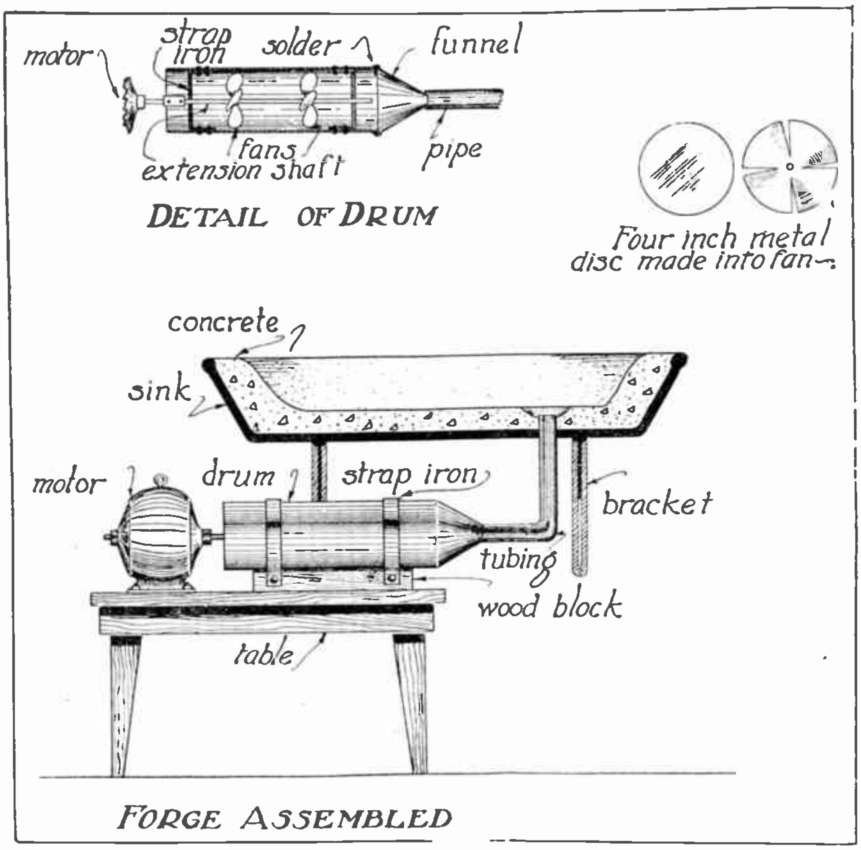
Homemade Forge With Motor Driven Air Blast

By Dale R. Van Horn

THE illustrations show how a forge was made from an old kitchen sink, a small amount of pipe and some galvanized iron. As will be seen by referring to the cuts, this forge is provided with an electric motor driven air supply which furnishes a strong, steady blast of air at all times for the forge. The construction of this forge was so simple that its manner of construction might be of interest to others who, lacking, perhaps, sufficient funds to purchase such an outfit, have felt themselves deprived of this shop necessity. Of course, where the motor is not already at hand, the venture might be rather expensive, but since a small electric motor will do the task nicely, one can be easily obtained in a second hand condition, or it may be that there is one already on the premises which has fallen out of use and which can be utilized. Construction of a forge similar to the one shown is carried on as follows:

Procure an old sink of the rectangular variety, and fasten it to the desired place in the shop. This may be set upon wood blocks or brackets, fastened to the wall. It should be seen that the sink rests securely and is able to withstand considerable weight and jarring. If desired, the sink may be fitted into the top of a concrete support while wet.

Unscrew the brass strainer from the bottom of the sink and run an inch pipe through the hole from underneath so that it extends about 2 inches through. Concrete is then mixed in proportions of one to three or four and moulded inside the sink as shown. The concrete, after being placed, is cupped about the pipe and the strainer laid on the top and two or three small nails run through it near the edges and into the concrete to hold it down. The pipe should extend several inches below the sink and should be provided with a "U" which is soldered to the drum.



Details of home-made forge with motor-driven air blast

The blower is made by making a galvanized iron drum four inches in diameter and a foot long, one end of which tapers funnel fashion to a size small enough to take the end of the inch pipe. This is then inserted and soldered or brazed. The drum or cylinder should be of heavy material and perfectly round. This may be trued after soldering the seam by fitting it over a four inch wood cylinder and carefully hammering with a mallet until it will pass along the cylinder without binding. The funnel will tend to hold the one end true.

This drum is then fastened to a wood or other form of support beneath the sink with strap irons. Room on one end of this support is left for the motor, a space of three or four inches to intervene between the motor and the open end of the drum. The motor drives an extension shaft mounted to run within the drum on which are mounted two blades. This is kept in motion by the motor when in operation, driving the air through the pipe and up into the forge.

The extension shaft may be of the same size as that of the motor and is connected by a short length of brass pipe which is slipped over the end of each, as shown in the detail, and held by rivets. This extension shaft is long enough to reach from the motor to the tapered end of the drum. The other end is held in a bearing made of a length of strap iron, as shown. The strap iron is bent to fit snugly inside the drum and is riveted, as shown. Another bearing is inserted as shown. The hole for the shaft should be exactly in the center of the piece so that the shaft will be held in the proper place. This strap iron is made of material five-eighths inch wide and a quarter of an inch thick. To prevent wearing a maple block may be riveted to the back side of it and the hole through the iron strap made slightly larger than the size of the shaft so that the wearing surface will come in contact with the wood only. This maple block should be boiled in oil before being placed. This is not necessary.

Before the final assembling, the blades are soldered to the extension shaft. These consist of 2 discs of heavy galvanized iron just small enough to turn within the drum without rubbing, in which are cuts made from their rims to within one-half an inch of the hole for the shaft. The blades are then bent to the proper pitch and soldered to the shaft. The solder is built up about the discs on either side to strengthen it and prevent possible working loose. The 2 fans not only increase the blast, relaying it on from the inlet to the funnel, but give it momentum and produce a steady, even pressure.

To regulate the air pressure, the motor may be run in connection with a rheostat with which the speed of the motor may be varied, or a slot may be cut in one side of the drum and a sliding door made to fit tightly over it. This door may be made of galvanized iron and should slide in grooves made of the same material, which is soldered to the drum at the sides of the opening. By providing this door with a sort of handle or by bending up one end, as much of the air blast may be allowed to escape as desired, thus regulating the amount which is delivered to the forge bed and the heat of the fire.

The motor should be housed in a box made to fit to keep out dust and smoke. This box may be made to fit over the motor to rest upon the motor support. A small drygoods box will serve the purpose nicely by cutting a notch in one side for the shaft. A block may be nailed on top to serve as a handle. Before using the forge, the concrete should be thoroughly hard and dry. To prevent the mixture from drying out too rapidly, the basin is filled with wet sawdust and left for several days. Several thicknesses of wire screen should be placed over the brass strainer to prevent its burning out.

While the blast furnished by this improvised blower will not surpass and probably not quite equal that made by a centrifugal type, still it will be of several pounds pressure and quite sufficient for all ordinary purposes. This blast can be easily regulated by the port in the drum and will be found to be suitable for all ordinary temperatures. In starting the fire, the port is opened when the motor is started, and, as the fire gains headway, this is gradually closed until the right blast results. A large inverted funnel made of galvanized iron may be suspended over the forge, and attached to a stovepipe leading through the roof, to allow smoke and fumes to escape.

CUTTING SOFT METAL

FOR cutting soft metal, place two blades in the saw frame, one in the usual way and the other reversed so that the teeth will point back toward the handle. One blade will cut while the saw is pushed forward, and the other makes its cut when drawing the saw back. While one blade is dragging, it will prevent the other from taking too deep a cut in the metal.

A computation of the distribution of the various metals in the crust of the earth indicates that about 1½ per cent of the weight consists of iron and about 5 per cent of aluminum. Of the various chemical elements, oxygen enters into the crust of the earth, into water and the atmosphere to a weight of more than the combined weight of all other elements, and hydrogen is about 16 per cent of the total.

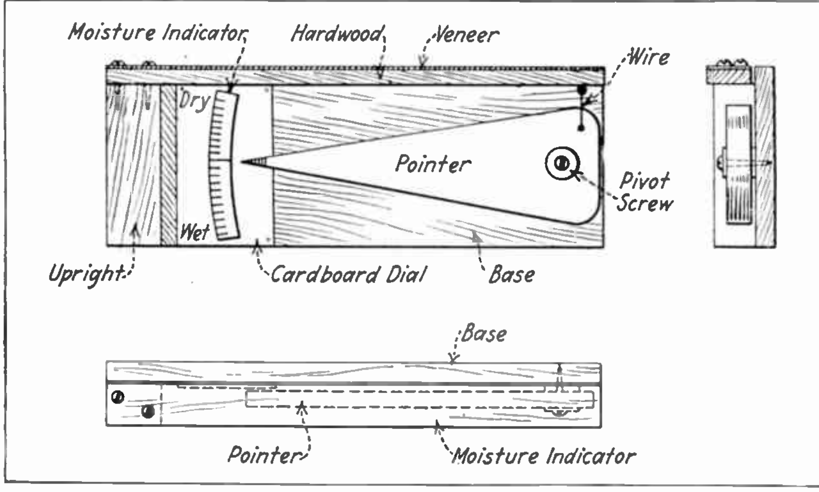
Previous to the war Belgium had fifty-five blast furnaces of which seventeen were running on June 1 this year. The pre-war output per day was nearly 8,000 tons of pig iron. The daily output of the fourteen furnaces now running is somewhat less than 3,000 tons, indicating that while Belgium is rapidly resuming its industrial activity, there is yet much to be done. The main reason for not starting up all the blast furnaces is lack of fuel.

Weather Indicator of Simple Construction

By L. B. Robbins

THERE are many contrivances for foretelling the state of the weather or the amount of moisture, all more or less complicated, but the following will be found simple to construct, compact, and, there being no materials to stretch or soften up, will always be fairly accurate. A piece of board about 1' long by 4" wide forms the base. Sandpaper the surface smooth and give a coat of shellac. At the left end nail an upright piece ¾" thick and 1" wide, cutting the ends flush with the top and bottom of base. This serves as to be tacked to the base just to the right of the upright. Letter the top line DRY and the lower line WET.

Lastly, a pointer must be cut out of light wood about the shape shown in the sketch. Pivot it to the base with a long screw, placing a washer each side of the pointer and being careful not to tighten the screw enough to bind the action necessary to its proper working. Connect the butt of the pointer to the bottom of the weather indicator, as shown, with a piece of light, stiff wire. Arrange this so the pointer will rest



Weather indicator of simple construction

a support for the weather indicator, which is constructed similar to a thermostat. The backbone of the indicator is of hardwood 1' long, ¾" wide and ¼" thick. Get a strip of veneer the same length and width and cement to one side of the backbone with waterproof glue. Be sure there are no uncemented places, as much depends upon the proper construction of this part. Then fasten one end of the indicator to the upright with two wooden screws.

A dial of cardboard and marked off in degrees, with a heavy center line and a heavy line at each end, is then opposite the central line on the scale when the moisture indicator is in a perfectly horizontal position.

The action of this weather indicator is due to the uneven swelling of the two strips called the moisture indicator. As the veneer absorbs and rejects moisture much faster than the hardwood strip beneath it, it forces the two to curve either up or down and moves the pointer with it to the proper indication. This is simple to build with practically nothing to get out of order and should prove useful about a farm or dwelling because it is reliable.

TEN WAYS TO KILL A BRANCH OF ANY ENGINEERING SOCIETY

(1) Don't come to the meetings. (2) If you do come, come late. (3) If the weather doesn't suit you, don't think of coming. (4) If you do attend a meeting find fault with the work of the officers and other members. (5) Never accept office, as it is easier to criticise than to do things. (6) Nevertheless, get sore if you are not appointed on the committee, but if you are, do not attend committee meetings. (7) If asked by the chairman to give your opinion on some matter tell him you have nothing to say. After the meeting tell everyone how things ought to be done. (8) Do nothing more than is absolutely necessary, but when members roll up their sleeves and willingly, unselfishly use their ability to help matters along howl that the branch is run by a clique. (9) Hold back your dues as long as possible, or don't pay at all. (10) Don't bother about getting new members, "Let George do it." — *The Engineering Institute of Canada.*

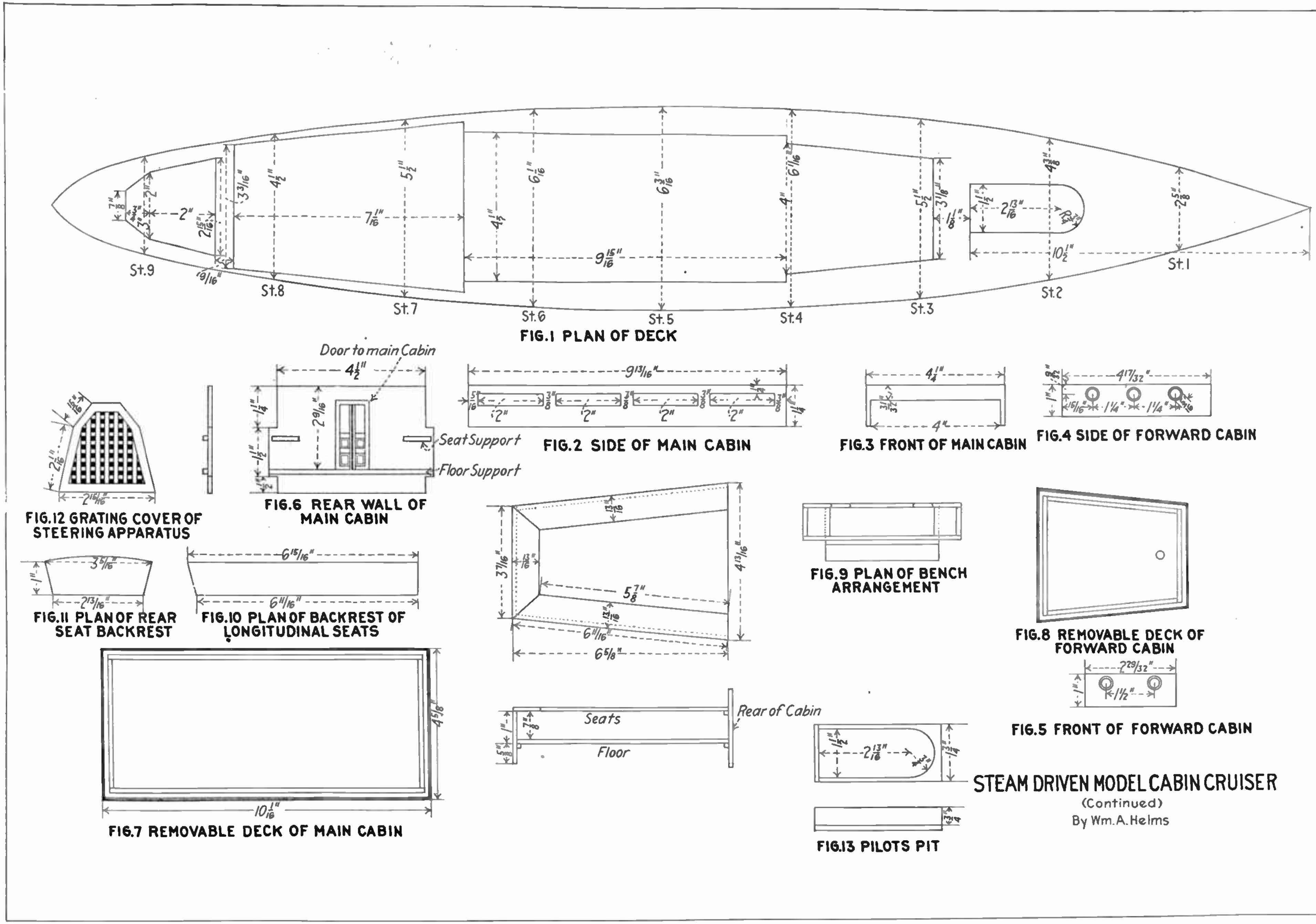


FIG.1 PLAN OF DECK

FIG.2 SIDE OF MAIN CABIN

FIG.3 FRONT OF MAIN CABIN

FIG.4 SIDE OF FORWARD CABIN

FIG.5 FRONT OF FORWARD CABIN

FIG.6 REAR WALL OF MAIN CABIN

FIG.7 REMOVABLE DECK OF MAIN CABIN

FIG.8 REMOVABLE DECK OF FORWARD CABIN

FIG.9 PLAN OF BENCH ARRANGEMENT

FIG.10 PLAN OF BACKREST OF LONGITUDINAL SEATS

FIG.11 PLAN OF REAR SEAT BACKREST

FIG.12 GRATING COVER OF STEERING APPARATUS

FIG.13 PILOTS PIT

STEAM DRIVEN MODEL CABIN CRUISER

(Continued)

By Wm. A. Helms

How to Construct a Steam-Driven Model Cabin Cruiser

By William A. Helms

PART II

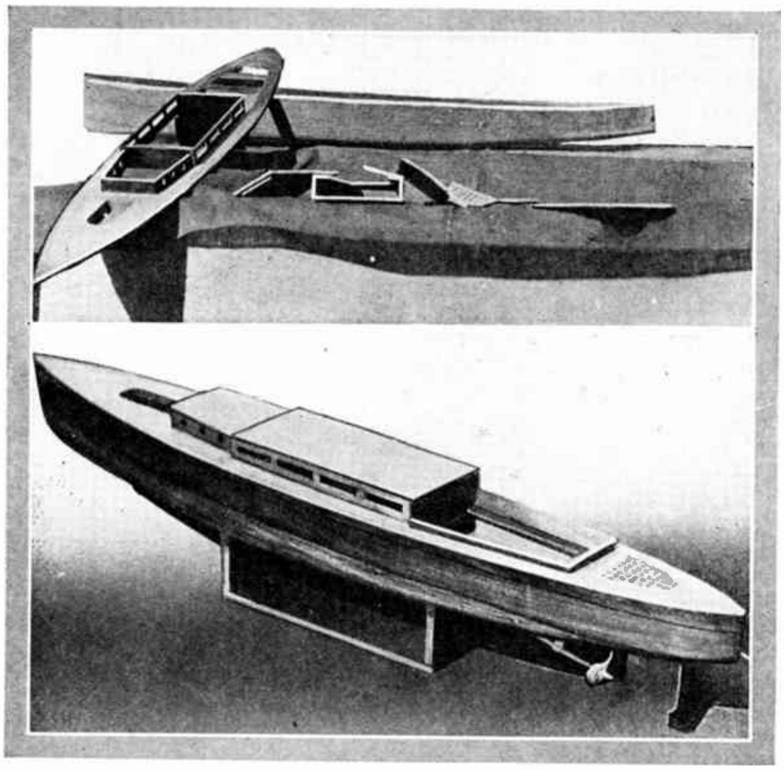
HAVING finished the hull and hollowed it to a uniform thickness of about 3/16 in., we come to the deck and cabins. The deck is made out of ⅛ in. bass wood. Before cutting the wood it is advisable first to make a pattern of the deck out of a stout piece of paper, taking care to make it slightly larger to allow for finishing the edge. Fasten the paper to the wood and cut the outside shape of the deck. Then draw the center line and mark out the openings for the cabins, etc. All dimensions are given in Fig. 1.

Next we cut out the sides of the cabins, starting with the main cabin. Fig. 2 shows the dimensions of the sides with the large port holes. Fig. 3 shows the front of the main cabin, which also forms the rear support of the forward cabin, and Fig. 6 gives the pattern of the rear wall. These parts are cut from ⅛ in. mahogany. The door in the rear partition can either be made as a dummy by simply marking it or it can be made to really open. The latter is to be advised as it offers a ready means of oiling the engine.

The deck of the main cabin is cut out of ⅛ in. bass wood to the pattern given in Fig. 7. It is removable so as to allow easy access to the boiler and engine. It is held in place by strips of bass wood ⅛ in. square fastened to the under side of the deck to fit snugly on the inside of the cabin walls when the latter are fastened to the main deck. Having cut out the various parts for the main cabin, we assemble the four sides. Then we place the main deck on the boat and fasten it temporarily so as to get the proper sheerline and fasten the main cabin to the deck.

The forward cabin is next taken in hand. Fig. 4 gives the dimensions of the two sides and Fig. 5 of the front piece. Like the main cabin it is cut from ⅛ in. mahogany and fastened to the deck. The deck of the forward cabin is made out of ⅛ in. bass wood and is fitted to the cabin in the same fashion as the main cabin deck. Both are painted in sail cloth color.

The plan at Fig. 9 shows the arrangement of the seats in the stern of the boat. They are assembled in box form as shown in the drawing before they are installed in the boat. The seats are made of ⅛ in. mahogany. The floor and seat supports are made of ⅛ in. bass wood. The floor can either be kept in the same color as the deck or can be painted to match the color of the cabin decks. The back rests are made of ⅛ in. mahogany to the dimensions given in Figs. 10 and 11. They are fastened to the main deck after the benches have been installed.



Upper view shows the deck and cabins ready for fitting to hull, the lower view shows assembled hull ready for the water

The cover of the steering apparatus shown in Fig. 12 is made of ⅛ in. bass wood. The square holes are best made by first drilling a round hole and then using a small square file to finish them. The illustration at Fig. 13 gives the dimensions of the pilot's pit. It is best made by taking a piece of wood ¾ in. thick and 1¾ ins. wide and 3¾ ins. long. Find the center line and mark the center of the half round forward section and drill a hole 1½ ins. in diameter to obtain the half round shape. Then saw the rest out. The bottom and end pieces are made of ⅛ in. bass wood. The pieces cut out from the deck can be used for these smaller pieces.

Before painting the hull it is necessary to first put the stern tube and strut in place. Below the water line the boat is painted green, and above white with a gold stripe running the length of the boat. The cabins and seats are finished in mahogany. The deck is lined with a pencil to represent the planking and then varnished. All the fittings are made of brass. This gives the boat a very handsome appearance. The fittings will be described in the next issue.

WHAT STRIKES COST

THE Conciliation Bureau of the Department of Labor estimates that the monetary losses throughout the country suffered during the fiscal year ended June 30 because of strikes amounted to $875,000,000. Approximately 3,500,000 workers were affected by industrial disturbances. The basis taken is that of $5 a day, an average continuance of strikes for ten days and a loss to workers of $135,000,000. The loss to employers in value of production curtailed is estimated at $700,000,000.

The steel strike alone is estimated to have cost the workers $3,000,000 a day in wages and the loss imposed on the country by the outlaw railroad strike cannot be, and has not been, estimated. As a matter of cold fact, $875,000,000 does not represent the loss by sustained strikes. The loss to the workers was greater than the figures given. There were cases where the men received aid from their organizations, but if they had money in the bank, or Liberty bonds they were required to use these. The losses to the manufacturers cannot be estimated.

Model Power Boat Racing In Central Park

By Wm. A. Helms

MODEL motor boat enthusiasts living in New York who care to get up early on Sunday mornings and take a stroll to the pond at 72nd Street and 5th Avenue will usually be rewarded by seeing several boats in action under the auspices of members of the Central Park Model Yacht Club.

The Power Boat division of this club held its annual race on the first Sunday in October. Mr. John Fawcett Rapp, who has done much in this country towards the development of Model Power Boating, awarded a cup for this race. It is to be presented to the winner at the annual club dinner. This is also the reason why we do not find him this year among the contestants for the trophy, a fact very much to be regretted, as I have had occasion to see some of his engines and boats which I feel sure would have given a good account of themselves.

There were five boats entered for the cup race. T. N. T. owned by the Johnson Bros., displacement 10 lb.; Bobo 4, owned by Mr. M. Bolles, displacement 15 lb.; Pep, owned by Mr. L. Blumenthal, displacement 12½ lb.; Mayo, owned by Mr. H. B. Seldon, displacement 13¼ lb.; Seminole, owned by Mr. H. Ringle, displacement 13½ lb.

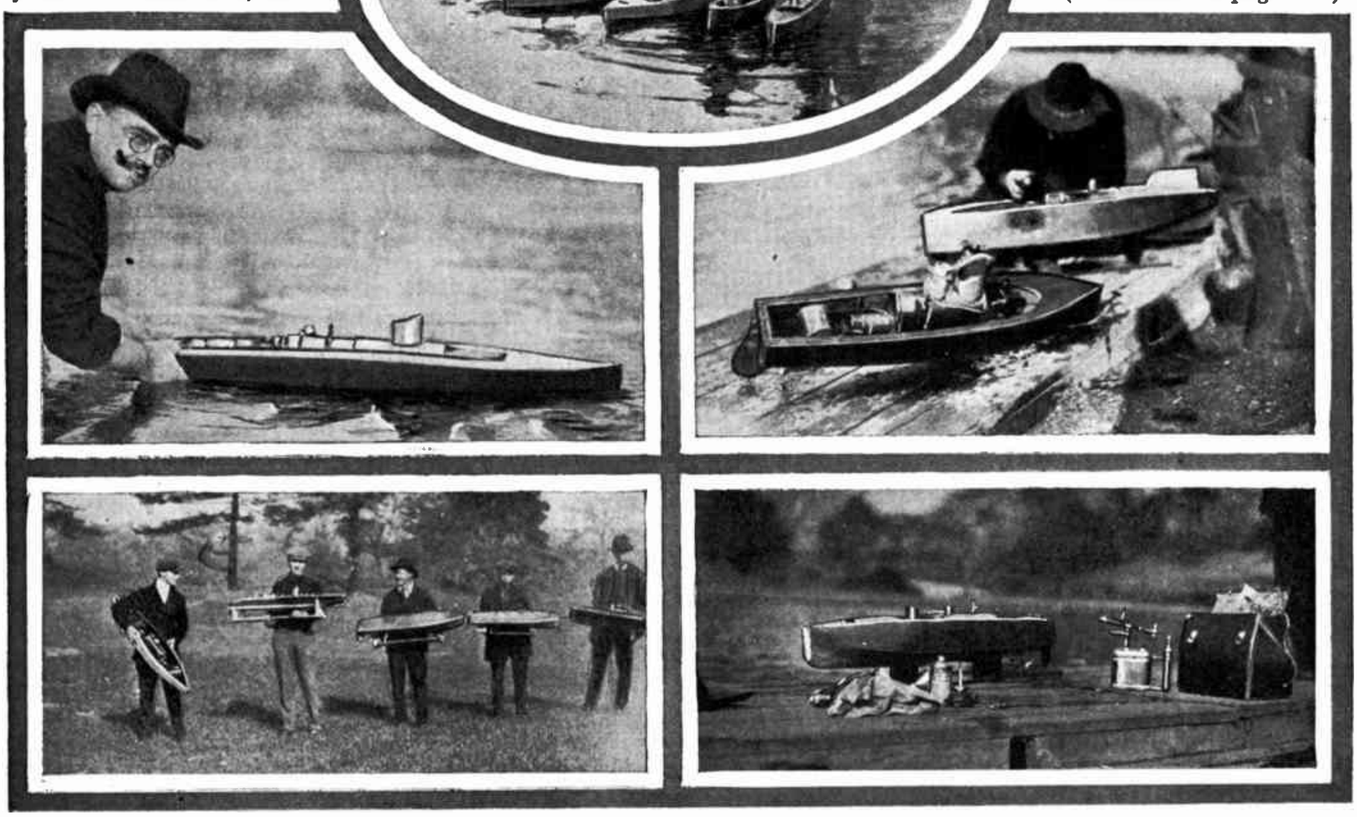
T. N. T. used as power plant a single-cylinder, double-acting engine of ¾ in. bore and ¾ in. stroke, and a Scott type boiler fired by a blow lamp. This method of firing was employed by all the boats. T. N. T. surely was a suitable name for the boat. In all three events it blasted itself toward the front and won first place.

In spite of the remarkably steady running of T. N. T., there seemed to be a doubt in the minds of some of the spectators as to which really was the faster boat, T. N. T. or Bobo 4. The latter won second place in the race. Its power plant consisted of a two-cylinder, single-acting engine of ¾ in. bore and ¾ in. stroke. The boiler used was a 4 by 10 in. water tube boiler. It seemed that Mr. Bolles had trouble with his blow lamp, for in the short runs when it was working right it showed a wonderful speed.

To really find. out which boat was the faster a special race between T. N. T. and Bobo 4 was arranged, but unfortunately it was terminated before the boats had really gotten under way. Right after the start, when Bobo 4, slightly leading, crossed the path of T. N. T., Bobo 4 caught the bow of T. N. T., carried it along and sunk it. This added greatly to the excitement and entertainment of the spectators. Fortunately T. N. T., when fished out by Mr. Rapp, who in his rubber pants acted as guardian of the boats on the starting line, showed no damages. I hope to witness in the near future a race between those two fast and interesting boats.

Mr. L. Blumenthal's Pep captured third place. The engine used by him is a two-cylinder, special single-acting, of ⅝ in. bore and ⅝ in. stroke. His boiler is a 4 in. by 8 in. water tube boiler. I may mention here that Mr. Blumenthal's boat rep-

(*Continued on page* 186)



View at top shows model boats in the water. Upper left shows Mr. J. F. Rapp, donor of cup, with Seldon's Mayo. Tuning up at the upper right, Johnson's T. N. T. in foreground. Lower left shows the contestants. The boat shown in lower right is Pep, winner of third place

STOP COCKS AND THEIR USES

(*Continued from page* 119)

operate very easily as soon as it gets warm.

Sticking is caused by the plug getting warm first and fitting tightly in the body for a moment, but when the temperature of the body reaches the temperature of the plug, the plug turns so easily that a small wrench may be used to move it. From this it can be seen that one cannot open the blow off very quickly on account of the uneven expansion of the plug and body. This is true of stop cocks in general when used for liquids at high temperatures.

There are of course many other valves on the market, and to obtain further information, catalogues and price lists should be consulted by those interested. The object of this article is to give a general idea of stop cocks as used in different branches of industry. Regarding the advisability of using a stop cock or a gate valve for blow off and the best method of connecting a cock or gate valve to obtain the best results, the reader is referred to various articles in *Power,* during 1918 by the same writer.

A NEW ALL-METAL AIRSCREW

By E. H. Lémonon

MANY efforts have naturally been made to design and construct propellers of metal, and it is not surprising bearing in mind the difficulties to be overcome, that these efforts should have been, in the past, almost consistently unsuccessful. Most of the designs split upon the rock of periodic vibration of the propeller blade, which causes extremely rapid deterioration of the metal; to such a degree, indeed, that a two minutes run in some cases brings about the destruction of the propeller. These difficulties were realised from the first in the case of the Leitner propeller, and precautions were naturally taken to avoid them.

A propeller for an 85 h.p. engine was later designed and two were constructed. The first was fitted to a 130 h.p. Clerget rotary, and ran for 30 hours at 1.150 r.p.m. without any fault developing. The second, on an 100 h.p. Mono Gnome, was run for 20 hours at 1.020 r.p.m without any sign of defects. These tests were sufficient to prove that propellers embodying this particular construction can stand up to the ordinary vibratory loads of an aero engine, provided proper care is taken with the welding and the normalising of the steel sheets.

This latter propeller was subsequently flown with very promising results, and it was resolved to test the former propeller to destruction. This screw had already undergone a period of 30 hours testing, and it was speeded up to 1,635 r.p.m. at which speed it was absorbing 340 h.p. This power being the limit which could be obtained at the Royal Aircraft Establishments, it was impossible to carry out the original intention of destroying the propeller.

The mode of construction of these propellers is the following: Two die forgings are made as a basis for attachment of the blades each of the shape shown. The material chosen for these is mild steel to specification S.6, which is a medium carbon steel with an ultimate tensile strength of 35 tons

All metal airscrew

per square inch, while that used for the blades is mild steel to specification S.3, which has an ultimate tensile strength of 26 tons per square inch. The dogs on the end of one half-sleeve are arranged to mesh with those on the opposite sleeve, and are so designed as to give the origin of the desired pitch. The meshing teeth are then edge-welded together; there is, of course, no stress on this weld, and the welding serves simply to ensure contact between the two halves. The blades of the propeller consist of mild steel plate, formed to the desired shape, and fixed to the center portion by edge-welding, further supported by a number of ribs, or driving bridges of which two are shown. These ribs are fixed in position by flush rivets and countersunk screws.

