

Everyday Engineering

"It Tells You How to Make and How to Do Things"

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No. 1

THE WIRELESS CONTROL OF TORPEDOES AND SUBMARINES

DETAILS OF THE SELECTIVE RADIO CONTROL SYSTEM OF MODEL
SUBMARINE, *EM2*.



Testing the radio control device in the Laboratory of EVERYDAY ENGINEERING MAGAZINE where the *EM2* is being constructed.

WHILE this article is essentially a part of the series on the construction of *EM2*, its importance and the adaptability of the devices it describes in other distantly-controlled mechanisms prompts the present treatment as a separate subject.

In the radiodynamic control of a distant mechanism, which we may assume in the present case to be a model of some sort, there are a number of practical considerations involved aside from the actual problem of how to do the trick. For instance, the distance over which control is to be effected is most important. The difficulties increase amazingly as the distance between transmitter and receiver increases. Another point to consider is whether the control must be selective or whether a progressive series of evolutions, each dependent upon the pressure of the radio key, is all that the builder desires. If it must be selective, how many evolutions must be performed? All of these questions must be answered by the individual worker. Our task has been to solve the problem of how to do it once these points have been decided upon.

Selective Control. In one of the early issues of this magazine, the design for a simple progressive control system was given in connection with the first model submarine *EM1*. This system was ample for a simple demonstration of the possibilities of radio control but it had its limitations in that the craft would have to go through the entire set of evolutions before any one of them could be repeated.

Many of these models have been built and we have the pleasure to publish in this number a brief description with photographs of the work of one of our readers who has turned out *EM1* with entire success. The call has been persistent and constantly increasing, however, for the selective control system which makes it possible to perform any desired evolution of the craft without having first to go through all of the rest.

There are several ways in which this can be accomplished. We have selected the system that has been worked out in detail in the Research Laboratory of this magazine as the one representing the greatest flexibility and dependability of control with the utmost of simplicity in construction and operation.

One thing that is absolutely essential in any system of this kind is some means of determining just what is going on inside the hull of the model when the key is pressed. True, the craft will respond, but we must know beforehand just what is going to happen at the instant of pressure of the key.

There are two ways of doing this. One is to have a series of colored lights on the deck of the model, each color representing some distinct evolution of the craft. A chart on shore tells the operator what each color means so that he can guide his signals

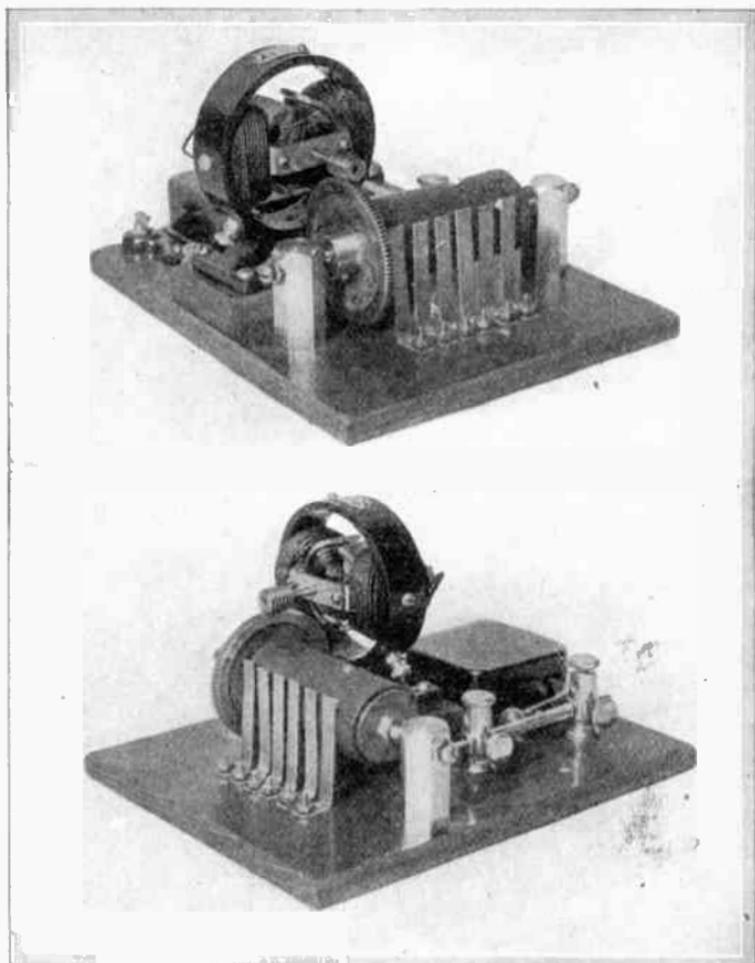


Fig. 1. Central distributor for controller having three circuits: Turn to right, neutral; turn to left, neutral; start motor, stop.

accordingly. The other method, and the details of this will not be published just now in the magazine for obvious reasons, involves the use of a clock-work mechanism to operate the control fingers, with a synchronous mechanism, turning at exactly the same rate of speed on shore in front of the control operator. By observing his clock, the operator can determine exactly what contact finger is in connection at any given time and can send his signals accordingly.

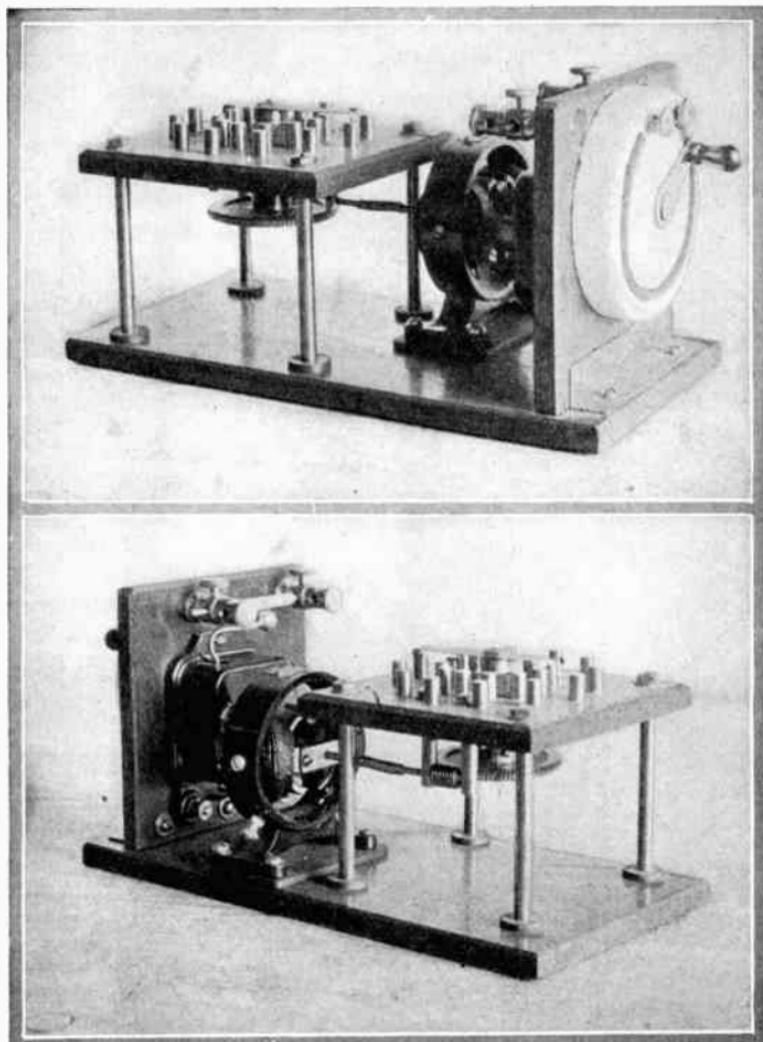


Fig. 2. Central distributor for controller having six or more circuits; that is, six "on" and six "off" positions.

The Controller. The colored-light signal device is admirably adapted for use with models where the control need not extend more than a few hundred yards at the most.

In presenting the details of the present system, we warn pro-

CENTRAL CONTROL BOARD

The EM-2.

Scale 0 1

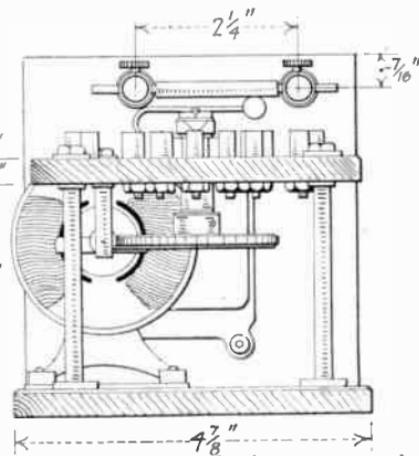
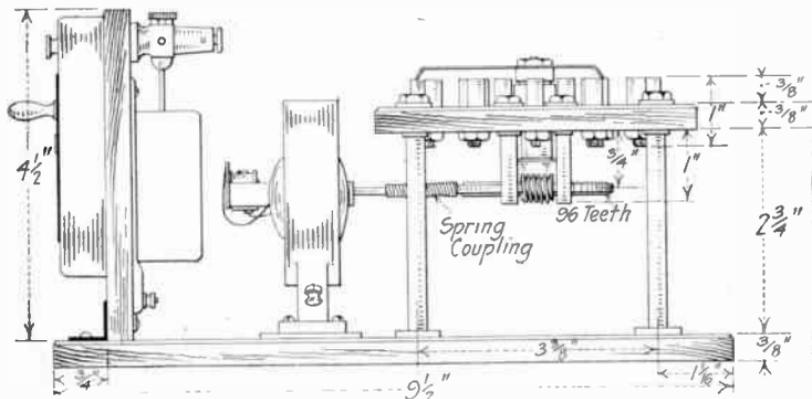
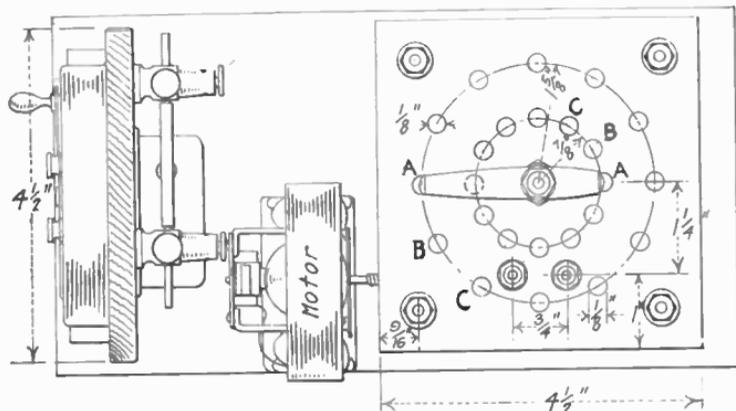


