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VOL. 9 MAY, 1920 NO. 2

EVERYDAY ENGINEERING MAGAZINE

2 West 45th Street **New York City**

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Published Monthly by
EVERYDAY MECHANICS COMPANY, INC.
New York, N. Y.

Entered as second-class matter November 20, 1915, at the post office at New York, N. Y., under the Act of March 3, 1879.

Subscription price $2.00 a year in the United States and possessions; Canada, $2.25; Foreign, $2.50 a year.

SPACE AND TIME

DID you ever stand and gaze into the illimitable depths of a starry night? You were awe-inspired? Why? Because space seems so vast, so unending or because you are so small? Is man's respect for the boundless space beyond us, due to the smallness of man or the greatness of space?

IF an ant approached a mountain, the ant would think that the mountain was infinite in size because he would compare the size of the mountain with his own tiny self. To an elephant, or a dinosaur, were such a creature in existence today, the mountain would not seem so large.

MAN is continually comparing things with himself. He calls a locomotive heavy because it weighs a great deal more than he is capable of lifting. He thinks that the earth is large because it is spread out under him in all directions as far as his eye can see.

WHEN man compares things by his own standards he is apt to be confused by the smallness of small things and the greatness of great things. The atom is thought to be extremely small not only because it lies just beyond the borderline of the visible, but because man attempts to determine its size by his own units of measure.

OUR minds are undeveloped and easily confused. The day will come when these things will be more understandable.

MAN measures time in much the same manner as he measures space—by units hopelessly small. A man's life to a man covers a considerable period. Compared to the age of the earth, for instance, man's existence is only a flicker of life, created and extinguished at almost the same instant. Yet as individuals time appears to drag on.

BEHIND space and time there is a great unanswerable "Why?". There is a "Why" to everything, no matter how small, trivial or insignificant it may appear to be. To the average man time is just time and space—well space is just plain space. Simple, is it not?

RAYMOND FRANCIS YATES, Editor.

Five Days to Prove I Can Raise Your Pay

I've done it for thousands of others. I can doubtless do it for you. If I can't, then it won't cost you a cent.

I MEAN just what I say. There's no trick or catch about it. Give me five days and I'll prove that I can get your pay raised for you. I'll do it on a "show you" basis. You get the proof before you pay me a cent.

You've probably heard of me. My name is Pelton. Lots of people call me "The Man Who Makes Men Rich." I don't deny it. I've done it for thousands of people—lifted them up from poverty to riches. There's no sound reason why I cannot do it for you. So let's try.

Now, follow me carefully. I'm going to tell you exactly how to do it. I'm the possessor of a "secret" for which men have been searching since Time began.

There's no need to discuss the whys and the wherefores of this "secret." Suffice it to say that *It Works*. That's all we care about—*It Works*. Over 400,000 men and women the world over have proved it for themselves.

Among them are such men as Judge Ben B. Lindsay; Supreme Court Justice Parker; Governor McKelvie, of Nebraska; Wu Ting Fang, ex-U. S. Chinese Ambassador; Governor Ferris, of Michigan; E. T. Meridith, Secretary of Agriculture, and thousands of others of equal prominence.

A FEW EXAMPLES

Personal Experiences

Among over 400,000 users of "Power of Will" are such men as Judge Ben B. Lindsay; Supreme Court Justice Parker; Wu Ting Fang, Ex-U. S. Chinese Ambassador; Assistant Postmaster General Britt; Gov. McKelvie of Nebraska; General Manager Christeson of Wells-Fargo Express Co.; E. St. Elmo Lewis, of Detroit; Gov. Ferris of Michigan; E. T. Meridith, Secy. of Agriculture, and many others of equal prominence.

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"If I had only had it when I was 20 years old, I would be worth $100,000 today. It is worth a hundred times the price."—S. W. Taylor, The Santa Fe Ry., Milans, Tex.

From $100 to $3,000 a Month

"One of our boys who read "Power of Will" before he came over here jumped from $100 a month to $3,000 the first month, and won a $250 prize for the best salesmanship in the State."—Private Leslie A. Still, A. E. F., France.

Some of the things this "secret" has done for people are astounding. I would hardly believe them if I hadn't seen them with my own eyes. Adding ten, twenty, thirty or forty dollars a week to a man's income is a mere nothing. That's merely playing at it. Listen to this:

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

In a little town in New York lives a man who two years ago was pitied by all who knew him. From the time he was 14 he had worked and slaved—and at sixty he was looked upon as a failure. Without work, in debt to his charitable friends, with an invalid son to support, the outlook was pitchy black. Then he learned the "secret." In two weeks he was in business for himself. In three months his plant was working night and day to fill orders. During 1916 the profits were $20,000. During 1917 the profits ran close to $40,000. And this genial 64-year-young man is enjoying pleasures and comforts he little dreamed would ever be his.

I could tell you thousands of similar instances. But there's no need to do this as I'm willing to tell you the "secret" itself. Then you can put it to work and see what it will do for you. I don't claim I can make you rich over night. Maybe I can—maybe I can't. Sometimes I have failures—everyone has. But I do claim that I can help 90 out of every 100 people if they will let me.

How It Is Done

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

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

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

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

How You Can Prove This at My Expense

I know you'll think that I've claimed a lot. Perhaps you think there must be a catch somewhere. But here is my offer. You can easily make thousands—you can't lose a penny.

Send no money—no, not a cent. Merely clip the coupon and mail it to me. By return mail you'll receive, not a pamphlet, but the whole "secret" told in this wonderful book, "POWER OF WILL."

Keep it five days. Look it over in your home. Apply some of its simple teachings. If it doesn't show you how you can increase your income many times over—just as it has for thousands of others—mail the book back. You will be out nothing.

But if you do feel that "POWER OF WILL" will do for you what it has done for over four hundred thousands others—if you feel as they do that it's the next greatest book to the Bible—send me only $3.50 and you and I'll be square.

If you pass this offer by, I'll be out only the small profit on a three and a half dollar sale. But you—you may easily be out the difference between what you're making now and an income several times as great. So you see you've a lot—a whole lot—more to lose than I.

Mail the coupon or write a letter now—you may never read this offer again.

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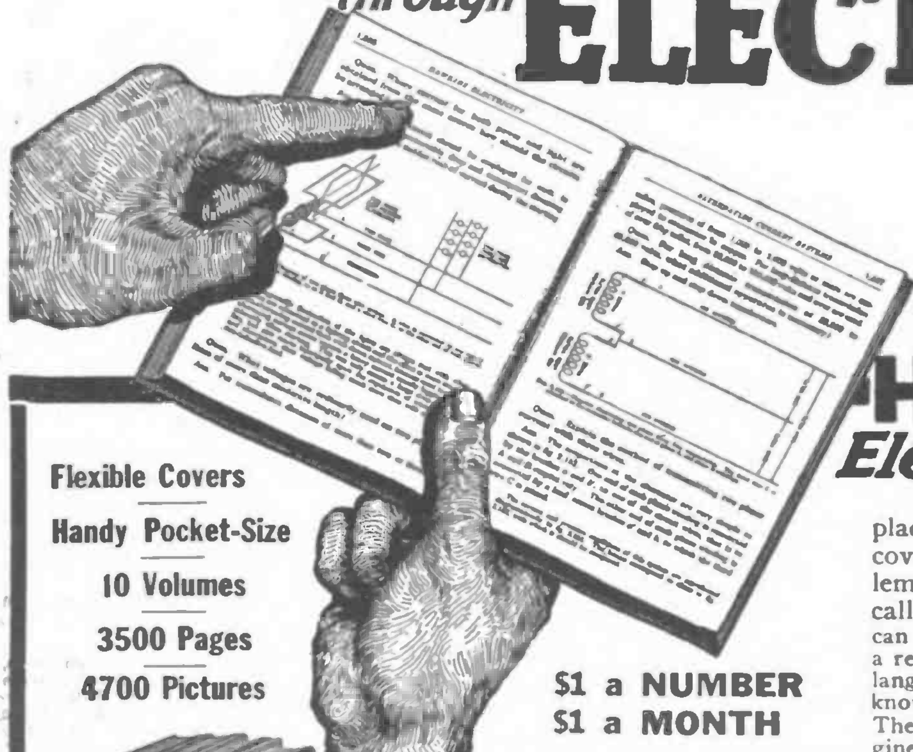

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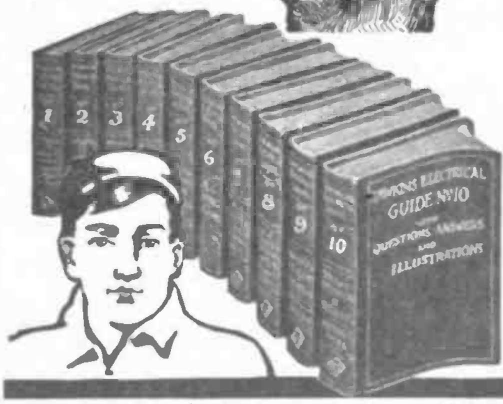

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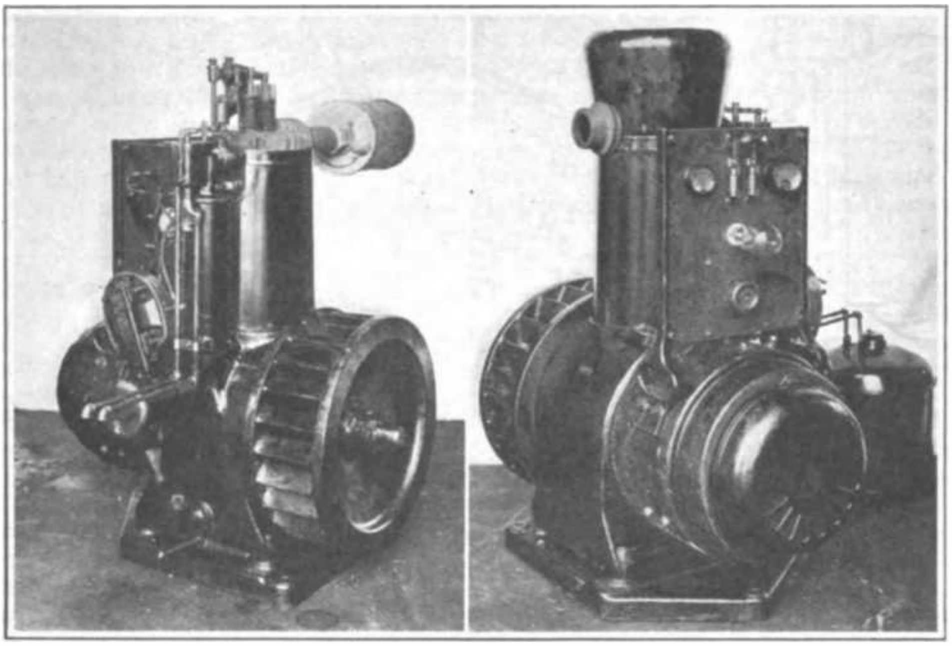
VOLUME 9 | MAY, 1920 | NUMBER 2

Isolated Lighting Plants

By Jerry Dare

TODAY the country or suburban home can be provided with all of the conveniences possible in the modern city dwelling. This is especially true with electrical conveniences and during the past ten years many thousand small lighting plants have been sold to people who are too far from a power station to have the mains extended to their homes. The isolated lighting plant is really a little power house all in itself. It is so simple to operate and maintain that most any one without any experience in electrical matters can take care of it.

Those contemplating the installation of a small lighting plant should first look over the available space in which the plant is to be placed and then make the purchase accordingly. Some plants are more compact than others. The ideal location for such an installation should be light, clean and dry. A concrete floor is also an added advantage and will greatly eliminate vibration. The attic or cellar, unless the latter is very dry and clean, are both bad places to install a private lighting plant. A little corner boarded off in the barn or a small shed are good places to make an installation. Care must be taken to see that the place does not get too cold in the winter else trouble will be had with the batteries. The plant should never be allowed to stand in an atmosphere at a freezing temperature. On the other hand it is not necessary that the building containing the plant should be heated.



A compact small lighting unit with the generator directly connected to the gasoline engine

For those who are not well acquainted with small lighting plants a general outline of their operation will be given. The generator is really the heart of the system. This is always a direct current machine driven by a gasoline engine. The voltage generated by these machines is generally in the neighborhood of 32 although some are manufactured that operate at 110 volts. The generator is usually directly connected to the gasolene engine but in the case of a gas engine the generator is driven by a belt.

The output of the generator is fed to a battery of storage cells. When the current of the storage battery reaches a certain value the plant automatically stops. This is brought about by a little cut-out or circuit breaker which functions when the current passing through it reaches a certain point. When the current of the storage battery falls below a certain value, the plant is automatically started in most cases although some systems do not have this advantage. Some manufacturers claim that a perfectly automatic system causes the plant to be neglected because the person responsible for its operation does not have to go near it. The author feels that this is a poor argument and that there is a great advantage in a perfectly automatic system. If one makes a practice of looking the plant over every few days there will be no danger of anything going wrong.

TABLE OF SIZES

Size of Generator k. w.	Number of Battery Cells	Voltage of Plant	Ampere Hour of Battery	Light Capacity of Plant 16 c.p. 20 watt.	Capacity Lamps of 16 c.p. 20 watt. Battery	Capacity of Plant when Generator Running and Battery Charged No. of Lamps 16c.p. 20 watt.
1-5	16	32	60	15	7	15
1-5	16	32	90	18	10	18
1-5	16	32	120	22	14	22
½	16	32	120	40	14	40
¾	16	32	150	50	18	50
1½	16	32	200	100	25	100
2	30	60	90	120	25	120
3	56	110	90	200	50	200

Once the storage batteries of a small lighting plant are charged, the whole system can remain idle until the charge in the battery falls below a certain value. Aside from general depreciation, the only expense of operating such a plant is incurred while it is in actual operation.

A very novel little isolated lighting plant that has recently appeared on the market is illustrated in the drawing. This has become known as the Sunnyhome Farm Plant and is extremely neat and compact. This little plant comes complete with a small enclosure which obviates the necessity of providing a special building for it. The space occupied is very small and the plant is so designed that it is very efficient in its operation. In the winter the engine is cooled with oil which is carried in a 5-gallon tank in the base of the machine. The same oil is used to lubricate the entire system and is forced into the bearings of the engine under pressure. One filling of the tank is sufficient to run the machine for an entire year.

This plant is probably the most automatic one that has been designed. For instance, if the gasoline in the fuel tank runs out a small red light in the house is lit. If the piston of the engine freezes up, the main switch is caused to open within three seconds time.

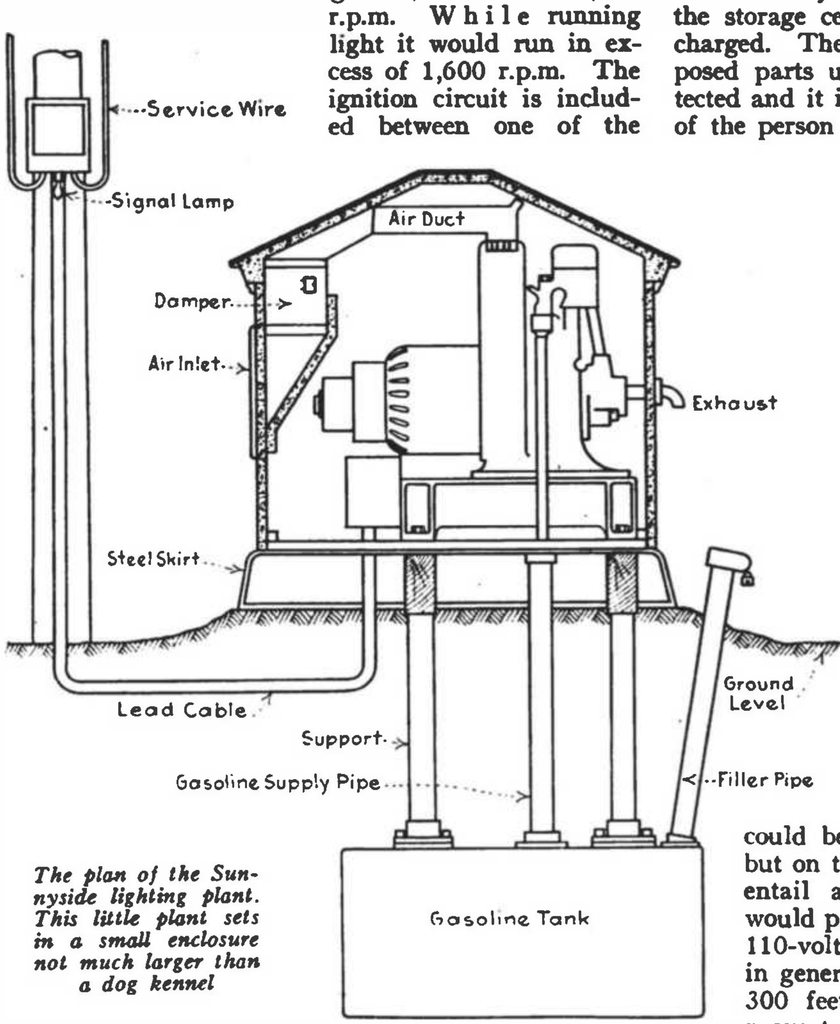
This plant is provided with a 110-volt generator and this makes it possible to obtain all the wiring fixtures at any electrical supply house. In the case of a 32-volt system the electrical fixtures cannot be obtained as easily. With this system, however, the standard type electric irons, toasters, fans, etc., cannot be used. This is a very important consideration and should not be overlooked by those who contemplate the installation of a private lighting plant.

The Sunnyhome plant has a 2½-hp. gasoline motor which reaches a speed of 2,000 r.p.m. This motor drives a 1¼-kw. generator which is capable of supplying sufficient current for the average size country or suburban home. Unlike most plants of this nature, the starting and stopping of the generator depends entirely upon the terminal voltage of the storage battery. When the voltage reaches a certain maximum value, a switch is opened and the plant stops. As the battery discharges the voltage drops and when it passes beyond a certain limit a switch is closed and the plant again starts. The starting of the gasoline engine is brought about by feeding the current from the storage battery into the generator which then acts as a motor. This is not a feature of the particular plant in question but is used on most all small lighting systems.

In case the coupling between the motor and the generator of the Sunnyhome plant breaks, the gasoline motor is prevented from racing by a simple form of suction governor which is placed in the inlet passage.

Compactness and simplicity of construction are the two most important considerations in farm-lighting equipment. While dwelling on the features mentioned above a brief outline of a new system employing the Knight sleeve-valve engine will be interesting. This outfit is provided with a 32-volt generator whose armature shaft is extended with the engine crank at one end. The engine is rated at 2 hp. when turning at 1,100 r.p.m. It is fitted with an aluminum cylinder head, particularly designed to dissipate heat. The cylinder is a gray iron casting with the cooling fins cast integral.

The method of govering this engine is by a fixed air passage which restricts the engine under load to 1,100 r.p.m. While running light it would run in excess of 1,600 r.p.m. The ignition circuit is included between one of the main brushes and an auxiliary or third brush. In starting the ignition voltage is 12 but owing to the armature reaction this drops down to about three volts while the engine is running. When the battery is fully charged, the ignition is automatically cut out. The battery cut-out, manual starting switch and overload switch are combined in a single electro-magnetic device. This device carries three windings, one series and two shunt. The electro-magnet also has two armatures arranged side by side one of which carries the switch contacts for both the main line and the field circuit.



The plan of the Sunnyside lighting plant. This little plant sets in a small enclosure not much larger than a dog kennel

The generator of this outfit is constructed along the most modern lines. There are no brush wires, the leads to the brushes being strips of copper imbedded in Bakelite. The control box is mounted on the field frame which gives a very compact outfit. The comlpete unit weighs but 350 lbs. without the battery. The battery weighs 52 lbs. per cell.

Most farm-lighting outfits are provided with storage cells mounted in glass jars. A shelf or number of shelves must be constructed to carry these cells. It is also necessary to paint these shelves with an acid-resisting paint. The room in which the cells are placed should also be very well ventilated to carry off the gases generated by the storage cells while they are being charged. These gases will corrode exposed parts unless they are well protected and it is also best for the health of the person taking care of the plant that means be provided for removing them.

The voltage of a farm-lighting outfit is a very important consideration as this will depend largely upon the nature of the installation and the distance that current is to be transmitted. The usual outfit which has a voltage of 32 is suitable in all cases where the lighting is confined to a fairly small area. In the average 8- to 10-room house the 32-volt system will make a suitable installation if the current is not to be transmitted over a distance of 300 feet. Of course, if larger wire was used, the current could be sent a greater distance but on the other hand this would entail a greater expense which would probably meet the cost of a 110-volt system. It can be said in general that for distances over 300 feet a 110-volt system will prove to be more economical and satisfactory.

On farms where a gas engine is already in use for driving cream separators, wash machines, etc., a lighting dynamo can be very easily belted to the engine directly or to a point on the line shaft. Some farmers prefer to have the whole outfit together. If the gas engine is powerful enough, the battery-charging generator can be driven while the washing machine or water pump is being operated.

For country use the Edison type of storage battery possesses many advantages over the ordinary lead plate battery. Although the lead type of battery will give splendid service if taken care of properly, it is very sensitive to abuse of any kind and when once injured it requires expert attention to put it back into a serviceable condition. The Edison alkaline battery never requires expert attention, does not need to be cleaned, does not make use of a corrosive acid and is not injured if discharged completely. The alkaline battery is also capable of receiving and making use of a charge "at any old time" which is not true of the lead battery which is generally charged only when its voltage falls below a certain point. Another point in favor of the alkaline battery is the fact that an accidental change in the polarity of the charging current will in no way injure the plates. Such an accident would be ruinous to a lead plate battery. The alkaline battery gives off non-corrosive fumes which is a very important consideration as the ventilating problem does not give so much trouble. A lead plate battery is very sensitive to a low temperature and they should never be exposed to a temperature below the freezing point. The alkaline solution used in an Edison type battery cannot be frozen at any winter temperature common to this part of the country as it is capable of withstanding a temperature of 50 degrees below zero. It is possible to leave the alkaline battery standing in a discharged condition for an indefinite period without the slightest deterioration which cannot be done with a battery of the lead plate type.

In a recent issue of *Automotive Industries*, a splendid outline of isolated lighting plants was given. The author has taken the liberty to include this:

"Most of these plants were specially designed for use on farms and country estates, while a few were developed for war purposes and are continued as meeting a certain peacetime demand. An output of 1 kw. or close to it is common, and this seems to best meet the requirements of the average farmer who wants light mainly. The great majority of the engines are single cylinder uprights, but there are two two-cylinder engines listed and four four-cylinder ones. While several of the most prominent makes use ball and roller bearings on the crankshaft, babbitt-lined bearings are used in most instances. Water cooling is common, though air cooling has advantages for an outfit that is expected to run for long periods without attention. In one case, oil is used as the cooling fluid to overcome the freezing difficulty.

"Ignition is almost equally divided between battery and magneto system and one manufacturer gives customers an option, fitting either the one or the other.

"About two-thirds of the systems are adopted to burn kerosene, while the rest use gasoline only. Two voltages are standard, viz., 32 and 110. For the former 16 battery cells are invariably used, while either 54 or 56 cells are used with 110 volts. There is considerable variation in the proportionate amount of battery capacity provided, ranging from about 3 to about 10 kw.-hrs. per kilowatt generator output, but the average is very close to 5.4 kw.-hrs. There is also an enormous range in the governed engine speeds, from 340 to 2,000 r.p.m. Two speeds have recently been adopted by the S. A. E. as standard for farm-lighting plants, namely, 1,200 and 1,800 r.p.m., but there is really little indication in the table that the speeds gravitate toward the two figures."

ELECTRIC MOTORS FOR MODEL LOCOMOTIVES.

By R. D. McMurry.

MANY readers of this magazine who are engaged in the construction of model electric locomotives will probably welcome a few notes along this line that come as the result of considerable experience the writer has had in making and operating such devices.

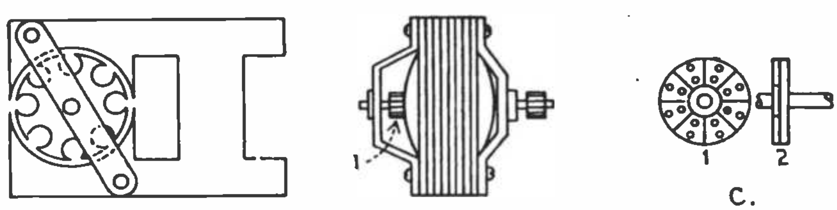
Experience has proven that the flat type of commutator is much better for this purpose than the drum type. This used in conjunction with a laminated field motor makes it possible to produce a motor that will fit into a very small space and yet be efficient. The writer makes his field laminations of black iron (the thinner the better). After they are all cut out they are packed together and placed in a vise when they are filed and the rough edges trimmed off. When this is done four holes are placed in the pieces and brass studs or rivets used to hold them together.

The armature from an old electric horn motor makes a very suitable type for use in railway motors but, of course, these are not always available when they are wanted most. Armature discs can be easily cut out of sheet iron. First the plain discs are cut and then the holes for the shaft are drilled in the center. When this is done the slots can be drilled out.

Motors constructed along these lines are in general much more satisfactory than those of the permanent magnet type. They are lighter in weight and far less bulky. For given size they are also much more powerful. The one advantage of the permanent magnet type is that the armature can be reversed at any point on the lines by simply reversing the polarity of the rails.

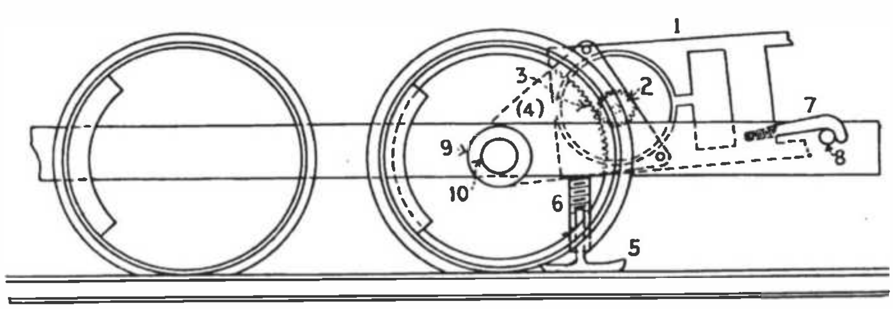
In the drawing, A is the motor the author has used with great success. At Fig. 1, B is the common type of commutator; the disc type is shown at C. This consists merely of a fibre washer with copper segments riveted to it. The holes for the rivets must be countersunk. At D Fig. 2 is shown the method of mounting a small electric motor in a model "steam" locomotive. One is the motor, 2 is the small driving pinion meshed with the main gear 3, which is not on the shaft but on the hub of the driver. Four is a frame fastened to the motor. This acts as a brush holder. Bearings for the motor are drilled and the axle put in place. The hook 7 rests on the cross-pin 8. Five is the contact shoe for the third rail. This is a tube fastened on an insulated cross member on the frame. The shoe has a plunger and fits loose in the tube 6 with a light spring inside the tube.

Motors of this type run heavy trains at a considerable speed and they may be used with either D.C. or A.C. current.



A. B. C.

FIGURE 1.



D.

FIGURE 2.

Heat Treating Alloy Steels

A Simplified Exposition of the Precautions to be Taken in Heat Treating Modern Alloy Steels to Bring Out Their Physical Properties to the Best Advantage and Reasons Why Such Steels Demand Careful Treatment

By Victor W. Pagé, M.S.A.E.

Part One

THE rapid growth of the automotive industries and the increasing use of automobiles, motorcycles, airplanes, and tractors has created an entirely new series of problems for mechanical engineers to solve. The solution of these resulted in the development of alloy steels, that require entirely different treatment than the high carbon steels of a decade back as the alloying elements ordinarily employed, nickel, chromium and vanadium, impart certain qualities to steel only when it is given a predetermined heat treatment found to be best for that particular alloy. It is not within the province of this series of articles to discuss the effects of the various alloying elements as it is not a work on metallurgy. The heat treating department of the modern shop will be given the chemical composition of the steel to be treated and the point to which the steel is to be treated before quenching will have been accurately determined previously by testing samples of the steel in a small electric furnace and finding its critical or quenching point. This means that any particular alloy has a point to which it must be heated, no more, no less, before quenching and the range of temperature permitted in some alloys is not more than twenty-five degrees either side of the theoretically correct temperature if its physical properties are not to be sacrificed.

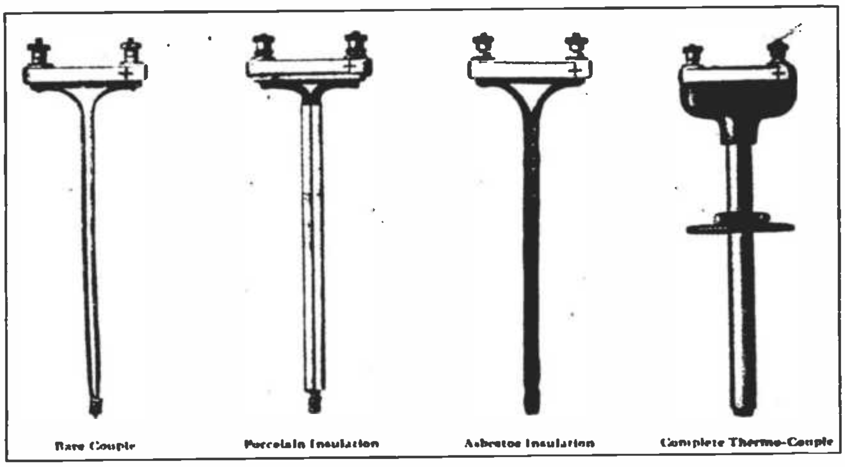


Fig. 1—Steps in the construction of heat measuring thermocouple

Science in Modern Hardening.

The chemist, metallurgist and hardener work in very close relation in the modern manufacturing plant. Scientific research and exacting processes have brought hardening steel from the old hit or miss methods of temperature determination by color to an exact science where the temperature of the furnaces may be determined with great accuracy by electrical pyrometers which show the heat within the furnace on a plainly read scale. Any mechanic who can tell time will be able to read the temperature scale and know the heat without attempting to approximate it by color of the furnace interior. On a light day, the colors do not appear as bright to the normal eye as on a dark day and it is easy to misjudge temperatures by 50 to 100 degrees Fahrenheit, which would be a serious matter if an alloy having a limited range of permissible treatment was to be hardened.

Alloy Steels Demand Multiple-Treatments

Modern alloy steels must receive double, triple and even quadruple treatments in some cases whereas the steels of the usual high carbon variety seldom required more than two treatments, the hardening and a tempering that followed. The tendency of the old-time hardener to guess at the proper heat treatment is no longer in evidence as costly experience has demonstrated that modern alloy steels cannot be treated intelligently unless their critical point and chemical composition are known.

Critical Point Important

The critical point determination is a scientific process based on the principle that steel undergoes a change in molecular structure when heated to the proper point, and that the quenching of the steel, when this point is reached, sets the molecules so that the steel is hard instead of soft. A small piece or specimen of the alloy to be tested is placed in a special holder and heated in a small furnace. The temperature may be controlled with great exactness and is measured and constantly recorded.

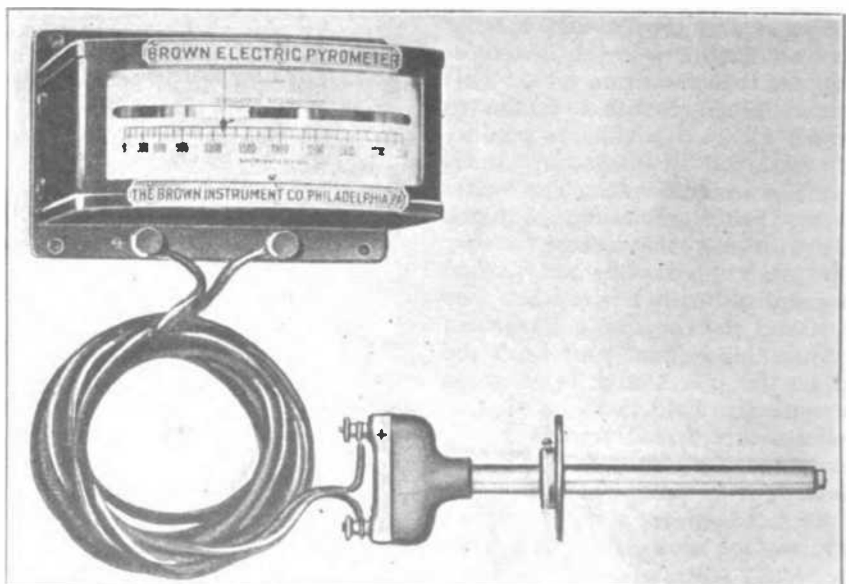
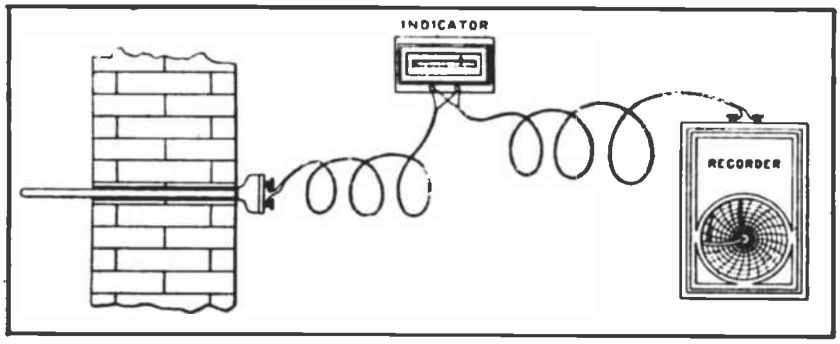


Fig. 2—An electrical recording instrument with calibrated scale is attached to the thermocouple

The temperature of the piece is also recorded and in some types of instruments it is registered on a recording chart. The heat curve rises up to a point where the critical point is at which point the steel specimen heat curve flattens out and finally drops.

The steel must be quenched at this or decalescent point and before the curve indicating the changed molecular structure drops.

Specimens of the steel are then hardened by the metallurgist who breaks them in a tensile testing machine to determine their strength and examines the structure under a powerful microscope to make sure the hardening process has been accurate. Other testing machines determine the hardness and endurance to fatigue the treated specimen possesses. It is only after the laboratory men have determined accurately the qualities of the alloy, that recommendations are issued to the hardeners for treating the steel in a commercial manner.



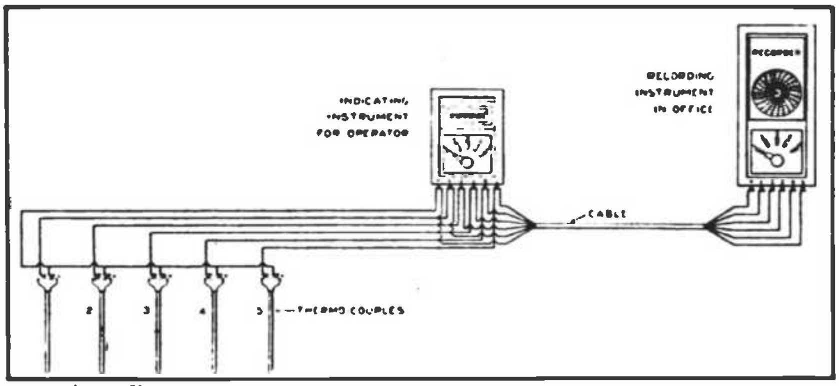


Fig. 3 at top shows how thermo-couple or fire end is inserted in furnace wall, and coupled to indicating and recording instruments. Fig. 4 shows how one set of instruments may take readings from a number of furnaces

Accurate Gauging of Temperature

By the use of recording pyrometers, which are a type of electric thermometer, it is possible for the men in charge of the furnace to regulate them to maintain a uniform temperature at all times, and for those in charge to make sure that the heat has been properly maintained for the period. This is especially valuable in carburizing or case hardening certain work where the proper depth of penetration is only obtained after a period of 10 to 24 hours at the carburizing temperature which is between 1650-1700 degrees Fahrenheit. Pyrometers also indicate the temperature of the oil baths and lead pots for tempering and the hardening furnaces. The secret of heat treating modern alloy steel is control of temperature, quenching at the critical point and then carefully following the subsequent treatment. So accurately do the instruments function that it is possible to maintain a uniformity in the hardness that would not have been possible with the old processes where individual skill of the hardener determined the grade of excellence of the output, which obviously could not be uniform because of the varying conditions.

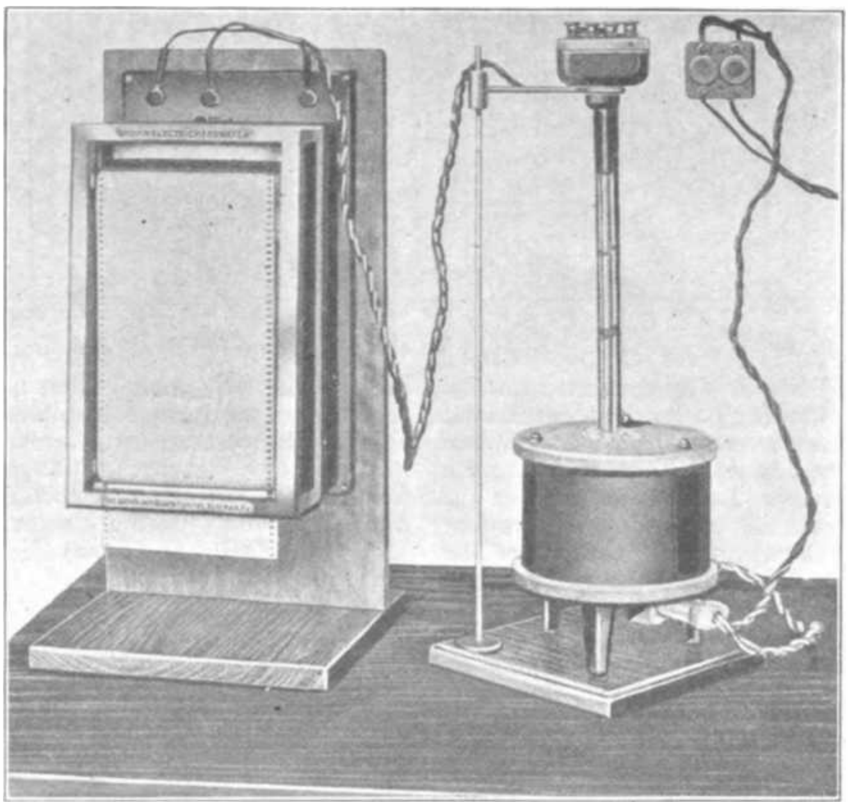


Fig. 5—Special apparatus for determining the critical point of steel specimens and indicating it by making a chart

Electric Pyrometers

Electric pyrometers operate on the principle discovered by Seeback, that if the juncture of two dissimilar metals is heated, an electric current will be generated, the voltage varying in proportion to the heating temperature. Different metals are used for this purpose, as the voltage will vary with the type of metals used. Base metal fire ends are commonly used in commercial application, rare metal couples are used for fine measurements and checking purposes. All that is necessary is a suitable fire end which is joined to a millivolt meter which can have a scale calibrated in temperature units instead of fractions of a volt. This is done by a pair of wires and they may be of considerable length, so the recorder does not need to be combined with the fire end as in the mechanical types. The temperature indicator may be in one building, the fire end in another. Base metal thermo couples are usually formed of nickel alloy wire and generate more current than the more expensive platinum-rhodium combinations. Typical thermo couples, indicators and method of installation are shown in Figs. 1 to 3. A recording outfit and the method of connecting it so it will serve a number of furnaces is shown at Fig. 4. It is not necessary to go deeply into this subject as full information may be obtained by writing the manufacturers of these devices.

Transformation Point Determinator

The freqent reference to "critical" point of alloy steel in the heat treatments described can be easily understood when it is explained how this critical or transformation point can be determined with an apparatus such as shown at Fig. 5. Briefly the operation of this instrument is as follows:

There are two small pieces of metal placed in the electric furnace shown. One is a neutral body of pure nickel, the other is the piece of steel to be tested. These pieces are about ¾ inch in diameter and 1 inch long. A 5/16 inch hole is drilled in each piece. It will be noticed that there are two thermo couples, one of which is placed in the test piece and the other in the neutral body.

The couples are connected to the proper binding posts on the instrument and current turned on. Each piece heats up at approximately the same temperature. Due to the fact that the instrument has two coils and a switching mechanism, the E. M. F. of the neutral body opposes the E. M. F. of the test piece when one record is made. When the other record is made the switch opens and the true temperature of the test piece is recorded on the chart.

When the point of transformation is reached, however, the necessary work to change the molecular structure of the steel means that the test piece will not heat up for probably several minutes. During this time, however, the neutral body which is not experiencing this transformation phenomena exerts its strong counter E. M. F. and produces a very exaggerated buck in the line made by the combined E. M. F.'s of both pieces.

An actual transformation chart at Fig. 6 made by this instrument gives a clear idea of the well-defined record line. On a rising temperature, the transformation occurs at which is known as the "decalescent" or "Ac" points, while those occurring on falling heats are known as recalescence or "Ar" points. At the highest Ac point the steel will have the finest grain and should be quenched when that point is reached. Steel should be quenched on a rising rather than a falling heat, so the highest "Ac" point is that usually chosen and the furnace maintained at a higher temperature to allow for the inevitable cooling that results during transfer of the piece to the cooling medium.

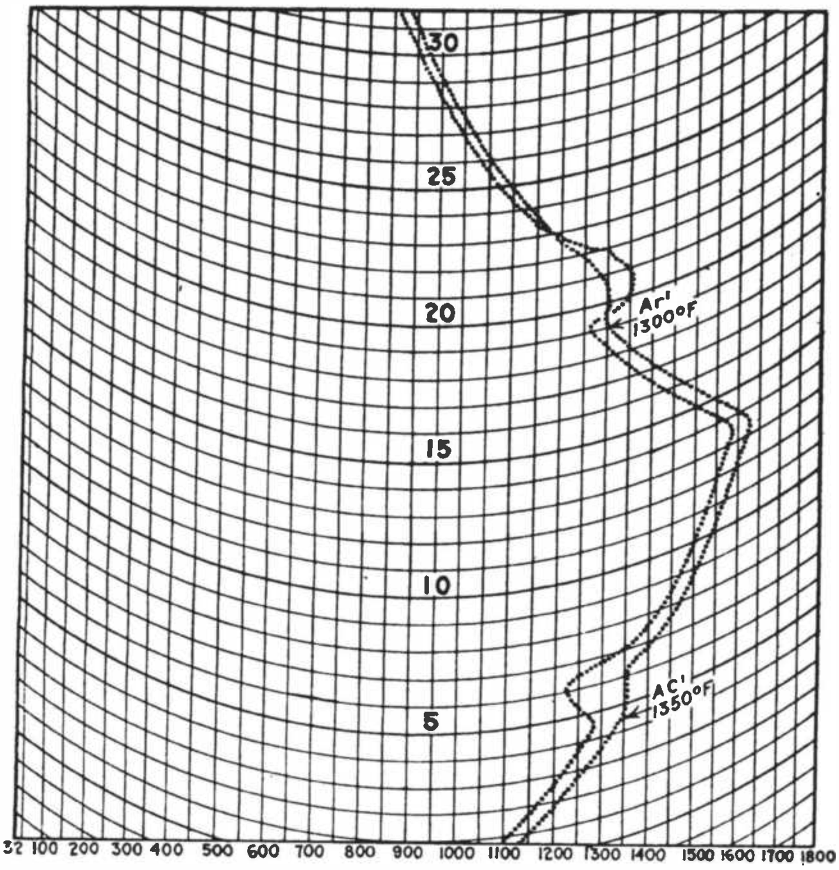


Fig. 6—Chart showing how critical point of steel is recorded by special apparatus

(To be continued)

For brazing steel, immersion in melted spelter is found very efficacious. The spelter picks up traces of iron, and this makes it much stronger. The joint may show from 10,000 to 20,000 pounds to the square inch strength. The steel is attacked at the rate of one thousandth of an inch for each two minutes of immersion. In the brazing the metal may be kept in the spelter for three minutes up to an hour.

It seems to be the oxygen in water which makes it corrode pipes. In hot water practice it is found that if no new water is added that the pipes will not corrode. If water has to be added from time to time, it is good practice to keep such water in a tank with expanded metal or other form of iron of large surface. This takes the oxygen out of the water.

WELDING COMPOUND

THIS process relates to the use of certain chemicals and ingredients which are dried and mixed to form a fine powder, and in this form are ready to apply to the iron or steel to be welded, when these metals are in a heated state and nearly ready for welding.

The chemicals and ingredients form a flux which spreads over the surface of the metal and prevents the steel or iron from burning if it be slightly overheated and in part so protects the heated surface from oxidation, so that a clear, sound weld is easily secured, the flux being driven out from the joint by means of the hammer carrying cinder or other impurities with it.

To prepare this welding compound use the materials listed below and in the proportions specified.

	Ounces
Boracic Acid	11
Fused Borax	4
Fine Iron Filings	3
Fine Steel Filings	4
Carbonate of Potash	2
Chloride of Ammonium	½
Potassium Nitrate	3
Silver Sand	½

All the chemicals and ingredients given above are dried on a tray over a low frame, and then finely powdered by tamping with a hammer, and when reduced to a fine powder are intimately mixed together by sifting.

After mixing the various ingredients, unless wanted for immediate use, they should be stored in airtight metal containers.

In using the mixture, the intended weld is first scarfed in the usual way, and when the parts to be welded approach welding heat withdraw each part from the fire and apply a small portion of the mixture to what will be the actual joint and then return it to the fire and bring the heat to a little less than the heat required for ordinary welding.

When the parts are then brought together, apply the hammer slightly at first, and then more heavily to complete the weld. If any part of the scarf is imperfectly welded, it can again be reheated and some of the composition sprinkled over the defective joint, and heat again to the desired point and complete the weld under the hammer.—*American Blacksmith.*

The water-power of British Columbia has been estimated lately at three millions horse power. One falls, Helmokon, has a clear descent of 450 feet. In the United States the steam railroads use 25 per cent of all the coal mined. The utilization of water power and the more economical generation of steam will have a profound effect on the future of the coal question.

Putting the Boat Hull in Condition

A Spring Cleaning Process that Keeps the Boat Looking Fit

By Andrew Jackson, Jr.

WHEN spring comes around and you are ready to get your boat in the water, you should commence in plenty of time. To properly put a boat in commission requires considerable time and care. The hull, both above and below the water line, should be well cleaned and all loose or scaly paint scraped off and sandpapered smooth. Any cracks, open seams or other spots that may leak should be well caulked with spun cotton and finished off with white lead or some good calking compound. For many places marine glue or similar preparations can be used to advantage. Jeffrey's marine glue or "Petro" liquid calking are excellent. These compounds are applied hot or semiliquid and are allowed to harden after which the excess is scraped off. If the edges of the crack, or hole, are cleaned and free from paint and are dry the compound will adhere firmly to the wood and will expand and shrink with it, thus insuring a tight seam. White lead is good for finishing a seam or crack but ordinary putty should be avoided. Any badly rotted, decayed or worm-eaten wood should be cut away and replaced by new timber or if on the bottom of the keel or skeg it may be merely cut away to solid wood, planed smooth and given a good coat of copper paint.

Tools and Supplies Needed

The following tools and supplies will be found of value in putting the boat in commission. If the boat is a large one, an old hoe will be very useful for removing marine growths. On smaller craft, cabinet scrapers or putty knives of large size will be adequate. A steel wire brush is also useful in this connection. A plumber's gasoline torch is very good for paint burning. Small calking irons and a calking mallet and two old files for cleaning out seams can be used advantageously. Paint and varnish brushes will be needed, two flat brushes about 2½ to 3 inches wide for paint and a varnish brush about 1½ or 2 inches wide. For sharpening the scraper fine-cut flat files are valuable. For general work around the engine, an auto tool kit will be useful.

The materials used will include white lead and raw linseed oil, turpentine for thinning paint and Japan dryer for insuring that the paint will not take too long to dry. Special prepared paint may be obtained for canvas decks and anti-fouling or copper paint will be needed for the bottom. Spar varnish of the best quality will be used for natural finished woodwork. If one wishes to do a real good job, the engine should not be neglected and a small can of engine enamel can be purchased to advantage. Paint and varnish remover will help in stripping off the old colors. Sandpaper and steel wool, about No. 1 grade, will help in smoothing down the wood preparatory to painting. If a wooden deck is used, some seam filler composition will prove useful to fill cracks and if calking is found necessary, special seam composition and calking cotton should be provided.

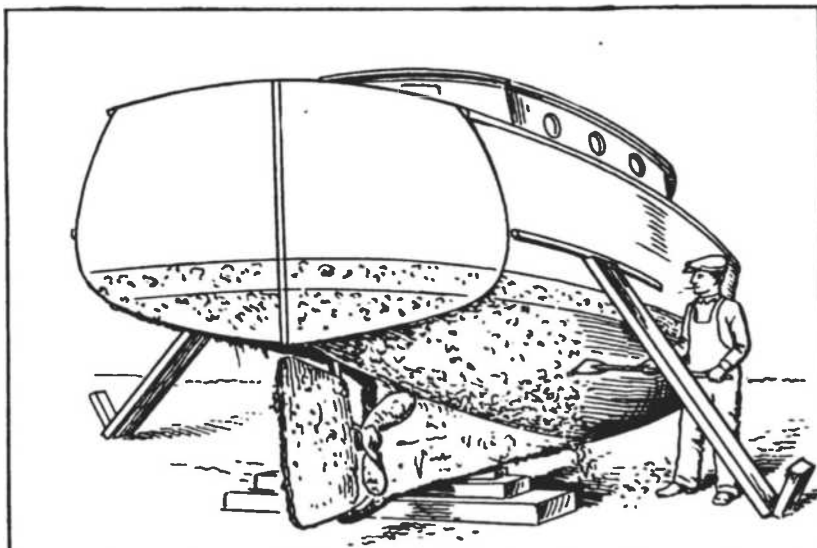
Removing Old Paint

Sometimes the old paint and varnish may be so badly cracked, blistered or worn that it must be removed. This may be done either by burning and scraping or by the use of some good paint and varnish remover. A number of these preparations are on the market and all are about equally good. Be sure and scrape off the old paint and varnish thoroughly after softening with the remover and then rub well with gasoline. When thoroughly dry sandpaper until smooth and do *not* apply new paint or varnish until the wood has dried and aired for 8 or 10 hours: if you neglect this the new paint may peel or soften from the action of chemicals remaining in the pores of the wood.

Old, hard paint or paint of several thicknesses is best burnt off. A gasoline torch should be used and as fast as the old paint blisters up it should be scraped off with a ship scraper, putty knife, broken glass or old knives. After all the paint has been scraped off, sandpaper smooth and rub with gasoline. The use of gasoline on scraped or cleaned woodwork is of great value as it removes all old traces of oil, paint, varnish, etc., remaining in minute cracks or pores and gives a fresh, clean, surface for the new paint. Boiling oxalic acid solution will bleach out woodwork and provides a clean surface for paint or varnish.

While almost any sort of paint will cover up wood and almost any varnish will give more or less of a gloss, yet for marine work you cannot be too careful in getting the very best and highest grades of paint and varnishes. Many paints and varnishes which will answer very well for use on shore are absolutely unsuited to boat work for the conditions are totally different and are far more severe and moreover the paint and varnish stands all the hard knocks and wear on a boat. For underwater parts either a high grade copper, anti-fouling, or bronze paint should be used. The particular kind and color which you put on will depend upon your own taste, for practically all the standard copper and bronze paints are equally good. Do not expect too much from any of these compounds however; they will prevent worms and marine growths to some extent but the best made will not prevent some weeds and barnacles from growing on your boat.

If you are situated near a river you may readily keep your boat free from salt water growths by occasionally running her into fresh water and leaving her there for a day or two. If you cannot do this, it will be necessary to beach her, or haul her out, two or three times each season and thoroughly scrub or scrape off all marine growth and when dry give her another good coat of



Scraping off Barnacles and Other Marine Growth.

paint. A wire brush is excellent for cleaning a boat's bottom but barnacles; young oysters and other shell fish must be scraped away with a ship's scraper, an old putty knife or a short-handled hoe.

Painting the Hull

For the topsides above the water line you should use either the very best

"Burning off" or Paint Removal with Torch.

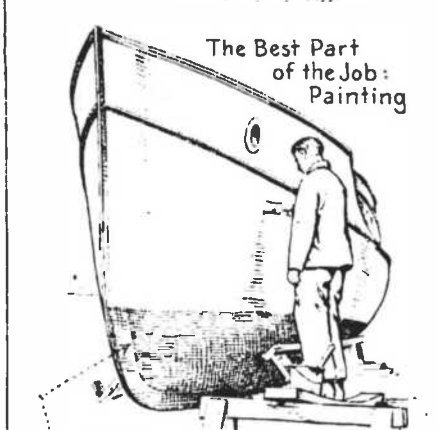
yacht paint or mix your own paint with white lead, oil and a little turpentine. Avoid zinc white as it dries very hard and is almost impossible to scrape off while too much dryer renders the paint less liable to stand the weather and hard usage. If colors are to be used you may either mix them yourself by adding the desired color to the lead paint or you can purchase them ready made. If a durable glossy surface is desired add some spar varnish to your paint or better still use the "Enamolin" colors. These paints are made in black, white and various colors for both above and below water and for exterior and interior work. They are brilliant, durable and will stand up two or three times as long as ordinary paints.

Use Only High Grade Varnish

For varnishing, use the highest grade marine or spar varnish you can buy. "Valspar," is as good as any but several other makes answer practically every requirement. In varnishing you must be sure to have your surface smooth, clean and dry and if you wish a high finish you must first use a "filler" and apply two or three coats of varnish and if unusually fine work is required each coat should be rubbed down with pumice stone and water before applying the next coat. A good brush must be used and cheap brushes do not pay. Rubberset brushes, or brushes which are guaranteed not to shed their bristles, should be used and before using on the boat they should be broken in by painting or varnishing an old board or plank, for the best brushes will always shed a few hairs at first. Keep each brush for a certain purpose and keep them clean. Cleanliness is one of the main points in successful painting or varnishing.

For metal work use enamels or aluminum paint but avoid gilt, bronzes, etc.: if gold stripes are required use size and gold leaf as no other gilt will stand salt water use. For decks use regular dark paint or mix the color desired with your spar varnish until the proper shade is obtained. White is the most common color for boats but it is hard to keep clean and looks badly when

Filling the Deck Seams before Applying Spar Varnish



The Best Part of the Job: Painting

scarred or dirty. Black is a neat and good color but it is harder to keep in good shape than white and makes a boat very hot, as well as dingy looking. Many boats are now painted bright colors and this custom is to be recommended as the colors serve to identify the boats and on small launches it gives an excellent appearance. Blues and greens wear well and are easily kept presentable but reds fade and turn color badly. The various "battleship grays" that have recently become so popular wear well but are not at all attractive.

It is economy in the end to keep a boat in good shape outside as well as in for a boat badly painted or with the paint scarred and rubbed, is an eyesore besides being more liable to rot, injury and decay than a well painted, clean craft. A boat may be readily touched up above the water line without pulling out but if the spots or places to be touched up are badly rubbed they should be smoothed with fine sandpaper before painting and care should be taken that they are thoroughly dry. Varnish should be kept smooth and bright at all times for if varnish is allowed to get scurfy, white or rough a new coat cannot be applied until the old is removed. As fast as varnished surfaces show scratches, wear, or discoloration they should be rubbed with fine sandpaper or with pumice stone and water and revarnished. Varnish that is in good shape but is scratched, bruised or dull in spots may be revived by rubbing with a soft rag dipped in oil and turpentine. Never use alcohol, kerosene or gasoline on varnish or paint; it may brighten it temporarily but will ruin it sooner or later.

LARGE BRITISH DIRIGIBLE AIRSHIP

Reliable reports indicate that the British Government has started to build the largest airship that has yet been constructed in any part of the world. This is to be large enough to carry six airplanes as auxiliaries for its own protection against enemy heavier-than-air craft. This airship and the two hangars to be built for it will cost $9,000,000. It will have a capacity of 10,000,000 cu. ft., will be 1,100 ft. long, 137 ft. in diameter and capable of lifting 100 tons, which would be about five times the lifting capacity of the R-34, which has recently completed a round-trip voyage across the Atlantic. The cruising radius of the new airship, which will be completed in about twenty months, is estimated as 16,000 miles. It looks as though Britain will have the largest air fleets as well as being mistress of the seas.

In Switzerland electric steam boilers have been experimented with. The current at a voltage of 10,000 is sent through vertical tubes immersed in the boiler contents. By changing the position of the electrodes in the tubes the current is modified as desired.

Building A Two-Passenger Seaplane

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

Consulting Aeronautical Engineer

THE dynamic balance and easy control of any airplane absolutely depends on the alignment, providing the machine is designed correctly. The first airplane that I was responsible for was a Farman type in 1911 which was badly out of balance at the first trial. But realigning it several times by varying the incidence in the main planes and the empennage planes it was considered a fairly stable plane. The final alignment of a new machine can only be made by actual trial, but it is absolutely necessary to diligently check up and inspect every detail before flight is attempted.