Three plates are employed near the boss. The shape of the free ends of the two inner and shortened plates is a matter of importance, since two conditions must be fulfilled. In the first place as much edge as possible must be provided in order to ensure constructional strength, and, secondly, the period of vibration of each plate must be out of harmony with the period of each of the other plates. These ends are attained in the design illustrated.

The steel plates are welded together at the leading and trailing edges, but are riveted together at the internal and shaped edges by wire rivets, finished flush with the face of the blade. Wherever necessary, steel struts or distance pieces may be fitted between the two faces of a blade, and riveted over at the ends. It is apparent that this construction demands a high standard of workmanship, and that constructional difficulties decrease as the scale of manufacturing rises.

Any tendency to increase in size will, of course, be to the advantage of the metal construction as against wood construction in the matter of weight. This is due to the fact that since a wood propeller is solid, the weight must increase as the cube of any linear dimension. In the case of the metal propeller, the increase in weight will not be as the cube, but as the square of linear dimension where similar gauge of metal is used. Heavier gauge metal or an increased number of laminations, will naturally be used in the case of larger propellers, so that the weight of metal airscrews may be expected to vary as a little more than the square of their diameters.

The manufacture of this metal airscrew is carried on by the Metal Airscrew Co. Ltd, of London, and the inventors are Mr. Leitner and Mr. H. C. Watts.

MAGNESIUM A SUBSTITUTE FOR TIN

ATTENTION has been drawn to the possible use of magnesium as a substitute for tin in brass or bronze valve bodies, says *The Valve World.* This is a comparatively new use for magnesium, and though it is not a substitute for tin in all particulars, it is effective in producing a dense metal free from oxides and blow-holes. The amount of magnesium used in this work varies from .05 to .1 per cent, and one pound of magnesium will deoxidize from 100 to 2000 pounds of brass or bronze.

Though the principal action of magnesium is to deoxidize, it has the additional effect of making a denser casting and a stronger metal. It is introduced into the mixture after the brass or bronze has been removed from the fire and is plunged by means of iron tongs or a "phosphorizer." Slow stirring should be continued after the metal has melted from the tongs, to insure a uniform mixture and to give the oxide of magnesium an opportunity to rise to the surface. Magnesium also makes a more fluid metal so that more difficult castings can be poured than without its use. Its deoxidizing qualities also eliminate the necessity for the addition of phosphorus.

MANUAL ARTS AND CRAFTS

PROJECTS FOR THE SCHOOL, HOME OR SHOP

SIMPLIFIED ROLL-TOP DESK

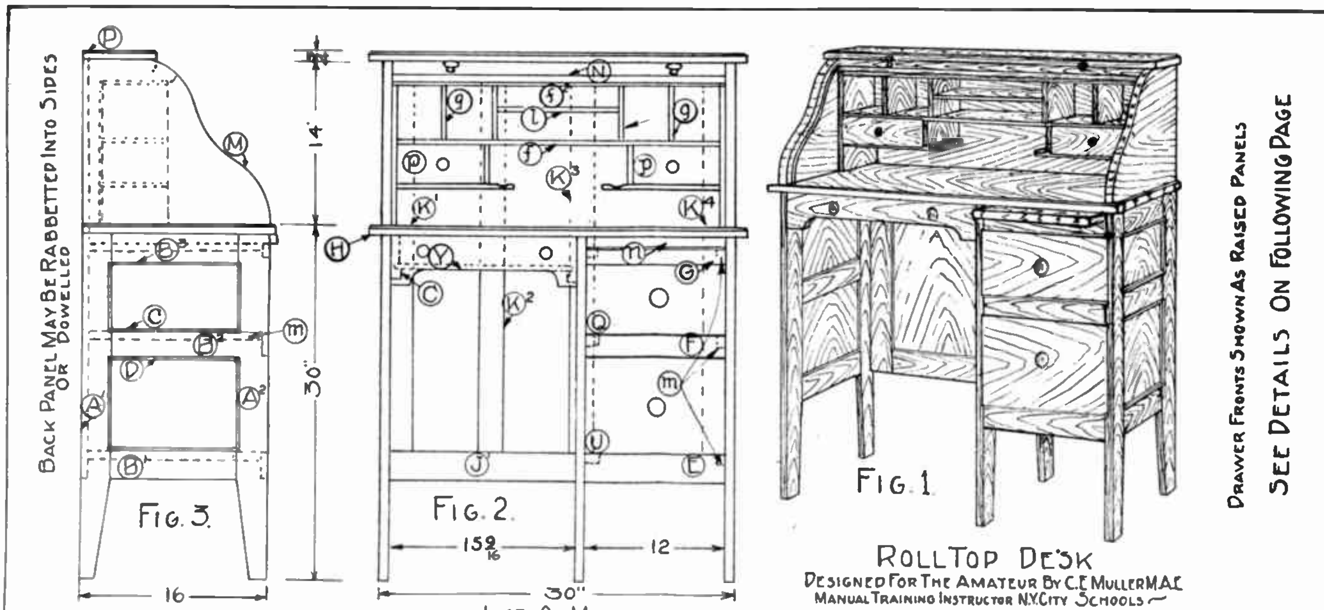
THE construction of this desk has been simplified to bring it within the scope of the amateur mechanic. The construction may be further modified without detracting from its actual utility and no appreciable loss in general appearance. Suggestions will also be offered where wide boards and battens may be substituted for panel work to further simplify the work. The roller front is not as complicated or as difficult to fabricate as one may imagine. A very simple method of dowelling is recommended as equal to the machine-made type.

Carefully selected dry chestnut will appeal as well as plain oak or ash, and wear, with reasonable care, as well. All wood-workers know that the difference in the laboriousness of production is an important consideration in favor of chestnut, especially where the greater strength of ash or oak is not essential. Chestnut may be stained to a very near likeness of ash or plain oak. Whitewood is recommended for its construction where it is desired to match cherry, mahogany or black walnut.

The illustration Fig. 1 is a perspective view suggesting how the grain of the material should run and match. Figs. 2 and 3 give the principal dimensions. Those omitted may be easily computed from the list of materials showing the length and width of a component. By following this general chronological order, parts may be assembled when ready, thus preventing some of the bothersome twisting and shrinkage due to thoughtless storage. All dimensions are for the finished sizes. Allowance must be made for sawing, planing and trimming, depending on the individual skill of the artisan. Allowances suggested for the average amateur are 1/8 inch for sawing, 1/16 inch for planing side grain and 1/32 inch for end grain and trimming.

The drawing at Fig. 4 shows the three side panelled members. Get out six stiles 3/4 inch by 2 1/2 inches by 29 1/4 inches and nine rails 3/4 inch by 2 1/2 inches by 11 inches, plus 1 inch for tenons. The rails may be mortised into the stiles with a 1/4-inch thick tenon, 1/2 inch long and 2 inches wide. This will fit into the plow or groove that is made with a combination or grooving plane, or the rails may be dowelled to the stiles. A plow plane may be easily made by following the sketch Fig. 9. It may be made of a piece of hard wood or even pine, a 3/4x3x8-inch section is cut out to accommodate a 1/4-inch paring chisel and a 1/4-inch thick wedge shaped as shown in Fig. 12. The wedge must be made of hard wood, maple, beech or birch preferred. Rabbet a flange 1/4 inch by 5/8 inch deep on the bottom of the plane to act as a guide. This type of plane must be adjusted for depth each shaving.

The sides may be single-panelled, omitting the middle rail B^2 and one panel. These panelled sides may be



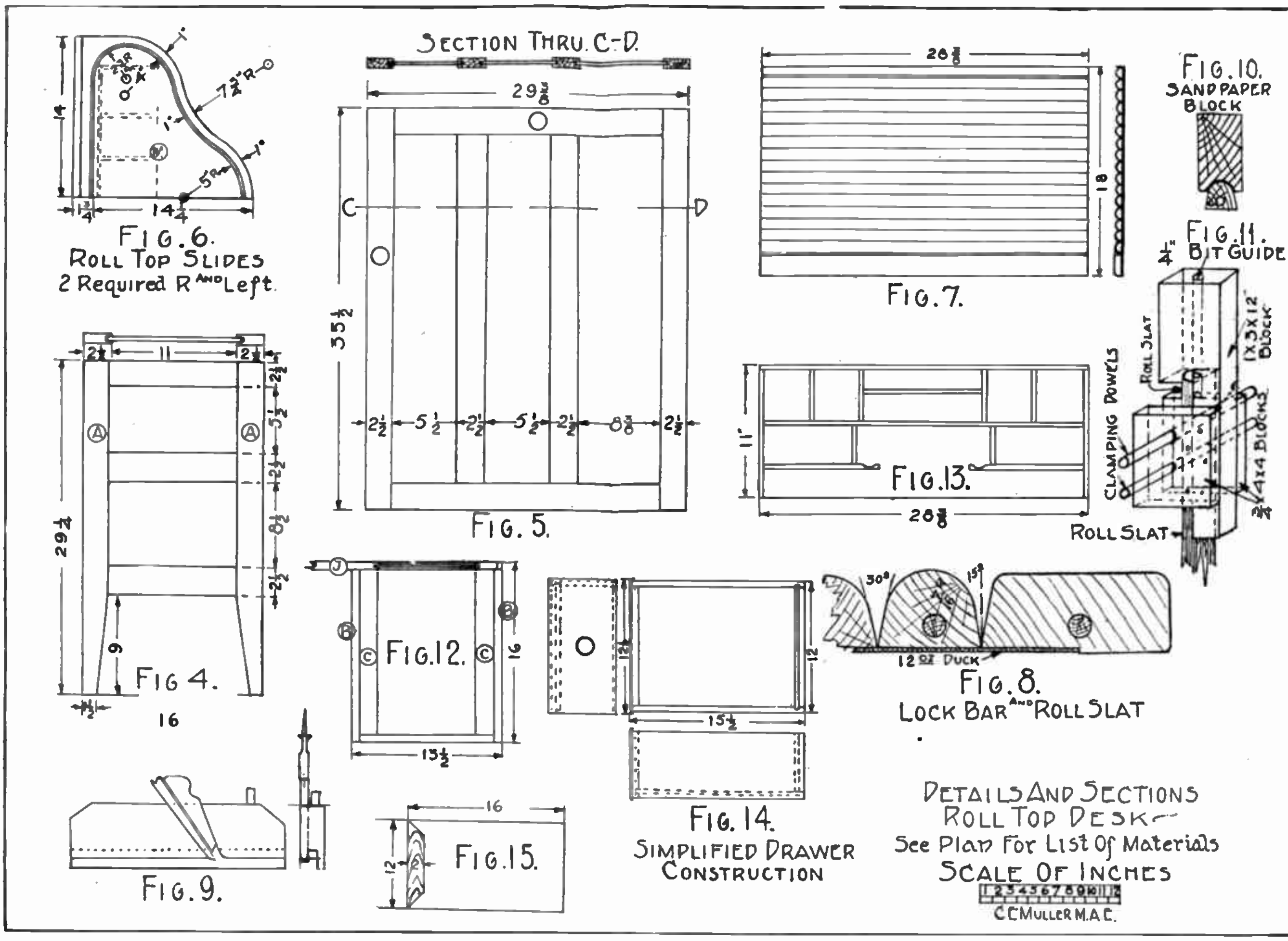
RollTop Desk
Designed For The Amateur By C.E. Muller M.A.E. Manual Training Instructor N.Y. City Schools

List Of Materials
All Dimensions In Inches Or Fractions

A	6	Stiles	3/4 x	2 1/2 x	29 1/4
B	9	Rails	"	2 1/2	11+Tenons
C	3	Panels	1/4	6 1/2	12
D	3	"	"	8 1/2	12
E	1	Rail	3/4	2	12+Dowels
F	1	"	"	2 1/4	12
G	1	"	"	1 1/2	12
H	1	Desk Top	"	16 1/2	32
J	2	Back Rails	"	2 1/2	28 3/8+Dowels
K	4	" Stiles	"	2	30 1/2+T or D
L	3	Back Panels	1/4	9 3/8	31 1/2
M	2	Desk Sides	3/4	14	16
N	1	Roll Front	"	2	28 3/8
O	18	Roll Slats	"	1	28 3/8

P	1	Top Shelf	3/4 x	6 1/2 x	32
Q	1	Drawer Front	"	6 1/2	12 1/2
R	2	" Sides	1/2	6	15
S	1	" Back	3/8	5	11 1/2
T	1	" Bottom	1/4	15	11 1/2
U	1	" Front	3/4	8 1/2	12 1/2
V	2	" Sides	1/2	8	15
W	1	" Back	3/8	7	11 1/2
X	1	" Bottom	1/4	15	11 1/2
Y	1	" Front	3/4	4	15 9/16
Z	2	" Sides	1/2	2 1/2	15
a	1	" Back	3/8	1 3/4	15 1/16
b	1	" Bottom	1/4	15 1/16	11 1/2
c	1	" Slides	3/4	1 1/2	14 1/2

e	2	Pigeon Hole Uprights	1/2 x	5 x	11
f	2	" Horizontals	3/8	"	27 3/8
g	4	" Partitions	"	"	4 1/2
h	2	" "	"	"	3
k	2	" Horizontals	"	"	9 1/2
l	1	" "	"	"	10
m	6	Drawer Slides	3/4	1	14 1/2
n	1	Slide Shelf	1	12	16
o	1	P.H. Backing	1/4	12	28 3/8
p	2	Drawer Fronts	1/2	3 1/2	7 1/2
q	4	" Sides	1/4	5	4 1/2
r	2	" Backs	1/4	3	7
s	2	" Bottoms	1/8	4 1/2	7
t	1	Canvas (12 oz.)	17	x 28 1/4	



substituted for by using a 16-inch board or gluing up two or more boards for its equivalent. They should be cut out approximately similar to that shown. To prevent the drawers from catching when being closed (if single panels are used) a filling in strip about 1 inch wide by ¼ inch thick will be required.

The drawer slides (M) are strips approximately ¾ inch by 1 inch nailed or screwed on the sides between the rails F and the back. A few spots of glue will hold the slides to the sides with greater security. It will add considerably to the finished appearance to chamfer the corners of the rails and stiles where conspicuous; *i. e.*, the four outside panels, or to ("break") insert a gee (cyma reversa or cyma recta) moulding around the panels. Glue up the sides and while these are hardening proceed with the next step.

Next get out the back as shown in Fig. 5. The conventional method is always to have the rails from stile to stile as they are shown. But they may extend over the ends of the stiles to make it easier for the amateur, as they are practically unseen. Fig. 5 shows three panels with stiles K^1, K^2, K^3, K^4, the mullion K^2 may be omitted and one 14-inch panel replacing the 2-6½ and K^2 mullion. Considerable lumber and hand work may be saved if this back be partly omitted. This may be accomplished by substituting the rail T only, in the position as shown, to have the side panels. The backing fastened horizontal across the pigeon-hole framing the full width of the upright C. This will suffice to stiffen the top and to give an appearance of solidity. Another scheme to substitute for the full back panels is to run the back from T-1 to a rail coinciding with the horizontal f^1 and a ¼x5x28⅜-inch board across the top pigeon-holes f^1 to f^2. This will give the desired aspect from the front. A third method is to place T^1 and T^2 in the present horizontal location, but ½ inch forward, then glue up a ½-inch panel 28⅜ inches by 35 inches and fasten by screws to the back of T^1 and T^2. See note on drawing Fig. 3.

The drawing at Fig. 6 shows the detailed dimensions and centers for laying out the desk sides and the grooves for the roll-top slides. The grooves 5/16 inch wide may be drawn by the compass, or thumb or scratch gauged, after the contour is fashioned. If a series of ¼-inch holes are bored 5/16 inch deep, it will assist in chiseling out the grooves. These grooves must be clean-cut and extend from the desk top. It might occur to the amateur to run the grain of these sides vertically, thinking it would be advantageous for cutting the grooves. There is no disputing that fact, but it would stamp the work as amateurish, as it would be decidedly unconventional and unsupported as it is shown now by the back panel stiles.

Making the Roll Top

The drawing at Fig. 7 depicts the fabrication of the roll top. Fig. 12 shows an end view of one slat and the lock bar (rail). Get out eighteen pieces ¾ inch by 1 inch by 28⅜ inches (straight-grained, if possible), taper two sides about 15 degrees, or 5/32 inch, approximately, then plane the narrow part round. A beading plane may be used, or a smoothing plane will do the work quite closely. It is then sand-papered with No. 2 sand-paper held in a block, Fig. 10, made with a suitable groove. These strips may be held on the bench by blocks and wedges while shaping and sand-papering. The lock bar also has a similar taper on one edge. When all the strips are finished they must be carefully glued to a piece of canvas or duck, about 12 ounces. Care must be observed when gluing not to get the glue on the fabric where the slats adjoin, as this part must remain very flexible, otherwise the fabric will crack and break in the joints. Glue is not flexible when dry, on the contrary it is very hard and stiff.

(*Continued on page* 175)

Heat Treating Alloy Steels

The Conclusion and Summary of A Series of Simplified Articles Detailing the Various Methods of Heat Treating Modern Alloy Steels. This Installment Outlines Various Grades of Standard Steels, Also Details Simple and Multiple Treatments Necessary to Secure Best Results

By Victor W. Pagé, M. S. A. E.

PART VII

THE main object of using alloy steels is to secure both strength and lightness, both of which qualities are very necessary in automotive engineering and it is chiefly in this branch of industry that one finds the alloy steels rather than in the machinery field except in limited applications. The tabulation shows recommendations made for internal combustion engine parts in a U. S. Government Bulletin, but the designers of other apparatus cannot fail to find suggestion of value therein.

Some low carbon steels (below .40 C.) may be too soft in the globular cementite condition and to machine properly require being left in the lamellar form. This is due to the predominence of soft ferrite in these steels with such a scarcity of cementite stiffener that it becomes necessary to prevent or drain the flow of the iron under the tool by the lines of stiffening cementite in the form of pearlite, and to obtain this proper cutting condition it sometimes becomes necessary to quench rather than cool slowly.

At times the previous work of forging may have been finished at so high a point above the critical range that the structure is exceedingly coarse. Annealing at Ac_1 will not refine this grain, but if this steel is first heated to Ac_3 or above, quenched and then annealed at Ac_1 and cooled slowly, the resulting structure will thereby be refined unless the steel has been burned. Stoughton states that steel of initially fine grain when subjected to cold work and then lightly annealed, show greater strength.

Owing to the annealing process generally being a long one and the cooling slow, there is a reat opportunity for scale (iron oxide) to form on the descending heat, owing to the contraction of the furnace gases in cooling, drawing in air, hence if scale is to be prevented, this air must be kept from the work by keeping it in closed receptacles. The prevention of heavy scale due to cooling from too high temperature in the presence of oxygen is extremely important in the case of teh higher carbon steels where the presence of oxide and heat will serve to oxidize the carbon in the metal (decarbonize) nearest the scale to often an injurious degree.

The thickness of the scale (iron oxide) always represents a depth deprived of carbon with a deposit of iron residue. Carbon oxidizes very rapidly and when decarbonization appears on surface of hardened steel we find that the carbon content of the steel has been lowered for a considerable distance beyond what the depth of fracture would indicate. Often a sand-sealed pot will suffice to keep out the oxygen and save the steel enclosed from scaling injuriously.

Stresses	Metal to be Used	Designation
Parts subjected to but slight or practically to no stresses or wear.	Aluminum alloy whenever possible.	Aluminum alloy
	Low or medium high carbon steel when aluminum alloys are not permissible.	Steel Type I
Severe wear but not severe fatigue stresses.	Low carbon steel suitable for case hardening.	Steel Type II
Severe wear and severe fatigue stresses.	Low carbon nickel-chromium steel suitable for case hardening.	Steel Type III
Severe fatigue stresses but not severe wear.	Medium hard nickel-chromium steel.	Steel Type IV
Severe fatigue stresses or wear or both when smaller ductility is permissible.	Self-hardening nickel-chromium steel.	Steel Type V
Distortion and softening at high temperature; valves	Tungsten high speed steel.	Steel Type VI

Composition of Types of Steel

Medium hard carbon steel containing from 0.30 per cent. to 0.40 per cent. carbon is Type 1. Low carbon steels including not more than 0.05 per cent. to 0.15 per cent. carbon and suitable for case hardening are classed as Type 2. Low carbon nickel-chromium steels of the following approximate chemical composition suitable for case hardening: Carbon not more than 0.15 per cent., nickel not less than 2.0 per cent., chromium not less than 0.50 per cent. and total nickel and chromium of not less than 2.50 per cent. or more than 4 per cent. are classed as Type 3.

Steels classed as Type 4 are medium hard nickel-chromium steels of the following compositions: 0.30 to 0.40 per cent. carbon; 2.50 to 3.50 per cent. nickel; 0.5 to 1 per cent. chromium; 3 to 4 per cent. total nickel and carbon. For softening, which is always applied before machining, the steel should be heated to 850-900 deg. C. (1,562 to 1,552 deg. F.) for 30 minutes or more, and slowly cooled. The machined parts should then be subjected to a strengthening treatment consisting in heating to 800 deg. C. (1,472 deg. F.) followed by air cooling or preferably to the double treatment consisting in heating to 800 deg. C. (1,472 deg. F.) and quenching in water or oil, followed by reheating to 400 to 650 deg. C. (752 to 1,202 deg. F.) according to requirements, and quenching or cooling slowly.

Air-Hardening Steel

Air-hardening nickel-chromium steel, containing 0.30 to 0.50 per cent. carbon; 3.00 to 4.50 per cent. nickel; 0.50 to 2.00 per cent. chromium and total nickel chromium and carbon, not less than 5 per cent. is classed as Type 5. In its forged or rolled condition, this steel is difficult to machine. It should be subjected to the usual softening treatment. The machined parts should then be either cooled freely in air from a temperature of 850 deg. C. (1,562 deg. F.) or quenched in oil from 800 deg. C. (1,472 deg. F.) and reheated to 300 to 600 deg. C. (572 to 1,112 deg. F.) according to requirements. Air cooling suffices to impart great hardness and great strength to this steel.

Composition of Standard Alloy Steels

While the accompanying table shows

the composition of standard steels adopted by aircraft manufacturers, the steels are similar to those used in automobile manufacture.

Definitions of Heat Treatment

The Engineering Standards Committee has proposed a set of definitions which were adopted by the British Air Board in framing their specifications. As they apply just as well to steels used for automobile parts and machinery of various kinds, it seems advisable to reproduce them in briefed form.

NICKEL STEELS

Number	Carbon	Manganese	Phosphorus Maximum	Sulphur Maximum	Nickel	Chromium
2335	0.30–0.40	0.50–0.80	0.040	0.045	3.25–3.75	....
2315	.10– .20	.30– .60	.040	.045	3.25–3.75	....
2320	.15– .25	.30– .60	.040	.045	3.25–3.75	....

NICKEL-CHROMIUM STEELS

Number	Carbon	Manganese	Phosphorus Maximum	Sulphur Maximum	Nickel	Chromium
3140	0.35–0.45	0.50–0.80	0.040	0.045	1.00–1.50	0.45–0.75
3240	.35– .45	.30– .60	.040	.045	1.50–2.00	.90–1.25
X3340	.35– .45	.45– .75	.040	.045	2.75–3.25	.70– .95
3330	.25– .35	.30– .60	.040	.045	3.25–3.75	1.25–1.75
3340	.35– .45	.30– .60	.040	.045	3.25–3.75	1.25–1.75
X3440	.35– .45	.30– .60	.040	.045	4.00–5.00	1.00–1.50
3120	.15– .25	.30– .60	.040	.045	1.00–1.50	0.45–0.75
3215	.10– .20	.30– .60	.040	.045	1.50–2.00	.90–1.25
X3315	.10– .20	.30– .60	.040	.045	2.75–3.25	.70– .95
3315	.10– .20	.30– .60	.040	.045	3.25–3.75	1.25–1.75

CHROMIUM VANADIUM STEELS

Number	Carbon	Manganese	Phosphorus Maximum	Sulphur Maximum	Chromium	Vanadium, Minimum
6140	0.35–0.45	0.50–0.80	0.040	0.045	0.80–1.10	0.15
6120	0.15–0.25	0.30–0.60	0.040	0.045	0.60–0.90	0.15

Note—The numbers refer to specification numbers of International Air Craft Standards.

(*a*) *Normalizing*—Normalizing involves heating a steel (however previously treated) to a temperature exceeding its upper critical range and allowing it to cool freely in the air. The temperature shall be maintained for about 15 minutes and shall not exceed the upper limit of the critical range by more than 50 deg. C.

(*b*) *Annealing*—Annealing means reheating followed by slow cooling.

Its purposes may be: To remove internal stresses or to induce softness, in which case the maximum temperature may be arbitrarily chosen; or to refine the crystalline structure in addition to the foregoing in which case the temperature used must exceed the upper critical range as in normalizing.

(*c*) *Hardening*—Hardening means raising a steel to its normalizing temperature cooling more or less rapidly in a suitable medium such as water, oil and air.

(*d*) *Tempering*—Tempering means heating a steel (however previously hardened) to a temperature not exceeding its carbon change point with the object of reducing the hardness or increasing the toughness to a greater or less degree. This operation may usually be followed either by slow cooling or water-quenching without materially affecting the final result.

(*e*) *Cementing*—Cementing involves bringing a steel above its normalizing temperature in a medium which will increase the carbon hardening and keeping it at that temperature with but slight permissible variation for a given period. Cementing is here synonymous of case-hardening.

(*f*) *Core*—The core of a case-hardened piece is the interior portions of the bar which is substantially unaffected in composition by the cementing process, or in which practically no additional carbon has been forced.

(*g*) *Refining Cemented Parts*—Refining means reheating a steel to its normalizing temperature usually followed by quenching. As here described this refined operation is identical to hardening. It is, however, applied for the purpose of refining the structure rather than for hardening the metal.

(*h*) *Bluing*—Bluing means reheating a steel to the specified temperature and allowing it to cool in air.

Division of Steels Into Types

The Society of Automotive Engineers, through its Standards Committee has recommended heat treatments for various steels which it has classified into six types to simplify the adoption of standard treatments.

Type I—One quenching above critical range, followed by one draw.

Type II—Two quenchings above the critical range, the second at a lower temperature than the first, followed by one draw.

Type III—Slow cooling from above the critical range followed by quenching from above the range, but at a lower temperature, followed by one draw.

Type IV—Case-hardening followed by cooling, and one quenching above the critical range of case.

Type V—Case-hardening followed by slow cooling, one quenching above critical range of core, one quenching above critical range of case, and one draw.

Type VI—Quenching from above critical range, followed by long heating (several hours) slightly below the range, followed by slow cooling, machining, quenching from above the range and one draw.

Reasons for Heat Treating

In heat treating rolled or forged steel we seek generally, first to increase its softness, that it may be more readily machined; second, to make it strong, that it may resist successfully the stresses to which it will be subjected in use; third, to make it hard, that it may resist wear or acquire cutting properties.

The corresponding heat treatments may be therefore described respectively as:

(*a*) Softening treatment or annealing.

(*b*) Strengthening treatment or tempering.

(*c*) Hardening treatment.

The Softening Treatment usually consists in cooling the metal slowly from a temperature exceeding its critical range, generally imparts to its maximum ductility but materially reduces its strength (and elastic limit).

The Strengthening Treatment consists usually in cooling rapidly through the critical range and may be followed, as later explained, by a second heating below that range.

The Hardening Treatment, like the strengthening treatment, consists in cooling rapidly through the critical range. In hardening steel, however, the primary requirement is to produce very great hardness, while overlooking the decrease of ductility implied. Indeed, as a rule, we use all possible means to hasten the cooling because of the greater hardness resulting. Hard steel is, therefore, a brittle material and must receive strengthening treatments. If it is a case-hardened steel, one treatment may be given for the case and another for the core.

It will be evident that a piece made of alloy steel may need all three of the treatments. First, the bar must be made soft enough so the piece can be fabricated. If low in carbon, it must be carbonized, or cemented, then quenched to obtain a hard case, then tempered to strengthen the core and perhaps given a further treatment to strengthen the case without reducing its hardness appreciably.

Softening Treatment

This process is done after the rough steel bar is fabricated by either forging or rolling but before machining. It is usually accomplished as follows:

1. Heating the steel to 900 deg. C. (1,652 deg. F.) and maintaining that temperature for 30 minutes or more, cooling slowly, sometimes with the furnace in which the steel was heated.

2. Raising the steel to 600-675 deg. C. (1,112 deg. F. to 1,247 deg. F.) for several hours and cooling very slowly.

3. Heating the steel to 800-850 deg. C. (1,472 deg.-1,562 deg. F.), then quenching in oil, then treatment No. 2. Treatments Nos. 2 and 3 are useful for steels containing 0.8 per cent. or more of carbon and to some alloys not readily softened by treatment No. 1. It is important to remember that the softening treatment is also beneficial in removing the strains caused by rolling or forging and that for these reasons it may be applied with good results even to steels soft enough to be readily machined.

Strengthening Treatment

To be applied after machining in case of fabricated parts and after milling processes such as rolling, stamping or forging if the pieces are not to be machined.

1. Heating to 50 deg. C. (90 deg. F.) above the critical or highest decalescent point of the steel, cooling slowly in the air. Steels containing less than twenty-five point carbon or 0.25 per cent. may be quenched in oil, those with less than 0.15 per cent. in oil or water.

2. Heating to 50 deg. C. (90 deg. F.) above the critical range of steel; quenching in water or oil (the former for low carbon steel), reheating to 50 deg. C. (90 deg. F.) or more below the critical range, cooling in air, oil or water.

The rate of cooling from a temperature inferior to the critical range does not affect the properties of the steel materially. The higher the temperature of the second heating, the less tenacious and more ductile the metal. While treatment No. 1 often yields satisfactory results, treatment No. 2 affords a means of securing greater strength. Steels so treated are generally also more resistant to shock and to fatigue stresses. There is little advantage in applying treatment No. 2 in preference to treatment No. 1 to carbon steels containing less than 0.25 per cent. carbon.

Hardening Treatment

Usually applied to finished machined parts as a final treatment as steel so treated cannot be shaped with cutting tools but is only susceptible to finish with abrasive wheels. Metals of great hardness are always very brittle. Finish only by grinding. Heat to 50 deg. C. (90 deg. F.) above the critical range of the steel, cooling rapidly in brine for extreme hardness, cold water, hot water or oil. Reheating to 200-400 deg. C. (392-732 deg. F.) which is applied in order to decrease the severe strains created in the metal by the sudden cooling while losing but little hardness. The higher the tempering temperature, the greater the softening effect of the operation and the less brittle the steel.

The three basic heat treatments described above are applicable to alloy steels as well as to carbon steels, bearing in mind the marked influence of some elements on the position of the critical range. Some special steels, for instance, should be heated, for the purpose of strengthening or of hardening, to temperatures considerably lower than those suitable for carbon steel, because of the lower position of their critical range.

Treatment of Case-Hardened Steels

Case-hardened parts generally require a strengthening and toughening treatment for the core consisting in quenching from 900 to 950 deg. C. (1,652-1,742 deg. F.) followed by a refining and hardening treatment of the case consisting in quenching from a temperature some 50 deg. C. (90 deg. F.) above the critical range, which for carbon steel would be in the vicinity of 800 deg. C. (1,472 deg. F.). For nickel and nickel-chromium steels, single quenching from some 800 deg. C. (1,472 deg. F.) is often sufficient. After quenching for hardening the case the parts may be tempered at some 200-300 deg. C. (392-572 deg. F.) in order to diminish the strains and the brittleness of the case.