Fig. 3. Detail drawings with dimensions of the multiple control distributor. The rheostat controls the motor speed to suit the skill of the operator who is to direct the model.

spective builders that certain features of it are protected by patents pending in the name of Mr. Curtis, and that before any commercial use, or any use that may be construed as commercial, is made of it, the builder should first write Mr. Curtis, enclosing the usual courtesy return envelope, for permission to use the system, and explaining what it is to be used for.

The system consists essentially of a mechanism the function of which is to periodically open and close a certain number of circuits. The colored lights, each color representing a circuit, tell at all times the position of the contactor. The function of the radio impulse is to complete the operative circuit to any given device in the submarine at just the desired moment. In other words, the operative circuits are all open, as the contact finger moves from one point to another, until such time as a radio signal comes in. This serves to close a relay, sending current through the desired solenoid or motor or whatever happens to be the operative mechanism of the circuit in question.

In the design for the distributor or controller-proper, there are a number of considerations. If space is at a premium, and a very large number of controls is deemed necessary, the type shown in Fig. 2 is better. While the model illustrated is larger than its contemporary in Fig. 1, still its size could readily be reduced to a quarter the volume and the number of circuits preserved. This device is essentially an instrument switch having a double row of contacts and a contact arm which is continuously rotated by means of an electric motor mechanically connected by means of worm gearing. The small rheostat is to control the motor speed.

In this controller or distributor, the operative circuits are taken from the outside row of contacts while the lamp or signal circuits are taken from the inner row. The one advantage of the two rows is found in the fact that but a single white lamp need be used to indicate the "off" position of the contact finger following each colored flash.

The coherer and decoherer are mounted upon an upright wooden piece at the end of the controller base in such a position that the coherer tube is readily accessible for adjustment through a hatch in the deck of the submarine.

The distributor shown has twelve contacts which means that it will control six complete circuits or evolutions; that is, six on and six off. Thus the model can be made to start, stop, turn to right, turn to neutral, turn to left, back to neutral, fire a deck gun, flash

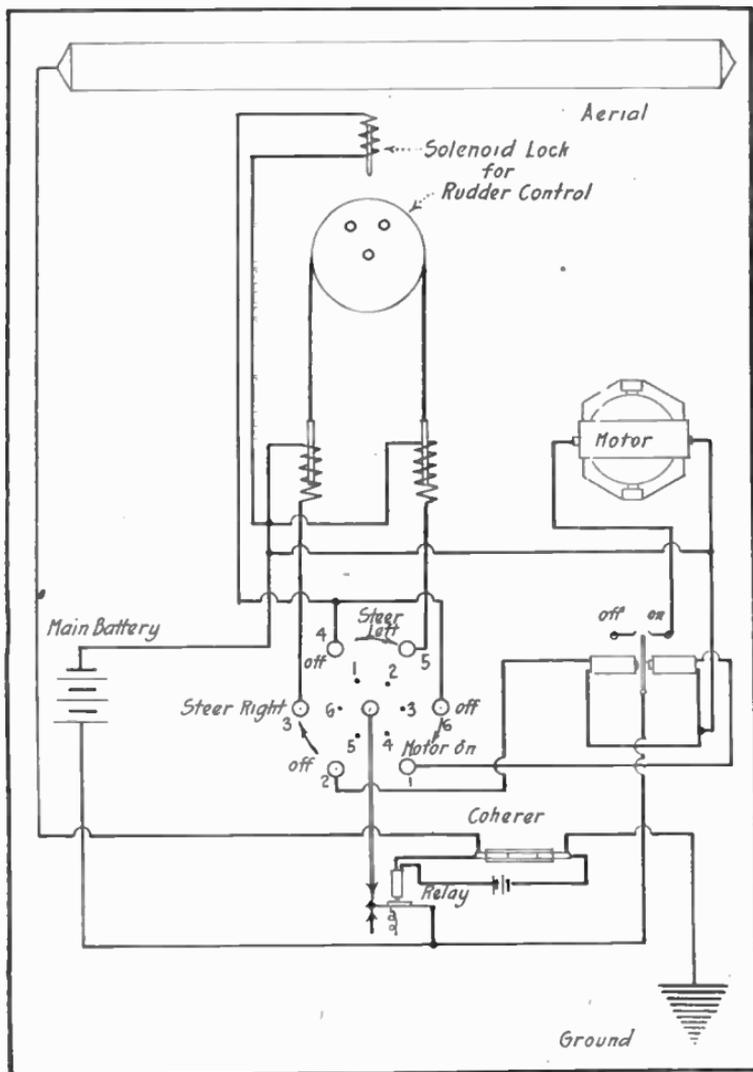


Fig. 4. Wiring diagram for the three-control distributor, showing circuits for driving motor, the right and left rudder control solenoids. The number of circuits can be increased at will by increasing the number of contacts on the distributor. Each circuit or control is connected with a colored signal light.

on a searchlight, turn it off, blow a whistle, discharge a torpedo, fire a signal rocket. Or, in lieu of two of these evolutions, it can be made to submerge and rise with the diving planes fore and aft. The point to remember is that any operation that is performed in an instant, such as firing a gun, can be done without the expenditure of the second contact to turn the current off. All of the devices such as rudder solenoids, driving motor, etc., in *EM2* are so designed as to keep on operating until a second impulse turns the current off.

The distributor shown in Fig. 1 is somewhat easier to build but it does not lend itself so readily to a large number of circuits. In this device, the cylinder carrying a series of contact studs, each contacting in turn with a brush or finger, is revolved slowly with the usual worm gear and motor drive. This distributor has six contacts which means that it is good for three evolutions: start motor, stop motor, turn right, turn back to neutral, turn to left, back to neutral. This is all that would be required of the average torpedo and for simplicity of construction and control, this form is splendid.

Still a third form may be used and this has some pronounced advantages over the others. It consists of a segmented ring of metal, each segment representing a circuit, around which a brush travels slowly. The advantage here is that it gives the operator the maximum of time in which to read and respond to his signals.

Connections and Wiring. The large wiring diagram will make all connections clear without many words of explanation. In reading the diagram, the builder is advised to trace with a pencil each circuit, keeping in mind the position of the contact arm at the time. For instance, to start the motor, he will see that the control current is sent through a two-way switch that will stay in whichever position it is drawn by the magnet on either side. To stop it, the current is sent through the opposite magnet for an instant to draw the lever over.

Coherers and Detectors. It is in this particular that the inherent weakness of any radio control system is found. For simple model work, we have decided that the old fashioned coherer with silver plugs and a half-and-half mixture of nickel and silver filings is about as good as any. The plugs should be at least half an inch apart in the glass tube and the intervening space loosely filled with the filings mixture.

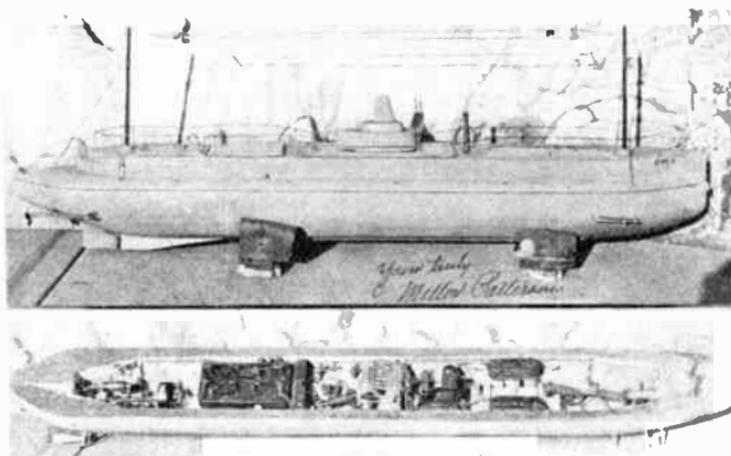
The research work in the Laboratory for several weeks will

be concentrated upon detectors and coherers for radiodynamic work as it is felt that this is a field of vast importance and interest to experimental engineers.

Members of the American Society of Experimental Engineers are urged to follow similar lines of experiment and to report their findings to Headquarters. The utmost confidence will be given to any work that is not for publication if the Member so designates. The work of the Laboratory Staff in this connection will be published for the benefit of Members in the first A. S. E. E. Bulletin which will be issued as soon as the experiments have been concluded or at least as soon as the work has reached definite results.