The method of alignment generally accepted by manufacturers and followed by the Air Service, U. S. A., is as follows:

1. Place the airplane in its normal flying position, *i. e.*, the top longerons to be levelled laterally and longitudinally, supported by wooden horses or blocking under the tail struts at station 7 and the nose station 1.
2. Alignment of the fuselages.
3. Alignment of the landing gear.
4. Alignment of leading edge of lower plane—dihedral, stagger and incidence.
5. Alignment of leading edge of upper plane.
6. Alignment of trailing edges.
7. Tightening and safetying all wires, turn buckles, nuts and pins.
8. Alignment of ailerons.
9. Alignment of stabilizers.
10. Alignment of elevator flaps.
11. Alignment of rudder.
12. Adjustment of rudder control wires and foot bars.
13. Adjustment of joy stick and its control wires.
14. Checking up propeller.

Fuselage Alignment

1. Level up the fuselage by a spirit level or in its absence a device may be made by combining a straight edge 90 degrees to a plumb line, shown at Figure 4.

2. Align the fuselage by starting at Stations 3 and 4, Plate Seven (January, 1920, issue). When tightening the diagonal wires be sure to loosen the opposition wires. Stations 2, 5 and 7, Plate 7, should have diagonal wires laterally in a plane parallel to the motor bulkhead.

The engine section should be checked next. Then work from the starting point aft to the tail post, which must be plumb, as it determines the position of the rudder.

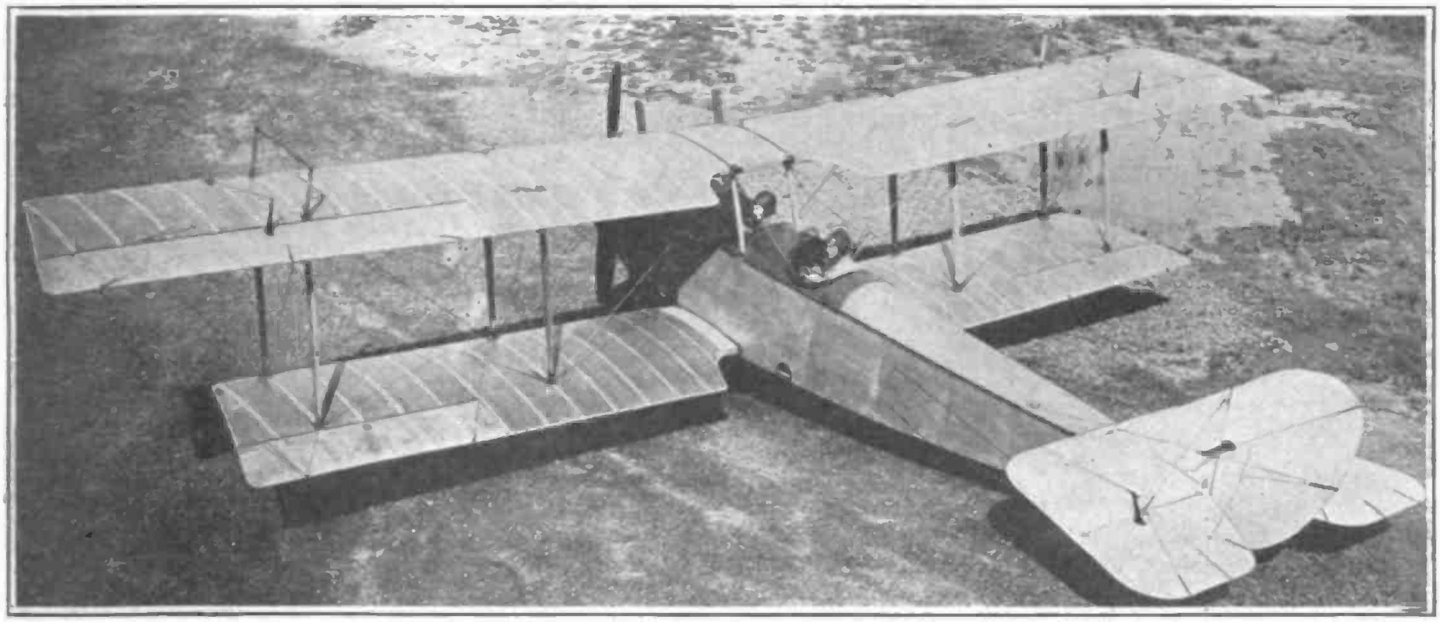
The dynamic balance may be checked up approximately by rigging up a bearing with a round edge to set under the lower longerons or the pontoons directly under a center midway between the centers of pressure of the top and lower planes as shown in the side elevation Plate 1 (August, 1919, issue). Bags of sand equaling the weight of the pilot, computed at 165 pounds, must be set in the rear cockpit for this.

3. The landing gear is then aligned. The pontoons must be properly blocked to avoid damaging the planking. This is usually done by constructing a cradle with padded blocking that bears along the chines and keel runners. It is a wise precaution to always support the tail end of the fuselage when working on the machine or when in storage. The above cradle may be equipped with wheels to serve as a truck.

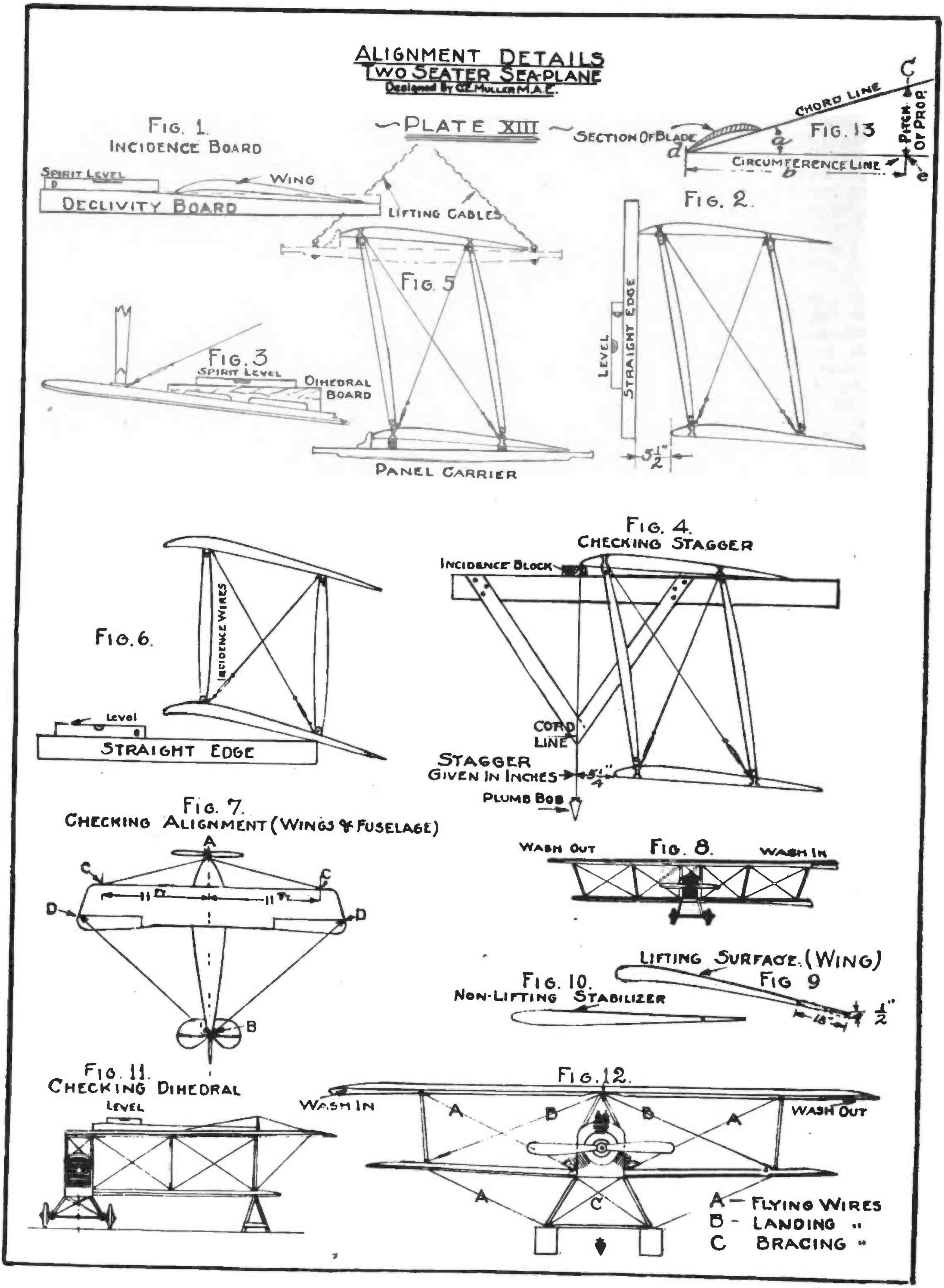
The end of all struts, particularly the landing gear struts, must fit solidly with a full cross area bearing, otherwise the ends squash or flatten out, which slackens the wires, throwing the entire machine out of alignment.

Pontoon Alignment

The alignment of the landing gear is accomplished by adjusting the "incidence" wires shown in Figs. 2 and 4, Plate 8, and the cross wires, Fig. 3, Plate 9, and Fig. 12, Plate 13. The bow of the pontoons should extend 3 ft. 10 in. forward at the end of the lower longerons. The center of the wheels of the wheel chassis should be 10 inches in the rear of the same point. A plumb bob should be dropped from the center of the propeller shaft to the center established between the pontoons at the bows and one similarly at the stern. The pontoons must line up fore and aft. The wheel chassis must also be correspondingly aligned. Take all measurements from similar points on the longerons and tack light strips across the bows and stern of the pontoons shown in Fig. 12.



Curtiss JN4D Biplane viewed from above shows clearly all wiring and controls of typical standard design


ALIGNMENT DETAILS
TWO SEATER SEA-PLANE
Designed By G.E. Muller M.A.E.
PLATE XIII
FIG. 1.
INCIDENCE BOARD
SPIRIT LEVEL
WING
DECLIVITY BOARD
LIFTING CABLES
SECTION OF BLADE
CHORD LINE
FIG. 13
PITCH OF PROP.
CIRCUMFERENCE LINE
FIG. 2.
STRAIGHT EDGE
LEVEL
FIG. 5
FIG. 3
SPIRIT LEVEL
DIHEDRAL BOARD
PANEL CARRIER
FIG. 4.
CHECKING STAGGER
INCIDENCE BLOCK
FIG. 6.
INCIDENCE WIRES
Level
STRAIGHT EDGE
CORD LINE
STAGGER GIVEN IN INCHES
PLUMB BOB
FIG. 7.
CHECKING ALIGNMENT (WINGS & FUSELAGE)
WASH OUT
FIG. 8.
WASH IN
LIFTING SURFACE. (WING)
FIG 9
FIG. 10.
NON-LIFTING STABILIZER
FIG. 11.
CHECKING DIHEDRAL
LEVEL
FIG. 12.
WASH IN
WASH OUT
A — FLYING WIRES
B - LANDING "
C BRACING "

Determining Dihedral

4. Align the leading edge of the lower plane for a dihedral of 3 degrees for each wing. This may be increased to 4 degrees at the option of the builder. The more the dihedral angle, the better inherent lateral stability and the reduction in lift is unappreciable up to 7 degrees dihedral to each wing. The dihedral or declivity board may be also used as an incidence board, as they are the same in this particular case. A number of methods are shown in Figs. 1, 3, 4, 5, 6, the method outlined at Fig. 1 being the simplest.

This board may be made by laying off 1 inch in height to every 57 inches in length for each degree, therefore there is a taper of 3 inches in a 57-inch straight edge for the 3 degrees incidence and dihedral. The level may be used as shown, or along the under edge if parallel or if the declivity is laid out from the lower edge. The natural sine is .017452 for 1 degree, which equals .994764 inches in 57. A block of wood on a straight edge may be used if figured and placed correctly as suggested in Fig. 4.

Adjusting Incidence and Stagger

5. The angle of incidence and the stagger of the top plane may be adjusted considerably by the manipulation of the wires shown in Figs. 2, 4, 5, 6. They are therefore known as incidence or stagger wires. If a machine proves nose or tail heavy, due to a difference in weight of materials used from that estimated, or if it is desired to allow for a difference in the weight of operator and that computed, it may be compensated for by slightly increasing or decreasing the stagger as decribed in a previous issue. The stagger of the plane with the 2-ft 6-in. plane is 8¾ in, for the 4-ft. chord it is 5¼ inches. Two methods of setting and checking the stagger are shown by Figs. 2 and 4.

6. The trailing edge is now aligned for "wash in and "wash out" to compensate for the propeller torque. This is accomplished by the rear flying and landing wires that are a duplicate of the A and B wires shown at Fig. 12.

7. All wires must be carefully inspected, particularly for over tension, as this is a common error even with experienced men. When tightening or loosening a wire, be sure to test all opposition and adjacent wires, as the adjustment of one always affects one or more.

Wire Tension Important

Too great an emphasis cannot be placed on the importance of the even tension of all wires, otherwise the airplane will become distorted and fly badly. The tension should only be sufficient to keep the framework rigid, if in excess of this it reduces the safety factor and by undue compression in various components of the framework crushes the fitting into the wood, thereby distorting the entire machine. There is no one best rule for tensioning wires. Experiments have been made with many devices for this purpose, but with little success. Only by careful observation can one be assured that the wires are not over tensioned.

When adjusting turnbuckles do not use a pair of pliers because the barrels are not as stout as they look. They are easily squashed out of round, thereby rendered useless. A piece of heavy wire or a nail-set inserted in the holes provided will answer the purpose much better. All turnbuckles must be properly safety-wired in the right direction, if not the barrel is liable to unscrew from a quarter to a half turn, destroying the fine adjustment necessary for the success of the airplane. A piece of 16 to 20-gauge soft copper or iron wire is threaded through the eye in the barrel, then carried in the direction that tightens the turnbuckle, then through the stem 3 or 4 times. Do this to both ends. The rule that the eye bolts of turnbuckles be screwed into the barrel for a distance equal to at least twice their diameter should be exceeded.

Control Surface Alignment

8. The alignment of controlling surfaces is of utmost importance, as the pilot depends upon them entirely in managing the airplane. Figure 9 graphically depicts the manner of allowing for the necessary slack of the aileron control wires. The general rule is to allow ½-inch drop for every 18 inches of chord in the controlling surface. The air pressure in flight will hold it in the stream line.

9. The stabilizer or tail plane on this machine was designed to set at a zero angle of incidence and must be carefully aligned to be horizontal. It is supported by ½-inch 20-gauge tubing braces from the trailing edge to lower part of the stern post. The same bolts that are used for the center hinges of the elevators may be used to anchor these braces. The ends of the braces are reinforced with a 16-gauge plate internally, then flattened and brazed to accommodate the anchor bolts. The stabilizer cross section is known as a symmetrical wing surface, which produces a lift even at 2 to 3 degrees negative angle of incidence, varying with the depth of the section.

10. The elevators (flaps) are set as shown in Fig. 10, because any adjustment needed is taken care of by a slight movement of the "stick". Each should have three hinges described later.

11. The rudder is aligned with the stern post, which is essentially plumb. It should have three hinges, as suggested in Figs. 5-9, Plate 4 (November-December issue), or may be simply modified strap hinges with a plate brazed to it to form a yoke section similar to Fig. 30, Plate 5. Another method of attaching these members is to have the rudder post, the trailing edge of the stabilizer and the leading edge of the ailerons of 20-gauge Shelby tubing ¾ to 1 inch in diameter, and then use 16-gauge shaped brass strips 1 inch or more wide, to pass around the tubing, bolting on to the adjacent components.

This arrangement if properly lubricated is simple, neat and effective.

Adjusting Control Wires

When adjusting control wires the joy stick and rudder bar must be operated smartly to be sure there is no binding over the pulleys or that there is no snatch due to slackness. If the adjustment is correct the control surfaces should show a slight movement when the joy stick moves ⅛ inch either side of the neutral position. After every flight examine the control wires, especially when they run over the pulleys by passing the hand over them; if a strand is broken, take no chances, replace them. Keep all internal wires well enamelled and external wires well greased or oiled for protection against rust. When inspecting the wires the airplane must be level or blocked up in the flying position, otherwise it is liable to have a twist, throwing some wires in undue tension and slackening others. If you find a slack wire do not jump to the conclusion that it must be tensioned, perhaps its opposition wire is at fault.

Get the habit of sighting the leading edge to see if it is parallel to the wing bars, the trailing edges allowing for wash in and wash out, the position of the stabilizer, etc. With practice you will become expert in determining by the eye faults in efficiency, stability and control.

Checking the Propeller

The propeller is usually the last thing to be attached and adjusted. The performance of the machine varies considerably with various propellers. Not only is the R. P. M. of the engine influenced by the careful checking up of the propeller, but the thrust of the propeller itself is greatly influenced by the correct pitch and tracking of the blades.

"Pitch" is the distance that the propeller would screw or travel forward in a medium if there were no slip. "Slip" is the difference between this (theoretical pitch) and the actual distance travelled.

(*Continued on page* 188)

The Knack of Carburetor Adjustment

Some Easily Understood Instructions for Adjusting Various Types of Carburetors to Secure Smooth Engine Action and Maximum Fuel Economy

By Victor W. Pagé, M.S.A.E.

THE average motorist who takes care of his own car and many of those engaged in running automobiles or for caring for them as a means of earning their living do not realize the importance of carburetor adjustment and usually any setting that will run the motor, regardless of the amounts of air and gasoline vapor in the mixture, is considered satisfactory. The result is often a waste of valuable fuel and actual mechanical depreciation may be caused by the dilution of the engine sump oil with excess fuel. Careful carburetor adjustment is especially important in these days of low grade gasoline, or rather motor fuel, which bears but little resemblance to the liquid known as gasoline several years ago for which most of the carburetors were initially designed.

Carburetor Construction

The modern form of spraying carburetor is provided with two chambers, one a mixing chamber through which the air passes and mixes with a gasoline spray, the other a float chamber in which a constant level of fuel is maintained by simple mechanism. A jet or standpipe is used in the mixing chamber to spray the fuel through and the object of the float is to maintain the fuel level to such a point that it will not overflow the jet when the motor is now drawing in a charge of gas.

The design of the components of modern carburetors differ largely, but most of the modern mixing devices operate on the same general principle. Certain features of design have been accepted generally, such as automatic mixture compensation by auxiliary air valves, Venturi type of mixing chamber, float and mixing chamber concentric, separate adjustment for gasoline and air, and simplicity of construction. Various carburetors have been devised of late in which auxiliary air valves are done away with and proper compensation for mixture variation due to the various engine speeds is made by ingenious applications of double jets. In some manual, regulation of the incoming air is again resorted to.

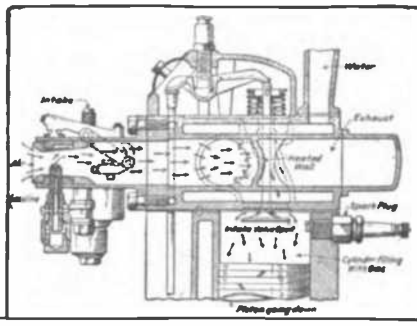
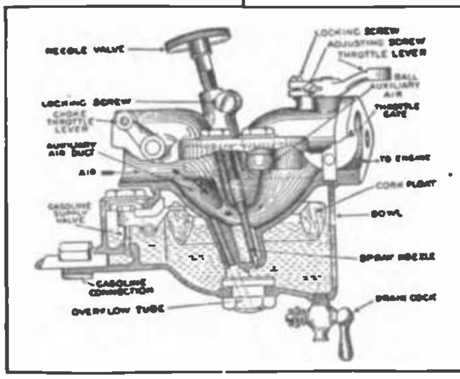


Fig. 1 at top center shows how the mixture is drawn in by descending piston through inlet valve opened by rocker arm on intake stroke



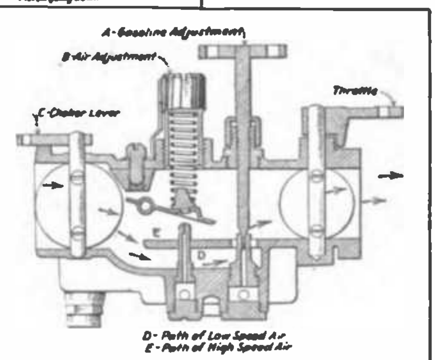


Fig. 2 at left shows sectional view of one model carburetor used on Ford cars. Fig. 3 at right outlines simple two jet mixing chamber

Automatic compensation is made necessary because a satisfactory mixture must be furnished at all engine speeds without the operator constantly varying the fuel supply or air proportions to allow for different conditions of operation produced by varying speeds. On early types of carburetors it was necessary to constantly vary the mixture proportions by working the air shutter or fuel valve from the driver's seat while the vehicle was in motion. The aim was to secure a mixture that best adapted to the conditions of operation then present, and while a skillful driver would manipulate the adjustments in a way to deliver well proportioned mixtures to the cylinder the average operator did not control the mixture exactly and the results obtained did not make for efficiency.

The velocity of entering gases depends upon engine speed, and as the draught diminishes it will not pick up as much fuel as when it is traveling at a higher rate. The present type of compensating carburetor provides for a sufficiently rapid flow of gas at low speed by constricting the mixing-chamber bore at the spray nozzle so that the gas speed will be sufficiently high when the engine is pumping slowly. The reduced diameter of the mixing chamber increases the velocity of the gases because the cylinder must be filled through a smaller hole in a certain unit of time than would be the case if the bore were larger. Therefore to insure a full supply reaching the cylinder the gases must pass the top of the jet at a high rate of speed even if the piston is working slowly. As the opening is constricted not enough air will be drawn in at high speed, and it is necessary to supply it through an auxiliary opening usually controlled by some automatic form of valve. This can be adjusted to open only when the suction effect is sufficiently high to overcome the tension of the spring which holds the valve to the seat, and this increased suction effect obtains only at high speeds.

The Venturi type of mixing chamber is being widely used at the present time because it has properties, when properly proportioned, of insuring high gas velocity at low engine speed. Special care must be taken in the proportions of the air passage, as it is necessary that the area be large enough to allow the air stream to pass through freely, yet at the same time it must be constricted to such a point that the entering air stream will pass the top of a standpipe with sufficient momentum to draw an adequate supply of gasoline from the spray nozzle. The velocity of the air stream has been variously estimated, but most authorities are agreed that it should be from 7,000 to 9,000 feet per minute to insure picking up a sufficient amount of liquid as it passes around the spray nozzle.

It is not possible to describe in detail several hundred carburetors that are procurable in America in an article of this nature, so, representative types are selected to familiarize the reader with the essential features of modern vaporizing devices, as well as suggestions for their adjustment.

One Adjustment Forms

One form of Ford Carburetor is shown at Fig. 2. This is a "puddle" type that is exceptionally simple in construction. The gasoline is admitted to the float bowl through the usual form of gasoline supply valve regulated by a float, which determines the proper level of fuel in the float chamber. The mixing chamber is a peculiar form, so designed that all air entering through the main air intake must pass over the small pool of gasoline at the bottom of mixing chamber before it can reach the engine. The amount of gasoline supplied the mixture may be varied by a regulating needle valve, and the amount of gas reaching the cylinders is controlled in the usual manner by a butterfly throttle valve. At low engine speeds, as when starting, the air cannot fail to pick up gasoline vapor no matter how slow it passes over the top of the spray nozzle. At higher speed the mixture is diluted by auxiliary air supply. Only one adjustment is provided, that regulating the fuel supply by a needle valve.

The Packard carburetor is an exceptionally simple device of the single jet type having auxiliary air valve control of the extra air needed at high engine speeds. As all parts are clearly lettered in the diagram, Fig. 4, the construction and operation can be readily understood.

The carburetor is placed above and between the cylinder blocks. Thus the heat derived from the exhaust pipes in addition to the hot water jacketed cross and cylinder block manifold permits a uniform temperature and insures efficiency in mixing the sprayed gasoline with air. The mixing chamber is a cylindrical chamber around and above the spray nozzle. The vacuum created by the pistons, causes air to rush into the mixing chamber through both the primary and the auxiliary air inlets. The air passes through the mixing chamber around the nozzle, atomizes and mixes with the gasoline sprayed through the latter. In this carburetor, the adjustment is by varying the air valve spring tension. Changing spray nozzles or altering float level is work that should be attempted only by expert factory service men.

It is important that the proportion of air and gasoline in the mixture be correct for all motor speeds. Consequently, although the primary air inlet valve is controlled by springs, so that while the valve opens slightly at low speed, the increased vacuum of high speed opens it still more, letting in the greater amount of air required to maintain the correct proportion of the mixture. The carburetor thus automatically produces a correct mixture for all motor speeds, the auxiliary air valve hand wheel on the control board being used only for the regulation of the mixture for starting and to suit different atmospheric conditions.

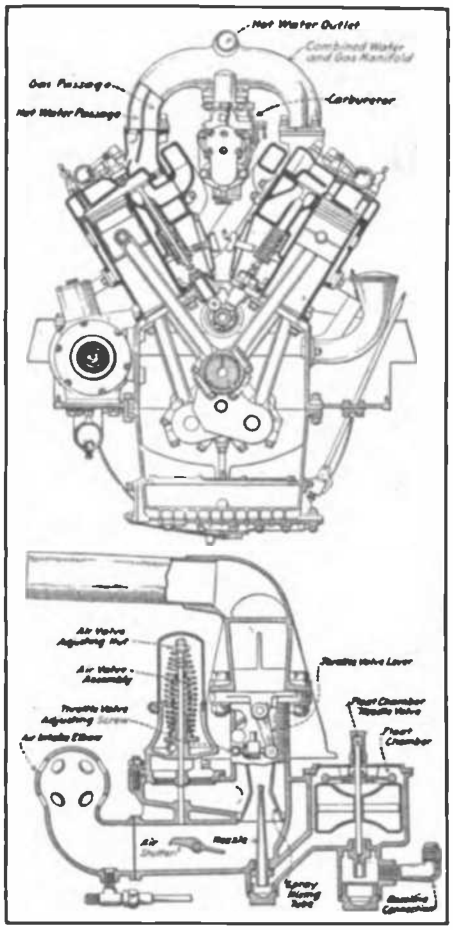


Fig. 4—The Packard carburetor and its installation

Multiple Nozzle Vaporizers

To secure properly proportioned mixtures some carburetor designers have evolved forms which two or more nozzles are used in a common mixing chamber. The usual construction is to use two, one having a small opening and placed in a small air tube and used only for low speeds, the other being placed in a larger air tube and having a slightly augmented bore so that it is employed on intermediate speeds. At high speeds both jets would be used in series. Some multiple jet carburetors could be considered as a series of these instruments each one being designed for certain conditions of engine action. They would vary from small size just sufficient to run the engine at low speed to others having sufficient capacity to furnish gas for the highest possible engine speed when used in conjunction with the smaller members which have been brought into service progressively as the engine speed has been augmented. The multiple nozzle carburetor differs from that in which a single spray tube is used only in the construction of the mixing chamber, as a common float bowl can be used to supply all spray pipes. It is common practice to bring the jets into action progressively by some form of mechanical connection with the throttle or by automatic valves; as shown in the simple mixing chamber of the two jet type shown at Fig. 3. This carburetor has two adjustments, one regulating the air flow valve for high speeds, the other a gasoline adjustment for low and medium speeds.

Tillotson Two-Jet Type

This is a double jet, variable Venturi carburetor and has been widely used on Overland cars. A partially uniform vacuum is maintained at the fuel nozzle by two flexible reeds mounted on a cage designed so that the maximum opening takes care of the volume required to fill the combustion chamber at maximum piston speed. When the reeds are seated they provide the highest possible vacuum at slower engine speeds. They are placed so as they move they form a virtually variable Venturi. A secondary nozzle comes into operation at higher engine speeds and is not in use at the lower speeds. The body design of the carburetor permits only one air intake, and thus it is quite simple to pre-heat the entire

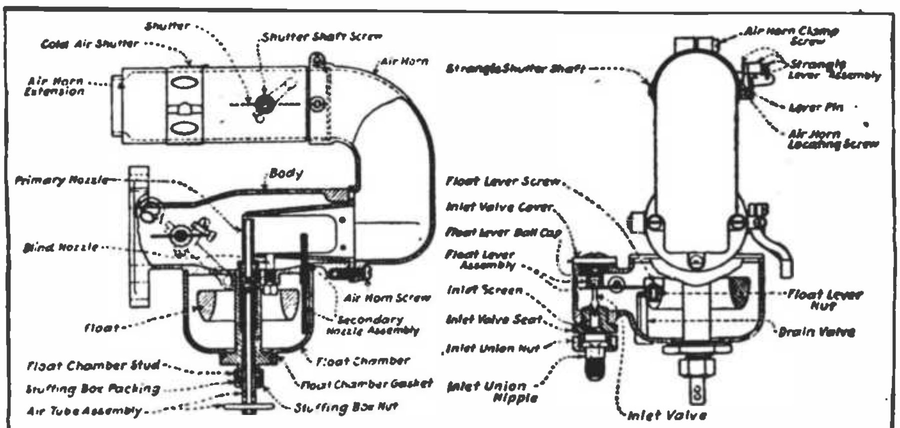


Fig. 5—Views showing construction and adjustment of Tillotson Carburetor, a simple two jet type

air supply. The particular feature is that the heavier fuel is taken care of by the pre-heated air and that the velocities through the variable Venturi are as high as possible. The construction is clearly shown in the sectional views at Fig. 5, and the relation of the car-

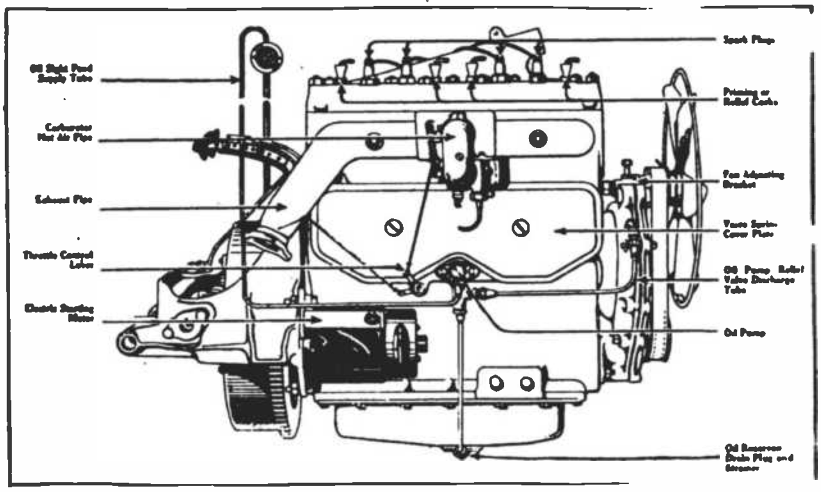


Fig. 6—How the Tillotson carburetor is installed on popular four-cylinder engine

buretor to the engine is outlined at Fig. 6.

There is but one adjustment necessary in the Tillotson instrument—the low speed adjustment or needle valve. The air supply is controlled by automatic valves.

1. To regulate the carburetor first run the motor until it is warmed up.

2. Retard the spark and set the throttle so that the motor is running at a car speed approximating fifteen miles per hour.

3. Turn the needle valve to the left or right until the best results are attained. When this adjustment is made the valve should be from one to one and one-half turns off its seat. For the most economical adjustment the valve should be gradually turned into the carburetor until the motor starts to miss and then slowly turned out again until firing becomes perfect.

Metering Pin Carburetors

Another carburetor classification is the type in which some form of metering pins are placed in the nozzle and provision made to lift this pin by raising or lowering it. The metering pin is like a pointed pencil, made with different degrees of taper to supplement the auxiliary air valve, the air valve perhaps caring for the high speeds and the metering pin for all intermediate speeds, while idling and low speeds may be taken care of in other ways such as pilot nozzles.

Controlling the metering pin is accomplished by various methods. In one design it is raised by the throttle as at A, Fig. 7, in another by the auxiliary air valve, and in a third by an air valve within the mixing chamber. In the Schebler carburetor Fig. 7, the metering pin is controlled by the auxiliary valve; when the valve moves downward in opening, it carries the metering pin with it, the latter being designed to increase the jet as it is lowered.

In the Stewart carburetor, the metering pin action of which is shown in diagram form at B, Fig. 7, the entire spray nozzle and air valve combination move together, the action being dampened by a dashpot. The metering pin may be regulated from the dash board

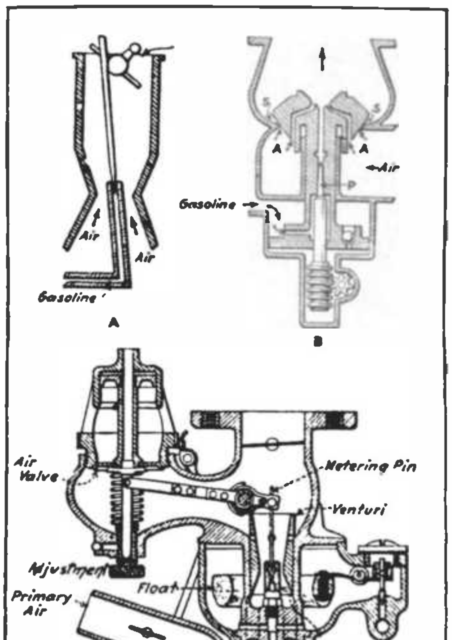
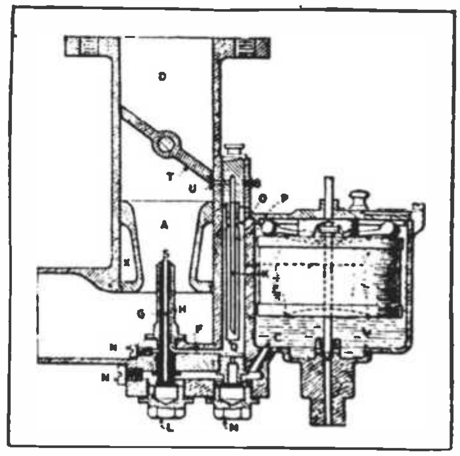


Fig. 7—Metering pin carburetor designs

but when once set it is intended to be left alone. At higher suctions, the air valve and spray nozzle combination lift away from the metering pin.

Compound Nozzle Form

In the Zenith carburetor which is shown at Fig. 8, a compound nozzle is used, this being composed of two jets designated as G and H. The center nozzle G is the main member and concentric with it is a tube which forms the compensating jet H. The inner nozzle communicated with the float chamber through passages E and C while the annular space between the main jet and the cap of the compensating member is supplied with gasoline by the passage F. At one side of the mixing chamber, and between that member and the float compartment, is a cylinder in which the secondary well P and the priming tube K are suspended. The upper end of the priming tube is in communication with the passage U in the mixing chamber walls. The passage U is controlled by the throttle T. When the throttle is closed the suction through the priming tube K is so great that it drains the gasoline from the secondary well and furnishes a very rich mixture through the opening U in the wall of the air tube D. The gasoline enters the sec-



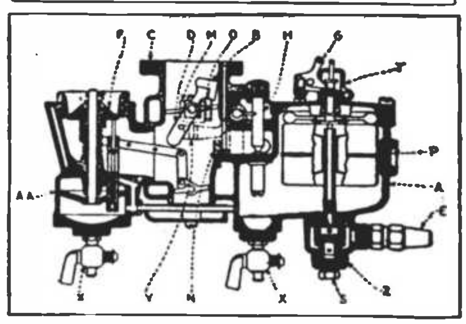


Fig. 8 at top shows Zenith carburetor construction

Fig. 9 is a sectional view of Rayfield carburetor

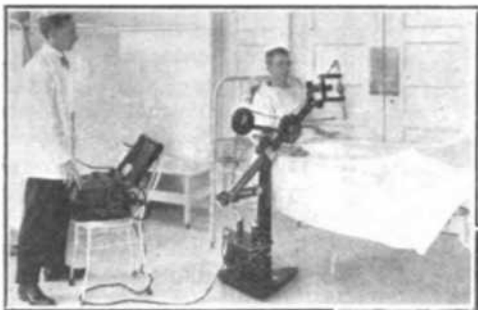
ondary well P through the small hole Q at the bottom. With this vaporizer the quantity of air increases almost directly as the engine speed but the gasoline supply does not.

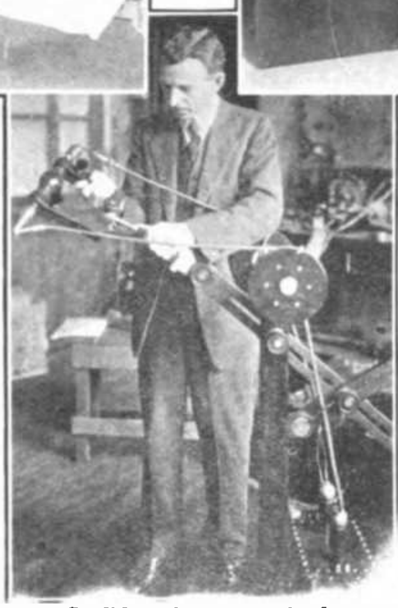
Since the air supply increases with a constant ratio the amount of gasoline must be regulated to such proportions that a correct mixture will be obtained at all speeds. This is the function performed by the double nozzle because at low speed the outer or compensating nozzle has a large quantity of fuel, but this decreases as the engine speed augments until at high speed the compensating nozzle does not add much fuel to

(*Continued on page* 186)

A New X-Ray Outfit

FOR many years the X-ray has been the invaluable ally of surgery and medicine, but until recently it has been necessary always to transport the patient to the X-ray laboratory. Those sufferers whose condition forbade this, were, through no fault or desire of their own, deprived of the X-ray's benefits with the result that medical skill has been handicapped in diagnosing conditions which otherwise might not have been recognized. Dr. W. D. Coolidge and his associates in the Research Laboratory of the General Electric Company at Schenectady have recently perfected a portable X-ray outfit which meets this need. The U. S. Army Portable Outfit, which they devised, rendered service of a high order in the European war and the new and more compacted outfit is the peace outgrowth of the army set.





Dr. Coolidge, inventor of the new X-Ray outfit

It is now possible for any doctor to transport the entire new outfit, packed in four hand-borne units, to any home wired for electricity and produce radiographic results as good as those secured in a completely equipped X-ray laboratory. The process of operating the machine is simplified for him by control systems enabling him to use the exact ray intensity he needs and a time switch that accurately controls the length of each exposure. With these adjusted, the doctor merely presses a button and the machine does the rest. Plates can thus be produced which show remarkable uniformity. An ordinary incandescent light circuit supplies all the necessary current.

The portable Coolidge X-ray outfit is made also for hospital use, so that it can be taken to the bedside of patients who cannot be conveniently moved to the X-ray laboratory. The results produced with this outfit are comparable with those of any ordinary X-ray machine except its power is too low for instantaneous gastro-intestinal radiography which requires greater speed and power.

The portable Coolidge set has been greatly compacted and simplified over the army type familiar to medical corps men. The bulb itself has been reduced in size to 2½ inches. By making the tube of thick lead glass thus replacing a heavy shield, the total weight of the tube and its protection was reduced five pounds with a consequent lightening of the frame which supports it. This lead glass made from a formula developed in the Schenectady laboratory contains about 57 per cent metallic lead and in its resistance to X-rays, is equal in protective power to lead one-sixteenth of an inch thick.

The new tube rectifies its own current, thus doing away with a heavy, bulky rectifier and adding to the efficiency of the set as a whole. The transformer has been reduced in size by the use of smaller windings and a case shaped to fit the coils. A minimum of weight and bulk is secured in all other parts of the outfit by a careful choice of materials and a study of sizes and shapes. Thus when the outfit is ready to be taken out for use, the doctor carries an ordinary size suit case, containing the tube, reels, cables, base of the stand and other small parts, the transformer borne by a special carrying cover, the tube stand in a cloth container resembling a golf bag and a small instrument and control box. The whole load is such as can be put easily into the tonneau of a small automobile and as easily carried in or out of a house. The transformer, which is the heaviest unit of the four, weighs 43 pounds with its case. It is oil insulated and delivers to the tube 10 milliamperes at 60,000 volts.

DETACHABLE BROOM MADE POSSIBLE BY LOW COST OF OXWELD MANUFACTURE

THIS is the day of H. C. L. plus—but it is also the day of new and crafty ways of sidestepping the onslaughts of the ugly ogre. The latest device to enlist on the side of the people is the detachable broom handle.

At first thought the broom handle seems inconsequential. Isolated and individually it is. Multiply it by some fifty millions or more, which probably approximates the number of brooms sold yearly in the United States, and you have something quite different.

The detachable broom handle is a brand new idea and it is "taking". At the present time there is a factory in Vermont devoted exclusively to manufacturing brooms with this type of handle. The handle is of wood fitted into an oxwelded metal holder that clamps easily onto the brush of the broom. The metal part is light but very strong, being securely welded by the oxy-acetylene process, which not only makes it rigid but allows the entire piece to be neatly finished.

This is but one of a long list of interesting new departures from man's habitual thriftlessness that have sprung out of the need for widespread economies to combat living costs. In fact, the oxy-acetylene process itself is perhaps the most far-reaching of all modern economies in the metal working industries. Owing to the superior quality of welds made by this process, its remarkable speed and almost unbelievable economy, it is now almost universally applied in manufacture, construction and repair work. All that is required for a complete portable outfit is an Oxweld blowpipe for welding, a cutting torch, a cylinder of Linde oxygen and a tank of Prest-O-Lite dissolved acetylene, with which practically everyone is familiar.

HOW TO FILL HOLES IN FURNITURE

A CEMENT for stopping holes in mahogany and other furniture or woodwork may be made by melting together five parts of shellac with one of Indian red and enough yellow ochre to give the correct color.

Or beeswax may be used, in the proportion of one part to Indian red to four of wax. When properly mixed and applied this filler after drying cannot be distinguished from the wood itself.

It is also good for other woods of a dark color, as oak and cherry. The proportions may be varied to suit the shade of the woods and all cracks and holes which are not too prominent may be well hidden.—JOHN UPTON.

A Model Engineer Aboard A Destroyer

By Harvey Dale

The bow of the destroyer

THE writer is a member of that unfortunate class of model makers whose desire to build models is aggravated to an intense degree by the sight of a suitable subject. Consequently, when the new twelve-hundred-ton destroyers of the United States Navy first made their appearance he suffered an acute attack of the building fever which raged for a long time unquenched owing to the absolute dearth of any data regarding the boats. Most people whom he consulted knew nothing about the boats except that they didn't look like the old ones, and the few who did know were forced by the censor to maintain an exasperating silence. At last, however, the Atlantic Fleet paid a visit to New York, and for the first time since the war visitors were allowed to go on board the various vessels and even to take photographs.

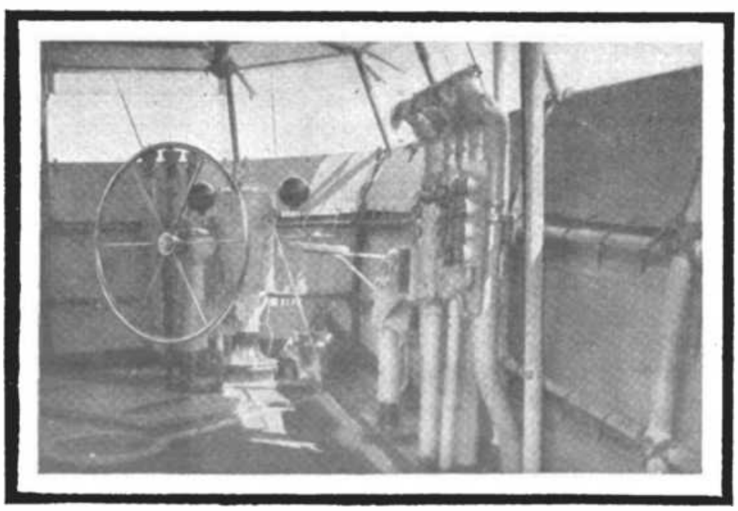
The writer promptly hied himself to the Naval Landing and jumped aboard the first small boat from a destroyer that came to the float. It happened to be a dory from U. S. S. Blank, No. 000, a brand new boat, a month off the ways of Cramp's yard at Philadelphia. He explained his mission to the officer of the deck and was taken below to the ward room and presented to the commanding officer. Both these gentlemen showed him every kindness and gave every assistance in getting sufficient details of the boat for a model, and although the writer unfortunately can- not disclose their names, he, nevertheless, thanks them for their courtesy.

After the consultation in the ward room the writer sallied forth in search of fair game for the all-seeing eye of his camera. There were many details of deck fittings that he recognized only in outline, and which were necessary for the construction of a presentable model. Chief among these were the appearance of the gun and torpedo tube mounts and the arrangement of bridge and bow fittings.

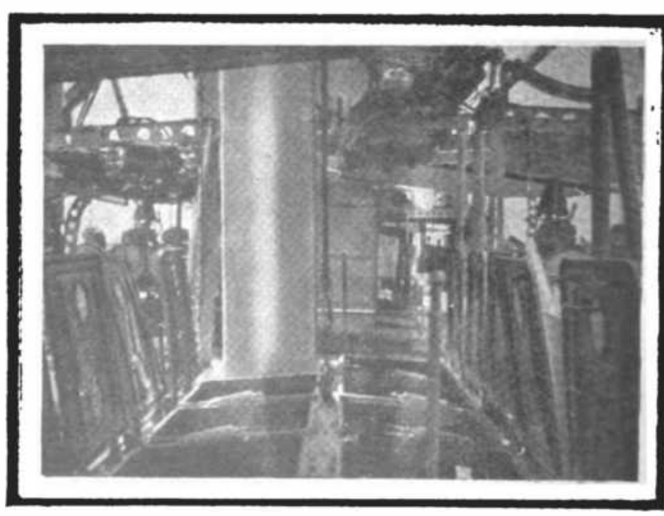
This is a vivid little article prepared by a "young salt" who would rather build model boats than call on his best girl—if he has any. It gives many details that will greatly assist those who contemplate the construction of a model of one of the new destroyers.— Editor.

On the system of starting at the bow and working aft the ground tackle came in for first consideration. By getting a fairly general view from the top of a hatch the details of the chocks, chain guides, anchors and anchor davit were fully taken in. The next things of interest were the forward 4-inch and anti-aircraft guns, but they were so shaded by the awning as to prevent detailed photographs, so one of the after guns was used as a model instead. The forward gun differs from these only in a small steel shield designed to keep some of the water away from the mechanism in a heavy sea. The shape of this is apparent from the photographs.

Next, of course, came the bridge, and this furnished opportunity for several pictures and also for nice model work in the future. First a general view of the bridge taken from the extreme starboard after corner covered the arrangement of steering wheel and indicators fairly well. A close-up of a torpedo director, one of which was mounted on each side, gave an excellent idea of the appearance of these interesting and intricate range and deflection finders. The signal and searchlight platform atop the bridge deck house seemed difficult of photographing until a climb up the foremast to the crow's nest spread the whole ship out like a map. The searchlight platform with its two signal stations at the sides was taken and a view looking aft, which was not of



The bridge of the new destroyer



The group of open hatches

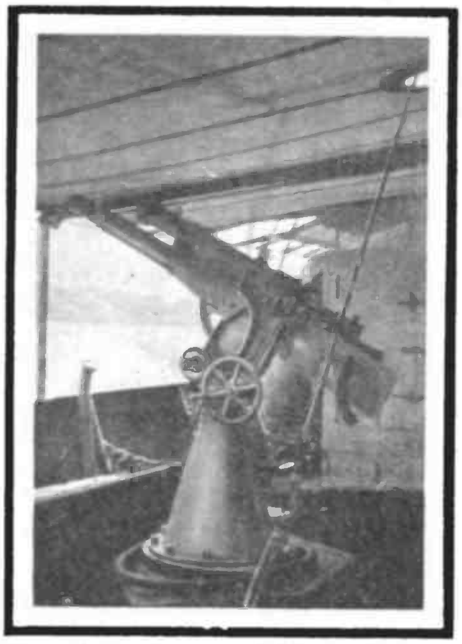
great help owing to the awnings which hid almost everything on deck from sight.

On coming back down to the deck the ship's mascot, a young and lively goat suitably tinted a low-visibility grey obligingly posed with the assistance of one of the men and was snapped on the last picture on the film. It is sure that no model of the vessel would be complete without the ever-present goat, but the writer is afraid he may be difficult to copy, especially his bleat.

The gun platform over the galley and beween the two funnel groups looked interesting, but the photograph shows its shape and arrangement better than a word description could. However, the two 4-inch guns gave an excellent opportunity for views of both sides of their mouths, which were promptly taken.

The anti-aircraft gun on the port side between the first and second funnels was next taken and although shaded by the awning a short time exposure recorded its details very well. In passing it may be noted that the guns differ on different boats. The one shown is a short barreled three-inch with a high angle mount. Other boats are fitted with a semi-automatic one-pounder, which is of quite different appearance.

Any picture of the general appearance of the deck was unobtainable owing chiefly to the awning, but one was taken looking forward over the after engine room skylight which is of some assistance. One of the four units of triple torpedo tubes was photographed both from the side to show its mount and from the rear to show the breach mechanism. The "tin fish" fired is a Whitehead 21 feet long and 21 inches in diameter overall.

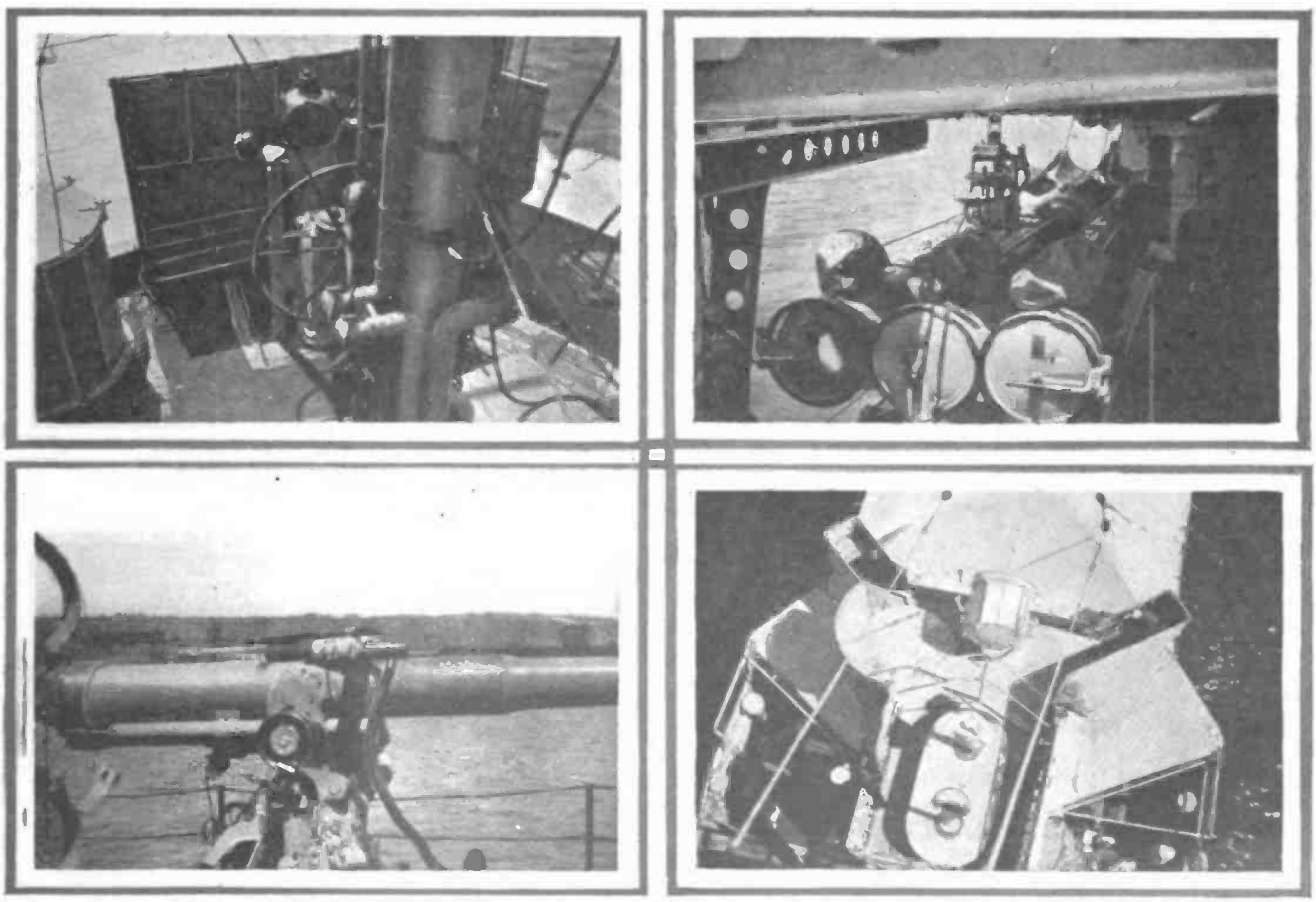


The anti-aircraft gun carried by the destroyer

The afterdeck house came next, and was taken from the after searchlight platform. Unfortunately, the depth charges and "Y-gun" for throwing them were not in their places, but the name "ash-can" is almost sufficient description of the charges and several pictures of the projectors have appeared in the press. Just what is contained in the Radio Compass Box is a mystery to the writer, but its external appearance is simple enough.

The after gun gave another opportunity for pictures, and one of the men obligingly swung it so as to show the view from the muzzle when elevated and from the breech when depressed. The four pictures of a mount of the same mark and modification should be sufficient to enable anyone to draw up plans of a very accurate model.

The possibilities for useful photographs and the film being both exhausted at about the same time, the writer went below decks and tried to puzzle out the maze of pumps and piping connected with the powerful turbines that drive the vessel at a thirty-seven knot clip. These consist of a high pressure and low pressure turbine connected to each shaft by reduction gears. The necessary condenser is mounted alongside each engine. The port engine is forward of the starboard



A group of interesting pictures showing the top of the bridge from above, the torpedo tubes and a deck gun making two separate and complete engine rooms.

When the writer finally set his feet on the shore he was in possession of the following information:

Length over all, 314 ft.

Length between perpendiculars, 310 ft.

Beam, 31 ft.

Draft, 9 ft.

Molded depth, 20 ft. 7 in.

Top of main mast 100 ft. 10 in. above water.

177 frames spaces 21 in. apart.

Small boats.

1 24-ft. motor sailing launch.

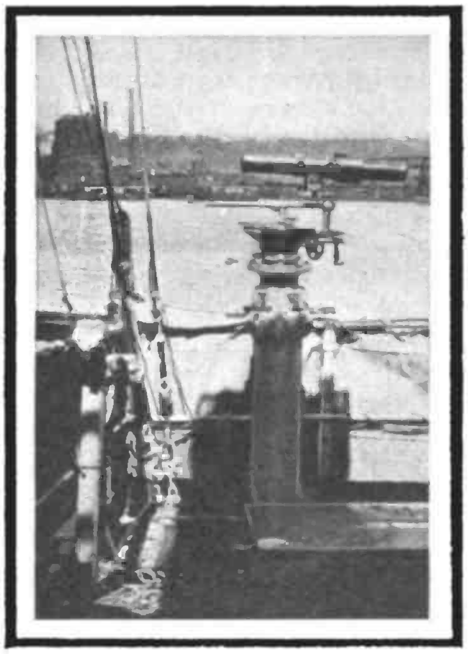
1 24-ft. whale boat.

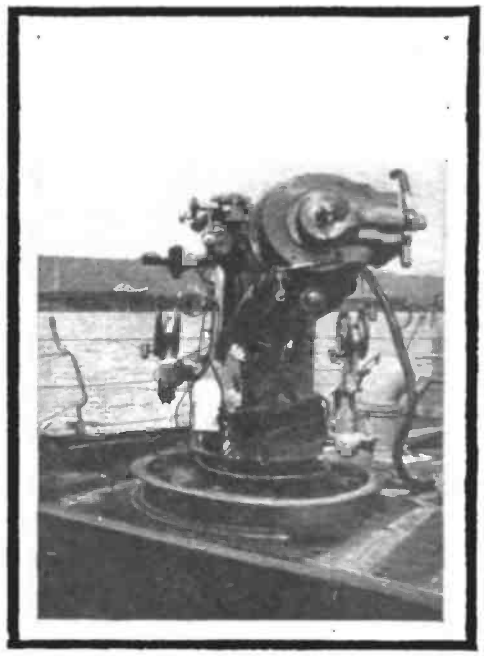
1 21-ft. motor dory.

1 14-ft wherry (carried between cutter and dory).