To resist severe fatigue nickel-chromium or chrome vanadium steel of suitable composition and properly heat treated have been found the most satisfactory metals to use. To resist severe wear the parts should be made as already mentioned of ordinary low carbon steel and should be case-hardened. In order to resist both severe wear and severe fatigue stresses the parts should be made of low carbon nickel-chromium steel and should be case-hardened or else self-hardening nickel-chromium steel should be used. The superficial hardness, however, of parts made of this self-hardening steel will not generally be as great as that of properly case-hardened parts.

Treatment of Special Steels

There are a few instances of special steels demanding treatments different from those applicable to all other steels. These exceptions should be briefly mentioned:

Manganese steel is very hard and wear resisting even after slow cooling. To make it ductile, however, it should be heated to 1,000 deg. C. (1,832 deg. F.) or thereabout and quenched in water.

Self or air-hardening steels become intensely hard on simple air cooling from a temperature of some 800 to 850 deg. C. (1,472-1562 deg. F.). They do not therefore need any hardening treatment and they may be softened by softening treatment No. 2.

High speed steels in order to acquire their remarkable physical properties must be heated to a very high temperature approaching the melting point of the metal and quickly cooled in air or in oil. They may then be tempered at a temperature not exceeding generally 600 deg. C. (1,112 deg. F.). To soften these steels, in order to machine them, they may be heated to 750-850 deg. C. for several hours and very slowly cooled.

High nickel steels, that is, those containing 25 or more per cent. nickel, are softened by quenching.

WEATHER FORECASTS BY WIRELESS TELEPHONE

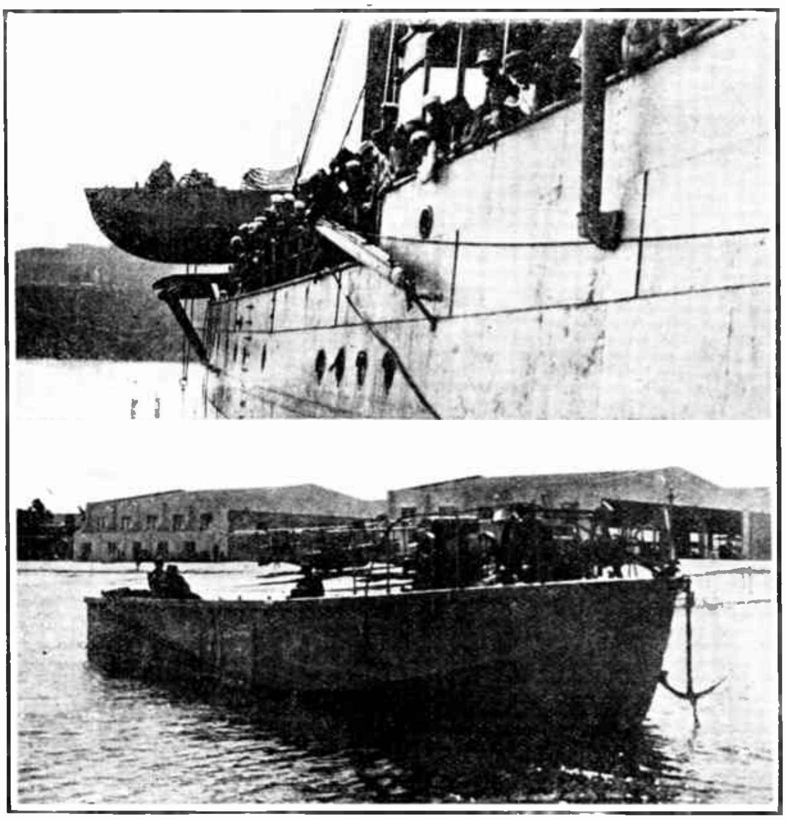
THE distribution of weather reports and forecasts by radio-telegraphy has made great progress since the war, and is no longer intended primarily for the benefit of mariners. The wireless telephone also has recently been pressed into the service of meteorologists. Arrangements have now been made so that the weather forecast sent out by this method every day at 10 A. M. from the Physics Department of the University of Wisconsin can be received, with suitable apparatus, anywhere in southern Wisconsin. A U. S. Weather Bureau station is located at the university.

In London there is a feeling against the old-fashioned soft coal open fire. Anthracite stoves and gas heaters, it is said, are to be supplemented by electric heaters. These are more economical in practice than would appear on first thought, because they are so easily turned off, when their services are no longer required. A load of 15,400 kilowatts is believed to be possible and probable for London.

AVIATION BRIEFS

FLOATING DRY DOCKS FOR SEAPLANES

A SEAPLANE if permitted to float on the water for any length of time becomes water-logged. When it becomes water-logged, or when repairs must be made to the hull, it is necessary to go into dry dock. Heretofore dry docks for seaplanes were unheard of, but a type of floating dry dock developed by the U. S. Navy is well adapted for this work. By allowing the water to enter the various compartments of the dry dock it is submerged. The seaplane is shoved into the "cradle" and hauled up on the deck of the dry dock. The water is then pumped out and the seaplane is high and dry, to be repaired or worked upon as if at her station ashore. The upper photograph shows a dry dock being launched from the deck of the Aroostook, the mother ship of the Pacific Aerial Fleet. The lower photo shows one of the dry docks in the water and the cradle ready to receive the seaplane hull. When the seaplane is ready to slide on the cradle, a winch at the front end of the dock facilitates placing it in position.



U. S. Navy floating dry dock for seaplanes

FRANCE TO ALGIERS BY AIR

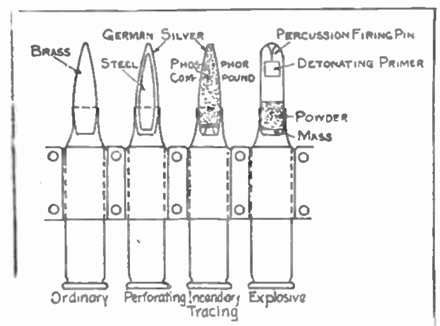
BEFORE the end of the present year the Breguet Airplane Co. intends to run a regular air service between Marseilles and Algiers, Northern Africa, with the new four-engine Type 20 plane. This machine is an entirely new construction, with all metal fuselage and wings, carrying four Bugatti motors. The design allows one or more engines to be disconnected in case repairs or adjustments have to be carried out in the air. As the distance over the open sea is 700 miles, the plane will be fitted with floats, and will also have a marine screw by means of which a speed of about 10 knots can be maintained on the water.

GERMAN AIRCRAFT AMMUNITION

The ammunition employed in the airplane machine guns used by the Germans are the following: Ordinary bullets, incendiary, perforating and explosive bullets. The incendiary and tracer bullets are hollow, and contain an incendiary matter of a phosphor base. They leave behind them a luminous trail, destined to ignite the gas in balloons and airplane gasoline tanks and to permit the gunner to rectify his fire.

The perforating bullets are composed of a hardened steel center, with a covering of German silver. They are to perforate the metallic portions of planes, and in particular the motors

Explosive bullets are carried in belts and drums in the proportion of about 10 to 15 per 100. They have the shape and composition of a small shell, a small plunger forming a percussion firing pin over a detonating primer. All the special bullets have trajectories which differ sensibly from the trajectory of ordinary bullets, their weights and their forms accounting for this divergence. Nevertheless, in combats at distances lower than 300 m. (1000 ft.) it was not necessary to use special sights.



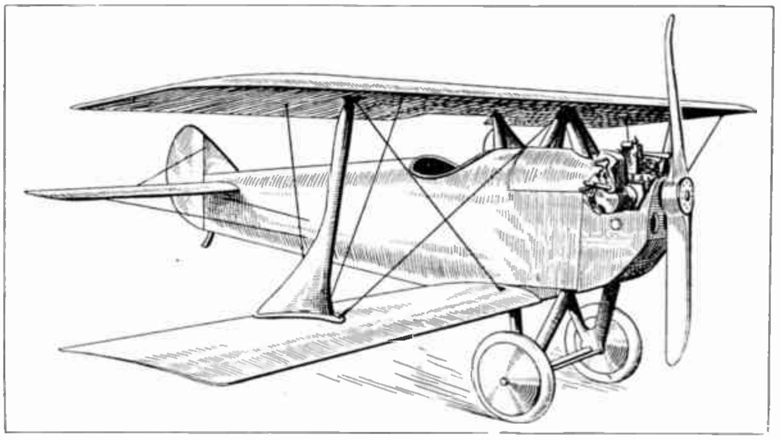
German ammunition for aircraft machine guns

SMALL BUT PRACTICAL AIRPLANE

REPORTS frequently reach us of the development of small, one-passenger airplanes, but no machine that has made actual flights seems to be of smaller size than the de Marcay Type, illustrated herewith. The Passe-Partout, claimed to be the smallest aeroplane in the world, is a tiny single-seater biplane equipped with the opposed two-cylinder 10 h.p. A. B. C. engine. The fuselage is of monocoque construction as in the case of the other and larger de Marcay machines, but the section is rounded rectangular rather than circular. The engine is mounted above the nose of the fuselage, presumably to get the propeller shaft as high as possible so as to allow of getting sufficient propeller clearance.

This tiny biplane has a span of only 18 ft. 1½ in. and a length of 10 ft. 5½ in. It weighs 220 pounds, including gasoline and oil for a flight of two hours and can fly at a speed of 68½ miles an hour. The gas consumption is very low, averaging 1.32 gallons an hour. The main planes are straight without dihedral, and the wire bracing is of the simplest possible type, one lift cable and one anti-lift cable. Lateral control is by warping the upper plane. To allow of doing this the interplane struts, of which there is one on each side, are tapered toward the top while they are wide at the bottom so as to reach both lower spars. The warp cables pass from front and rear top spars down over pulleys in the front plane and thence to the control lever. This would appear to be quite a neat way of arranging the lateral control in a small machine, as the fitting of ailerons entails a considerable amount of extra work and also adds somewhat to the weight.

The tail plane, as on the other machines of de Marcay, is of the lifting type and is covered with three-ply wood. The elevators are fabric covered, but both fin and rudder are covered with ply wood. The tail skid is very simple and neat, consisting of a laminated spring of wood. A diminutive vee under-carriage with rubber shock absorbers is fitted. The machine is very neat in appearance and appears to be extremely well built along good aircraft engineering lines. Its low maximum speed indicates that its landing speed will be satisfactory for the average pilot. While the engine is conservatively rated at 10 h.p., it will actually deliver twice that amount of power.



The De Marcay biplane is known as the "passe-partout" model because of its small size

AERO DYNAMIC LABORATORY AT ST. CYR

THE newest and perhaps the most efficient branch of the Military Academy at St. Cyr, France, which is the West Point of that country, is the new Aero Dynamical Department which has been recently established. This is equipped with very complete apparatus for not only testing the airplanes and engines, but also for testing the student aviators themselves. In this institution one finds the efforts of the mathematician, phsycologist and pathologist directed to solving the many problems incidental to aerial navigation. The most important of all the experiments carried on at St. Cyr Institute are those which concern the aviator himself.

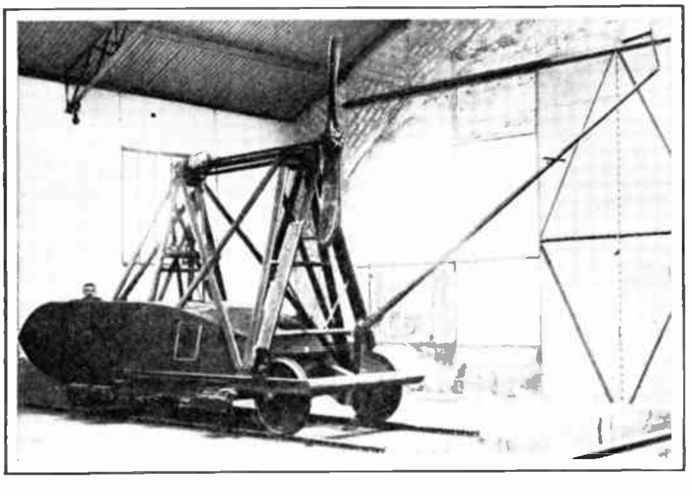
The accompanying illustration shows a caisson for testing the ability of the pilot to ascend to high altitudes. First the aviator is placed in the caisson and is fitted with an oxygen mask connected to oxygen bottles. By means of a pump, the air inside the caisson may be regulated to any desired degree of accuracy to meet the barometric pressures that obtain at various altitudes, which an aviator might meet in climbing upwards. Records of his lung action and blood pressure are obtained by the recording instruments to determine his capacity of resistance to cold and decreasing air pressure. The maximum altitude a person may attain varies according to the physical condition and this research shows whether or not the pilot is adapted for certain kinds of work.

This equipment is a modification of a design by the Medical Branch of the American Air Service, which established research laboratories at all important aviation centers to make tests on aviation students. The results obtained were so good that European nations have adopted similar systems.

Another interesting testing appliance which is also illustrated, is a large chariot which is mounted on four wheels and placed on rails so that the machine may be run a distance of a few hundred meters. This enables experimenters to determine the effective thrust of propellers, and the horsepower required for various speeds and also familiarizes experimenters with the air resistance of various aero-foil types as well as propeller resistance.

Students of Aerial flight will remember the interest taken in Lillienthal's aerial experiments and achievements in gliding. Eventually, he lost his life in this work. One of his gliders, in the possession of the Royal Aeronautical Society, has been transferred on permanent loan to the South Kensington Science Museum in London. An educational exhibit of Aeronautics is being formed in this Museum.

Switzerland has had at its disposal an excess of electric power in summer which has been transmitted across the frontiers. Owing to the scarcity of coal this way of disposing of the surplus power is under government regulation and there is even a possibility that its transmission into other countries may be prohibited by law.



Interesting apparatus in the aero dynamic laboratory at St. Cyr, France. Car for testing propellers shown at left; caisson for testing pilot's ability to function normally in rarefied atmosphere shown at right

Theory and Practice of Heat Engines

By G. B. Warren, B. S.

I. Elementary Thermodynamics.

THERE is, perhaps, no other single factor which has effected the progress of our modern civilization during the course of the last century as much as has the growth and development of the heat engine. By "heat engine" is meant, of course, all prime movers or engines using the heat of burning fuel as their source of energy. In other words, all steam, gas, and oil engines or turbines. Prior to the development of the steam engine man had to move everything by muscle, wind, and water power. The few factories of any size which did exist were by the side of running streams where water power was available. As a result of this lack of power these factories were small, generally consisting only of the owner and two or three workmen; and each community had to be practically a unit and produce everything which was needed since transportation was so difficult. There were no steam railways, steamboats, motor cars, trucks, or aeroplanes. Man, beast, and the wind furnished the only motive power to carry the loads of the world from one place to another.

Then came a great transformation. Watt, together with several other men invented and developed the steam engine. The great Industrial Revolution followed. Factories were built, employing hundreds and thousands of men. Ships crossed the ocean and sailed the rivers and canals propelled by this new source of motive power. Railroads spread out their long arteries of commerce, developing large sections of the country which had hitherto been inaccessible. Transportation became easy and each portion of the country produced the things for which it was best fitted. On account of the ease of transportation and the large machines of production which the steam engine made possible one man became as productive as were tens or in some cases hundreds of men before the advent of the steam engine. The standard of living increased and man started on his rapid upward climb of the last few decades.

About half a century after the invention of the steam engine the steam turbine was invented, or rather re-invented. Formerly steam engines in units of five thousand horsepower were the ultimate, but with the development of the steam turbine it became possible to build steam units as large as fifty thousand horsepower. With this great increase in available power industry has grown by leaps and bounds, the small steam engine has been replaced by the electric motor, electric railways have increased in number and in size, and electric lighting has been made cheap enough for all.

During the latter part of the nineteenth century several men in different parts of the world began to work upon an explosion motor, another form of heat engine. Gradually this took shape and developed into the gas engine. This new engine made the great motor car industry of today possible, made it possible for man to realize the age-old dream of mankind and imitate the birds in flight, and made it possible for him to displace the steam engine on the high sea and run his great passenger and cargo ships by oil engines burning half the fuel consumed by the old steam engines.

Such has been the progress of this wonderful art, and from all present indications the heat engine for many generations to come will be the prime mover back of the great electrical generators that supply the world's power.

In view of these facts, and in view of the fact that fuel for heat engines is becoming ever more scarce and more expensive, the economy with which heat engines can be made to run is of prime importance. It is this thing which makes the science of thermodynamics so important to the world today, for it is this science which teaches the why of the heat engine, and how to improve it.

Work.—Before we can gain a good conception of the heat engine we must get a clear idea as to the meaning of the word "work" as it is used in science. By "work" is meant mechanical energy; that is, the overcoming of resistance by a force acting thru a definite distance. Work is measured by the product of the force acting and the distance thru which it acts. Thus, if a ten-pound weight is lifted one foot a certain amount of work is done. If it is lifted two feet twice the work is done. It can be seen by this definition that if one merely stands and holds up a weight he does no work. Such is of course opposed to our feelings in the matter were we holding the weight, but surely if we place the weight on a table and let it lie there we cannot say that the table is working.

The unit of work in English speaking countries is the "foot pound," and is equivalent to an amount of work equal to that exerted if one pound is lifted one foot.

Heat.—What is this thing called heat of which we speak so frequently? For ages that question has baffled mankind, and it is only within comparatively recent times that the question has been answered with any degree of certainty. According to the modern Kinetic Theory, the molecules, or particles of matter of which everything is composed, are in a state of violent motion or vibration, this motion being

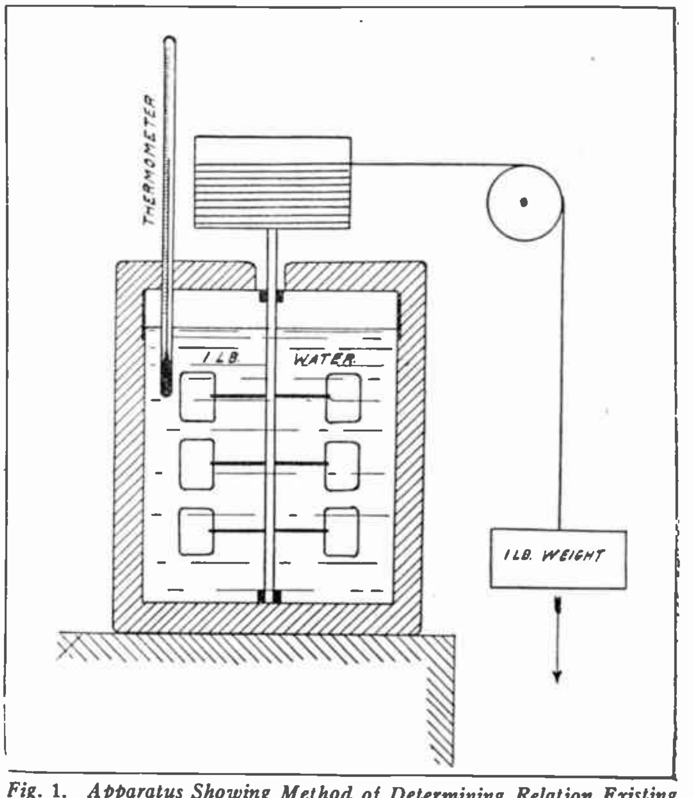


Fig. 1. Apparatus Showing Method of Determining Relation Existing Between Mechanical and Heat Energy

somewhat restricted along more or less definite paths in solids and liquids, whereas in gases the molecules move in free paths bounded only by collisions with other molecules. The velocity or violence of this motion is dependent upon the temperature, and increases with an increase in temperature. In general it may be said that *the energy which it takes to heat up a given body goes into increasing the kinetic energy of motion of these molecules and into increasing their distance apart.* In other words, *heat is a form of energy.*

Before we go any farther it might be well to point out a distinction existing between quantity and intensity of heat.

To use a time-worn example there may be more heat in a frozen lake than in the boiling tea-kettle on the stove at home, but the heat is more intense, or in other words at a higher temperature, in the tea-kettle.

This leads us to methods of measuring heat. First let us consider the intensity or temperature. For this purpose two scales are in common use, the Fahrenheit and the Centigrade. Just how or why the Fahrenheit scale was adopted no one seems to exactly know, or at least explanations seem to differ. At any rate, on this scale the temperature of melting water has been fixed at 32 degrees, and the temperature of boiling water at sea level at 212 degrees, making 180 degrees between them. Unfortunately this is the scale which is in most common use in this country and in England among the engineering profession, and has led to no end of confusion because all scientific work thruout the world as well as most engineering work in the other countries is conducted in terms of the Centigrade scale. On this latter scale the tempera-

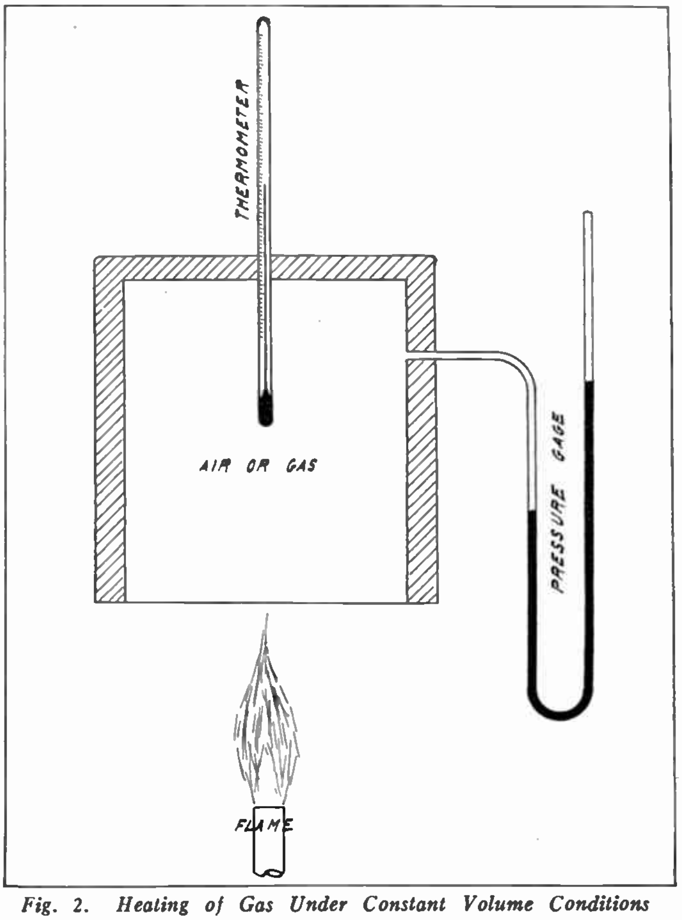


Fig. 2. Heating of Gas Under Constant Volume Conditions

ture of melting ice is fixed at 0 degrees, and that of boiling water at sea level at 100 degrees. In addition to these two scales there is another scale called the Absolute Scale, which may be measured in terms of either Fahrenheit degrees or Centigrade degrees, and of which more will be said in a later paragraph.

As opposed to this measurement of the intensity of heat, we have another measure of the quantity or amount of heat. If a certain amount of water is heated so many degrees with a given gas flame in five minutes, it will take two such gas flames to heat twice the amount of water the same number of degrees of temperature in the same time. Thus we say that the amount of heat in the second case is twice that in the first case, altho the temperature may have been the same in both cases. It is necessary to have some unit of measure to convey to another person just what is meant by so much heat, just as one needs a measure of distance to tell how far it is from New York to Washington. In English-speaking countries this unit has been called the British Thermal Unit, and is equal to the amount of heat which will just heat one pound of water one degree Fahrenheit. This unit has been conveniently abbreviated the B. t. u. The Metric unit is the Calory, which is the amount of heat which will just heat one gram of water one degree Centigrade. The reasons for choosing water as the standard were numerous, but the most important reasons were that pure water was easy to obtain, that it was the same the world over, and it had with the exception of a few of the lightest gases, a higher heat capacity per pound than any other substance.

Specific Heat.—The Specific Heat is the amount of heat, measured let us say in B. t. u. s, which one pound of a substance will absorb and just have its temperature raised one degree. The specific heat of water is, therefore, 1.00, while that of most other substances is a fraction inasmuch as their heat holding capacity per pound is less than that of water. If then we have a definite substance, iron for example, which has a specific heat of 0.112, and if we want to raise five pounds of it from the temperature of the room or about 70°F. to 200°F., a difference of 130°, it is easy to see that we will have to apply 0.112 times five times 130 B. t. u. s. In other words if we put it in mathematical terms, and let

C equal the specific heat of any given substance
t_1 the initial temperature or temperature before heating
t_2 the final temperature or temperature after heating
Q the quantity of heat put in B. t. u. s
and w the weight of the substance heated

it is easy to see that

$$Q=wC\,(t_1—t_2) \qquad (1)$$

This simply means in plain everyday English that if we want to find out how much heat it is necessary to put into a substance to raise it a given number of degrees in temperature we merely multiply the weight of the substance by the specific heat and then by the difference of temperature, or the degrees rise.

First Law of Thermodynamics.—The writer knew that such a law existed, and what it meant as a general principle, but he will have to confess that he had to go and get a text book and look it up in order to find out what it was. This merely means that the principles of any science should become a part of one in their fundamental meaning, and not in the wording or their expression. We all know that if one rubs one's hands together very vigorously they will get warm, in fact very warm, just try it once. How many of my readers have not when they were boys climbed a rope on a dare, only to be tired out at the top and inclined to slide down rather rapidly, and as a result suffer burned hands and legs where the rope was allowed to slip? How often have we seen the sparks fly from the brake shoes of a long freight train as it was sliding down grade? These are all examples of the working out of the first law of thermodynamics; that is, that work can be converted into heat. On the other hand, suppose that we put a fire-cracker under a tin can and light the fuse. The can will be blown a hundred feet in the air if we have a large enough fire-cracker. This is an example of the first law of thermodynamics working in the other direction; that is, that heat can be turned into work. The heat generated by the burning and explosion of the powder in the fire-cracker was turned into work in lifting the can up into the air. Scientifically this proposition is demonstrated in a bit different manner, merely so that quantitative measurements can be made. Thus if an apparatus as in Fig. 1 is set up, arranged so that as the one pound weight falls it will unwind the cord from the drum and turn the paddles in the water contained in the insulated container, heat will be generated due to the friction of the wheels churning in the water. Now if the can were insulated to prevent the radiation of heat, the pulley nearly frictionless, and if there were just one pound of water in the container it has been found that when the weight has dropped about 800 feet the temperature of the water will have increased just about one degree Fahrenheit. Of course the apparatus as thus described and illustrated is rather crude, but the results of very refined measurements indicate that work can be converted into heat in the ratio of 778 foot pounds of work to one B. t. u. of heat. Conversely it can be shown theoretically that if we had a perfect heat engine, and if we added one B. t. u. to it we should get 778 foot pounds of work out. Unfortunately we never have actually accomplished this latter feat. The most efficient heat engine known (The Still Engine) gets but little more than 350 foot pounds out of each B. t. u. put in, whereas most engines get but from 50 to 200 foot pounds of work per B. t. u. added. A formal statement of this first law of thermodynamics is as follows: *Heat can be converted into work, or work into heat in the ratio of 778 foot pounds to one B. t. u.* This is merely another way of stating the law of the conservation of energy; that is, *Energy cannot be created or destroyed.*

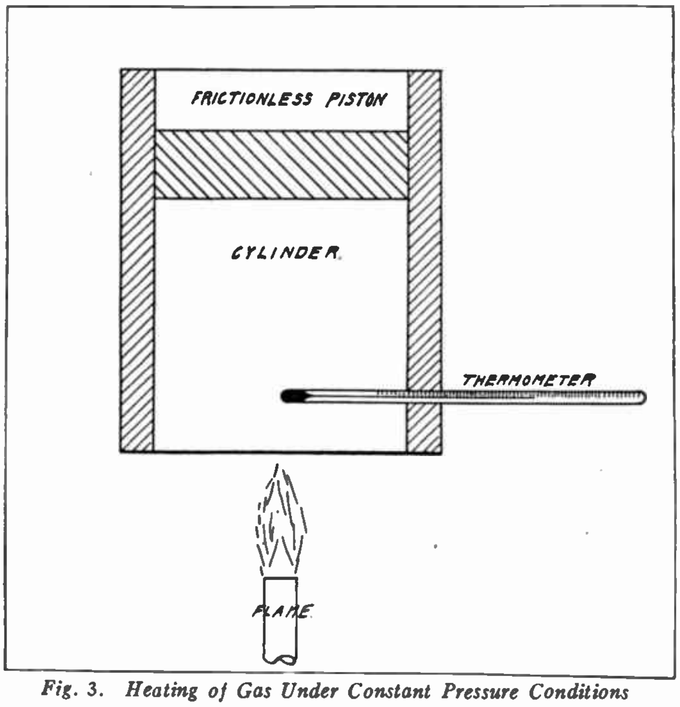


Fig. 3. Heating of Gas Under Constant Pressure Conditions

Laws of Gases.—In studying gases it is a general practice to speak of so-called "perfect gases." Such a gas does not exist, but all gases which are considerably above their liquefaction temperature behave so very nearly like what we think a perfect gas would behave that we call them perfect gases. Steam, unless highly superheated, does not, therefore, behave as a perfect gas.

If we have a closed vessel as in Fig. 2, filled with a gas and having a thermometer so arranged that the temperature of the gas can be measured, and also a manometer or a pressure gage so arranged that the pressure can be measured, we will find if we heat the gas up its pressure will rise 1/460 of what it was at 0° F., for every degree that we raise its temperature. This is, of course, only true if we speak of the absolute pressure; that is, the pressure above the atmospheric pressure, which our gage will record, plus the atmospheric pressure. Thus if we have 5.3 pounds per square inch gage pressure, or 20 pounds per square inch absolute pressure with the temperature at 0° F., and then if we raise the temperature to 460° F., it follows that we will double the pressure which we had at zero and will therefore have 40 pounds per square inch absolute or 25.3 pounds gage.

Now on the other hand, if we have a vessel as shown in Fig. 3 with a frictionless and weightless piston (such is, of course, not physically possible, but other experiments have been made which indicate that the following would be true) and arranged so that we can measure the temperature, we find that for every degree Fahrenheit that we raise the temperature we would increase the volume of the gas 1/460 of its volume at 0°F. The piston would, of course, move out and the pressure would remain the same; that is, it would always equal the atmospheric pressure on top of the piston. This means that if we have one cubic foot of gas at zero degrees temperature we would have two cubic feet at 460°F. There two facts as given above lead to the conclusion that if we have a perfect gas (one which would obey the above laws at all temperatures), the volume and pressure would become zero when a temperature of 460° F. below zero was attained. This point is called the Absolute Zero. Such could not take place with real gases because the molecules of the gas take up some room, and at very low temperatures all of our gases liquefy or freeze into solids. Hydrogen liquefies at the lowest temperature, and has been boiled at very low pressures within a few degrees of the Absolute Zero. This then gives us a new temperature scale, the so-called Absolute scale which was spoken of previously. The temperature on this scale can be found by simply adding 460 to any temperature Fahrenheit. Thus ice melts at 460° plus 32° or 492° Absolute on the Fahrenheit scale.