ST. LOUIS READER SUCCESSFULLY BUILDS MODEL SUBMARINE *EM1*

MR. MILLER PATTERSON, an enthusiastic experimental engineer of St. Louis, has sent us the photographs reproduced on this page showing Model Submarine *EM1* constructed in his own workshop from the instructions given in *EVERYDAY MECHANICS*.



This is the work of an amateur mechanic who has followed the instructions given in former issues of this magazine.

Mr. Patterson's work is particularly gratifying to us for it shows what an amateur mechanic can do in this direction, if he is the possessor of sufficient skill, patience and stick-to-it-iveness. In this

connection our reader has shown himself to be above the average for he has persevered through seemingly endless obstacles in the construction of this model and has produced a piece of work of which he may well be proud.

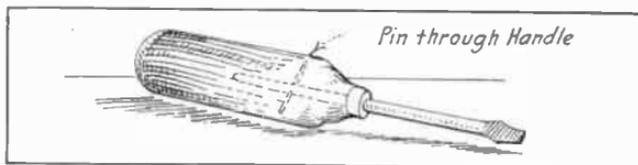
Mr. Patterson advises us that he has given a number of very successful demonstrations in the large stores of St. Louis with models and apparatus he has built. It would seem that there is a splendid field here which needs only to be developed in order to make the construction of these elaborate and somewhat expensive models well worth while from the standpoint of financial remuneration.

We take our hats off to Miller Patterson and extend to him our congratulations. May his work continue and may he, with each succeeding year, receive an increasing amount of pleasure and profit from his hobby.

FOR THE SCREWDRIVER

THE ordinary screwdriver is subject to much misuse in the hands of the amateur mechanic who has a limited number of tools. Very often this tool is used as a substitute for a chisel, box-opener, etc.

By taking a wooden handled screwdriver and drilling a hole



This stunt will prevent the blade from working loose or turning in the handle.

through the shank and handle, then inserting a small brad and fastening it, the blade will not turn and will stand a great amount of hammering without splitting the handle. The brad may be kept in place if riveted slightly at each end.—FRANK E. BURNETT.

TRANSPLANTING POPPIES

The only successful way of transplanting poppies is to do it when the ground and the plant are soaked with rain. The poppies can previously be thinned to single specimens by cutting off the weaker surrounding plants. Use a spade and take up enough earth so that the poppy roots are not exposed.—F. H. SWEET.

THE EQUIPMENT OF AN EXPERIMENTAL ENGINEER'S WORKSHOP

EDITOR'S NOTE:—This is the first instalment of a two-part article describing the equipment of the laboratory of the American Society of Experimental Engineers. This first instalment deals with the workshop, while the second part, appearing in the May number will describe the testing equipment.

IN fitting up the new research laboratory for the A. S. E. E., we have had to deal with a number of practical, everyday problems that are likely to beset the average experimental engineer or group of engineers. The site for the laboratory was chosen after mature consideration. Many buildings were inspected and the various considerations such as light, heat, air, rental per square foot, accessibility to transportation lines, proximity of raw material markets, current supply available, and the question of a radio telegraphic antenna upon the roof were given due attention.

The building selected is one that seemed to comply very nearly, if not quite fully, with the standard we had set for each of these points. It is a modern fireproof structure in the heart of New York City, convenient to all subway, elevated and surface lines and having an elevation which places our antenna at a higher altitude than the top of any building within many blocks.

It is not presumed by the writer of this article that the average reader will be in a position to duplicate the quarters of the headquarters laboratory. The object of the article is rather to describe the equipment of the laboratory with a view to suggesting how our various little difficulties, engendered by the limited space available, were overcome. Whether the individual workshop is situated in an office building or in a deserted barn matters little in its equipment. The important features are maximum convenience and utility with the minimum of space and expense.

LAYOUT OF WORKSHOP AND LABORATORY

A single room 12 ft. wide and 24 ft. deep houses the entire workshop and laboratory. A large window in the end of the room facing east affords a cheerful abundance of light, without the annoying direct sunshine, except in the early morning when its rays are quite welcome. As the room is on the nineteenth floor, and above all the surrounding buildings, the light is unobstructed and the ventilation splendid.

The entrance to the room is in the end opposite the window, the door being at the left. A neat but substantial railing provides a reception enclosure sufficiently large to accommodate three or four people.

Referring to the plan view, the first bench to the left is a substantial affair, upon which are mounted a mitre box, a small speed lathe and a soldering and brazing enclosure in the order named. Next to this bench comes the engine lathe which sets in a recess suggested by the presence of a door leading to the next room. Next comes a second substantial bench intended for actual construction work and equipped with a heavy mechanic's vise. This finishes out the wall space on the left-hand side of the room and practically completes the "workshop part of the equipment" with the exception of the grinder and scroll saw, both of which are portable in order that they may be moved to the point most convenient for the work in hand. For instance, when working at the lathe, it is delightfully handy to have the grinder so close at hand that one need not arise from the lathe seat in order to grind the tool. And likewise, when sawing long planks on the scroll saw, the tool must frequently be placed in the center of the floor.

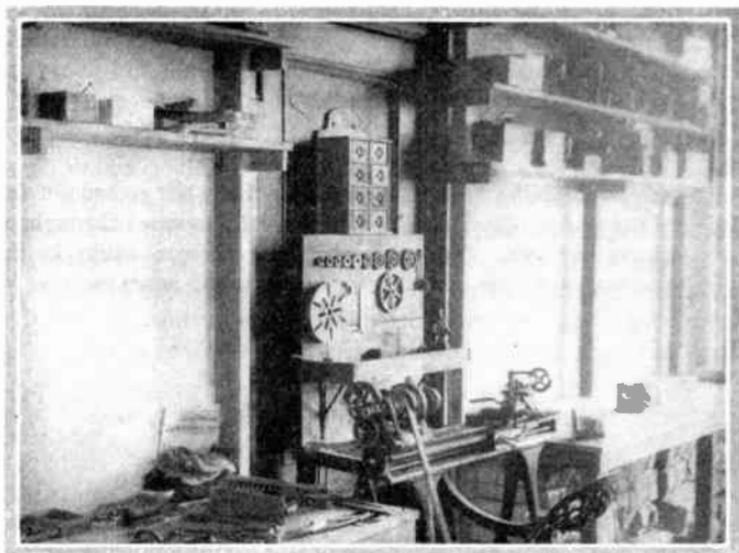
Independent electric motor drive is used on both scroll saw and grinder with cable attachment to the most convenient socket.

The space in front of the window is left perfectly free and clear for photographing by daylight. A small kitchen table or low stand as the case may be affords the proper support for the instrument to be photographed.

Above and below the benches on the left-hand side of the room are shelves in abundance for raw materials and stock as well as certain finished instruments that will not immediately be used.

To the right of the window is a 54-in. kitchen table with center drawer. The top of this table has been shellaced and sand papered until it presents a fine hard, lusterless surface. This table is at once the writing desk and drafting table of the laboratory. The light is excellent as it comes in from the northeast and is reflected by the white wall down upon the table. It is here that the reports of tests and articles describing the construction of instruments and devices are prepared.

Next in order on the right of the room is a second 54-in. table with drawer. In this drawer are kept in compartments, electric measuring instruments and speed indicator, standard resistances



Looking toward the window of the shop, and showing the method of supporting the shelves over the work benches.

and capacities, etc., together with a small wrench, an insulated screwdriver and a good pair of pliers. This is the general testing table. Beneath it and in back of it are mounted the various generators and storage batteries which supply current for testing purposes.

Facing the test table on the other side of the generating equipment is a small table upon which the radio apparatus is mounted. Here both transmitting and receiving sets are tested and checked purely for experimental purposes. No serious operating is done for the sole reason that none of the staff can seem to find time for this fascinating type of amusement, when there is so much else to do.

Between the test tables and in front of the generator is a switchboard made of asbestos board. This is a product as stiff as slate, easily drilled and cut with a saw, and of course absolutely fireproof. Upon this board the switches and resistances controlling all circuits are mounted. Circuits leading from the board run in duplicate to outlets in back of both radio table and general testing table.

Coming forward one step on the right, we find the 48-in. table

which, situated alongside of the wash basin with running water, constitutes the chemical laboratory. This table is fitted with the usual shelf at the rear and is painted with a good acid proof paint. Above the table are shelves for the glassware and stock of chemicals.

At the end of the room is a set of book shelves which contains the reference library of the laboratory. Here the records of experiments not only of ourselves, but of our collaborators throughout the country are kept. The text books and reference works in this library are supplemented with copious marginal notes in cases where our experience has differed with that of the author. A small shelf and chair forms a part of the book-shelf construction.

PROBLEMS ENCOUNTERED

One of our first stumbling blocks was a clause in our lease which specifically stated that we were not to drive nails into the wall. This may sound formidable in the case of so rough and ready a place as a workshop, but we surmounted the difficulty quite easily by building all our shelves and benches upon the principle illustrated in the drawing.

In a nutshell, the scheme is to make both shelf supports and the legs of the benches in one. This was effected easily by running a line of two by threes against the wall and nearly up to the ceiling. We had to be careful to make the altitude of the top shelf lower than that of the fire sprinklers with which the building is equipped. Referring to the front elevation of the benches, Fig. 2, the center two by threes were nailed in inconspicuous places to the door casing. These stiffened the entire structure in the center. To secure stiffness at either end, it was only necessary to run a brace from the top of a 2 x 3 over to the steam pipe passing through the center of the room and well supported where our braces rest upon it. This structure, without a single nail in the wall, and with the additional support of the bench as illustrated in the side elevation, Fig. 2, is as stiff and trustworthy as one could desire.