1 10-ft. punt (carried on deck by galley).

at the top about three feet high and shaped as shown. The two power boats are carried on steel supporting frames when hoisted aboard ship, but the whale boat not having the weight of an engine simply hangs from its davits six feet above the deck. The sections shown are taken on the frames as numbered, and are not evenly spaced as is the usual procedure. This accounts for the apparently somewhat irregular



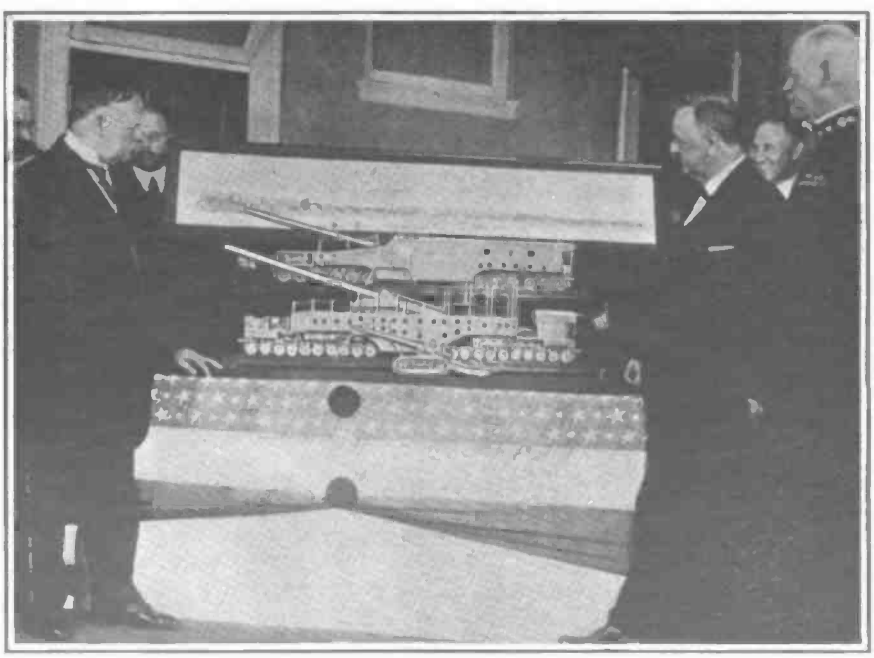


This group of pictures show two more views of the deck gun and one of the range finders

Shafts incline downward and aft at 2 deg. 40 ft. 54 in.

Shafts diverge from center line at 1 deg. 16 ft. 12 in.

Screws 110 in. x 122 in. Port, left hand; starboard, right hand.



Secretary of the Navy Daniels was recently presented with several very elaborate models of the new coast defense guns now being constructed by the Baldwin Locomotive Works. The guns are of the railroad type and are somewhat similar to those employed in France. The models are exact scale reproductions, and cost several thousand dollars to build

The photographs are very nearly self-explanatory, but one or two things are worthy of note. The forced draft blowers on the port side of the galley are simply steel boxes with a wire grating

shape of the hull. The separate details show the tops of the three deck houses, while the main deck plan shows the shape of the house itself. It will be noted that in each case the two are quite different. One detail not shown in the photographs is the railing stanchions. These are slender steel rods spaced about eight feet apart and carrying two wire hand lines. They run wherever no obstruction such as torpedo tubes interfere.

It is sincerely hoped that this brief account and the pictures and drawings will enable many builders to make an accurate model of these magnificent boats which have doubtless already attracted their interest.

ENDURANCE OF OXWELDED JOINTS

OUT of the debris of a $400,000 fire that swept two blocks of Tampa's industrial district last December practically the only salvage was a 12,000-gallon oxwelded oil storage tank, which was afterwards found intact excepting for dents and scars that were later removed. Inspection showed that the oxwelded seams held tight at every point, no leak developing anywhere in the welds. The tank contained 5,000 gallons of gasoline at the time of the fire.

Turning Wheels and Pulleys*

THE machining operations on flywheels, pulleys, rings, casings, etc., are not so simple as those on objects of smaller diameter because of difficulties attendant on the chucking and the production of true running surfaces in the finished article. The proportions of the diameters in relation to thicknesses of rims and arms or webs are so great that it is very easy to spring and warp the castings with a chuck or clamp pressure that does not appear to be actually excessive. The resistance of a disc-shaped casting in the flat plane direction is not very effective against clamping pressure, unless the metal is supported on firm bedding in a line with the direction of the pressure.

Neither is the power to resist distortion circularly on open portions of a rim or flange. Yet, unless a sufficient hold is obtained for driving, the piece will move in the chuck, or on the face-plate, possibly after a certain amount of work has been performed on it, with resulting waste of time, sometimes damage to the surfaces, or occasionally a loss. The large diameter on which cutting has to be done renders the problem a difficult one, especially if the amount to come off is considerable, or the metal is hard. The secret of success in the majority of awkward examples lies in getting a drive somehow without making the friction of the chuck jaws or of the face-plate clamps assume all this duty. The inclusion of bolts, pegs or occasionally of special clamps projected in a suitable manner solves the matter and reduces the machining time and the risks of disaster.

In considering this subject, the question of concentricity takes an important place. It looks very bad to see a flywheel or pulley or other element running slightly eccentric on the rim, or wobbling ever so little sideways, while in the case of gear blanks, friction wheels, brake drums, certain types of covers, etc., any error in these directions is fatal to correct fitting and running. The relation of a bore to an exterior must be ensured correctly by careful workmanship at one chucking, or the operation must be divided, turning the outside, (or, at any rate, finishing it) while the piece is mounted on a mandrel. Very careful boring is required to get accuracy by the first named method, as a small deviation from truth, by reason of the spring of the boring tool or fault in the lathe head or the slide-rest, is much magnified at the periphery of the casting when mounted on its shaft. Hence the popularity of the practice of putting the job on a mandrel, which enables concentricity to be more easily gained and any faint imperfections to be seen readily, either with the eye or more closely by an indicator.

Two important variations arise in respect of the methods of chucking, say, a flywheel or pulley of good size—that is, whether one desires to have the rim portion free for turning or at least roughing out, or whether its covering with jaws or clamps does not matter, when boring the hub is the only operation desired. The relative advantage of having the rim available for holding depends on several factors, such as the diameter in respect to that of the chuck or face-plate, the thickness of the section, the presence or otherwise of arms or spaces in the web. In certain instances it becomes advisable to drill two or three holes in a solid web for the purpose of passing bolts through, being an easier way than trying to secure a hold on the rim with a chuck that barely reaches thereto while the jaws are but inadequately supported in their slots, and also leaving the rim clear for the action of a tool.

The matter of support really settles the point whether a wheel will spring and warp out of truth during the time it is held. This applies both to pressure radially and axially. For example, a severe degree of pressure exercised radially against a rim where it is unable to offer effective resistance is certain to cause disturbance of circular truth. The pressure may come on an open portion of the rim, away from arms, or the thickness of the metal may

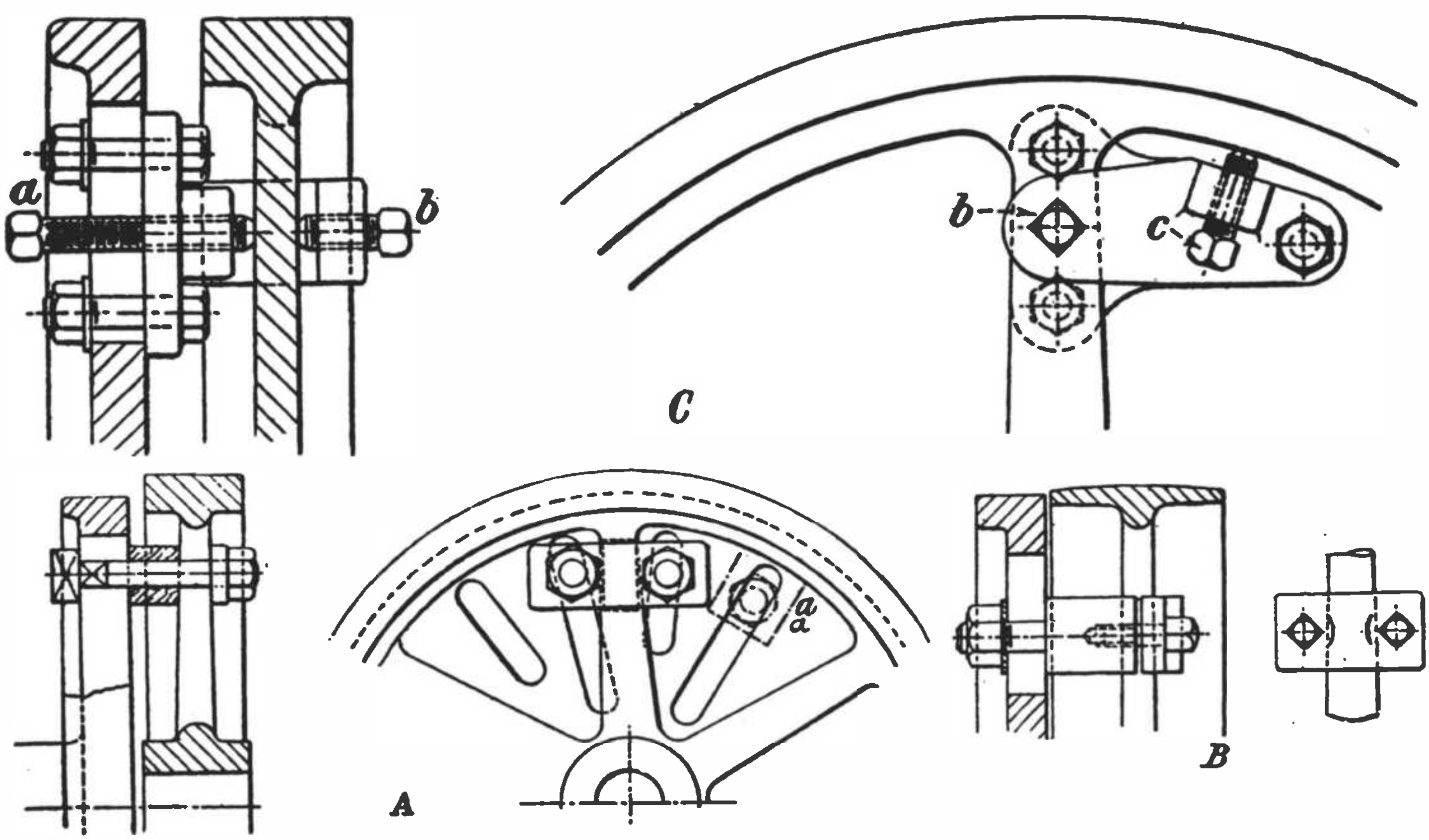


Fig. 2

* Reprinted from the English *Model Engineer and Electrician.*

be not enough to resist the push of the jaws or screws; chucking force must therefore be always tempered to the circumstances. If arms come suitably the grip should be taken directly in line with them in holding on the outside of a rim, and as closely adjacent to them as practicable when gripping from the outside. Some of the risks can in any case be obviated by the expedient of bolting a driving pin to the chuck, thereby carrying the wheel around positively and lessening the need for hard setting out of the jaws.

If clamping-plates are employed to fasten a wheel on a face-plate the effects of their pressure upon the shape of the casting will depend upon the degree of support that is afforded to it. Bearing down at positions where the metal lies over air must inevitably introduce chances of deflection. The ideal method, and a simple one, is to rely on the well-known three-point principle, giving three supports, with an equal number of clamps placed directly over them, and not adding to

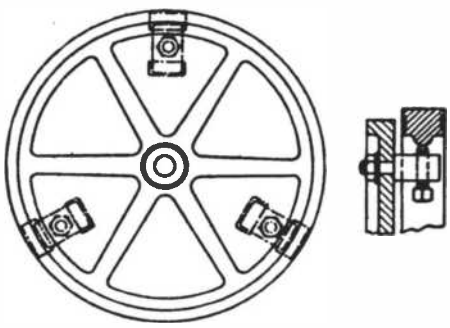


Fig. 1. A correct method of packing and clamping wheel to avoid distortion

these with a view of gaining greater holding power. This is illustrated at A, Fig. 1, the rim in this instance resting on packing blocks and the clamps biting on the curve of the inside of rim. A peg may be projected from the face-plate to give a circular drive, if found desirable. Two pegs are really more correct, located at opposite positions of the circle, otherwise the cut may induce the casting to slew round in an eccentric path. Increase of friction is easily secured by the dodge of placing emery-cloth between the packings and the meeting surfaces, or by using wood packings. These give an excellent drive on rough castings, as the metal sinks into the wood slightly where the little bumps and nodules occur. The inclusion of inside dogs is common in dealing with such objects as these, as they assist the drive, but still better, provide a rapid means of setting to adjust the interior of the rim, see B. The screws are not tightened up more than to a moderate degree or the risk of bulging out the rim is involved. Three clamps seen in the previous view are retained as given.

The alternative practice of setting the clamps across the arms in order to leave the rim entirely free is represented at A in Fig. 2, with packing directly beneath the pressure spot. Prevention of skidding here is dealt with by stop-plates, one being dotted at A, these being tightened up while pushed against the rim with the fingers. No actual driving friction is thereby brought about, but the wheel cannot change its concentric position so long as these plates remain firm. The idea is specially useful in chucking thin pieces, such as rings and washers; for these the projecting bolt-head may be in the way of the tool, so a countersunk head will be let into the plate to leave a flush face. Where wheels and pulleys with regulation shapes of arms are frequently handled it pays to make special dogs for their chucking, to avoid the time consumed in preparing packings and fixing up them and their bolts. A simple device comprises the preparation of small plummer-blocks, either cast on a disc at fixed radii for repetition work. or with stems adjustable in the standard face-plate B, the only operation for chucking and releasing being the manipulation of the two setscrews on each cap, which can be done rapidly with a socket wrench. Another useful arrangement may be observed in sketch C. Three of these castings are employed for a six-arm pulley, and after the latter has been gently pinched and adjusted to run true laterally, through the medium of the screws a and b the screw c is adjusted (in collaboration with its two companions on the other clamps) to bring the rim concentric. Incidentally, the rig-up brings the wheel clear off the face-plate so that with suitable hooked tools it may be practicable to turn the inner faces of the rim and boss.

Limitations of size often bring the turner up against difficulties when his face-plate does not reach to the diameter of a rim. A mode of giving a temporary increase of range consists in bolting on straps or plates of a sufficient thickness to form a firm support for the work, and fixing the latter in any of the ordinary ways with dogs or clamping plates arranged inside or outside the rim. These extension portions can be either formed in link shape for convenience, Fig. 3, A, or made from plates B, this showing countersunk bolts so as to present a level surface right across. Sometimes it may be preferable to utilize a complete ring or a disc, should such a one be available; this procedure offers more variety in the choice of holes or slots on the enhanced temporary diameter, since there is more metal around the circle for drilling suitable holes into.

Reduction of overhang of bolts is usually prevented by reversing them, running the tail into a nut at the back of the face-plate. Or, on occasion, it may be necessary to employ hook bolts so as to get the least possible projection at the front, to avoid dulling the tools. Another matter in connection with bolting, that concerns the turner more in repetition work than in occasional and varied jobs, is that of keeping the bolts stationary while removing a wheel and putting on another. The bother of the bolts slipping in their slots, and flopping about with much waste of time, can be avoided by locking them with a nut, C, Fig. 3, the body being threaded down to permit this; the bolt is thus held out rigidly always at the same spot on the plate ready for setting up or releasing the work. In dealing with thin-rimmed pulleys, a handy type of bolt or clamp is the hooked design, applicable when it is not required to turn the rim, but only to bore the boss at the first chucking. Either the bolt head is shaped to catch round the rim D, or a loose clamp of similar outline is slid over the bolt. The second idea enables bolts of different lengths to be used with one clamp.

TWO INTERESTING EXPERIMENTS WITH BORAX

THE writer has performed two very interesting experiments which, he believes, ought to be familiar to the chemistry student. They are both easily performed, using borax.

For the first experiment a concentrated solution of borax is prepared. It has been found advisable to saturate the solution in the hot, and get the best results by dissolving about 20 gms. of borax in the least quantity of water necessary. The success of the experiment depends on having the least amount of water possible. Some blue litmus is added, followed by acetic acid until the litmus is just red; if water is now added the solution is diluted and turns blue.

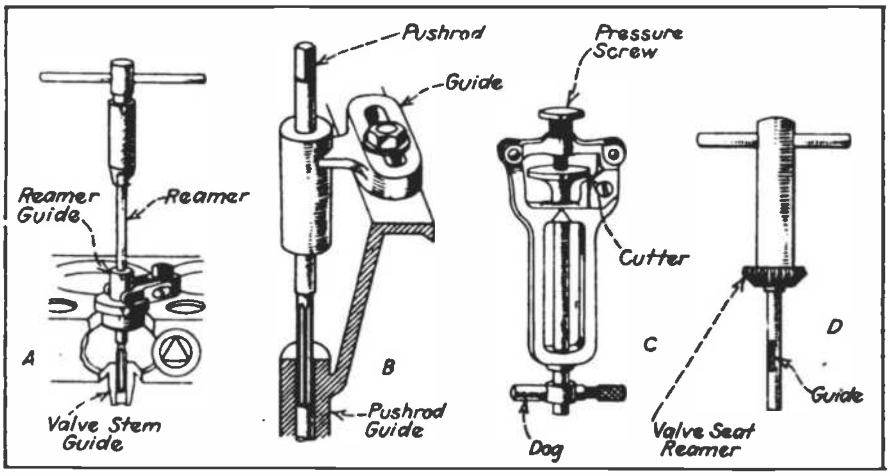
The reason for this is that boric acid is a very weak acid; its salts consequently are highly hydrolyzed. When, after the concentrated solution of borax is reddened by acetic acid, the water is added, the base (sodium hydroxide) is set free and colors the litmus blue. Boric acid is so weak that it has scarcely any effect on litmus.

The second experiment is also the result of hydrolysis—in this case of silver borate. Silver borate is formed by mixing concentrated solutions of borax and silver nitrate. It is thrown down as a white precipitate. If, instead of using concentrated solutions, dilute (usually dilute solutions should be used) ones are used, a dark brown precipitate of silver oxide is obtained This brown precipitate may often be hastened by application of heat. The reason for this is that silver borate is completely hydrolyzed to silver oxide and free boric acid in the dilute solution.

EVERYDAY MOTORIST

SPECIAL TOOLS FOR VALVE REPAIR

AFTER an engine has been used for a time, valve grinding no longer suffices to keep the valve mechanism in proper condition because of depreciation at various points. For example, the valve stem bearing guides at the top of the cylinder block and the push rod guides at the bottom are apt to wear out of round which will result in noisy action. The remedy is to ream out the guides when they are cast integrally with the cylinder block and use valves having oversize stems or use oversize push rods in their guides. If these holes are reamed out larger than can be taken care of by oversize valve stems or valve plungers, as the case may be, it may be possible to place thin bushings of steel tubing in the enlarged guide bearings. The important thing to observe in this connection is to centralize the reamer tools so that they will not bore out the holes one sided and so the parts will be in absolute alignment after restoration is complete. Two forms of guiding fixtures are shown that do this work on the Ford motor, in accompanying illustration. The sketch at A shows the use of a simple fixture for reaming out the valve stem guides. That at B shows a similar fixture for reaming out the push rod guides. In order to restore the valves to proper condition after they have been in use for a time, it is advisable to reface the valve head in a special fixture such as shown at C and ream out the valve seat in the cylinder block with a special form of reamer shown at D. When the valve head is properly dressed off and the pits and scores reamed out of the seat, it will be a very easy matter to grind them to a correct seating.



A RESILIENT WHEEL FOR AUTOMOBILES

THE pneumatic tire, which has helped to bring the bicycle and the automobile into common use, cannot be said to be a wholly satisfactory solution of the problem of minimizing vibrations and joltings on uneven roads. The risk of puncture is an ever-present source of trouble. A French inventor, M. Guiot, has devised an elastic wheel which is free from this defect of the pneumatic tire. It may be said to have passed the experimental stage, for it has stood the test of a 6,250 miles trial adapted to a 4-seater car, with a full load.

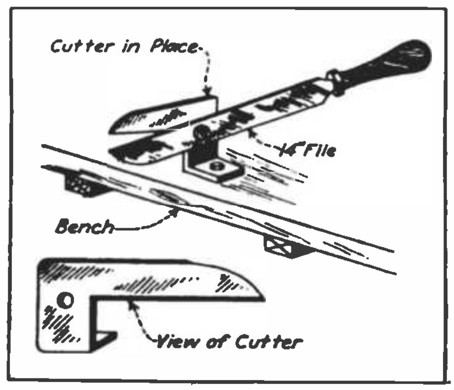
The wheel consists of two concentric rims, both rigid, but joined together by steel helical springs. The axes of these springs are not set in line with the spokes of the wheel, but obliquely, so as to withstand the maximum strain of starting and when stopping with the brake on. The outer rim is provided with a solid rubber tire. Experience has shown that on rough roads, this elastic wheel runs quite as easily as the ordinary pneumatic-tired wheel, and that the springs have a long life when the speed does not exceed 50 miles an hour. Breakage of one of these springs does not involve stoppage, so that no repairs or change of wheels on the road are said to be necessary. This type of elastic wheel is claimed to be suitable for motor trucks and other heavy vehicles, as well as for motor carriages and cabs. This is but one of a legion of similar devices as the resilient or elastic wheel has long been a problem that has defied complete solution and the Patent Office archives of all civilized countries have thousands of patent applications pending and have granted hundreds of patents on devices of this character during the past decade. In spite of this, the air filled tire still reigns supreme for passenger cars, bicycles and motor-cycles and is gaining ground in the heavy vehicle field as well.

HOLDING SHORT STUD

TO hold a short stud while threading the end sometimes troubles the mechanic. A stud box is useful to hold the stud, also to drive it into position. But as an off-hand kink the writer learned a new one the other day. Simply hacksaw a nut lengthwise across the centre of one of the flats through to the thread. This gives the nut a spring hold. Run the stud into the nut, place the nut in the vise and you have a perfect hold for the stud without injuring the thread.

CUTTING SHEARS

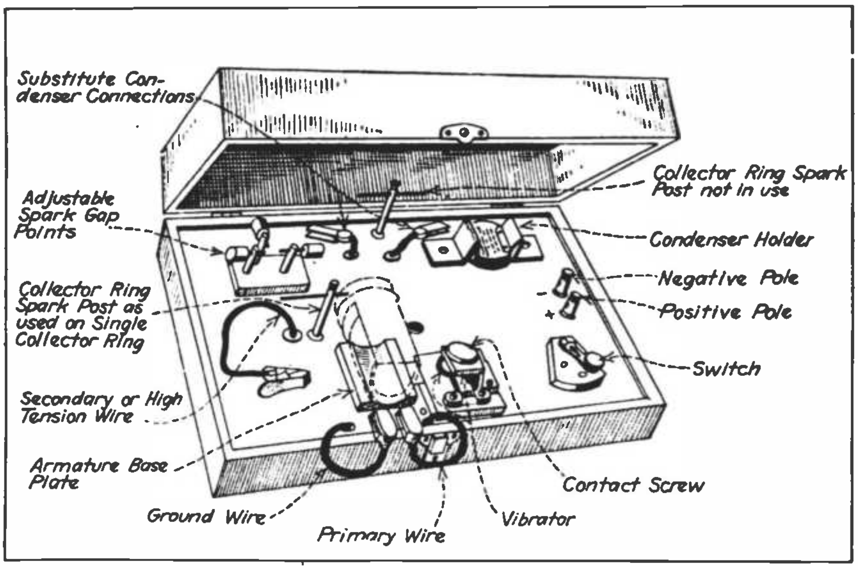
SHEARS for cutting sheet metal and intended to be attached to a bench can be constructed by any mechanic. The stationary jaw that is fastened to the bench may be formed from a section of wagon spring. Heat the spring in the forge and bend to the shape shown in the illustration. Drill holes near the end to fasten to the bench and another hole as a bearing for the cutting bar. Grind the cutting edge on a sharp bevel so that it will retain its edge. The lever is made from a 14-inch file, the teeth of which are ground off on an emery wheel and the cutting edge beveled. Clamp the two sections together with a bolt which is used as a bearing. The file must be annealled to drill the hole in it as a bearing.



The electrical resistance of carborundum diminishes with increasing voltage. This makes it valuable to be used in parallel with any apparatus which needs to be protected from sudden increases of voltage or so-called surges. For series resistance this property is undesirable.

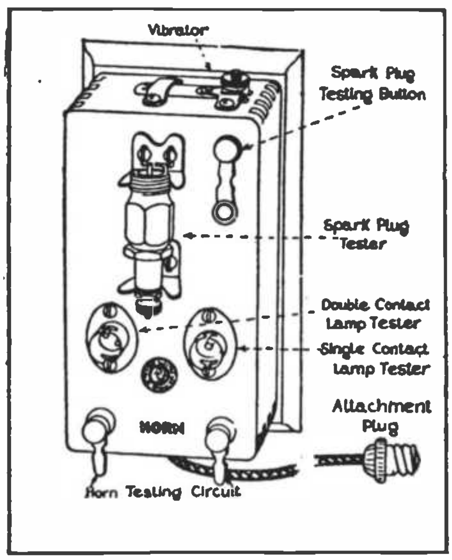
ELECTRICAL SYSTEM TESTERS

THE Defectometer is a new and useful device for those engaged in magneto repair work. It enables the repair man to quickly locate shorts in the various parts of the magneto. It is designed and manufactured by a firm, who are authorities on magnetos. It



is the first instrument of its kind ever put upon the market and should prove to be a valuable assistant to electrical repair men, as its possibilities are very extensive for test work, as all parts may be tested for short or open circuits and any other electrical faults that may prevent proper generation of current.

Another handy all around testing device for the repair man and accessory dealer, as well as the individual,



is illustrated. It is designed for testing spark plugs, single or double contact lamp bulbs, horns, or for locating general electrical troubles. There are two types, the first for attachment to alternating current lighting circuits, and the second for battery attachment. In either case lamps of any candle power or voltage, spark plugs of any length, or electric horns of any voltage can be tested.

THE HEAT TREATMENT OF DROP FORGINGS

THE forging heat of the part is so far above the average critical temperature that it is necessary to heat-treat the steel after the forging process to restore its physical properties; all forgings which will be subjected to severe shocks or strains should, therefore, be properly heat-treated. Simply allowing the forging to cool from the forging heat is by no means proper heat-treatment. Heat-treatment begins after the forging has cooled. The forgings are taken from the hammers to the heat-treating department. Here they are given a preparatory heat to reduce forging strains. Next they are treated to the critical temperature and quenched and then drawn and tested to the proper hardness. This hardness is the proof of the suitability of the forging for the wear and strain of actual use. The forgings are then pickled to remove the scale.

The forging is then subjected to an oil and water-quenching operation. An abundance of water insures absolutely uniform cooling and consequently a uniform hardness. After the forgings have been heat-treated, it is necessary to heat them again to reduce the quenching strains, and prepare the metal for the machine. This is known as the "draw-heat," and is considerably lower than the critical temperature. After the forgings have remained in this heat for the required length of time, they are removed from the furnace, and allowed to cool in the air.—*American Blacksmith.*

In the southwestern part of the United States much trouble is experienced with the presence of fine silt in the water used in irrigation developments. In the Zuni reservoir 4.86 per cent. of its capacity is filled up annually. Sixty per cent. of the volume of the reservoir is now filled. No solution of the problem of getting rid of the silt has as yet been evolvea.

POLISHING WOOD

A VERY nice polish on wood is obtained by using the following mixture: ½ pint of alcohol, ¼ ounce of shellac, and ¼ ounce of resin. Dissolve the shellac and resin in the alcohol; then add ½ pint of linseed oil, and shake the whole mixture. Apply with a sponge, brush or flannel. Rub the wood thoroughly after the application.

TO CASE HARDEN CAST IRON

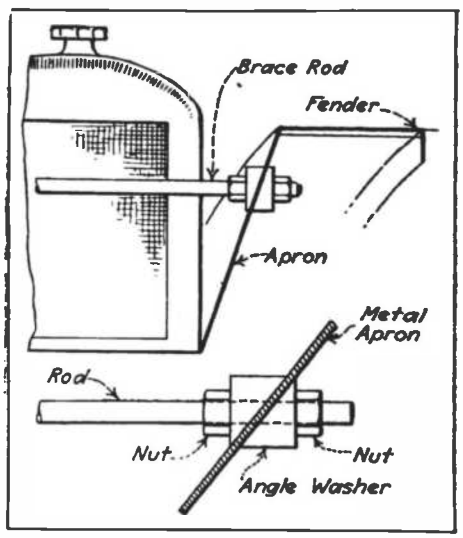
A CORRESPONDENT has successfully case hardened cast iron, using the following receipt. Pulverize and mix together equal weights of saltpetre; prussuate of potash and ½ ounce of sal-ammoniac. Heat the cast iron pieces till red hot, roll them in the powder, and then plunge them into the liquid.

HARDENING FORMULA FOR CUTTING TOOLS

TO make a hardening solution for metal-cutting tools, mix, saltpetre, 2 ounces; sal-amoniac, 2 ounces; alum, 2 ounces; salt, 1½ pound; and soft water, 3 gallons. Keep the solution in a stone jar for it will eat a wooden tub and rust an iron pot. Do not draw the temper but only warm the tools enough to relieve the hardening strains. It is also well to rinse the tools well in water, for if this is not done, the solution will rust them.

BRACING MUDGUARDS

MANY cars rattle at high speeds due to vibrating front fenders. These can be reinforced and made more rigid by joining them with a rod



below the lamps. Make two angle washers of metal and draw the rod tight into place. Pull the fenders back first by hand to get the length of the rod and the angle at which to make the angle washers. Make the rod of one-quarter inch iron and cut the thread long enough so a nut can be placed on each side of the fender apron as shown in accompanying illustration.

A Universal Lathe Attachment

By H. H. Parker

Drawing by the Author

PART I

THIS device is called a universal attachment for the reason that it is used on a small lathe for surface and other grinding; milling, with the work held in the lathe chuck, clamped to the lathe bed or to a table between centers, or in the attachment itself. It can also be used for indexing and shaping or planing. One three-quarter inch bolt clamps the device to the cross slide and the drive may be either from an overhead drum pulley or, as in the writer's case, from a small electric motor bolted to a wooden base which is screwed directly to the vertical slide. The work can all be done on a small screw cutting lathe, the round column with slide keyed to it being chosen as more adapted to amateur construction than flat or vee-d sliding surfaces which require a planer or shaper to finish accurately. The long keyway in the column is cut in the lathe, after first drilling a series of shallow holes to remove some of the material, by clamping a cutting tool on its side in the tool post and by running the carriage back and forth by hand, thus making the tool cut the groove like a shaper tool. The keyway in the slide casting, of course, must be sawed and filed to shape by hand.

Although only intended to be used on small and light work, such as parts of models, this attachment will be found of great service for a large variety of operations, especially if the builder is not equipped with a small grinder or shaper or miller, as is usually the case. One instance in which the shaper head would be of value, for example, occurs in undercutting the segments of a dynamo or motor commutator—rather a mean piece of work to attempt by hand. The dimensions given are suitable for a ten-inch engine lathe, but these may readily be altered to suit any individual machine. It would be a good idea to draw a rough plan view of the column, slide and spindle sleeve and cut out a cardboard templet. Then by laying this upon the cross slide of the lathe and moving the tool slide in and out, any changes in the dimensions necessary to be made could be decided upon. We will not go into a detailed description of the various machining operations, believing this to be unnecessary except in a few instances, but will give a general idea of the various parts and their uses.

Figs. 3, 4 and 5 show the vertical slide, column and cap, all of cast iron, though the column could be turned up from a piece of steel shafting drilled

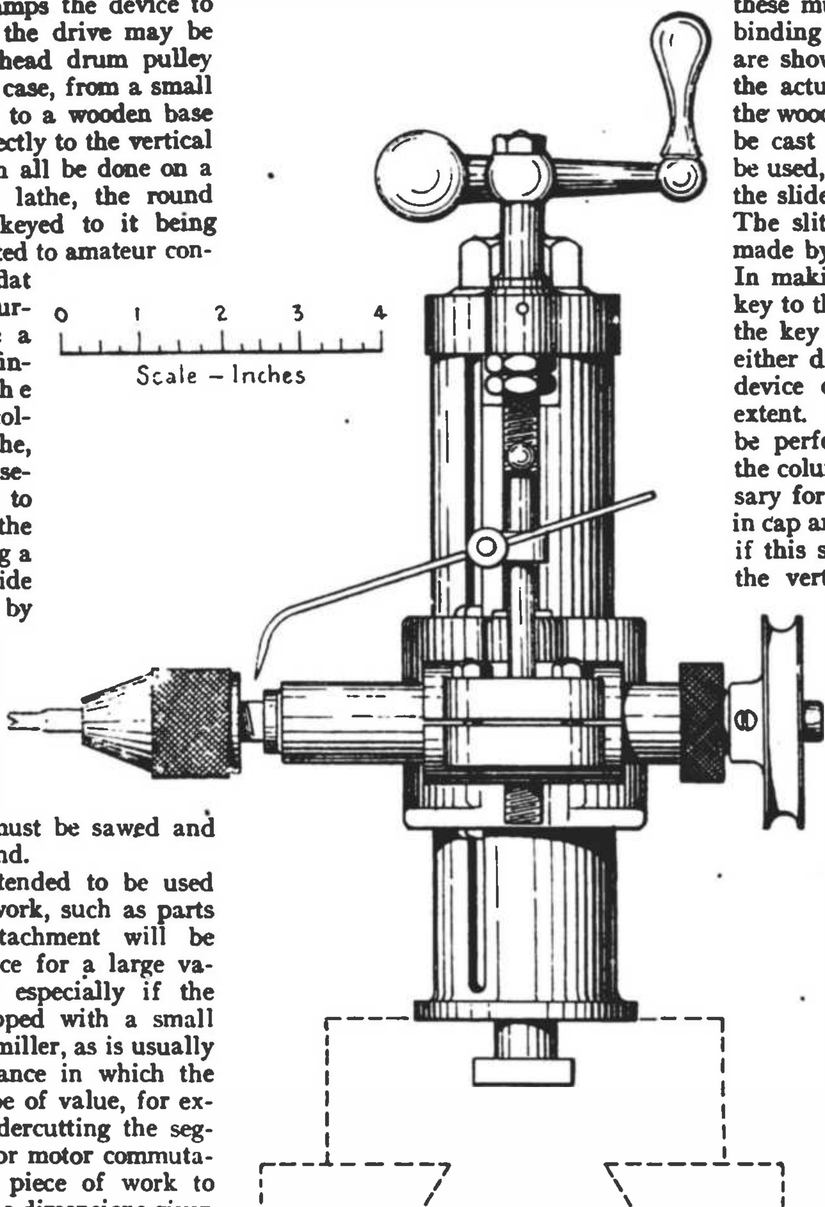


Fig. 1

for the clamping bolt. No complicated core work is used in the patterns, the cores all being straight and cylindrical. It is optional with the builder whether or not the horizontal hole in the slide casting is cored out or drilled out of the solid; the latter method being perhaps preferable, as there would be no sand or chilled surfaces to throw the boring bar out of true or dull the cutter. If the column is cast, it should be cored out to one inch, and it will be unnecessary to drill out this hole later.

The machining of the column is a simple lathe job; if the builder understands lapping he could make a lead lap and finish the surface accurately, and another lap mounted on a taper mandrel could also be used to smooth up the slide after boring; in any event, these must fit over each other with no binding or play at any joint. Four lugs are shown on the bottom of the slide; the actual purpose of these is to hold the wooden motor base, but they should be cast on even if the motor is not to be used, as they are a means of holding the slide to the face plate while boring. The slit through the clamping lugs is made by hand with a hack-saw frame. In making the keyways and fitting the key to the slide care must be taken that the key fits into place without play in either direction, as the accuracy of the device depends upon this to a great extent. Similarly, the keyway should be perfectly parallel with the axis of the column. A jig will be found necessary for drilling and reaming the holes in cap and slide for the adjusting screw; if this screw does not stand parallel to the vertical axis, binding will occur.

Fig. 6 shows the bushing into which the adjusting screw turns. This is made a driving fit into the slide, but not so tight as to split the casting, and held by a set screw as an extra precaution. The screw, Fig. 7, is fitted with two lock-nuts which will take up all lost motion through the cap. In Fig. 8 there is a rather elaborate handle. Castings and forgings of such handles are on the market or one may be turned up on the lathe, or, if the builder prefers, a more simple form can be substituted. The quarter-inch square steel key is shown in Fig. 9, and Fig. 10 is the clamping bolt. This is a standard iron or steel three-quarter inch bolt with the head filed down to fit into the tool block. The S.A.E. pitch of sixteen threads to the inch would allow of an easier tightening of the bolt than the 10 pitch U.S.S., though either may be used. The split slide is tightened on the column by a nut into which is fitted a sliding handle and screws down over a three-eighths inch stud screwed fast into the clamping lug. Figs. 11 and 12. In setting up work when the attachment is to be

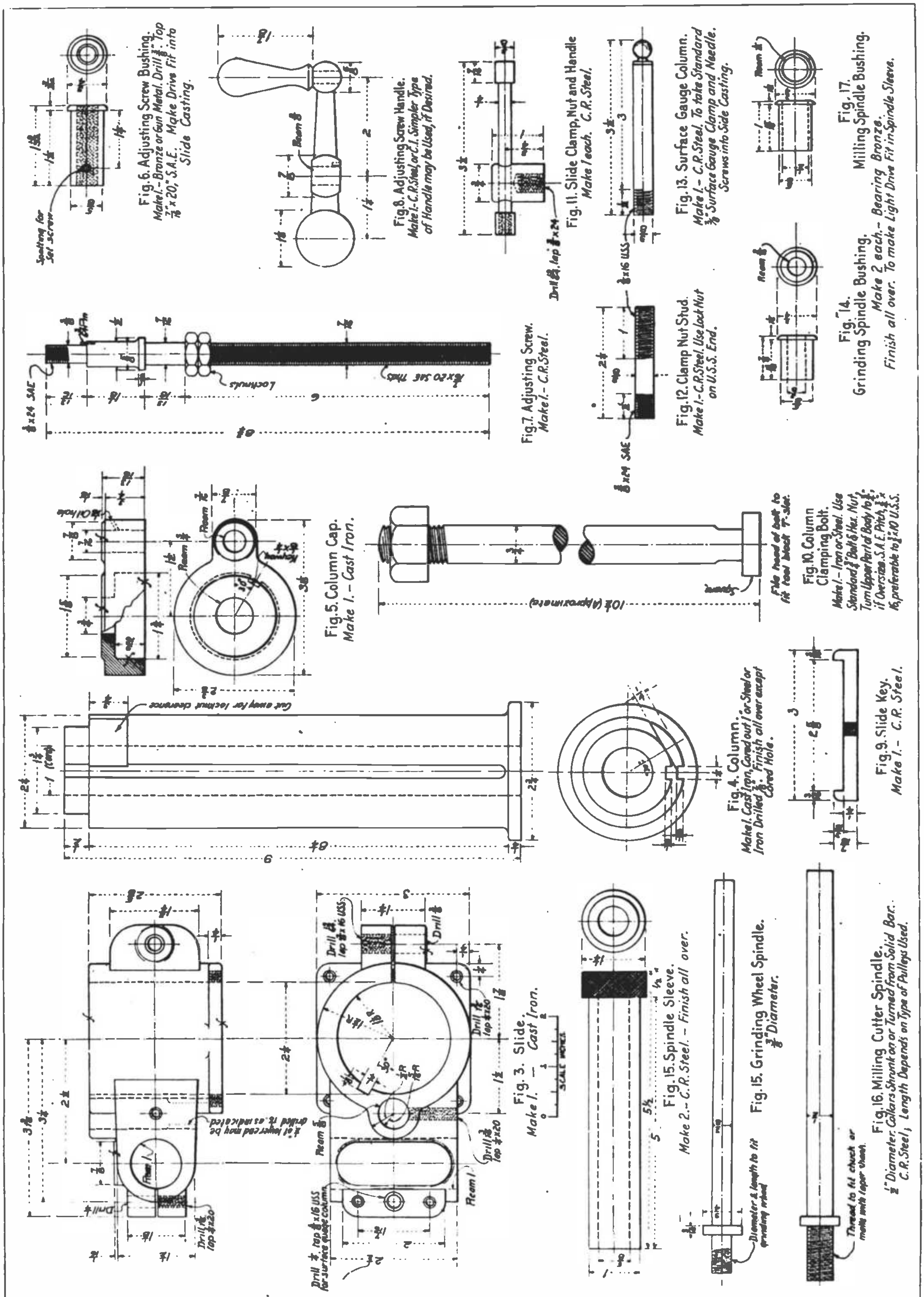


Fig.3. Slide. Make 1. - Cast Iron.
Fig.4. Column. Make 1. Cast Iron, Cored out 1" or Steel or Iron Drilled 1". Finish all over except Cored Hole.
Fig.5. Column Cap. Make 1. - Cast Iron.
Fig.6. Adjusting Screw Bushing. Make 1.- Bronze or Gun Metal. Drill 3/8". Tap 7/16"x20" S.A.E. Make Drive Fit into Slide Casting.
Fig.7. Adjusting Screw. Make 1.- C.R.Steel.
Fig.8. Adjusting Screw Handle. Make 1.- C.R.Steel, or C.I. Simpler Type of Handle may be Used, if Desired.
Fig.9. Slide Key. Make 1.- C.R. Steel.
Fig.10. Column Clamping Bolt.
Fig.11. Slide Clamp, Nut and Handle. Make 1 each. C.R.Steel.
Fig.12. Clamp Nut Stud. Make 1.- C.R.Steel. Use Lock Nut on U.S.S. End.
Fig.13. Surface Gauge Column. Make 1.- C.R.Steel. To take Standard 3/8" Surface Gauge Clamp and Needle. Screws into Side Casting.
Fig.14. Grinding Spindle Bushing. Make 2 each.- Bearing Bronze. Finish all over. To make Light Drive Fit in Spindle Sleeve.
Fig.15. Spindle Sleeve. Make 2.- C.R.Steel. - Finish all over.
Fig.15. Grinding Wheel Spindle. 3/8" Diameter.
Fig.16. Milling Cutter Spindle. 1/2" Diameter. Collars Shrunk on or Turned from Solid Bar. C.R.Steel. Length Depends on Type of Pulleys Used.
Fig.17. Milling Spindle Bushing.

used, a surface gauge or dial indicator is necessary, and in Fig. 13 is a short three-eighths inch steel upright which screws into the slide at any convenient joint and over which is slipped a standard surface gauge or dial or other indicator. We are now ready to take up the various grinding, milling and other attachments.

Surface Grinding

For surface grinding a narrow two to three inch wheel is used, the spindle of which rotates in two bronze bushings (Fig. 14) set into a steel sleeve (Fig. 15). The sleeve makes a snug sliding fit into the horizontal one-inch hole in the clamp. The obvious way to make this hole is to clamp the slide to the column and the latter to the tool slide, making sure that it stands vertical. Then move the cross slide over until the boss can be drilled out about seven-eighths of an inch in diameter and finish nearly to size with a boring bar between centers. A reamer is then run through to finish the hole, and the boss is split with a hack-saw. To return to the spindle sleeve, this is first drilled and reamed to five-eighths inch inside diameter, then set on centers and turned down to one inch, thus making the surface concentric with the bore. Then the bushings are drilled with a reamer drill, turned down, driven into the sleeve and a finishing reamer run through. If the builder desired he could fit tapered, split adjustable bearings to take up the wear, otherwise they are discarded when worn and new ones fitted. The grinding wheel spindle is three-eighths of an inch in diameter and carefully lapped to fit the spindle sleeve. The pulley depends upon the type of drive.

As mentioned above, the writer has used a one-sixth horsepower electric motor, running at 1750 r.p.m. mounted directly upon the slide casting, to drive the grinding wheel. This has given good results, but if no motor was at hand an overhead driving drum would have to be rigged up. Fig. 2 shows a plan view of the motor drive. (To appear in Part II.) If a wooden base bolted directly to the bottom of the slide interfered with the lathe cross feed handle, an offset flange could be made of cast or plate iron which would raise the base up higher.

Some work may be held between centers for surface grinding; sometimes it is clamped directly to the lathe bed or to the face plate or to an angle plate, but small flat pieces are best operated upon by being clamped to a small flat table held between centers (Fig. 18) provided with adjustable legs to level the table transversely. The size of such a table would depend upon the builder's tastes and the size of his lathe. A pair of Starrett Toolmakers' Clamps, Fig. 19, are very useful for work of this kind, as they may be fastened to the table in any position by flat head screws and the work clamped in them. This table is also used for milling, when the cutter is rotated in the sleeve spindle as described later. Cylindrical grinding also, to a limited extent, may be performed by swinging the sleeve around parallel to the lathe bed.

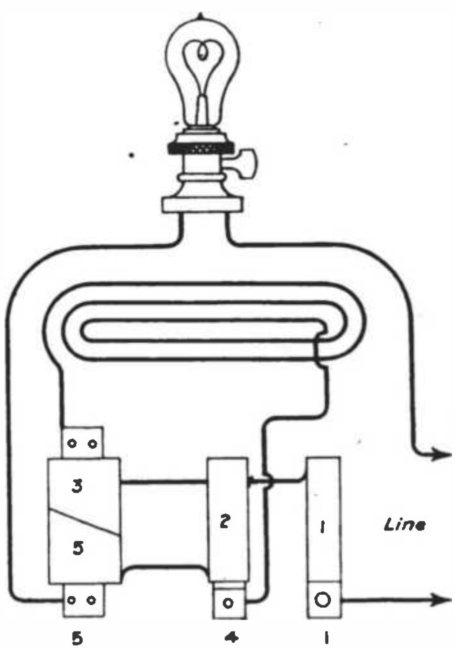
Milling, Cutter in Spindle Sleeve

A side elevation of the attachment is shown in Fig. 1, where the device is fitted up to do milling. A second spindle like that of Fig. 5 is made and fitted with bushings reamed out to half-inch, Fig. 17, and a half-inch shaft. The business end of the shaft is machined to take a drill chuck, lathe chuck or whatever is used to hold the milling cutters, while a pulley is fitted to the other end. Of course, the pulley must be taken off when the sleeve is to be removed. The electric motor can be used here also, the same as in surface grinding, but the spindle would rotate at a much lower speed. Fig. 1 shows the adaptation to overhead drive.

A SIMPLE DEMAGNETIZER

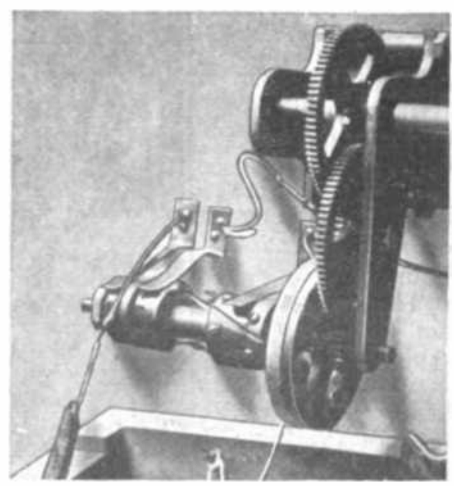
By J. A. Statler

THE little demagnetizer illustrated in the photograph will be found very useful in different work. It can be used very successfully in a jewelry repair shop for the demagnetization of watches. It will also find a number of uses about the experimenter's laboratory.



The connections for the device are sketched in on the drawings. By rotating the shaft carrying the reverser and collector rings, the polarity is changed at each revolution of the shaft. The ratio of the gearing is such that the current reversals can be made very rapid by turning the handle slowly. If A. C. current is used with the device, the handle need not be turned. Of course, magnetizing cannot be done with this current. When the device is used with batteries, a fuse is merely inserted in place of the lamp seen in the photograph. The lamp is used when the device is employed on a 110 volt circuit. A 50 C. P. lamp is employed because it draws a heavier current through the coil.

The completed demagnetizer



The gearing of the demagnetizer

The author has since made a machine similar to that described above but driven with a spring motor so that the hands are free to manipulate the work.

A TIP ON DRILLING

THE average mechanic who uses a handdrill always reverses the rotation of the drill when he desires to take the drill out of the hole made. This is bad practice, as it not only helps to take the edge off the flutts but is also liable to break the drills. In removing the drill it should always be revolved in the one direction.

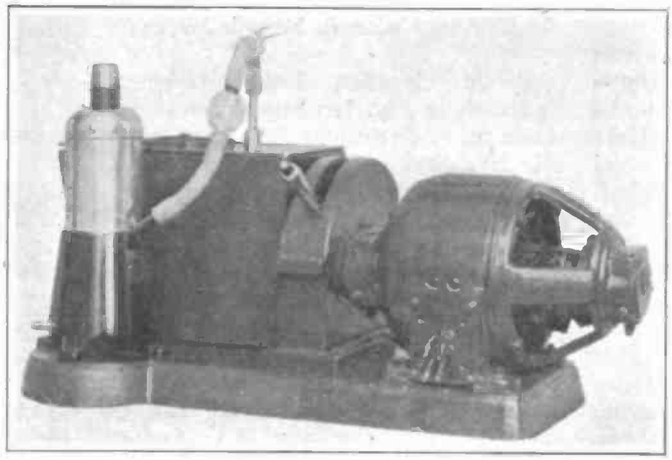
The Langmuir Condensation Pump

By L. A. Hawkins

SCIENCE and industry have produced many triumphant feats through the agency of vacuum. for in it there can be no loss of energy through heat conduction and matter cannot decompose by oxidizing. So the degree of achievement has been in proportion to the perfection of vcauum attained. Many machines have in the past been devised to extract as much air as possible from containers. Suction pumps are sufficient even today for exhausting such containers as electric light bulbs, but for the higher grade vacuua such as those required for Coolidge X-ray tubes and for high power tubes for wireless use, a mechanism of much higher efficiency is required. Many types of pump have been designed to produce a specially high vacuum, but the crowning triumph in their construction was reached when Dr. Irving Langmuir devised his mercury vapor mechanism since come to be known as Langmuir Condensation Pump.

This device is not only the most rapid of all high vacuum pumps, but it also will produce the highest vacuum.

It came into being as the result of efforts to get higher and higher vacuum for the purpose of research and to get it quickly. The pump, in spite of its remarkable effectiveness, is simplicity itself in operation. It has no moving mechanical parts. A stream of mercury vapor, produced by a small electric boiler, and moving at high velocity, entraps and sweeps along with it the air or gas molecules from the vessel undergoing exhaustion and delivers them to the rough pump, which ejects them into the air, while the mercury vapor itself is condensed and flows back into the little boiler.



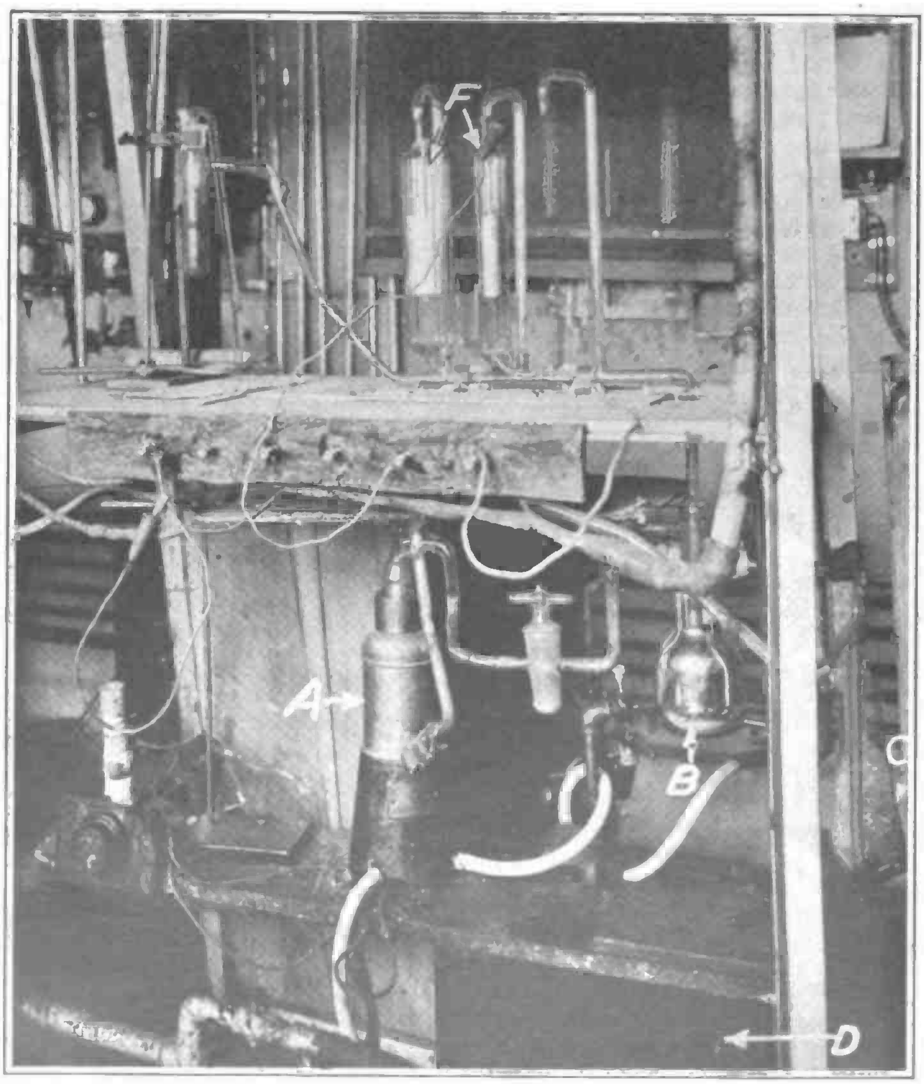
A Langmuir pump with driving motor for the two-stage rough rotary pump

Like most new tools of science, the Langmuir Condensation Pump has found a field of great practical utility. All the Coolidge tubes, which have revolutionized X-ray practice, and all the high-power radio tubes or pliotrons, as they are called, which have made long-distance wireless telephony practicablefi are exhausted by this pump.

Its speed has been stated in this way—it will reduce the pressure in a 1-liter vessel (approximately 1 quart) from 100 microns (approximately 1/10,000 atmosphere) to 1/100 micron (approximately 1/100,000,000 atmosphere) in two seconds.

But such a statement, while it tells the whole story to a physicist, does not mean much to a layman, so suppose we put it this way—Since a million is about as large a number, and a second about as short a time, as have a real meaning to the average man, how long would it take to accomplish the result above stated, if, from the vessel in question, we removed a million molecules a second? The answer is 750,000,000 years.

As for the degree of vacuum which may readily be obtained with the Langmuir pump, the physicist would say: Better than a ten-thousandth of micron. This can be expressed approximately as 1/10,000,000,000 atmosphere; but, even so, the statement lacks clear- (*Cont. on p.* 180)



The Langmuir pump in use: D is the rough rotary pump; A the Langmuir pump, and F the vessels being exhausted; B is a liquid air trap for the mercury vapor

Surface Combustion

A Special Process of Burning Hydro Carbon Gases in Industrial Furnaces

By Prof. T. O'Conor Sloane

SURFACE combustion is the term adopted to designate a system of burning hydrocarbon gases, in industrial furnaces, using just enough air to give an explosive mixture. The air and gas are mingled intimately outside of the furnace by means of a sort of mixing-valve. If such a mixture is ignited at a given point, time is required for the explosion to be promulgated, the explosive wave travels at a definite

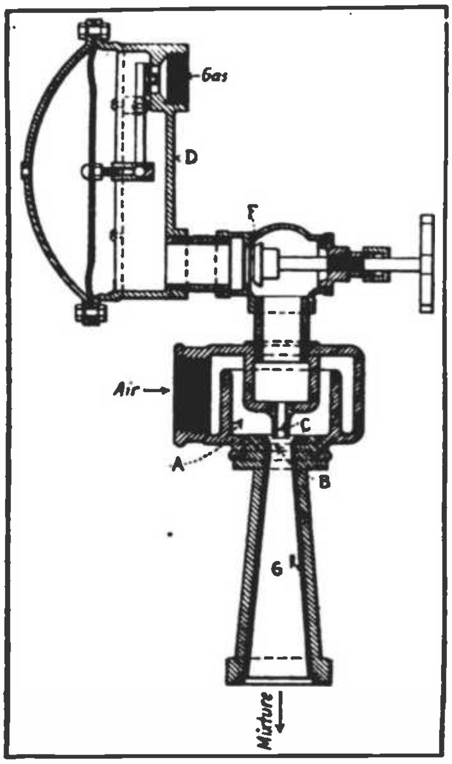


Fig. 1. Low pressure mixing valve

speed of so many feet per second, according to the proportion of the constituency. If therefore the velocity of the current of the air and gas in a pipe or conduit exceeds this rate the mixture cannot explode back. As the explosive gases rush out of the nozzle into the furnace its velocity of current or of flow rapidly diminishes, and a few inches from its point of entrance the velocity is lowered to that of the explosive wave transmission. At this point the mixture burns instantly in a very limited space, with almost no flame, but with intense heat.