The above leads us to two very fundamental laws of thermodynamics. Thus it can be said that at *constant volume the pressure changes in direct proportion to the absolute temperature.* Likewise it can be said that at *constant pressure the volume changes in direct proportion to the change in absolute temperature.* If T_1 and T_2 represent any initial and final temperatures respectively on the absolute scale, and if P_1 and P_2 represent the corresponding initial and final pressures under constant volume conditions, then

$$\frac{P_1}{P_2} = \frac{T_1}{T_2} \qquad (2)$$

or in other terms

$$P = CT \qquad (3)$$

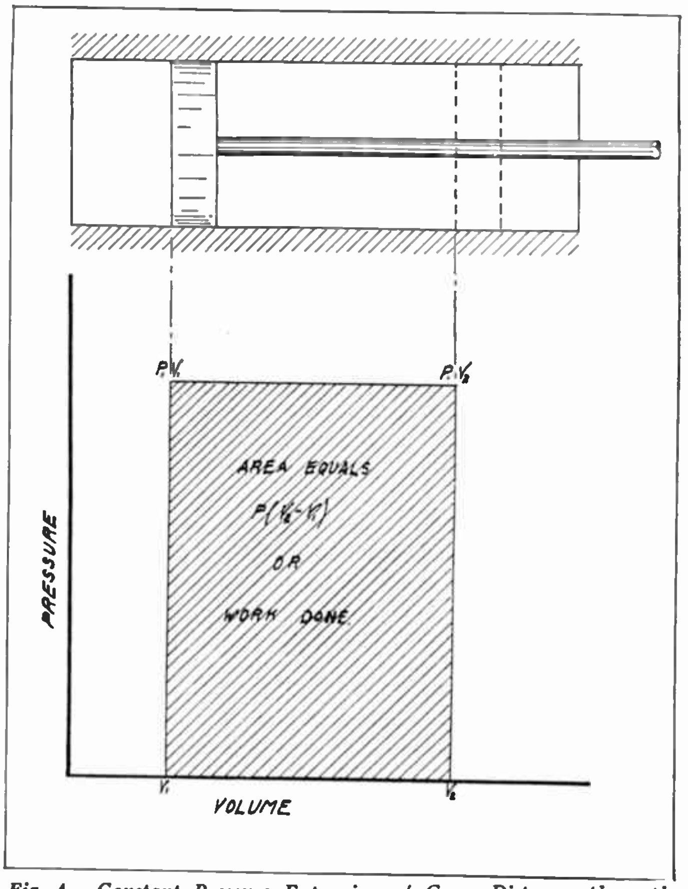


Fig. 4. Constant Pressure Expansion of Gas. Distance Along the Vertical Line Indicates Pressure in Pounds Per Square Foot, and Distance on the Horizontal Line Represents Volume in Cubic Feet. The Cross-Hatched Area Then Represents Work Done in Foot-Pounds

where C is a constant depending upon the unit of pressure and temperature. Likewise from the latter law it can be seen that if V_1 and V_2 represent the initial and final volumes corresponding to an initial and final temperature with the pressure remaining constant we will have

$$\frac{V_1}{V_2} = \frac{T_1}{T_2} \qquad (4)$$

or in other terms

$$V = CT \qquad (5)$$

where C is another constant, different from the one given above, but depending upon the units of V chosen.

We can now derive one of the most important formulas in the thermodynamics of gases. Suppose that we have a cylinder with a piston as in Fig. 3. Let us fix the piston in a given position so that it cannot move. We will then have the air or gas as the case may be under the piston at a definite volume, temperature, and pressure, say V_1, T_1, and P_1. If now we heat the contained gas to some higher temperature say T_m where T_m is any temperature different from T_1, the pressure will rise let us say to P_2 but the volume will remain the same. If now we release the piston and still heating the gas allow the piston to move out so that the pressure remains just at the pressure P_2, we will finally get a new volume V_2 when the temperature reaches a value which we will call T_2. Now in the first instance we have

$$\frac{P_1}{P_2} = \frac{T_1}{T_m} \text{ or } T_m = \frac{T_1 P_2}{P_1} \qquad (6)$$

and in the second instance

$$\frac{V_1}{V_2} = \frac{T_m}{T_2} \text{ or } T_m = \frac{V_1 T_2}{V_2} \qquad (7)$$

Things equal to the same thing are equal to each other, so we have

$$\frac{T_1 P_2}{P_1} = \frac{V_1 T_2}{V_2} \qquad (8)$$

or

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} = R \qquad (9)$$

where R is a constant, depending in value upon the gas and the units of volume, pressure, and temperature. If we are considering one pound of air with P in pounds per square foot and T in degrees absolute on the Fahrenheit scale, then R is equal to 53.36. This simply means that the product of the volume and pressure divided by the absolute temperature of any given quantity of gas under any given conditions is equal to the product of its pressure and volume divided by its temperature under any other condition. Thus it can be seen that knowing any two of these conditions enables us to arrive at the third providing we know also the kind of gas since we can then determine the value of R. This same equation is more generally expressed in the form

$$PV = wRT \qquad (9a)$$

where w is the weight of the gas in pounds contained in the volume V.

Specific Heat of Gases.—Gases differ from solids and liquids in that they have two distinctly different specific heats. We found in a previous paragraph that the specific heat is the amount of heat required to raise one pound of a substance 1°F. This heat or energy goes into increasing the speed of motion and thus the kinetic energy of the molecules of which the substance is composed. Suppose now that we have a gas confined in a vessel as shown in Fig. 2. If this is heated it will rise in temperature and pressure, but its volume will remain the same. Under these conditions it will require a definite amount of heat to raise its temperature one degree. For air this amount is about 0.170, depending upon the temperature, and moisture content, which heat, of course, goes into increasing the kinetic energy of the molecules. The specific heat under these conditions is called the "specific heat at constant volume" and is generally designated as C_v.

On the other hand, let us consider conditions such as shown in Fig. 3 with the gas confined in a cylinder having a movable piston so that it is held at constant pressure. If now the gas is heated the piston will move out and altho the temperature will rise the pressure will remain the same, while the volume will increase. In order to raise the temperature of one pound one degree under these conditions we will, of course, have to supply the same amount of heat as before in order to speed up the movement of the molecules so as to correspond to the new temperature. In addition the piston is forced out of the cylinder against resistance, this means that a definite amount of work is done, and since, as we found, heat and work are mutually convertible, the energy necessary to do this work must come from the heat energy supplied to the gas. This means that we must supply an amount of heat in addition to the 0.170 B. t. u. per pound per degree rise which will be equal to the work done in forcing the piston out. It comes out in the case of air at ordinary temperatures that this amount is about 0.070 B. t. u., making the total amount of heat which must be supplied to raise one pound of air one degree Fahrenheit under constant pressure conditions about 0.240 B. t. u. This is called the "specific heat at constant pressure" and is generally designated as C_p.

Expansion of Gases.—Constant Pressure Expansion: Suppose that we have a cylinder as in Fig. 4 with a frictionless piston as before, and let us also assume that we have a rod attached to the piston and moving with it so as to transmit the pressure and thus the work to some kind of a machine. Further let us assume that we have a gas confined in the cylinder at the condition of pressure and volume as represented on the curve by P_1V_1. (The vertical scale represents pressures, the horizontal scale represents volumes.) If now we apply heat as before and keep the pressure on

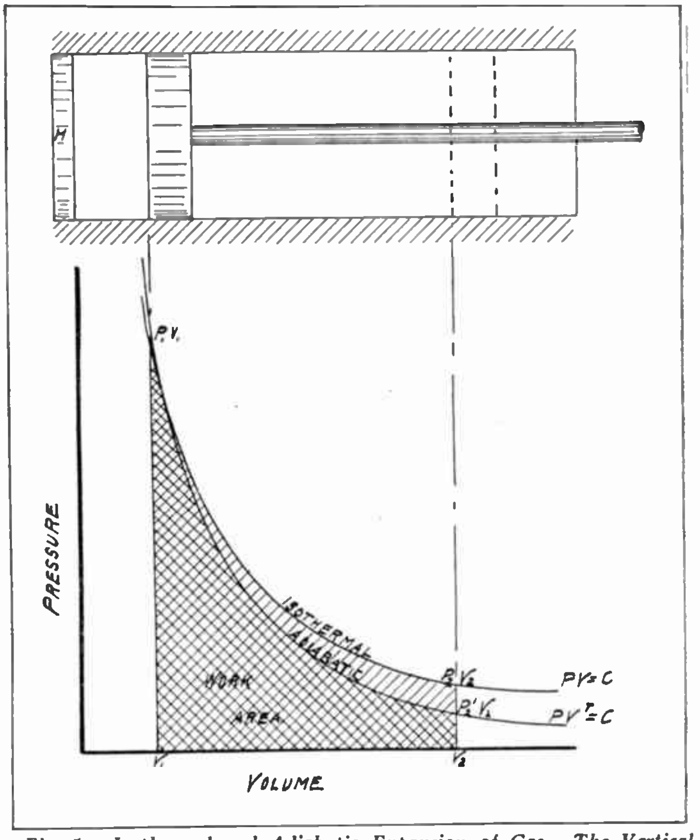


Fig. 5. Isothermal and Adiabatic Expansion of Gas. The Vertical and Horizontal Scales Represent the Same Quantities as in Fig. 4. The Cylinder Head H Must Be a Perfect Conductor in the Case of the Isothermal Expansion in Order to Keep the Gas at the Same Temperature as the Surroundings, Whereas It Must Be a Perfect Insulator in the Case of Adiabatic Expansion

the piston constant, the piston will move out as the temperature rises to some other volume V_2 at pressure P_1. This expansion is indicated upon the pressure-volume diagram by the line P_1V_1 to P_1V_2. Now the work done on the piston is equal to the pressure on the piston times the distance in feet moved, but the total pressure is equal to the pressure per square foot of area times the total area of the piston in square feet. In other words, then, if we let d equal the distance thru which the piston moves, P the pressure in pounds per square foot, and A the area of the piston in square feet, for the work done or W we will have

$$W=PAd \quad (10)$$

but Ad is equal to the increase in volume or to $(V_2—V_1)$.

Therefore $W=P(V_2—V_1)$. (11)

Now if the ordinate or vertical scale on the curve represents pressures in pounds per square foot, and the horizontal scale represents cubic feet volume of the gas in the cylinder, then the cross-hatched area represents $P(V_2—V_1)$, or in other words the amount of work done in foot-pounds. It can also be shown by means of the calculus that the area under any expansion line on the P-V diagram, be it curved or otherwise, represents the work done. It is this principle which is the fundamental basis of the steam and gas engine indicator.

Constant Temperature or Isothermal Expansion.—It has been found experimentally that if the temperature of a gas be kept constant and its volume doubled its pressure will be just one-half what it was before the change in volume took place. Likewise if its volume be increased four times, its pressure becomes one-fourth, and so on. In other words the product of the pressure and the volume of a gas at constant temperature is always constant. That is PV=C. This can be seen from equation (9a), for we found there that PV=wRT, where wRT becomes the constant C. Such expansion is called isothermal, meaning constant temperature, and must be represented on the P-V diagram by a rectangular hyperbola as shown in Fig. 5. From the preceding paragraph we saw that the area under any curve is equal to the work done during the expansion. Since the gas is at the same temperature and thus has the same energy in it at the end of the expansion as it had at the beginning, we reach the inevitable conclusion that heat must have been put into the gas during the expansion in order to account for the work done. By actual experiment we find this to be true, and the heat added is just equivalent to the work done. Thus we have very nearly a perfect heat engine for a part of one cycle, but the trouble comes when we attempt to raise the pressure back again so that we can do it over again.

Adiabatic Expansion.—We have one other fundamental type of expansion called Adiabatic expansion. This means expansion without the addition or subtraction of heat as heat. Suppose that we have the cylinder and piston as in Fig. 5 made of a perfect heat insulating material. If now we have a gas confined in the cylinder at P_1V_1 conditions and allow it to expand to some condition P_2V_2 we will have an amount of work done equal to the area under the expansion curve. On account of the insulating side walls and piston we will not, however, have added any heat from an external source. This means that the energy necessary to do the external work must come from the internal energy or heat of the gas itself, and consequently its temperature must drop. This accounts for the lower pressure at any given volume on the adiabatic curve. The equation of this curve is

$$PV^r=C$$

where C is a constant, and r, the exponent of V, is a constant for any particular gas at a given temperature, and is equal to $\frac{C_p}{C_v}$ or about 1.41 for air at ordinary temperatures.

To derive the foregoing equation requires the use of the calculus and its use requires a knowledge of logarithms or the slide rule. Those interested in following this farther will find complete instructions and the derivation in any standard text book on Thermodynamics.

In all of the three fundamental types of expansion which we have just considered, we might have compressed the gas instead of expanding it. We would then have had to expend work and to have subtracted heat instead of adding heat. That is the gas would have become heated during compression due to the work done upon it by the machine furnishing the power for compression. It is this thing which makes the bicycle pump get hot when we work it rapidly.

Actual Expansion Curves.—In actual practice in heat engine or air compressor work we very seldom have either pure constant pressure, isothermal, or adiabatic expansion or compression. The actual expansion curves approach these theoretical curves if the conditions are right, but due to friction of valves, heat flow thru walls, and other factors the theoretical curves are very seldom followed exactly. However, a knowledge of these three fundamental curves is necessary to fully understand the various heat engine cycles which will be discussed at a later date in the articles which follow.

COLLOIDS AND ELECTRIC OSMOSIS

CONSIDERABLE attention is now being given to what is known as colloid chemistry and electric osmosis. A colloid is taken as being a substance finely divided and suspended in a fluid, its state of division being so fine that it remains in suspension for an indefinite period. Sometimes this is called peptized suspension. It is a most curious property. Some of the colors of gems are supposed to be due to colloid, presumably disseminated through them when they were in the liquid state in early geological ages. A very curious instance of the utilization of the properties of colloids is in the purification of China Clay. This is suspended in water forming a case of peptized suspension. The water having nothing in solution is almost the non-conducter of electricity. Two electrodes are immersed in it and a potential of twenty to one hundred volts is maintained between them. A curious result of this is that the clay goes to the anode to which it adheres as a coagulated mass and is actually said to be dried to a certain extent. The impurities are left behind. This is the only way by which silica can be removed from clay. Besides silica iron pyrites are removed if present, and the substances removed may even have some value as by-products. The clay, thus purified, is found to have very superior qualities. It fires at a lower temperature and gives a product far more resistant to high temperature. A general superiority is observed in clay thus treated.

The suspended clay in the tank is forced through a perforated cathode. This gives it an electric charge and it is attracted to a cylindrical revolving anode about ¾ of an inch distant from the cathode. It adheres to the anode and as the cylinder rotates it is scraped off. The impurities in clay, silica, pyrites, and mica are said to be: electro-osmotically indifferent and are washed away with a little of the clay, the latter being recovered and treated over again.

It is found an equivalent process can be used in filtering almost impossible substances; that water can be forced towards the cathode with the voltage just stipulated and the filtration of the most difficult substances effected. The use of straw in bricks by the Egyptians is told of in the Bible. It is now said that it was an example of colloidal action; that the straw was not used as a binder as is generally supposed. It was fermented in tanks and mixed with the clay making it more plastic.

To deodorize gasoline add 2% of chloride of lime, then 1% of muriatic acid, and shake violently, repeating the operation several times. It is then put into another vessel with slaked lime, shaken up, left to settle and decanted.

Variometer Type Regenerative Receivers

Working Data for the Design of Regenerative Sets Using Radio Shop Variometers

By M. B. Sleeper

Illustrations by the Author

THERE is one mandate which must be observed in designing a regenerative set of the variometer type—"Know your variometers." In order to give the readers of EVERYDAY ENGINEERING accurate data on this kind of a set, careful tests were made on the Radio Shop variometers, as these were of excellent and typical construction.

The values given are accurate within 3 to 5 per cent, an allowable variation for all practical use in design work.

First off, the mechanical dimensions were taken. The variometer stator was 4 15/16 ins. square, and each wooden half 1⅛ ins. thick, with a separation of ½ in. Each side was wound with 26 turns of No. 20 D. C. C. wire. The rotor measured 3⅞ ins. in diameter and 2¾ ins. thick, with 27 turns of No. 20 D. C. C. wire on each side. Terminals of the rotor were soldered to the shaft, which is open in the center. Connection to the shaft was made thru large brass bearing blocks, fitted with springs which maintained a constant pressure against the shaft.

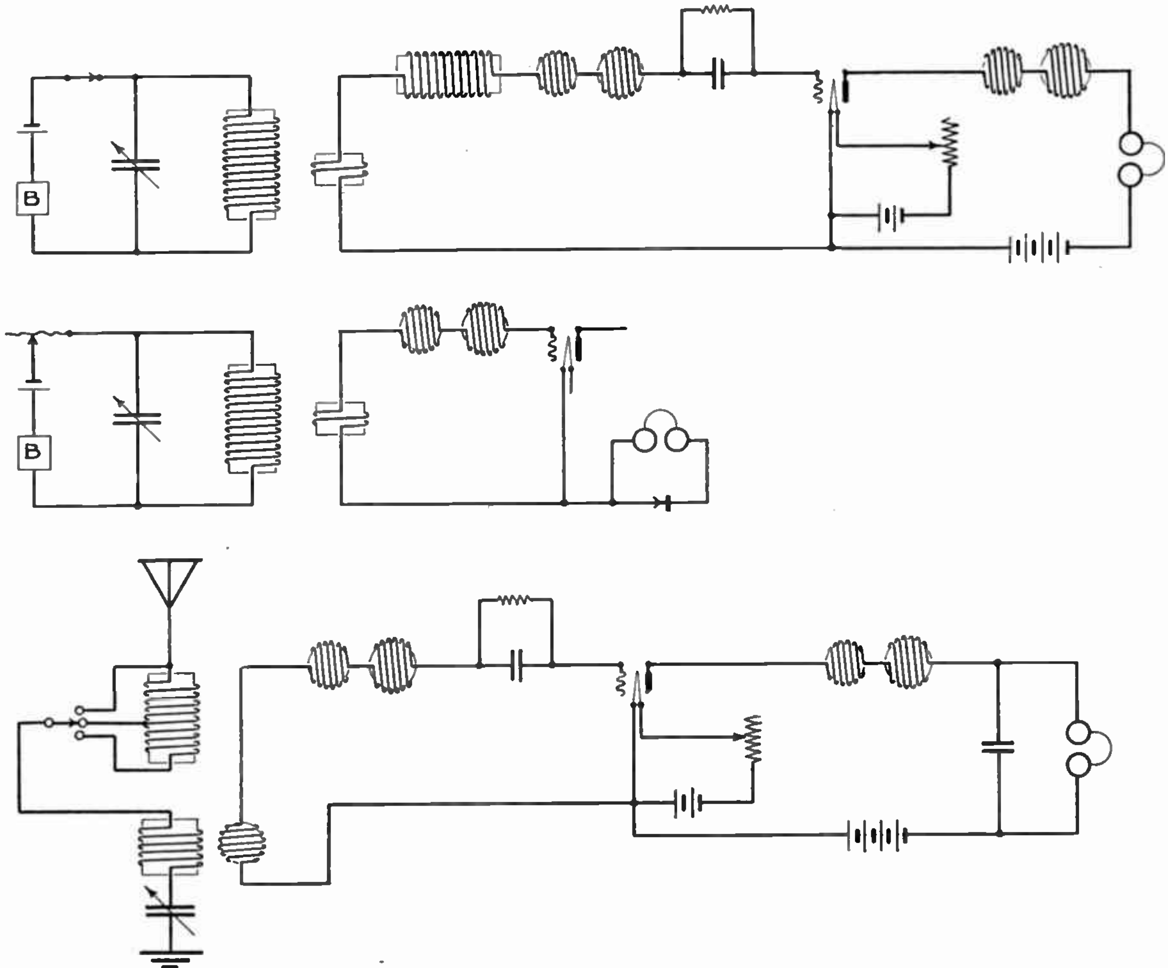


Fig. 1—Circuits used in the test and for the complete regenerative set

The true inductance, making the necessary allowance for distributed capacity, was calculated as 31,000 cms. at minimum, and 538,000 cms. at maximum, giving a ratio of 1 to 17.

Altho the variocoupler was not used in the set described in this article, its constants will be given. The base was

5 ins. square, on which was mounted a tube 4 ins. in diameter, wound with No. 20 D. C. C. wire. It was tapped at the 8th, 15th, 22nd, 30th, 37th and 45th turns. Connected with a capacity of 0.0003 mfd., the average antenna capacity, the wavelength was:

Tap	*Wavelength*
1	....
2	175 m.
3	245
4	307
5	355
6	415

and with 0.0004 mfd. it was:

Tap	*Wavelength*
1	....
2	210 m.
3	285
4	358
5	420
6	495

The coupling ball of the variocoupler was 3½ ins. in diameter and 1¾ ins. thick, wound on each side with 14 turns of No. 20 D. C. C. wire.

Tests on the Circuits

Fig. 1, at the top, shows the circuit used in the preliminary tests. In the grid circuit the variometer is in series with the coupling ball—shown as a tubular inductance—and a coil of two turns which provided coupling to the buzzer-excited wavemeter. Resonance with the wavemeter was obtained by adjusting the grid and plate variometers until the signals were sharp and clear. No trouble from howling was noticed, although the variometers were separated only 3 inches. The wavelength variation was from 155 to 355 meters with a VT1 tube, and 140 to 340 with a Marconi type detector.

Next, one variometer was connected as in the center diagram of Fig. 1. This was to show that the variometer, with the capacity between the grid and filament, actually form an oscillatory circuit.

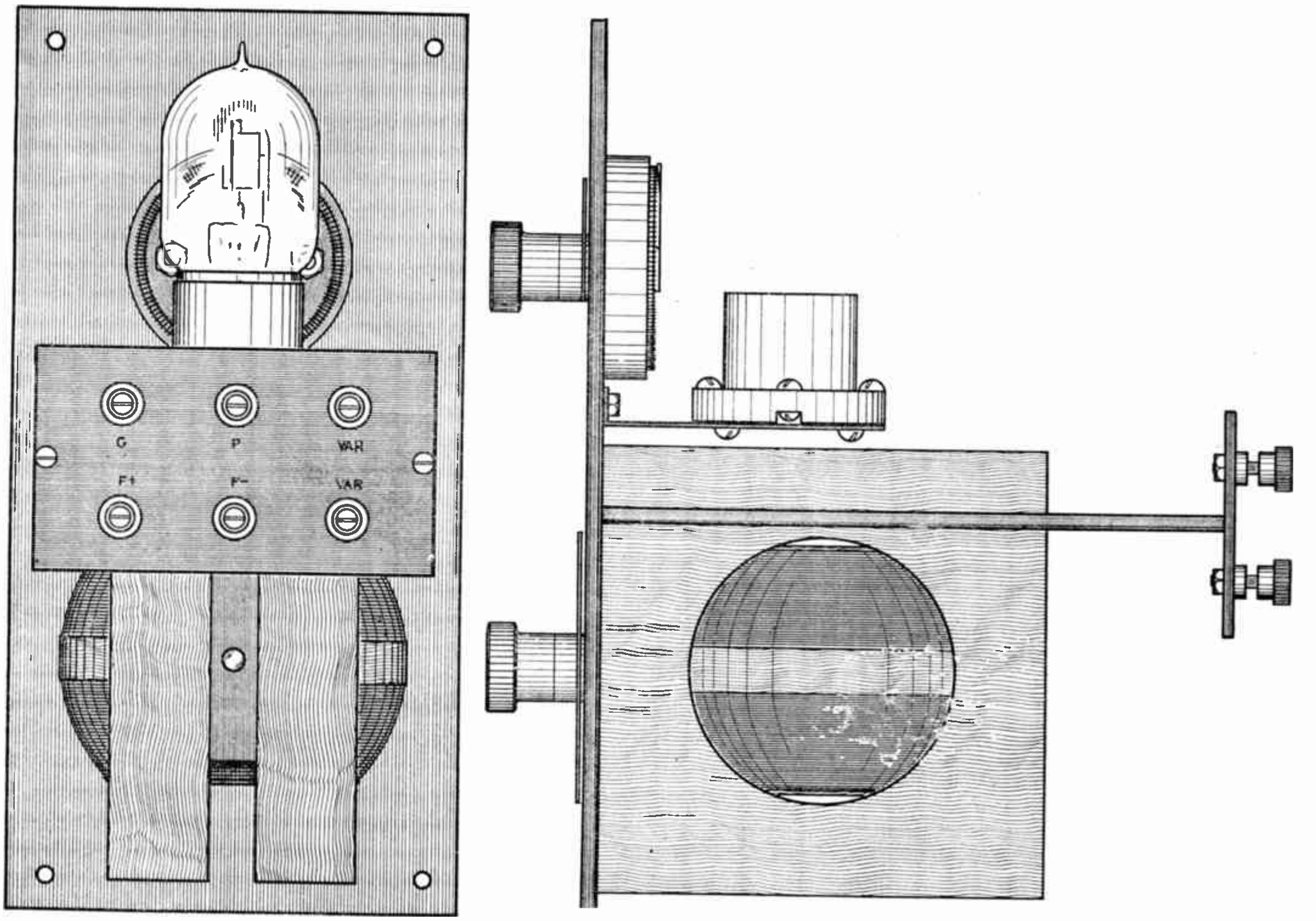
At first it was not possible to find a resonance point, for the sound in the telephones was the same over the range of the wavemeter. In fact, it seems as if there was no tuning in the circuit. Loosening the coupling only weakened the signals. Finally, a piece of Advance resistance wire, with an adjustable contact, was put in series with the buzzer. The resistance was increased until the buzzer barely vibrated. Under this condition a sharp resonance point was found without difficulty.

With a VT1 the wavelength range, at minimum and maximum on the variometer was less than 140 to 300 meters, and with a Marconi tube, less than 140 to 290 meters. This was expected, as the elements in the VT1 are much larger than in the other tube.

Another test was made to determine the relative settings of the grid and plate variometers, for maximum amplification, over the wavelength range. A larger coupling coil to the wavemeter was used, with connections as in the upper diagram of Fig. 1. The following readings were taken:

Wavelength	*G VMR*	*P VMR*
200m.	27°	0°
225	40	20
250	45	30
275	53	33
300	60	41
325	68	46
350	82	51
370	100	55

In all cases the plate inductance was less than the grid inductance.



Figs. 2 and 3—Details of the audion and plate variometer mounting

Construction of a Regenerative Receiver

With the data given above, the design of a complete receiver was undertaken. The last table given showed that, in the secondary, no difficulty would be experienced in making the secondary circuit oscillate over a range of 200 to 350 meters. Since the set was designed especially for 200-meter reception, it seemed unnecessary to include a condenser for longer wavelengths. However, a condenser was used in the primary circuit, as an experimental set-up showed that tuning in this way was more easily accomplished. The switch once set, according to the antenna capacity, only the condenser was used for tuning.

Bakelite panels, 5 by 10 inches were used, instead of the 5 by 5 inch ones, for the very practical reason that the variometers were too large for the smaller panels. Instruments of the same circuit were put on one panel, that is, the primary loading coil and condenser, the secondary variometer and coupling coil, and the vacuum tube and plate variometer. The improved method of mounting the binding posts is shown.

The Tube Panel

Fig. 2 shows the rear, and Fig. 3 the side of the tube panel. The plate variometer is mounted directly behind the panel, held in place by wood screws, put in from the front. Any indicating dial can be used, according to the discretion of the builder.

Above the variometer are the rheostat and tube socket, the latter supported on two brackets of 3/8- by 1/16-in. brass strip. The grid condenser and leak, as well as the 'phone condenser, shown in Fig. 1, can be mounted on the top of the variometer stator. Two 6 13/16-in. lengths of 3/16-in. square brass rod hold the terminal panel, which is of ⅛-in. bakelite, 2½ by 4 7/16 ins. The rods were threaded with a 6-32 tap at both ends.

Secokdary Panel

Because of the large size of the Radio Shop variocouplers, the rotor was taken out and used with a small primary coupling coil, Fig. 4. No taps were needed, as a condenser gave the fine adjustment.

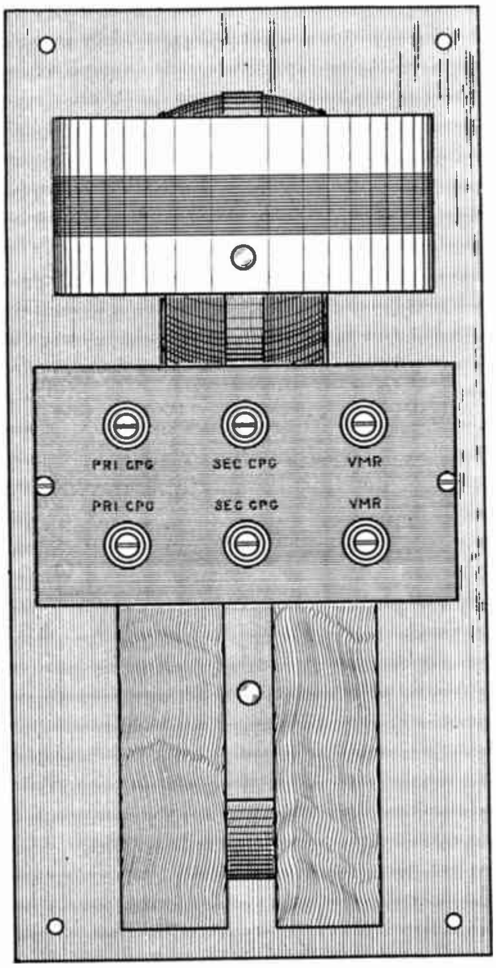


Fig. 4—On the secondary panel are mounted the coupling coil and grid variometer. One-half scale

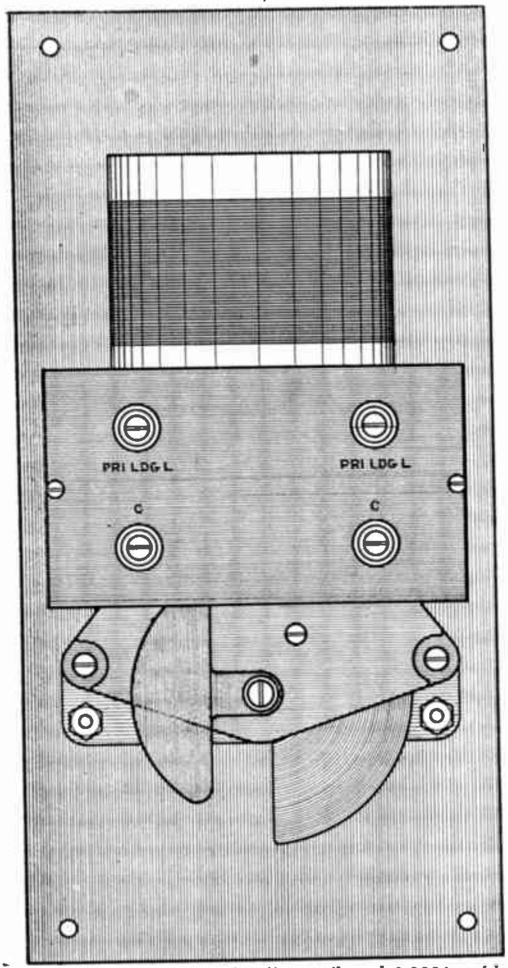


Fig. 5—The antenna loading coil and 0.0006 mfd. condenser are carried on the primary panel. One-half scale

The variometer was mounted as in Figs. 2 and 3. The primary coil was wound on a tube 4 ins. in diameter and 1⅞ ins. long, with 25 turns of No. 24 S.S.C. wire. Brackets of ⅜- by 1/16-in. brass strip were made to hold the tube to the panel.

An interesting method of locating the holes for the rotor shaft was employed. Obviously the rotor would touch if the holes were off center. The tube was placed on a sheet of ordinary ruled paper, such as is used for note books. Then it was moved until one of the lines passed through the center of the tube. Marks were made on the tube where it intersected the line, and extensions drawn up ⅜ in. Thus the holes were located diametrically. Flexible leads provided connections to the rotor winding.

Primary Panel

Fig. 5 shows the primary panel, made up of a 0.0006 mfd. Chelsea condenser and the primary loading coil. This condenser is particularly recommended, both for its mechanical and electrical advantages. The insulation is good, the construction rigid, and the price reasonable. A counterbalance offsets any tendency for the variable plates to rotate of their own accord.

Above the condenser is a loading coil made up of 60 turns of No. 24 S.S.C. wire, wound on a tube 3 ins. in diameter and 2½ ins. long. A tap at the center was run to the primary switch, as shown in Fig. 1.

No connections from the instruments to the binding posts have been shown in these illustrations, but they can be determined easily from the wiring diagram.

Operation

This receiver, according to the adjustment of the plate and coupling, will

(*Concluded on page 154*)

The Radio Department

A Discussion of Current Topics of Interest to Manufacturers and Experimenters

IF radio work is of no other benefit to the experimenter it teaches him patience and self-control. That may be said of any aggravation which is beyond arm's length. But the trials of an operator attempting to receive telegraph signals thru interference is nothing compared to ordeal of telephonic reception thru the "daaaaa-derrt-daaaa" of a spark set.