The shelves of $\frac{3}{8}$ x 10 in. pine are notched to pass the two by threes, thus distributing the weight upon each shelf in such a manner that the force of gravity acts practically in a downward direction instead of partly outward as would be the case if brackets had been used. Furthermore the simple wooden cleats are ever so much cheaper and easier to put up than are iron brackets.

spective builders that certain features of it are protected by patents pending in the name of Mr. Curtis, and that before any commercial use, or any use that may be construed as commercial, is made of it, the builder should first write Mr. Curtis, enclosing the usual courtesy return envelope, for permission to use the system, and explaining what it is to be used for.

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and ends have been covered separately in other short but complete articles in this issue. It is believed that this method of description will break up the monotony of a single very long article and will call particular attention to each device and innovation as it is described.

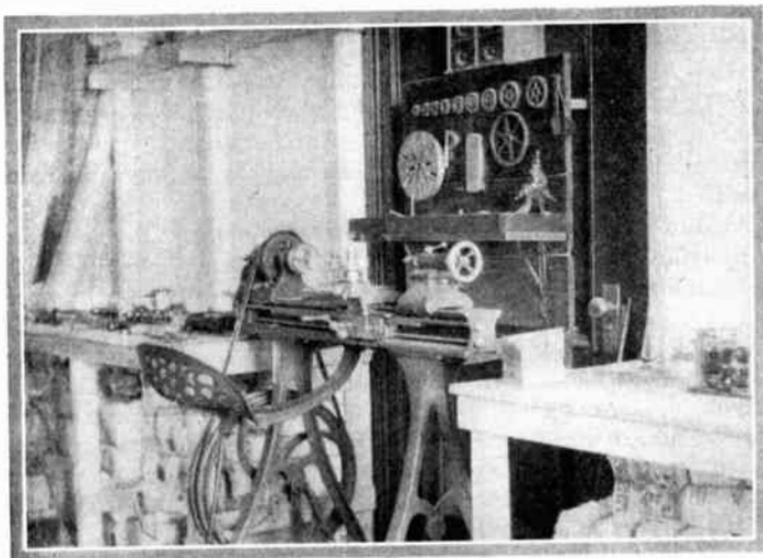
No attempt will be made to give an inventory of the tools in our equipment as there are many that we have built ourselves for special purposes. These tools would defy description in a list. They will be described separately as the occasion demands. We have appended however, a summary of the tools purchased in the open market from our advertisers and others as the need for each tool made itself felt. It is believed that this is an excellent course to pursue in the purchase of the equipment, as it does not entail any great initial investment. The list with appropriate explanatory notations follows:

WOOD AND METAL WORKING TOOLS*

Metal Working Tools. The first requisite is, of course, the lathe. Our first lathe was the No. 125 Bench Lathe of the Goodell-Pratt Company. A full description of this little tool was given in an early issue of this magazine in the Technical Adviser department. The lathe has held up sturdily and it is now used for metal spinning, drilling, and wood turning. It is admirably adapted for such purposes. We have added the circular saw attachment with saw table and thus have greatly enhanced the value of the combination. A $\frac{1}{2}$ H.P. Eck motor drives the lathe and, while this is a smaller machine than we advise, the little motor has never stalled yet.

The engine lathe is the No. 4 $\frac{1}{2}$ machine, swinging nine inches, made by the W. F. & John Barnes Company. It is exceptionally well adapted for our work as it is of light weight compared with its capacity, has hollow spindle, compound rest, is screw cutting and back-geared, and is fitted with a velocipede foot power drive that is the cleverest proposition we have ever seen for such jobs as winding coils, taping, screw cutting, etc., as the operator can run the tool right up to the last turn, stop instantly, and reverse direction of rotation by back pedaling. On a heavy cut, the foot power is tiresome and to relieve in such a case we have arranged a 1/6 H.P. shunt motor to be belted to the stepped flywheel of the lathe. This is, however, very seldom used.

* Names of manufacturers have been given as a matter of convenience to our readers. This is not to be regarded as a piece of free advertising or as a final endorsement on our part. They are simply the tools we selected in the open market.



The engine lathe fits in the space between the two benches.

The engine lathe is fitted with large and small faceplates and a three-inch chuck of the scroll type. Just as soon as the munitions makers let up on the demand for chucks, we will add a larger one. Other accessories include wooden faceplates, special centers, etc., all of which will be described separately as occasion demands in the future.

The lathe tools of the forged variety consist of the standard outfits supplied by the makers of both lathes at nominal cost. To these we have added a good assortment of special tools of self-hardening steel that we use in a simple cradle in the tool post.

Drills. Very early in the game, we found that a complete set of numbered drills from one to sixty was not only indispensable but the cheapest investment in the long run. Our set is put up in a sturdy, three-cornered cast steel holder that permits the worker to reach a given drill instantly and which serves further to tell him at all times whether the drill stock is complete or whether some sizes have been broken.

Pliers and Small Tools. These we have selected freely from the Red Devil line made by the Smith & Hemenway Company. One of the handiest of all is a cutter for glass tubing which is a marvel of simplicity and convenience.

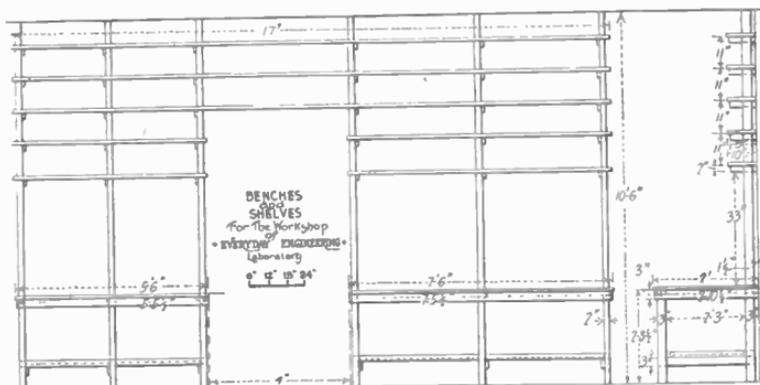
Taps and Dies. We have followed the lead of the set of drills in the selection of our taps and dies. The complete set is the thing every time. The case affords a convenient and safe place in which to keep these dainty little tools which, when purchased separately, are always getting lost or misplaced. Furthermore, the full set up to certain sizes assures the correct tap and die of any size being on hand.

Added to our sets, we have found a series of large taps and dies with fine threads to be very handy. For instance, the $\frac{1}{2}$ -in. 24-thread combination is a wonderfully useful one in instrument work. Very few pipe taps and dies have been added as most of this thread-cutting is done in the lathe.

Gages, Scales, Etc. We have added a profusion of small tools for laying out, measuring, marking, etc. These have for the most part been added one by one. Our calipers, center-finders, bench anvil, scales, drill-holders, etc., are nearly all of the Goodell-Pratt make. The micrometer is from Brown and Sharpe's stock. The handy drill gage made by Starrett and called their "Time Saver" occupies a prominent position over the drill shelf. This tool is a little wonder, since it not only gages drills and wire but it gives the size of each in thousandths and the tap and clearance drill sizes for all taps from 2-56 to 14-20. Steel beam squares and straightedges, and the usual odds and ends that gradually make up the small tool equipment have been selected at random from the product of various manufacturers. Incidentally, one of our handiest tools is the ratchet screwdriver which drives or draws screws while you think about it.

Drill Press. We have a Goodell-Pratt bench drill of the inexpensive type but do not use it as frequently as we do their small lathe for this purpose. The lathe has a quick-feed attachment to the tailstock which makes it wonderfully handy for drilling. The small drill press has been found very handy for tapping a large number of holes, all of the same size in a piece laid out to template.

Grinders. Of grinders we have two and they are rivals in the respective degrees of utility. The main grinder is one of the Goodell-Pratt make with double wheel, one of alundum and the other of carborundum. This grinder is mounted upon a portable stand as described elsewhere in this issue and is fitted with its own electric driving motor of 1/10 H.P. Again the power is perhaps meagre but sufficient. The other grinder is one of the handy little machines comprising a small electric motor with a carborundum wheel at



Benches and shelves. This is the scheme we have employed to support our shelving without fastening to the plaster wall.

one end and a buffing wheel at the other. We cobbled up this rig ourselves but they can be purchased for five or six dollars ready to use in the open market. This little grinder rests on the bench within a foot of our working space, wherever that may be.

Scroll Saw. We have a substantial Barnes saw with a big wooden table. This saw, equipped with our home-made electric drive, cut the hull planks for Submarine *EM2* in a jiffy. The largest blades are $\frac{1}{4}$ -in. wide and a thirty-second thick. Such a blade will rip through 2-in. pine or 1-in. hardwood. At the same time, the delicate wire blades fit perfectly. Next to the lathe, we regard the saw as our prize. We have found a jewelers' hack saw blade that fits the machine and we can cut brass or fibre sheeting without great difficulty.

Vise. Of all the tools in a shop of this kind, the vise is the one that should be selected for quantity as well as quality. Our vise, a Goodell-Pratt, weighs forty pounds and has a three-inch jaw. It is worth every ounce of its forty pounds, too. We use it for wood-working as well as metal.

Mitre Box. Where so many small cabinets, wooden standards, frames, supports, etc., have to be made, a good mitre box is an essential. We have a Greenfield box, made entirely of metal, and fitted with a protractor device that locks the saw guides at whatever angle we wish to cut. The box has saved days' of time in squaring up. We finish the end grain frequently by placing the piece of stock against a sandwheel (to be described) and a true cross-cut is imperative.

Saws, Planes, Chisels, Etc. We have found a substantial rip saw of Disston make and its counterpart in the cross-cut to be ample. A compass saw is also called into use frequently. The hack saw is used constantly, of course, and we have tried blades of various makes with but little choice when used intelligently. They all give us good service.