If the point of instantaneous combustion were to be determined simply by the velocity of the current as it was reduced by its entrance into an open furnace it is evident that the element of uncertainty would be considerable. To fix an unchanging place of combustion the current is received by a mass of refractory material, carbonundum or alundum are two substances which have proved available. The refractory material is soon brought to a white heat by the combustion, and thus fixes the zone of such combustion.

Air is a mixture of about four volumes of nitrogen to one volume of oxygen. In burning hydrocarbon fuels the heat is produced by the chemical combination of the oxygen of the air with the carbon and hydrogen of the fuel. If the combustion is perfect theoretically, the products of the operation will be carbon dioxide and water, and if the theoretical result is attained, the highest practical efficiency will result.

While it is possible to combine nitrogen with oxygen no such combination occurs in ordinary burning. The nitrogen is inert, does no good except as a diluent, making the reaction less intense and more manageable, but adds no heat. After the combustion it is still nitrogen, unchanged in all respects. It has been aptly termed the ashes of the air. As the nitrogen leaves the furnace it inevitably carries off some of the heat, so that its presence impairs the economy of the process. Now suppose that, as in ordinary furnace work, there is a large excess of air. Such air does no good whatever, but does harm, as it carries off a quantity of heat up the chimney. The excess of oxygen is nearly as harmful in impairing the economy of the process as is the same quantity of nitrogen, and with the excess of air there is the more serious nitrogen to waste heat by carrying it up the chimney.

The clue to the practise of surface combustion is the quiet and regulated burning of an explosive mixture of air with a hydrocarbon gas. The theory is simplicity itself; the practical application is now to be described.

The cut, Fig. 1, shows the construction of the low-pressure mixing valve. The gas in the pipes is maintained at a pressure of from 2 to 6 inches of water. The air is supplied from ¼ to 4 lbs. per square inch; this is over ten times the gas pressure. The air and gas inlets are named in the cut. As the air rushes in through A, it produces a slight vacuum around the mouth of the nozzle, C, so as to draw the gas in with its own current. The two mix rapidly as they pass through B and G; the pressure of the gas is kept constant by a governor, D, and the amount passing the nozzle is regulated by the valve, F. There is a valve to regulate the flow of air: this is not shown. The mixture thus produced is carried through pipes connected to G, to the furnace. As the gas pressure and air pressure are constant once the setting of the valves is effected so as to produce the explosive mixture all goes on indefinitely without further attention, except for watching the minor adjustments.

It is seen that the low pressure system needs two pipe lines—one for air and one for gas; the air at the higher pressure does the inspirating. In the high-pressure system the air is taken in at atmospheric pressure; the gas, at a pressure of 10 to 25 lbs. per square inch, issuing from a small jet enters the open end of an outlet tube, draws in air from the atmosphere, and the mixture is thus formed. Only one line of pipe, that for the gas, is used.

The cut, Fig. 2, shows the gas inlet at the top; at C is the jet, above which is the screen, B, to remove any dust from the gas. At D is the adjutage,

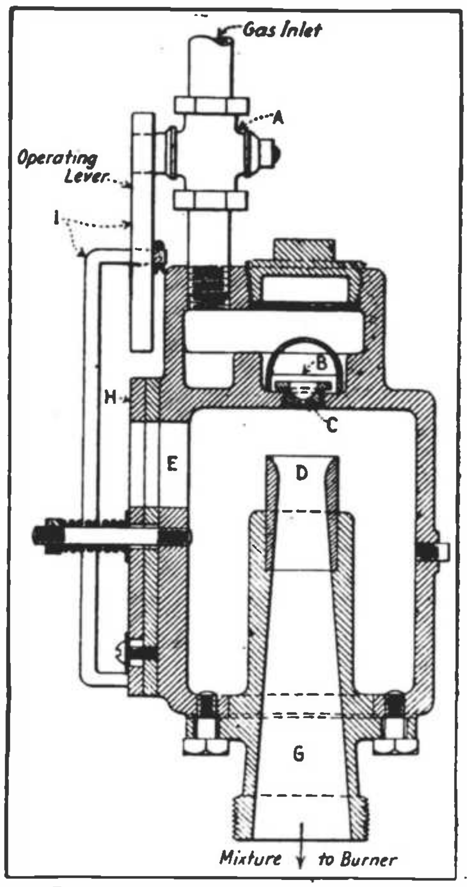


Fig. 2. High pressure mixing valve

coaxial with the gas jet. The small high-pressure stream of gas draws with it through the opening, D, a quantity of air, which enters directly from the atmosphere through the opening, E, adjusted as to area by the shutter, H, by setting this shutter more or less open, the proportion of air to gas is regulated. The handle of the gas-cock is connected by a link, I, with the air-shutter. When the gas is shut off, the shutter is closed with the cock. This is necessary because there is always maintained in the furnace a slight pressure above that of the atmosphere, and closing the air-shutter prevents back-draught. The pressure within them exceeds that of the atmosphere. No air enters except that which comes in mixed with the fuel gas. The analysis of the escaping gases shows perfect combustion as far as the burning of the gas is concerned, and the absence of free oxygen indicates the absence of any excess of air. These are the two conditions ensuring economical operation.

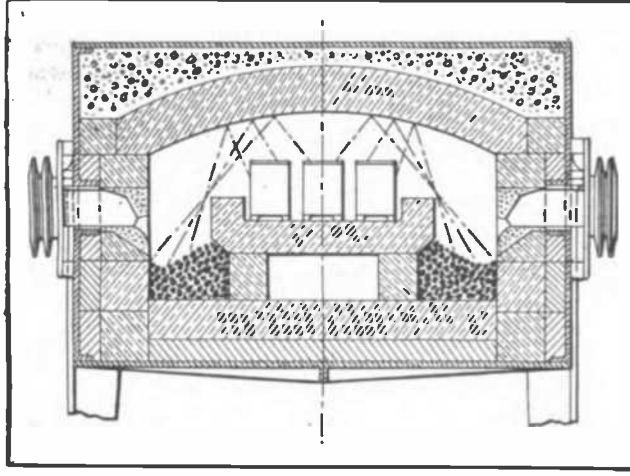


Fig. 3. Semi-muffle type furnace utilising surface combustion principle

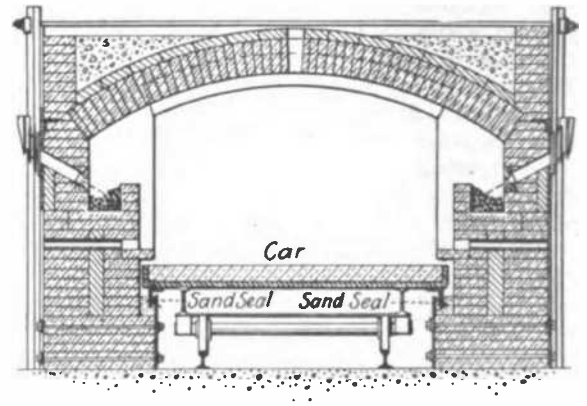


Fig. 4. Furnace in which charge is run in on a car

mixture passes into the conduits to the furnace through the pipe, C.

The burners are generally of what is called the impact type. After various trials of material, cast-iron was selected for their construction. Their contour is seen in the cuts of furnaces. It is an object to keep them as cool as possible. Accordingly outside of the furnace each burner is provided with cooling fins, of disc-shape, shown in the cuts; the air circulating around and between them keeps the burners from over-heating.

In front and below each burner is a pile of refractory material, to localize the locus of combustion. The furnaces are so arranged that the pressure with-

In one of the cuts, Fig. 3, is shown a furnace of semi-muffle type. The oblique lines indicate the radiation and reflection of the heat from the intensely heated refractory material. The principal heating effect is attributed to radiation, rather than to convection in this type of furnace.

The next cut, Fig. 4, shows a furnace in which the charge is run in upon a car. The floor of the car is a little longer than the furnace so that a few inches at both ends project, like shelves, at each end. The vertical doors of the furnace rest upon these shelves. To right and left of the car and underneath it are sand-seals to exclude air.

An annealing furnace, Fig. 5, working on thirteen-inch shells is next shown. This is different from the preceding ones. There are no heaps of refractory material and the burners are horizontal. The mixture enters somewhat tangentially against the walls of the furnace. High- and low-level burners are used to secure an even distribution of heat.

There are other types of burners, but those shown are the ones most largely in use. In one type of burner, of the utmost interest from the scientific standpoint, the mixture was passed through a diphragm of porous material, such as fire-clay. It burned on the surface of the diaphragm, with intense and localized heat. There was absolutely no flame visible, and the heat was confined to the thin outer layers of the plate of refractory material.

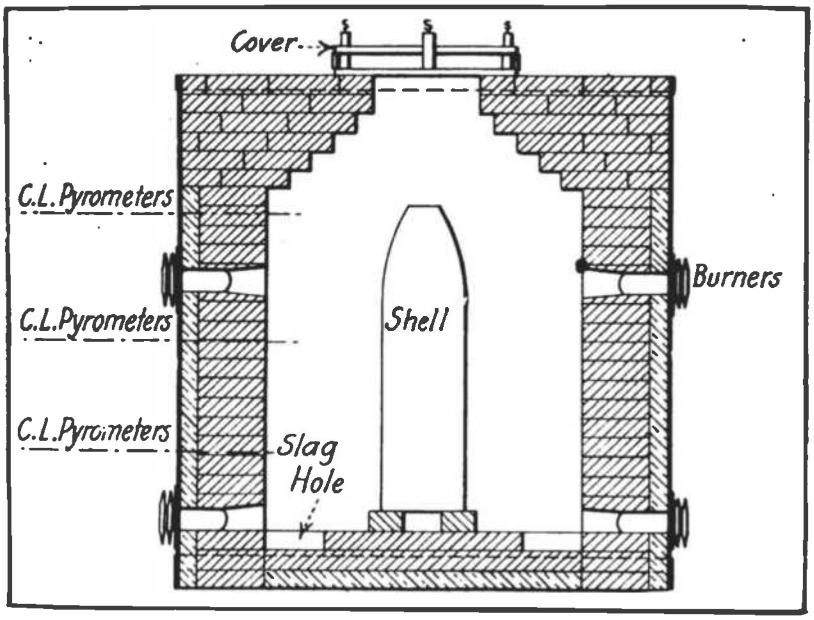


Fig. 5. Annealing furnace for large objects

TURNING COPPER

THOSE who have had to turn copper in the lathe have generally wished that they had let someone else do the work and that they stood by and jeered when it was being performed, or else criticised it after it was done. Soap and water do not help; turpentine or kerosene is a delusion and a snare; but milk does the trick with neatness and dispatch.

Under existing conditions it is calculated that there is room on the earth for only twelve first-class wireless stations. But by directional methods, varying wave lengths and such features of operation it is thought that eventually there may be room for 175 times as many. The trans-Atlantic wave lengths are 40,000 and 80,000 feet.

Electric heating furnaces for work on guns are being constructed for France. The largest are 90 feet deep. They are built in sections, so that they can do different work. For shrinking on a breech lock 37 kilowatts, and for the longest pieces 1,000 kilowatts are used. The chamber is seven feet in diameter. The temperature control is automatic. For shells a special furnace is made in which graduated temperature can be applied so as to produce a shell with a different temper for the nose than for the body. It can cover a range of 300° F. in the length of a projectile.

Manual Arts and Crafts

Projects in Wood and Metal Work for the School, Home or Shop

NOVELTY SEWING BASKET AND SMOKING SET PEDESTAL

PROJECT No. 1 graphically depicts a very easily made, yet decidedly convenient, Sewing Basket that any one ever sews will appreciate more and more each time they use it. A few slight changes as described later will produce a wonderfully convenient Smoking Stand. It is designed particularly for the beginner and may be made of any convenient and easily procured wood such as ash, oak, mahogany, walnut, cherry, hard pine, chestnut, red wood, white wood, white pine, cypress or spruce, and if stained carefully will make an ornamental as well as useful article of funiture.

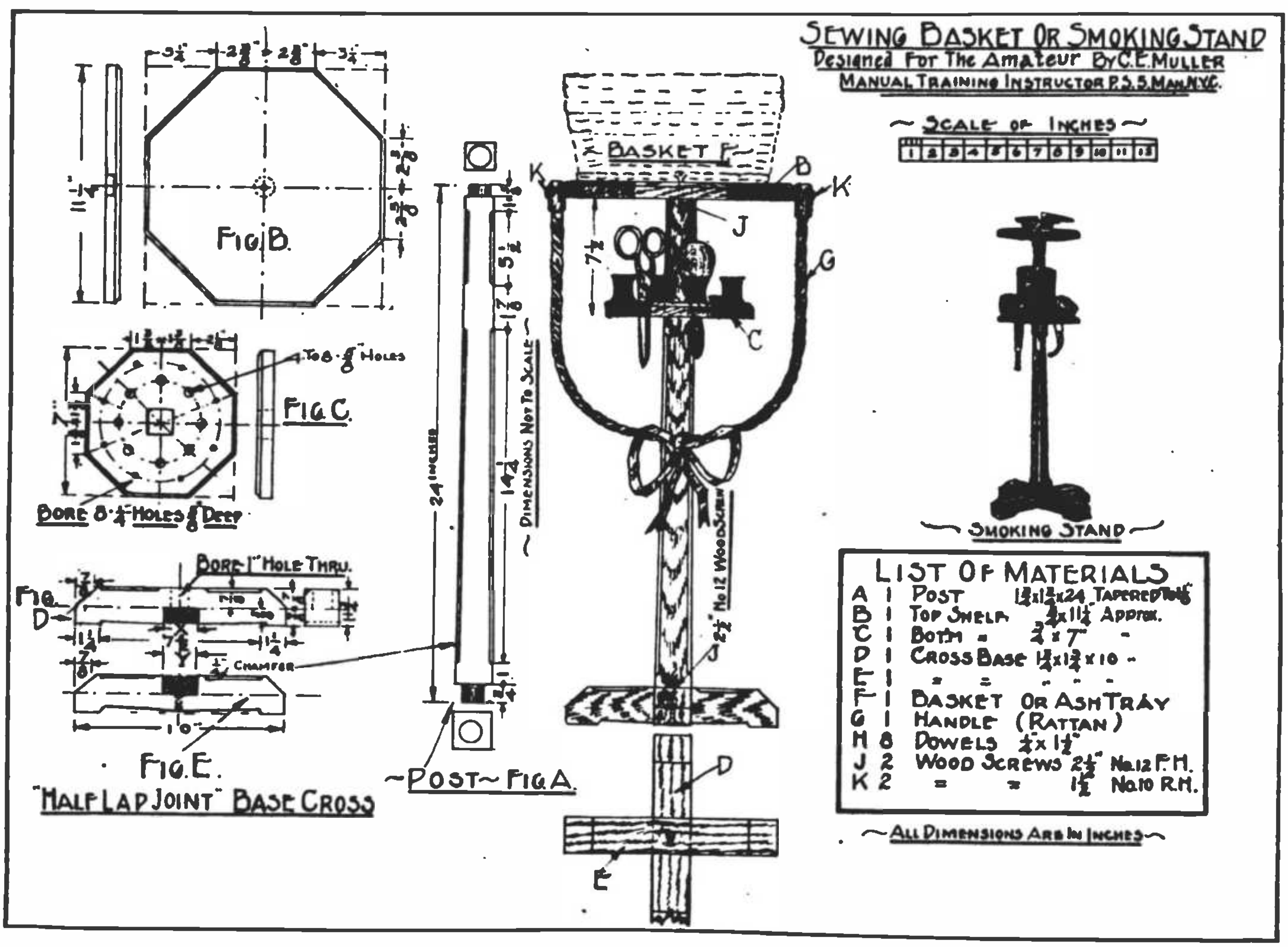
The tools actually required for this project are: 1 Plane (Smoothing plane preferred), Block or Jack will answer; 1 Saw—Fine tooth Cross Cut preferred; 1 Screw Driver or Hammer and nails instead of screws; 1 Pencil; 1 Ruler; 1 Brace and Bits or Holes may be burnt with red hot irons; 1 Try Square or a Tee Square.

The central post, Fig. A and the base, Fig. E-F, may be made of one and one-half inch to two inch sq. stock, the shelves of boards ⅝" to 1" thick. A basket of proportionate size with or without a handle, Fig. G, will suffice for the Sewing Basket or may be substituted for by a suitable ash tray which will make the "Smoking Stand".

The first step is the careful selection of the lumber. It should be thoroughly dry, free from knots, cross grain, weather of kilm checks (which appear as slight cracks running with the grain and are found usually in the ends of the board). Frequently the boards are found badly warped across their width and sometimes sprung lengthwise due to being poorly stacked when drying. These should be avoided if possible. These defects are often not noticed by the amateur until assembling. They are very annoying and detract from the appearance of the article and more often it is found necessary to replace them at additional expense and trouble. If care is taken in the proper selection and if the parts are stood on edge while waiting for operations, no difficulty will be met with.

It is strongly recommended, especially for the novice, that they work as closely to the dimensions as possible, especially where the parts fit together as a slight deviation may affect the other finished pieces. However, if allowances are made in all the adjacent parts, the dimensions may be altered to suit the available material.

The first step in construction is to lay out the length of the post accurately, as in Fig. A, squaring the lines on all four sides of the post. Saw off squarely to the overall length. Next lay out the 1" pins on both ends. From experience gained in teaching elementary school boys from the 4th year to 8th year inclusive (ten to sixteen years of age) I found that better results were obtained by using a twenty-five cent piece as a template to draw a circle on end grain in lieu of the compass, which has a tendency to follow the grain. It is easily centered, by sighting the margin on the four sides. Now plane the taper, using the top pin as a guide



maintaining the relation of the sides square to one another. Of course it is optional to taper the post to a 1" or 1⅛" square. If the pins are dressed to a 1" square, then sawed across the corners and pared down to an approximate octagon, then these corners dressed down to the 1" circle, a slight rub of a flat file or the corners scraped off with glass will produce a fairly rounded dowel. By using a 1" hole bored in a spare piece of wood as a template, the dowels may be carefully and gently rotated to a very satisfactory fit.

Stop chamfers, Figures A, E and F are easily made if care is taken to equally thumb gauge pencil lines on both sides of each corner. Proceed very slowly, using a chisel or knife, taking a little off at each time. The mistake that the inexperienced usually make is to slice off too much at the first cut and where the wood is curly or cross grained a bad tear results.

Through chamfers, Figures B and C are always planed with a slicing cut, holding the plane at an angle, especially across the grain. One must be constantly on the watch for cross or curly grain also when planing the corners of diagonal cuts (corner cuts of polygons) to cut with the grain, otherwise the corners will split off. The grain of the wood may be compared to the hair on one's head, the shape or angle of the piece will not present any difficulty if the cuts are always made with the grain.

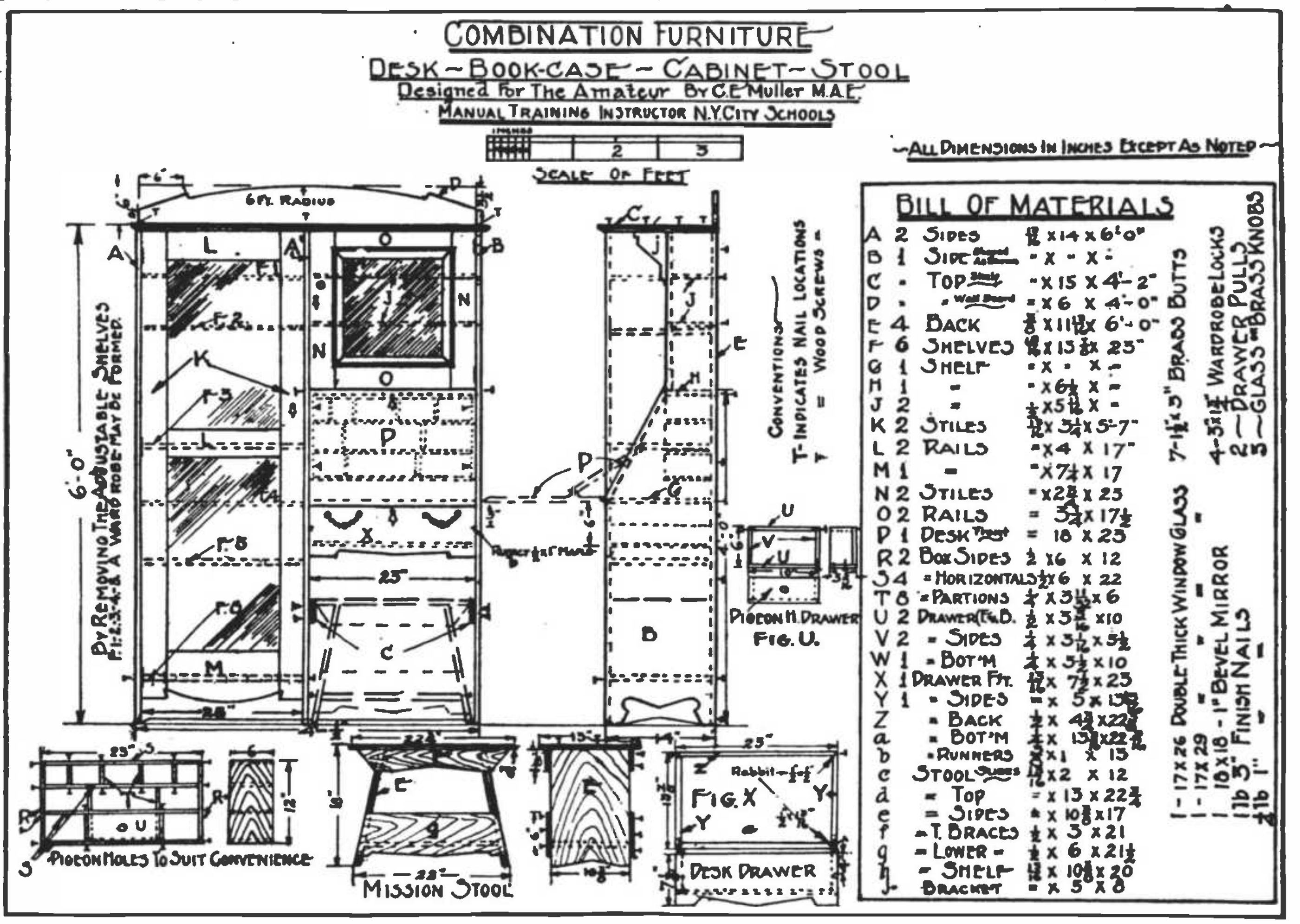
The pieces shown at Figures E and F are made of the same size material as the post and are the next to be produced. Lay out 2—10 inch lengths, square the lines on all four sides. Saw close to but leave the lines; if carefully sawed as directed it will save the trouble of block planing. After the pieces are all fashioned ready for assembling, a piece of No. 2 sand paper will remove all saw marks. Lay out the shape as shown with center lines, lengthwise with 2 opposite sides and crosswise on all four faces. This should be very carefully done with a try square. The center line lengthwise is the depth of the cut for the half lap joint shown at X Fig. D and at Y Fig. E, the cross hatched section must be removed so that the components D and R fit snugly in the form of a cross. If repeatedly tested before cutting and during the process of cutting out, it will safely guide even the beginner to a satisfactory fit. If this cross half lap joint is made before the contour is shaped it will avoid any possibility of the mistake of having the bevel ends upside down. The 1 inch hole is then bored or burnt through Fig. D only. The piece shown at Fig. E or the lower part has a small hole just large enough to admit the wood screw used to clamp both members of the base Figs. E and D to the post Fig. A when finally assembled.

The recessed clearance is made by first cutting a saw kerf 1¼" from each end ¼" deep, then chiseling a tapering cut from the center to this kerf. The principal reason for cutting this tapering recess is that it often requires skillful manipulation to avoid slivering when cutting in confined limits and when paring diagonally to the fibers of the grain this difficulty is avoided.

It is now time to decide whether it shall be a Sewing Table or Smoking Stand. If the former, proceed as per drawing. If the Smoking Stand be desired, make both shelves approximately 7 in. The top shelf has only one 1 inch hole to about 2/3 of its thickness, with a smaller hole to admit the 2" to 3" No. 10 to No. 14 flat head woodscrew that clamps the basket or ash tray to the post. The lower shelf for the Sewing Basket is laid out as in Fig. C 8—¼" x 1¼" dowel pins are glued in the ¼" holes. These are used to hold the spools of thread. The inner set of ⅝" holes are bored through the shelf to hold the scissors, thimble, darning ball, etc.

When boring a hole through any wood it is necessary to protect the under-surface from splitting. This is accomplished in several ways; the preferable method is to bore from the top down until the worm or point of the bit protrudes through the under side, then using this tiny hole as a center, bore from the opposite side.

The most elementary way to produce a hexagon is to lay out a square, then lay off the corners as shown. The first



step in all wood work is to establish a working edge, *i. e.*, plane the edge smooth, straight and square with the face side. Second step, mark out a square end with the side of a try square held tightly to the working edge, then square this line on the other three faces. (This method is excellent practice for the amateur, as it enables him to watch the saw cut very closely and it surely repays in the results for the additional time so spent.

Now lay out the rest of the octagon. There are many ways to do this, but the simplest one is to follow the drawing. Another way is to inscribe a circle tangent to the square, then use a 45 degree angle and project the other 4 sides tangent to the circle.

Next inscribe a 6" and a 4" circle from the center of the hexagon. Connect the corners with lines passing through the center at the intersection with the 6" circle bore 8 ¼" holes until the point of the bit just protrudes through the under side. Then halfway between the ¼" holes bore the ⅝" holes as stated above. When boring be sure all holes are perpendicular so that all the parts affected look "plumb".

The hole through the lower shelf to fit over the post is surely a test for a beginner. However, if you will follow these directions carefully you are assured of success. First bore or burn a hole a trifle less than the diameter of the post at the location of the shelf, then file or chisel the hole to a square and constantly test it by placing it on the post. Be sure to maintain all shelves level or truly horizontal when fitting and assembling.

For the Smoking Stand the only changes required are the size of the top shelf, which is the same size as the lower shelf; also omit the outside circle of holes and dowels in the lower shelf.

Now assemble the project. Always sandpaper carefully with the grain where possible, using Nos. 1½ to 2, followed with No. 1, then ½. Precautions must be taken not to mar the sharp corners, as these are the signs of good workmanship. Stain the completed article the desired color. This may be purchased in many shades. The directions with the stain will clearly explain the method particularly recommended for that stain.

A satisfactory stain may be made by thinning out green or brown paint or burnt umber with turpentine, applying it with a brush or cloth. Let this dry from 6 to 24 hours, then apply prepared polishing wax or, instead of the wax, a coat of shellac (orange preferred), which will dry in a few hours, then rub down with fine sandpaper, No. 0 or 00. Another coat of shellac or thin varnish will complete the finishing process. If a finer finishing surface is desired read the process described for advanced projects to come later.

PROJECT NO. 2—COMBINATION BOOK CASE OR WARDROBE, SECRETARY, WALL CABINET

WHILE this combination is designed especially for the advanced student and wood worker, there is nothing in the construction or execution that should deter the ambitious handy man or boy from successfully and satisfactorily completing it. There are no useless or complicated joints. Every joint is practically a square cut butt joint. The rails are fastened to the stiles by ⅜" dowel pins in all the doors. All cuts may be made with a fine tooth cross cut saw (even the rip saw may be omitted), followed by a slight paring with the chisel. Anyone who will lay out the work accurately, make all cuts squarely, leaving the guide lines until completed, may be absolutely assured of success.

The only tools necessary are: One ruler and pencil, 1 try square, 1 cross cut saw and ripsaw if convenient, 1 smoothing plane and jack plane if convenient, 1 brace, 1⅜" twist bit and 1 screw driver bit, 1 hammer, 1 1" or 1½" chisel.

The following precautions if observed faithfully will avoid the disappointing mistakes so liable to creep in amateur work:

1—Careful selection of all materials. 2—Careful handling of materials. 3—Faithfulness to details. 4—No change in dimensions without carefully studying the adjacent components. 5—Establishing the *true* working edges before laying out, *i.e.*, straight, lengthwise, square, crosswise, and smooth. 6—Accurate layouts. 7—Work close to, but leave the guide lines until assembled. 8—When assembling avoid all bruising by the hammer, the clamps, or by any foreign material on the floor or bench. An excellent shop rule is to clear the bench of all nails, blocks, etc., before operations. A nail or screw that is left accidently lying on the bench may cause a very ugly scar in an otherwise beautifully grained surface in a most conspicuous place. 9—Sandpaper always with the grain wherever possible, as the sandpaper invariably leaves scratches, but if they run parallel to the grain are not noticed. 10—Stain and paint always with the grain so that the brush strokes will blend with the grain.

The Bill of Materials practically tells the complete story. Outside of a few suggestions no further instructions are needed. A drawing usually to scale, but sometimes only a sketch with overall dimensions is given to a cabinet-maker or carpenter to build the project accordingly. If the components are fashioned and assembled in the order listed and temporarily nailed, *i. e.*, the nails are not driven in completely, but allowance made for the claw of the hammer to fit under the nail head to withdraw it if desired, surely one should be sufficiently experienced to proceed without further assistance.

The first assembly is made by nailing the sides A and A' to M and F. 1, then A-1 to H and G, shown in the side view, then the top shelf C to A—A1 and B, then the back E to the top shelf and to F. 8 and H and G. The sides A and B are rabbitted ½ of their thickness to accommodate the ⅜" back. The side A' is made 14 inches minus the thickness of the back, approximately ⅜". The top shelf C is also rabbitted or cut out to allow the back to fit flush. The shelves marked J are nailed in position or may be adjustable. The pigeon hole rack is amply strong if made only of butt joints; it is built up as a unit, then screwed in position. The secret of nailing permanently is to lock the nails by slanting each nail alternately. This acts as a dove tail and they will hold more than the wood. Especially is this necessary in the end grain.

The slides for the drawers should be made of hard wood and screwed in position. The cleats or supporting runners for the stool may be made of the same material as the cabinet. They should be screwed in position to hold the stool about ½ inch above the floor. The door stiles and rails K-L-M-N-O should be rabbitted for the glass, which is held in place by narrow strips bradded in.

The small drawer Fig. U may be just butt joints, the bottom bradded to the sides and back. Observe very carefully that each part butts to its adjacent component.

You will note the drawer fronts are one piece, the bottom butting against the back so that the joint is not visible from the front.

The large drawer is similarly constructed. It is advisable, however, to rabbit the sides into the front ⅜ of an inch, also the back into the sides. The bottom may be dadoed into the front or a butt joint with a cleat fastened to the front would suffice.

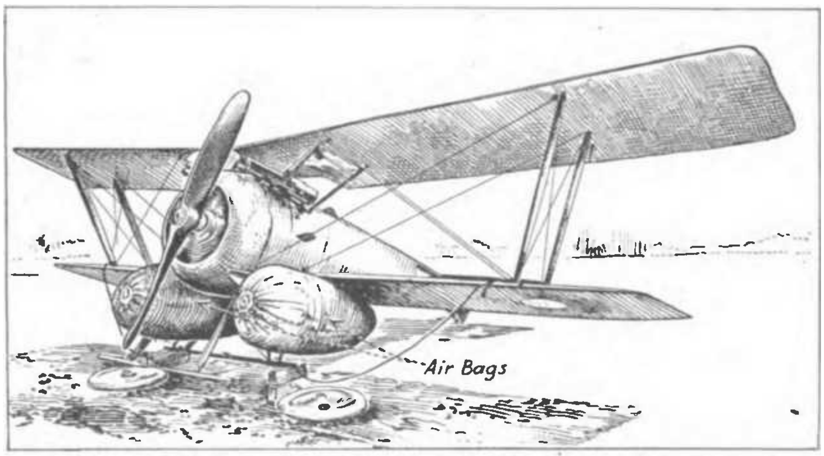
Another very elementary way, yet efficient one, is to make up these drawers as a tray, with the front a separate piece glued or screwed on from inside the drawer. The front can then project ¼" as a margin on the four sides. This makes a neat and a positive stop for the drawer. The main thing is to have two slides either under the bottom edge of the large drawer or two rabbitted grooves as shown for the hard wood slides to work very freely in. If these are well paraffined, they will slide very smoothly.

The stool is very simple and requires no further description. Follow the design as you choose. There is surely great room for elaboration; simply keep the overall dimension near the size. The sand papering and wood finishing is practically the same as the No. 1 project and offers no difficulties.

AVIATION BRIEFS

SECURITY OF AIRPLANES IN FLYING OVER THE SEA

THIS article deals with the provision of collapsible floats which can be instantaneously filled with compressed air at the desired moment. The idea is due to Colonel Busteed, and has been developed both by him at Grain, and by Lieutenant Bonnet-Labranche in France. The air floats have been filled on some hundreds of British and French airplanes patrolling the North Sea, the Channel and the Mediterranean, and many aviators owe their lives to them.



Airplane provided with air filled floats to permit landing on water

Airplanes fitted with these floats have been largely employed on airplane carrier ships in place of seaplanes, which are, of course, much less efficient.

Two or more floats of rubberized fabric are rolled up and stowed under the wings or under the fuselage, and these can be filled by means of a compressed air outfit in 30 secs. The number of bottles of compressed air required is reduced considerably by the addition of an injector with three concentric cones, inserted in the pipe leading from the compressed air bottle or bottles to the float bags. A jet of the compressed air issues from a fine nozzle, whose walls are divergent toward the orifice, and by its expansion draws a large quantity of the external air through the triple opening between the three cones.

Several reservoirs of air in rubber bags are symmetrically arranged in the fuselage framework, and connected by tubing provided with taps by which the pilot can partially deflate them at altitudes. A hand-pump allows loss of air pressure due to leaks during long flights to be made up. The wheels of the chassis may in some cases be dropped off before alighting on the sea. In addition a hydrovane is fitted in front of the chassis to prevent too great a shock to the inflated floats on alighting. A machine weighing 1,000 kg. requires floats of an aggregate volume of 2,000 litres.

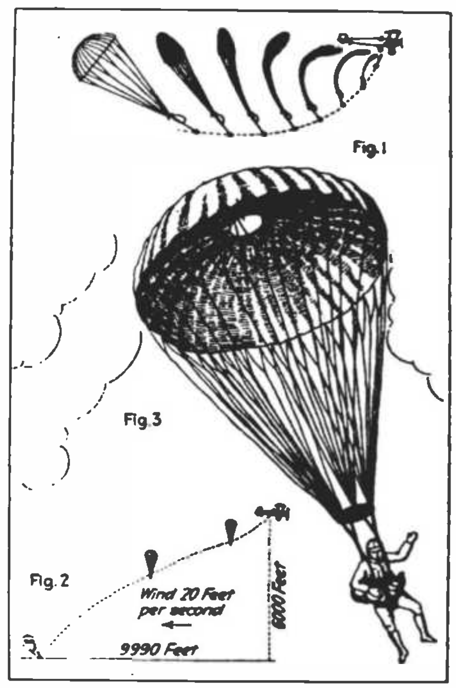
NOTES ON PARACHUTES

FOR many years one of the thrills at a country fair was a balloon ascension and the jump of the intrepid aeronaut from a great height with a parachute. During the war, aerial observers, both allied and enemy, made their escape from observation balloons when these were set afire or shot down by this means. Dirigible airships have parachutes as life preservers much as ocean liners carry life boats and rafts. Parachutes are easily launched from either free, captive or dirigible balloons, but the problem is a more difficult one when they are used as a life-saving auxiliary to airplanes.

In the early days some inventors figured out schemes of having a parachute large enough to sustain the weight of the entire airplane, but if this was difficult of practical achievement in the days when airplanes weighed but 650 to 700 pounds, it surely cannot be very easily accomplished in these days with aircraft weighing from 2,000 pounds to several tons. To check the fall of an airplane of modern design would require a spread of fabric about 8,800 square feet in area. The inventors, therefore, have confined their efforts to the design of parachutes suitable for the individual and even at that, it takes a good-sized parachute to keep an average man from falling too fast.

An empirical figure is 4 square feet area per pound supported so as to obtain a safe rate of fall. This is estimated to be about 10 feet per second. As a parachute would require about 3.5 minutes to fall 2,000 feet and about 10 minutes to drop 6,000 feet in still air, the latter figure is the usual height considered safe for normal flying. Recent tests have demonstrated that parachutes of latest pattern will open and check the fall of the pilot from heights ranging from 200 to 500 feet. The greater the area of canvas available for supporting a given weight, the slower the rate of fall. An area of 5 sq. feet per pound will allow a drop of about 8 feet per second—while allowing 3 sq. ft. per pound, will result in a drop of nearly 14 feet per second.

The important points to secure in parachute design are to have as rapid opening as can be obtained, this to be absolutely automatic and have a means of suspending the individual using it so there will be as little shock as possible when the parachute does open and checks the fall. The pilot of an airplane catching fire, for instance, must



How parachute opens and falls

be able to make a quick getaway, therefore the "Parachute pack" in which the aviator carries the entire safety apparatus canvas attached by straps and belt to his back, is favored by some authorities. A modern parachute will open in a distance ranging from 50 to 100 feet. Special efforts are made in the design to avoid tangling the supporting cables and to secure positive opening by having some air in the chute, as a partial vacuum would cause the folds of cloth to stick together.

In descending a parachute goes through three phases. During the first, as it is still folded it does not support the aviator, who falls very fast, at the beginning of the second phase the canvas spreads and checks the speed of the fall; in the third phase, the device balances itself and continues to approach the ground at the reduced speed of 10 to 15 feet per second, depending on the weight supported.

In the second period the aviator is subject to a very considerable amount of strain, because of the sudden "braking" produced by the spreading of the canvas. To prevent this from being dangerous the aforesaid strain is distributed over the entire body of the aviator by a system of wide webbing straps and belts. The parachute is also provided with a rubber shock absorber which seems to be quite effective.

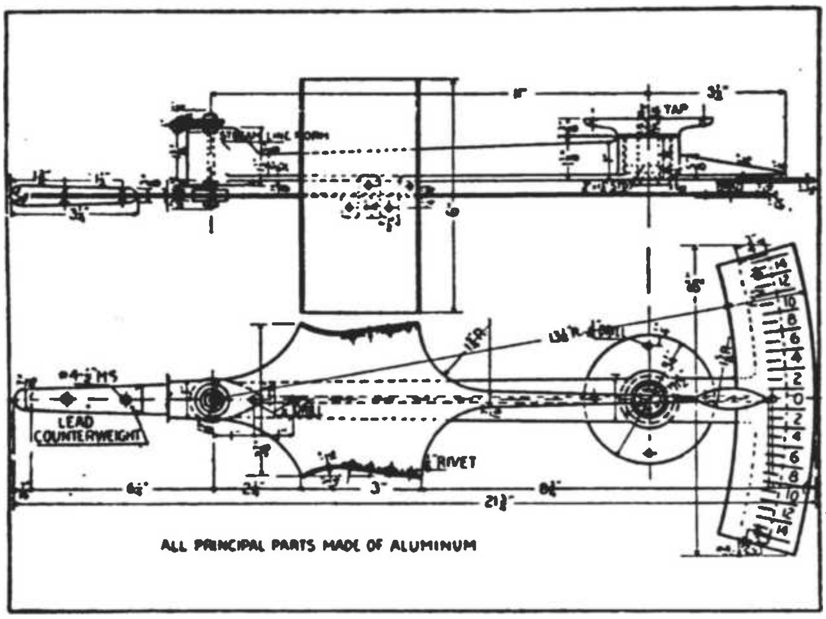
The lateral movement of the parachute is at first equal in speed to that of the aircraft from which it was launched and becomes gradually less until it entirely disappears, provided there is no wind. Strong gusts of wind, however, cause landing to be comparatively dangerous, since the parachute retains the horizontal speed of the wind, and for this reason it is important for the aviator to be able to free himself from the apparatus as soon as he reaches the ground, since otherwise he may be dragged into various obstructions with considerable force and injured to a greater or lesser extent.

A new German optical glass is colorless, yet cuts off the ultra-violet rays; it can be used for goggles instead of the usual colored glass. It is said that the rare earths, such as thoria are the characteristic constituent.

AIRCRAFT INCIDENCE METER

THE construction of an aircraft incidence meter is described in the *Franklin Journal* by A. D. Zahm, Ph. D., of the Navy Department, Bureau of Construction and Repair.

To enable the air pilot to read at a glance the direction of flow of the air past his airship or airplane, a balanced weather-vane, indicating promptly small changes of incidence, has been developed and tried under regular working conditions. The scale drawings and test of the device herein described were made respectively by L. H. Crook and S. S. Rathbun, members of the aeronautics staff at the Washington Navy Yard.



Figs. 1 and 2. Aircraft incidence meter experimented with by U. S. Navy Department

Model.—Figs. 1 and 2 give the general appearance and dimensions of this instrument. It consists of a two-blade weather-vane supported from a horizontal pivot at the end of a bracket arm protruding forward from an airplane strut and adjustable in pitch by means of a clamping nut at its base. The vane has a forward counter-weight to insure static balance and a pointer playing on a graduated arc of 14 in. radius, indicating even degrees and readable to fractions of a degree from the pilot's seat. The blades have the sectional shape of an Eiffel Wing No. 5, which at zero incidence possesses very slight drag and a large increase of lift with slight increase of incidence.

Test in Flight.—The instrument was finally mounted midway between planes on the nearest right-hand strut of Flying Boat HS-2 No. 1840, and carried through very still air at three different fixed speeds. The following table indicates its behavior under these circumstances.

Wind Tunnel Test.—When the instrument was given its preliminary test in the 8 x 8 ft. tunnel, its pointer remained steadily fixed in the wind direction until forcibly displaced. It then promptly returned to zero incidence without lag or indication of friction.

OBSERVATIONS WITH C. & R. INCIDENCE METER IN FLIGHT

Speed of Flight in Knots	55	65	75
Normal variation...	±0.6°	±0.4°	±0.4°
Precision of reading possible	±0.3°	±0.2°	±0.2°
Occasional variation.	±2.°	±1.°	±1.°

Conclusion.—If this instrument is to be put into use, it may be lightened somewhat and provided with a strap to lash its flange to the airplane strut. So finished, it would weigh about 1.5 lb.

AN ALL-METAL BIPLANE

THE Austin "Whippet" is a biplane of English design and its dimensions have been reduced so it can be accommodated in the ordinary garage. From nose to tail it measures 16 feet while the wing span is 21½ feet. But by the introduction of wing-folding facilities the over-all width of the machine is so reduced as to permit storage within a building measuring 18 feet in length by 9 feet wide and 8 feet high. The folding arrangement is simple, it only being necessary to unlock four bolts holding the wings securely and rigidly in position for flight to permit the wings to be folded back to the side of the fuselage. Folding and spreading the wings is a simple operation and can be carried out in two or three minutes. The fuselage and landing chassis are constructed of steel and streamlined steel tubes take the place of the usual bracing wires, so that the necessity to undertake re-rigging from time to time is obviated.

It is powered with a six-cylinder, air-cooled radial Anzani engine developing 45-50 horsepower. Its climbing capacity is moderate, it being possible to attain 5,000 feet in 8 minutes and 10,000 feet in 18 minutes. Its flying speed is 85 miles per hour, but the landing speed is only 30 miles an hour which is a very desirable feature. The builders have had considerable experience in airplane design and construction, having built 2,000 machines of various types including the S.E-5, single seater fighting scout which was popular among the American airmen and over 2,500 engines. The "Whippet" is marketed at about $2,500 and the flights which have been made have demonstrated that the machine is a very able one and that it possesses considerable inherent stability.

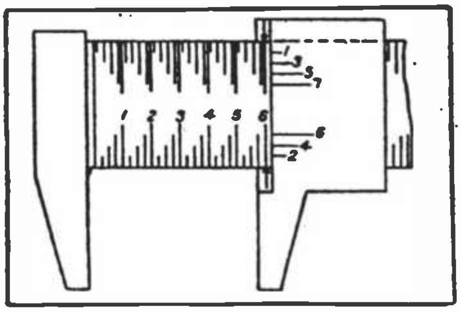
It has been found that the sun gives more heat from its central parts than from its edges. The distribution is quite irregular. It is thought that the irregularity may be due to refraction by the gaseous layers.

EVERYDAY SCIENCE NOTES

BY PROF. T. O'CONOR SLOANE

EASILY READ CALIPERS

A VERY simple and clever way of marking calipers, so as to make them easy to read, is shown in the cut. It is of the ordinary slide construction. The stem is marked in two scales. The upper scale is marked in inches, each of the longest lines indicating an inch, and on this same scale the shorter lines indicate the odd eighths, 1/8, 3/8, 5/8 and 7/8. The lower scale is laid out on the same system except that here it is the even eighths that are marked. All this refers to the scales



of vertical lines. On the slide of the instrument there are two scales of horizontal lines, each coinciding in position with the end of the line of the other scale corresponding to the number of eighths marked on it. When the calipers are opened to any given extent, the inches are read directly, and the fractions are given by the horizontal line coinciding in position with the nearest vertical line's end. It will be noticed that the lines of the upper scale are unevenly spaced; this is because they start with a single eighth and end within a single eighth of the inch line, while the intermediate lines are spaced two eighths apart.

A concrete arch, 95 feet high and 300 feet span, has been erected in Sweden, the longest span of reinforced concrete in the world. It is in three pieces with hinge joints between the sections. A year of settling and seasoning was allowed before it was put into service. Under its working test it received a permanent set of only 1/16 inch.

As a breakwater, a horizontal pipe laid under the water and perforated with holes through which air is blown has been successfully applied. It is said to form an "air reef." It has been used in salvaging a ship and a pier in California has been kept in use by means of such an appliance.

Impressive figures of what may be done in the saving of coal have been published. In Silesia by saving twenty per cent of the waste heat in zinc furnaces an economy of 800,000 tons of coal per annum is represented. It is held that by other simple and inexpensive changes Germany could save 25,000,000 tons per annum. The fact, that there would be so large a number of individual cases each requiring treatment of its own operates to prevent the fullest application of such methods. The point has been made that in the case of wet coal it is not only the loss of heating power that is to be considered, but also the increased cost of transportation, and the longer the distance the greater is the loss due to the weight of the water to be carried.

In St. Louis trouble has been experienced with the electrolysis of lead-covered electric cables. The lead sheathing was injured, so that water got at the insulation and heating ensued.

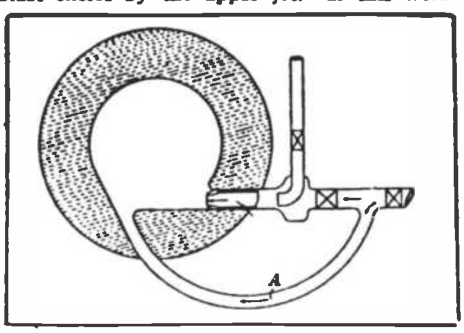
A system of stereo-photography from two aeroplanes, taking parallel courses, and whose distances apart is determined also by photographic methods, gives a series of photographs with stereoscopic effect. Each plane has its own camera, adjusted for the distance between the planes. They may also be in tandem instead of parallel. It is even possible to get a result with a single machine in two successive flights.

Slag from furnaces, such as gas works but not from blast furnaces because of the sulphur and other characteristic constituents, is recommended for concrete. It must be well wetted down in the mixing, and it is quite essential, that it is weathered a long while before use. One part of cement to eight parts of cinder is a typical proportion.

Some interesting work in the intensive hydration of concrete has been reported. The mix is rotated in a bowl at high velocity of rotation; the bowl was open at top. A curved arm continuously cut off a ribbon of the concrete from the outer edge, and the ribbon was returned to the center of the whirling material. The process brings about a very rapid and thorough mingling of the ingredients and was quite rapid in effecting the result.

TANGENTIAL BLAST GAS FURNACE

THE illustration of this furnace is self-explanatory. The object is to avoid the destructive impingement of flame upon a small area of the fire chamber. The principal blast enters by the upper jet. If this were

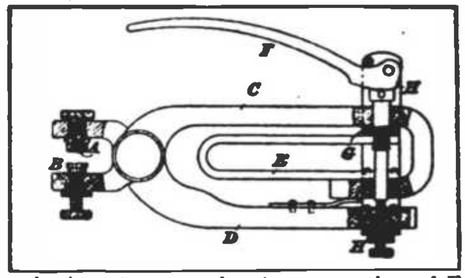


the only jet, the blast would strike the opposite wall of the chamber and would soon injure it by the concentrated heat. To avoid this action there is a supplemental lower blast of air, entering tangentially, which sweeps around the chamber and carries with it the horizontal upper blast. Thus the heat is distributed, and destructive localized heating is avoided.

The deterioration of calcium carbide brought about by the moisture of the air can be prevented entirely by immersing the carbide in kerosene oil. The oil may be poured into the receptacle holding the carbide and then at once is poured off. The treatment preserves it indefinitely, and has been rigorously tested.

BRINNEL HARDNESS TESTER

THE Brinnel test for the hardness of steel or other material is based on the depth to which a hardened steel ball is forced into the metal under definite pressure. As the test is comparative it is essential that the pressure is always the same. In the apparatus shown, which is a species of tongs, the ball is held in the socket, A, and the sample of metal is held in contact with it by the screw, B. Pressure is brought to bear by the handle, F, acting as a cam. H H is a stirrup,



and when drawn up by the cam action of F it presses the ball into the test piece, by compressing the spring E. The arms of the apparatus, C and D, are thus drawn together by the force of the spring, so that the pressure brought to bear on the ball is always identical, as it is due to a practically identical compression of the U-shaped spring, E.

Considerable interest is now shown in the electrolytic purification of iron. For many years copper has been thus purified. In both cases the process is simplicity itself. Anodes of the metal to be purified are suspended in an electrolytic bath, and by the action of the current are dissolved, and by the further action all the metal with the impurities eliminated is deposited on the cathode. To purify iron the bath contains various solutions; double oxalates or sulphates are employed; organic salts, such as the sulphocresylate is one that has been used. The cathode is rotated mechanically; it may be made of various metals; copper and lead working very well as regards the ease of separating the sheet of pure iron deposited on it. The cathodes are treated with alkali solution to dispose of any grease and are then put directly into the bath. Carbon almost inevitably accumulates in the electrolyte, and this is very objectionable, and it has to be filtered out periodically. The color of the solution is a guide for judging of its purity. The iron deposited contains a little hydrogen, nitrogen, carbon monoxide and carbon dioxide, all of which are expelled by heat treatment. It is so pure that it is nearly as soft as copper.

The toxic effects on vegetation of salts of the alkalies in soils has been investigated with the result that the effect of the salts is not in proportion to the salts which have been added, but to the salts which can be extracted by leaching from the soil.

A floating mill has been tried with some success on the Mersey off Liverpool. It consisted of two or more parallel endless chains working on two drums or wheels, and floats are carried at regular spaces on the chain. The construction is simple in all respects, and it would seem applicable to many small installations where limited power only is needed.

Aluminum maintained at a temperature of 1000° C. for seventy-three hours evaporates until there is but three per cent of the original weight left. The residue is supposed to be an allotropic form of aluminum, and oxidizes spontaneously in the air.

It is calculated that in the great Witwatersrand mining district of Africa three hundred and sixty million tons of rock have been hoisted in the last fourteen years. The deaths by accident, largely by falling of rock in the mines, have been 10,600 with 22,400 wounded and hurt.

The Wheatstone telegraph apparatus using the perforated tape system of transmission has been tried with success in England on a wireless circuit. One hundred words a minute could be transmitted and it is believed that much better can be done.

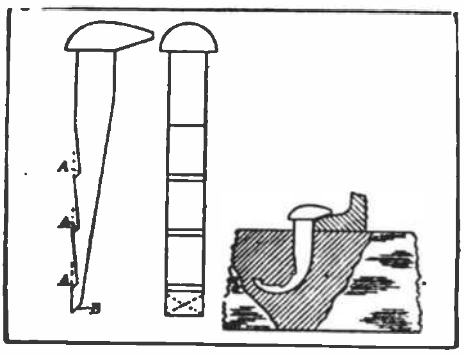
It is proposed to send power from England to France by a power line under the waters of the Channel. Sweden and Denmark are connected by a power line, carrying 50,000 kilowatts at a voltage of 25,000. This would represent many shiploads of coal.

An ingenious way of measuring the velocity of projectiles is based on firing them through coils of wire on closed circuits, so that the currents induced can be made to record the passage of the steel body through them. One of the coils may surround the barrel of the gun so as to give a record for the shell before it has left the piece.

The experiments with oil borings in Derbyshire, England, have produced one well, which delivers oil steadily; one well has been abandoned on account of water troubles, and other borings are proceeding satisfactorily. England is much exercised over the rising price of gasoline, and the subject of motor car fuel is receiving much attention.

RAILROAD SPIKE

THE object of this spike is to hold rails on the sleepers and to be to an extent locked in position. The effect of the three



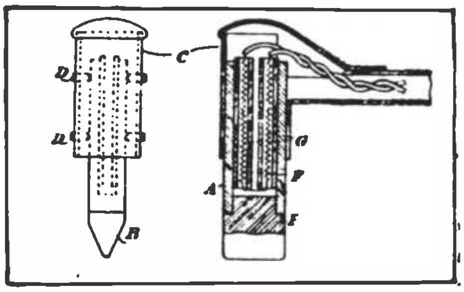
notches, A, A, A, and of the inclined face or edge, B, is to cause the spike when driven to bend around as shown and thus to get a good hold on the sleeper.

To have water for power stations at all seasons arrangements have to be made for impounding a sufficient quantity to carry over the dry season. It has been brought out that this is easier in the case of high falls rather than in low ones. Obvious as this is, it has only recently been commented on. In Switzerland it is proposed to transmit power at 120,000 to 150,000 volts, generating in the plant at 45,000 to 50,000 volts.

Low temperature carbonization of coal is advocated from some standpoints. It gives a smokeless fuel residue, produces gas and as by-products oil and ammonia are given. The oil is adapted for internal combustion engines.

ELECTRIC SOLDERING IRON

THIS tool comprises a tubular section, A, into whose lower end the soldering bit, E B, fits. Outside of the tubular part is a jacket, C, and set-screws, D D, hold all the



parts together. In the upper part of the bit, E, are holes containing quartz tubes, F, which receive resistance coils to effect the heating. In one form of construction the end of the bit, B, is made detachable so as to be readily renewable.

Several propositions to reform the calendar have recently been made. The simplest and to that extent the most rational one provides for the division of the year into quarters, each quarter to comprise two months of thirty days each and one month of thirty-one days. This gives 364 days. Then there is to be one day each year additional, which day is to be outside the week, and there are to be two such days in leap year. One effect of this would be that week days would repeat themselves every year; any week day would always come on the same day of the month. The extra or leap days would come at the end of the year. If the year began in March it would give meaning to the names of the last four months; September, for instance, is now the ninth month, yet its name means seventh month. If the year began with March, then September would be the seventh month; October, which means eighth month, would be the eighth in reality, where it is now the tenth, and the same applies to November and December, the eleventh and twelfth months in their order, and in name the ninth and tenth.

Electric iron ore reduction furnaces in Sweden use electrodes of carbon 24 inches in diameter and four or five feet long. Provision is made for attaching new sections to the old pieces as they grow short. The electrodes cost 4 cents a pound and 16 to 20 pounds are used per ton of iron reduced. A 3,000-kilowatt furnace will have six electrodes.

The treatment of the water in swimming pools has become a problem to be dealt with. One college is cited, where the water is changed only once a year. It is repeatedly filtered and purified with chloride of lime (bleaching powder). The standard temperatur is 76° F. except for swimming matches, when it is reduced to 72° F. In another prominent university ultra-violet light is the purifying agent; elsewhere ozone or copper sulphate is employed.

It is officially stated that England is five years behind on her proper building program, and half a million of additional houses are said to be needed. Steel frame houses with bolted fastenings are in use there now. A light concrete wall filling is used for the houses in question.

By combining the water gas process with the old distillatory process complete gassification of the coal is brought about. The coke is the basis for the water gas, so that there is no residue or by-product, except the ash of the coal. The gas is of 425 British thermal units heat value.

The Ford radiator is coming into its own. It has been promoted to the service of cooling the oil in transformers. The oil is circulated, exactly on the lines of the water in an automobile, and an electric fan, of the office type, is used to accelerate the cooling if necessary. This is reported from a railroad in the Southern States.

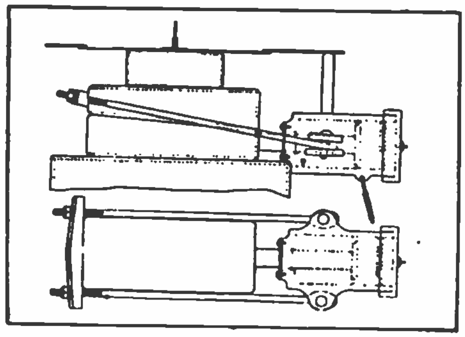
In France a wireless alarm system is being installed on the railways. The block stations use an antenna about 46 feet long, operated by an 8-volt battery coil with an inch and a quarter spark. One pole of the battery is earthed, the other connects through the primary of the induction coil to an insulated rail, which is grounded by the passing train. The locomotive carries its own local battery, coherer and antenna. The grounding of the insulated rail causes a whistle to blow upon the passing of the signal station.