Apparently 200-meter stations never stop. In the gray hours before daybreak, when they should be asleep, or on Sunday morning when they should be at church, or Sunday night when they ought to be making family calls, the 200-meter boys and men are at the key. Radio certainly has made precedents in the schedules of many homes. Since radio has banished sleep, it can be expected, before long, to stop all work, except on the wireless.

Interference is annoying at all times. At the DX stations it is heartrending. Radio clubs and magazines have discussed the problem endlessly. If every word thus used had been an inch of wire, every experimenter in the country would have a lifetime supply.

Much has been accomplished, but it is only a scratch on the surface. Operating schedules will never be effective because they will not be maintained and cannot be enforced. Courtesy is Utopian. Each year brings a new crop of beginners, some ignorant and some wilful offenders. When undamped wave sets have supplanted the spark types, which they will never do unless the spark is legislated out, they will be sufficiently more numerous to negate their advantage. The man who says that a hundred undamped stations can work between 150 and 200 meters does not know that audio frequency beats between two transmitters make trouble.

Those who spend time and thought on schedules and propaganda will do better to accept the inevitable and work at more selective receiving circuits, and more efficient methods of handling what they have.

THE Transatlantic Sending Tests have brought about considerable activity among the ambitious experimenters, judging from the letters which have been received. The amount of work and the expense involved has held back many who will register within the coming month. It is no small task to build special stations, as some are doing, or to rebuild sets now in operation.

Manufacturers and dealers have been quick to take advantage of this opportunity to help the contestants in a venture which will mean much to experimental radio. Three months remain before the Tests will take place, but this is no more than time enough.

The men who go in for these Tests will make history in the records of experimental achievement.

YOU know the thrill you have when a post card comes to you saying, "I heard your signals QSA on Wednesday night. Needed only a detector bulb," and the signature is from some station much farther away than you ever expected to transmit.

Be generous. It only costs a penny to tell a man that you heard him. It may be just the word of encouragement he needed at a time when he thought his set was not doing well.

QUITE an original experiment was the subject of the paper read at the October meeting of the Institute of Radio Engineers, namely, "Radio Taste Reception." At the suggestion of Mr. Arthur A. Isbell, Dr. Goldsmith and Mr. Edward T. Dickey undertook to determine the practicability of receiving radio signals by means of the familiar stinging taste caused by the passage of a current thru the tongue.

Silver electrodes were employed. A voltage of 4, giving a current of 0.01 milliampere, gave a "readable signal." At higher voltages the taste nerves became fatigued, this effect being more noticeable on direct than alternating current. On actual reception it was found practical to copy, at a speed of five to ten words a minute, signals amplified from an original intensity of 500 times audibility by a four-step amplifier.

The conclusion was drawn that taste reception requires such concentration that, under very noisy conditions where other than audio methods would be preferable, this method defeats its own purpose.

SEVERAL attempts have been made to form an association of radio manufacturers. Partly because of the attitude of the companies concerned, but more because of the nature of the proposed organizations nothing has been accomplished.

There is a way, however, in which the radio companies can combine forces, and very effectively benefit individually thereby.

It may seem, at first thought, that the radio business is of considerable magnitude. So it is, but very small compared to what it would be if it were handled in a different manner. Everyone is interested in radio. The average man whom you meet, if approached about a radio set says, "Oh, I don't know anything about it. It's too complicated for me to learn. I'd like to have a set, but I haven't the time to go into it." Yet these very men, if a few principles are explained to them, can be sold six times out of ten. In fact, the T. B. M., who takes up radio for fun, usually turns out to be the best customer, for he has more to spend than the boy. As for the boy, he is a better customer if reached through his father, for then he has his father's approval rather than his skepticism.

Radio advertising is now confined to radio magazines, read by those who are already interested in the work. No attempt has been made to reach the other, and larger class. To do this means national advertising, which, to be effective, must be very costly, much more than individual concerns can afford.

The idea of combining on national advertising is not new. It has been done many times by companies in various lines, and invariably with astonishingly successful results. The campaign should be purely educational, not with the idea of selling any particular kind of apparatus, but to sell the art itself, to make the Any Man understand how easy it is to put up a set, how interesting radio is, how his son will be benefited by experimental work, and what a wonderful common interest it affords a man and his boy.

Under such an arrangement the cost to each company would be small, and the benefits enormous.

LIKE many other things not founded on scientific methods, the origin of the inch as a measure of length is rather obscure, but the records of historians show that it was determined by the length of three grains of barley, dry and round, placed end to end. The inch is still the basis of our measure of length, sometimes divided decimally, and more often in the unhandy fractions of sixteenths and thirty-seconds.

The World Trade Club, at San Francisco, has collected data which show that the English system of weights and measures, as well as other arbitrary standards of other countries, are being rapidly replaced by the metric system. We all know that metric standards are used exclusively for scientific work. Many of the formulas used in radio must undergo conversion before they can be applied to design drawings.

That even those who oppose the adoption of the metric system favor a decimal scale is shown by its universal application to all fine measurements. Probably the opposition comes from those who believe that, to change over to the metric system, every machine and tool now in use must be scrapped, and entirely new ones built.

Actually the change would be effected

(*Concluded on page* 154)

Vacuum Tube Transmitter and Radiophone

This Set Is Just the Thing for the Experimenter Who Wants to Get the Most From a Low-Powered Transmitter

By Allen H. Wood, Jr.

THE tendency of the present day amateur is to employ vacuum tubes to as large an extent as possible for Radio Communication. The sharpness of the emitted wave and the flexibility of tube transmitters is admittedly better than spark transmitters.

With bulb sets, three forms of communication are available; voice, buzzer-modulated waves, and undamped waves. Hitherto, the possession of suitable tubes for transmitting purposes has been a matter of luck, in which considerable money, influential friends, and underground methods played important parts. This condition undoubtedly dampened the experimenter's interest in radiophones. Fortunately at present there are several excellent types of tubes available, and the amateur can also buy most of the other constituent parts of a phone as regular products of the manufacturers of radio apparatus.

Amongst the many wiring diagrams existent, the amateur is often at loss which one to adopt after he has determined to construct a tube set. It is well to keep in mind that a minimum of parts and complicated controls usually proves most efficient.

With this in view, the set described herewith is offered as an instrument which is extremely simple and yet efficient. With this phone, music has been transmitted over a distance of 175 miles. This was due to exceptional circumstances of course, but the phone can be counted on to transmit speech over a distance of 30-50 miles with regularity.

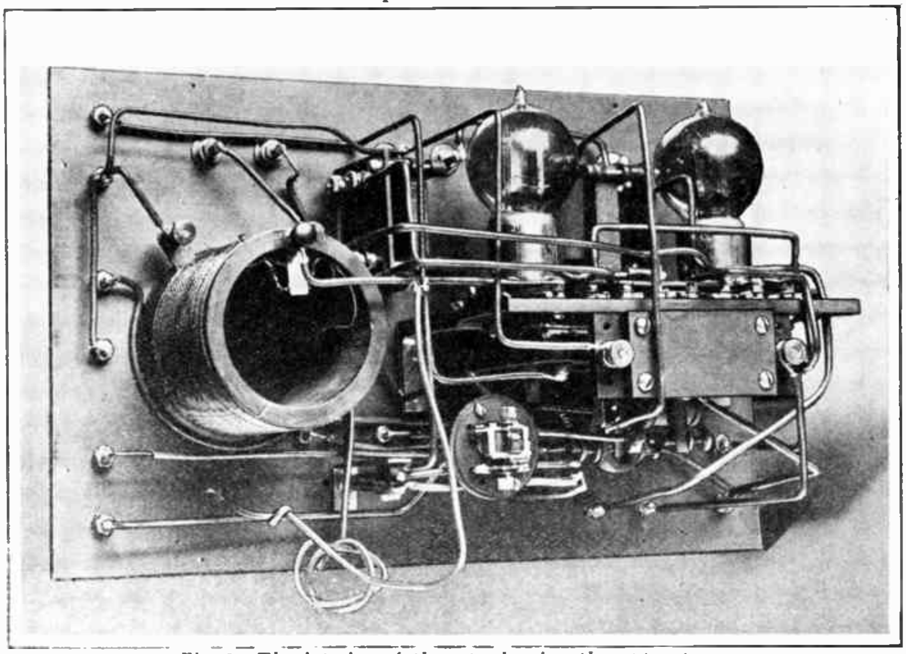


Fig. 2—The interior of the set, showing the apparatus

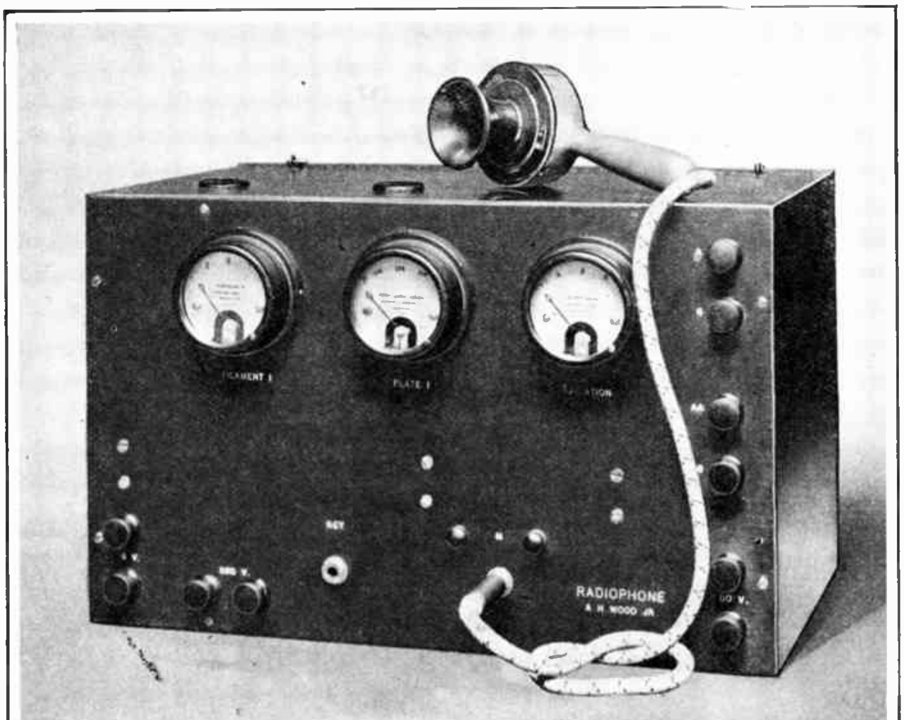


Fig. 1—A feature of this set is that there are no switches or condenser knobs on the panel

Practically all measurements are omitted as they will vary with individual taste, but the illustrations will afford a comparative scale of measurement for those who wish to copy this set. The panel on which the various instruments are mounted is of dull-finished bakelite 12 by 16 by ¼ in. thick.

The antenna inductance is wound on a bakelite or formica tube, threaded to receive the wire. The tube is 4 ins. in diameter and 5 ins. long. 26 turns of No. 12 hard drawn bare copper wire are wound on the tube and spaced 1/16 in. apart. A tap is soldered to the 13th turn.

The instrument marked Z on the wiring diagram is a closed core transformer. The dimensions of the core are 2¼ by 1¾ by ½ in. square. The winding consists of 2000 turns of No. 30 enamelled wire. The function of this reactance is to assist in maintaining a steady direct current on the plates of the tubes at all times.

Condenser C is a mica condenser with a capacity of .01 mfd. This capacity is not particularly critical and may vary somewhat either way.

In Fig. 3 MOD TR is the modulation transformer and has a core the same size as impedance Z. The primary winding consists of 300 turns of No. 22 enamelled wire, and the secondary winding of 6000 turns of No. 40 enamelled wire. These transformers are of standard size and can be purchased from practically any radio supply house.

Weston meters are recommended but hot wire instruments or any other make of meter that has the correct range can be substituted. Three meters are necessary—a filament current ammeter, range 0-5 amperes; a plate current milliammeter, range 0-200 milliamperes; and an antenna current ammeter, range 0-1 ampere.

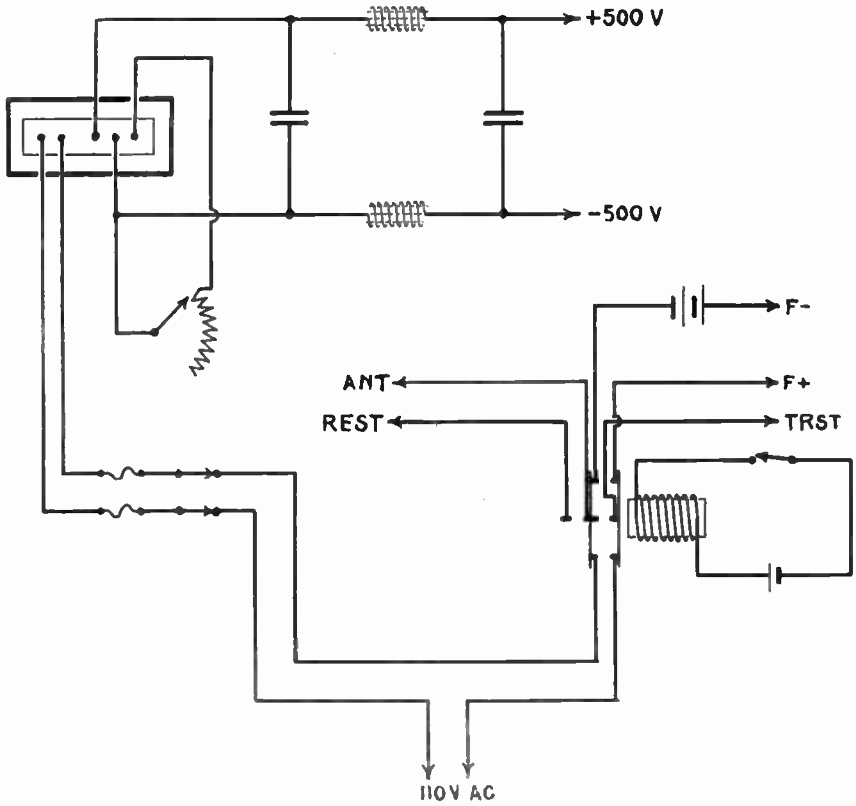


Fig. 4—A relay system for controlling the tubes

Two tubes are employed, preferably Western Electric VT 2's, but Marconi Class II tubes can be substituted at somewhat of a loss in output.

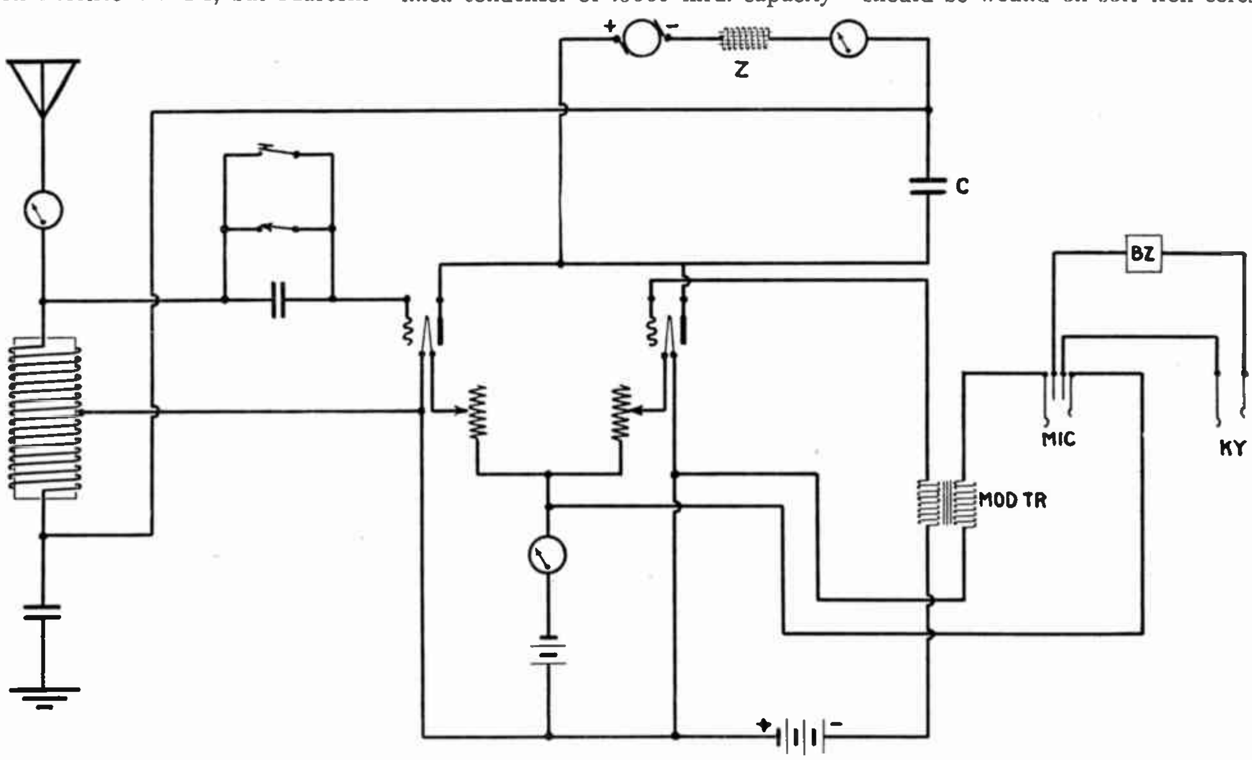


Fig. 3—Diagram of connections for the vacuum tube transmitter, giving telephone damped or undamped wave telegraph signals

Two jacks are introduced, one for the microphone, and the other for a key to be used when buzzer modulation is employed. Any standard make of buzzer may be used, still it is better to use one which is easily adjustable and whose frequency is steady. If undamped wave telegraphy is desired, a mica condenser of .0005 mfd. capacity should be inserted between the grid and the antenna inductance, and shunted by a key. A suitable switch should also be incorporated to keep the grid-antenna circuit closed when undamped wave transmission is not desired.

A negative potential of about 20 volts is necessary in the grid circuit of the modulator tube to give the proper operating point on the characteristic curve. Any standard B battery of 22.5 volts potential can be used.

The A battery should be a storage battery of 8 volts, with two rheostats to control the filament. The VT 2 tubes were designed to function on exactly 6 volts, but some of the tubes require a small additional potential to work satisfactorily. The addition of 1 volt and .1 of an ampere sometimes marks the line above which the set operates correctly, and below which it is a dismal failure.

If the operator wished to use the phone on more than one wavelength, the addition of an antenna condenser becomes essential. A balanced condenser of 0.001 mfd. capacity provides a suitable instrument to use in this instance.

The source of high voltage for the plates can be derived from a motor-generator, rectified alternating current, or from batteries. A motor-generator affords the most satisfactory results. Unless the commutator has a large number of segments, there is apt to be an unpleasant hum in the phones at the receiving station when the phone is in use. A 2 mfd. condenser shunted directly across the line will sometimes eliminate this hum, but more often it is necessary to use a filter. Two coils should be wound on soft iron cores ⅝ by 3½ ins. Each core is wound to a diameter of 2¼ ins. with No. 26 d. c. c. wire. About 2 pounds of wire will be necessary for each coil. One of these chokes is placed in series with each side of the d. c. circuit and a 2 mfd. condenser shunted across the line before and after each choke. This arrangement effectively absorbs and smoothes out what commutator ripple there may be.

Care should be taken when operating the set not to place more than 50 milliamperes on either of the tubes as current in excess of this is apt to prove disastrous to the tubes. A voltage of about 300 is about the correct potential for use with VT 2 tubes, but the exact voltage can only be determined by experimenting with the tubes after they are in use. The plates should never be allowed to heat above a very dull red as secondary emission occurs and the output will drop. When buzzer modulation is used, the filament current and plate voltage should be somewhat reduced, as the buzzer draws more plate current than does the microphone.

The antenna current of this phone is about 0.5 ampere when the antenna resistance is 14 ohms. Good modulation will be indicated by a slight falling off of the radiated current when the microphone is employed.

Fig. 4 indicates the connections of a relay which has been modified to be used as an automatic transfer switch. A bakelite arm with two addition contacts has been fastened on the rocker arm of the relay, and two brass posts bearing the opposing contacts fastened to the base on either side of the magnets. When this arrangement is used, pressure on a button or the closing of a switch will automatically throw the phone into use, start the motor generator, and light the filaments of the tubes. When the button is released or the switch opened, the receiving set is connected to the antenna and ground, the motor-generator is shut off, and the filaments of the transmitting tubes extinguished. This method provides a very handy method of quick transfer from receiving to transmitting.

When the motor current is shut off, it usually requires from 20 to 40 seconds for the armatures to stop revolving. During this period, the voltage in the field is breaking down and will cause a very disagreeable crackling in the telephone receivers of the receiving set if it has been thrown into circuit by means of the relay. Also if the station being worked has answered promptly, considerable difficulty will be experienced in reading the signals. A good way to avoid this is to place a resistance of about 8 ohms in series with a switch and shunt the two across the generator. This provides an automatic brake which stops the motor-generator in about 3 seconds when the switch is closed.

It is sincerely hoped that many amateurs will find it practical and convenient to do their transmitting this fall and winter with vacuum tubes instead of spark coils and transformers, as this method seems to offer the only practical means, at present, of eliminating the intense QRM which exists today.

THE RADIO DEPARTMENT

(*Continued from page* 151)

gradually so that no one would remember just when he stopped using inches and took up centimeters. The pros and cons will not be argued here. The purpose of this note is to ask the radio men who read Everyday Engineering if they think it practical to substitute the centimeter for the inch in design details of apparatus described in this magazine.

We shall all be interested to know the opinions of the radio men in this respect, so that we can get a really representative opinion. Will you please drop a postal to the Radio Editor, simply stating that you are or are not in favor of this procedure?

REGENERATIVE RECEIVER

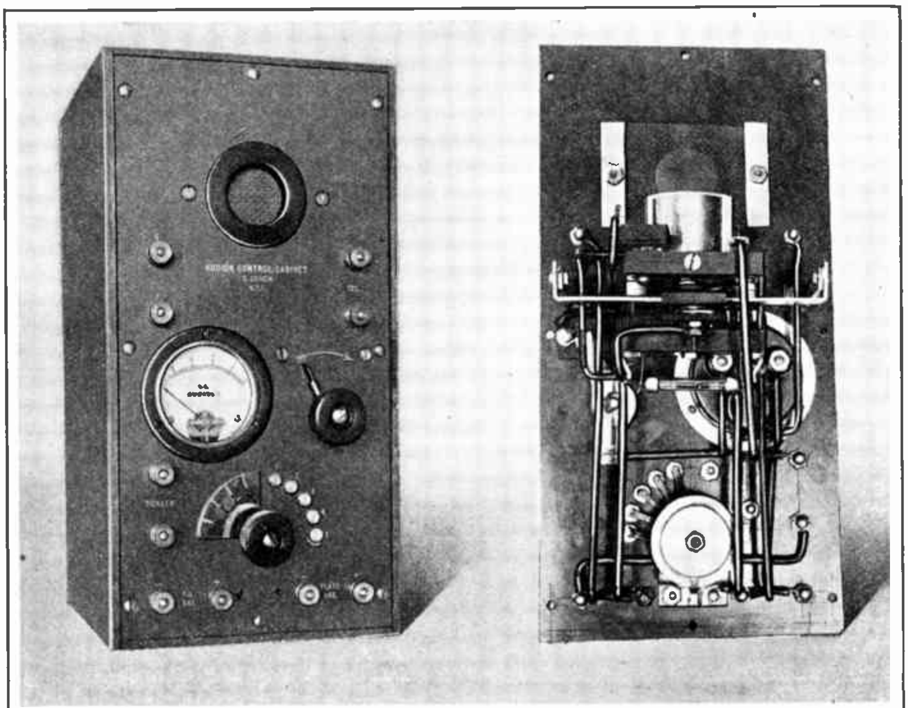
(*Continued from page* 150)

receive damped, undamped, and telephone signals. Damped signals are easy to tune in, but the other two require some knowledge of operation. Both telephone and undamped signals are first distinguished, usually, by the supply current hum. Then a slight detuning, either by the coupling, primary condenser, or plate variometer brings in the signals sharply. If he removal of the hand from the knob causes any change in the signals, it is better to detune with the primary condenser.

A Neat Audion Detector

Essentially all audion detector sets are alike, yet no two makes are similar in appearance, nor do they all operate with the same efficiency. The particular one shown here is quite complete in detail, and shows up well under test.

The audion socket is an interesting detail. Instead of securing the socket's shell to the base permanently, the base is counterbored, and the shell is free to turn until it is clamped in place by the machine screw to be seen in the rear view of the set. Thus bulbs specially made for other than the usual sockets can be used.



At the left of the shell is a small fixed resistance to give a negative voltage on the grid. Below, half hidden, is the resistance element for the rheostat. This type has the advantage that it occupies very little space on the panel or to the rear. A Marconi grid leak is carried under the audion socket. Provision is made for absorbing shocks which otherwise would be transmitted to the tube, with a resulting interference in the telephones.

The filament current is indicated by a small ammeter on the front of the panel.

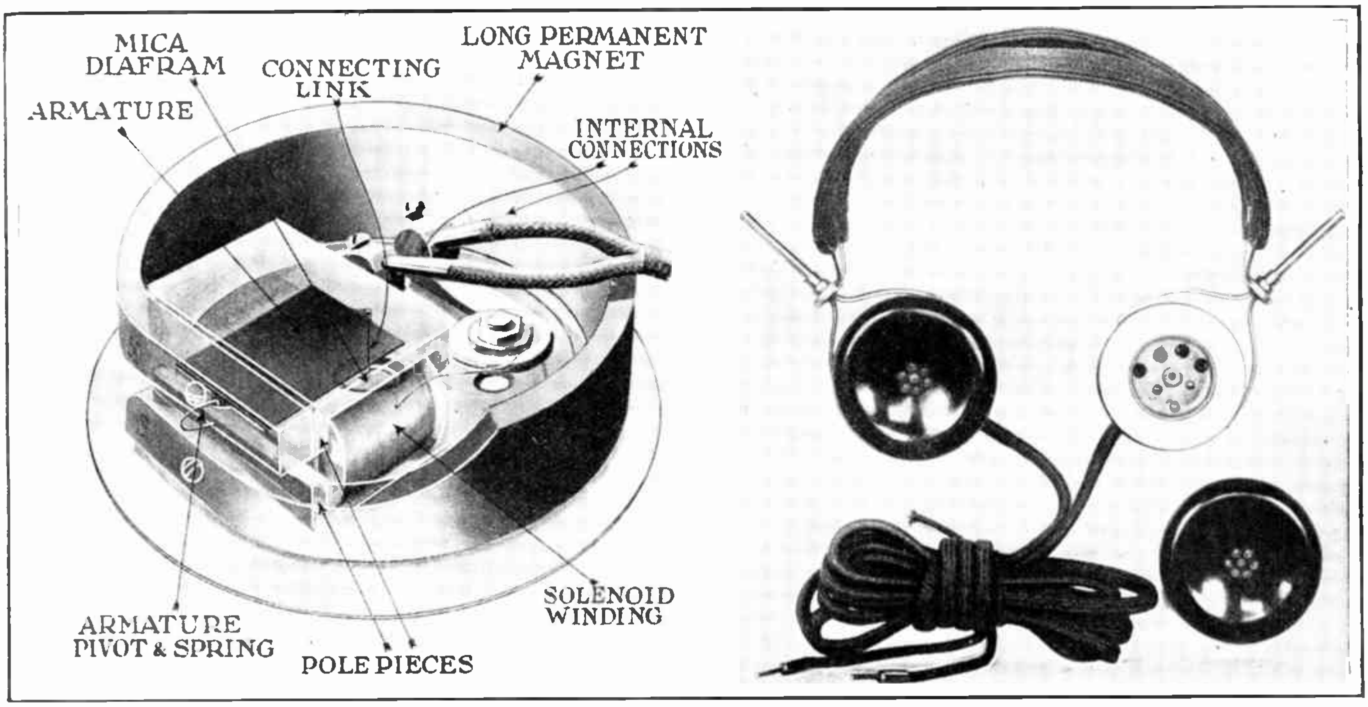
Adjustment of the bypass condenser, connected around the telephones and B battery, is obtained by means of a Dubilier mica condenser of the disc type.

Binding posts are furnished for a tickler coil to be inserted in the plate circuit. When no tickler is used, the posts are short circuited.

Baldwin Type Telephone Receivers

This Article Explains the Action of the Baldwin Telephones, With Which Few Experimenters are Familiar

During the last few years the United States and other governments have used Baldwin telephones, but it is only recently that they have been available for experimenters. While they have become familiar enough now, identified by the mica diaframs, their action is not apparent even to those who have looked inside. It is generally known that they are proportionately more sensitive to very weak signals than to strong ones, but an inquiry as to why they work seldom brings an intelligent answer.



A phantom picture of the receiver, and a head set with one cap removed

It is obvious that the single magnet does not draw down the diafram in the usual way, for, as can be seen from Fig. 1, the axis of the magnet is parallel to the diafram. Moreover, the permanent magnet is of an unusual shape. It is this difference that makes the Baldwin phones interesting, and accounts for their efficiency.

Fig. 1, at the left, shows one of the phones with the cap removed, exposing the mica diafram set in a wide aluminum ring, to which the other parts are also fastened. Although the diafram is much smaller than those of steel, the mica gives a very sensitive response to vibrations imparted to it.

From Fig. 1 it can be seen that a U-shaped iron pole-piece is secured to each end of the circular permanent magnet, making one pole-piece north, and the other, south. Between the pole faces a steel armature is mounted, held at one end by a pivot set into the lower pole-piece, and at the other end by a linking wire fastened to the diafram. The armature is carefully located so that the pull from one pole of the magnet is equal to the pull from the other pole. In the same way, a nail can be set between the poles of a horse-shoe magnet so that it is attracted equally in both directions, and does not move.

Set in the opening formed by the U-shaped pole pieces is a single solenoid magnet, just large enough inside to fit over the armature and to allow it a slight play. Actually the movement of the armature is imperceptible. This magnet, when a current is passed through it, becomes polarized, north at one end and south at the other.

For example, let us suppose that the upper pole-piece, Fig. 1, is north, and the lower one south. If, when a current flows through the magnet, the left hand end becomes north, the balance of the armature will be upset, the combination of two north poles being greater than one south pole. Thereupon the armature will be drawn up sharply at the left end, as a nail jumps to one or the other pole of a horse-shoe magnet. At the right hand end, however, the magnet will have a south polarity, which, with the south polarity of the lower pole-piece will draw the armature down. This movement of the armature, up at one end and down at the other, is transmitted to the diafram through the connecting link.

Thus it can be seen that the telephone does not depend entirely upon the current in the coil to operate the diafram, but utilizes it to produce the unbalancing effect, by which the permanent magnet actuates the armature.

Fig. 1 illustrates the method employed to secure the terminals of the connecting cord. The socket shell and cap is of moulded bakelite. The head band, although duplicated by other manufacturers, was originated by Mr. Baldwin, the inventor of the telephone receiver.

Three types of these phones are made, each with its particular advantage. Type C is the U. S. Navy Standard. The mica diafram is 2⅛ inches in diameter, larger than the others. The complete headset weighs 18.5 ounces. Each phone is wound to a resistance of 1,000 ohms.

More sensitive is the type E, though the diafram is smaller and the resistance the same. The weight is 15.5 ounces.

Type F phones are made for extra lightness, weighing only 13 ounces. In sensitiveness they are slightly superior to the type E, and many operators find them more comfortable to wear.

Some experimenters who buy expensive phones do not treat them as the delicate instruments which they really are. Removing the cap never does the phones any good, and frequently prying fingers break the connecting wires. The diafram is bound to suffer from handling. Most important of all is to protect them from shocks. Dropping them on the floor, or even setting them down roughly on the operating table is hard on the mechanism, and causes the permanent magnets to lose their magnetism.