Our selection of planes, chisels, augers, etc., is just the average. We add to the wood-working equipment as we need it and find that a few tools of the very highest quality are superior to a kitful of cheap ones.

In the next issue, the equipment of the "Laboratory" or testing portion of the plant will be covered. Elsewhere in this issue will be found constructional descriptions of the several novelties referred to in this article. Later issues will supplement with additional suggestions for shop equipment as we add to it.

(Continued in May Issue.)

HOW TO MAKE A SUN-DIAL CORRECT FOR ANY LATITUDE

By L. L. LLEWELLYN, C. E.

DRAW a line AB , and at right angles to it draw 66 . From any convenient point, as C , on AB , draw the perpendicular CO . Make the angle CAO equal to the latitude of the place; (in this case Latitude 42°) also the angle COE equal to the same; join OE . Make EN equal to OE , and from N as a center, with the radius EN , describe a quadrant ES , and divide it into 6 equal parts. Draw EY parallel to 66 , and from N , through the 5 points on the quadrant, draw lines NT, NI , etc., terminating in EY . From A draw lines $A5, A4$, etc., passing through T, I , etc. From any convenient point, as F , describe an arc, RMH , as a kind of finish or border to half the dial. All the lines may now be effaced, except the hour lines, $A6, A5, A4$, etc., to $A12$, or AH ; unless, as is generally the case, the dial is to be divided to quarters of an hour at least. In this case each of the divisions on the quadrant ES , must be sub-divided into 4 equal parts; and lines drawn from N , through the points of subdivision, terminating in EY . The quarter-hour lines must be drawn from A , as were the hour lines. Subdivision of 5 minutes may be made in the same way; but these, as well as single minutes, may usually be laid off around the border, by eye. About 8 or 10 in. for the length of AH will be a

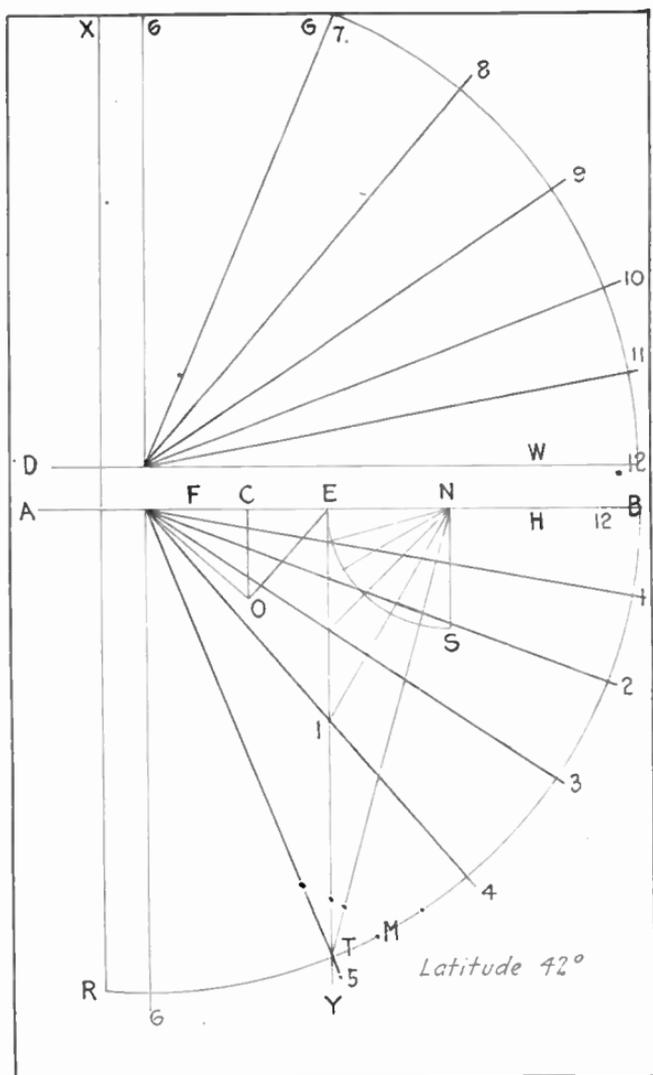


Fig. 1. How the dial is laid out.

convenient size for an ordinary dial. To draw the other half of the figure, make AD equal to the intended thickness of the gnomon, or style, of the dial, and draw $D12$ parallel, and equal to $A12$;

and draw the arc $G12$ precisely similar to the arc RMB . Between X and W on the arc $G12$, space off divisions equal to those on the arc RMB , and number them for the hours, as in the figure. The style F , of metal or stone (wood is too liable to warp), will be triangular; its thickness must throughout be equal to AD or HW ; its base must cover the space $ADHW$; its point will be at AD ; and its perpendicular height HU , over HW , must be such that lines VD , UA , drawn from its top, down to A and D , will make the angles UAH , VDW , each equal to the latitude of the

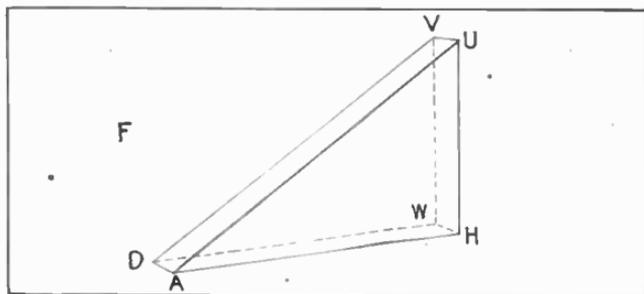


Fig. 2. The style.

place. Its thickness, if of metal, may conveniently be from $\frac{1}{8}$ to $\frac{1}{4}$ in.; or if of stone, an inch or two, or more, according to the size of the dial. Usually, for neatness of appearance, the back $HUVW$, of the style is hollowed inward. The upper edges, UA , UD , which cast the shadows, must be sharp and straight. The dial must be fixed in place horizontally, or perfectly level. AH and DW must be placed truly North and South, not magnetically with a compass; AD being South, and HW North for North Latitudes, and vice versa for South Latitudes. The dial gives only sun or solar time; but clock time can be found by means of the "fast or slow of the sun," as given by all almanacs. If by the almanacs the sun is 5 minutes, etc., fast, the dial will be the same; and the clock or watch, to be correct, must be 5 minutes slower than it; and vice versa.

TO MAKE A VERTICAL SUN-DIAL

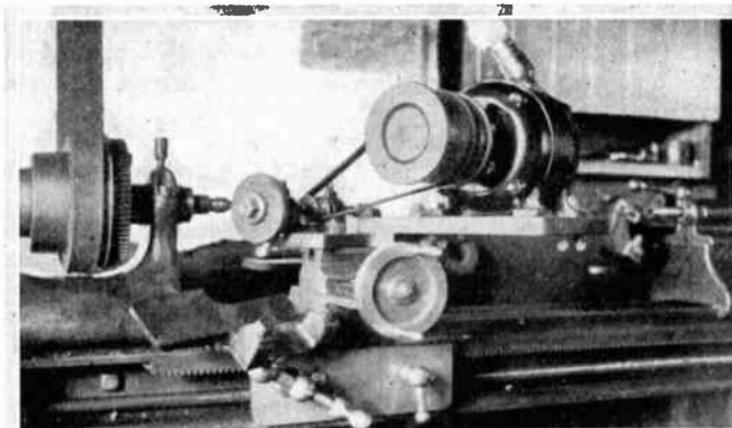
Proceed as directed above, except that the angles CAO and COE on the drawing and the angle UAH or VDW of the style, must be equal to the co-latitude (which is the difference between the latitude and 90°) of the place, and the hours must be numbered the

opposite way from those in the above figure; that is, from *H* to *Y* number 12, 11, 10, 9, 8, 7; and from *W* to *G* number 12, 1, 2, 3, 4, 5. The dial plate must be placed vertically in the position shown in the figure, facing exactly south, and with *AH* and *DW* vertical.

CONCERNING LATHE CENTERS

BY H. H. PARKER

THE live and dead centers of a small metal turning lathe, especially when in the hands of an amateur mechanic or experimenter whose shop equipment is necessarily limited, soon become so battered up that the turning out of accurate work is impossible. If the centers are left soft because no means are at hand for grinding



How the center is ground at sixty degrees.

them, in a short time they assume the appearance of Fig. 2; the point, in the case of the dead center, burns and is cut up by the revolving work and to add to its misery the workman usually lets his file slip every now and then and cuts nicks and grooves in the center. He often does not concern himself with the proper angle of the point, which should be exactly sixty degrees, but when the point is worn or burned off files it up again to any convenient angle.

Since the live center revolves with the work it is possible to leave it soft, but it is by far the best practice to have them both hardened. Sometimes they are turned up to shape in the lathe, then removed,

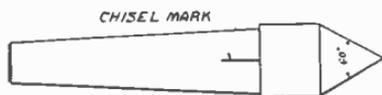


Fig. 1. As it ought to be.

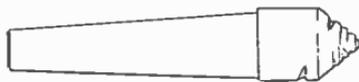


Fig. 2. As usually found.

hardened, tempered and replaced. This method is not satisfactory because the center is almost sure to warp or spring during the hardening process and so will not run true when replaced in the spindle. Moreover, whenever such a center is damaged, which happens very often, the temper must be drawn in order to shape it up again in the lathe and then the hardening process must be repeated. Another objection in regard to the live center being hardened this way is that it is practically impossible to make it run true after removing and replacing even though it should be true originally. The only satisfactory way out of these difficulties is to grind the centers while *in place on the lathe spindle* and to grind the dead center first and then leave the live center in place after grinding.