The peat beds of Manitoba are calculated at 12,000 square miles area, with an average depth of six feet. This gives over nine billions of tons of peat, equivalent to over five million tons of good quality coal. A number of peat deposits or bogs are in the neighborhood of Montreal and Toronto not as extensive as the Manitoba fields, but representing fifty million tons, about equally divided between the two localities.

As a means of increasing the vacuum in a liquid gas container in the outer space, charcoal has been found to be useful; it absorbs under the reduction of temperature, incident to the filling of the bottle, any gas in the vacuous space. But this is believed to be a cause of explosions; if there is any leakage of oxygen from the container into the outer compartment containing the charcoal, an explosion may result, on account of the reaction between the oxygen and the charcoal impregnated, it may be, with combustible gas in addition to its own combustibility.

NEW KEEL BLOCKS

IN dry-docks and on launching ways ships are carried, as regards greater part of their weight, on blocks placed under their keels.



In the system of launching employed in this country and in England, the weight of the ship at the last moment is transferred to parallel ways at each side of the keel, and the key-blocks have to be removed. In the construction shown in the cut, each block consists of two opposed wedges. When they are to be removed, before the ship goes down the ways into the water, hydraulic rams applied as shown pull one of the blocks, in this case the upper one, in such direction as to reduce the height of the pair, which releases them so that they can be removed. In this arrangement there is a possibility of various other applications.

A recent report on helium for balloons states that the helium to inflate a balloon would cost more than the balloon itself. Efforts are to be made to cheapen the production of the gas in question.

EXPERIMENTAL CHEMISTRY

The Chemistry of the Common Metals

Part III—Calcium

By Henry L. Havens

THE metal calcium, which belongs to the alkaline group, was first prepared by Sir Humphrey Davy in the year 1808. The calcium prepared by Davy was in a very impure state, and it was not until the year 1898 that the metal was obtained in a perfectly pure condition by Prof. Moissan. In this instance it was obtained by the electrolysis of the fused iodide and by the reduction of this salt with sodium.

Calcium is a very abundant element and occurs in the form of silicates, carbonates, sulfates, fluorides, phosphates, borates, etc. The human body contains a considerable amount of the element, the teeth being largely made up of calcium carbonate.

Today calcium is prepared by the electrolysis of the fused chloride. This is carried out with a carbon anode and an iron cathode. The liberated calcium clings to the iron cathode which is in the form of a rod. The temperature of the bath is kept as low as possible. To accomplish this calcium fluoride is added to the bath, which, since it dissolves, lowers the melting point of the chloride.

Calcium melts at 800 degrees and will voltalize below this point under reduced pressure. It has a density of 1.55 and is extremely malleable. It decomposes water forming calcium hydroxide or lime water Ca (OH_2). Calcium acts vigorously with acids and burns brilliantly in air. Combines at higher temperatures with nitrogen, chlorine, sulphur, silicon and phosphorous. When heated in a closed vessel, both the oxygen and nitrogen present are almost entirely removed if a sufficient amount of the metal is heated. A very high vacuum will result.

Calcium hydride (CaH_2) is a white crystalline substance that reacts with water, forming the hydroxide and hydrogen. Calcium combines directly with hydrogen to form the hydride.

Calcium oxide (CaO) is one of the most important compounds of calcium. It is commonly called lime and finds a multitude of uses in the workaday world. This important substance does not occur in nature but is prepared by heating marble or limestone in a high temperature: The following reaction takes place:

$$CaCO_3 \rightleftarrows CaO + CO_2$$

This reaction is carried out in what has become known as a lime kiln.

Calcium hydroxide $(Ca(OH)_2$ is made by the action of calcium oxide on water. The following reaction is carried out:

$$CaO + H_2O = Ca(OH)_2$$

This action is very slow in starting, but once started the heat gradually rises, the rapidity of the reaction increasing with it.

Calcium carbonate $(CaCO_3)$ occurs very freely in nature as limestone, marble and chalk.

Calcium chloride (CaCl) occurs very abundantly in nature and the oceans contain great quantities of it. This important compound finds great use in the industries. It is extremely soluable in water and crystallizes out with varying amounts of water. It is possible to prepare it in the laboratory by dissolving pure calcium carbonate in hydrochloric acid. The compound is very diliquescent and melts at exactly thirty degrees.

Calcium hypochlorite $(CaCl_2O)$ is prepared by the reaction resulting when chlorine is allowed to come in contact with slacked lime:

$$Ca(OH)_2 + Cl_2 = CaCl_2O + H_2O$$

This compound is sometimes called bleaching powder. It is partially soluable in water and yields calcium, chlorine and hydrochlorite ions. It is capable of reacting with all the acids. The following is an example:

$$Ca\,Cl_2O + H_2SO_4 = CaSO_4 + HCl + HClO$$

Calcium fluoride (CaF_2) is found to a considerable extent in nature. This substance is commonly called fluorspar. It melts at 1330 degrees and is quite insoluble in water. It has the peculiar property of becoming luminous at temperatures below redness. It is used as the source of most all other fluorine compounds and especially for the production of hydrofluoric acid.

Calcium nitrate Ca $(NO_3)_2$ is produced by the action of nitric acid on calcium carbonate. The compound occurs in nature and is found in all fertile soil. When calcium nitrate is heated it gives calcium oxide, nitrogen peroxide and free oxygen. The substance is very soluable in water and forms a number of hydrates.

Calcium phosphate $(Ca_3(PO_4)_2)$ occurs in nature as part of the mineral $Ca_5(PO_4)_3F$. This substance is found widely distributed in but small quantities in practically all rocks and soils.

Calcium sulfide (CaS) can be readily produced by heating the sulfate with charcoal. It is produced commercially as a by-product in the Le Blanc process for the production of soda. It is insoluble in water but can be slowly hydrolyzed forming hydroxide and the hydrosulfide. The following equation represents this:

$$2CaS + 2H_2O = Ca(OH)_2 + Ca(HS)_2$$

Calcium sulfide has the property of phosphorescence when the compound is mixed with impurities but the pure substance does not exhibit this property.

Calcium sulfate $(CaSO_4)$ takes two forms in its occurrence in nature, the mineral anhydrite $(CaSO_4)$ and gypsum $(CaSO_42H_2O)$. The latter is by far the most important of the two, as it is used largely in plaster of Paris and cement plaster.

Calcium carbide (CaC_2) is formed in the electric furnace by the reaction produced when carbon is brought into contact with lime at the high temperature of the furnace. The following equation represents the reaction which takes place:

$$CaO_2 + C = CaC_2 + CO_2$$

The calcium carbide thus prepared reacts vigorously with water for the production of the inflammable gas acetylene. Calcium carbide is produced in enormous quantities at Niagara Falls, where electric power is cheap.

Calcium cyanamide $(CaCN_2)$ is produced in the electric furnace. This substance, which is used as a fertilizer, is formed when nitrogen gas is brought in contact with calcium carbide at the proper temperature. The reaction follows: $CaC_2 + N_2 = CaCN_2 + C$.

Calcium silicate is contained in almost all of the natural silicates. Artificial and very complex silicates in the form of glass are produced in great quantities and the following equation shows how the production of one of these is carried out:

$$Na_2CO_3 + CaCO_3 + 6SiO_2 = Na_2CaSi_6\ O14 + 2CO_2$$

Experimental Physics

Ultra-Violet Rays—Part 1.

By James L. Clifford

THE twentieth century was ushered in by a series of epoch-making discoveries. With each new advance, the mind of the scientist reached further into the mysteries of the unknown. Modern physical science is one of the most fertile fields for study and experimentation. The study of the various types of radiations, Roentgen, radioactive, ultra-violet, and infra-red, aside from being intensely interesting, is instructive as well. It is the purpose, then, of this series of articles to outline a few experiments in physics, suitable for amateur investigation. The field of radioactivity has been omitted, as it has been covered by the author in previous numbers of this magazine.

Light is one of our most familiar entities. We all recognize light and appreciate its many simple properties. It is defined as the sense impression formed by the eye. This definition would have been accepted generally for light 30 years ago, but now we know that there is light which it is impossible for the human eye to detect. To say, then, that light is what we see, is an obvious absurdity. We had better speak of light as a transverse wave in the all-pervading ether. This wave has a constant velocity of 186,000 miles per second, but may vary greatly in the wave length and the frequency.

The ether can probably transmit waves of any wave length. The shortest waves detected by Shuman, and later accurately measured by Lyman, have a wave length of but .0001 mm., while the waves of radio-telegraphy, also ether disturbances, sometimes reach a wave length up to 20 kilometers. Thus we see that the ether is probably overflowing with vibrations of all wave lengths and frequencies. The human eye can only recognize vibrations of from .0004 mm. (violet) to .0007 mm. (red) wave length, this being the range of the colors of the rainbow. Wave lengths greater or less than these cannot be detected by the eye. It was long thought that this 3/10,000 of a millimeter variation of wave length constituted all of the radiation known as light.

By the action on a photographic plate, and the phosphosescence caused in certain substances, waves of but .0002 mm. wave length were detected.

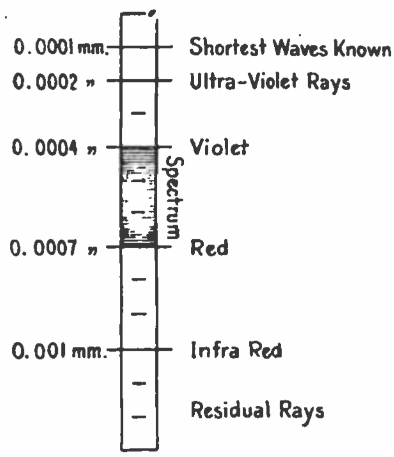


Fig. 1. The wavelength scale of the spectrum

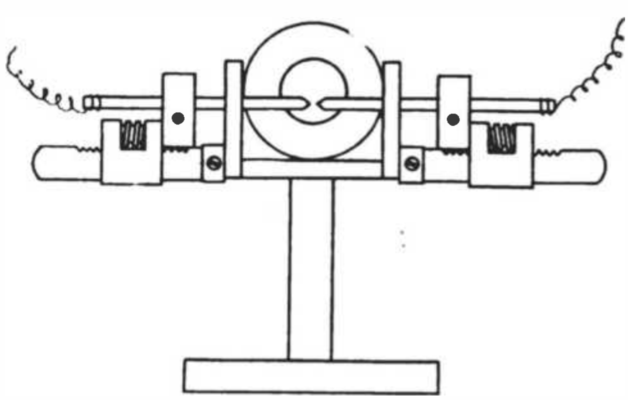


Fig. 2

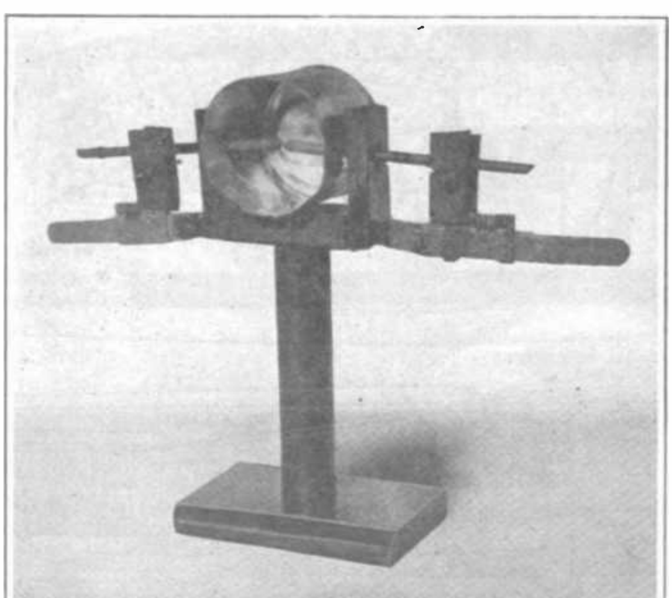


Fig. 3. A simple arc light used for the production of ultra-violet rays

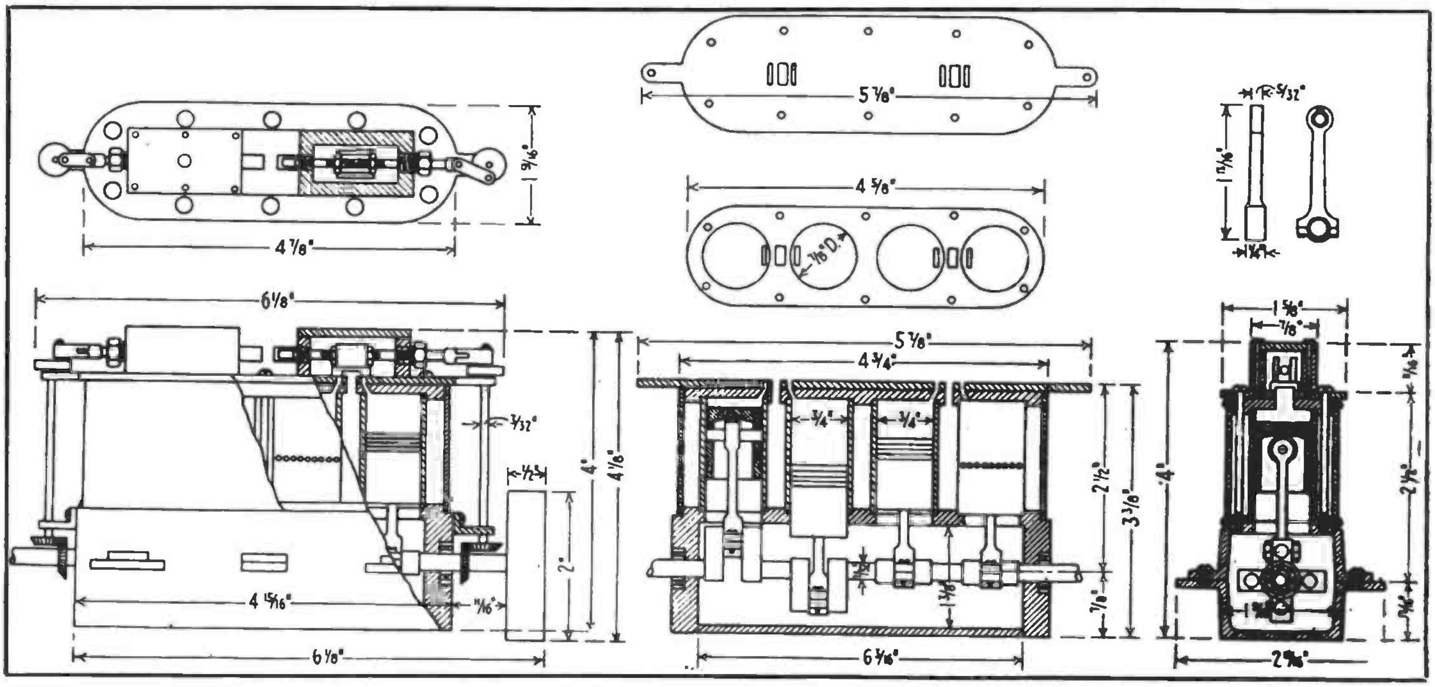
These were called the ultra-violet. On the other end of the spectrum, heat light waves were discovered with a wave length of .001 mm., and were called the infra-red. By repeated reflections from quartz, flourite, and sylvite residual rays were isolated having wave lengths up to .06 mm. In Fig. 1 is shown the relationship of these various types of light rays. In this article we shall confine ourselves to a discussion of the ultra-violet rays.

It has long been known that in light there is a peculiar ray having the property of producing chemical action. If a ray of light is broken up into a wide spectrum by a diffraction grating, or a prism, all the colors can be obtained. If a small volume of equal portions of chlorine and hydrogen is first placed under the red portion of the spectrum, and then successively moved under the orange, yellow, green, blue, violet, it will be found that the gas will be unaffected until after passing the violet, when it will explode. This action is the combining of the chlorine and the hydrogen to form HCl due to the ultra-violet rays.

The rays have also a distinct physiological action. It is these rays that produce sunburn and sun-stroke. Everyone knows that it is dangerous to look long at a bright artificial light, but few understand that this is because of the ultra-violet rays emitted by the light which affect the eyes, often causing total blindness. Some time ago an experiment was tired to find the action of these rays on life. A beam of sun light was separated into its component colors by a diffraction grating or other device of this kind. Small cages containing ants were placed under each successive color from beyond the red to the ultra-violet. The actions of the ants were then observed. The ants everywhere except under the ultra-violet acted normally, but under the ultra-violet they were very much disturbed. They seemed to try to get away from the radiation. If kept long enough under the light the ants died. Ultra-violet light isn't good for healthy life cells.

Ultra-violet light, unlike ordinary light, does not pass

(*Continued on page* 166)



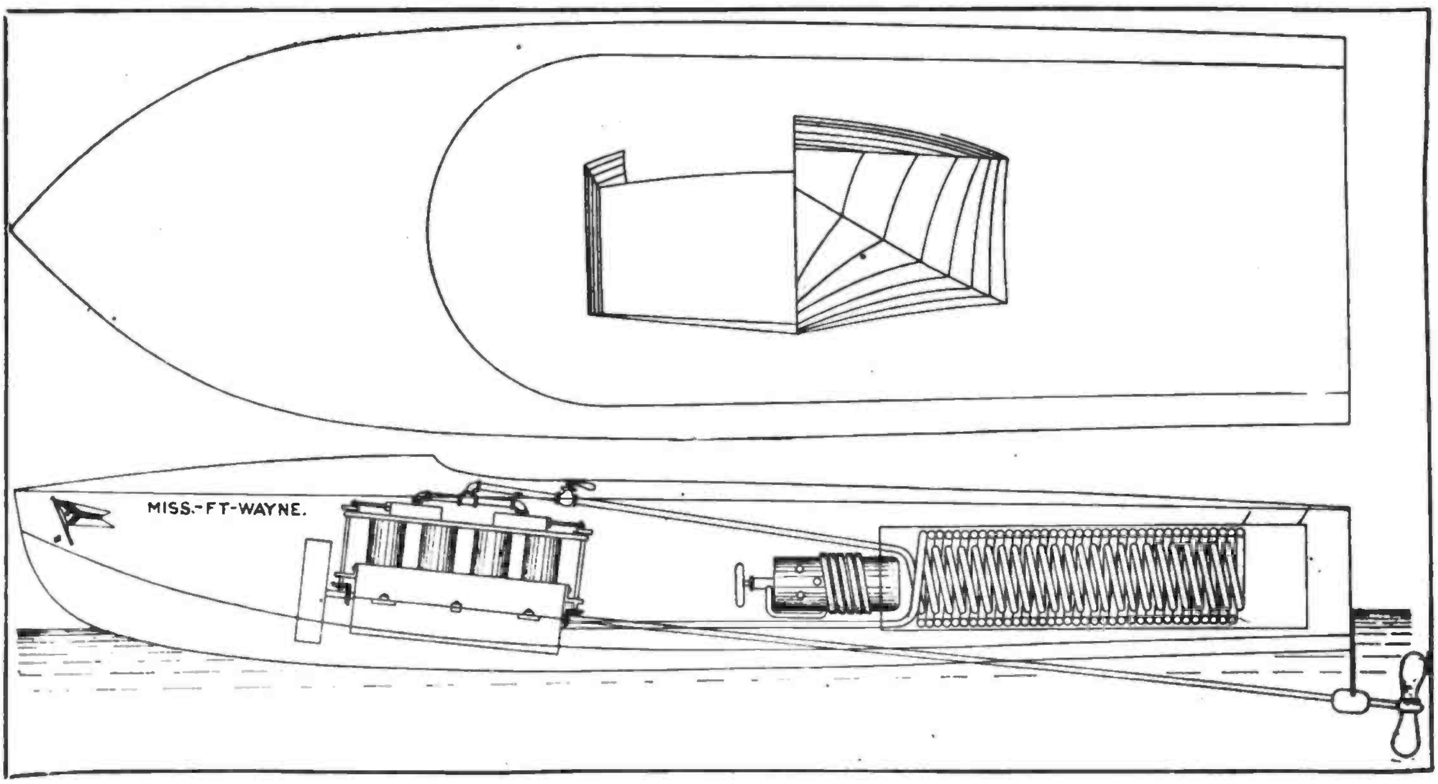
A Model Record Breaker Under Construction

MISS FORT WAYNE is the name of a new model speed boat being constructed by Mr. E. J. Stroud, of Fort Wayne, Ind. The new craft is to be motored with a four-cylinder engine similar in general design to the Westinghouse type of engine described in the September, 1918, number of EVERYDAY ENGINEERING MAGAZINE. This engine has a three-quarter bore and three-quarter stroke. An extra large blow torch and boiler supply the four cylinder engine with steam. The valve design is in general the same as that of the Westinghouse engine previously mentioned.

The hull of Miss Fort Wayne is designed along lines that have not been employed in model work heretofore and great interest will be shown in the trials of this craft. Of course, this type of hull is not as easily constructed as the common single step hydroplane hulls and therefore it may never become quite so popular even though it may be more efficient.

The model power enthusiasts at Central Park may well feel concerned over this newcomer as it is very apt to set new records that will be difficult to beat. Mr. Stroud, the builder and owner of the new boat, has great expectations, and if these are fulfilled someone will have to leave New York before the summer is over and go out to Fort Wayne with a boat under their arm to prove to that part of the country that model speed boats of the real fast variety are really made only in New York. It is certainly gratifying to those who are following the sport to see new designs making their appearance from different parts of the country.

The Editor has one suggestion to make: He would advise Mr. Stroud to take the stop cock off the steam line. If this is closed when the boiler is in operation something is going to happen between that point and the water end of the boiler.



Construction of a Long Distance Indicator

By George Leslie

IF you were asked to devise an apparatus which would indicate and record the temperature of one corner of a thousand acre orange grove at the opposite corner, or the gas pressure of a large feed pipe at the main works, it would seem quite a difficult task. Yet such systems are in operation. The principle on which the apparatus works, the Bard induction balance, was patented several years ago, but has been applied to this use a comparatively short time.

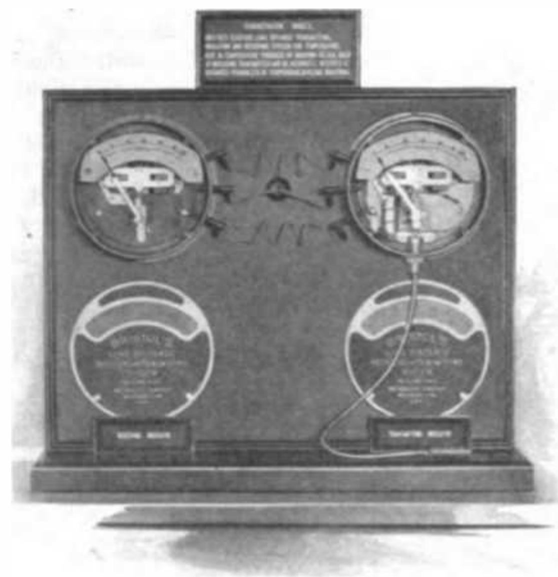


Fig. 1. Complete set for indicating temperatures at a distance

Fig. 1 shows the interior of the transmitter, while Fig. 2 explains the working of the instrument. This particular instrument is for recording gas, water or steam pressure, although a change in the measuring device makes it applicable to the measurement of water-level, temperature or mechanical movements. This is composed of two soft iron cores with two coils turning horizontally between them. Jewelled bearings support the moving element. Since alternating current is used to energize the coils, it will be seen that any change in the relation between the cores and coils will change the current, allowing more current to pass in the coil which moves away from the core, and less in the other one.

At the receiving instrument, perhaps many miles away, a pair of solenoids, mechanically balanced and free to take any position, are connected to the transmitter coils. As the current increases in one coil of the transmitter, the corresponding solenoid of the receiver will attract its core with more force, while the opposite is true of the other set. If it is desired to make a permanent record of these changes, the solenoids are connected by a frictionless multiplying lever to an arm which moves over a circular chart. This chart is continuously revolved by clock-work, so that it gives an indication of the pressure at any time during the day. A new chart is put on every twenty-four hours.

Three wires are required to connect the two stations, as indicated in Fig. 1. One end of each magnet, at both transmitter and receiver, is joined to the common wire, or the center lead shown in Fig. 1. The other ends of the transmitter coils go to the corresponding connections on the receiver. The batteries or source of current is inserted in a break in the common wire. Thus two circuits are formed, each with the battery, one transmitter magnet, and one receiver magnet.

If 110 volts, alternating current, is used, and the wires are of number 14 gauge, the stations can be thirty miles apart, or if number 12 wires are employed, the transmitter and receiver can be separated by forty miles. The transmitter is mounted in a moisture-proof case, so that it may be set up out of doors, on the bank of a reservoir or irrigating system if it is desired to record the level of the water.

There are many applications for this apparatus. Now that such care is used to get the greatest efficiency from heating and power plants, these instruments are being used to show in the chief engineer's office the performance of the boilers. In heat-treating rooms the recorder is used that the results of different treatments can be compared. This is particularly true in factories where rubber is vulcanized.

One practical use of this apparatus is the installation of a steam-pressure indicator to show on the first floor of a house the condition of the furnace in the cellar. The transmitter can be attached to the steam gauge, to move the solenoids. A simple pointer on the receiver solenoids will make indications corresponding to those of the gauge. 110 volt, 60 cycle current can be used, though a higher frequency will give better results. A small light must be put in series with the apparatus, or the coils wound to a sufficient resistance to keep the current down to the carrying capacity of the wire. The greater the number of turns on the transmitter coil, the larger the range of variation in resistance.

The principle of the system is one which can be applied to other instruments. Perhaps some of our experimenters can work out a new use for this type of induction balance.

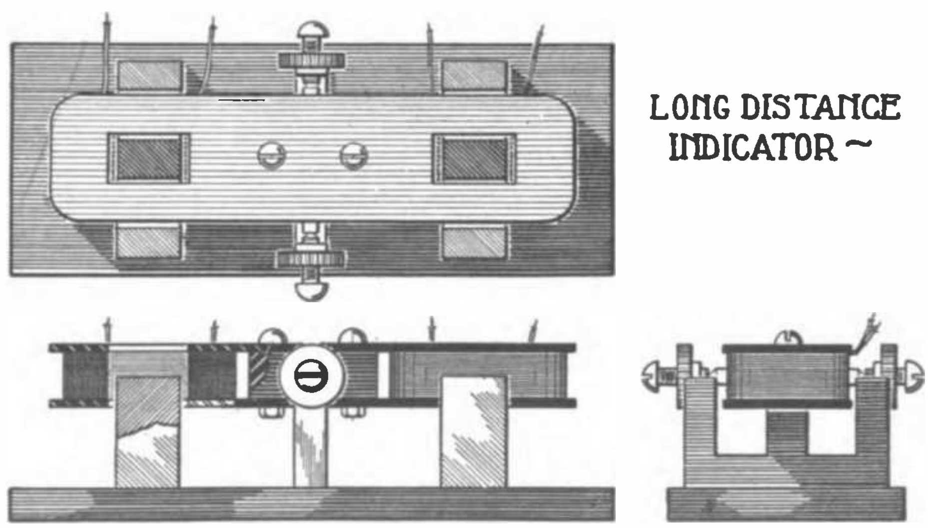
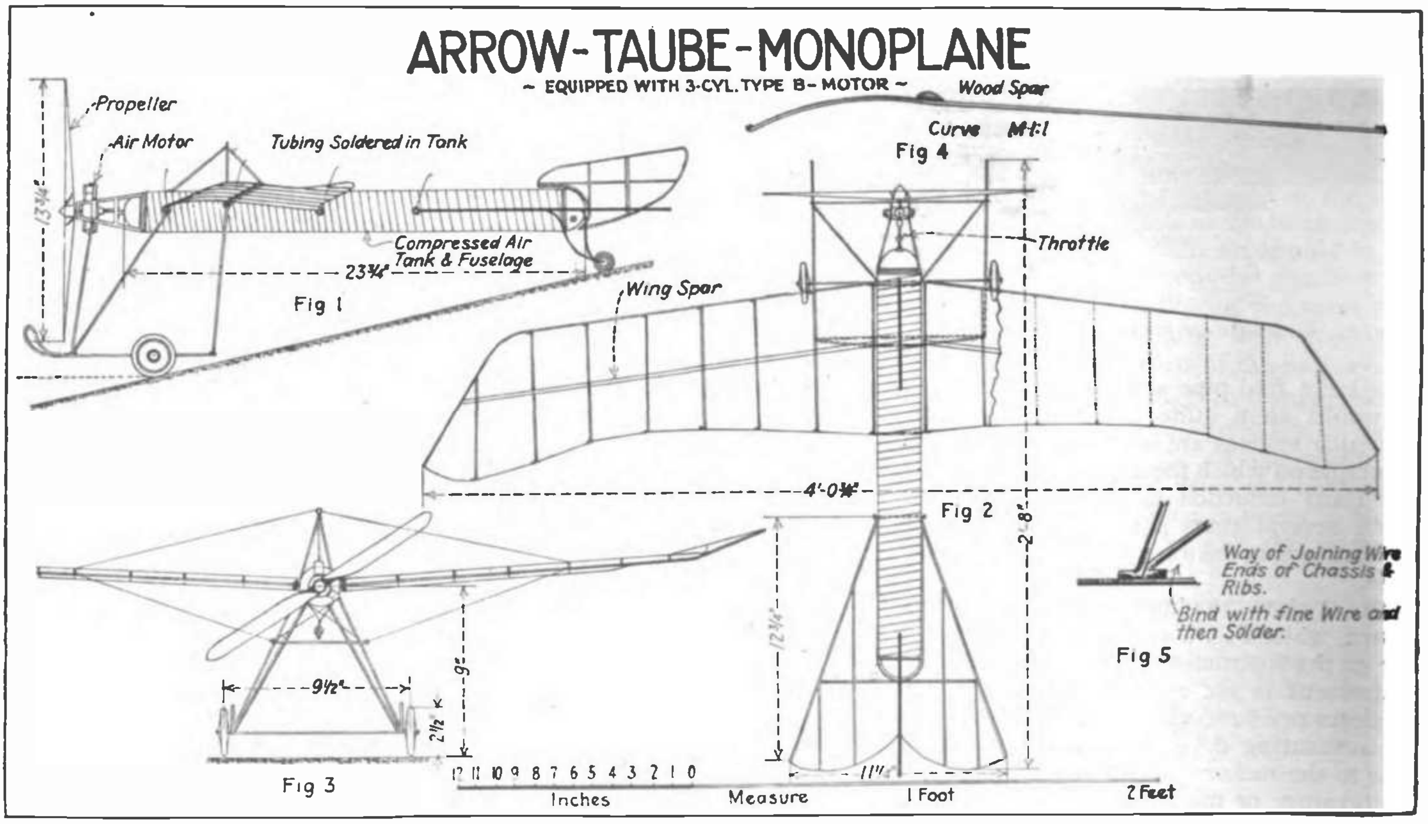


Fig. 2. A model of the long distance indicator which will find various uses in the experimental laboratory

The experimenter who keeps in mind the practical application of his work is the one who finds some material reward aside from the pleasure of the work he performs. Moreover, there are always new applications of old principles which the student inventors are rapidly bringing out as commercial products.

Compressed Air Driven Monoplane

By H. C. Ellis



BEFORE attempting the construction of this model study the drawings carefully. Use the scale for measuring in laying out full size components. Two main planes are required, one left and one right. The wing spar is of spruce 3/16" x ¼" and tapered as shown to a stream line form. The leading and trailing edges of the main planes are of flat steel wire, 28 gauge is used for the leading edge and 26 gauge for the trailing edge. The ribs are constructed of the same material. Be certain to have the same curve on all ribs.

To assemble the wings make a full size lay out on a piece of board and place small nails or brads along the edges. These will aid in holding the wire in place. If any difficulty is experienced in shaping the wings heat the wire at the point where the bends are to be made. All joints are to be wrapped with 30 gauge wire and carefully soldered. The wing spar is bound to the ribs at the points shown with linen thread and glued. After the main planes are completely assembled cover with a good grade of silk, glue same to the ribs on the bottom side. After the glue is thoroughly dry apply three coats of dope, being sure to apply one and allow it to dry before applying the remainder.

The tail is built up the same way as the main planes. "A" is a long bolt which passes through the tubing soldered in the tank and through the loops at the front edge of the tail. This provides for the connection of the tail to the fuselage. "B" is a small sleeve on the tank cap. This receives the wire running length wise through the tail just at the end of the tank. The rudder and rear wheel chassis is soldered to the tail.

Landing Chassis

The landing chassis is built up from 18 gauge piano wire and bound with 30 gauge wire, then soldered. The upper ends of the struts are bent into small loops, the wing spars passing through same. The lower ends which join the skids are bent parallel to same. The strut at A measures 9¾ in.; B, 11 in.; C, 10 in. One-half inch is allowed for bending the loop on each side. The skids are 13 in. long, 5 in. being required for shock absorber. The chassis measures 9 in. in width. The spreader D is 9 in. long and has two loops at the ends to receive the guy wires. The wheels used on this model are 2½ in. in diameter, or larger. They are the rubber stream line disc form that can be secured from dealers in model supplies. The axle is of ⅛-in. steel rod, 10½ in. long, threaded and fitted with nuts. It is bound to the landing gear with 30 gauge wire and soldered. The tank and motor used for this model are the same as the one described in the March issue of the EVERYDAY ENGINEERING MAGAZINE.

Flying Instructions

In flying the model charge the tank with 75 lbs. pressure with a foot pump. Grasp the tank with the right hand just to the rear of the main planes. Open the throttle with the left hand and launch the model gently forward at a slight upward angle, with the wind. The maximum pressure capacity of the tank is 150 lbs., and with this pressure, the model should fly from 600 to 800 feet. When the tank is pumped up to its capacity, the model will rise from the ground under its own power.

The temperature of ignition of liquid combustibles has been determined with a simple apparatus as below. A steel block, three inches high and four inches across has deep grooves turned to make it easily heated. It is bored out so as to receive a crucible. Oxygen is admitted through holes in the block, so that it is heated when it reaches the crucible. The oil to be tested is dropped in and the temperature is taken by a thermo-couple. The combustion of the oil produces a slight explosion and the temperature of combustion is thus determined.

It is reported that two tons of tin are smelted each day in Canada at Brantford, Ont., by electrically heated furnaces.

CHEMICAL COMPOSITION OF MAN

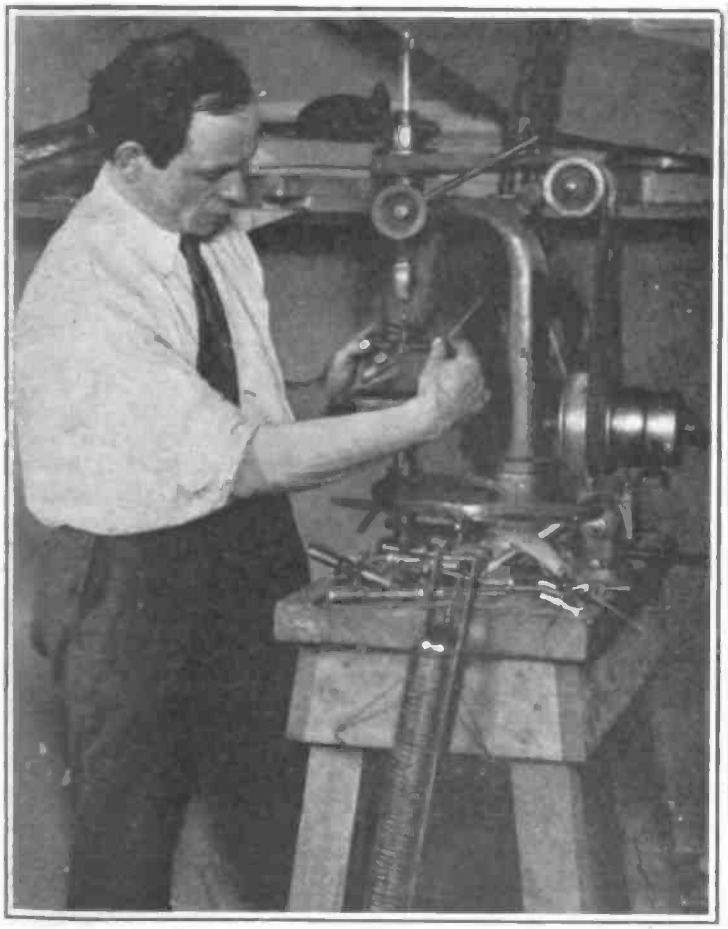
CHEMISTS and scientists have whiled away many a long day by delving into the mystery of the substance of mankind. They have brought many interesting things to light. One French scientist discovered, for example, that the stuff of which a 150-pound man is composed equals a thousand ordinary hens' eggs. An experimenter, with nothing of more practical value to do, busied himself with discovering, that in every one of us is 3,500 cubic feet of oxygen, hydrogen and nitrogen, sufficient gas to inflate a balloon with a lifting power of 200 pounds, or to illuminate a street a quarter of a mile long for several hours: for the humbliest of us contains, without suspecting it, $3.75 worth of illuminating gas. And if the 22 1/6 pounds of carbon in the average body were reduced to graphite, there would be enough leads for 780 pencils. Another chemist found out that enough iron is stored in the human system to make seven large nails. And as for phosphorus—there is enough in each of us to tip 820,000 matches or, improperly administered, to poison 500 people. It has been estimated that we are worth, if we could be separated into our respective chemical elements, $18,300, which is considerably more than most of us have of the world's goods.

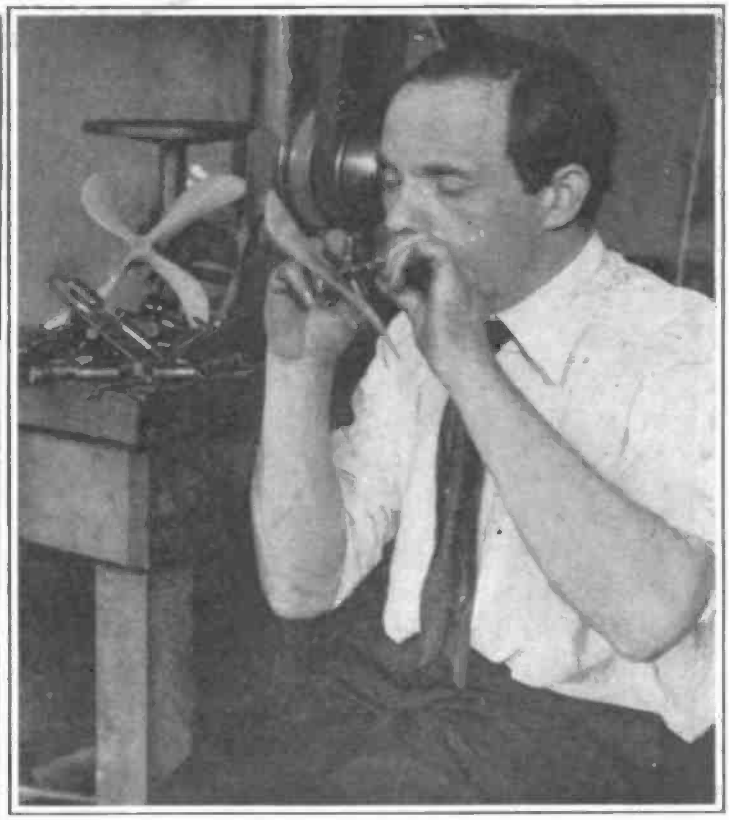
NEW MOTOR BOAT RECORD

A SUNBEAM motor of the same construction as that used in the British dirigible R-34 is said to have broken the World's speed record for motor boats during a recent trial on the Seine river, near Paris. The trials were carried out on a 500-meter course where the current is slight, and the official chronometers recorded that this was covered in from 14 to 16 seconds at different trials. The general speed may be set down as 120 kilometers, or 75 miles an hour. The Sunbeam motor used in making this record is 450 hp. Naval constructors have held that a propeller turning more than 1800 revolutions a minute would produce a vacuum about itself and in consequence fail to secure speed. The inventors of the new record-breaker, however, have disproved this theory and used a multiplicator which produced 3000 revolutions a minute.

LARGE CAPACITY AIRPLANES

A STRIKING development noted in European aviation is the great increase in size and power of the large airplanes suited for bombing in war and for passenger carrying in times of peace. The Carproni triplane which made a flight from Villacoublay, France, to London with a number of passengers, has been remodeled for passenger service and carries eight passengers, with three additional seats for pilot and mechanicians and is the same type in essentials that was used in bombing. The largest Caproni but recently developed is a triplane which, fully loaded, weighs about 25,000 pounds and is driven by five 200 horsepower engines. This has a double-deck cabin and accommodation for 22 passengers. The Vickers-Vimy has been remodeled and is carrying ten passengers. The Farman "Goliath," which is making regular passenger trips between Paris and Brussels, carries ten passengers at a time, and with this load aboard has attained a height of 10,000 feet. The Handley-Page four-engined biplane has been fitted for passenger accommodation and is credited with having accommodation for thirty persons. Another huge machine is the Bleriot four-engined machine, with accommodation for twenty-eight passengers. Commercial flying in Europe is well established and showing rapid development.





A sensitive drill press can be used to "run in" a compressed air motor. At the right one method of testing for free running is shown

The presence of nitrogen in iron may affect its qualities to a considerable degree. Some investigations of the contents of the bubbles often found in the metal have shown that they contain nitrogen with a little carbon dioxide and hydrogen. The latter is derived from the moisture of the air which has been used as a blast in the manufacturing processes. Red hot iron can bring about the combination of nitrogen and hydrogen to form ammoniacal gas (NH_3), so if this is formed conditions of heat may determine the combination of the nitrogen, in the nascent state with the iron.

Who's Who in the American Society of Experimental Engineers

C. Vey Holman, LL.M.

C. VEY HOLMAN is a resident of Maine, in which State he has served as State Geologist and State Assayer. Mr. Holman was born at Poughkeepsie, New York, January 23, 1861, of parentage running back on both sides to early colonial and pre-Revolutionary New England stock.

He was educated in the common schools of Maine, Rhode Island and

C. Vey Holman, LL.M.

Massachusetts, becoming a graduate of the Boston Public Latin School, the oldest school in America. Studied four years as a member of the class of 1882 at Harvard College, where he received honors in the classics and prizes for excellence in reading and declamation. Matriculant of Boston University Law School and graduate of the Law School of the University of Maine, receiving from the latter the degrees of Bachelor of Laws and Master of Laws. Founder of daily journalism at Harvard College where, as a sophomore he established the *Harvard Daily Echo*, published in Boston and other Massachusetts cities. Member of the bars of the Supreme Courts of Massachusetts and Maine and of the Courts of the United States. Member of many technical and scientific bodies, including the American Institute of Mining and Metallurgical Engineers, The American Mining Congress, of which he is a Vice-President, the American Association for the Advancement of Science, The American Electrochemical Society, life member of the Association of Harvard Engineers and a charter member of the American Society of Experimental Engineers. An owner and developer of mining properties in Maine, Alaska, Pennsylvania and Nova Scotia. Member of the Boston Veteran Journalists' Association and of the Navy League of the United States.

Mr. Holman very interestingly sets forth his experiences in life in the following lines:

"I was first attracted to the little magazine, then called *Everyday Mechanics*, by the casual purchase of a copy on a railroad train. My interest was excited by the plucky and straightforward way in which the Editor was appealing to his constituency of readers for support in his fight to retain the use of that title in which I believe he would have received universal public support had he been able to contest it to the bitter end. I immediately subscribed, mailing my subscription from the train.

"The cleverness of his editorship, the brightness and aptness of the little publication so won my admiration that when the proposition to consolidate the amateur engineering talent of young America in our Society was broached, I was happy to yield instant and enthusiastic support. I am only regretful that I have not been able to do more, but as the years advance, duties accumulate rather than lessen, and the desire to do all that I should frequently succumbs to the necessity of doing merely what I can.

"I have always been interested in boys—bright boys—bad boys (who are usually only over-bright boys lacking opportunity to express natural aptitudes of the highest order) and, of course, good boys, not preternaturally good, but well-dispositioned and teachable lads of spirit and principle.

"Looking back to a boyhood now nearly half a century behind me, I am as young as ever in my love of all outdoor sports, boating, hunting, fishing, tramping in the forest and in the open, studying always and everywhere the lessons which in imperishable characters God has written in the massive rocks in glacial-cut river valleys and glacier-deposited moraines, rames or "horse-backs" as they are termed in the vernacular, in forest, field and mountain, for the guidance and government of us, His children, who, after all, are only boys of a larger growth and elder stature, and pitifully small boys at our best and greatest, in His great scale of creation.

"With many years of pupillage in the school of experience, as journalist, publicist, lawyer, miner and mining geologist, I am continually being more and more impressed with the duty we owe the young of this great, free America, happily still possessed of our unrifled Constitutional character of liberty regulated by law, to impart to them the wisdom we may have been so fortunate as to steal or borrow from the great book of Nature and of Nature's God. So from me, as one whom a Connecticut Pegnot Indian taught to swim, and a Maine Penobscot Indian taught to paddle a canoe; who in my youth knew by sight and by name every native bird with its nesting habits and tricks of flight; who understood how to set dead-fall and figure-four traps, and to prepare the pelts of the small animals, grey and red squirrels, weasels and minks they caught; who knew the Rhode Island hillsides where grew the hickory and chestnut trees, and when to gather the nuts the early frosts dislodged from their hold upon the branches; who knew the Maine Hardwood ridges where the beech and oaks scattered their mast in brown profusion in the golden autumn days, convey to our brethren of the American Society of Experimental Engineers my salutations and best wishes.

"I hope the time may come when every American boy may know more than I ever learned of these wondrous lessons; may see in every angleworm a chemical engineer fertilizing more efficiently than ever any farmer did the soil he continually works over, in the wasp the original pulp wood paper-maker, in the beaver the earliest and most indefatigable hydraulic engineer, in the bee, nature's greatest conservationist of food supply, in the ant, the mole and the rat, mining engineers surpassing in ingenuity, fertility of resource, and untiring application, the graduates of the technical schools which have distinguished the names of Freiberg, Columbia, Cawborne, Harvard and the Massachusetts Institute of Technology among the many of the world's polytechnic schools.

"And may it be the mission of our Society to encourage, foster and develop, in American youth, enthusiastic love of scientific research along all lines of mechanical, electrical, chemical and geologic science."

TESTING METALS

FILE, or grind, the pieces to be tested and polish them smooth, then place them in a dilute nitric or sulphuric-acid solution for a day. Wash and dry the pieces, and if they are of the best steel, the surface will have a frosty appearance. Ordinary steel will have a honeycomb surface, and iron will present a fibrous structure running parallel with the direction in which the metal was worked.

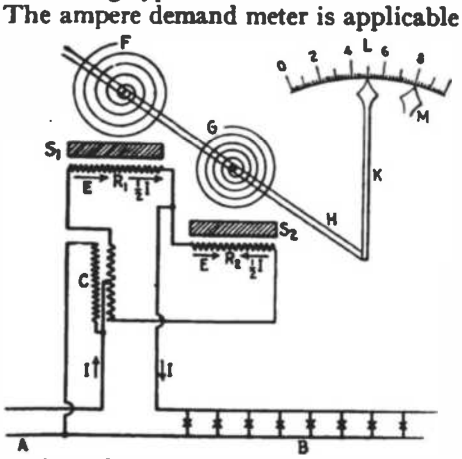
ELECTRICAL PROGRESS DIGEST

A New Thermal Demand Meter

RUGGEDNESS, compactness and simplicity of construction are the distinctive mechanical features of a new type of demand meter now being manufactured by the Westinghouse Electric & Manufacturing Company. The instrument employs the principle of thermal storage and indicates what has been termed the logarithmic average demand. The new line of instru-

ments consists of indicating watt demand meters for alternating current circuits, and ampere demand meters for alternating and direct current circuits.

The watt demand meter can be used to measure the watt demand in all types of alternating current circuits where it is desired to measure the load with an indicating type of demand instrument. The ampere demand meter is applicable



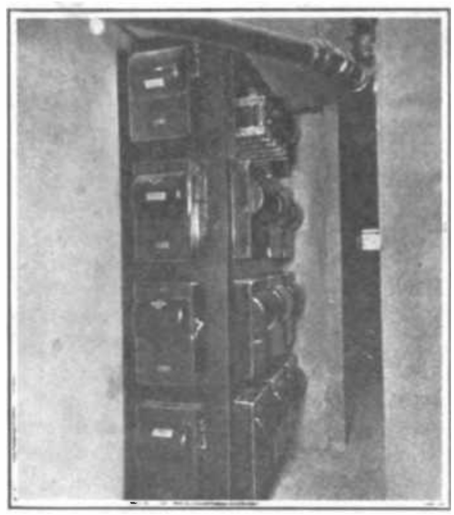
to installations where it is desired to measure the current demand; this type of ampere demand meter is espeically applicable in determining the average current in steel mill and railway work where a motor load varies through a wide range within a very short time.

The moving element of the instrument consists of a shaft connected to two bi-metallic spiral springs. The springs are attached to the shaft at their inner ends, and to a cylindrical case at their outer ends. The springs are wound in opposite directions so that an equal change in the temperature of both springs does not produce any rotation of the shaft. The instrument is, therefore, independent of atmospheric temperature changes. However, if one spring is raised to a higher temperature than the other, it will deflect through a greater angle than the other, and the shaft will move through an angle which is proportional to the difference in temperature of the two bi-metallic springs. Each of the cylindrical cases mentioned above contains a heating element which is connected to the electrical circuit in such a way that one spiral spring is raised to a higher temperature than the other, which results in the shaft deflecting through an angle proportional to the load on the meter.

In the wattmeter, the difference in the temperature of the two spiral springs, and hence the deflection of the shaft is made proportional to the watts by causing the load current to pass through the heating elements in such a way that in one heater it is additive to a current which is proportional to the voltage, and subtractive from the same current in the other heating element. In other words, if E is a current which is proportional to the line voltage, and I is the load current in each element, then the total current in one heating element will be $E + I$ and the other $E - I$. The losses, and hence the heating in the elements, are proportional to the squares of these currents, and it is readily seen that the difference in the heating is the difference between the squares of $(E + I)$ and $(E - I)$, which is proportional to the product EI or watts. Due to the thermal storage of the cylindrical cases surrounding the bi-metallic springs, the wattmeter does not respond instantly to a change in load, but always indicates the logarithmic average load for the time period immediately preceding the instant of observation. The thermal storage capacity of the cases is so designed that the wattmeter gives a deflection equal to 90 per cent of the final deflection in the rated time interval of the meter. This means that a 30 min. meter will give an indication equal to 90 per cent of final indication in 30 min.

PRESENT TENDENCIES IN CONSTRUCTION OF SWITCHBOARDS

OWING to the increasing labor shortage which necessitates the employment by industrial plants of men and women having no electrical experience, the question of protecting the "green employee" from electrical hazards is of paramount importance. Industrials, cognizant of this new responsibility created not only by a realization of the humanitarian aspects of the problem but by the tremendous expense entailed by accidents, are rapidly reconstructing their electrical equipment in such a manner that the element of danger is reduced to a minimum. Exposed portions of current-carrying parts are being protected so as to insure safety to life, reduction of fire hazards and simplicity of operation.



Dead front switchboards have already found a broad range of application as they protect the inexperienced operator by providing a centralized control for starting motors and miscellaneous power circuits.

The accompanying illustration shows fourteen modern type safety switches mounted on steel panel boards in the Sperry Flour Company plant at Spokane, Washington. The safety switches made by the Square D Company of Detroit, control 2300, 440, 220 and 110 volt circuits.

Such a board has a great many advantages. It can be constructed by any responsible electrical contractor, as the material used consists chiefly of pipe or angle irons, pipe clamps, conduit, steel plates used for panels and the safety switches themselves. An unusual feature is its flexibility. Switches that are already individually installed on motors are easily convertible to a central power panel, and panels already mounted can easily be changed for individual drives.

MONSTER ELECTRIC PASSENGER LOCOMOTIVES

THE Chicago, Milwaukee & St. Paul Railroad is one of the trunk lines which bridge the gap from Chicago through to the coast. Building the road in itself was a pretty big feat of engineering, and the railroad operators had their problems when it came to hauling trains successfully over the steep inclines. For there are several steep grades, many short radius curves, and numerous tunnels. A sample of what they have to negotiate is a 21-mile, 2-per-cent grade between Piedmont and Donald, Montana. And another climb is a 49-mile, one-per-cent grade on the west slope of the Big Belt Mountains.

Two sections of the lines are electrified. One, the longer, and more important, comprises a division 440 miles in length extending from Harlowton, Montana, to Avery, Idaho. The distance is approximately equal to that from New York to Buffalo or from Boston to Washington.

The success resulting from the use of electric power on the division just described led the company to electrify another section further west, extending from Seattle to Othello, Wash., a distance by railroad of 211 miles.

Each locomotive is equipped with six electric motors capable of developing in the aggregate four thousand two hundred horsepower. The driving wheels of the giant engines are 12 in number, six on each side. Their diameter is 5 feet 8 inches, or equal to the height of a man of average stature. The diameter of the so-called "bogie" and trailer wheels is 3 feet. The height of the engine from rail to top of cab is 14½ feet. The overall length is nearly ninety feet.

Electrification of railroads goes a long way in solving the coal problem which confronts the United States today. The energy used for driving these trains over the mountains is obtained from the great waterfalls of the Montana Power Company, thereby utilizing the "White Coal" which otherwise might be wasted.

The electric locomotive described makes use of a feature known, as regenerative braking. That is to say, when the engine is running down hill, the motors become generators which deliver power back into the line, and in so doing they resist the impelling force of the train and act in a retarding or braking capacity. This is a big factor when one considers the pushing force brought to bear on the locomotive, by a heavy train. This tremendous energy, which would otherwise be lost by friction braking, is in part saved and used for moving other trains. It were as though a train going down one side of a mountain were helping to pull another up the other side. Power is saved and the down moving train is effectively braked as well. This form of braking has increased the safety of operation on grades and has greatly reduced the wear on wheels and tracks, to say nothing of the saving on brake shoes, which, under the friction braking method, wear down quickly, the friction often becoming so intense as to heat the brake shoes red hot.

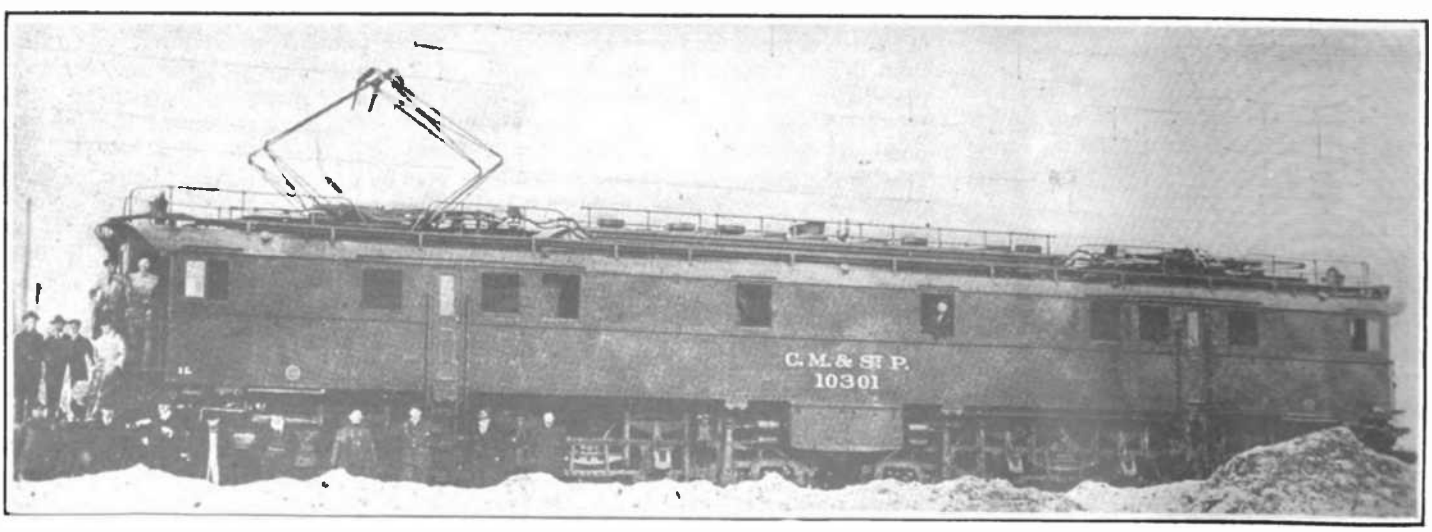
Anyone who has traveled through a tunnel behind a steam locomotive will at once recognize the advantage secured by electric operation through the elimination of noxious coal gas. This is an important item out on that mountain line with its 36 tunnels to be negotiated.