Telephone receivers cannot be expected to keep their sensitiveness if they are not accorded the proper treatment.

COUNTY RADIO CLUB ORGANIZED

A MEETING was held recently at the home of Merritt E. Gregory, on Pine Street, Morristown, N. J., at which the Morris County Radio Club was organized. M. E. Gregory was elected President, R. M. Lacey, Secretary, and M. W. Gilso, Treasurer.

The principal purpose of this Club is to better the condition of Amateur Radio in this vicinity and to act as a reliable link in a direct line of communication between cities. It is felt that with an efficient organization of this character relay messages can be more promptly handled. It is proposed to have at least one member stand watch at an official station of the Club every evening so that stations in other towns may be assured of a good route through this vicinity.

Another purpose of the Club is to co-operate with members in solving their individual radio problems, also to gather together for the benefit of the members such bits of news and knowledge as is of interest to the radio amateur.

At the meetings which for the present are held at the homes of members, it is expected to have from time to time speakers of note, or other features of peculiar interest.

The second meeting of the Club was held at the home of M. W. Gilso, 22 Early Street, at which time applications for membership were considered. Those desiring membership should apply to the Secretary, R. M. Lacey, 11 Mills Street, Morristown, who will furnish blanks and explain necessary qualifications for admission.

A radio broadcast concerning the Club's activities will be sent out each evening at 7.30 sharp (Eastern Standard time) from one of the Club's official stations which at present are 3 LY and 3 ABG.

The Experimental Station on Signal Hall, St. John's, N. F., picked up and heard without interruption the transmission of wireless telephone speech, as given by Chelmsford on the occasion of a wireless telephone demonstration to Denmark at 5 p. m., on August 3rd. The distance between Chelmsford and St. John's is approximately 2,673 miles.

Transatlantic Sending Contests

Plans Are Now Well Under Way For Communication Across the Ocean

SINCE the first announcement of the Transatlantic Sending Tests, in the September, 1920, issue of EVERYDAY, the most gratifying interest has been shown by experimenters as well as manufacturers and dealers who are working to promote interest among the radio men in the contest.

The honors, as well as the prizes, make the position of the winner one to be envied. Quite a number of experimenters, however, have hesitated to register for the contest because they felt that, with their equipment, they would not have a chance. As a matter of fact, the first place may go to a "dark horse", for the more elaborate the station, the greater the possibility that some vital thing may go wrong at the very last minute. As for getting across —great confidence is felt in the high sensibility of the receiving equipment to be used. Mr. Coursey, of the *Wireless World*, will enlist the aid of a number of radio engineers in England who have unlimited resources in the way of apparatus. Since no restrictions are placed on the receiving sets, there will be some stations which will hear almost a whisper from this side.

Careful data on the equipment and results will be compiled, material of considerable practical value.

A list of prizes offered up to the time of going to press is given below. In addition, many others have been promised, but the conditions not decided upon. Those will be announced in the December issue. The total will be in the neighborhood of one thousand dollars.

Acme Apparatus Company—$50.00 in gold to be given unconditionally to the winner of the tests.

Radio Distributing Company—Apparatus of the value of $43.00. Either a complete set of Radisco coils, two variometers, one variocoupler, with dials, switches, etc., or a Radisco oscillation transformer and Clapp-Eastham 27,000-volt transformer, mounted, to be given unconditionally to the winner.

The General Apparatus Company, Inc.—$50.00 in gold to be given unconditionally to the winner.

Atlantic Radio Supplies Company—Apparatus of the value of $40.00 for first prize, consisting of two A-P electron relay, two A-P amplifier, and two A-P transmitter tubes, and one each of these tubes to the second and third place winners, to be given unconditionally.

American Radio and Research Corporation—$100.00 in gold, to be given to the station winning the highest score with an Amrad quenched spark gap, provided that man owns his own station and is not connected in any way with a manufacturer of radio equipment.

The C. D. Tuska Company—Apparatus of the value of $28.00. A Tuska filter and inductance, to be given unconditionally to the winner.

Atlantic Radio Company—Apparatus of the value of $130.00. A complete 500-volt, 200-watt motor-generator with field rheostat, to be given unconditionally to the winner.

These prizes generously offered by the manufacturers and dealers, total considerably over $400.00, with many more to come.

The first registrations, received before October first, are printed below. Those received subsequently will be published in the December issue. Others, which lack of space requires postponement to next month, with those from experimenters who are not yet ready to register, will bring the total to twenty-five or thirty. There is, therefore, plenty of room in the schedule for newcomers.

September 14, 1920.
34 Hobart Ave.,
Summit, N. J.

Radio Editor, EVERYDAY ENGINEERING.

Dear Sir: I would like to enter your Transatlantic Sending Tests. The following information of my transmitter is:

1. Irving Romeon Groves.
2. 34 Hobart Ave., Summit, N. J. Call 2DX.
3. Set has just been completed and no distance has been attempted yet.
4. One kilowatt Thordarson 25,000 volt transformer, one Dublier .007 mfd. condenser, one 1 K.V.A. Amrad Quenched gap with a note of 240 cycles. One home-made oscillation transformer with 1½" ribbon on primary, 3¾ turns, and 1" ribbon on secondary, 8 turns, one Amrad resistance for regulating note of transmitter. Large eight-wire aerial 75 ft. long, 60 ft. high with wires spaced 2 ft. apart. Counterpoise with 10 wires running under aerial. Also large metal plate buried 6 ft. underground and about 12 driven pipes. Also connection made to water and gas pipes. The set is all connected up with 1½" brass ribbon and no lead is over 2 ins. long.

Hoping you can arrange a schedule for this station, I remain

Yours truly
I. R. GROVES.

October 9, 1920.

EVERYDAY ENGINEERING MAGAZINE,
New York City.

Dear Sirs: I wish to enter the Transatlantic Sending Contest. The information required is given below:

1. P. E. Fansler.
2. Noroton Heights, Conn. Call not assigned.
3. Set under construction.
4. 1 k.w. vacuum tube set, to operate on undamped waves. T-type antenna, with counterpoise ground.

Please let me know if this application is accepted, and the place I shall have in the schedule. I am intensely interested in this Contest, and I believe that experimenters who go into it seriously will be able to get across. Best wishes,

P. E. FANSLER.

(*Continued on page* 158)

A Tube Set Operated on A. C. Without Rectification

Details of the Circuit and the Operation of the Set, the Transformer for Which Was Described in the October Issue

PART II.

A VACUUM tube telegraph transmitter in which alternating current is applied to the plate is the latest innovation for experimenters and one which promises much in the matter of high efficiency as well as simplicity. A set of this sort is the subject of one of the Scientific Papers of the Bureau of Standards, written by Lewis M. Hull, Associate Physicist.

Two sizes of transformers for this type of equipment were described in Part I, which appeared in the October issue. This article describes the circuits and operation of a transmitter for 200 meters, using the ordinary lighting current.

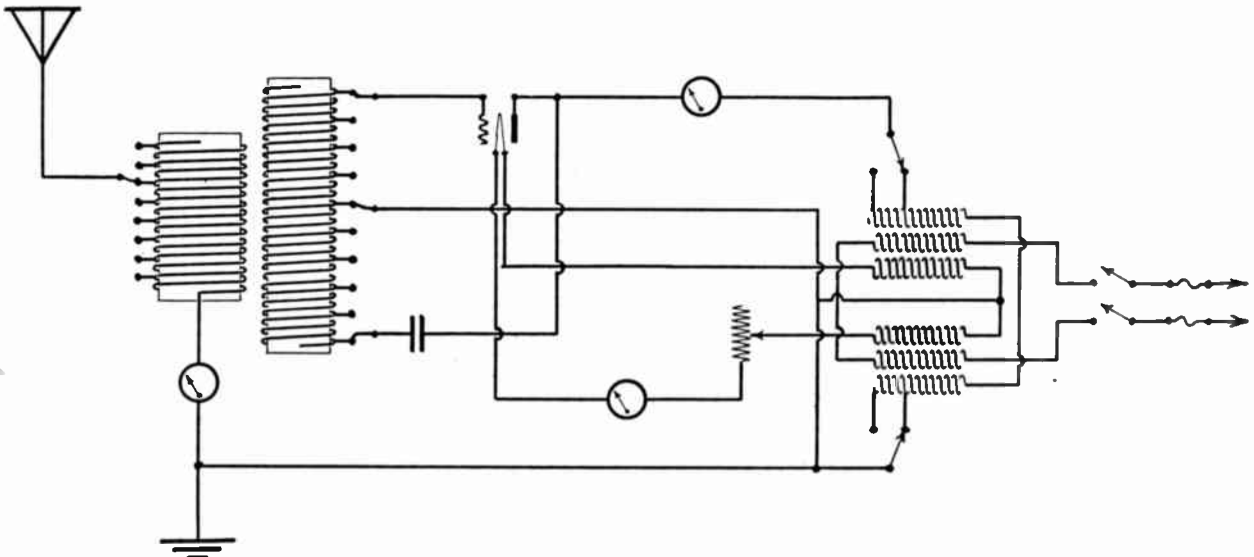


Fig. 1—Diagram of connections for the vacuum tube transmitter

General Description

Fig. 1 gives a wiring diagram of the set with one vacuum tube, although the only changes, when several tubes are employed, is to connect them in parallel. It will be seen that the transformer windings supply current to the filament as well as the high voltage, either 350 to 500, according to the position of the switches. A double-pole, double-throw switch can be used to facilitate the changing from one voltage to the other. In the plate lead is a milliammeter, of a range dependent upon the current passed by the tubes.

The "negative" side of the high voltage is grounded. It is also joined to a tap on the inductance, and to the center lead of the transformer filament winding. This is done to keep the grid from becoming alternately positive and negative. Another lead, in which is inserted a small mica condenser of 0.004 mfd., built to withstand 2,000 volts, runs to the lower end of the inductance. The capacity of the condenser is not critical. However, by varying this capacity, it is possible to create a resonance effect which will greatly increase the voltage applied to the tube.

The filament, with a rheostat and ammeter in series, is wired to the terminals of the low-voltage winding on the transformer.

It is better to make the inductances with short tapping wires extending half an inch from the tube than to use switches, not only because the former is easier to build, but because it does away with elaborate connecting wires. Spring clips are suitable for connectors. The same may be said of the antenna inductances. Radiation is shown by the hot-wire or thermo-couple meter in the lead from the antenna coil.

A Low Power Transmitter

A very satisfactory set for short distances can be made with one to three of the small transmitting tubes now on the market. The tubes might be mounted in a row on a bakelite strip. In this way the grids and plates, as well as the filaments, can be connected readily in parallel. Since there are no satisfactory high-current carrying rheostats available, separate small ones can be put in series with each tube, for it is necessary to regulate the current. An ammeter in the lead from the transformer will show the total current consumed. No definite ideas as to the method of mounting the apparatus will be given, as each man has his own way.

The transformer for this set is the smaller one, described in Part I. It should be connected to the power line through 10-ampere fuses and a double-pole, single-throw switch.

Outside of the transformer, the only other instrument that requires any work is the oscillation transformer. One size will do for small or higher power sets. The coupling coil should be four inches in diameter and six inches long. Experimenters who do not find it too difficult to take taps from high-frequency cable will use 3x16 No. 38, and the others, No. 14 solid copper wire, wound with a string between the turns. In the former case, forty turns will be required, and in the latter, sixty. Instead of having an adjustable connection, the center lead, to the filament, may be fixed permanently. At grid end coil should be tapped every two turns and at the plate end every three turns.

The antenna coil, because it must slip over the other, should be 5½ inches in diameter, wound with ten turns of 3x16 No. 38 cable, or fifteen turns of No. 14 solid copper wire, tapped every two turns. If solid wire is employed, a short piece of wire, ⅜ or ½ inch long, can be soldered on at the tapping points. Then, after one coat of Valspar or Sterling varnish, the thread should be removed and two more coats put on. That will hold the wire under all ordinary handling.

No telegraph key is shown in the wiring diagram. There are several ways to connect it. One is to put the key in the power supply circuit. This is, perhaps, the best. Another way is to short circuit two or three turns of the antenna inductance, or to put the key

(*Concluded on page* 158)

TRANSATLANTIC TESTS

(*Continued from page* 156)

Ann Arbor, Mich.
October 9, 1920.

Radio Editor, Everyday Engineering,
2 West 45th St., New York City.

Dear Sir: I am interested in the Transatlantic Tests you are about to sponser.

I wish to enter the contest and also to suggest that some sort of a handicap be placed on the men in different sections of the country. For instance: Men with stations 600 miles from the coast can hardly compete with men right on the coast.

The handicap should be a wavelength basis, in my estimation, as I am sure I could work almost as far with 700 watts as I could with a 1000 watt.

However, any sort of an arrangement which would place the east and west on about the same footing would be appreciated.

Information for registry:

1. Ross Gunn—Entire Charge.
2. Ann Arbor, Michigan, Station not yet in actual operation.
3. 1,100 miles over land in 1916.
4. C.W.

In closing I wish to express my appreciation of your excellent magazine.

Very truly yours,
Ross Gunn,

426 Maynard St., Ann Arbor, Mich.
September 23, 1920.

Everyday Engineering Magazine,
New York City.

Attention of Mr. M. B. Sleeper.

Dear Sir: We desire to enter our names as contestants in the Transatlantic Sending Tests.

We note from the first condition of the contest that credit is to be given to the man who engineers the work. We wish to have an exception made to this rule in our case and desire that credit be given equally to each of us.

The following information is for your use in assigning us a place in the transmitting schedule:

1. M. B. Williams and S. S. Frizzell.
2. Station will be located at Duxbury, Mass. Call letters have not yet been assigned, but upon their assignment will be forwarded to you.
3. 700 miles on spark set.
4. The type of transmitter must at present remain secret. When our schedule is assigned we shall be at liberty to divulge the method we propose to employ for this transmission.

We trust that this information is complete and that you can accept our entry into this contest.

Very truly yours,
M. B. Williams
S. S. Frizzell.

The following letters, taken from communications from English experimenters, show the interest on the other side, and their readiness to hold up their end of the work.

25 Thirlmere Road, Streatham,
London. S. W. 16, England.

M. B. Sleeper, Esq.,
Radio Editor, Everyday Engineering,
New York City.

Dear Sir: I notice from the "Wireless World" of the 18th of September 1920, that you are desirous of receiving the names of English Amateurs who are willing to co-operate with American Amateurs in an attempt to transmit from U. S. A. to the British Isles.

I shall be pleased to be one of those, on this side of the Atlantic.

My receiving set is sensitive. I have received Annapolis, and should be glad to see if I can receive the American amateur stations. I am,

Yours faithfully,
John N. Cooper.

Chateau d'Etroyes; Bourgneuf-Val-d'Or;
Saone et Loire.
Wednesday, Sept. 22, 1920.

Mr. M. B. Sleeper, Radio Editor,
Everyday Engineering Magazine,
New York City

Dear Sir: Having read in the September 18th issue of the "Wireless World" that American amateurs wished to make some Transatlantic tests, I inform you that I would gladly co-operate with them in these tests.

I have a highly sensitive receiving station located at Villa des Hautes Roches, 55 Boulevard de Mont-Boron, Nice, France, where I will return early next month to stay until the summer and at which I get good signals from America.

I have been for the last two years of the war detached by the French High Commission in Washington to the Navy Department for Transatlantic radio work and I would be especially pleased to help in any possible way American radio amateurs in this interesting attempt.

In the hope of hearing from you soon at my Nice address, I am, Dear Sir,

Yours sincerely
Leon Deloy.

63 Strone Road, Forest Gate,
London, E. 7, Sept. 19, 1920.

Dear Sir: I shall be very pleased to cooperate with you in your efforts to achieve Transatlantic transmission by one of your Amateur stations and accordingly shall be very pleased to hear particulars.

I may state that I am credited with the possession of one of the finest experimental stations in England and can average to listen in on a 3-valve set, using stranded wire inductance coils and tuned high frequency magnification.

Thanking you in anticipation and with the very best wishes for the success of your most excellent project, I am, Dear Sir,

Yours truly
Alexis J. Hall,
Assoc. Inst. Radio Engs.

Clifton House, Hartford, Cheshire.
September 18, 1920.

M. B. Sleeper, Esq., Radio Editor,
New York City.

Dear Sir: Re-Transatlantic tests for amateur receivers. I am very pleased to see your communication in the "Wireless World" and will be pleased to try and receive our American amateur friends, if you will kindly supply the time (G.M.T.) for working, the wavelength and call letters. I possess a licensed receiving station, first obtained in 1913.

My arrangement at present for receiving consists of: A four valve resistance amplifier set, three Marconi V24 valves and one Q valve, De Forest honeycomb coils for tuning inductance, H. W. Sullivan Condensers, Weston ammeter and Fuller block accumulators.

The following are some of the long distance stations I have heard: Moscow, Budapest, Posen, Nauen, Lyons, also the Concerts from Chelmsford.

I have adopted for my call letter, HMH. I am employed as a chemical engineer on the staff of Messrs. Brunner-Mond & Co., Ltd., Winnington, near Northwick.

Yours sincerely,
H. M. Hodgson.

A TUBE SET OPERATED ON A. C. WITHOUT RECTIFICATION

(*Continued from page* 157)

in series with two turns wound around the antenna inductance.

Filament and plate meters, although they are not absolutely essential, are needed if many experiments are to be made. The radiation meter, however, is a necessity. When the set is ready for operation, the antenna clip should cut in about six or eight turns, with ten or twelve in grid and plate circuits.

If, upon closing the current supply switch, the radiation meter shows no indication, the switch should be opened at once. Because no current is taken from the tube circuit, it will be under a considerable overload. After juggling the clips, the circuit will oscillate. Then the problem is to obtain maximum output at 200-meters. The wavelength is determined by the antenna inductance. This circuit adjusted approximately, the grid and plate taps should be moved back and forth until, without causing the tubes to turn blue, or the plates to turn red, the radiation is highest.

High-Power Transmitters

If care is taken to keep the insulation high, vacuum tubes of greater capacity can be employed. There are no air condensers, leaks and other instruments which must be changed when the power is increased. A larger transformer, however, will be needed to supply the heavier current.

It may be found that the telegraph key is not of sufficient capacity to weaken the supply current, as should be done on larger sets. Then a relay, with silver dimes for contacts, will be required. Such an instrument can be made from an old telegraph sounder.

Notes

This type of transmitter cannot be received readily with a crystal detector, but requires an oscillating audion. The range compares favorably with other vacuum tube or spark sets. There are numerous experiments which can be tried with audio frequency tone circuits to give an audible note when a straight detector is employed at the receiving end.

Experiments were made at the Everyday Engineering laboratory on a frequency doubler, but the results were not satisfactory. The frequency doubler does not actually double the frequency, but causes a distortion of the wave form which must be smoothed out by a filter circuit. It is practically impossible to predetermine the design of the transformer. Even those used in commercial stations are made by the cut-and-try method, and in some cases require water cooling to keep them in operation. Therefore, it is not surprising that the decision was reached that a frequency doubler was not a good project for the experimenters.

CONSTRUCTION OF MODEL ELECTRIC CARS AND LOCOMOTIVES

(*Continued from page* 127)

precisely throughout their entire length, and that the scratched line is near the middle of the jaws. This leaves both ends projecting beyond the jaws of a $2\frac{1}{2}''$ vise. With a $\frac{1}{8}''$ drill and with the holes a-a, b-b, f-f and g-g as guides bore the corresponding holes in the truck frame. Unscrew the vise and the first frame piece will appear as in Fig. 10.

We are now ready to locate the holes for the screws which hold the wooden end pieces and the upper and lower bolsters. The first are 3 5/16" each way from the center scratch, and the latter $\frac{1}{2}''$. Referring now to Fig. 3, it will be noted that the screws for fastening the upper bolster are 5/64" x $\frac{1}{2}''$ machine screws, therefore these holes (in the upper side frame only) must be bored for the corresponding tap. All the remaining holes in both upper and lower frames may be bored for a $\frac{1}{8}''$ x $\frac{3}{8}''$ round-headed wood screw. Be sure to locate all holes precisely on the center line of the piece. When completed, an upper frame piece will correspond with Fig. 11. For the lower bolster enlarge the small holes to $\frac{1}{8}''$. It would be forehanded to make an extra upper piece as a template. Remember that all these frame pieces are $\frac{1}{4}''$ too long at each end. The excess will disappear later.

We can now separate all the journal boxes along the center line of the bolt holes. This job requires care. When finished file off whatever burr remains, being careful to remove as little metal as possible, consistently with a "square" finish. Now bore the holes for the box lid screws, $\frac{1}{8}''$ from the top of the box, as per Fig. 7. Tap these holes for a 5/64" x $\frac{1}{2}''$ screw, attach the lids securely, nip off the excess of the screw, and file smooth. All the parts of the four side frames are now ready for assembling, as per Fig. 3. The sixteen bolts, $1\frac{1}{8}''$ x $\frac{1}{8}''$, with hex. nuts, can be obtained from model supply dealers. When the bolts are tight, and if the *original* box and frame stock has been true and square, there should be no "twist" in the assembled frames, and because the bolt holes have been bored with a template, the wheel-base distance *must* be the same in all. The parallelism of the axles is thereby assured.

The respective cross-sections of the wooden end pieces and the upper and lower bolsters are shown in Figs, 12, 3 and 4. Cut the strips for each a few inches longer than the aggregate lengths, and plane them true and square to the required sections. Make the four end pieces first, each $4\frac{1}{4}''$ long, and round at the ends, Fig. 4. Now slip the side frames over the journals until the tightly screwed box lids touch the ends, then insert the end pieces and mark the location of the screw holes, bore them, and attach the end pieces. The side frames will now project about $\frac{1}{4}''$ beyond the end pieces, but do not cut them off until *both* bolsters are attached. Cut the stock for both bolsters about an inch longer than the finished length, square the truck and mark the holes for the small machine screws of the upper bolster. Bore and countersink these holes, and after the bolster is attached mark the excess length thereof, remove from the truck and cut to the marks. Then replace it. During this stage see that the truck is held square and that the bolster is exactly mid length of the truck. The truck will now stay square and no difficulty will be found in attaching the lower bolster. Neither bolster should project beyond the frames. Now remove the projecting ends of the side frames and the excess length of the upper bolster screws. Remember that the swing bolster has a sliding contact immediately under the latter and therefore requires a smooth surface.

The swing bolster is shown in detail in Fig. 12. Make sure that its ends are square so that the spring plates will also be square. The latter are attached with machine screws because one of them must be removed to pass the bolster through the truck. Locate the center screw hole in both upper and swing bolsters carefully.

Mounting the Motor

In mounting the motor put on the L-shaped brass straps first, as per Fig. 3. Then mark the screw holes to match those in the lugs of the motor. Next attach the sheet iron plate, either over or under the name plate, but do not bend it at K until the proper meshing of the gears determines the precise point, and do not bend at a sharp angle. Remember that it is not essential that the motor shaft be precisely vertical, so long as it is radial to the driving axle, and the gears mesh properly. It remains only to attach the shoe to both trucks and the axle brush, as per Figs. 2, 3 and 4. Various modifications of this truck will suggest themselves, but its essential features will remain.

Both trucks are now ready for the body, wiring, controller and reversing switch. But these, as well as a discussion of four and six-wheeled trucks, car bodies, couplers and electric headlights, will be taken up in later installments.

Ed. Note—Model railway enthusiasts will be interested to learn that another article by Mr. Henry Greenly has been received and will be published in an early number, also the second part of Mr. De Lancey's interesting article.

NIGHT LANDING BY MEANS OF RADIO

Wireless calls for aid sent out by a Government mail plane which faced a descent in the dark enabled the plane to make a safe landing, according to *Wireless Age*. Delayed an hour by a windstorm on the last lap of a journey from New York to Chicago, the radio operator on the plane sent out calls while approaching Chicago to light the landing field and prepare for the machine's descent. The message was picked up by the wireless operator at Great Lakes Naval Training Station and on several amateur wireless outfits and relayed to the landing field by telephone. The plane, which carried three passengers and 1,200 pounds of mail, landed at eight o'clock.

ELIMINATION OF INSULATOR FAILURES

In a recent issue of *Electrical World*, Mr. E. J. Kallevang describes methods of detecting faulty insulators and notes the fact that insulators that have been stored several years are found to have deteriorated. This deterioration may be due to mechanical stresses or to the electrical test that has been applied at the works. It is observed that insulators near railway tracks break down readily. This is supposed to be due to sulfur fumes, which may attack the cement and promote crystallization. It is also suggested that in such cases the insulators may reach higher temperatures due to their blackened surfaces. Methods of testing by the oscillator or by the megger are described. It is believed that the higher percentage of failures in the top unit in suspension strings is due to the fact that it is subject to more abrupt changes in temperature. Trees which are near the line or overhang it are a frequent source of damage.

It is said that in Japan it takes ten years to get a new telephone installed. The effect of this is that if anyone gives up his telephone, it is transferred to another and a price of between $500 to $2,500 is paid for it. This has established a business, telephone brokerage. These are men analogous to insurance brokers who devote their energy to keeping track of the telephone situation by buying and selling the rights to same.

The Brown-Bourveri Company of Switzerland has put some large mercury rectifiers in service. There are six of the mercury units in each apparatus in sets of two. The anodes are cooled by the familiar finds and the group of six are good for the delivery of 920 kilowatts at 230 volts d.c.

LIGHT FOR DISINFECTING BARRELS

Ultra-violet rays have long been employed for sterilizing drinking water, milk and other liquids, but a new application of them in Germany reported in *Chemische Apparatur* (Leipzig) is for the disinfection of barrels and casks, particularly beer casks. For this purpose quartz lamps are lowered into the cask to be sterilized and the light turned on for fifteen to thirty seconds. It has been found inadvisable to continue the illumination for a longer time in ordinary casks coated with pitch, since the resultant rise of temperature causes the formation of fumes of pitch. The lamps vary in size according to the dimensions of the casks. In small and average size casks the time mentioned is sufficient to secure complete sterility. Some difficulty is met with in using this method for very large pitch-coated barrels, even when there is a corresponding increase of size in the quartz lamp and a suitable tension, for the reason that so long an illumination is required that the aforesaid fumes are produced. The method is not to be advised therefore except for barrels which are not coated with pitch.

REMOTELY CONTROLLED ELECTRIC LOCOMOTIVES

In a recent issue of the *Electric Journal* there appears an interesting account of a remotely controlled electric locomotive. The motorman first brings the locomotive with eight empty cars and spots the first car under the loading chutes at the screen station of the coke plant. This motorman then throws a switch and places the locomotive under the control of the operator in the screen station and leaves the locomotive. The operator then slowly moves the train forward, stopping or reversing it as conditions may require, thereby securing an evenly and completely loaded car. When the cars are loaded, the motorman returns to the locomotive and draws the cars to the classification yards, returns for empty cars and the cycle is completed.

South Africa is coming into the front field of engineering in her proposal to electrify her railroad system. One line is mentioned which carries a heavy suburban traffic and another line over which a very large freight business is done. Both of these are to be electrified. The sooner the locomotive is replaced by electric motors the better it will be from the engineering and coal saving aspect.

We are frequently asked for back numbers of Everyday Engineering Magazine that are out of print. No issues can be supplied back of January, 1919, and only a limited number of the earlier issues of last year are now available.

ELECTRICALLY OPERATED DRAWBRIDGE

THE United States Government requires all drawbridges on navigable streams to be supplied with two independent sources of power, and where electricity is available this is usually one of them, a gasoline engine usually being the other.

However, at Rio Vista, where Solano and Sacramento Counties have recently completed a bascule type bridge over the Sacramento River, both sources of power are electric. This was possible on account of service being available from both the Pacific Gas & Electric Company and the Great Western Power Company at that point.

Each apron of the bridge is operated by a 20-h.p. 3-phase 220-volt motor, and each motor has its own control, so that the movements of the aprons are independent of each other, though they are usually operated simultaneously. The large bolts which lock the aprons together when the bridge is closed are operated by two 5-h.p. motors, and the gates at each end of the bridge by 2-h.p. motors. All this apparatus is under the control of the bridge operator located in the small operator's house at the west end of the bridge.

As the Pacific Gas & Electric Company has only single-phase service available at Rio Vista, a motor generator set was installed in the operator's house to convert the service to 3-phase. This comprises a 40-h.p. single-phase motor direct-connected to a 30-k.w. 3-phase 220-volt generator and exciter.

By a system of switches power can be supplied to the bridge from either service at will and changed from one to the other almost instantly so that the chance of failure in the operation of the bridge is so very remote as to be practically obviated.

HIGH SPEED WIRELESS

MANUAL operation is doomed as far as long-distance radio traffic is concerned. The ever-increasing cost of high-powered stations makes it necessary to handle a far greater volume of traffic than can be handled by the usual method. Thus some of the present transatlantic stations are operating at 50 words to 100 words per minute by means of automatic transmitters and receivers. In England experiments have been going on for some time with automatic transmitters capable of a normal speed of 450 words per minute, and even 1,000 words per minute during demonstrations. The recording is effected by means of a special electrochemical apparatus. This apparatus consists of a specially prepared paper drawn between a roller and a marking pointer. The arrival of the signal causes a current to pass through the paper producing discoloration.

Radio Co-operation of Radisco Instruments

Did you ever stop to consider the "Radio-Co-operation" of the instruments you buy? How do they co-operate and conform with each other, when they are hooked up in your station? Do you get the strength of signal that only comes from apparatus "that works in harmony". Radisco apparatus does just that; every single instrument turned out by Radisco Engineers is a piece of master craftsmanship which must be subjected to the most rigid scrutiny of laboratory censorship known; and not a single article is marketed until it is proven by actual tests to work in harmony with the other Radisco instrument of quality in "Radio-Co-operation."

The latest triumph to be released from the Radisco Laboratories is the

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No. 2 Coupler (as illustrated) $8.50
No. 2 D. Coupler with dial $9.75

Shipping weight 3 pounds

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OMAHA, NEBRASKA
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PORTLAND, ME.
Atlantic Radio Co.,
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PITTSBURG, PENN.
Radio Electric Co.,
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COMBINED COAL GAS AND WATER GAS PROCESS

THE outlines of a process of gas production is given here, from Vienna, in which the distillatory coal gas method is operated in combination with the well-known and more recent water gas process. To start with, air is blown through a converter filled with coke. This produces a gas rich in carbon monoxide and of fairly good calorific value. It is used to heat a superheater. This may be taken as the first step. Next, the converter is charged with bituminous coal and superheated steam is blown through it in the reverse direction to that taken by the air. The steam has been superheated in the superheater just mentioned. Here a double operation takes place. The hot steam generates in the presence of the hot coke, hydrogen and carbon monoxide gasses. This mixture is water gas. Simultaneously the coal is acted on by the intense heat and ordinary coal gas is distilled and mixes with the water gas, and the two go off to the purifiers and to the gasholders. When the heat falls to a point where the distillation and decompositions no longer take place in proper degree, the first cycle is recurred to and air is blown through the coke now in the converter, but in the reverse direction to that taken by the steam; it is a recurrence to the original direction of the air. It will be seen that there is here no residue of coke, that even the production of tar may be minimized, and that the principal side product will be ashes and slag.

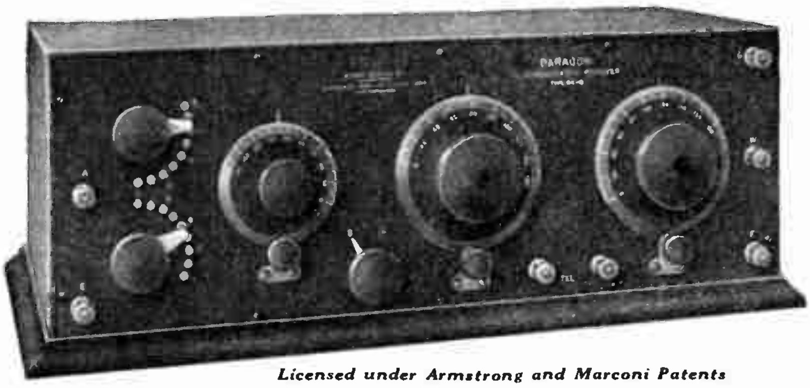
A SECRET WIRELESS STATION

A WIRELESS telegraph outfit has been discovered by fishermen at Melleha Bay, anchored in 20 fathoms of water, with the masts and working parts below the surface to a depth of 8 fathoms. The apparatus, which is said to be complete in every detail and of German manufacture, was removed by the Dockyard Authorities for examination.