The average home worker is not equipped with the means for performing this operation, but directions will now be given for building a simple type of hand traverse tool-post grinder, which may be driven either from an overhead drum belted to countershaft or by a small electric motor mounted directly on the base of the grinder. The machine shown in the photograph and drawings was built entirely on the small lathe shown in the picture and while indispensable for keeping the lathe centers in good order is very useful for various other grinding operations, since the shape of its base permits of bringing up the tailstock and so operating upon work held between centers. For cylindrical grinding a sleeve may be slipped over the spindle between the handle and bearing and the regular lathe carriage feed used.

The simplest way to build such a grinder would be to bolt two cast iron "dolly boxes" upon an iron or steel base plate cut to the right shape, but a much better way would be to have a casting made for the base and bearings as shown in Fig. 3 and the photograph. A wooden pattern should be made and a casting obtained from it at the nearest iron foundry. Such a pattern may be seen in the photograph lying on the bed of the lathe just above the apron; its construction is simple. A few dimensions are given in Fig. 3 as a guide, though it would be better to shape the base to fit the lathe upon which the grinder is to be used. Care should be taken to make

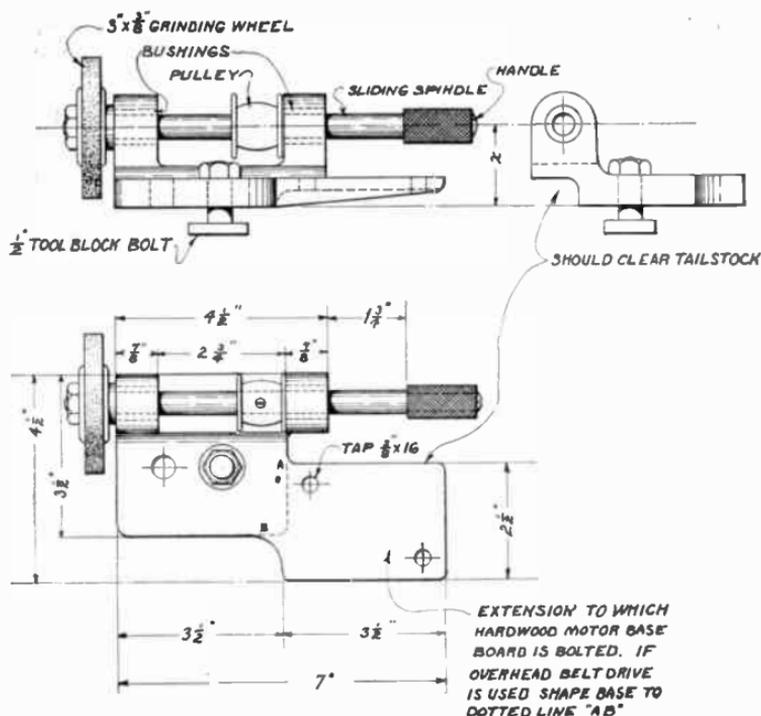


Fig. 3. Hand transverse tool, post grinders, electric or overhead drive. All dimensions not given. Base should be adapted to lathe. Distance X same as height from tool slide to center of lathe.

the base of such a shape as to clear the tailstock when grinding cylindrical work; this will greatly increase the range of usefulness of the machine. If an electric motor drive as shown in the photograph is not to be used, the extension to which the wooden base board is bolted should be omitted, thus simplifying the construction. The distance from the bottom of the grinder base to center line of spindle is to be made equal to the distance from top of the lathe tool-block to center line of lathe spindle, or in other words the center line of grinding wheel should be at the same height as center line of lathe centers.

After filing off the bottom of this casting, drilling the half-inch holes for the clamping bolt and making this bolt (preferably by turning down a larger machine bolt, say a three-quarter inch, and filing up its square head to fit the tool-block slot) for casting may be clamped to the tool-block and by testing with the lathe centers

in place punch marks are made on the outside of each bearing post at the exact height of lathe centers and at the centers of the posts. Then line up the casting, still clamped to carriage, making the punch marks coincide with the lathe centers, remove the live center, substitute a drill chuck and a 47/64-inch drill and drill through both boxes, taking great care that the drill starts true with the punch mark. A three-quarter inch hand reamer may then be run through.

The grinder spindle is turned up from a piece of cold rolled or machinery steel about three-quarters of an inch in diameter, leaving



Fig. 4. Laying out angle of 60°.

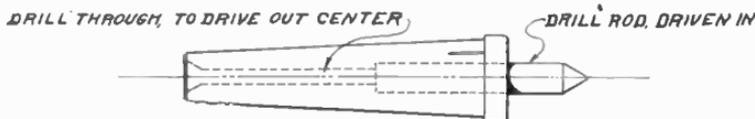


Fig. 5. Dead center for small work.

a shoulder near one end for clamping the grinding wheel; the body of spindle is half an inch in diameter and great care should be taken to make it true—it would be a good idea to “lap” the surface if the builder understands this process. A small grinder of this type is extremely sensitive and its shaft and bearings must be accurately fitted. The bearings may be either bronze bushings, or if the machine is to have only occasional use they may be poured with babbitt. One trouble experienced with a grinder with an exposed shaft is that dust from the grinding wheel is likely to lodge on the shaft, especially in the presence of oil, and work its way into the bearings; the bearings then act as a “lap” and wear away the shaft. Babbitt bearings would cause more trouble in this respect than bronze, but considering the amount of use the grinder would have in the hands of the home worker this would be of little consequence.

The outer end of spindle is turned down and a freely turning handle attached and held by a screw as shown. The pulley should be about an inch in diameter.

If there is a small electric motor of about one-eighth or one-sixth horsepower about the shop this may be used to drive the

grinder. It would not be necessary to attach it permanently but it may be held by a couple of wing nuts as shown in the photograph and when through grinding is quickly removed and put to other uses. The photograph also clearly shows the belt drive from a large drum pulley on motor shaft, driving the three-inch grinding wheel about six thousand revolutions per minute. As the spindle of the grinder is traversed the belt moves back and forth over the face of the motor pulley. A three-quarter inch belt is used. If no motor is at hand the grinder may be driven by a round belt (using V-pulley on spindle) from an overhead drum driven either from the lathe countershaft or from the line shaft.

Having such a machine at hand the operator is enabled to

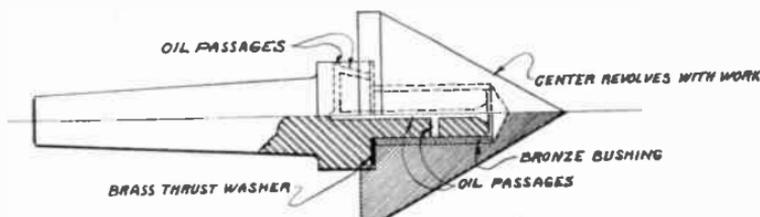


Fig. 6. Pipe center for work with large center hole.

quickly grind his centers to the proper angle whenever they become damaged or inaccurate. The points should be at an angle of exactly sixty degrees as in Fig. 1; this angle must be found by trial by swinging around the base of the grinder and testing with a sixty degree "center gauge." Such a gauge may be bought for about thirty-five cents or one may be made by pricking off an equilateral triangle on a piece of flat steel, filing to shape, and, if possible, hardening. (See Fig. 4.)

As mentioned before, it is practically impossible to remove the live center and replace it so that it will run true. It would help matters somewhat if a chisel mark were made on the end of lathe spindle and a corresponding mark put upon the body of the center as shown in Fig. 1; this allows the center to always be replaced in the same position. A new center, after being so marked, should be driven into the spindle, then removed and examined for bearing marks; in all probability it will be found to bear on the spindle taper at a few spots only. The body should then be filed and scraped until it has a good bearing surface in the spindle, but take great care to replace it while fitting so that *the chisel marks always coincide*. Furthermore, it is essential that all dirt and chips be

always removed from the spindle bearing before replacing the center; this is quickly accomplished by cutting a slit in the end of a quarter-inch steel rod, holding a cloth or bunch of waste on the end of the rod by means of this slit, clamping the rod in the chuck of a hand or breast drill and then running the rag or waste through the spindle bearing (or tailstock bearing). All these points will assist in making the center run true; but for any accurate work the live center should be ground in position before placing the work between centers.

After once being ground the live center should never be removed unless absolutely necessary, in which case it should be carefully tested upon replacement. *On no account should a live center be removed before the machine work on any one piece of work is*



Fig. 7. Do not center drill the work like this.

completed. Even though the center be replaced and ground before re-inserting the work, the accuracy of the result would be affected.

The tailstock sleeve and dead center should be chisel-marked similarly to the live center; the dead center should not be removed during the progress of the work, for like the live end, it would not go back in exactly the same position and this would tend to make the work untrue.

Fig. 5 shows a form of dead center adapted to turning small work, since it allows the turning tool to get in close to the end of the piece to be turned. The body is turned up from a piece of soft steel and a piece of hardened drill rod driven in as shown. The end is ground to a sixty-degree angle while rotating in the lathe spindle. A smaller hole drilled entirely through the body permits of the small center being driven out and replaced with a new one in case of damage.