BAKING BY ELECTRICITY

THE extraordinary rise in the prices of fuel caused by the war has considerably furthered baking by electricity, although a great many electric bake ovens existed in Norway, Sweden and Switzerland before the outbreak of hostilities. The cheapness of coal at that time was not conducive to the bakeries taking up electric baking, in spite of the fact that in those countries which possess water power, baking by electricity is of considerable economic importance, as the employment of electric ovens permits the utilization of superfluous energy which usually cannot be made use of during the night. The night energy can be supplied by hydroelectric power stations at such cheap rates as to make the use of electric ovens much more economical than those heated by coal or steam.

AUTOMATIC TELEPHONES IN NEW YORK

THE telephone company operating in New York City has recently announced that, following exhaustive experiments, it has developed a machine switching central office system that has proved so satisfactory in a number of practical trials as to warrant its use in several places within its territory. Installations are now being made in Dunkirk, Ithaca and Geneva and the work is expected to be completed about the first of the year, in the three new exchanges, but none of these installations can be completed, according to present estimates, much before the end of 1920. The latter changes are expected to help meet the abnormal demand for telephone service in that city. The new system has been carefully worked out and the means of co-ordinating it with the other types of switchboards have been so perfected that the different types of equipment will interconnect without difficulty. In fact, a subscriber connected with one of the new switchboards will not need to know whether the called party is connected to a machine-switching or a manually-operated switchboard and vice versa.



The new giant electric locomotive built to haul trains over the Rocky Mountains

Detecting Flaws in Mica With X-Rays

By Brewster S. Beach

THE difficulty of detecting flaws and the presence of foreign bodies, of a metallic or other nature, in built up mica which is used for insulating purposes, has caused the General Electric Company to install an X-ray testing outfit for this purpose. As will be shown, the detection of such flaws before the mica is actually used for insulation purposes is highly important, as much damage, and loss of time and money, due to faulty mica are averted.

Mica, a substance which has a very high dielectric strength, is extensively used in the electrical industry as an insulator, especially in building commutators for direct current generators and motors. In this construction the copper segments of the commutators are separated by sheets of mica, to prevent short circuits between the copper segments. Mica is best for this purpose because of its high insulating properties even when it is in the form of a comparatively thin sheet and also on account of its heat resistance.

When it is received at the factory it comes in the form of flakes varying in size, but none very large, and with a thickness of one-one-thousandth of an inch. These flakes are given various treatments and built up into sheets, which are cut to any desired size. These sheets are pressed in a hydraulic press.

Since at best the bars are not very thick—about one-thirty-second of an inch—it is important that they have a uniform cross section, and be free from all foreign substances, because a thin spot in the bar, or the presence of some small metal object would weaken its resistance and probably cause considerable damage to the machines in whose commutator it was. A good many of the processes involved in building up these sheets are done by girls, and it has been found that, in spite of all precautions, pins, bits of chewing gum, tinfoil wrappers, small pieces of wire and other foreign substances are sometimes built up in the mica.

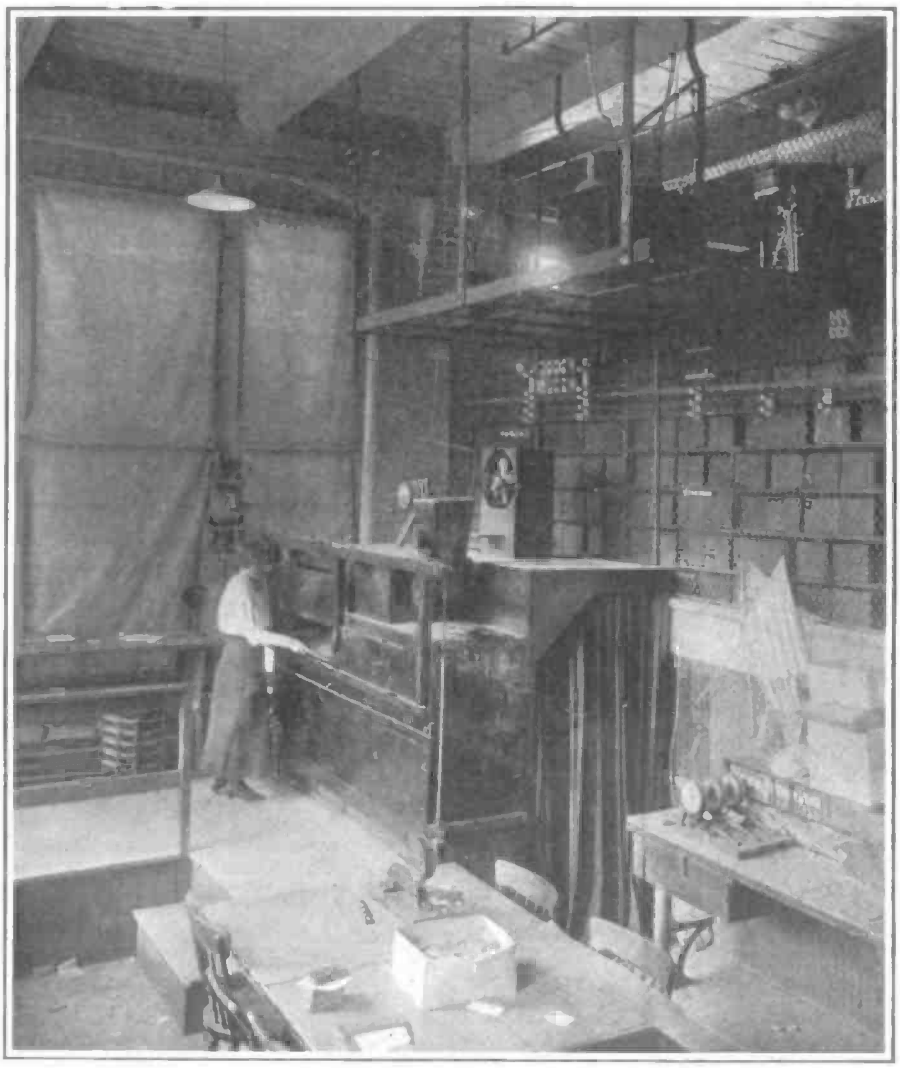
Since objects like these, as well as unevenness in the density of the structure are invisible from the outside of the sheet, the X-ray method of testing is about the only one that will reveal these faults with any degree of certainty. The installation itself has features that are well worth description.

The testing is done in a light-proof cabinet, which is equipped with protection in the form of lead sheeting so that neither the observer or any one outside can be burned by the rays. The section where the observer sits is merely a cabinet, painted black throughout and having a light-proof curtain over the door. Directly in front of the observer's face is a lead glass window through which she can see the reflection of the mica under test.

On the front of the observing cabinet is another smaller cabinet, which is divided into two sections, laterally. The upper of these sections contain the X-ray tube, in a lead-covered case, with a fan at one end and an exit at the other, for ventilation. There is a hole in the bottom of this section, directly under the tube, which permits the rays to fall directly upon the mica under test. The lower section contains a track and truck with a fluorescent screen upon which the trays of mica are set, same being about two feet long and a foot wide, consisting of a light wooden frame stretched with white cloth.

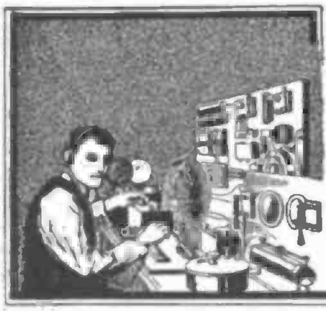
This arrangement is necessary so that the observer can move the trays from her cabinet without moving from her seat. There is a lead shutter, which is connected to the end of the truck, and which closes when the tray is moved over, shutting off the rays from above, which would otherwise discolor the glass of the mirror. The mirror in question is set at a 45-degree angle, about a foot under the tray, and so placed that it reflects the image of the mica directly through the glass in front of the observer.

The mica to be tested is placed on the trays, which are put on their track through a lead-covered door in the front of the section beneath the tube, which closes by means of counterweights. The aperature between the tube and the trays is then opened and the observer has before her the X-ray reflection of the mica. This reflection has the general appearance of an X-ray photograph. The solid parts of the mica strips appear light gray, the spots of lesser density being of a lighter shade. The absence of comparatively few mils of mica will show up in the form of light spots, which increase in brightness in proportion to the decrease in the density of the mica object. Foreign objects, such as pins, bits of wire—no matter how fine

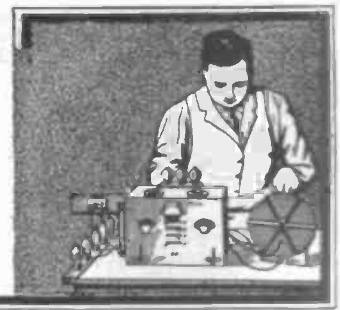


Complete apparatus for X-ray examination of side mica to locate flaws

(*Continued on page* 184)



RADIO
TELEPHONE AND TELEGRAPH APPARATUS



Ideas for the Radio Laboratory

An Oscillating Audion Circuit, Use of a Milliammeter, Winding and Tapping Banked Coils, and Other Ideas for the Experimenter.

By M. B. Sleeper

A SMALL laboratory oscillion is a very useful as well as interesting instrument. It can be employed for undamped wave reception, as a transmitter for testing receiving sets, a wavemeter, and a short distance transmitter, when the industance coil is replaced by a loop antenna.

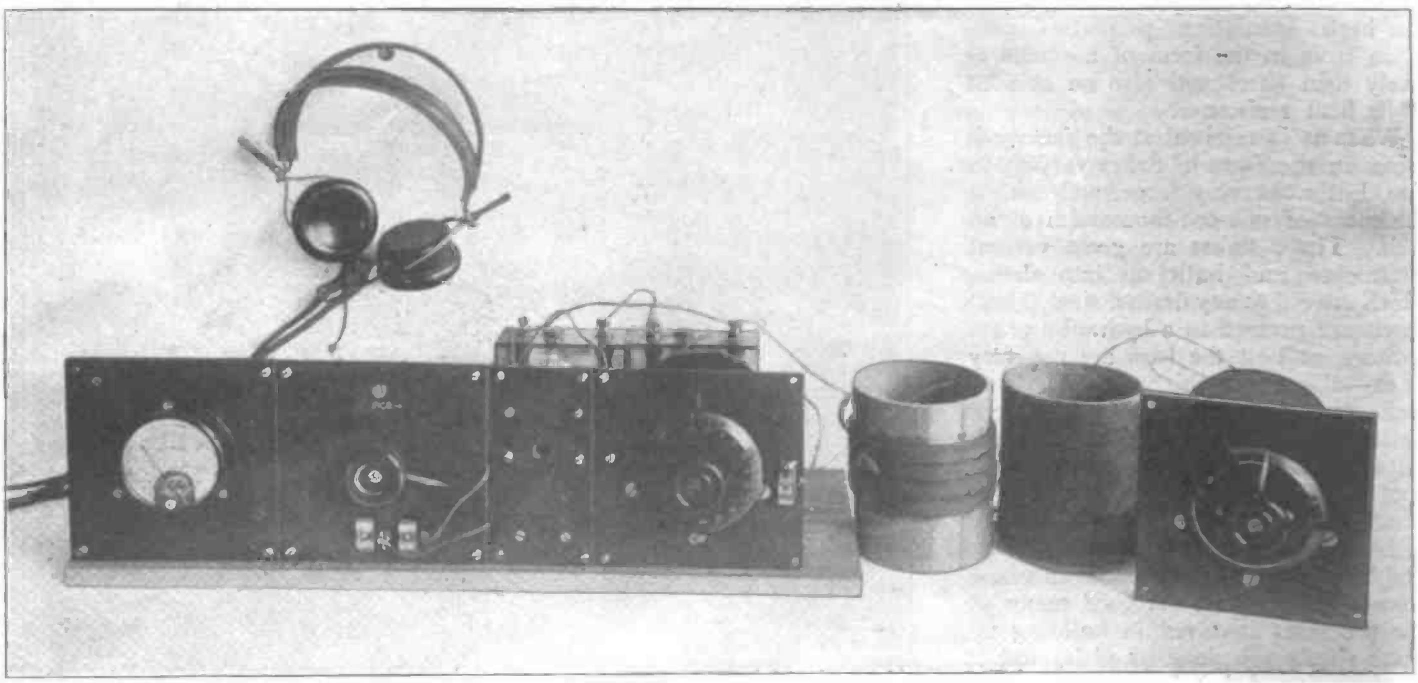


Fig. 1. A front view of the oscillator used as a wavemeter

The instruments are illustrated in Figs. 1 and 2. The panels carry a milliammeter, rheostat, tube mounting, and variable condenser. There is a grid condenser on the tube panel, but this is short circuited. This is the simplest type of oscillator, and a very efficient one, too. Wave-length control is effected by means of the variable condenser, while the strength of the oscillations is regulated by the rheostat which controls the brilliancy of the filament.

The Oscillator Circuit

In this type of set, the inductance is connected in shunt with the condenser, and the condenser is put across the grid and plate of the audion. The B battery, milliammeter, and telephones are all put in the lead from the condenser to the plate. The filament is in series with two small storage cells and a rheostat. A lead is taken from the negative side of the filament to a tap at the center of the inductance. This completes the wiring.

The condenser, audion, and rheostat panels have been fully described in previous issues of Everyday. Fig. 3 shows the Weston milliammeter. A 0 to 1 milliampere type was selected because, in this type of oscillion, the plate current seldom exceeds 1 milliampere, and readings as low as 0.01 milliampere or 10 microamperes can be taken.

Mounting the meter is an easy matter. A hole can be turned out in the panel, or a series of small holes can be drilled in a circle, and the work completed with a file. Three small screws hold the instrument in place. One of the binding posts on the meter is marked +. This side goes to the plate of the audion; the + lead from the B battery is joined to the other post.

A 1/4 inch panel was used to carry the meter, while the other panels were of 1/8 inch bakelite. When the panels were linked together, the discrepancy in thickness was made up by putting washers at the back of the thinner panel, under the links. Thus the fronts were made flush. Small angle brackets at each end supported the panels.

Calibrating the Oscillator

Several coils of different sizes were made up, so that the oscillator could be used as a wavemeter. A wavemeter was set up with rather close coupling between meter inductance and the oscillator coil. The buzzer and detector circuit were not used with the wavemeter, the milliammeter and telephones in the oscillator plate circuit serving as the indicators. As the capacity of the oscillator condenser was increased, the plate current increased, and, when the point of resonance with the wavemeter was passed, the milliammeter dropped back slightly, then moved up again.

When, however, the oscillator condenser was left stationary, and the wavemeter varied near the resonance

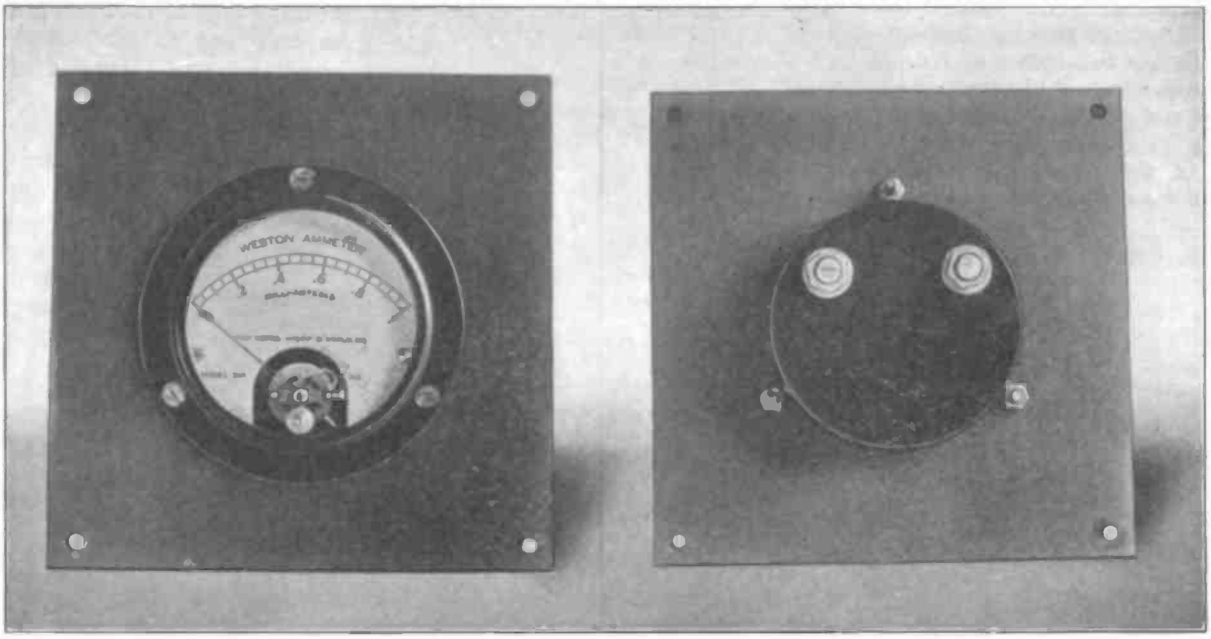


Fig. 3. A low-reading milliammeter is a very useful instrument for the radio laboratory

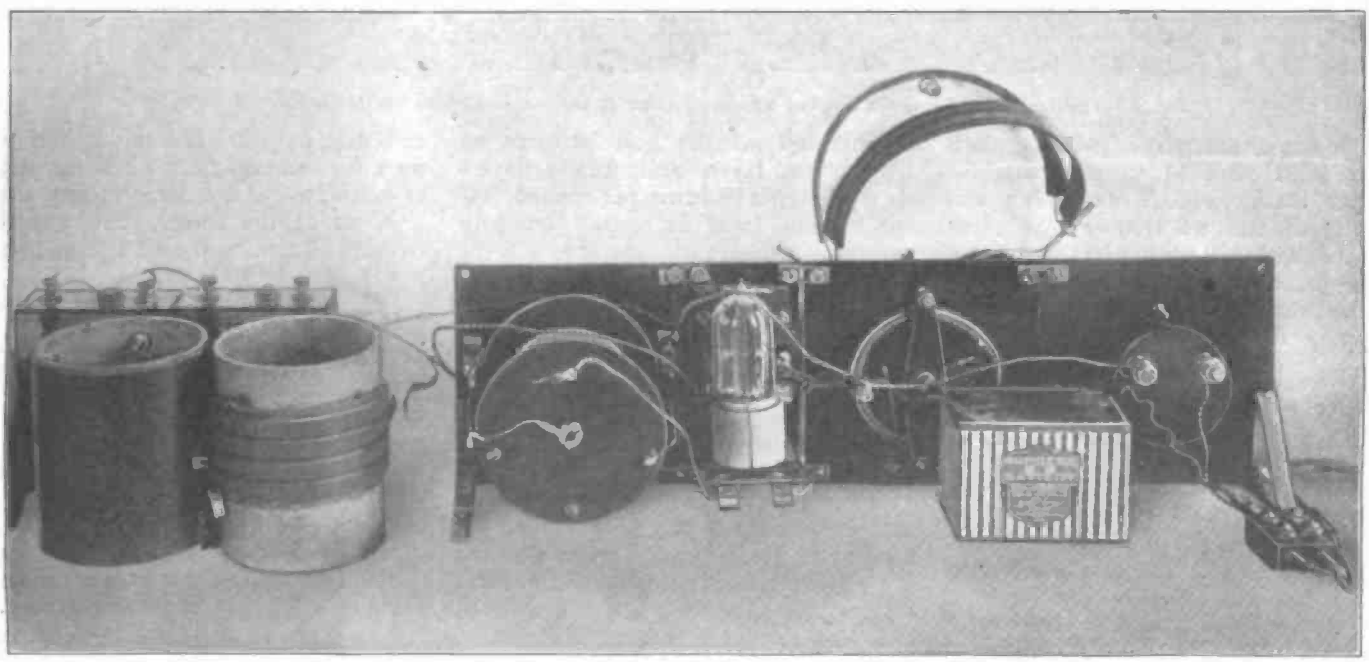


Fig. 2. A rear view of the set, showing how the panels are assembled to make an oscillating audion circuit

point, the plate current increased up to a point at which it dropped back again. The telephones were used for a more accurate determination of resonance. The method was as follows:

For example, when the capacity of the wavemeter was increased, a click was heard in the telephones when the pointer passed 88°. Reducing the capacity of the wavemeter condenser, a click occurred at 80°. The coupling between the oscillator and wavemeter coils was reduced. Then, on the increase, a click occurred at 85°, and on the decrease, at 83°. This indicated that the resonance point was at 84°, half-way between the clicks. Reference to the wavemeter calibration curve gave the wavelength of the adjustment at 84° on the condenser scale, which was also the wavelength of the oscillator.

Calibration of a Receiving Set

To calibrate a receiver, it is generally sufficient to measure only the secondary, particularly when it is to be used on various antennas. The primary has, of course, the same wavelength as that of the secondary circuit, when they are tuned to an incoming signal.

The primary should be moved away from the secondary coil, and the oscillator coupled to the latter. Then, by setting the oscillator for a given wavelength, the secondary circuit can be tuned to it, using the click method described above.

Undamped wave receivers can be tested by means of the oscillator. The receiver is set up at one end of the laboratory, and the oscillator at the other. Then leads are run from the antenna and ground posts to a small coupling coil placed beside the oscillator. A condenser of about 0.0003 mfd. is inserted in one of the leads, to replace the antenna capacity.

With the oscillator to supply the undamped waves, the characteristics of the receiver can be readily determined.

Undamped Wave Reception

The use of a separate oscillator for receiving undamped waves has been discussed in previous issues of Everyday Engineering. A set of this sort is well adapted to such work.

An ordinary damped wave receiver is employed, with a small coil of twenty turns connected in the ground lead. This is coupled to the oscillator. Beats are set up with the incoming oscillations, producing audible signals.

Continuous Banked Windings

Fig. 4, at the left, illustrates a coil which was used in making measurements. This has two banks of No. 24 S. S. C. solid wire. Although experimenters are not generally aware of the fact, this is excellent wire for banked windings, in that it is very easy to handle, and can be tapped readily.

Grouped Banked Windings

The problem of producing an efficient coil of high inductance in a small space is a difficult one for the man who makes his own apparatus. Probably the easiest method is that shown at the right of Fig. 4. The turns are wound on in the following manner:

46 47 48 49
45 44 43 42 41
35 36 37 38 39 40
34 33 32 31 30 29 28
20 21 22 23 24 25 26 27
19 18 17 16 15 14 13 12 11
1 2 3 4 5 6 7 8 9 10

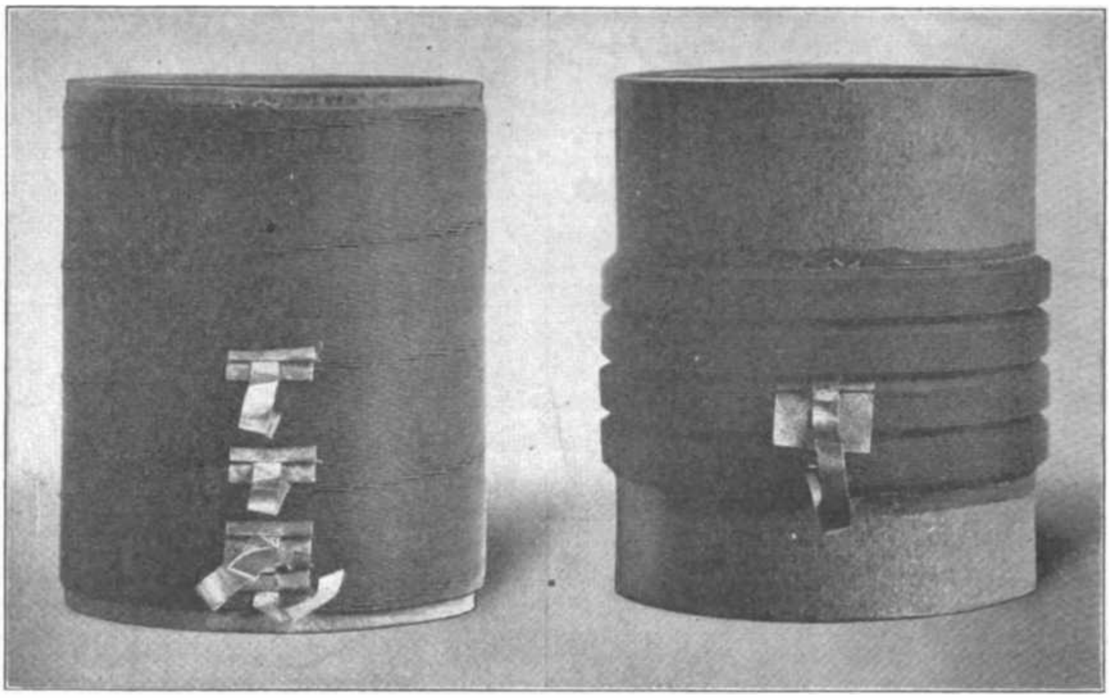


Fig. 4. Continuous and grouped banked windings, showing the method employed for taking off taps

The important part of winding coils with solid wire is to maintain the proper tension. G-A-lite tubing was employed, and no trouble was experienced with slipping wires. After a little practice, it is possible to wind banked coils of this heavy wire without stopping at the crossovers.

Where taps were made, the insulation was scraped away for ¼ in. Then a strip of paper ⅜ in. by 1 in. was put under the wire. After a piece of copper foil had been placed over the paper and under the bare section of the wire, the winding was continued one turn. Next, a second piece of paper was put on the coil, with one end over the tapping point. Subsequent turns were wound over the paper.

The result, as can be seen from the illustration, was the complete segregation of the tapped wire from the other turns. When the coil was completed, each tap was soldered, making a perfect joint. Copper foil 0.0002 to 0.005 in. thick is the best material for tapping, as it is so thin that it does not distort the winding.

This coil actually had 20 turns on the bottom layer, and was 7 layers deep, giving 119 turns per section. If the bottom layer is wound on with sufficient tension, no trouble will be experienced from slipping. To make doubly sure, after the first layer was wound, a thin film of beeswax was run around the tube at the starting end of the coil. A soldering iron was used to melt the wax.

No difficulty should be experienced in bringing the wire from the end of the top layer down to the tube to start the next section. Any slipping can be eliminated by bending the wire, at the top, to the side at a sharp angle, then, holding the bend with the thumb nail, bringing the wire down on the tube. A drop of beeswax should be put on each of these jumps after the coil has been completed.

Four of these sections, wound with No. 24 S. S. C. solid wire on a tube 3½ in. in diameter, gave an inductance of 22.35 millihenries, 8 sections, 40.4 mh., and 12 sections, 107.2 mh. These coils, measuring at the bottom, were 1.8 in., 3.6 in., and 5.4 in. long respectively.

It is not practical to attempt to tap this type of coil in the center of the section, but a tap can be taken off easily at the end, as in Fig. 4. Here a piece of paper was put under the wire, and a strip of copper foil soldered to the wire.

Some difficulty was experienced with breaking taps at the edge of the solder. An easy way to get around this was found, however. Instead of using a single copper foil strip, a long strip was bent double at the center, and this end of the foil put under the wire. The upper half was soldered to the wire, and then cut off. The under half was used for connections. Thus the strain of bending did not come at any sharp line, as at the solder, but was distributed, lessening the chance of breaking the copper foil strip.

THE RADIO REGISTRY

All kinds of opportunities are coming up in radio work, not only in the United States but in foreign countries as well. Men to fill these positions cannot be located readily, but they will be found through the Radio Register. Is your name among the others?

The following information, clearly written, is needed for proper registration.

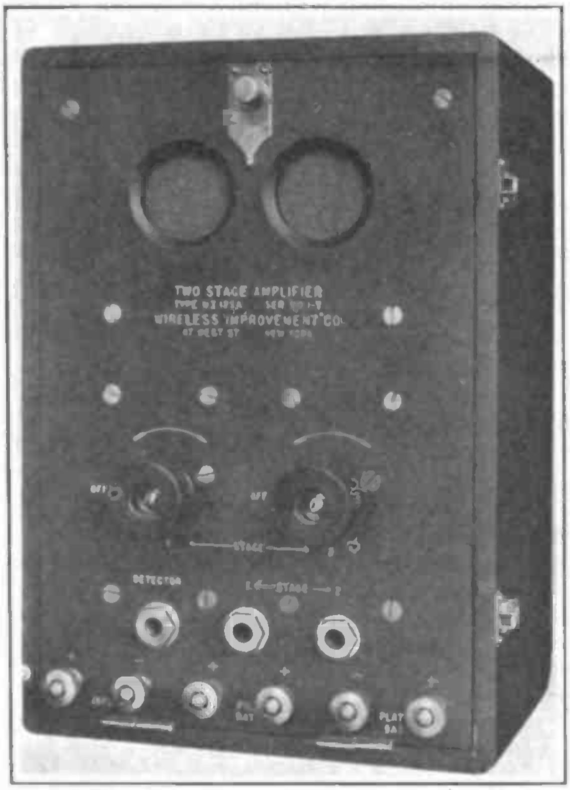
Don't put it off—send in your name at once.

Name.
Address.
Engineer or Experimenter.
Age.
Experience.
Special qualifications.
Radio station owned, if any.

Address your letters to the Radio Department, Everyday Engineering.

A Two-Stage Amplifier

This Instrument, From the Wireless Improvement Company, Illustrates Some Features of Standard Navy Practice



ALTHOUGH, from the point of view of the experimenter, construction following what has become known as standard Navy design is expensive, it gives to purchased or home-made equipment a dependability which inspires a consistent faith and pride in the instruments.

The amplifier illustrated here is carried in a case 9½ ins. high, 4½ ins. deep, and 6½ ins. wide. All the instruments are carried on the removable panel.

At the front are the tube observation windows, closed to dust by a fine mesh screen, filament rheostats, telephone jacks, and binding posts. Connections from the detector are run to the posts marked INPUT. When signals are of such strength that no amplification is required, the telephone plug is simply inserted at the jack marked DETECTOR.

For one or two stages, the filaments are lighted by turning up the rheostats, and the phone plug put in the one- or two-stage jacks.

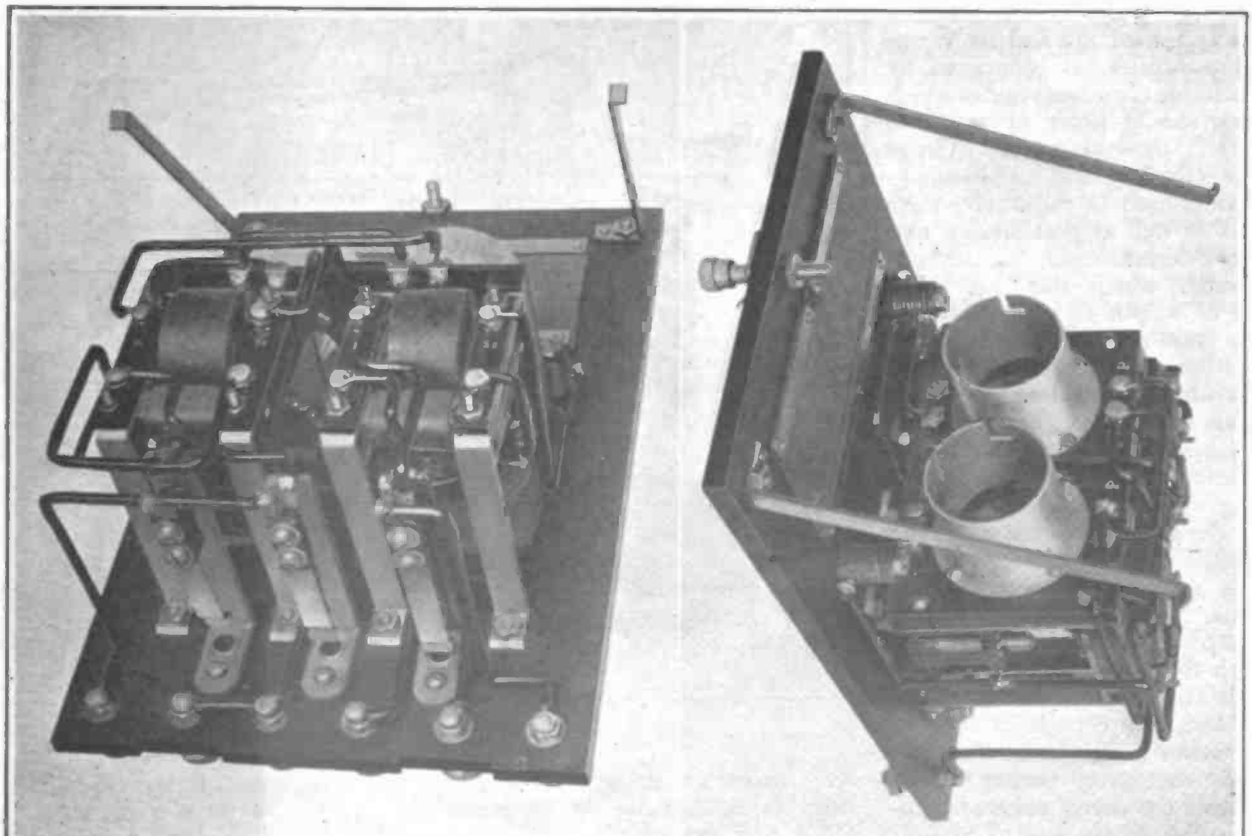
The rear views, with the panel removed from the case, show the very compact arrangement of the apparatus. Four U-shaped brackets hold the transformers and tube sockets. This type of mounting has not been used extensively by experimenters, although it is readily adaptable to the compact design of all kinds of instruments. A bakelite plate on the upper legs of the brackets carry the sockets.

Between the upright parts are two Navy type rheostats, just visible in the side view. A dead point is left on each rheostat so that the corresponding tube circuit can be opened. This is accomplished by connecting the tubes in parallel, with a rheostat in series with each tube.

Small biasing resistances, to give negative grid potentials, are mounted just above the socket plate.

The phone jacks are clearly shown. The first is of the open circuit type. Therefore, as long as the plug is not inserted, the plate circuit of the detector goes directly to the grid or input circuit of the first stage. The second and third, however, are of the closed circuit type. The plate circuits are closed through the jacks, when the plug is removed, or the telephones placed in series with the plate when the jack is inserted.

(Continued on page 158)



A close examination of these illustrations will reveal a number of ideas which experimenters can incorporate in their own equipment

Quenched Gap Operation

An Explanation of the Construction and Use of the Amrad Gap for 200-meter Transmitters

By H. J. Tyzzer

THE writer was once questioned by a puzzled father as to why radio should hold such a fascination for his son as to occupy all his spare time.

The question was certainly a sticker for, while the writer could readily sympathize with the youthful enthusiast, being in a similar state himself, he had not, at that time, analyzed his own feelings sufficiently to give a satisfactory answer.

There is but one thing that will keep the human mind concentrated on a single subject and that is to have that subject constantly presenting new problems or novelties which demand thought and attention. Radio is far from being a cut-and-dried art and its variation of possibilities, as influenced by the innumerable conditions under which it is used, should prove attractive to any person possessing an average amount of curiosity and ambition.

All devices used in radio have their limitations as well as possibilities, and depend to a certain extent on the conditions under which they are used. Each one to be put to best advantage must be studied, its requirements noted, and favored as much as possible. To show the importance of this, imagine an enterprising amateur who has purchased an audion detector to replace the crystal formerly employed. Not being well acquainted with the operating characteristics of the vacuum tube, possibly he fails to supply sufficient plate voltage to obtain satisfactory results. Were it not for the fact that perhaps a friend has a similar tube which does remarkable work, he would, in all probability, regret his purchase and revert back to the old crystal detector. Such instances prove conclusively that every person who is contemplating the use of some new apparatus should, to be fair to himself and to the new device, extend every effort to obtain facts concerning it.

In these days of QRM, anything which tends to lead to selectivity of reception or transmission is certainly welcome to the average amateur. Receivers of the loose coupled and regenerative types have assisted considerably in solving this problem but when several stations within a few miles' radius persist in using transmitters having a decrement of ——— (no decremeter manufactured reads high enough to obtain this value), these are of little avail. In vain we attempt to persuade them to loosen up the coupling of their transmitters but it is more or less difficult to give a comprehensive reason for doing so when it results in a decrease in radiation of about fifty per cent.

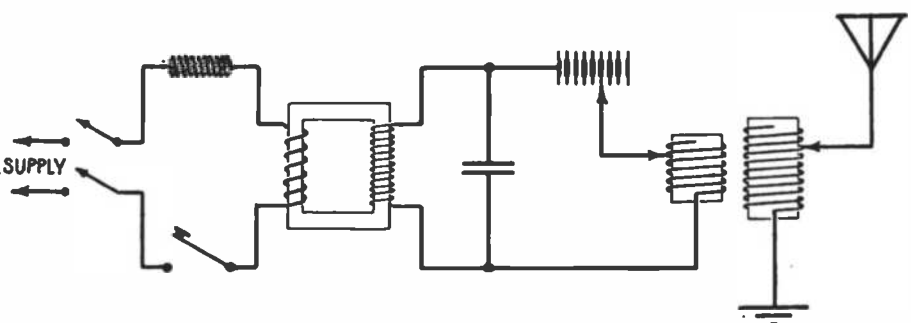


Fig. 1. Circuit for the quenched gap transmitter

For some time rotary gap transmitters have proved most effective for amateur use but that does not necessarily mean that they could not be replaced by something better. For instance, there are comparatively few rotary gap installations in commercial service at the present time, because Radio Inspectors have enforced the government regulation limiting the decrement to 0.2. This low value can only be obtained in case of a rotary or plain gap by employing exceedingly loose coupling which results in low radiation and efficiency. There is no question as to the merits of employing a low decrement as it results in greater selectivity together with longer distance transmission with a given power.

The association of 500 cycles with the quenched gap has led many people to believe that they are inseparable and hence the employment of a lower frequency has led to considerable skepticism on their part. However, 500-cycle transmitters were only adopted because their signals might be easily read and not because they were specially adapted to the quenched gap.

In such a transmitter there are 1,000-wave trains emitted from the antenna per second corresponding to a 1,000-spark note. It is evident that if the number of wave trains were decreased to 500 as by using a 250-cycle supply the energy per wave train will be doubled and, as the audibility at the re-

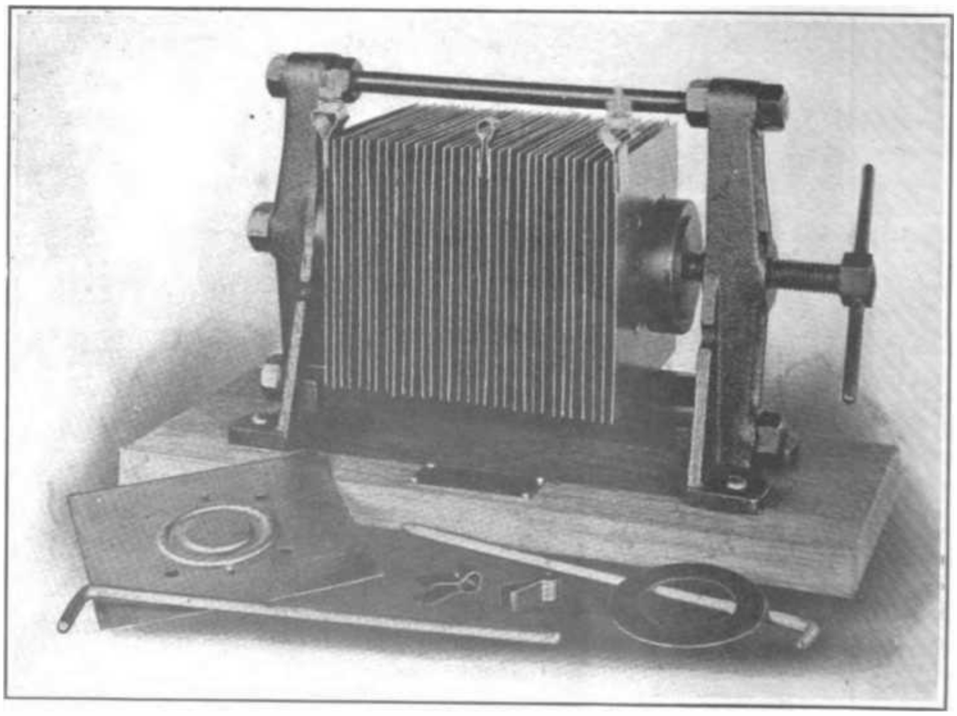


Fig. 2. The completed gap and a disassembled section

ceiver is dependent upon the amplitude of the wave train, the signals will be greatly increased. This shows the advantages of employing a 60-cycle rather than 500-cycle supply for long distance transmission, although in some cases this may be partially compensated by the fact that the receiving telephone diaphragms might operate more efficiently at the higher frequency.

There are certain requirements which must be met in successful operation of quenched gap transmitters, and it is desired to explain these in detail in order that the Amrad Quenched Gap, shown in the accompanying photographs, will meet with the success which it deserves.

Commercial transmitters make use in greater efficiency but reduces the possibility of an arc when the gap is broken down by acting as a high impedance choke, thus decreasing the secondary voltage. The power in watts consumed in such an equipment, neglecting transformer losses, is equal to CV^2N where C is the capacity employed, V the maximum or peak value of the secondary voltage and N the frequency of the A. C. supply. This is figured on the basis of one spark per alternation or two sparks per cycle, such as is ordinarily made use of in quenched spark transmitters. From this the amateur may readily figure the average value of the transformer secondary voltage necessary, which is

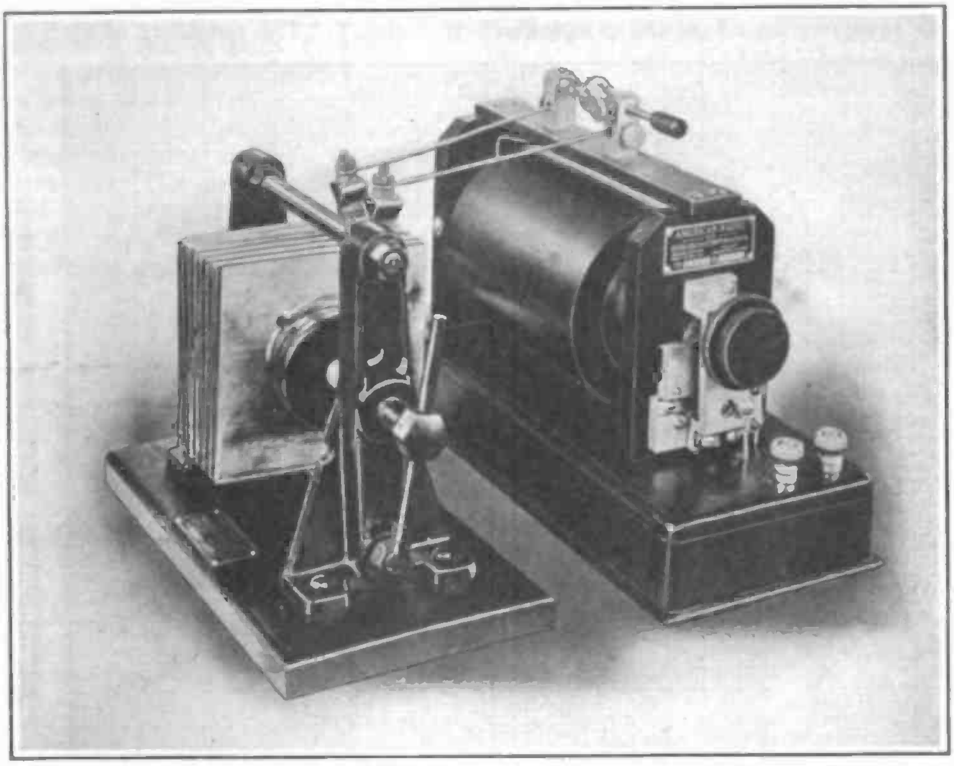


Fig. 3. A quenched spark gap for use with an induction coil

$$\frac{\sqrt{\frac{W}{CN}}}{1.41}$$

The result will probably be much higher than the voltage rating of some of the radio transformers now on the market, many of which were constructed for rotary gap use where the number of sparks is much greater than two per cycle. With such low voltage transformers the power consumed will be small when properly resonated and the primary inductance necessary for resonance must be much greater. In the event of insufficient primary inductance being present, there will be a tendency to crowd in several sparks per alternation, which results in an exceedingly mushy and uneven note, although the power consumed may be increased. This shows conclusively the necessity for the highest voltage transformers manufactured for radio purposes and now on the market.

of the phenomena of resonance to obtain satisfactory and efficient quenched gap operation.

Reference to Figure 1 will demonstrate clearly what is meant by this term. In alternating current circuits the current may lead the voltage or lag behind it, depending upon whether the capacity or inductive reactance predominates. It is desirable from the standpoint of best efficiency to have these values equal. If the step-up transformer shown in Fig. 1 is of the non-leakage type, a condenser shunted across the secondary leads will have the same effect upon the supply line as a much larger capacity, depending upon the primary and secondary turn ratio, replacing the transformer.

It may readily be seen then that by inserting a variable inductive reactance in series with the primary of the transformer a condition of resonance may be secured. This not only results

The major difficulty encountered by amateurs employing the Amrad quenched gap has been in obtaining resonance, due to the variety of transformers used. Because of the complications from the use of a primary inductive reactance, the manufacturers of this gap have recommended the use of a variable resistance as an alternative. Although this latter method is not as efficient as employing an inductive reactance, due to heat loss, it gives the necessary falling characteristic to the transformer and if a sufficient amount is used it prevents arcing. As in the case of the reactance the less the transformer voltage the more resistance is necessary and the lower the efficiency.

Amateurs familiar with alternating current circuits and having the necessary equipment may be able to operate their transformers successfully at resonance but unless this is true the use of a primary resistance is recommended, the value of which may best be determined experimentally as it varies with the type and voltage of the transformer employed.

The radio circuits are much the same with the quenched as with the rotary and plain gaps with the exception of the coupling which is sharply defined. An ammeter in the antenna circuit is quite sufficient for indicating when the primary and secondary circuits are in resonance, but if the effectiveness of the quenched gap is to be compared with some other it is urged that a sensitive meter, placed in a tuned circuit and coupled to the antenna, be used. This latter method is the true way of determining the effectiveness of the transmitter as it discriminates between a high and low decrement.

The quenched gap is particularly well adapted for use with induction coils which supply a peaked secondary voltage wave, thus eliminating the possibilities of arcing. The use, or rather misuse, of induction coils for transmitters, with the high decrement which has caused them to be such a source of Q R M, has caused much prejudice against their use. However, when used with an oscillation transformer and properly tuned, remarkable results may be obtained from them. For the amateur who has no A. C. supply and must use batteries, they offer the only solution to the transmitting problem.

The induction coil illustrated in Fig. 3 in similar to those supplied to the United States Army Signal Corps for trench warfare. These proved very effective for use on the European battlefields and often formed the only means of communication between advancing troops and headquarters.

It has been the custom of amateurs and manufacturers to rate induction

(*Continued on page* 158)

The Measurement of High Frequency Resistance

Part I. The Effects of High Frequency Resistance, and a Comparison of Different Types of Windings.

By L. M. Clement

THE resistance of the coils and condensers which make up the radio frequency circuits of transmitting and receiving radio apparatus plays an important part in the operation of the apparatus as a whole. The resonance curve of a circuit was taken, Fig. 1, with various values of series resistance in order to show what effect this resistance has on the operation of the circuit. The tuning of the circuit is made less sharp by the addition of resistance and the circulating current is reduced for the same total amount of energy in the circuit. In radio apparatus, therefore, where it is desired to obtain sharp tuning, the resistance of the circuit should be kept low. In radio transmitters it is essential that the resistance be kept low in order to keep the losses in the circuit to a minimum. If this is to be done we must know something about the resistance of the component parts of our radio frequency circuits.

It is the purpose of this article, therefore, to describe some means for obtaining the values of the radio frequency resistances of coils and condensers and particularly a method which almost every experiment can use.

Many attempts have been made to calculate the effective resistance of straight conductors at radio frequencies with a considerable degree of success. Unfortunately, however, when this wire is wound in the form of a coil, the resistance based on the calculation for a straight wire is useless so that it is necessary to go to some method of measurement.

The total resistance of a coil is the sum of a number of component resistances which result from the following causes:

1. D.C. resistance of the wire.
2. Skin effect at High Frequencies.
3. Eddy current losses in the conductors.
4. Eddy current losses in material in the magnetic field of the winding.
5. Loss due to the effect of distributed capacity of the coil. This is maximum at the natural period of the coil.
6. Losses in dielectrics in the electrostatic field of the coil.

In order to illustrate the effect of different types of coil construction on the resistance of the wire at radio frequencies seven coils were made up having the dimensions and constants shown in Table 1. The resistance of each of these coils for wave lengths between four hundred and two thousand meters was measured. The results of these measurements are plotted on curves which show the radio frequency resistance and the ratio of radio to direct current resistance for various wave lengths, Figs. 2 and 3.

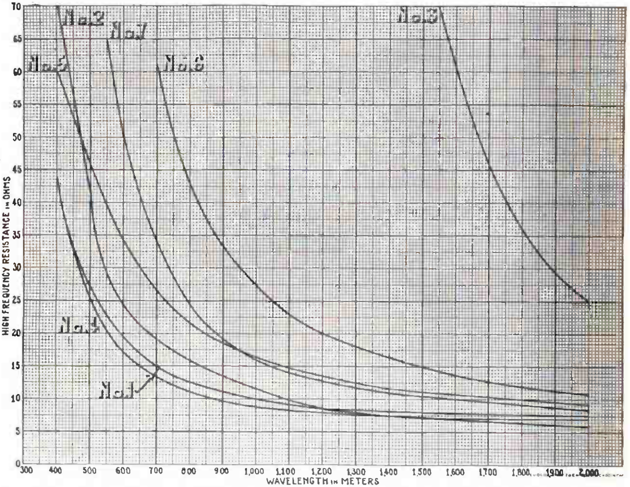


Fig. 2. High frequency resistance of 1 millihenry coils of different types. No. 1, single layer, 10-No. 38; No. 2, single layer, No. 26 D.S.C.; No. 3, double layer, 10-No. 38; No. 4, two-bank winding, 10-No. 38; No. 5, two-bank winding, No. 26 D.S.C.; No. 6, concentrated coil, 10-No. 38; No. 7, basket weave, 10-No. 38

It is evident that at the lower wave lengths the single layer or double banked wound coil using ten strands of No. 38 B.E.C. wire is the best. (Coils

No. 1 and No. 4). The two-layer coil, because of the high capacity between layers, has a higher natural period than any of the others measured and should never be used in radio frequency circuits. The effective resistance of this coil is by far the highest of the coils measured.

The increase of the high frequency resistance due to skin effect or the tendency of the radio frequency currents to travel in a thin layer on the surface of the conductor is illustrated strikingly by the results obtained on coils 1 and 4 and 2 and 5.

Coils 1 and 4 are wound with 10 strands of No. 38 B.E.C. wire and have a smaller cross section of copper, as shown by the higher D.C. resistance, than coils 2 and 5, which are wound with solid No. 26 D. S. C. wire.

At the longer wave lengths coil 2 is of lower resistance than coil 1, but at the shorter wave lengths, due to eddy currents in the conductor, coils 1 and 4 have much less resistance than coils 2 and 5. The eddy currents are reduced by the stranding of the conductor and insulating each of the strands from the

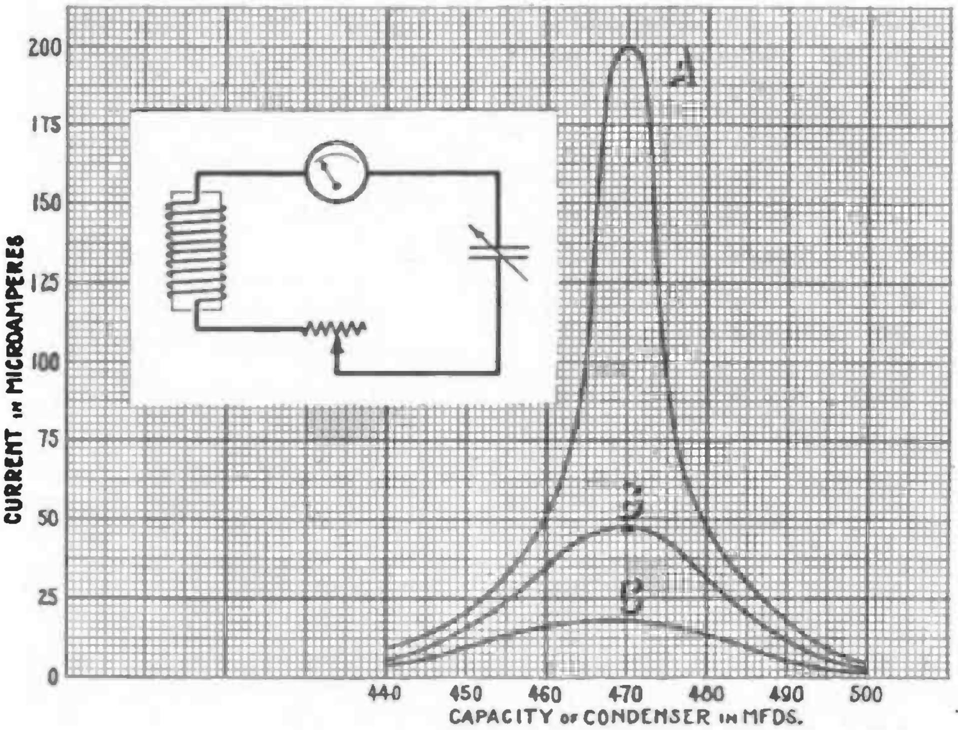


Fig. 1. At A, 4 ohms resistance are inserted; B, 8 ohms; C, 15 ohms

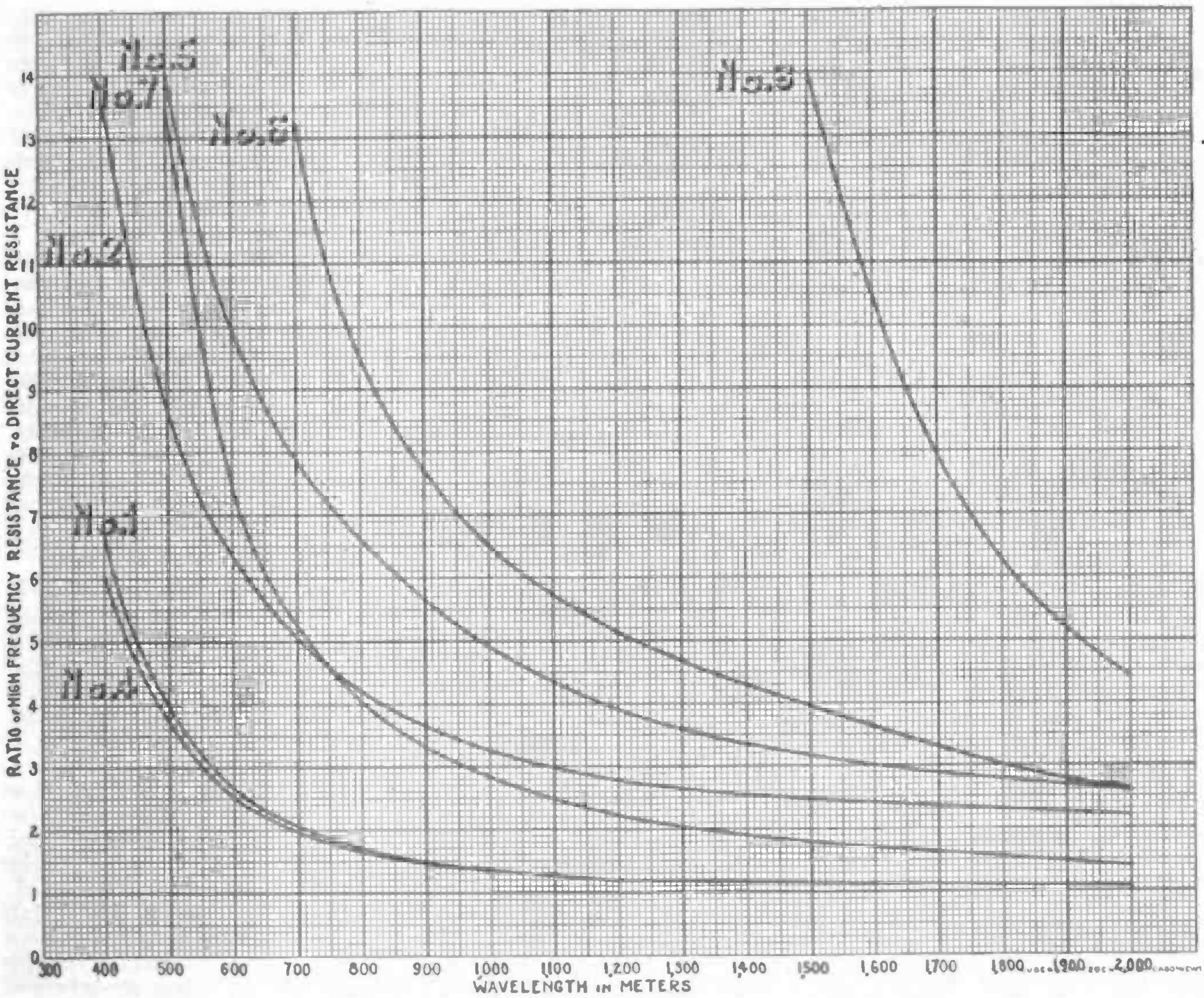


Fig. 3. These curves show how much greater is the resistance of a coil to high frequencies than to direct current. At frequencies greater than 2,000 meters, which corresponds to 150,000 cycles, the high frequency resistance drops still lower, approaching the direct current resistance. The results shown here and in Fig. 1 are convincing arguments in favor of stranded conductors

others. The 1 m.h. concentrated and pancake coils, while not as good as the single layer solenoids, can be used in special cases more or less satisfactorily at wave lengths above 1200 meters.