The smelting of zinc was commenced in England about the year 1743 by Champion, who maintained great secrecy about the process. The zinc was used for a variety of purposes previous to its employment in brass making as all brass made at that time was produced by the calamine method, by means of which no metallic zinc was required. The fact that better brass could be made from the metallic zinc required a long time for acceptance and it was even as late as 1859, says Percy, that a few calamine brass furnaces were still left. Within a few years, however, they passed out of existence.

Amplification 100 Times

Do you want to receive signals of marvelous strength; to hold those that gradually fade out and to bring in stations that you have never heard before? You do not need a big aerial to get them,—use the new



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Amplifying Short Wave Receiver

Greatest Improvement in Modern Radio

Do you remember the super service of the old original Paragon RA-6 amplifying short wave receiver? This new set surpasses it in every respect

and the original RA-6 was the only one of its kind

150% improvement over the old original Paragon, away ahead of all other receivers and excels the most serviceable set on the market today.

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A Wave Length range of 160 to 1,000 meters.
24% more sensitive and selective than the RA-6.
All amplification obtained without change of spark tone.
Objectionable effect of change in note entirely eliminated.
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Controls on all adjustments fitted with vernier attachments permitting of very fine tuning and control.
No dead end losses.
Cabinet of quartered oak; overall size 20⅝ x 8 x 7½"; white filled engraving, bakelite panel, knobs and dials.
Every set sealed before leaving factory, which is a guarantee for two years.
A super product of Adams Morgan Co.'s unapproachable engineers.
And the price $85.00.

Startling surprises in store for you if you will send for special bulletin describing this set.

Remember the old Paragon—this one beats it and all others by miles—our special bulletin tells you how. Send for it—it's free.

Our word of honor to you is our guarantee. Let us prove it.

CONTINENTAL RADIO AND ELECTRIC CORP.

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BOOK REVIEW

SELECTED STUDIES IN ELEMENTARY PHYSICS. By E. Blake. 175 pages, 43 illustrations, cloth bound, 7½ by 5 inches. Published by The Wireless Press, Ltd., London, England.

A man who knows nothing of wireless can make a set work, and a man can know quite a little about radio tho he is entirely ignorant of the scientific phenomena upon which it is based.

To sum up Mr. Blake's book in a few words, it supplies the information which writers do not consider a part of radio books, namely, explanations of such subjects of physics as aether and space, matter, force, and motion, stress, strain and elasticity, electromagnetic theory of light, chemical actions, names, formulas, and electro-chemical equivalents, all of which have a bearing on radio work.

Many answers to puzzling questions which continually confront the radio experimenter are found in this book.

NONFERROUS MINING INDUSTRY IN THE UNITED KINGDOM

DISCUSSING the nonferrous mining industry in the United Kingdom, Consul-General Robert P. Skinner, of London, says that tungsten ores (wolfram and scheelite) are mainly by-products in tin mining, and the high prices realized for these materials and for arsenic ore during the war were of great assistance to the tin mining companies producing them. Tungsten was in great demand for high-speed steel making and some attempts were made to work mines yielding wolfram alone; but, with one exception, these mines scarcely reached the productive stage during the war, and at the present market price for the ore they cannot be worked at a profit. The British production of tungsten ores amounted in 1918 to 302 tons, or about 1 per cent of the world's output.

Arsenic ores (arsenical pyrites or mispickel) is a sulpharsenide of iron. White arsenic is the product of a roasting process, and in most cases is a by-product of the treatment of tin ore. During the roasting process the iron is oxidized and the arsenic volatilizes as "arsenic soot," being collected in the flues. "White arsenic" (As_2O_2) is the refined product. The British production in 1918 was 2,349 tons, or about 15 per cent of the world's production.

Barium minerals occur as barytes (sulphate of barium) and witherite (carbonate of barium), the latter forming only a small proportion of the production. The present British production (66,360 tons in 1918) is about 22 per cent of the world's production and 66 per cent of the normal home consumption. Barytes is in part a by-product of lead and zinc mining; but the larger proportion is mined independently, and the production can be largely increased.

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Type C-300 is produced by an entirely new process of manufacture. Gas action must be coupled with electron emission for high signal audibility and sensitiveness as a detector. In the past it has been impossible to control this necessary gas content during manufacture and also obtain uniformity. Put Type C-300 to the test as we have in comparison with all previous types of tubes. I am confident of your answer.

Produced in large quantities entirely by machinery in the largest vacuum tube factory in the world has made it possible to offer Type C-300 at the remarkable price of $5.00. Every tube is carefully inspected and tested and is guaranteed free of all mechanical and electrical defects.

Insist on Type C-300

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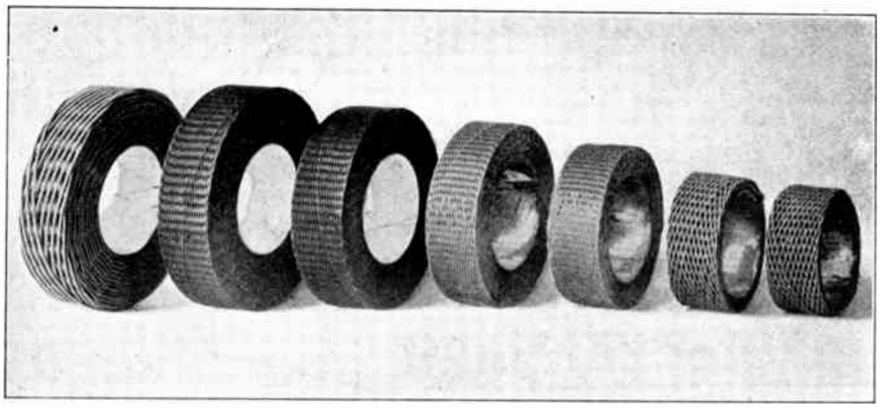
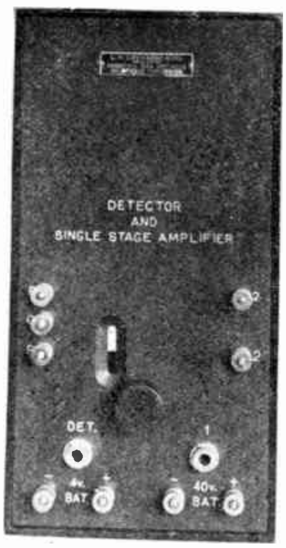




STEEL FOR DIES

Die blocks for making drop forgings are made in four standard grades of steel, of which three are alloy steels. Blocks of chrome steel, heat treated, come ready for service and require no further hardening. This steel makes a good block for medium and heavy forgings, such as crankshafts, gear blanks, etc. These blocks show a normal scleroscope hardness of about 45, but can also be furnished in a hardness of 50 to 55, if required.

Die blocks of chrome nickel steel are furnished both in the annealed and in the heat treated state. When annealed, they show a scleroscope hardness of 30 or less. When heat treated, the hardness varies between 33 and 36. When furnished in the heat treated state, the blocks do not require hardening. These blocks are especially recommended for forgings of heavy sections, owing to the heavy strains to which the die blocks for such forgings are subjected. Blocks of this material can be hardened to a scleroscope hardness of 65.

The third grade of alloy steel from which die blocks are made is the oil hardening chrome nickel steel. The annealed blocks show a scleroscope hardness of 32, while the heat treated blocks show a hardness of 34 to 36. Blocks of this steel are especially recommended for thin sectional, deep impressions or intricate shape forgings. These blocks may be hardened to 70 scleroscope and in hardening them it is essential that the entire block be immersed in oil.

Blocks of carbon steel are also furnished either in the annealed or heat treated state. The annealed blocks show a scleroscope hardness of 30 or under, while the heat treated blocks show 33 to 35 deg. Heat treated blocks may be sunk without any further treatment. These blocks are especially recommended for upsetting dies. With blocks of this steel, a scleroscope hardness up to 60 is obtained.

In heating die blocks for heat treatment, the blocks are placed in the furnace face up, and an air space of at least 6 in. is allowed between blocks. The blocks are allowed to heat slowly and evenly till they reach a temperature of 1400 deg. F. In order that the block may be thoroughly "soaked," that is, uniformly heated all through, a period of 50 minutes per inch of the smallest dimension of the block must be allowed. The block must be drawn immediately after hardening. If blocks which have been hardened are to be annealed they are heated to 1400 deg. F. and allowed to cool slowly in a sealed furnace.

Before a die block is heated for hardening the impression should be carefully polished. Cold blocks must not be introduced into a furnace already hot. If a block shows uneven heating by uneven color it should not be quenched. The block should not be allowed to become dead cold in the bath. The above information on die blocks is taken from a booklet on the subject issued by the Pennsylvania Forge Co.

SYNTHETIC RUBBER IN GERMANY

THE production of synthetic rubber by the firm of Friedrich Bayer in Germany attained 150 tons per month toward the end of 1918. This rubber sold at 37 marks per kilogram ($4 per pound on a nominal exchange rate basis), and was used almost exclusively for storage battery jars for submarines, portable lamps for the army, army automobiles, etc.

FIGURING MATERIALS USED IN CONCRETE

ONE of the first problems in planning any concrete construction is the quanity of each material necessary. The quantity may be estimated as follows: Suppose 850 cubic feet of cement is needed. A mixture of 1-2-4; that is one part cement, two parts sand, and four parts gravel by volume is used, requiring two bags of cement and making a total of 8½ cubic feet of concrete. It will require just 100 times as much of each material as in a two bag cement mixture, or 200 bags of cement, 375 cubic feet of sand and 750 cubic feet of gravel to make 850 cubic feet of concrete. Calculations may be made for any size structure on this same basis.

ELECTRIC VEHICLES IN ENGLAND

In England there is considerable interest in the electric vehicle. Its development is restricted, however, because there are so few charging stations. Of the two standard types of storage battery of motor cars no preference is reported for the other. It is said that the nickel-alkali-iron oxide battery represented in this country by the Edison Battery, stands abuse better. There is a new Italian battery, the De Markis, of the lead plate type which is very favorably spoken of. The storage battery shunting locomotive is being used in England in track yards with considerable success. The warning is given that in charging a storage battery the temperature should not be allowed to rise above 115° Fahrenheit.

In Chicago the customers purchasing electric power and light are increasing at the rate of 30,000 to 40,000 additional consumers each year. It is thought that the Chicago Co. is the largest one in the world of its kind.

OLD INNER TUBES HAVE MANY USES

ALL motorists, and that term now includes many thousand farmers and mechanics, accumulate damaged or unserviceable inner tubes. What to do with them besides selling them at a small price for old rubber is a question. But these old tubes can be used in many ways to give excellent and varied service. If cut crosswise in widths from a quarter to a half inch, excellent rubber bands can be made. They may be used in numerous ways, as for holding the pages of note-books, or for holding the tubes that have been repaired and are carried in the automobile. They may be used for holding the covers of the boxes filled with small drills, cotter-pins or nuts. They also serve for securing small bundles. Various other uses will suggest themselves to the owner. Being so much larger and heavier, they are much more useful than the bands usually sold in stores.

Pieces of tubes may be cut with scissors and used for washers for various purposes. These washers will not last as long as washers made of treated fabric or special packing for general use, but considering what they are, they give reasonably good service. Occasionally the nozzles on hose or tree-spraying outfits will not fit tight and a washer cut from an old tube will serve an emergency purpose and perhaps will save a special trip to town or to a store when work is pressing.

By starting at the end, cutting spirally round tube, one can get as long a strip of the rubber as one wants. These strips may be used to wind hammer and ax handles and iron lever handles on farm implements. Put on some rubber cement on the handles and then wind on the strips of rubber, being careful to keep them stretched fairly tight. There is a little trick to tucking the last end under the last "two times around," but after one handle has been wrapped the others are done easily. These wrapped handles do not blister the hands and the rubber wrapping will be found perferable to wrapping with adhesive tape.

By all means save the valve stems. Sometimes a valve stem is damaged and must be discarded. The valve stem out of an old tube can be inserted, cemented, then fastened by the wing nut and lock nut, and the tube will be as good as it ever was.

Pieces of old inner tube can be used for patching any articles made of rubber in an emergency but great care should be taken in cementing to insure adhesion of the rubber. Old rubber will not stick as well as new material.

A BRIEF HISTORY OF ARTIFICIAL LIGHTING

JUST how man first came to harness fire for heat and light we shall probably never know. Many are the legends and myths as to its origin. Innumerable are the phases of its worship. Incalculable are its beneficiences. And interesting, indeed, are the steps by which man has advanced from the flickering torch and arduous firestick to the brilliant filament and powerful arc of modern times. Perhaps a flash of lightning kindled the leaves of some primeval forest to the wonderment and alarm of our arboreal forebears. Perhaps the striking upon a rocky ledge of a stone hammer aimed at some enemy, showed the latent spark awaiting man's bidding. Who can tell?

And like was his wont as to all things that represented his greatest needs and above which clustered his most direful fears, man, from the beginning of time has worshipped the "sacred flame." The Peruvian with his Vestals of the Sun and the Roman with his Vestal Virgins, were but echoing the worship of the savage and of the early Egyptian, who looked upon fire as a ravenous beast that bit all that approached, or as an insatiable god that devoured everything it could seize, only to be ultimately destroyed by what it consumed.

All tribes agree that some time—somehow—the priceless gift of fire came from the sky—whether from the mysterious recesses of the sun or from the sacred realms of the gods. And strange to say, the ultimate in light was the result in part of a significant "message" from the clouds interpreted by that mighty minded American, Benjamin Franklin; although nearly a hundred years elapsed before man fully profited by the lesson of the kite and the key.

Probably the most interesting and beautiful of all of the myths having to do with the origin of fire is that of the Greeks with reference to Prometheus. He and his brother, Epimetheus, were commissioned by the gods to create and people the earth. Epimetheus, it seems, was so prodigal in endowing the animals with distinctive qualities that when he had finished man, he found that he had no gift worthy to bestow. He therefore appealed to Prometheus, who, with the aid of Minerva, lighted his torch at the chariot of the sun and gave to man the precious gift of fire.

Man was thus enabled to make weapons and tools; as well as to light and warm his dwellings and ultimately to develop the arts and industries. The cave man doubtless felt duly grateful for his fitfully flaring torch which revealed to him the yawning abyss or

(*Continued on page* 173)

The Radio Articles Are a Distinctive Feature of This Magazine

A BRIEF HISTORY OF ARTIFICIAL LIGHTING

(*Continued from page* 171)

prowling beast. Indeed down to the time of Queen Elizabeth the "man about town" who sallied forth at night to join congenial spirits at the village inn or to pay his respects to his lady fair must needs call into service a torch bearer if he would not fall prey to the "strong arm" men of his day.

The men and women of early Rome, and Pompeii and Athens, in all their splendor, were dependent upon lamps burning animal fat, the bronze and silver workers vieing with each other in their designing and fashioning. Candles of tallow, bayberry and "wax" came later, and gave rise to a wide variety of artistic candlesticks and candelabras. Illuminant gas made from coal was used as early as 1800. Petroleum-kerosene—or "coal oil" as it was first called, came into use as an illuminant about the time of the Civil War.

The first arc lamp was invented by Sir Humphry Davy in 1810, the energy being developed by the use of batteries. In 1863 the first machine to generate electric current for an economic purpose was used to light French and British light-houses.

Thomas A. Edison, in 1879, astounded the world with his "incandescent" lamp, the first high resistance lamp, in which a filament was made to glow in a vacuum. The first filaments were made of paper, bamboo, etc., and later of carbon; tungsten in the past few years having taken the place of other substances.

Distribution of electric energy was first accomplished by numerous plants supplying limited areas. The world's first electrical station was operated in Appleton, Wisconsin, in 1882. Alternating current came into use in 1885. The first steam turbines were installed by the Westinghouse Company in 1900. An approximation of the development of electric business of today may be had from the statement that in 1912 over seven and one-half million h.p. was developed in America, of which nearly five million was developed by steam and about one-half that much by water power.

The wonderful Mazda lamp and enclosed arc of today would seem to be the ultimate in convenience, utility and economy in the lighting of home and office and yet the greatest scientist must doff his hat to the ideal efficiency of the humble little firefly's "lighting apparatus" in which the non-utilized heat is reduced to a negligible minimum, notwithstanding the slur it has to bear of carrying its headlight on behind.

THE PRIME MOVER OF THE FUTURE

THE country has wonderful coal resources, upon which ever and ever greater demands are made by our industries and, for the time being at least, by the entire world. This great natural wealth is the result of centuries of geological formation—it is an inheritance handed down from prehistoric ages—so last year we were richer than we are today, and considerably richer potentially when James Watt invented the steam engine than we will be next year. It is a case of a diminishing national fortune, squandered in large part, for we rarely secure more than from 10 to 15 per cent. of the value of the coal we burn. The large balance is wasted—unavoidably, perhaps, on account of our ignorance as to ways and means of more efficient transformation of energy, but wasted neverthless.

This crude presentation of facts is not an attempted portrayal of the brief of our conservationists of national resources, but is made to explain in part the ever repeating belief held by prominent men that this country must pass into what may be termed a petroleum age. Chairman E. N. Hurley, U. S. Shipping Board, intimated not long ago that this country would have to come to a petroleum age, that petroleum was the only fuel which would allow the country's shipping to compete with foreign shipping and that fuel oil was bound to be used generally for power generation. *Coal Age*, at about the same time, published an editorial predicting that it was only a question of time when no raw coal would be sold, *i. e.*, that gas or byproducts would be extracted from the entire coal supply.

These excerpts simply emphasize the well grounded belief that the chief prime mover of the future will be the internal combustion engine. Already, such motor is an important power producer in our industrial activities, a prime mover which is daily proving highly economical and reliable in service and by which a constantly increasing proportion of industrial motive power is being developed.

NON-LEAKING STORAGE BATTERY

A NEW storage battery said to be absolutely non-leaking has been produced. It has a special valve to let off the explosive gas, so arranged that no acid can get out. The plates are separated by strips of wood which not only prevent short-circuiting inside the cell, but retain the acid when the storage battery is upside down, giving an electrical efficiency of 75 per cent in this position. This battery is a German invention.

MANUAL ARTS AND CRAFTS

(Continued from page 137)

When boring for the ¼-inch dowels care must be taken to have the holes line up parallel with the slats; that is, not to tip sidewise; this can be checked by sighting. A jig may be made for boring which would also answer as a depth gauge. Fig. 11 will suggest one type. A block ⅞ inch, long enough to steady the slat and bit with a cleat nailed on each side to act as a socket, with two dowel pins to act as a lock. The upper part to be just long enough to permit the bit to bore a hole 1 inch deep in the ends of the slats. The ¼-inch dowels are then glued into these slats, leaving a ¼-inch projection to engage the grooves. It is not necessary to have a dowel in every slat, every alternate one will suffice.

Pigeon-Hole Unit

A detail of the pigeon-holes is shown at Fig. 14. The vertical members g are nailed with brads to Z, then the horizontal members f are nailed to all the g partitions, the side components e are then bradded to the two f's, the N partitions are then nailed to f, the k's are bradded to e and to h. The k horizontals are fluted on the extended end convenient for penholders and pencils. The pigeon-hole unit should be a snug fit and may be fastened by screws to the sides of the desk. A backing ¼ inch by 12 inches by 28⅜ inches should be bradded to the back of the pigeon-holes to prevent papers from interfering with the roll top when sliding. The drawers p of this unit may be constructed similar to Fig. 14, or they may be just plain trays with a false front (an additional piece added ¼ inch thick, ⅛ inch larger all around and the outside edges slightly rounded to give a finished appearance).

The details of a simplified drawer construction are given at Fig. 14. This is a method much used by carpenters when making drawers by hand when done outside of the shop. While this method is not the equal of dovetailed joints, they are very durable and practical. The fronts are rabbetted 1 inch by 2/3 of its thickness and full width to receive the sides which are glued and bradded (lock-nailed) to the front. One must not forget to dado the sides for the back and groove the sides for the bottom before nailing them to the front, also rabbetting the top and bottom edges for the raised-panel effect of the fronts.

There are a number of methods for drawer slides, the one shown being the simplest one. The bottom of the drawers and the roll-top grooves should be well paraffined to prevent squeaking

(Continued on page 176)

and to slide easily. This is best done by melting a small quantity of paraffine and brushing it where desired. The drawer front Y is cut out, as shown, for additional clearance for one's knees, and the sides to cover the slides. A slide shelf, Fig. 15, may be made of pine or white wood with a piece scarfed into it, as indicated in the sketch, of the same material as the drawer front, etc. All drawer sides, bottoms and backs, pigeon unit and back panels need not be of the same kind of wood. Usually they are of white wood, bass wood, maple, birch and beech. That which is exposed to view may be stained to match the outside.

Drawer sides, bottoms and back are not usually stained, they are sometimes, however, shellacked. The grain of the wood in the bottom of the drawers always runs parallel with their fronts and never glued in place, but fastened at the front with brads. This permits the wood to expand and contract, according to the moisture of the atmosphere, without causing the drawers to bind. Bear in mind that one cannot prevent wood from swelling or shrinking. That is the principal reason for panelling and drawer construction.

Using Hot Glue

A project of this magnitude surely is worthy of superior materials and especially of the best obtainable glue, as this particular feature is often misunderstood and consequently much abused. By all means buy the best French glue, one-half pound will be more than sufficient for this project. Soak this over night in cold water in a clean kettle or regular glue pot. Then insert this kettle in another pot of sufficient size to permit a body of water to surround the inner one's sides and bottom. The supply of water must be maintained while the glue is melting (cooking), and all the time that any heat is applied to the glue. If the glue is scorched at all it absolutely destroys its adhesiveness and should be thrown away as worthless. Clear water, cold if added before the glue is heated or warm if the glue is cooking, must be added to the glue until it has the consistency of light molasses. Care must be taken that oil or soap in any form does not contaminate the glue, as it will utterly destroy it. It is astonishing how infinitesimal an amount of any foreign grease will cause its destruction.

Another precaution to carefully observe is that the glue does not chill (become cold) before the surfaces are tightly clamped. In cold weather have the surfaces warm; the hand screws or clamps in position for quick work before applying the glue.

It is considered necessary in hot glue work that the work be fitted and clamped in position to be sure there will be no hitch in a critical moment.

To facilitate operation everything should be convenient for rapid work before the glue is applied to any joint; clamps, blocks to protect the edges where clamped, paper to prevent the blocks from sticking to the work, braces to straighten angles and to hold the work flat, mallet for tapping or starting joints, try-square to check the work, and any other appliance that may be required in special cases.

Whenever it is possible to divide the gluing-up process into steps it is advisable to do so for many reasons. For illustration, when gluing the side frames, glue all the rails into one stile, slide the panels in place (panels are never glued in place, as they must be free to contract and expand), then glue the opposite tenons or dowels into the remaining stile. If dowels are used, they should be glued in the rails first, the surplus glue removed around the dowel, then glued as before mentioned.

When gluing the back panel it will avoid a possible mishap if this sequence is followed: glue a rail and stile at one corner, then slip in a panel followed by a mullion glued into the rail, then panel, etc., finishing by gluing the top rail last. It is considered better practice to brush the glue on both surfaces, using the glue a trifle thinner. Glue holds best on side grain, but end grain can be made to hold fairly well by sizing with a thin glue. This must dry, then be pared down to the wood and reglued as ordinarily.

Surfaces that have been sandpapered will not glue well, they should be scratch-planed with a tooth iron. A piece of glass ought to substitute for a tooth iron if used judiciously, using a reasonable amount of precaution not to mar the exposed edges. Surfaces of hard woods, especially close-grained woods, should be scratched or tooth-ironed.

Glue may be water-proofed by adding one part of potassium bichromate to fifty parts of glue. It becomes hardened and insoluble when exposed to the light and the air.

Remove as much of the surplus glue that is squeezed out at the joints as possible with a warm, damp cloth, or it may be peeled off with an edge tool or a scraper before it sets too hard. Both of these ways are surely preferable to digging or practically chopping it off after it has firmly hardened. Hot glue work should remain at least six hours in the clamps before removing; if fish glue or liquid glue is used, at least twelve hours or longer if done in humid weather.

When the side panels are glued and dressed they may be assembled temporarily in position, the components E, F and G fitted, when the back is ready the whole fastened as a unit. The desk top is then made and placed and dowels are used to hold the front edges in position. The roll-top slats are glued on the canvas. While this is drying the desk sides may be fastened and temporarily placed. The roll top must be repeatedly operated in the grooves to be sure of it working freely before the desk sides are fastened permanently in position.

If the top shelf is not attached until the pigeon-holes are fitted in position, the roll top may be pushed back further out of the way. When the top shelf is finally placed it acts as a stop for the roll top, permitting it to push up to the knobs that are used as handles. Above the pigeon-holes may be used as a secret compartment.

The drawers may be finished and assembled in any convenient order. The next step is to thoroughly sandpaper the project, using No. 1½, followed by No. 1, then No. ½. Care must be taken to sandpaper with the grain and never across the side grain. All scratches, bruises or scars must be eradicated before staining, as any kind of finishing accentuates these blemishes.

The sandpaper must be carefully stretched around at least three sides of a conveniently sized block, approximately ¾ inch by 2 inches by 7 inches. Bruises may be sandpapered by using a piece of felt or the fingers instead of a block. Be sure that no surplus glue is left on any exposed surface, because stain will not take effect there.

The next process is to stain the work the desired color to match the general surroundings, or at least to harmonize with the color scheme. It is impossible to write a complete treatise on stains in this article. The reader is referred to the June, July, August and September editions of Everyday Engineering Magazine for suggestions for the making and the using of oil, water, spirit stains and those due to chemical changes in the wood, such as fuming, etc.

The last process is the polishing, or so-called "finishing." There are three principal forms of wood polishes, each with its virtues and its defects. They are, first, oil; second, wax; third, varnishes. These will also be found sufficiently complete in the forementioned editions in the articles by the writer under "Manual Arts and Crafts." In the following articles will appear additional stain mixtures and polishing methods.

To bleach ivory and bone it is sometimes sufficient to expose them to the sun under a plate of glass. The glass plate is absolutely essential. The bleaching can be made more intense by placing under the glass along with the objects some turpentine in a cup or saucer, it being most important that the turpentine should not touch the articles to be bleached. Only its vapor must react upon it.

HARDENING HIGH SPEED STEEL

A HARDENING paste made according to the following formula has been used on high speed steel with success, enabling it to be hardened by heating in an ordinary gas oven, and thus making unnecessary the very high heat usually called for in hardening such steels: Mix two pounds rye meal, one pound common salt, ¼ pound pulverized borax, ¼ pound pulverized charcoal, ⅓ pint (or ¼ pound) liquid cyanide of potassium, ½ gill or two ounces of water glass (silicate of soda) and three pints of water. The liquid cyanide is made by dissolving three ounces of pulverized potassium cyanide in one pint of boiling water. Mix thoroughly to form a paste.

When using the paste it has been found best to apply it in the following manner: Provide a small cast iron vessel or a crucible of the shape of a drip pan and spread a thin layer of the paste on the bottom. Put the work in the pan and cover that with paste also. Place in the gas oven and heat until it reaches a nice full red. Dip in sperm, fish or kerosene oil.

BLACK FINISH FOR STEEL

THE pieces to be blackened should be polished with No. 120 emery cloth. After polishing, the surfaces should be cleaned carefully, and then the work placed over the fire and drawn evently to a second blue. Then, the work is dipped in lard or sperm oil, from which it is immediately removed, and all loose oil shaken off. This prevents the forming of blisters. An old piece of rubber, for instance a piece of old garden hose, is then placed on the fire, and as it burns, the work is held over the flame and smoke that comes from the rubber, until it is covered with a thick coat of black soot. The work is then removed from the fire, and permitted to cool off slowly. When cool, it is rubbed with an oiled cloth. All this must be done in one heat.—*American Blacksmith.*

A system of uniting plate by a version of electric spot welding is supposed to replace riveting. It is more economical than spot welding and can be applied to thicker plates. It is executed with a similar welding machine, and is said to give a joint superior to a riveted one. The plates have depressions pressed or rolled into them where the welding is to be done, each depression representing practically the place where a rivet would normally go. Discs are supplied slightly less in diameter than the depressions and thick enough to keep the plates out of contact. A spot welder is applied to each pair of depressions with a disc inserted and the two plates will be held firmly together.

TO CALCULATE THE HORSE-POWER OF A RUBBER MOTOR

ASSUME the screw is wound to 500 turns, that it runs down in 20 secs. and the mean thrust is 3 oz., pitch being 15 ins., and mean speed 1,100 r.p.m. The number of foot-pounds of energy developed =

$$\frac{3 \text{ oz.} \times 1{,}100 \times 1\tfrac{1}{4} \text{ ft. pitch}}{16 \text{ oz.}}$$

= 258 ft. lb. per min. approx.

Since the motor runs down in 20 secs., the energy actually developed =

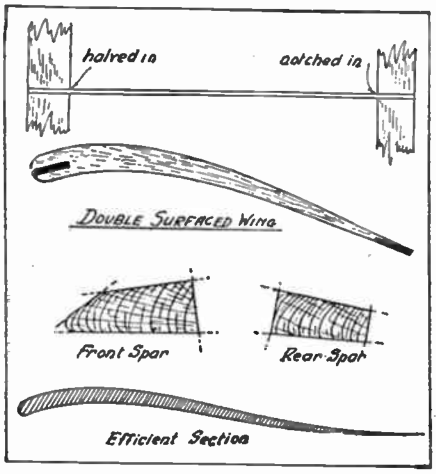
$$\frac{258 \times 20}{60} = 86.0 \text{ ft. lb.}$$

The motor develops power in the order

$$\frac{258}{33{,}000} = .0079 \text{ h.p., but for 20 secs. only.}$$

WING CONSTRUCTION

The accompanying drawings show a new way of constructing cambered wing framework. It is to cut the ribs to the correct camber, and then to let the spars in, as shown black. The usual method of bending the ribs to the camber is inefficient, because the bottom



Cambered wing construction

camber is thus equal to the top. This method, however, whilst it does not add to the weight, permits of a more efficient construction and also double surfacing. I also show an efficient wing section for models, and spar sections which lend themselves to the construction of cambered surfaces more readily than do the ordinary rectilinear section. —*F. J. Camm in Flight.*

A vessel with a single smokestack or with two very close together is found to give less indication of its course to the observer at a submarine periscope than where the smokestacks are widely separated. Rounding the ends of the bridge was found also to conduce to this element of protection. Dazzle paint is put on with a view to deceiving a periscopic observer as to the course taken by the vessel rather than with any idea of making the vessel invisible at sea.

GEAR STEELS: THEIR PROPERTIES AND TREATMENT

IN gas welding work one of the most common jobs that the blacksmith encounters is that of building new teeth into gears that have been stripped. Owing to the fact that special steels and heat treatment are used in gear manufacture for trucks and tractors, it should be of some value to the gas welders to gain an idea of the types of steel used in the gears which he may be called upon to weld.

In gear design the steels used are divided into two groups. Steels for case-hardened gears where there is a hard surface and soft core and steels for tempered gears where there is uniform hardness throughout the entire tooth section. For automobile work, case-hardened steels of six types are generally used, three of these types being quite common. These are: Simple carbon steel, mild chrome steel, 3½ per cent nickel, 5 per cent nickel, medium chrome nickel and high chrome nickel. In tempered gears, medium, mild and high chrome nickel steels are used, also air-hardening chrome nickel.