Sometimes it is necessary to turn down pieces of pipe or parts having a large center hole. This may be accomplished by plugging and center-drilling these openings, but a quicker way is to use what is called a "pipe center" as shown in Fig. 6. This consists of a tapered body fitting the tailstock center bearing, upon which a large pointed center revolves. This center goes into the opening

in the pipe or other piece to be machined and revolves with it: if the large center was stationary it would soon be cut to pieces by the rotating edges of the work. The drawing shows the construction clearly and one of these useful contrivances may be easily built in a small lathe; the pointed center is made by turning down a piece of iron or steel or by having a pointed piece made from cast iron. The tapered body should be made first, then the pointed



Fig. 8. Nor countersink at any angle.

center roughed out, the body placed in lathe spindle and the center driven or clamped on to it for finish turning or grinding. Upon the final assembly the center should turn freely but with no shake. Note the thrust washer and oil passages shown in Fig. 6.

If the reader wishes to construct extra live and dead centers, these may be turned up from a piece of tool steel and should be hardened. If hardened in a forge or coal fire it would be best to heat them in a piece of pipe plugged at one end in order to protect the steel from direct contact. When heated to a bright red remove from fire and quickly plunge into a bucket of water; when cold run an old file over the surface to see if hard; if not, heat up again to a brighter red and quench as before. In this state the center would be too hard and brittle for use and should be tempered. Brighten the surface and then hold over a bunsen or other blue



Fig. 9. Nor countersink only, even at 60°.

flame burner—not nearly the amount of heat is necessary for tempering as for the initial hardening. Apply the flame to the tapered body, and watch for a change of color on the surface brightened up by emery cloth. The body will eventually turn dark blue and now watch carefully how the color runs out toward the point: When the point has reached a dark straw color, but before it turns violet or blue, remove from flame and quench in

water. This process leaves the body of the piece fairly soft while the point will be hard. Although these hardening directions may appear rather crude to the experienced man, it must be remembered that the amateur's equipment and knowledge are apt to be extremely limited.

After hardening, the tapered body may be filed and scraped to fit as described above and then the point ground in place on the spindle.

In order to keep lathe centers in good condition it is necessary to

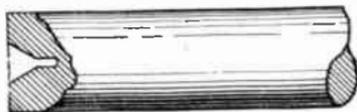


Fig. 10. But drill and countersink at 60° as shown.

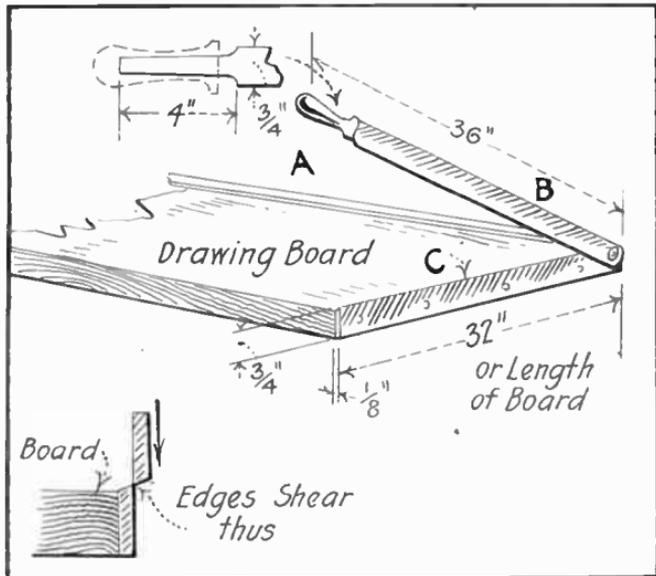
properly center-drill the work. This should be done as shown in Fig. 10, either with a drill and sixty-degree countersink or with a drill and countersink combined. The drill hole forms a protection for the point of the lathe center and also forms a small oil reservoir; the oiling of the center is of great importance and much damage would be caused by running dry. In Fig. 9 a sixty-degree countersink only is used; this will wear off the point of center and there is no room for oil. Often the work is merely drilled and not countersunk, as shown in Fig. 7. In this case the center bears only on a narrow surface and is either quickly cut and burred or the hole wears and throws the work out of true. Fig. 8 shows a condition practically as bad, for although the center has been drilled and countersunk, the angle is not sixty degrees and the lathe center has not sufficient bearing. Sometimes an extreme case has been noticed where the work centers had not been drilled at all, but merely marked with a center-punch, and where the "machinist" expressed surprise at seeing his work climb right out of the lathe as soon as he attempted to take a cut.

In closing, it might be mentioned that another source of damage to lathe centers is the heating and consequent expansion of the work when taking a heavy cut. Often this is not noticed until the dead center begins to burn and is heard squealing lustily. When the work begins to heat up the lathe should be frequently stopped and an examination made to see if the dead center should not be slacked off slightly.

TRACING OR BLUEPRINT CUTTER

BY J. E. CAHILL, JR.

THIS cutter is similar to the knife used by photographers, but is built larger to meet the requirements of the draughtsman or blue-printer. The two blades *B* and *C* are cut to the desired length of cold rolled steel and sharpened, in a manner not unlike the



The cutter is merely a photographer's tool on a larger scale.

sharpening of skates, except that the edges are beveled $1/16$ in., to facilitate cutting. The end of *B* is cut to take a wooden handle. The lower blade *A* is fastened to the board with four $1/2$ in. wood screws, carefully countersunk. To take these four $1/8$ -in. holes must be drilled equal distances apart.

The upper blade *B* is fastened by means of a round headed screw through the other blade into the board. Between *B* and the screw head place a washer. The wooden strip *A* is 1 in. by $1/4$ in. by the length of the board. This is marked off to inches and the marks are numbered from right to left. Before sharpening the blades, note the detail drawing in the illustration, which shows how they are made to cut.

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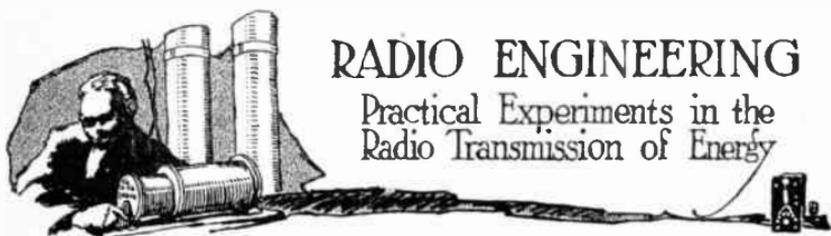
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RADIO ENGINEERING

Practical Experiments in the
Radio Transmission of Energy

THE NEW MORECROFT INDUCTANCES

A 10,000 METER INDUCTANCE IN TWENTY-FIVE CUBIC INCHES

BY GORDON CROTHERS

SINCE inductances have been used in wireless work there have been no great improvements or changes in the usual types of pancake and cylindrical coils. Prof. J. H. Morecroft, Associate

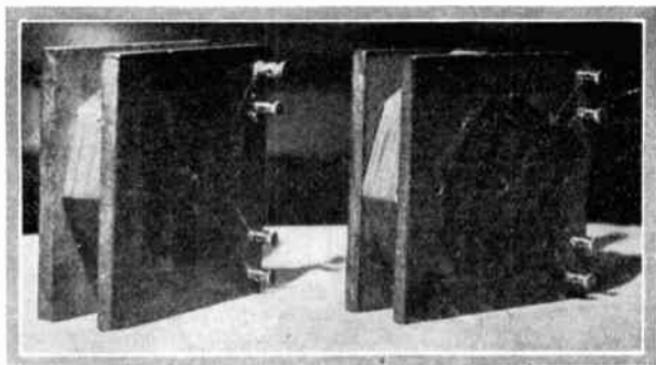


Fig. 1. One of these coils, shunted by a 0.0002 mfd. condenser, will tune to Nauen.

Professor of Electrical Engineering at Columbia University, has quietly conducted experiments in radio work which have resulted in the bringing out of a new type of inductance coil which is as much more efficient as it is radical from the ordinary form of winding.

It is of interest to the experimental engineers to know how Prof. Morecroft took up radio work. Up to a few years ago, he had done very little with the wireless. He decided, however, to become

a radio engineer. Then, with the principles of physics and mathematics already mastered, he applied them to research work in wireless, with the result that he became, in a remarkably short time, a Radio Engineer. And what Prof. Morecroft did, others can do in different branches of science when they have acquired the fundamentals of mathematics and physics or chemistry.

Before the description of the new coils, it may be well to point out the defects of the cylindrical windings, and coils with high distributed capacity.

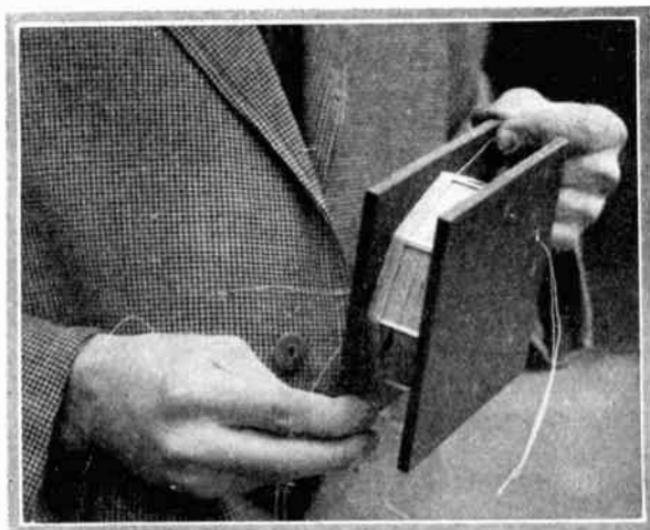


Fig. 2. A slight air space separates the layers.

In designing large inductances, the first difficulty comes in calculating the constants. There are two factors always present in coils—inductance and capacity. The inductance cannot be predetermined accurately, and figuring the capacity is out of the question. Moreover, the capacity changes with the wavelength.