The conclusions drawn from these results should not be applied to coils of other electrical or geometrical dimensions, as in all probability they would not hold. It is therefore necessary to investigate each series of coils from actual measurements and tests made on them under the actual operating conditions. In general that coil is the best whose ratio of high frequency resistance to D.C. resistance approaches nearest to unity. See coils 1 and 4, Fig. 5.

The continuation of this article will take up some of the available methods for measuring the resistance of coils and condensers at radio frequencies, and in particular a method by which the amateur can make measurements with apparatus generally found in an amateur laboratory.

TABLE 1

TABLE GIVING THE DIMENSIONS OF THE COILS USED IN THE TESTS

Type and Number of Coil	*Wire Used*	*Length of Winding*	*Depth of Winding*	*Mean Dia.*	*Total No. of Turns*	*Direct Current Resistance*
1. Single Layer Coil	10 Strands No. 38..	2¼		3⅝"	106	7.23
2. Single Layer Coil	No. 26 D. S. C.....	2¼		3⅝"	106	4.20
3. Double Layer Coil	10 Strands No. 38..	⅞"		3⅝"	86	3.81
4. Double Banked Coil	10 Strands No. 38..	⅞"		3⅝"	86	6.53
5. Double Banked Coil	No. 26 D. S. C....	⅞"		3⅝"	86	3.42
6. Concentrated Winding	10 Strands No. 38..	.5	.3	.6	300	4.1
7. Basket Weave Coil	10 Strands No. 38..		.6	3.52	64	6.0

(To be concluded)

Determination of Distributed Capacity and Inductance of A Coil

ALL coils have a certain amount of distributed capacity which will resonate with the inductance of the coil at a wave length called the natural wave length of the coil. At all other wave lengths this capacity adds to the capacity of the condenser which is connected around the coil when resonance is obtained. L_u is the true inductance of the coil, C_u is the distributed capacity of the winding and C_v is the capacity of the shunt condenser to obtain resonance at the various wave lengths.

The wave length of the circuit at wave length λ is expressed by

$$\lambda = 59.6 \sqrt{L_u\ (C_u + C_v)} \quad (1)$$

At a wave length λ_1 the condenser reading will differ from C_v if L_u and C_u remain constant. Call this value of capacity C_{v1}

$$\lambda_1 = 59.6 \sqrt{L_u\ (C_u + C_{v1})} \quad (2)$$

From these two equations in two unknowns, L_u and C_u, we can obtain the solutions for the inductance and the distributed capacity of the coil as follows:

Dividing 1 by 2 eliminating L_u, we have

$$\frac{\lambda_1^2}{\lambda^2} = \frac{C_u + C_{v1}}{C_u + C_v} \quad (3)$$

Solving for C_u

$$\lambda^2 C_u + \lambda^2 C_{v1} = \lambda^2_1\ C_u + \lambda^2_1 C_v$$

from which

$$\lambda^2 C_u - \lambda^2_1 C_u = \lambda^2_1\ C_v - \lambda^2 C_{v1}$$

$$C_u = \frac{\lambda^2_1\ C_v - \lambda^2 C_{v1}}{\lambda^2 \quad - \lambda_1^2} \quad (4)$$

Substituting the value of C_u in either equation (1) or (2) and solving for L_u, we find

$$L_u = \frac{\lambda^2 - \lambda_1^2}{3552\ (C_u + C_v)}$$

The following table indicates one of the many ways in which data of this sort can be tabulated and shows a typical example of a calculation of distributed capacity and inductance of a coil from two of the observations.

TABLE 2

TYPICAL SET OF DATA AND CALCULATION OF L_u AND C_u

Observation Number	*Wave Length in Meters*	*Capacity Necessary for Resonance Mfds.*	*Resistance in Ohms*
1	600	.00091	5
2	800	.000170	4.2
3	1000	.000271	4.1
4	1200	.000395	4.0

Distributed Capacity of Coil

Let $\lambda = 600 \qquad C_v = .000091$

$\lambda_1 = 1200 \qquad C_{v1} = .000395$

then $C_u =$

$$\frac{(1200^2 \times .000091) - (600^2 \times .000395)}{600^2 - 1{,}200^2}$$

$$= \frac{-\ .001114}{-1.08}$$

$= .0000103$ Mfd. distributed capacity.

From this it can be seen that the inductance of a coil cannot be measured accurately by the wavemeter method. Readings taken in this way are high, because no account is made of the capacity of the coil.

A TWO-STAGE AMPLIFIER

(*Continued from page* 153)

All the wiring is done with heavy solid copper wire, covered with Empire cloth tubing. The neatness of the soldered joints can be observed from the illustrations. Experimenters who have difficulty in making smooth and regular joints where wires are fastened around screws will find that, if they file or sandpaper both parts, and make the soldering iron very hot, this difficulty will be overcome. A soft, long-haired brush is excellent for removing filings or soldering paste which may collect in the corners of the parts.

QUENCHED GAP OPERATION

(*Continued from page* 155)

coils by the length of the secondary spark, not watts input, and under this category it may be classed as a two-inch coil. The frequency, approximately 100 cycles, while not high, is easily readable. A study of the engineering problems encountered in spark coil design will reveal the reason for this when it is realized that a high frequency two-inch coil necessitates a low inductance primary. Such a primary would consist of but few turns, which means so high an input current as to make its use prohibitive to the average amateur employing a battery supply.

An exceedingly rugged vibrator with large and ample contacts is supplied with the coil which ensures long life and permanent satisfaction. The coil is manufactured in two types, Type C being wound for a six volt battery supply and Type C-1 for a 32 volt D. C. source such as is often furnished with farm lighting outfits.

This coil and the quenched gap shown in the photograph provide an admirable equipment for amateurs. Its range is comparable with many transformer transmitters and it is particularly adapted to motor car, camp, and other use where a course of alternating current is not available.

FOREIGN RADIO ACTIVITIES

COMMERCIAL radio systems have been expanding rapidly in the European countries. A commission of Danish experts is now in the United States, making arrangements for direct communication between this country and a station to be erected at Copenhagen. Traffic is now carried on with the Norwegian station near Stavanger.

Successful radio telephone trials have been carried out from Chelmsford, England, up to a distance of 1,000 miles at sea, and to Rome, Italy.

The German Government has erected a station at Dortmund. Telephone experiments have been made between Berlin and Karlsborg, Sweden, and between Berlin and Moscow, with the view of maintaining regular service.

High Inductance Variometers

A Method for Making Variometer Windings of Very Slight Clearance

THE variation of inductance in a variometer composed of two coupled coils in series is due to the change of the mutual inductance between them, according to the formula

$$L = L_1 + L_2 + 2M$$

or $$L = L_1 + L_2 - 2M$$

where L = total inductance,
L_1 - inductance of one coil,
L_2 = inductance of other coil,
and M = mutual inductance, all measured in the same units.

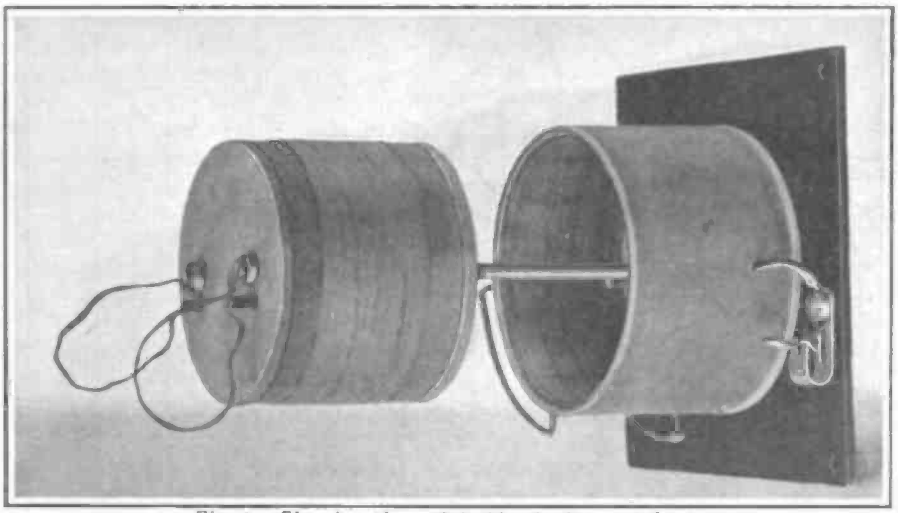


Fig. 1. Showing the coil inside the larger tube

To obtain the largest maximum value of M, the coils must be very close together. For this reason, the ball type of variometer is widely used, since at maximum, the coils can be made quite near each other.

This method of constructing a varometer, has limitations, however, in that only a small amount of inductance can be used in each coil, unless the windings are made of very large diameter. The type shown in Figs. 1 and 2 is adaptable for coils of high inductance, and the windings can be made as close as with the ball method. Moreover, the design is simple and inexpensive.

The only disadvantage is that the coils cannot be changed from opposing to aiding as is the case with the ball type. A switch is needed for the variometer described here, to reverse the connections of one coil to give positive or negative values of 2M.

An outstanding feature of this instrument is that one coil is wound on a cardboard tube, while the other is on the inside of a tube. For this particular instrument, two-bank windings of No. 26 S. S. C. wire were employed.

It was was easy enough to wind the smaller coil and to fit wooden end pieces on the tubing. The larger coil was the real problem. Here is the method:

A 3-in. tube was used for the smaller coil. To wind the other, a piece of 3-in. tubing was cut to a length slightly greater than that of the proposed coil. First, the tubing was slitted down its length with a sharp knife. Then a piece of cardboard 1/16 inch thick was wrapped once around the tube. This was covered by one wrapping of thin paper. Several turns of threads were put around the paper to keep it in place.

All this accomplished, the coil was wound on. The cardboard acted as a spacer to make the inside of this coil slightly larger than the outside of the other.

When the coil was done, a pot of beeswax was heated to the boiling point, and, with a paint brush, a very thin coating of wax was brushed over the coil. After cooling, the inside slitted tube was carefully removed, then the cardboard, and, finally, the thin paper was drawn out, leaving a self-supporting winding held together with wax.

This was by no means the end of the work. Attempts to push the coil inside another tube failed, for the wires were loosened. Ultimately a tube 3½ ins. in diameter was slotted and enough cut off, lengthwise, so that, when the tube was pressed around the coil, the tubing closed exactly.

To keep the tubing together, a wooden disc was turned up to fit inside the tube, and the tube was nailed to the disc with small brass escutcheon pins. As a finishing touch the completed coil was held in the heat of a gas burner just long enough to warm the beeswax, but not melt it, causing the wax to adhere to the tubing.

Figs. 1 and 2 show the variometer mounted on a 5x5 in. bakelite panel, ready for use. It can be seen that the movable coil slides on two brass rods, held to the panel by nuts. A third rod, carrying a handle, serves to move the smaller coil in and out.

This method of mounting is also good for any sort of coupling coils, tho, in the case of primary-secondary or secondary-tickler coupling, it is not necessary to have such a small clearance between the windings. A particular advantage is that this method of mounting takes up very little panel space for the large inductance obtained.

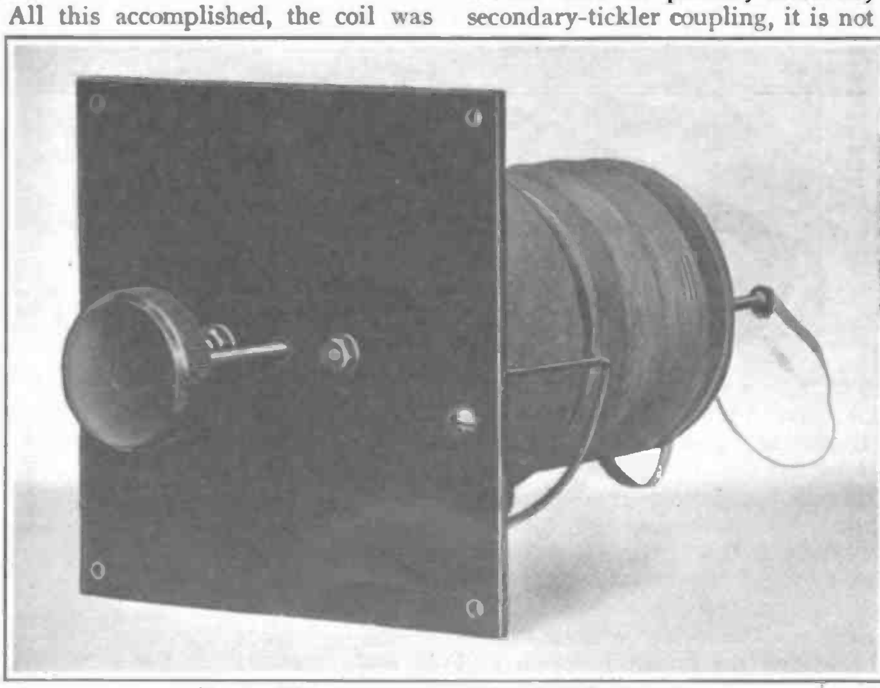


Fig. 2. The variometer completed, ready for use

Radio Tuning Circuits

The Radio Man Thinks in Terms of Wavelengh; the Electrical Man, in Reactance. This Article Discusses Radio Circuits From the Latter Aspect

NEARLY all radio experimenters take up wireless work because it is interesting and gives them something to do. And most of them stop with wireless, thinking that the electrical considerations are too dry and uninteresting.

Since electrical engineering forms the basis of all radio work, the experimenter must have some knowledge of the former to be profficient in the latter. Moreover, an understanding of the electrical side makes radio problems more interesting.

This is particularly true of tuning circuits. The radio man says, "Resonance is obtained when two circuits are tuned to the same wavelength." The electrical man says, "Resonance is obtained when the reactance is zero."

Thereupon the former looks puzzled and asks, "what do you mean by reactance?"

Let us start at the beginning. In all radio tuning circuits, only alternating currents and voltages are considered. Fig. 1 shows an alternating current, I, and a voltage, E, changing at the rate of one complete cycle per second. The current and voltage are said to be in phase, because they reach the zero and maximum points simultaneously.

A cycle can be divided into so many parts of a second, or, as is more usual, 360 degrees, as is a circle.

The values of the current and voltage, during the complete cycle, are given by the table below:

Degrees	Seconds	Current	Voltage
0	0	0.0	0.0
30	2/24	+1.0	+2.0
60	4/24	+1.7	+3.5
90	6/24	+2.0	+4.0
120	8/24	+1.7	+3.5
150	10/24	+1.0	+2.0
180	12/24	0.0	0.0
210	14/24	—1.0	—2.0
240	16/24	—1.7	—3.5
270	18/24	—2.0	—4.0
300	20/24	—1.7	—3.5
330	22/24	—1.0	—2.0
360	24/24	0.0	0.0

The power in Watts is given by

$$W = E\,I \qquad (1)$$

where E = potential in volts,
W = power in watts,
and I = current in amperes,

whether direct or alternating current is employed. Since the alternating current is varying continuously, the watts at any instant are as shown below. It should be noted that, in multiplying the amperage by the voltage, the product of two negative quantities is a positive quantity.

Degrees	E		I		W
0..........	0.0	x	0.0	=	0.0
30..........	+2.0	x	+1.0	=	+2.0
60..........	+3.5	x	+1.7	=	+5.9
90..........	+4.0	x	+2.0	=	+8.0
120..........	+3.5	x	+1.7	=	+5.9
150..........	+2.0	x	+1.0	=	+2.0
180..........	0.0	x	0.0	=	0.0
210..........	—2.0	x	—1.0	=	+2.0
240..........	—3.5	x	—1.7	=	+5.9
270..........	—4.0	x	—2.0	=	+8.0
300..........	—3.5	x	—1.7	=	+5.9
330..........	—2.0	x	—1.0	=	+2.0
360..........	0.0	x	0.0	=	0.0

The effective value of the current and voltage, that is, the value indicated by an ammeter or volt meter, is

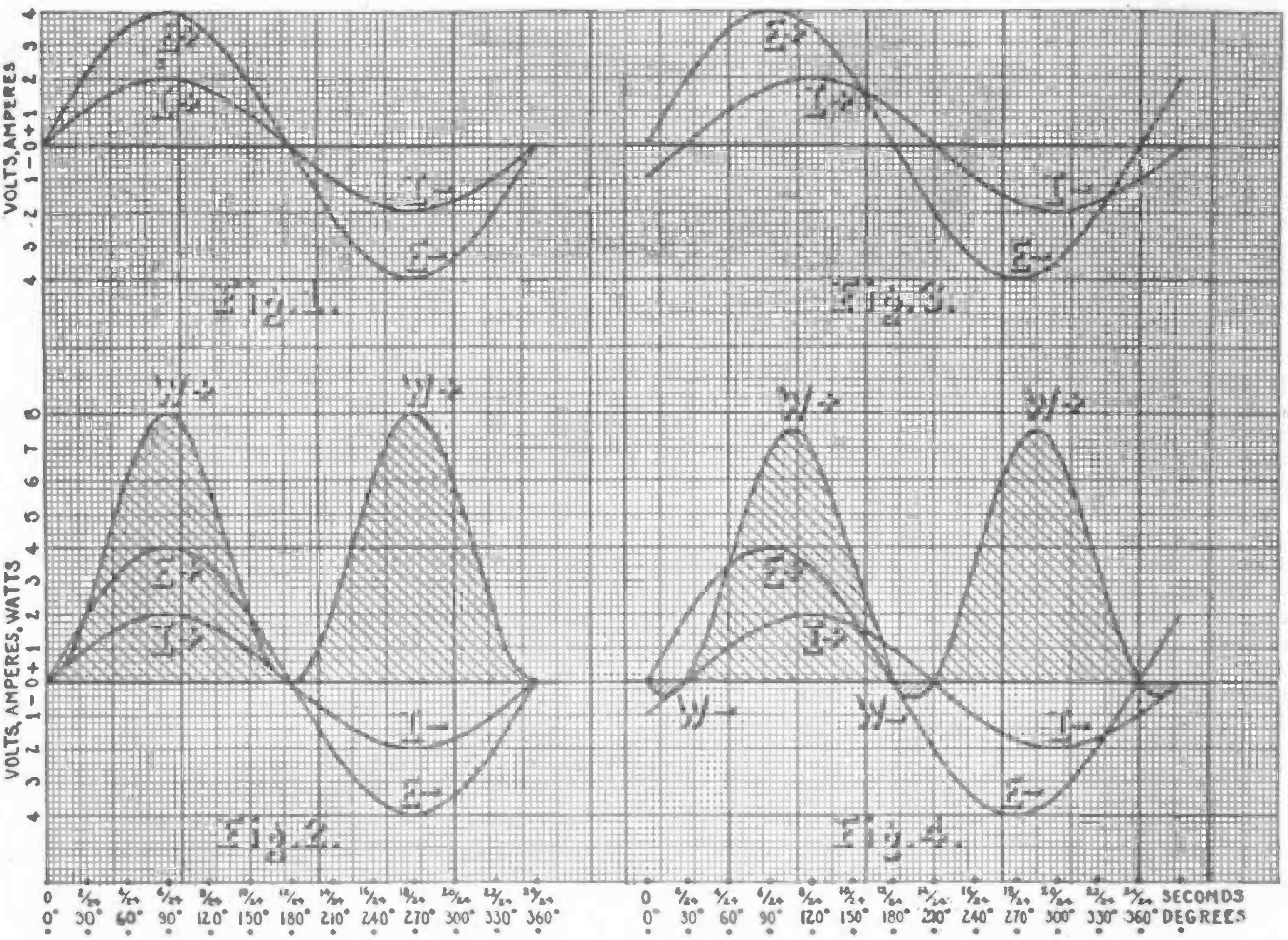
$$E_{eff.} = 0.707E \qquad (2)$$

where $E_{eff.}$ = effective voltage
and E = maximum value

or

$$I_{eff.} = 0.707I \qquad (3)$$

where $I_{eff.}$ = effective current
and I = maximum value



Illustrating the loss of power when the current and voltage are not in phase, due to the unbalancing of inductive and capacity reactance

Therefore, the effective voltage in Fig. 1 is
$E_{eff.} = 0.707 \times 4 = 2.8$ volts effective,
and the effective current is
$I_{eff.} = 0.707 \times 2 = 1.4$ amp. effective.
The effective power, in watts, is
$$W_{eff.} = E_{eff.} \times I_{eff.} \quad (4)$$
or $W_{eff.} = 2.8 \times 1.4 = 3.9$ watts effective.

It may appear as if the foregoing has nothing to do with radio tuning circuits, but what is to follow is based on Figs. 1 and 2.

Fig. 3 presents a new problem. It will be seen that the current and voltage are not in phase, that is, at some instants, one is positive when the other is negative. This is one of the effects which we know occurs, even though we have not actually seen the electricity itself do that way.

If an alternating current, taken, perhaps, from a vacuum tube oscillator, is put through a carbon resistance rod it will obey Ohm's Law, which is
$$E_{eff.} = I_{eff.} \times R \quad (5)$$
where R = resistance in ohms.

In a radio circuit, however, there are, in addition to the resistance of the wires, inductance and capacity. These also act as resistances. Resistance due to inductance or capacity is spoken of as reactance. Resistance or reactance indicate an absorption of power, for work must be done in overcoming them.

Losses in pure resistance are dissipated in heat. Reactance losses are indicated in Figs. 3 and 4. When the current I is zero, the voltage E has passed through 30° of its cycle. In other words, the voltage is leading the current.

When the reactance due to capacity is greater than the inductive reactance, the voltage leads the current, or when the inductive reactance is greater, the current leads the voltage.

Let us make another table to determine the power when the current and voltage are not in phase, as in Fig. 3.

Degrees	E		I		W
0	0.0	x	—1.0	=	0.0
30	+2.0	x	0.0	=	0.0
60	+3.5	x	+1.0	=	+3.5
90	+4.0	x	+1.7	=	+6.8
120	+3.5	x	+2.0	=	+7.0
150	+2.0	x	+1.7	=	+3.4
180	0.0	x	+1.0	=	0.0
210	—2.0	x	0.0	=	0.0
240	—3.5	x	—1.0	=	+3.5
270	—4.0	x	—1.7	=	+6.8
300	—3.5	x	—2.0	=	+7.0
330	—2.0	x	—1.7	=	+3.4
360	0.0	x	—1.0	=	0.0

This table is plotted in Fig. 4, the shaded portion of which represents the watts. The area of the W+ sections are smaller than in Fig. 2, where the current and voltage are in phase. There is a small area, W—, in Fig. 4 which accounts for the lost power. This occurs when the current and voltage have opposite signs, for a positive quantity multiplied by a negative gives a negative quantity.

As the difference in phase is made greater, the power loss increase until the current and voltage are 180° apart. Then the watts at any instant have a negative value. This is called a wattless current, for, while a voltmeter and ammeter would show the passage of electricity, the current would perform no work.

The reactance due to inductance in a circuit is
$$X_l = 2\pi f L \quad (5)$$
where
X_l = inductive reactance, in ohms,
$\pi = 3.1416$,
f = frequency, in cycles,
and L = inductance in henries.
1 cm. = 0.000000001 henry.
1 mh. = 0.000001 henry.

Capacity reactance is given by the formula.
$$X_c = \frac{1}{2\pi f C} \quad (6)$$
where
X_c = capacity reactance, in ohms,
and C = capacity in farads,
1 mfd. = 0.000001 farad.

The formular for impedance, which includes the pure resistance and the reactance is
$$Z = \sqrt{R^2 + (X_l - X_c)^2} \quad (7)$$
where Z = impedance in ohms.
If the capacity reactance is greater than the inductive reactance, the latter is subtracted from the former.

Thus it will be seen that if the reactance is made zero by balancing X_l and X_c, then the only opposition to the flow of the alternating current is pure resistance, no power is lost in overcoming reactance, and the current and voltage are in phase.

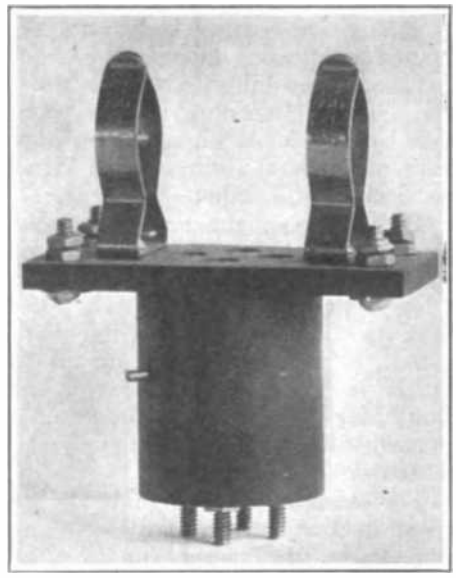
This is shown by the formula
$$\cos \Phi = \frac{R}{Z} \quad (8)$$
where Φ = difference in phase of current and voltage, in degrees.
If there is no reactance in the circuit, from (7) it will be seen that Z = R. Then (8) will read
$$\cos \Phi = \frac{R}{R} = 1,$$
and, as shown by a cosine table, Cos 0° = 1. Therefore, there is no lag between the current and voltage.

(To be continued)

A TUBULAR AUDION ADAPTER

An interesting socket adapter has been introduced by the International Electric Company. In contrast to other types, the arrangement is such that the axis of the tube is at right angles to that of the socket.

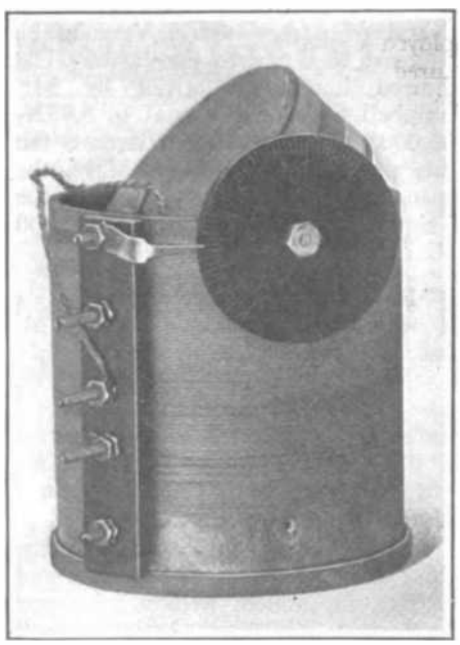
The fibre plate which carries the audion clips also has four binding posts to which connections are made from the tube. These posts are, in turn, joined to four pins which make contact with the springs in the socket. Thus a tubular bulb can be used with a regular VT socket.



Such an adapter is particularly good for apparatus where the tube protrudes from the panel, as is the case with International Radio and de Forest unit panel instruments.

OSCILLATOR COUPLING COIL

An instrument such as is shown here is useful in oscillating circuits, as well as for other purposes. This coil was designed for coupling a test circuit, in series with the small coil, to an oscillator, of which the longer coil was the inductance.



The vertical bakelite strip has five binding posts, two of which are connected by flexible leads to the rotating coil. The others serve as connections to the ends and center tap of the large winding.

The Radio Department

IT may appear to be a reflection on the intelligence of radio men to bring up here the subject of Martian signals, the possibility of which has been brought to the attention of the public through newspaper statements attributed to Marconi, though he has denied the responsibility for them. However, some interesting points were made by Mr. A. A. Campbell Swinton in his presidential address to the Wireless Society of London.

"Perhaps is might be pointed out with advantage that the intensity of received signals varies inversely more or less as the square of the distance between the source and point of reception, so that, if we suppose the mysterious signals in question originate on the planet Mars, the power of the sending apparatus must be of prodigious dimensions.

"For example, if the signals are received in London as loudly as those from Paris, the power employed at Mars must be greater than that used at Paris, in the proportion of the square of 200, the rough distance of 49,000,000, the distance in miles to Mars.

"The power employed at Paris is about 200 horsepower, so that, unless the inhabitants of Mars have improved methods of directional sending greatly surpassing our own, the power used on Mars to give equal effects at London must be about 60,000,000,000 times greater than at Paris, or say 12,000,000,000,000 horsepower."

While the circumstances might be such that this power could be reduced greatly, it is obvious that an impossible amount of energy would have to be employed to signal to the earth. The required horsepower given by Mr. Campbell Swinton is equal to 8,952,000,000,000 kilowatts. If it costs ten cents per kilowatt-hour on Mars, the expense to the Martians for each hour of signaling would be 895,000,000,000 dollars.

THE vacuum tube situation, as was stated in the March, 1920, issue, is such a complex affair that is it almost impossible to pick out facts of importance to the experimenters. This is made doubly difficult by the legal definitions which have come to supplement and modify general technical understanding.

According to Judge Mayer, "An amplifier really consists of two or more detectors in tandem with a telephone transformer interposed between each element in series. The primary element of such an amplifier may be either an audion or any other form of a detector. . . . In other words, an 'amplifier' is part of a detector."

In regard to the Oscillion, the following statement is from Judge Mayer:

"While the claim covers broadly the device (Fleming valves) when used in the radio art, yet when read with the context of the specification, it is plain that Fleming's disclosure was addressed to the use of the instrumentality as a detector only.

"It is, however, a principle of patent law—so well settled as not to call for citations of authority—that a patentee is entitled to all of the benefits of his invention whether or not known to or foreseen by him.

"The testimony of the experts and numerous demonstrations in the court room... proved beyond a peradventure that the two element valve possesses inherently the same capacity for generating radio waves as is possessed by defendant's (de Forest's) three-element device."

In a demonstration, "The valve was made to oscillate without a condenser although the action in this regard is not certain and reliable; but, this latter fact is immaterial."

It is not generally known that a Fleming valve has been made to oscillate. This was done with a special gas tube, but further information concerning the means employed is not known.

The statement in the March issue, concerning the purchase of vacuum tubes, may have been misleading. To make it more clear— "Tubes not licensed under the Fleming patents can be used only for other than radio work or non-communication purpose, and then only when licensed by the de Forest Company for the use of the grid."

RADIO men, whether concerned with the commercial or experimental aspect of radio work, will be greatly pleased at the announcement, made by Dr. Goldsmith at the May meeting of the Institute of Radio Engineers, that the Department of Commerce, in its decisions regarding radio regulation and legislation, will be guided by a committee of twenty-eight radio engineers, of whom twenty-seven are members of the Institute, while the twenty-eighth man is about to become a member.

This means that the future control of radio has been put, not in the hands of uniformed men or in the military, but in a representative body of engineers who are entirely familiar with the problems involved, and personally interested in their most useful solution.

It was notable that, in the discussions by this committee, almost unanimous agreement was reached on the various subjects discussed. The decision to put the radio problem in the hands of such a committee, and the promise of successful results, lifts from the art the gathering cloud of Government monopoly.

TWO papers by Dr. Austin, of the Bureau of Standards, were read at the May meeting. The first was on the quantitative predetermination of loop antenna transmission and reception. These were checked by actual measurements made at the Bureau on signals from Arlington.

A point brought out, of special interest to experimenters, was that loop transmission and reception is very much more efficient at short wavelengths, in the neighborhood of 200 meters, than at the long waves. This was shown clearly in one of the tables accompanying the paper.

The second paper summed up the results of observations on static, showing the variations in audibility on different wavelengths over periods of twenty-four hours.

A striking feature of the curves shown was that a receiving set tuned to 15,000 to 20,000 responds several hundred times more loudly to the static than when it is adjusted to 200 meters. This accounts for the static interference during transatlantic communication.

This led to a discussion of the characteristics of the static discharge. Mr. Pickard maintained that the static is a critically damped impulse, and showed several slides illustrating results which were obtained from an artificial static producer. These checked with Dr. Austin's curves on the audibility of static at a receiver tuned to different wavelengths.

It may be added, for the benefit of those who are not members of the Institute, that copies of the Proceedings can be purchased from the Secretary, Institute of Radio Engineers, College of the City of New York, New York City. Application blanks for membership can also be obtained by writing to this address.

NEXT month, a heterodyne wavemeter for 150 to 20,000 meters will be described, with full details and illustrations of the apparatus. The instrument, under construction in EVERYDAY's laboratory, is nearly finished. An amplifying unit is also being made for the June issue. Both of these devices have much of interest for experimenters who make their own apparatus.

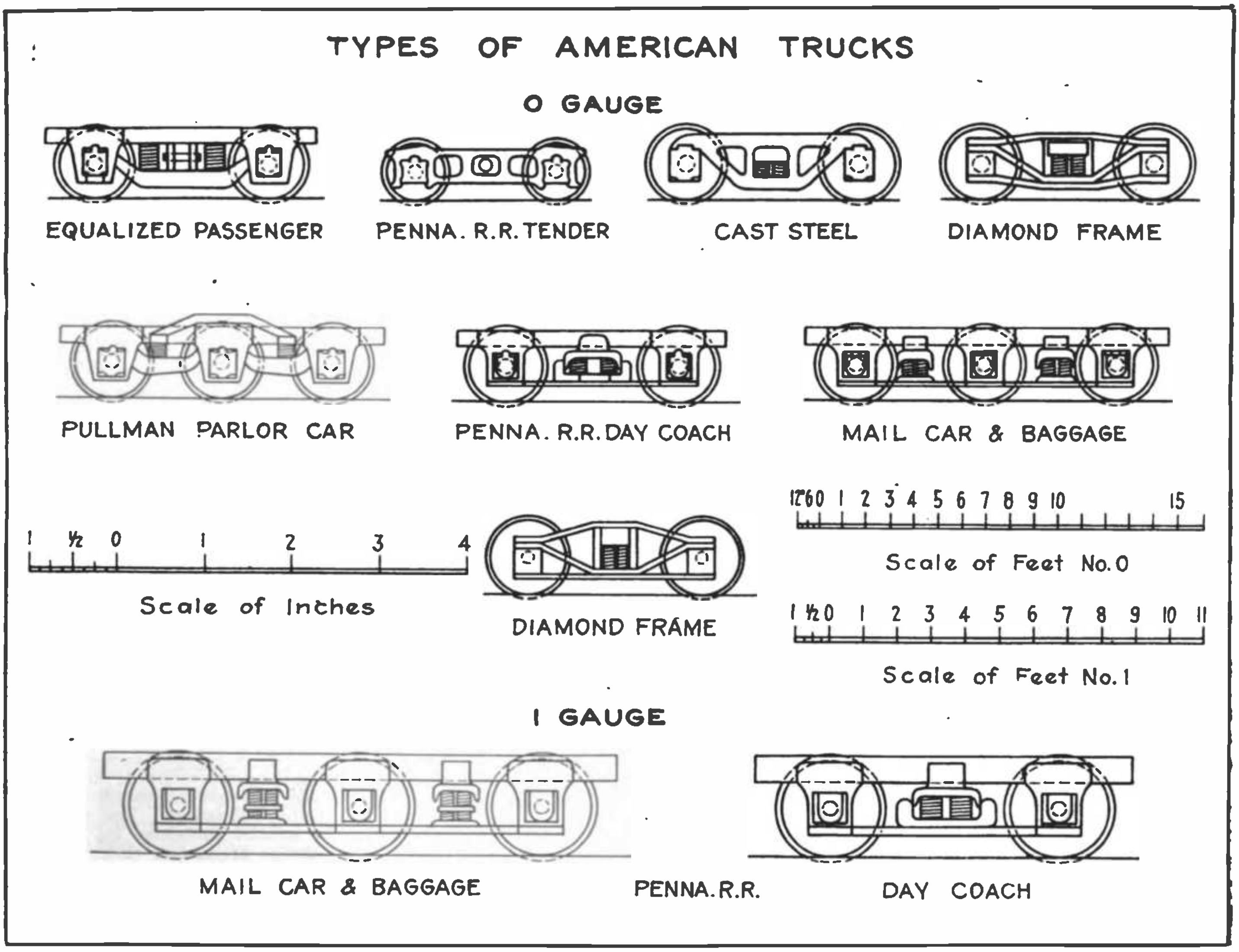
The article on the non-inductive resistance box has been postponed to accompany the conclusion of Mr. Clement's article on high frequency resistance measurements. In the June issue he will describe several circuits which can be used for this purpose, and one special method not disclosed before.

Several new instruments from the manufacturing companies will also be shown in the next number.

A Model Automobile

THE automobile shown in the illustration is one of the best pieces of model engineering that has come to our attention in some time. Not one of the constructional features of the little machine differs from those of its prototype. The characteristic lines of the body, which were designed after those of a well-known car, will be immediately recognized. Even the tires are included on the model and how the builder overcame this difficult problem is quite beyond the Editors of EVERYDAY unless he succeeded in inducing some of the large manufacturers to

make them especially for his use, which seems somewhat doubtful. The steering gear, headlights, windshield, fuel tank, upholstering, radiator wheels and dash are carried out with amazing detail, to say nothing of the smaller fitments. As far as can be learned, the little machine is not equipped with a workable gasoline motor. It appears that the constructor of the machine (who appears in the photograph) made the device to demonstrate a new automobile top of which he is the inventor. It will be seen that the top is not similar to the conventional type.



This chart, which shows the different types of American car trucks, was prepared by Mr. George Bender. It will be of great assistance to model engineers engaged in the construction of model railways

A Home-Made Hygroscope

By L. B. Robbins

ONE of the earliest forms of barometers consisted of a long piece of "gut" hanging vertically and held straight by a weight. This was called a hygroscope, and foretold weather changes by recording changes in atmospheric moisture. As the gut absorbed moisture its length varied and these variations indicated certain changes in the weather.

The apparatus herein described makes use of this principle inasmuch as the gut is used, but is arranged in such a way as to be in a convenient form and readily accessible. Only simple things are needed in its construction which can be found or made at any work bench.

First procure nine deep grooved spools about 2 in. in diameter. There are certain brands of high grade fish line, which come wound upon spools admirably suited to this purpose. Five are used for stationary pulleys and four for weighted ones. Mount four of them near the top edge of a base board 3 ft. 6 in. long by 2 ft. wide, setting them in a straight line allowing considerable more space at the left of the row than at the right. A screw eye takes the place of a fifth pulley at the left. Use long slender screws for the pulleys to rotate on and provide washers if the heads are too small to retain the spools upon them. One more pulley is mounted in a similar manner at the lower right hand corner of the base.

The four remaining pulleys are then provided with hangers made of sheet tin bent in the form of a U as shown in detail. Holes through the top of each leg take the axle of the pulley, which consists of a small bolt. A hole in the center at the bottom is for a wire by which 4 oz. weights are attached to each hanger. These weights are made by pouring moulten lead into small sand moulds, letting them solidify about a wire through their centers. Make a fifth weight for the dial.

Next, take about 32 ft. of ⅛-in. rawhide "gut" or belt lacing and weave it back and forth through the stationary and weighted pulleys as indicated. One end attaches to the screw-eye; the other passing under the lower pulley.

Cut out a cardboard dial 19 in. in diameter, and mark it out in degrees as shown, from 25 to 31. This is in imitation of the common barometric readings. Three lugs on the back of dial serve to fasten it to the cover on the base.

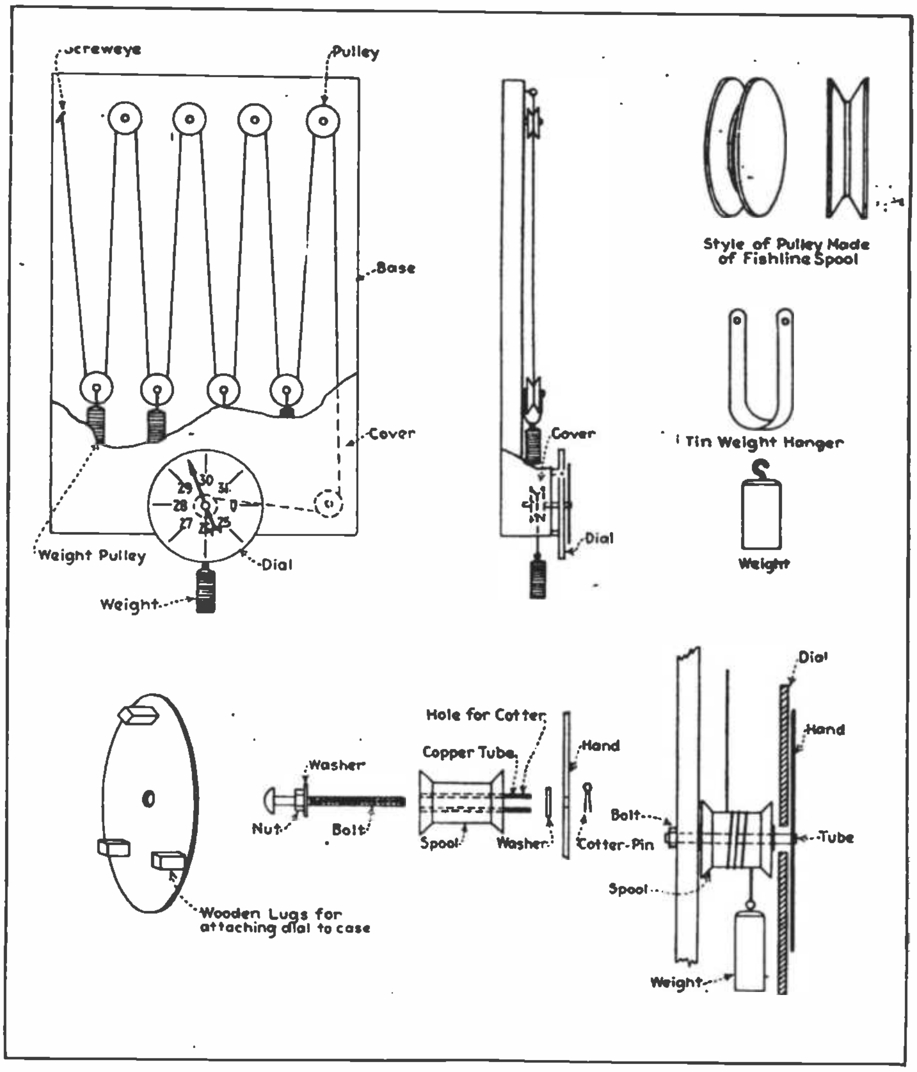
The dial drum is shown in detail and consists of a somewhat wider spool than the rest. A copper tube is driven through the hole and acts as a bearing which revolves upon a bolt projecting from the base. Wind several turns of the lower end of gut around this drum, hanging the extra weight from its end as shown.

When this is done and the gut is in place, fit a cover over the base to hide the entire workings. This can be held in place by screws or hooks so it can be easily removed if necessary. A hole should be provided in the cover to coincide with that in the center of the dial and allow the bearing of the drum to project through. Cut out a hand of thin metal and ream out a hole in the center to make a driving fit over the end of the bearing. A cotter pin can be used to hold the hand in place if desired.

Set the barometer on the wall in the desired location and allow it to remain there several days before placing on the cover in order that the weights may take up all slack in the raw hide and stretch it to its full length. Then set the hand on the bearing so it points to the same figure as a regular barometer would indicate at the same time and secure it finally to the bearing with a drop of solder. This is done, of course, after the cover is replaced.

While this instrument is not intended for a barometer in the strict sense of the word, it will, however, serve to indicate the relative and absolute humidity, the dew point and approach of frosts and rains. Numbers on the dial can be marked as such after it has had a few tests.

It also will assist in determining a healthful degree of humidity in the house while the heating apparatus is being operated.



The six-hour day in factories has been investigated in England. It was found that for work requiring heavy muscular exertion, it was advantageous, but the contrary was the case for light work. It is said that the noise in a factory is a serious element in fatiguing the workers. One advantage for the six-hour day is that if two shifts are used, it gives twelve hours of production for the expensive machinery.

An electric treatment of seeds is described in an English publication. The seeds are put into a solution containing 2½%-5% of sodium chloride or calcium chloride. Five gallons of the solution suffice for a bushel of seed. Eight watts of electric power are taken for each gallon. Remarkable results are claimed in the way of increased yield, although the same favorable results have not always been attained by others than the originator. The seed must be used soon after the treatment, as the effects of the electricity last only a month.

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EXPERIMENTAL PHYSICS

(*Continued from page* 141)

readily through ordinary glass, so the interposition of glass will often cut out the rays entirely. It is for this reason that a person will not tan so readily inside a glass conservatory as out in the open air. Quartz, however, passes ultra-violet light easily,, so in all work with this type of radiation prisms and lenses must be of quartz.

There are many methods of producing ultra-violet light experimentally; the most common being, the mercury vapor lamp, a spark discharge, and an electric arc. When using a mercury vapor lamp it must be provided with a quartz window to allow the rays to escape, and since this type of lamp is somewhat expensive the author has used the spark and arc methods exclusively.

Of these two the arc is much preferable. If, however, the experimenter is the possessor of a wireless transmitting set, he may use his transformer, condenser, inductance and gap, to produce ultra-violet light of fairly good intensity. The spark gap should be fitted with zinc electrodes, as this produces much better rays.

The construction of a good arc lamp for the experimental production of ultra-violet rays is shown in Fig. 2. The completed instrument is shown in Fig. 3. From these two illustrations the construction should be easily seen. Of course, any small hand arc lamp may be used, and the following description of the author's is only given for those who do not have one suitable for this type work.

A small round metal container is fastened horizontally on the top of a wooden support. In each side of the container two holes about an inch in diameter are cut to allow the electrodes to enter the container. On each side a common ten cent monkey-wrench is fastened by a suitable clamp arrangement. The object of the monkey-wrenches is to permit easy manipulating of the electrodes. An insulating clamp formed of two thin pieces of fiber or hard rubber bolted together. is attached to the moving portion of the monkey-wrench. Through this clamp the electrodes are inserted and firmly fixed in place. By turning the small worm screw on each monkey-wrench the electrodes may easily be brought together, an arc struck, and then separated sufficiently to form a good arc discharge. The cheapness of construction and the ease of handling should recommend this arc lamp to the amateur experimenter. Besides ultra-violet ray work it may be used in countless other experiments, and is a valuable addition to the amateur's laboratory.

In the rear of the metal container a reflector is placed. This cannot be of

(*Continued on page* 168)

Wireless Telephone Industry Presents Tremendous Field of Opportunity to Ambitious Americans

E. R. Haas, Director of the National Radio Institute, tells how the development of the Wireless Telephone has opened a fertile and uncrowded field of opportunity to American men and women.

When Alexander Graham Bell announced his invention of the telephone to the skeptical world he was hooted, laughed at and told that his device was simply a scientific toy. But the men and women who backed the Bell Telephone with their money and their energies have reaped rewards far beyond their rosiest dreams.

Marconi met with a similar experience when he claimed completion of the first Wireless Telegraph with which messages could be sent through space without wires. But Marconi started something which has revolutionized all former methods of communication for today it is possible to send messages around the world by Wireless Telegraphy. There are thousands of people and millions of dollars involved in carrying on the industry and a permanent demand exists for more men and women, trained in Wireless than can possibly be supplied. Salaries in the wireless field have advanced steadily and today range from approximately $250 a month to $15,000 a year.

And now comes the last word in the development of Wireless with the perfection of the Wireless Telephone and the announcement that wireless telephone communication is actually established between New York and Chicago and that perfectly audible conversations may now be held between rapidly moving aeroplanes high in the air and stations located on land.

The Wireless Telephone annihilates space and in doing so overcomes many of the serious objections to older methods of telephonic communication. So great has been the development in this line that Congressman Steenerson of Minnesota recently stated that all telegraph and telephone wires would soon be scrapped owing to the perfection of Wireless.

Men and women are needed and will be needed in ever increasing numbers to carry on the work made necessary by the advent of the Wireless Telephone. Those who realize this fact and who prepare now to successfully fill positions in this great field, will be the first to profit—as in the case of the pioneers in the telephone, automobile, talking machine and flying machine industries.

America has always been at a disadvantage because of the inadequacy of her oceanic cable system. This is one of the many important obstacles to greater world commerce which the Wireless Telephone will effectually remove. In fact the Wireless Telephone puts the world at America's front door and elevates her from a minor to a major position in world communication.

The permanent success of Wireless Telephony in America is definitely assured because of the recent formation of the Radio Corporation of America (controlled by the General Electric Company) which has taken over the basic Alexanderson patents covering radio intercommunication and will virtually control this important industry in America and as a further sign of progress American apparatus is now standard throughout the world.

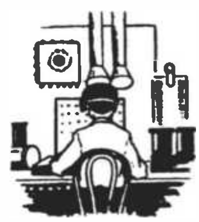
Due to its low cost of operation, installation and maintenance, the wireless telephone is steadily supplanting the long distance telephone for practical business purposes. Branch factories located in different cities may now enjoy the advantages of frequent telephonic intercourse by means of their individually controlled wireless stations; the wireless telephone makes possible telephonic communication between moving trains, ships and other carriers, something heretofore impossible of accomplishment and it will soon be as simple a matter to talk by wireless phone with people across the ocean as it now is to phone across the street.

The Wireless Telephone is bound to do more toward unifying the commercial, political and social interests of the world than any other single factor. The day of wireless, while still at its dawn, is here to stay and the field of opportunity which it has opened to ambitious men and women is second to none.

Each new step forward in the development of wireless creates a still further demand for men and women who are trained in this modern method of communication and it was in order to help meet this ever increasing demand that the National Radio Institute was founded in the Nation's Capital, in 1914 by James E. Smith, E. E.

The National Radio Institute was one of the first schools of Wireless Telegraphy in America and was the first to teach this science by mail. Thousands of students have completed their practical courses in this fascinating study. Hundreds of them are still holding important positions in the wireless field and a permanent demand now exists for all graduates of the National Radio Institute.

It is only natural that the National Radio Institute should also be first in the field to teach Wireless Telephony by mail to the hundreds of progressive Americans who realize that this modern method of communication in all its various branches presents a broad field of commercial opportunity in which to exercise their abilities and make their fortunes.



You, who have read this far will find in Wireless Telephony the opportunity for growth and successful accomplishment for which you have long been seeking. By taking up the study of Wireless Telephony now, as taught by the National Radio Institute you will advance rapidly as its universal use increases and you will be carried along on the crest of the wave to success in what is fast becoming one of the foremost industries in the world.

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EXPERIMENTAL PHYSICS

(*Continued from page* 166)

glass as ultra-violet rays do not pass through glass readily, nor are they well reflected from it. The reflector then, must necessarily be of metal. It has been found that a nickel plated brass or tin reflector is the best suited for this type of work. For some unaccountable reason silver plated reflectors do not give very satisfactory results. For good results the reflector should be parabolic in order to focus the rays on one spot. This is necessary as it is impossible to use a lens to focus the rays, as glass is impervious to the rays.

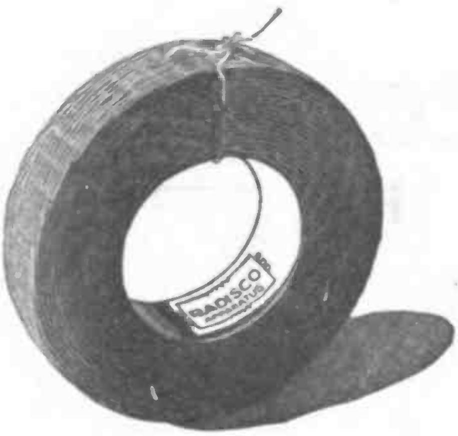
At first the arc should be provided with ordinary carbons. Using them fairly good ultra-violet content will be found to the light. Using one metal and one carbon electrode more rays will be formed. The author has found that the combination of one iron electrode and one carbon gives excellent results, although the arc is somewhat hard to start. One authority on the subject has suggested the use of two tungsten electrodes, but the price of tungsten has kept the author from trying this combination.

By far the best method, however, is to use ordinary carbon electrodes impregnated with certain salts. The manner in which these electrodes are made is as follows: Two ¼ inch arc carbon electrodes are cut the required length for the arc lamp to be used. Some uranium nitrate, easily procurable at any good chemical supply house, is dissolved in water and placed in a large test tube. The carbons are now placed in the solution which is boiled until the carbons are well soaked with the salt. When dried the carbons are inserted in the lamp and used just as ordinary electrodes. More ultra-violet light will be found to emanate from the lamp using these electrodes than by the use of any other combination.

Just what constitutes the efficacy of the uranium salt for the production of ultra-violet rays is not known. Whether the fact that uranium is a radioactive element has something to do with the matter, or simply the fact that uranium is the heaviest element, is not known at the present time. To be sure other salts when soaked into the electrodes will aid in the production of the ultra-violet rays; chief among which are the salts of tungsten, thorium, iridium, etc. It is a wonderful field for experimentation and study. This field holds forth as much opportunity for original research as any in the work in modern physical science.

The next article of this series will outline a number of very interesting experiments with ultra-violet.

(*To be continued.*)



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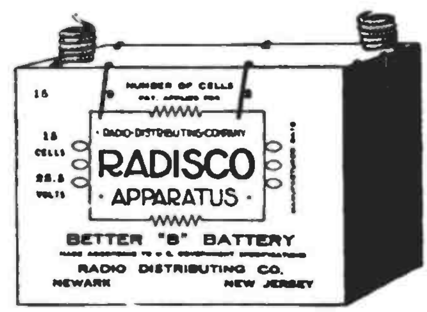

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EVERYDAY SCIENCE NOTES

An elaborate report on the effect of the utilization of electric light on the laying of eggs has been issued recently from the Manitoba Agricultural College. The experiments were carried on in the winter, when daylight was short. The light was turned on at dusk and was kept going until 10.30 p. m. It was next turned on at 7 a. m. The most impressive results were obtained between November 15th and April 15th, 1918-1919. In the darker months, the cost per dozen including light was 21.1 c. and 9 ounces of grain were eaten per egg produced. This was for the artificial light division. For the other, the eggs cost 33.6 c. per dozen and for each egg 24 ounces of grain were eaten. From November 15th to March 1st the artificial light division gave 6,324 eggs against 2,557 eggs of the unlighted division. But for the period from October 27th to June 22d, the relative production was not so favorable to the lighted part; the eggs produced were 13,544 against 11,661.

A simple test for the hardness of steel has been introduced. Sample bars of standard hardnesses are supplied. They are placed in a holder with a steel ball below them, and the whole is then held on the sample to be tested. A light blow is given and both sample and standard bar are indented. The indentations are compared, and if the same then the two are of identical hardness. Each bar can be shifted about so as to be used over and over again, and the effort is to obtain a bar that will give the same indentation as the piece tested.

The relation between shoemakers' sizes in the French and English or American system have been published in a French contemporary. The English system is the same as the American, three numbers to the inch. In France there are four sizes to the French inch; this reduces to almost the same dimension as the English shoe size; the English inch is .0255 meter, the French is .027 meter, a difference of about .08 inch, and the English size number is .06 inch longer than the French.

Efforts are being made to utilize horse-chestnuts. By steeping them in a proper solvent, such as water, and fermenting the liquid by a special process, acetone and butyl alcohol are produced. The distillate from the fermented liquid, called the "mixed oil", contains 1/3 acetone and 2/3 butyl alcohol. The nuts give 19% of the "mixed oil". The works are at King's Lyn, Eng.

Pomace, the residue left in the press after the juice has been expressed from fruit, such as from apples in making cider, is of little value for cattle food, as it is deficient in some of the important elements of nutrition. It can be made a valuable food by mixing it with 45% of its weight of molasses. This has to be done at a temperature of about 180° F. with vigorous stirring. The result is a dry product, easily handled, and a good feed for cattle. The molasses supplies the deficiencies of the pomace.

The explosion of meteorites as they approach the earth is accounted for by the resistance of the air. Their velocity is so great (it may be 30 miles a second) that the contact with the air is almost or quite like a blow. The loud sound they make when exploding is attributed to what is called the shock wave. This was observed with projectiles in the war. They produced a noise like that of an explosion, under conditions of high velocity as they passed on their trajectory.

EVERYDAY SCIENCE NOTES

The output of ships and vessels in the United States for the year 1919 was 57 per cent. of the output of the world, and nearly 74 per cent. of that of all other countries. Of turbine-driven ships, about 1,900,000 tons, and of ships for internal combustion engines, about 43,000 tons were built. Of the internal combustion-driven ships one was of over 6,000 tons. Five concrete vessels of an aggregate of 18,046 tons, including two of 5,000 tons, were launched. In Great Britain the concrete ships were 53 in number. No sailing vessel was reported launched there in 1919. The world's output for that year is placed at 7,144,549 tons.

There has been considerable trouble in treating Douglas fir with liquid preservatives, as they did not penetrate the wood beyond the outer layers. A system of superficial perforation is now applied. The logs are passed through rolls carrying projecting blades. These cover the surface with perforations ⅛-inch wide, ¾-inch deep and about 7 inches long. This facilitates the charging of the wood with liquid preservatives.