It should be remembered that warpage of case-hardened gears as a result of heat treatment always occurs to a greater or lesser extent. This warpage is reduced by care in annealing before hardening the gears. The forgings as they come from the hammer and are cooled under varying conditions always have some internal strains. Annealing leaves the metal in a state of rest so that warping does not follow to the same extent.

Tempered gears are made principally from the four types of steel named above, especially of the mild chrome steel. In all gear design the steels used may be placed in five groups:

First—Cast iron and semi-steel.
Second—Steel castings.
Third—Unhardened and untreated steel.
Fourth—Case-hardened steel.
Fifth—Tempered steel.

Gray iron castings for gears have, of course, extremely variable hardness, which varies with the size of section, temperature of casting and the analysis of the iron.

Semi-steel is a name given to cast iron to which has been added by melting in the cupola steel scrap of varying proportions up to 20 per cent or even 30 per cent. The addition of steel increases the density of the iron and also its strength and results in better wearing qualities on the gear teeth than is obtainable with cast iron alone.

Steel castings for gears will usually be found to have approximately the following analysis and tensile properties: Carbon, .30-.40 per cent; manganese, .40-.75 per cent; silicon, .20-.50 per cent; phosphorus, not over .06 per cent; sulphur, not over .06 per cent; 25,000-35,000 lbs. per square inch elastic limit; 60,000-70,000 lbs. per square inch tensile strength; 18-22 per cent elongation in 2 inches; 25-30 per cent reduction of area.

For this class of gears unhardened and tempered steel may be picked out, representing almost anything from .15-.40 per cent in carbon with usually very high values for manganese, phosphorus and sulphur, the latter two elements being the ones whose presence is necessary in relatively large amounts in order to insure easy machining. The tensile strength of steel of this character will vary between 55,000 and 70,000 pounds per square inch.

In case-hardened steel gears the steel is purchased by the gear manufacturers in bar form, in forgings and in rolled blanks. The standard analysis is: Carbon, .15-.25 per cent; manganese, .40-.60 per cent; phosphorus, not over .04 per cent; sulphur, not over .05 per cent.

In tempered steels, again bar stock, forgings and rolled blanks represent the conditions in which this steel reaches the gear maker. A hand-book by a steel manufacturer of forged and rolled carbon steel spur blanks gives two ranges of carbon contents for this type of work. The medium grade of .35-.50 per cent and the hard grade of .55-.65 per cent carbon. Experts are of the opinion that the latter grade is too high in carbon for quenched gears, and that .35-.50 per cent carbon is the range which will on the whole give most satisfactory results from the standpoints of ultimate service, warpage in hardening and breaking either in hardening or in service.—*Canadian Blacksmith.*

DRILLING HEXAGONAL AND OTHER HOLES

THE degree of perfection to which the drilling of square holes has attained has induced some of our inventors to proceed further, and, it is claimed that hexagonal and even octagonal holes are being drilled by a Hungarian named Bartholomius.

This new machine is said to be free from the defects of earlier types and is automatic in its action. It can be attached to any boring machine, lathe, etc., without regard to the type or method of supporting of the particular machine. The device, is, in fact, an independent and self-contained tool. The angular holes are drilled very accurately, as the drill is guided over the whole of its length and the work-piece and the clamping device are in immediate contact with the guides. At the same time that round holes are being drilled, the new type of boring tool automatically drills hexagonal and polygonal holes. To obtain different sized holes, it is only necessary to change the drill used.

BOOK REVIEW

HISTORY OF NAVAL CONSULTING BOARD

A very interesting volume has just been received, this having been published by the Government Printing Office of Washington, entitled "The Naval Consulting Board of the U. S.," which gives in narrative form an account of the origin and achievements of this board, which was created in 1915. Many of the most interesting inventions of the war with illustrations are set forth in this volume, including the work of T. A. Edison, who is President of the board. The development of the listening devices which were so successfully used by our Navy to detect submarines are described in detail with suitable illustrations.

The volume also sets forth the returns from the mobilization of the inventive talent of the country as well as the industrial preparedness of the board and the origin of the Council of National Defense.

The author, Lloyd M. Scott, was given free access to the records of the board, the individual assistance of its members and also much valuable data in Navy departments was made available in the preparation of this book. If the demand for copies satisfies the Superintendent of Public Documents, the Navy Printing Office, Washington, D. C., will issue a sales edition and application for copies should be made to that office. The book is a particularly interesting volume to those following invention and shows how the ingenuity and inventive abilities of the members of the board were utilized in developing devices that helped materially in winning the late war.

NEW MODEL AIRPLANE CATALOG

The 1920-21 revised and enlarged edition of the hand book, "Model Airplanes, Supplies and Accessories," issued by the Wading River Manufacturing Co., 672-D Broadway, Brooklyn, N. Y., has been received.

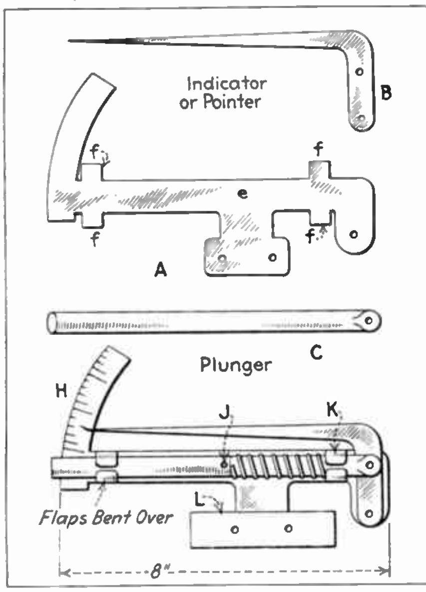
This shows many interesting forms of models and lists a very complete selection of materials and supplies used in their production. Several new forms of models of recent development are illustrated in its pages, the most interesting of these being the Curtiss HS-2-L Navy Flying Boat, the Loening Scout Monoplane and the NC-4 Seaplane, which was the first heavier-than-air craft to cross the Atlantic Ocean.

The book contains 52 pages and is well indexed for ready reference and all of our readers who are interested in the manufacture of model airplanes of different types, should have a copy of this complete hand book in their files for ready reference.

HOW TO MAKE A LOOSE BEARING INDICATOR

It had always been a difficult matter for me to determine at what point in a motor the loose connecting rod or bearing was after I had learned by the sound that there was one in some part of the motor To detect the locality of such looseness I made an instrument which helps greatly to determine the location of the loose bearing Securing a piece of sheet steel that I could cut with metal shears and yet of sufficient stiffness to not bend too easily, I cut out the shape as shown at (A) and slightly curved the part at (e) to give it more stability.

I then flattened the end of a piece of No. 8 wire and drilled a hole through the end. I then cut from a thinner piece of sheet steel a pointer as at (B) which I riveted to the plunger, making a close-fitting but free-moving joint, so that the slightest movement would not be retarded. I then riveted the pointer

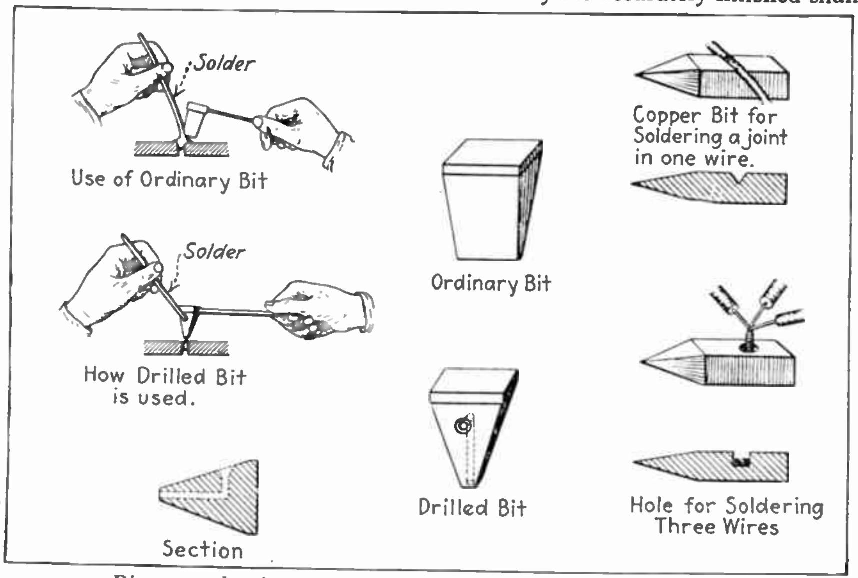


to the frame, using the same care as above. Then after placing a light coil spring over plunger and held by cotter pin at T to hold plunger down, I bent up the lugs (f f f f) over the plunger, leaving the one at (K) with sufficient freedom so as the circular movement of pointer would not bind the movement of plunger. I left a projection on frame at (L) of handle and to this I riveted a piece of ½ in. x 2 in. x 4 in. iron to prevent the vibration from moving the frame of the instrument. By holding the end of the plunger on motor over first one cylinder, then another or on the different bearings, the vibrations will cause the pointer to register more or less on the graduated arc H and the place held at which it registers the most is of course where the greatest vibration exists and where the loose bearing causes the knocking

Geo. G. McVicker.

SOLDERING IRONS

SOME variations on the usual form of soldering iron are shown in the cuts. In the first pattern two holes are drilled as indicated; they are not over the fiftieth of an inch for fine work. One is counterbored, as shown. In use, the hot iron is held over the work and solder is introduced through the holes, which carry it to the desired spot with great accuracy and without waste.



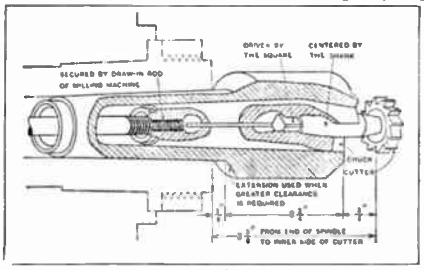
Diagrams showing variations in usual form of soldering irons.

The next cut shows an iron with a transverse groove filed across one side. This is to be used for soldering wires. A little solder is preferable to too much; in both the irons shown the solder is placed just where it is wanted and where it will do the most good. This second type is of special use for electrical workers.

Finally, where the ends of a number of wires are to be joined, a simple hole drilled in the side of the iron will provide a receptacle for forming a little pool of melted solder into which the ends of a number of wires may be dipped, as shown.

SPECIAL CHUCK FOR WOODRUFF CUTTERS

ONE of the most popular systems of keying that has been developed in connection with the manufacture of automotive appliances is the Woodruff Key which was described in a recent issue of EVERYDAY ENGINEERING MAGAZINE. A special cutter is necessary for making these keyways. The accompanying illustration shows a chuck that provides a positive drive and it some times insures accurate centering of the cutter shank. As will be apparent, centering is done by the accurately finished shank, but the cutter is driven by a square end that fits automatically into the self-adjusting chuck. The device is made in various sizes, and as the sectional drawing clearly shows, it can be adapted to fit any spindle.



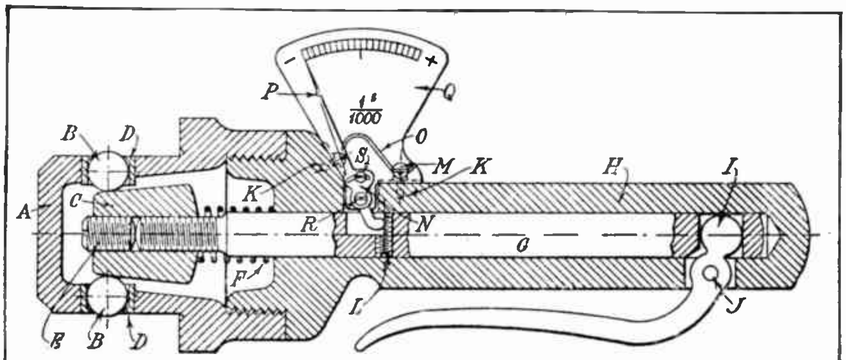
Special chuck for Woodruff keyway cutters.

A New Adjustable Indicating Plug Gauge

By G. Gordon Perry

THIS gauge was designed with the primary object of eliminating the inevitable wear caused by insertion of the usual solid plug gauge into the bore to be measured, this wear being a serious item where the gauge is made to exceedingly fine limits and the work on which it is used is hardened; an example of such work being the grinding of "bores," of inner races in ball and roller bearing manufacture. The new type of gauge, being inserted in a collapsed state into the bore to be measurer, wear by frictional contact is almost eliminated.

If the bore is not yet up to size, the amount still to be removed is immediately shown on the indicator, enabling the operator to take correspondingly heavy cuts and not waste time continuously taking light cuts, because the ordinary solid plug will not enter, and the amount to be removed is unknown.



-Sectional Elevation of Adjustable Indicating Plug Gauge.

As the action of the gauge is entirely controlled by a spring which always remains of constant strength, it cannot be "forced," and a false reading obtained, by a careless operator. After considerable use and no more adjustment can be made on indicator needle to compensate for wear, those parts subject to wear can be replaced at a nominal cost. The following particulars of the construction of the gauge will, I think, be clear when read in conjunction with the drawing.

This invention relates to the use of three hardened steel spheres, and a hard steel cone, for determining the size of a hole.

The portion of the gauge A is slightly smaller in diameter than the smallest hole to which the gauge can be applied. Around its circumference, equally spaced and midway in its length, are three hard steel spheres B (two are shown in sectional drawing for simplicity) free to move slightly in a radial direction in hardened bushes D. Into A is screwed the handle portion H containing a sliding rod G terminating in a hard steel cone C, which normally is kept pressed forward by spring F. Movement of rod G in a longitudinal direction is obtained by lever I pivoted about a point J and working in the slotted end of rod G.

A quadrant shaped indicator Q of the lever type is secured to H by screws K passing through lugs on Q. Pointer P and quadrant N are independent parts moving about a common pivot R, but are locked together after adjustment by small screw S. Rod G is recessed for quadrant N to work in, and hardened screw L is inserted through same, being cut away to center line, forming a hard face for N to work against. A light spring O keeps N up to its working face on L.

On picking up the gauge for use, the lever I is at once operated, so withdrawing cone C and allowing spheres B to fall in by gravity or outside pressure. Pointer P also moves to the "Minus" side of scale. In this state gauge is inserted into bore to be measured up to the shoulder, thus ensuring that the center line of H is at right angles with center line of bore.

On the lever I being relaxed spring F forces forward cone C, expanding spheres B, the longitudinal movement of C corresponding to the size of bore and being recorded by pointer P. Quadrant Q can be calibrated to suit nature of work and either English or metric. Cone C is screwed on rod G for convenience in manufacture, allowing adjustment in relation to face L, also for renewal, and is locked by screw E. Screw S is inserted in pointer P, through the arcuate slot in N, and allows for adjustment of pointer P to compensate for wear, or for setting to special size, shrink fits and the like. Gauge is checked for accuracy by inserting in a standard reference ring, and lever released, any slight variation found from center line "size" adjusted by screw S.—Reprinted from *The Model Engineer and Electrician.*

MODEL POWER BOAT RACING IN CENTRAL PARK

(*Continued from page* 134)

resented his first attempt to use a built-up hull and an engine of his own construction. The boat did not come up to his expectations, in spite of the light weight of the hull, 12 ounces. The hull was designed for a displacement of 9 3/10 lb. When actually finished it weighed 12½ lb. This difference in weight was largely responsible for the fact that it did not obtain a greater speed.

Mr. H. Seldon's boat, Mayo, was easily the best looking boat, to my mind, and his hull and boiler were examples of good workmanship, for which the builder is to be highly recommended. It was too bad, though, that Mr. Seldon experienced trouble with his power plant and was unable to get the boat in action. Especially as he had come all the way from New London. He used a two-cylinder, single-acting engine of English make with ¾ in. bore and ¾ in. stroke, and a 3 by 12 in. copper water tube boiler. The boat had only been finished the previous night and had not been tested. This was also largely responsible for the non-performance of Mayo.

The last of the entries, Mr. Ringle's Seminole, was equipped with the same type of power plant as Mr. Bolles' Bobo 4, except that the valve gear was operated by a groove from the flywheel. The boat itself seemed to be well constructed, but it developed blow-lamp trouble and we did not have a chance to see it in action.

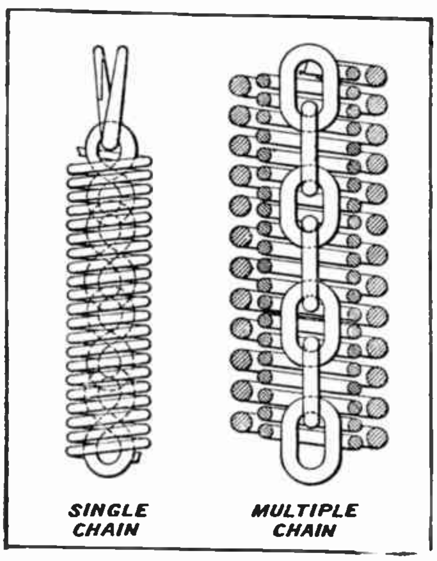
It has always been the aim of the Central Park Model Yacht Club to have boats which really perform and are reliable in their performance, in their sailboat as well as their power boat division. This is the reason why this year's race was open only to boats up to 15 lb. displacement. We hope to be able to see many other interesting races, as there is no inspiration quite like that of actual participation in races of this type to spur the model maker on to further and further effort.

MAKING SOCKET WRENCHES

HEREWITH are a few suggestions as to methods of making a set of socket wrenches: The wrenches can be made from Ford radius rods that have been junked. As these rods taper, several sizes of wrenches can be made from a single rod. First, cut the length of the wrench desired from the rod, then heat the end of the tube to a cherry red and hammer it to shape around a nut. The piece of radius rod must be large enough to fit over the nut and a hole drilled in the opposite end of the socket so that a punch or a small rod can be inserted and used as a handle.

THE CHAIN HELICE

THE old fashioned chain pump is familiar to all our readers. A simple modification of it, sometimes cited as a sort of curiosity, consists in the substitution of an endless rope for the chain. Such a rope with its lower bend immersed in the water of a well and with its upper end carried by a grooved pulley or, better, by a spider wheel, will raise water just as the chain will, and now another form of elevator for liquids called the Chain Helice has been developed by a French inventor, M. Bessenet Favre. It originally consisted of a rope as described above, but which was wound around with a spiral wire. This has been developed and the present pattern consists of an endless series of sections of double open-wound wire helix connected by swivels at short intervals for its entire length, as illustrated below. This chain passes over a driving pulley at the top, and at the lower end is weighted by a heavy flanged pulley which rests in the loop of the chain, keeping it taut. This pulley should be submerged to the extent of about 2 ft. if possible. The chain is driven at a speed of 400 to 700 ft. per minute. The fluid is carried up by the chain, and as it turns around rapidly over the rotating upper wheel the water is discharged



from it by centrifugal force. Of course, water is running down the chain all the time, yet 70 to 80 per cent of the water raised by the chain is delivered and the mechanical efficiency of the device is put at about 50 per cent. These figures will give a clue to how much of the water runs down the chain. The chain is made in lengths of 5 ft. as a standard, with swivel links to take care of the twisting effect due to the spiral winding. Two sizes of chain are manufactured in metric sizes, one about 1¼ in. in diameter, the other about 1¾ in. in diameter. The systems of winding employed are illustrated in the cuts.

Taking the larger one, it is found

that with 3 ft. submersion and a lift of 30 ft., 2,250 gallons per hour will be delivered when it is driven by a one-horsepower engine. With a single spiral chain, about one-half the above capacity is given, 0.7 of a H. P. will raise half the above amounts per hour to a height of 30 ft. and 3.2 horsepower to a height of 200 ft. Smaller pumps are made for hand operation.

An interesting point is that this pump was used during the war by the English, in France and elsewhere, some 20,000 being in use in France alone. Its installation is very simple, there being no need for anybody to descend into the well, and its cost is only about one-half that of a cylinder or rotary pump. We speak above of the use of a simple rope for raising water. Recent examples are given of the use of a common chain and even of a canvas belt for raising liquids.

BE CAREFUL TO ELIMINATE GRIT WHEN REPLACING CYLINDERS

IN fitting cylinders to the engine base after their removal for repair work, care should be taken to eliminate all chances of grit entering at the bottom and working up on to the cylinder walls, causing the pistons to score the cylinders. The better method is to wipe the interior walls of the cylinder with a clean cloth slightly coated with oil, which will remove any traces of grit. Do not allow the hands to come in contact with the walls of the cylinder, as they are oily and grit may unknowingly be deposited on them in this way. Small loose parts, after being cleaned with gasoline should be kept wrapped in clean cloths to prevent the entrance of grit and not jumbled together in a box, as is the usual custom. The chief destructive agent in an engine is grit and other abrasive matter, and though it is physically impossible to keep it out entirely, it will repay the trouble taken to keep it to a minimum by scrupulous care when replacing the part after handling.

NEW ROTATING ARC LAMP

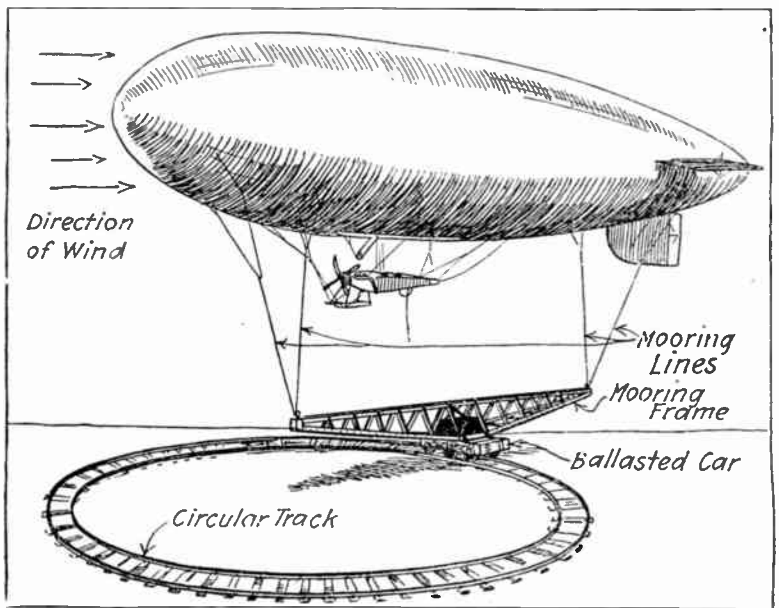
The Garbani rotating arc lamp has a horizontal positive electrode with a central crater. The negative electrode is of metal in shape of a ring through which water is circulated. In action the arcs strike from the crater to the ring which latter, the negative electrode, is absolutely non-luminous. The crater of the positive is in the center of the ring. A solenoid with a positive electrode is so arranged as to keep the arc revolving around the annular electrode at the rate of 500 to 3,000 revolutions a minute. All that is seen is the brilliant crater surrounded by a slightly luminous haze.

THE MOORING OF AIRSHIPS

AIRSHIPS, great and small, are now bound to earth in one or the other of two ways. Either they are bound under cover in sheds, which give them complete protection from the weather, but are very costly to erect and troublesome to maneuver the ship into, or the craft are moored by the nose to tall towers or masts, so that they can swing head to wind always. The latter system has been found safe and satisfactory; it is cheaper in construction than a shed and it occupies less ground space. The modern airship does not suffer much from exposure to the weather, and when in general use only requires housing when being overhauled at regular intervals or for repairs.

PANAMA WATER LEVEL LOW

Dependent entirely upon the water from rains of the wet season gathered in the great storage reservoir of Gatun Lake for its operation, the Panama Canal was brought down to a narrow margin of supply by the unprecedented dry season just ended. Official reports show that this was the dryest season since American occupation of the Canal Zone, and the lake was reduced to within less than a yard of the point where there would not have been sufficient water for safe navigation. Only resort to steam power for operation of the canal mechanism during part of the season kept the water level up to the minimum point of 8.76, which was recorded on May 28.



English method of mooring airships

A new system of mooring is the subject of a patent just granted to a Lancashire engineer, and is indicated in the accompanying illustration, which is reproduced from our English contemporary, *Everyday Science.* There is laid down on the aerodrome a circular railway, on which travels a long narrow-wheeled frame or platform set radially to the center of the circle. When a ship comes to be moored she is attached to the frame by guy-ropes from each end and held with her nose towards the circle center. The frame being free to move round the trace in either direction, the ship will automatically ride head to wind from whatever point it may blow. Retaining collars are provided to keep the frame on the track against the upwards pull of the airship, and the frame, instead of being a simple girder, as shown, may carry a landing platform for the ship's passengers and cargo.

RELATIVE POSITIONS OF GERMANY AND FRANCE AS REGARDS IRON

The relative positions of Germany and France in regard to iron ore resources are at present as follows: Germany, about 1,270,000,000 tons, and France, 5,630,000,000 tons. It is estimated that the production of iron ore in Germany, excluding Luxemburg but including Alsace-Lorraine, during 1913 was 28,608,000 tons and in France 21,918,000. It is further estimated that at present it is possible for Germany to produce about 7,000,000 tons and that France should be able to produce about 43,000,000 tons, due to the recovery of Lorraine. The coal situation, however, is somewhat different, as according to present indications, France will require 40,000,000 tons more than can be produced in her own mines, while on the other hand Germany has sufficient coal resources but a limited supply of iron ore.

Complete Drawings for Building a 20 Ft. V Bottom Boat Will Be Found in EVERYDAY ENGINEERING for December.

NEW PROCESS OF VULCANIZING RUBBER

AN entirely new process of vulcanizing rubber has recently become available. This is due to the discovery by Mr. S. J. Peachey, lecturer in chemistry at the Manchester College of Technology, that by exposing rubber alternately to the action of two gases, sulphur dioxide and hydrogen sulphide, it becomes rapidly and completely vulcanized, even at ordinary temperatures.

Hitherto there have been three processes of vulcanization. The first is due to Goodyear, who in 1839, discovered the process now known as vulcanization; this investigator found that by incorporating rubber and sulphur and heating the mixture for a suitable period to a temperature of 140°C, the rubber became profoundly modified and acquired entirely new properties. It lost its adhesiveness, became resistant to temperature changes, and exhibited far greater strength, elasticity and durability.

A year or two later the process was discovered independently in England by Hancock, although the method was somewhat different in detail. Hancock's method was to immerse sheets or articles of raw rubber in a bath of molten sulphur at a temperature of 135°-140°C. A little later still, in 1846, Parkes showed that rubber could be superficially vulcanized by immersion in a cold dilute solution of sulphur chloride in carbon bisulphide, but this method is adapted only to thin sheets or films of rubber.

For the new process it is claimed that: (1) It is true surphur vulcanization, as distinct from the sulphur chloride treatment just mentioned and yields a product comparable in every way with that given by the Goodyear process. (2) the use of heat is eliminated, and to a great extent the use of mechanical pressure also. (3) The two gases employed can be produced very cheaply on a large scale. (4) Rapidity of action is a great advantage. (5) Organic filling materials, such as leather, waste, sawdust, shoddy waste, etc., can be employed, whereas with the hot process this is impossible. (6) Coal tar dyes and even natural dyes, which as mostly destroyed by the hot process, may be used.

It is stated that these claims have all been substantiated in the laboratory. Material suitable for upholstery has been produced. In view of the present high price of leather this alone is of great importance. Also no difficulty is experienced in producing this material in any desired color. Naturally enough the new process may have an immense effect on tire manufacture, and it is stated that inner tubes repaired by a modification of the process have an excellent life.

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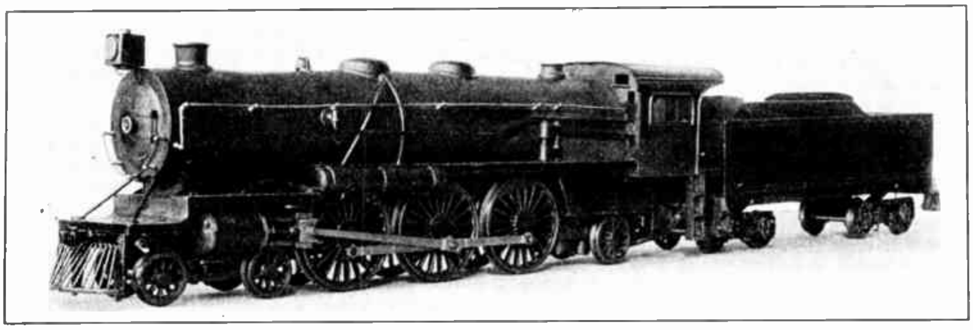

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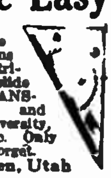

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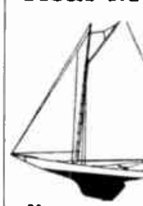

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WIRELESS PARTS. PROMPT DELIVERY. Standard 1¾" switch knob-lever complete 35c. Switch points with screws 25c dozen. State panel thickness. Novotoy Electric, Charlotte, N. C.

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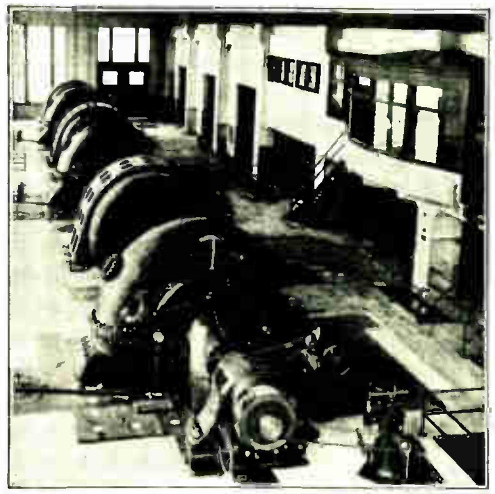
I am a Graduate Electrical Engineer. I have the legal right to sign *E. E.* after my name. *E. E.* means Degree of Electrical Engineer and is awarded by Universities and Schools of Science only after years of study and research.

My practical experience is extensive. I was formerly with the General Electric Co.; former General Manager of company manufacturing Jenney Electric Motors; also formerly with Fairbanks, Morse & Co.; and now President and Director of the Wicks Electric Institute.

Albert Wood Wicks, E.E.



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Albert Wood Wicks, E.E.

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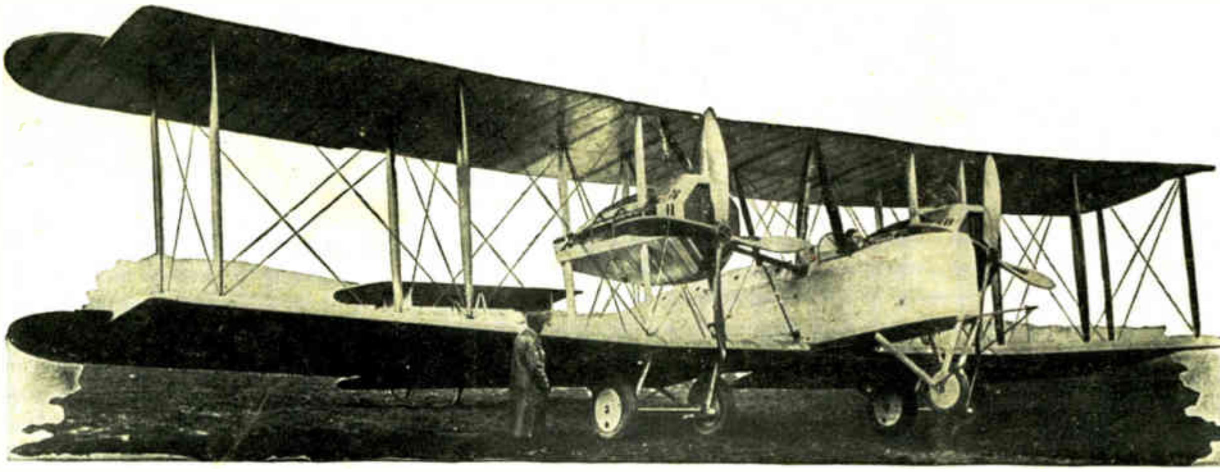

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