In England wooden centered car-wheels are still in use, although they seem to be going out of use. The center is filled with sixteen blocks of teak, and the principal problem in their construction is securing the wood in place. The bolt holes wear under the effects of the brake action. The tire is forced on by hydraulic pressure or by heat, blacksmith-fashion. The wheels are rotated at a standard of forty miles an hour to test their dynamic balance, and are brought into quiet running by counterweights. An ingenious method of making carwheels in use here is to rotate the mould. A manganese alloy steel is poured in and by centrifugal force forms a ring around the periphery; then a soft steel is poured in to make the center. Cast iron wheels are still made here in great quantity, the capacity is put at 20,000 per day. They are sold to the railroads under a five-year guarantee.

A thoroughly up-to-date aquarium is to be established in Golden Gate Park, San Francisco. In addition to the glass-sided exhibition tanks, there will be out-of-doors tanks, a feature to which the climate of the locality lends itself; the absence of extreme cold favors or facilitates the maintenance of outdoor features.

The readings of the mercurial barometer on a fast traveling ship are affected by the variations in centrifugal force, if the ship is going east or west. Traveling west, the ship's progress reduces the centrifugal force of the earth's motion, and its readings of the mercurial barometer vary from those of an aneroid, which is not affected. On an easterly course the centrifugal force is increased and the opposite effect is produced on the barometric column. It is calculated that a ship may weigh 4 cwts. less going in one direction than when going in the other at a speed of 22 knots. Aneroid barometers are unaffected by this phase of course and speed. An aeroplane will climb faster in the northern hemisphere going clock-wise, and the reverse is the case for the southern hemisphere.

The vibration of the engines on a ship affects and reduces the lag of the mercury, and draughts of air through the chart-room may affect its readings.

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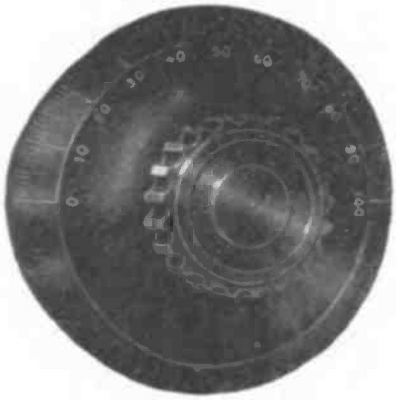

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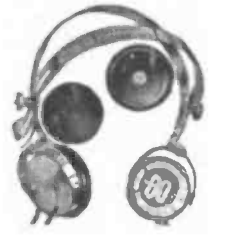

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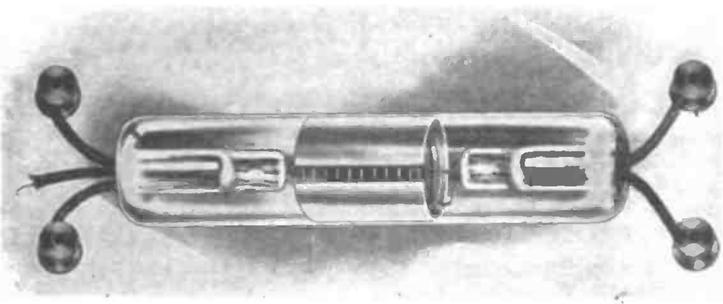

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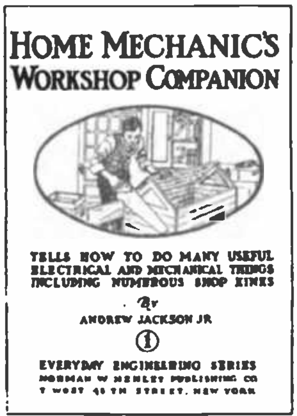

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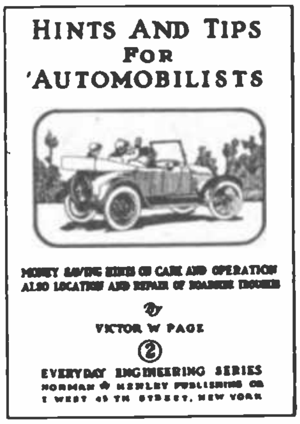

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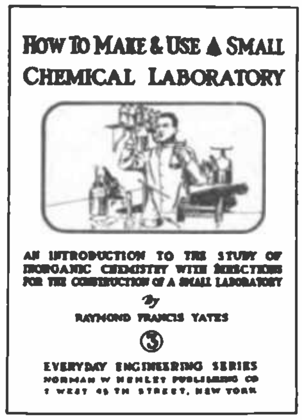

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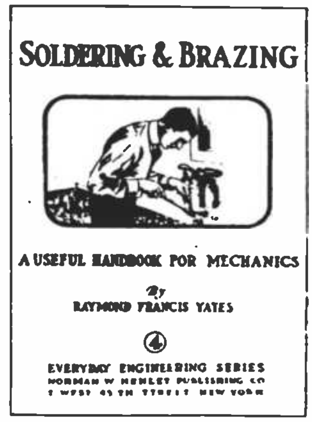

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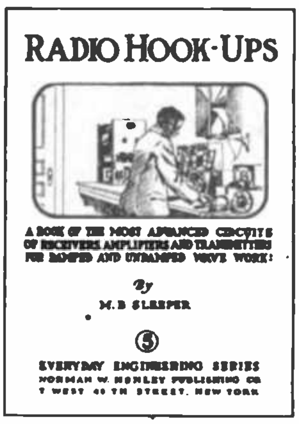

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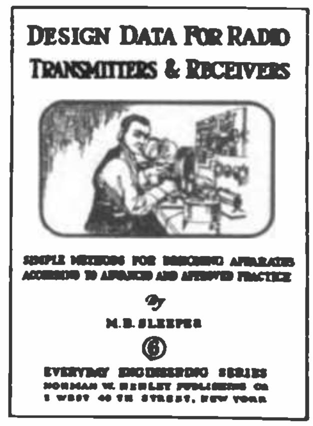

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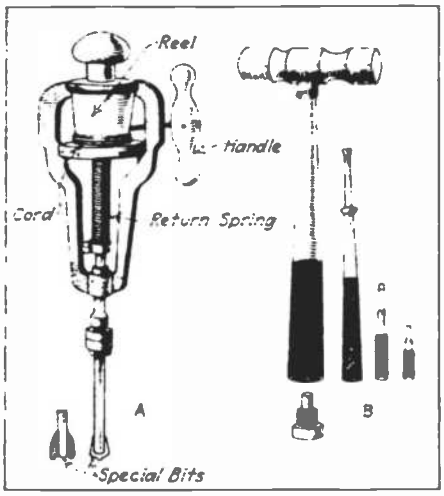
NOVEL ENGLISH TOOLS

THE tools shown in the accompanying illustration were exhibited at a recent English motor car show and should be valuable to motorists because of their simplicity. A new form of valve grinder which is shown at A is provided with special bits to suit the various types of slots in the valve heads.



It is actuated by a reel over which a piece of cord is wound by a spiral spring. Pulling on the handle unwinds the cord and imparts several revolutions to the valve grinding bit. Releasing the pull on the handle allows the spring to return the reel and cord to its original position, which imparts a rotary motion to the valves in a reverse direction to that given when the bit is actuated by the cord. A very neat arrangement for carrying a set of screwdrivers nested into a hollow metal hammer handle is shown at B. All the screwdrivers have hollow handles and fit into the next larger size. The nest of screwdrivers is held in place by a threaded plug which fits into the end of the handle, and the parts are so proportioned that they are firmly held and do not rattle around when the hammer is used.

UNTYING KNOTS

IT is often a difficult business to get rid of knots in ropes especially if these are of long standing. By following the plan indicated it is a simple matter to free the hardest knots whether these be in straps, harness, rope, cord, or anything of a similar nature. As a first step place the knot on some hard surface and give it a good hammering on all sides with a mallet or thick piece of wood. Now boil up a little water with soap in it sufficient to make rather a cloudy solution. Then soak the knot for two or three minutes in the liquid. At the end of this time it will be found that it can be quite easily untied, often enough with the fingers. The loosening can be done with some sharp implement.

FLYING AT HIGH ALTITUDES

THE advantage of flying at high altitudes, with provision for maintaining engine power, is pointed out in a recent issue of *Flight* and the difficulty of attaining such conditions discussed.

Under normal conditions the density of the air at 20,000 ft. is only half that at ground level; also the engine power falls off approximately as the density. At the same time, owing to the density being halved, the lift of the wings is also halved, and to make up the loss in lift the angle of incidence must be increased.

If, on the other hand, it were possible to maintain power at height the machine would be able to fly faster, since the resistance, other things being equal, is directly proportional to the density; but the speed has to be increased to obtain the required lift. However, as the horsepower varies as the cube of velocity and thrust is inversely proportional to speed, the increase in speed to obtain the same lift as a constant angle of incidence is not attainable.

In order to maintain engine power it would be necessary to either carry a supply of oxygen, or over-dimension the engine, raise its compression and regulate the fuel supply at low altitude or supercharge; all of the above add weight to the airplane in addition to the extra weight which might be required for apparatus to supply air or oxygen to the pilot and passengers.

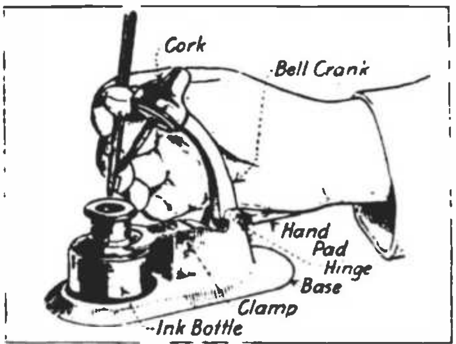
THE LANGMUIR CONDENSATION PUMP

(*Continued from page* 130)

ness, so let us try it this way. First, to get an idea of what atmospheric pressure means in terms of molecules, suppose each molecule of air enlarged to the size of a fine grain of sea-sand or sure means in terms of molecules, suppose each molecule of air enlarged to the size of a fine grain of sea-sand or 1/100th of an inch in diameter. How big a beach could be made from the sand corresponding to the contents of a cubic inch of air at atmospheric pressure? It would make a beach extending from New York to San Francisco, one thousand feet wide and over ten feet deep. Had it been on such a beach as this that Alice's friends were strolling when the Walrus put his hypothetical question of seven maids with seven mops sweeping for half a year, there could have been no doubt in the Carpenter's mind of the futility of their suppositious efforts. And yet by the aid of the Langmuir pump, assuming the sand were air again, that magnificent beach could in a few minutes be reduced to an almost invisible line only two grains broad and one grain deep.

DUST-PROOF INK BOTTLE

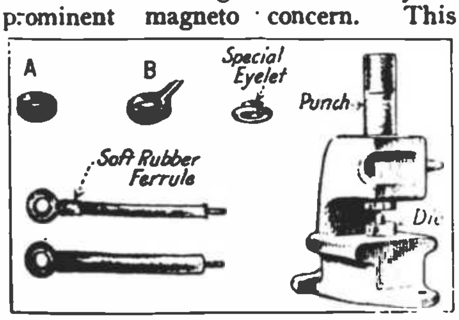
THE simple device shown herewith is a very useful ink bottle holder for draftsmen and artists. The ink bottle is tightly closed, but with a cork that is installed in one end of a bell crank lever instead of one that is free from all connection with the bottle. The lever is hinged at the base holding the bottle, and connected in such a way that the pressure of the hand on the short arm of the bell crank lifts the cork out of the bottle neck and leaves the bottle open.



The cork is one with a quill fixed in its bottom; and the relative position of the hand pad and the quill is such that while the cork is held out of the bottle with the wrist, the hand is in the right position to sweep the pen across the point of the quill and load it with ink. So instead of three unconnected operations, one fills the pen from this dust-proof bottle with a single series of motions—a sweep of the arm bringing the wrist down on the lever, followed by a twist of the wrist to secure the ink. The re-corking is automatic, taking place by spring action as soon as the weight of the hand is removed from the lever, so that no forgetfulness can result in an open bottle. The heavy base keeps the bottle from tipping over and the automatic cover means positive enclosure and keeps the dust out.

NEW TERMINAL MACHINE

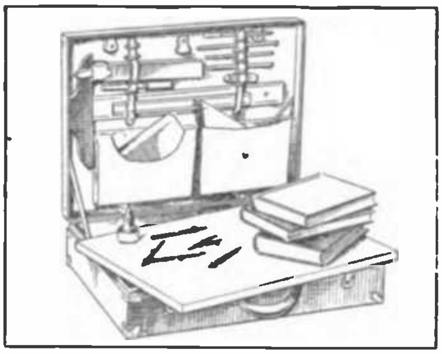
A VERY simple form of punch and die arrangement for rivetting over a copper or brass eyelet, to form a terminal is being marketed by a prominent magneto concern. This



makes a tight joint around the wire and a very neat one, that insures a good contact under the terminal clip. The terminal end is composed of a cup having a channel in which the wire is placed and a central opening in which the tubular shank of the eyelet is pushed after the wire is laid in the channel. The terminal end is then laid on the die and the punch is driven down with a sharp blow from a hammer. This bends over the shank of the eyelet and firmly holds the wire between the two parts of the terminal. Two forms of cups are provided, the one shown at A being the simplest. That at B shows a form with an extending lip covered with a rubber ferrule after the joint is made.

DRAFTING KIT FOR TRAVELING ENGINEERS

THE travelling engineer in many branches of industry, especially in the construction and erection lines has been inconvenienced in his drafting work by the lack of a kit which could be easily moved from point to point and one in which he could carry all the paraphernalia such as T-square, instruments, slide rule, bottles of ink, etc. A Milwaukee engineer has contrived a



kit to meet these conditions, which is shown in the accompanying illustration. It consists of a leather-covered case much like the ordinary suitcase. This is large enough to hold an 18 by 24-inch drafting board which is placed on top of the lower portion of the case when open. There is enough space below the board to carry several handbooks, ink bottles and miscellaneous supplies. In the cover are two slip-in envelopes for triangles and set of instruments. Then there are two narrow leather straps made up with loops to hold a T-square, slide rule, eraser, pen, pencils and scale, all of which are plainly shown in the illustration.

DISTILLATE PRODUCTION DISCONTINUED

THOUSANDS of owners of motor vehicles on the Pacific Coast who have been operating their machines with distillate will be forced to use gasoline unless a carburetor is perfected to burn kerosene, through the decision of the Standard Oil Co., to discontinue the distribution of distillate. This action was taken by the company because of the scarcity of crude oil and the necessity to refine it more thoroughly in order to produce more gasoline.

THOMAS-MORSE MAIL PLANE

THE Thomas-Morse mail plane illustrated herewith is a biplane which has a center nacelle and twin fuselages. It carries its two engines in the center nacelle, one in front and one in rear. The pilots, having dual control, sit in the two fuselages, the nacelle being given over to the engines, which are Wright-Hispano engines rated at 300 hp. each, and to compartments for freight. wire stretched across the spar tips. Every part of the plane is streamlined to reduce parasitic resistance. The only exposed wires are those used for bracing between the planes. The control wires except those to the ailerons are inside the fuselages. There are two complete control systems—one in each fuselage. In flight tests, the plane has demonstrated that it will stay in the air without losing altitude with only one engine running. The wing spread

Side view of Thomas-Morse mail plane using two engines in a central nacelle

The ratio of loading is such that the weight of plane empty is 2890 lbs., the useful load being 2610 lbs., almost the weight of the machine itself. The framework is laminated wood built up to a strength which gives a factor of safety of six. A cross-section of the wing is said to be more nearly like the cross-section of the wing of a bird than that of any other airplane. It is usually thick at the front like the wing bone and tapers toward the rear. The foundation of the trailing edge is a is 45 ft. 6 in., the wing chord 8 ft. 10 in. and the overall length 25 ft. 10 in. The maximum speed is 130 m.p.h. Four of these machines are being assembled for the aerial mail service.

INK FOR WRITING ON CELLULOID

INK for writing on celluloid triangles, etc., can be prepared by dissolving a tar dye stuff of the desired color in anhydrous acetic acid.

WHEN PUTTING CAR IN COMMISSION

IF a car has been laid up for more than a couple of months, it is advisable to introduce a plentiful supply of oil into the cylinders through the valve caps or spark plug orifices. Care should be taken that the oil does not run out through the open valves, but that it is applied to the top of the pistons. The quantity to be introduced is as a rule, two or three tablespoonfuls, which should be sufficient, and when the engine is subsequently started (with a full supply of fresh oil in the sump) a great deal of blue smoke will issue from the exhaust, but this will soon pass off. The engine should not be run at a high speed for five or ten minutes after it has been started. to give time for the oil to circulate to the bearings. On the other hand the engine speed should not be very low, but one that will be sufficient to cause the lubricant to be thoroughly thrown up by the connecting rod ends to the various parts.

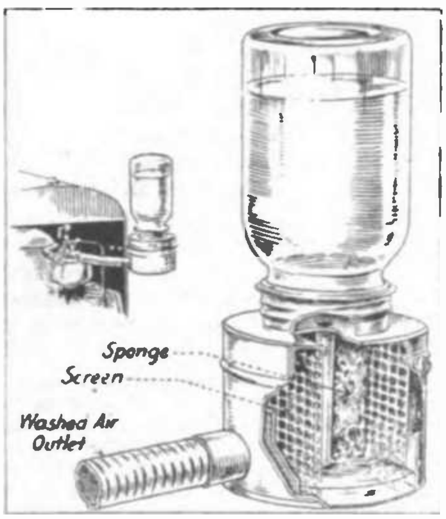
The air pressure at the center of the earth, were there a shaft reaching thereto. would be about 6,000 tons to the square inch. The figures calculated for the proposed 12 mile deep shaft give a doubling of the atmospheric pressure for every two or three miles. Air shields and locks would be needed to make it accessible to the workmen and observers. To ventilate it liquid air might be sent down in vacuum-jacketed pipes. Aeroplanes have gone up over seven miles in the air, but our penetration of the ground is in only very few cases a little in excess of a single mile.

A totally immersed water wheel, mounted on a float, has been tried at Lyons, France, at the confluence of the Saonne and Loire rivers. It gave 25 horse power at an efficiency of sixty per cent. It would seem that much could be done on this line on rivers free from winter ice.

Three-quarter front view of Thomas-Morse mail plane showing central nacelle for engines and twin fuselages for pilots and mail

AIR CLEANER FOR TRACTORS

It has been found desirable to use special types of air cleaners before air is supplied to the carburetors of gasoline or kerosene engined tractors because the dust laden air not only contributes to carbon deposits but also assists in mechanical depreciation by wearing cylinders and bearings and other parts of internal mechanism. Dry cleaners of the centrifugal type are stated to have the disadvantage of not removing the light and fine particles of dust from the air because these do not separate out either by centrifugal force or gravity. Water type cleaners are said to remove all dust only when the air bubbles are very small which is sometimes accomplished by screens in the water to break up air bubbles.



A new type of air cleaner in which water is used has been developed by the Midwest Engine Co. The method of cleaning the air in this device is to draw it through the pores of a wet sponge saturated through its capillarity by resting in about ¼ in. of water maintained automatically and supplied from the transparent reservoir above. As the air zigzags through the pores, the dust is caught by the wet surfaces and held on the surface of and in the pores of the sponge. The sponge is washed out once or twice a day, depending upon the amount of dust in the air.

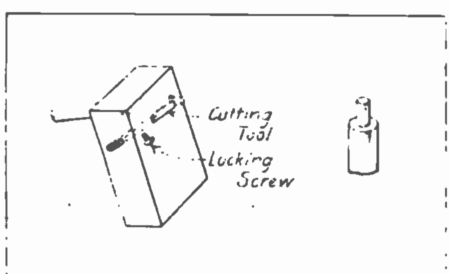
As the cleaner is used, dust will begin to work through the sponge, and if the day is very dusty the dirt may penetrate one quarter the way through. Every time the reservoir is filled, which will be once or twice a day, the sponge should be taken out and thoroughly washed in a bucket of water, put back and the reservoir put in place. There is a hole through the sponge for the feed pipe. When the reservoir is inverted, water will flow into the sponge cup until the end of the tube is covered, and as the water passes up by capillary attraction through the pores, more water will be fed to the sponge cup. Little water is said to be taken up by the air in this cleaner because the air cannot pick up globules of water, only absorb sufficient for complete saturation.

THE DEEP ETCHING OF STEEL

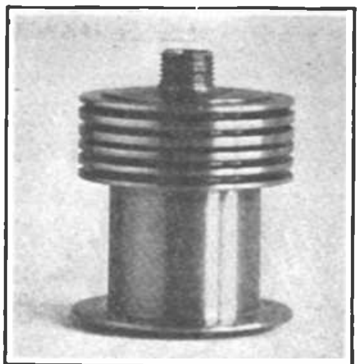
In Technologic Paper No. 156 of the Bureau of Standards the extent to which defects in steel may be brought out by deep etching is described. A lack of homogeneity is shown at once, internal fractures are emphasized, and any faults due to initial stresses, caused by preliminary mechanical and thermal treatment, may be revealed. Segregation is indicated by a roughened surface after etching, due to the greater extent to which the non-metalic inclusions, such as sulfides and oxides are soluble as compared to the metal itself. Stresses due to the mechanical and thermal treatment have been found great enough to cause specimen balls made from the metal to crack when subjected to the action of strong acids. In the case of steel, this is similar to the behavior of brasses and bronze under corrosion tests. Lack of physical homogeneity is usually evidenced by minute cavities resulting in spongy metal. Often internal fractures are so small that the metal appears to be continuous, and this type of fault is frequently found in defective rails of the transverse fissures type. Deep etching reveals these internal fissures as short cracks. Special methods have been developed for the examination of metals by the deep etching process.

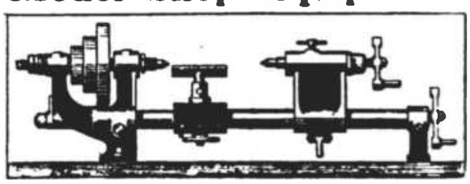
TURNING WITHOUT A LATHE

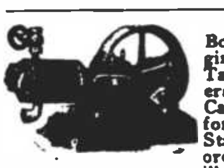
The cuts show how a shoulder can be cut on brass rod without a lathe. A hole the size of the rod to be turned down is made through a block of fibre. In a direction to intersect this hole a second hole is drilled to receive the cutting tool. The cut shows the disposition perfectly. The tool is set so as to



be in a position to cut off all that is to be removed in one cut. When thus in place it is secured by a set-screw. The rear end of the rod is held in a drill stock or auger brace and turned by hand and gradually fed forward. The result, if the operation is properly carried out, is a perfect shoulder, such as shown in the smaller figure.

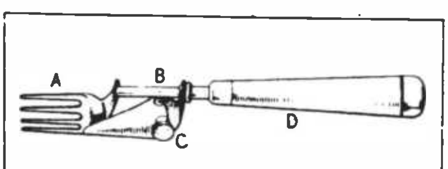






COMBINED KNIFE AND FORK

THIS table utensil is especially for the use of one armed people, although we are free to regard it as adapted for anyone to use to eat his dinner with. Back of the fork, A, and normally above it is a curved knife, C. When the handle, D, is pressed down, the knife slides down back of the fork.



A piece of meat or other food held by the fork is thus cut. If simple pressure of the knife is insufficient a rotating motion can be given by turning the handle to and fro. When pressure on the handle is released the knife is drawn back into its original position, sliding along the rod, B. This rather clever aid to the injured comes from France.

DETECTING FLAWS IN MICA WITH X-RAYS

(Continued from page 149)

sharply defined outlines. In fact, the —tinfoil, etc., are a jet black, with smallest piece of metal or wire shows with a distinctness that reduces the possibility of its remaining undetected to almost an impossibility. The same is true of weak or thin spots in the mica itself. The trays themselves are equipped with clearly marked scales, one on the side, and the other on the bottom, as it appears in the reflection, so that by reading the figures it is possible for the observer to tell any one outside exactly which mica piece is faulty and indicate the location of the fault in the piece.

The only limit to the number of strips that can be tested is the speed with which the trays can be loaded and set on their tracks.

The result is a test that cannot fail to show instantly any piece of mica that is faulty for any reason whatsoever, and thus assures the company that all the mica that is sent out is as nearly perfect as is possible from an insulation is that one of the tubes used in this test has an actual running time of one thousand hours to its credit, which is standpoint. A further item of interest nearly, if not, the record for life in an X-ray tube.

An ingenious arrangement for ensuring the perfectly even angular velocity of a rotating body is the following. On the shaft in question there are mounted a square, a pentagon, a hexagon and a star. The rotating figures are shown by a timed series of sparks. Thus if the square appears motionless it shows that, during the interval between two sparks, it has rotated through 90° or some multiple of 90°. Other speeds of rotation are shown by the other figures appearing stationary. A stationary pentagon means a higher speed, and so for other figures of a greater number of points. It enables a high speed of rotation to be closely watched and to be kept constant.

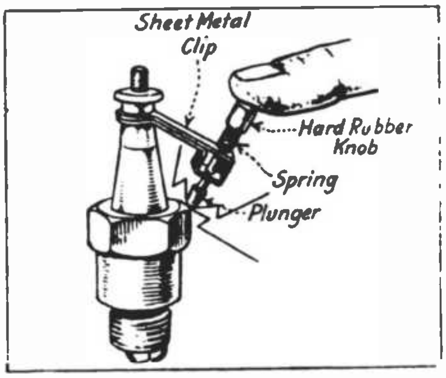
Tidal power, long neglected, is now coming into the field. The great tides of the Bay of Fundy are to be used in a power station of 90,000 horse power. The station is in the center of a 25,000 population. The horse power will cost per unit $80.00 per annum. The tide in the Bay of Fundy rises and falls from 32 to 40 feet.

The Pyrenees are now in course of development as a manufacturing region, their water power is being utilized, ten times as much being harnessed as in 1914. What may be called the Niagara Falls products are being made, bleaching compounds, abrasives, caustic soda, cyanamide, aluminum, carbide nitric acid from the air, steel alloys, and it is proposed to make electrolytic iron.

In studying ballistics by the kinematograph exposures at the rate of 20,000 per second were required. This rate and even more were obtained without the use of a shutter by using the Leyden jar spark at 5,000 volts potential, and controlled by a jet of air. It was found possible to get 80,000 sparks a second. Each spark gave an exposure; no mechanical shutter could be operated at anything like such speed.

NOVEL SPARK PLUG TESTER

A NEW device for testing spark plugs has recently been introduced by an English manufacturer. The device consists of a spring supported plunger carried by a simple bent sheet metal fitting that screws down under the terminal nut. Pressure on the insulated knob overcomes the spring pressure and brings the plunger close enough to the plug body to show a spark if the ignition device is functioning properly. The construction is



simple and there is nothing about the device to get out of order. It eliminated the use of a screwdriver blade, hammer head or other makeshift in making the tests and permits one to short circuit a plug at will in endeavoring to locate a cylinder that is not firing. If only one cylinder of a four or six cylinder engine is at fault, when the spark plug in that cylinder is short circuited, it will not affect the running of the engine. If the plug in one of the operative cylinders is shorted the engine runs even more irregularly so the faulty cylinder can be easily lolated by testing each plug in turn.

VALUE OF U. S. PETROLEUM PRODUCTS

PETROLEUM and its products can well be said to be our greatest national asset, the exports to date exceeding $4,000,000,000, or more than all the gold mined in America since its discovery. The annual production of oil is now eight times in value the production of gold, and it equals, if indeed it does not exceed, the annual output of all of the minerals, as well as all other precious metals and gems combined. There are over 300 by-products made from crude oil. They include benzine, gasoline, lubricating oil, naphtha, kerosene, fuel and paraffin, asphalt products, axle grease, coal tar and soaps.

Off the coast of Queen Charlotte's Island, in the North American Arctic, it is proposed to use the aeroplane to search for whales. The cetacean can be detected at a distance of thirty miles from the working height attained and its location is given to the ship by wireless.

THE KNACK OF CARBURETOR ADJUSTMENT

(*Continued from page* 118)

the mixture. In this form the multiple nozzle construction is employed to do away with the automatic air valve, all air being drawn through the primary air opening at the bottom of the mixing tube D. A strangling tube A is dropped into the air tube in order to constrict its area at the spray nozzle and secure a Venturi tube effect. Outside of the idling jet adjustment the only way to alter the mixture in a Zenith carburetor is to change nozzles and strangling tubes.

Rayfield Mixed Type

Rayfield uses a metering pin, as shown at Fig. 9, which is lifted as the throttle opens in the main jet through a linkage, and so establishes a right to be classified as a metering pin type, but it goes further: It incorporates an auxiliary nozzle, which also has a metering pin which is depressed when the auxiliary air valve opens. Thus, by having two distinct nozzles, it establishes its right also to be classified as an expanding type of instrument. But Rayfield goes still further in that it combines a pumping action on the gasoline in the auxiliary nozzle whereby a very rich mixture is furnished for acceleration whenever the air valve is opened suddenly. This is accomplished by the piston, the lower end of the air valve stem this piston working in a dashpot above the piston and is admitted to the space below the piston by the disk valve in the piston. When the air valve suddenly opens, forcing the piston downward, this disk valve is closed automatically, forcing or pumping the gasoline upward through the fuel passage into the nozzle, where it is sprayed into the inrushing air. Only when the valve opens is this pumping function occurring. At other times the gasoline issues through this auxiliary nozzle according to the suction of the motor. Thus Rayfield is a compound of two metering pins in conjunction with the pumping function for acceleration. The dashpot also prevents any fluttering action of the valve, since the gasoline flow dampens sudden opening or closing.

Rayfield Adjustment for Various Speeds

Adjusting low speed. With throttle closed and dash control down, close nozzle needle H by turning low-speed adjustment N to the left until the block Y begins to leave cam M; then turn to the right about two complete turns. Open throttle not more than one-quarter by advancing lever marked G on steering wheel. Prime the carburetor by pulling steadily a few seconds on lever G (see cut of carburetor). Start motor and allow it to run until warm, then with retarded spark (see lever marked S on steering wheel), close throttle until motor runs slowly without stopping. Turn low speed adjustment N to the left until motor slows down, then to the right, a notch at a time, until the motor idles smoothly. If the motor does not throttle low enough, turn stop screw B to the left until the motor runs as slowly as desired. Adjusting the high speed.—With dash control down, advance the spark about one-quarter and open the throttle rather quickly. Should this cause the motor to backfire, the mixture is lean. Correct this by turning the high-speed adjustment O to the right, one notch at a time, until the throttle may be opened quickly without causing backfiring. If "loading" or "choking" is experienced when the motor is running under heavy load with throttle wide open, the mixture is too rich. This may be overcome by turning high-speed adjustment O to the left. Adjustments made for high speed will in no way affect low speed. Low-speed adjustment N must not be used to get a correct mixture at high speed; it is to be used only when motor is running idle.

General Rules for Carburetor Adjustment

The adjustments should only be made by one possessing an intelligent knowledge of carburetor construction and must never be made unless the reason for changing the old adjustment is understood. Before taking up the adjustment a few hints regarding the quality to be obtained in the mixture should be given some consideration, as if these are properly understood this knowledge will prove of great assistance in adjusting the vaporizer to give a good working mixture of fuel and air. There is some question regarding the best mixture proportions and it is estimated that gas will be explosive in which the proportions of fuel vapor and air will vary from one part of the former to a wide range included between four and eighteen parts of the latter. A one to four mixture is much too rich, while the one in eighteen is much too lean to provide positive ignition.

A rich mixture should be avoided because the excessive fuel used will deposit carbon and will soot the cylinder walls, combustion chamber interior, piston top and valves and also tend to overheat the motor. A rich mixture will also seriously interfere with flexible control of the engine, as it will choke up on low throttle and only run well on open throttle when the full amount of gas is needed. A rich mixture may be quickly discovered by black smoke issuing from the muffler, the exhaust gas having a very pungent odor. If the mixture contains a surplus

(*Continued from page* 190)

Statement of the ownership, management, circulation, etc., required by the Act of Congress of August 24, 1912, of EVERYDAY ENGINEERING MAGAZINE published monthly at New York, N. Y., for April 1, 1920.

State of New York, County of New York, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Stephen Roberts, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Everyday Engineering Magazine and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager, are: Publisher, Everyday Mechanics Co., Inc., 2 West 45th St., New York City; Editor, Raymond Francis Yates, 2 West 45th St., New York City; Managing Editor, Victor W. Page, 2 West 45th St., New York City; Business Manager, Stephen Roberts, 2 West 45th St., New York City.

2. That the owners are: Everyday Mechanics Co., Inc., 2 West 45th St., New York City; Norman W. Henley, 2 West 45th St., New York City; Edward J. Richmond, 2 West 45th St., New York City; Stephen Roberts, 2 West 45th St., New York City; George Rosendale, 52 Broadway, New York City.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiants' full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

S. ROBERTS.
Business Manager.

Sworn to and subscribed before me this 30th day of March, 1920.

(Seal.) ANNIE M. HOLDEN.
(My commission expires March 30, 1921.)

Reg. No. 1461, N. Y. Co. No. 501.

GOING AWAY THIS SUMMER?

You may not be near a news stand while you are away this summer, but you must not miss the radio articles, for you will want the information when you start up in the fall. Don't take chances SUBSCRIBE BEFORE YOU GO!
EVERYDAY ENGINEERING

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BUILDING A TWO-PASSENGER SEAPLANE

(*Continued from page* 115)

Select any point (say for instance 2 feet) a given distance from the hub center, then by the aid of a protractor find the angle the chord line of the blade makes with the table. Lay this angle out on paper (this may be laid out to any convenient scale) or the table top, as shown in Fig. 13.

A = Angles of incidence at a given point.

B = Selected diameter X 3.1417.

C = Length of line (taken at 90 degrees to circumference line) is the pitch of the propeller in inches.

For example, the point selection is 2 ft. from the hub center, which is the radius, double it equals the diameter 4 ft. X pi. 3.1417 equals 12.5668 ft., the circumference at that point. Now draw a line from C (which is the length of the circumference 12.5668 from A) 90 degrees to the circumference line, until it intersects the chord line at C. The length of this line is the actual pitch, and should be within one-half of a degree of the specified pitch of the propeller, which should be stamped on the hub. Any error is usually due to the propeller blade distortion, to faulty manufacture, to the hole in the propeller hub being out of place or hub not properly bolted, which is also the cause of the error in tracking. Both blades should be tested at points 2 ft. from the hub and each additional six inches.

Propeller blades should be within 1/8 inch of each other in length. The propeller should balance exactly on a ball-bearing shaft. The camber should be equal in curvature, the area should be tested for equality in surface. Tracking is also esential and may be tested by revolving the propellers, while measuring corresponding points in both tips with some convenient established point. The limit allowed is 1/8 of an inch. This may be corrected by the manipulation of the hub bolts or shimming with paper between the propeller hub and the shaft flange.

When bolting the propeller hub in place it should be set at about 45 degrees past the vertical and should cause ignition in the motor when slightly above the horizontal.

Notes on Flying

The A B C of Aviation by Pagé is an excellent book on Aviation. The suggestions for the art of flying are about as complete as it is possible for a book to give, and its use is recommended to prospective pilots. There is very little that I can add to it. Although the writer was taught to fly by the Army instructors officially at Mineola, he feels convinced that it is quite safe to acquire the art without concrete flying instructions. I realize that I will be criticised severely for this statement, but I shall state a few facts and leave it to your judgment. Of course if it is possible to receive proper instructions it surely is by all means the only sane thing to do. However, the Wright Bros., Curtiss, Bleriot and most of the early pioneers were self-taught with s l u g g i s h , ill-balanced, poorly proportioned machines. Up to and including 1911 the writer saw a number of amateurs take the initiative and became quite proficient aviators. Hadley, in a Farman type, Schneider in a Curtiss type, Brown in a Wright type, Dixon in a Bleriot type of their own manufacture were self-taught and never had an accident with the exception of young Dixon, who was killed flying over the Rocky Mountains in a factory-built airplane in the fall of 1911. These men began by taking short, straight-away flights, gradually increasing the "hops" until they got accustomed to the motion and speed.

It is obviously necessary to understand the controls perfectly, working them automatically as far as humanly possible, and have a thorough knowledge of the mechanics of the airplane. The Army method is to give the student a course of instruction in aerodynamics and aero-mechanics, then have him watcsh the flying until he gets so enthusiastic and anxious that he will almost steal a plane to fly it. He is then given a few rides called "joy rides" to further arouse him. Finally he is taken up in a dual control machine, and after an indeterminate time ranging from the first trip to the 'steenth trip he is given permission to hold the "joy stick" with the admonition that if he did not let go at a prearranged signal he would be struck on the "bean" with a cudgel.

Finally he is permitted to use the "joy stick", and after they attain 500 to 1,000 ft. altitude to bank, elevate and depress the machine on signal from the pilot, who is in the front seat. He continues this until the instructor has a heart to advance him, depending on the personal equation both sides. He is then permitted to use the rudder with the ailerons until he banks and steers simultaneously and satisfactorily. He then practices climbing and gliding. Later he practices the landings and eventually "solos" or flies alone. I have yet to learn of a single accident in all the first solos of more than 200,000 Army and Navy flyers. Any experienced one may acquire riding a fast motorcycle at top notch speed (the Indian model 16 is supposed to do 72 m.p.h) will accustom one to speed and making quick decisions.

THE KNACK OF CARBURETOR ADJUSTMENT

(*Continued from page* 186)

of air there will be popping sound in the carburetor, which is commonly termed "blowing back." To adjust a carburetor is not a difficult matter when the purpose of the various control members is understood.

For example, types are illustrated which have a single needle valve to change the fuel flow, others are adjusted by altering the lift of the air valve or otherwise varying the amount of air admitted to the mixture, either at the carburetor itself or at the air stove around the exhaust pipe. Before any attempt is made to change a carburetor adjustment, it is well to make sure that the trouble does not exist in the ignition system or that dirt and water are not present in the gasoline.

The first thing to do in adjusting a carburetor is to start the motor and to retard the sparking lever so the motor will run slowly leaving the throttle about half open. In order to ascertain if the mixture is too rich cut down the gasoline flow gradually by screwing down the needle valve until the motor commences to run irregularly or misfires. Close the needle valve in those types having this method of fuel regulation as far as possible without having the engine come to a stop and after having found the minimum amount of fuel gradually unscrew the adjusting valve until you arrive at the point where the engine develops its highest speed. When this adjustment is secured the lock nut is screwed in place so the needle valve will keep the adjustment.

The next point to look out for is regulation of the auxiliary air supply on those types of carburetors where an adjustable air valve is provided. This is done by advancing the spark lever and opening the throttle. The air valve is first opened or the spring tension reduced to a point where the engine misfires or pops back in the carburetor. When the point of maximum air supply the engine will run on is thus determined, the air valve spring may be tightened by screwing in on the regulating screw until the point is reached where an appreciable speeding up of the engine is noticed.

If both fuel and air valves are set right, it will be possible to accelerate the engine speed uniformly without interfering with regularity of engine operation by moving the throttle lever or accelerator pedal from its closed to its wide open position, this being done with the spark lever advanced.

The positive electrification of the atmosphere is found to increase more and more in degree with the height. The rate of increase is quite irregular, and is due to the action of the sun's rays, which ionize it; the action is virtually the same as that of the heated conducting filament in a vacuum tube. Its charge may have a potential of many thousand volts. The upper layers are most highly charged; they get more of the powerful ultra-violet rays, and being further removed from the earth lose less of their charge by conduction to the earth. In the dry air of winter the electrification is greater than at other seasons. In January, 1917, at an elevation of 3,500 meters the U. S. Weather Bureau determined the potential as 26,835 volts, and at 500 meters it was but 410 volts.

An Italian racing automobile is provided with wings, like those of an aeroplane, but they are set at a negative angle of incidence so as to hold it down on the ground instead of tending to raise it or reduce its net weight. Their use would seem to be of rather doubtful value.

Switzerland is electrifying her railroads; twenty years will be required to carry out the work as planned, with an annual expenditure of $25,000,000. The work has been delayed by the difficulty of getting insulators for the power lines.

EVERYDAY SCIENCE NOTES

The wearing away of concrete in sea-water, where it is exposed to great variations of temperature has been noted. But another cause of wear is the attrition with the stones and sand of the beaches, where it is used on the sea coast. On the Sussex shore, in the south of England, as much as 4 to 6 inches of material have been worn away in a year. An attempt to prevent this wear by facing the surface exposed to the waves, with four inch flint stones, met with a degree of success, as the stones lasted five years. Wooden blocks, set with the grain end-wise, like paving blocks are being experimented with as a facing.

In England experiments in running automobiles with a mixture of 45% of ether with 54% of alcohol denatured with 1% of triethylamine have met with much interest. The triethylamine acts not only as a denaturant but also neutralizes any acetic acid which may be produced in the combustion. This is desirable as the acid is corrosive. The calorific power is as 95 to 134, compared with gasoline, yet it gives 85% to 95% of the mileage of the latter. It is in practical use in South Africa; 3,000 gallons a day are made in Durban, and it is also made in East Africa, and is in prospect of further extension. The ether is cheaply produced, and it fulfils its function of making the engine start easily. It is said that the carbureter needs no readjustment for the new fuel.

Fairly good results are claimed for solar engines in Egypt, still in the experimental stage. An efficiency of 4.2% was shown; with the range of temperature utilized the theoretical efficiency would be 5.9%. A steam engine under the best possible practical conditions would give 11.5%. The expense of running the engine figured out as equivalent to a coal-price of £3 10s. a ton.

The war brought out the fact that the existing French maps were on too small a scale. For future work three scales are assigned or suggested; for artillery 1/20000, for general staff work 1/10000, and for infantry use 1/5000. The artillery scale bids fair to be the most generally useful.

Pulverized coal in use in this country on railroad work is being tried in the Netherlands, in New South Wales and in Italy. In the latter country there is no coal, unless lignite be so considered. This fuel is to be used if possible to give some degree of independence of foreign fuel.

On the Northern Pacific road larger cylinders have been placed on existing engines, the boilers have been lengthened, and better efficiency, lower boiler pressure and an increase of power has been secured. The driving mechanism of the engines was not changed.

An interesting example of what can be done in the way of propagating pedigreed seeds is cited in an exchange. A peck of Red Rock wheat was sown and from it the succeeding year there was obtained 7½ bushels of seed. This took care of several acres. The last reports are that in 1919, six years from the first sowing, about 60,000 acres were planted. This report comes from the State of Michigan.

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Advertisements in these columns 5c per word, average 7 words to the line. To insert advertisement under proper classification copy should reach us not later than the first of the month.

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SCIENCE CREATES NEW AUTO WONDER; solves puzzling problem; no more rain or snow blurred windshields; mystic cloth works like magic, deposits invisible chemical film; one rub keeps glass clear 24 hours; one agent sold 5,000. Security Mfg. Co., Dept. 255, Toledo, Ohio.

MAKE $30.00 NEXT SATURDAY. Speederator for Fords selling like wildfire. Used by Ford Motor officials. Makes any Ford run like a Packard. Stops stalling and bucking. Put on quick—instant satisfaction. No holes to bore. Sell ten to twelve a day easy. Splendid profits and exclusive territory. Write quick for information. Address Perrin Co., 1047 Hayward Bldg., Detroit, Mich.

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MORE POWER, less fuel, no carbon. No Mystery, plain facts, results guaranteed. Write for booklet. No-Leak-O Piston Ring Company, Baltimore, Maryland.

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EXPERIMENTAL LABORATORIES, fully equipped—$11.00 to $100.00. Payment Plan or Cash. Descriptions and actual photographs free. Write Dept. E-27. Lions Scientific Institute, "Laboratory Outfitters," Mt. Oliver, Pittsburgh, Pa.

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Do you see the significance of this advance information?

EVERYDAY ENGINEERING MAGAZINE.

CONTENTS

VOL. 9 JUNE, 1920 NO. 3

EVERYDAY ENGINEERING MAGAZINE

2 West 45th Street **New York City**

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

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Advertising Manager
STEPHEN ROBERTS

Branch Advertising Office
SEARS & IRVING, Peoples Gas Building, Chicago, Ill.

Published Monthly by
EVERYDAY MECHANICS COMPANY, INC.
New York, N. Y.

Entered as second-class matter November 20, 1915, at the post office at New York, N. Y., under the Act of March 3, 1879.

Subscription price $2.00 a year in the United States and possessions; Canada, $2.25; Foreign, $2.50 a year.

The Metric System Controversy

THE columns of our mechanical contemporaries are full of letters and editorials against the adoption of the Metric System of weights and measures as an American standard, and there seems to be real cause for their alarm. Considering the subject from the viewpoint of the mechanical and civil engineer, it would be undesirable to have any learned, well-meaning but impractical group of professional men influence Congress in passing legislation to confuse any industry that has always thought and worked to dimensions and values such as inches and pounds by making a system of foreign units such as millimeters and kilograms compulsory.

ANY mechanical man knows that the adoption of the metric system would entail an enormous first cost of new equipment to conform to the new standards and a constantly augmenting cost in the maintenance of a double standard for repairs and renewals, and also an increased cost of the product to the consumer. The confusion would be even greater among mechanics, most of whom would have to be re-educated to think and plan their work in accordance with the unfamiliar, and to them, new units. The opportunities for errors are great enough now without introducing any new hazards. The matter is very serious, and American manufacturers are thoroughly alive to the trouble-making possibilities of any double standard. Practically all are using their influence to retain the present reasonably satisfactory British system every one is familiar with.

THERE are two sides to every question, however, and the advocates of the Metric System have a substantial following among men of science who are able to and who do use metric units advantageously in their work. The British units are those long used in our commerce and industry, the metric units are evidently best for our chemists, physicists and other scientists who are using these units and who are thoroughly familiar with them. No law is needed for them to continue the use of units best adapted to their requirements. The issue should not be made more complex by legislators trying to force the majority in this country to use weights and measures that are obnoxious to them while there is no obstacle to their use by those who do favor them and do apply them to good advantage in scientific research work.

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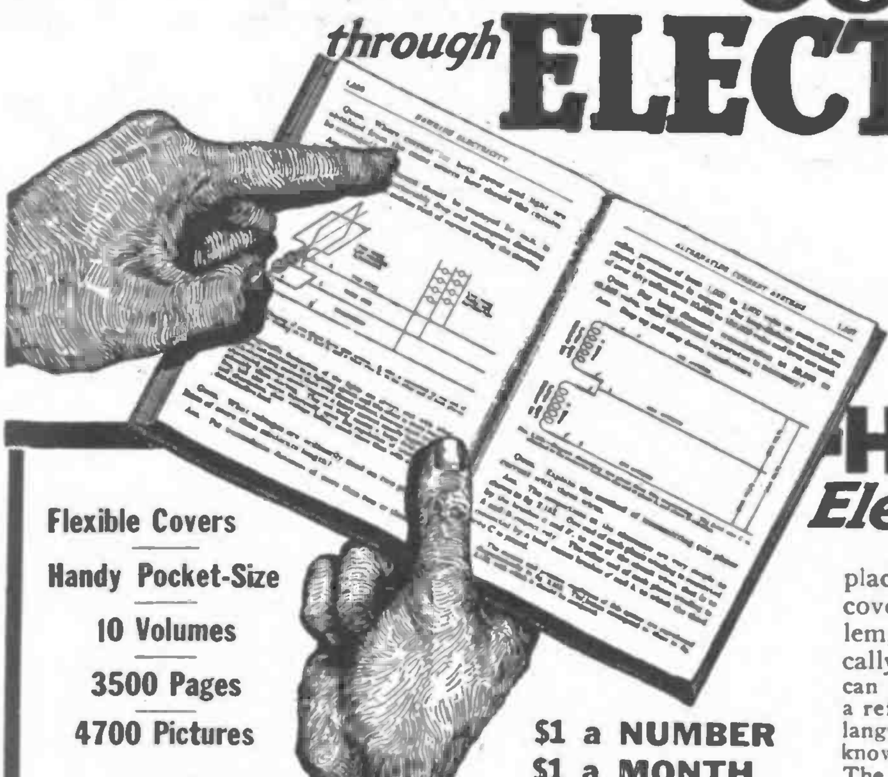

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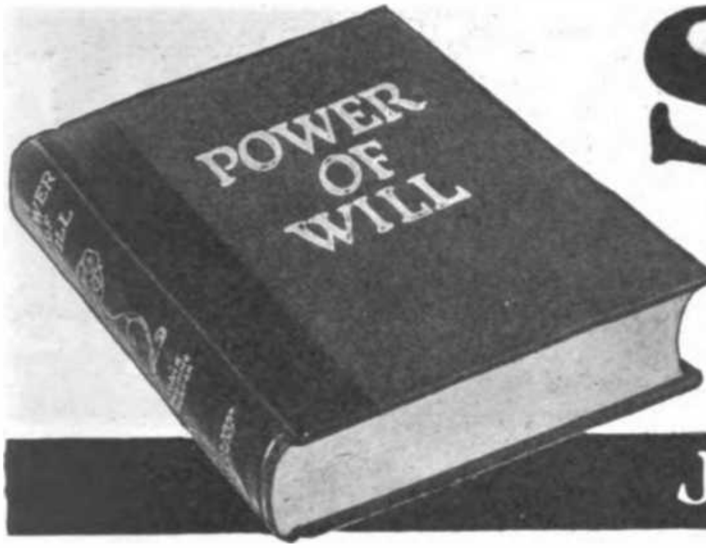

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How the Will is made to act.
How to test your Will.
How a Strong Will is Master of Body

This is only a partial list—a complete list of contents would almost fill this page.

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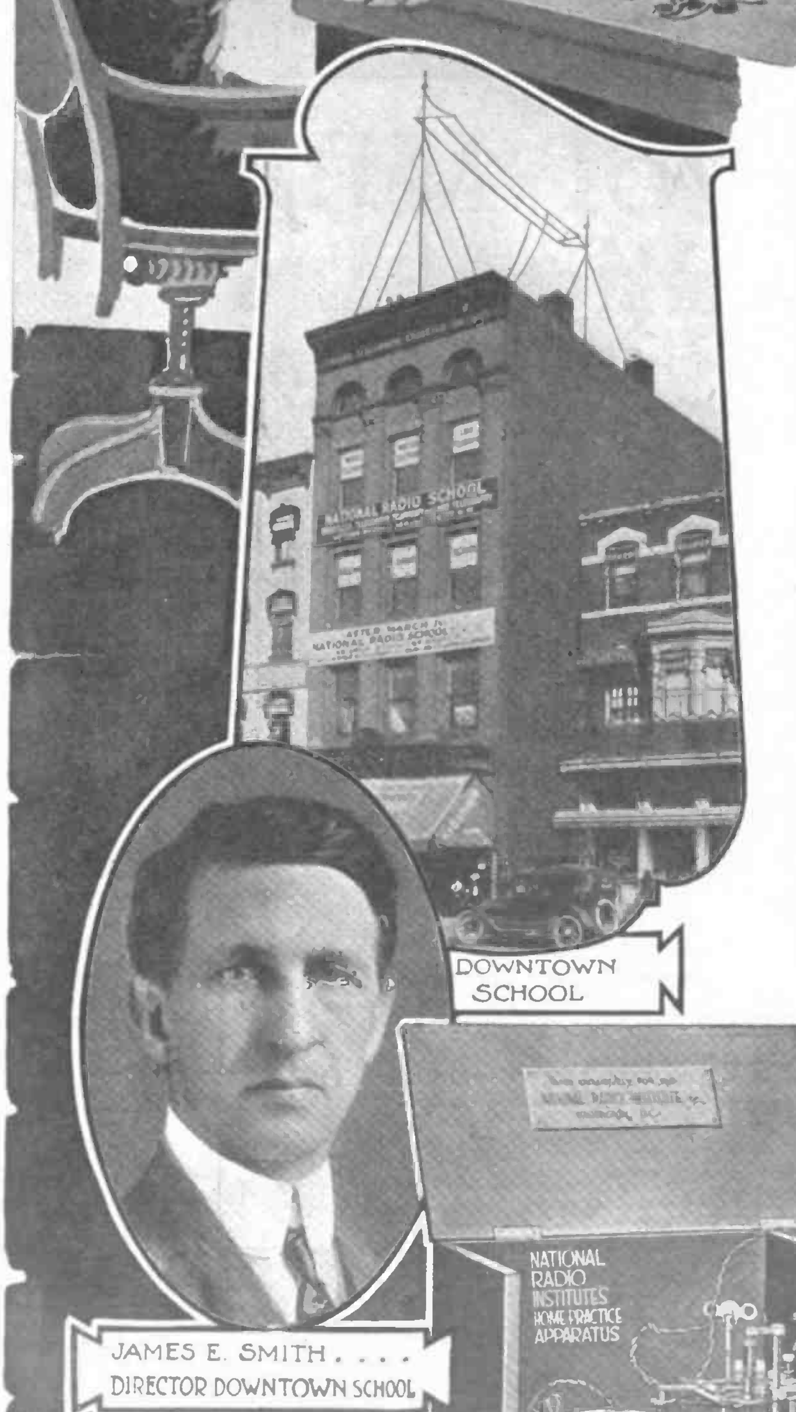

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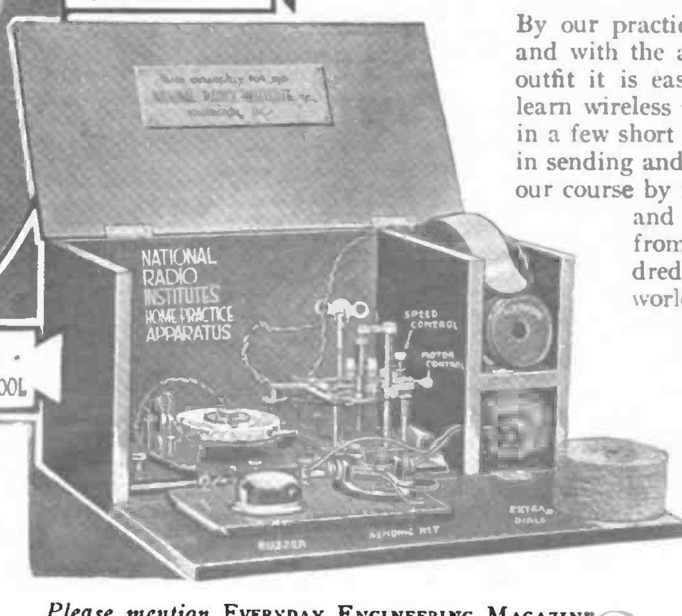
By our practical method of home instruction and with the aid of our improved Natrometer outfit it is easy for any intelligent person to learn wireless and become an efficient operator in a few short months. You get actual practice in sending and receiving messages while taking our course by mail. Every step is made clear and you will make rapid progress from the start. We now have hundreds of students throughout the world.



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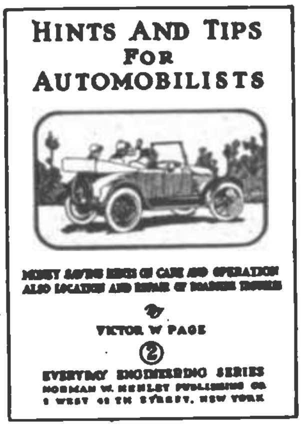

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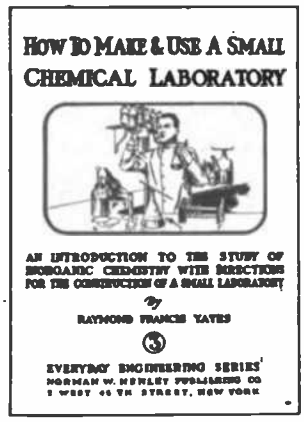

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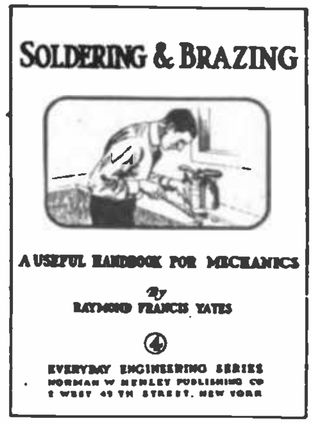

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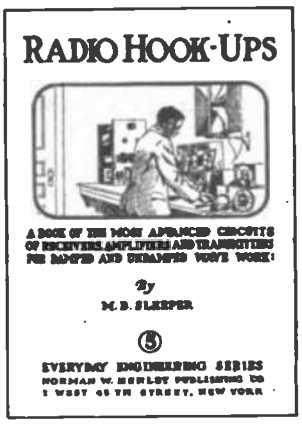

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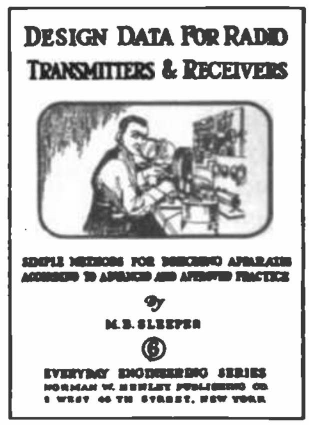

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