Consider the secondary unit of an inductively coupled tuner, using a shunt condenser. The wavelength of this circuit should be

$$\lambda = 59.6 \sqrt{LC}$$

where

λ = wavelength in meters,

L = inductance in cms.,

and C = capacity in mfd.

However, the distributed capacity in the coil has the effect of a second shunt condenser. That is, the circuit is actually composed of an inductance and two condensers in parallel. Therefore, the wavelength of the circuit will be

$$\lambda = 59.6 \sqrt{L(C_d + C)}$$

where

C_d = distributed capacity in mfd.,
and C = condenser capacity in mfd.

The effect of the distributed capacity is to require a larger variation of the condenser, giving broader tuning and a decrease in sensitivity with Audion circuits.

A long loading coil is not only awkward to handle, but it has a peculiar disadvantage in the reception of undamped waves. The

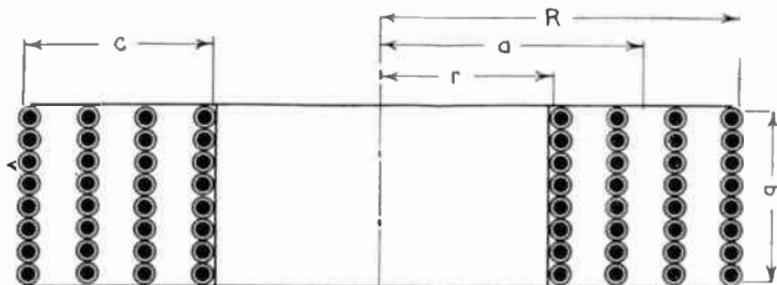


Fig. 3. Cross section of a Morecroft coil to show the dimensions used in calculating the inductance.

electromagnetic field extends radially at a distance of two or three feet at the center of the coil. Any distortion of the field, caused by movements of the hand, make the pitch of the signals go up and down. A point worth noting here is that the hand, when touched to the lower, earthed end of a coil, will not affect the signals.

Prof. Morecroft's coils are illustrated in Fig. 1. They are composed of two wooden end pieces, connected by eight dowels arranged in a circle. One layer of wire is wound directly on the dowels. Then strips of cardboard, 0.04 in. thick, are put on the first layer, over the dowels, as in Fig. 2. These pieces are just long enough to fit snugly between the end pieces. In this way, an air space is left between each layer. *No taps should be taken off*, for this destroys the advantage gained by this method of winding, and leaves an unused section to absorb energy from the active turns.

Coils wound in this manner have several distinct advantages. There is a large value of inductance in a very small space, the

efficiency is high, for the distributed capacity is low, can be calculated, and does not change with the wavelength, the tuning is very sharp, and there is practically no external field about the coils.

Formulas for the calculation of inductance in multi-layer coils are given in Dr. Louis Cohen's book, "Formulae and Tables for the Calculation of Alternating Current Problems." For the benefit of those who cannot get Dr. Cohen's book, the formula is given below.

$$L = \frac{4 \pi^2 a^2 N^2}{b + c + R} F' F''$$

where

- L = inductance in henries,
- a = the average radius of the coil,
- b = the axial length of the coil,
- c = depth of the winding,

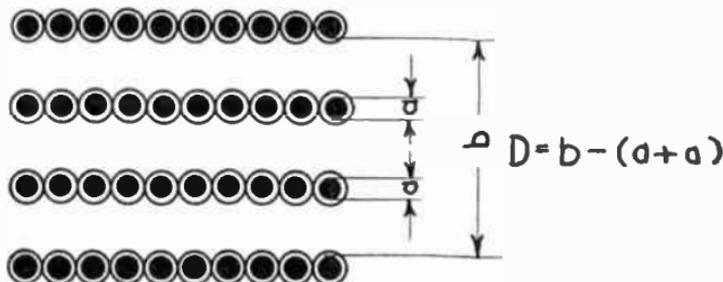


Fig. 4. Dimensions used to calculate the capacity of the coil.

- R = outer radius of the coil,
- N = total number of turns,

$$F' = \frac{10b + 12c + 2R}{10b + 10c + 1.4R}$$

$$F'' = 0.5 \log_{10} \left(100 + \frac{14R}{2b + 3c} \right)$$

Fig. 3 shows more clearly the use of the letters in the equation. The values F' and F'' should be found first, and substituted in the formula. To change the measure of inductance from henries to centimeters, multiply the value of L by 1,000,000,000. The actual inductance and the value calculated by this formula are very close.

The capacity of two metal plates separated by air, the areas of which are great compared to the separation, is given by the equation

$$C = \frac{A}{4 \pi D 900,000}$$

where C = capacity in mfd.,
 A = area of one plate in sq. cms.,
 and D = separation of the plates in cms.

If the separation is large compared to the area of the plates, the capacity is greater than that given by the formula, for the electrostatic field bends outward around the plates, due to the edge effect.

The formula just given can be applied to the Morecroft coils,

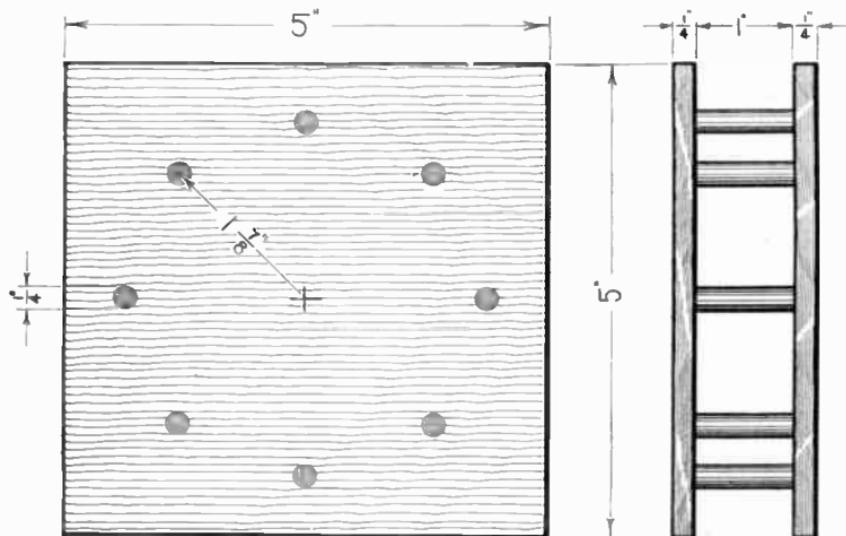


Fig. 5. The frame of a Morecroft inductance.

since the electrostatic field is almost entirely within the windings, not bending out, as in a cylindrical coil. However, to make it correct, the equation should read.

$$C = \frac{2A}{4 \pi D 900,000}$$

Here, A is the average area of the inner and outer layers. D is the distance between the inner and outer wires, minus the total thickness of the wires in the intermediate layers, Fig. 4.

Fig. 5 shows the dimensions of a coil which Prof. Morecroft used as a secondary in tuning Nauen. There are 10 layers of No. 30 single silk covered wire, with 75 turns per layer. This coil was shunted by a condenser of 0.0002 mfd. maximum capacity, to give the variation in wavelength necessary for tuning. The primary coil varies with the antenna. On a 200 meter aerial, a coil similar to

the secondary, shunted by a 0.0005 mfd. condenser, may be used. No attempt should be made to vary the wavelength beyond the limits of the condenser, for a set used on a large range of wavelengths loses the efficiency gained with the Morecroft coils. However, several small coils may be constructed, and connected in series when tuning long wave stations. In any size of inductance, the depth and width of the winding should be nearly the same.

An elaborate coupler is unnecessary if these inductances are used. They are simply mounted on a shaft and moved together or apart to vary the coupling. There is, of course, the disadvantage of the short tuning range, but this can be overcome by the use of several of the small loose couplers.

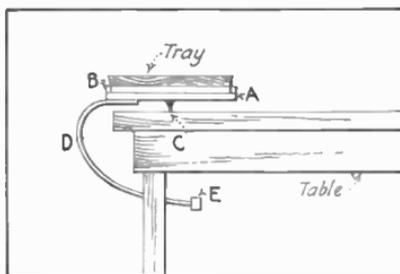
Several of these Morecroft coils have been built in the A. S. E. E. Research Laboratory, and the results of tests now being made will be published as soon as the work is completed.

SELF-ROCKING DEVELOPING TRAY

When it is necessary to develop a great number of plates, it becomes tiresome to rock the tray in which the development takes place. A self-rocking tray may easily be arranged in the following manner:

Cut a piece of thin wood large enough to fit the tray nicely as shown at *A* in the illustration. Around the edges nail small strips of wood to prevent the tray from slipping off *A*. A wedge of wood, *C*, as long as the tray is wide, and 1 in. wide is nailed to the bottom of the wood piece *A*. This forms the pivot on which the tray rocks.

A strip of soft iron, 2 ft. long and $\frac{3}{4}$ in. wide, has one end fastened to the under side of the tray support, and is bent in the shape shown. A weight fastened



How the self-rocking tray is made to rock.

to the lower end of the strip serves to balance the whole arrangement.

The tray containing the developing solution is placed on *A*, and after the plate is immersed, the tray can be started rocking by causing the weight *E* to swing. The rocking motion will continue for some time since there is practically no friction at the pivot.

Contributed by T. W. BENSON.

THE CONSTRUCTION OF A COMPACT RECEIVING SET

BY JAMES B. ARMSTRONG

THE case for this set is made from a Waltham watch box $4\frac{3}{8}$ " x $3\frac{3}{8}$ " x 1"; the rounded corner style is preferable to the square. Remove the top face of the box and put on a piece of $\frac{1}{8}$ " hard rubber of the same size to take its place. After chamfering its edges, drill holes as in Fig. 1.

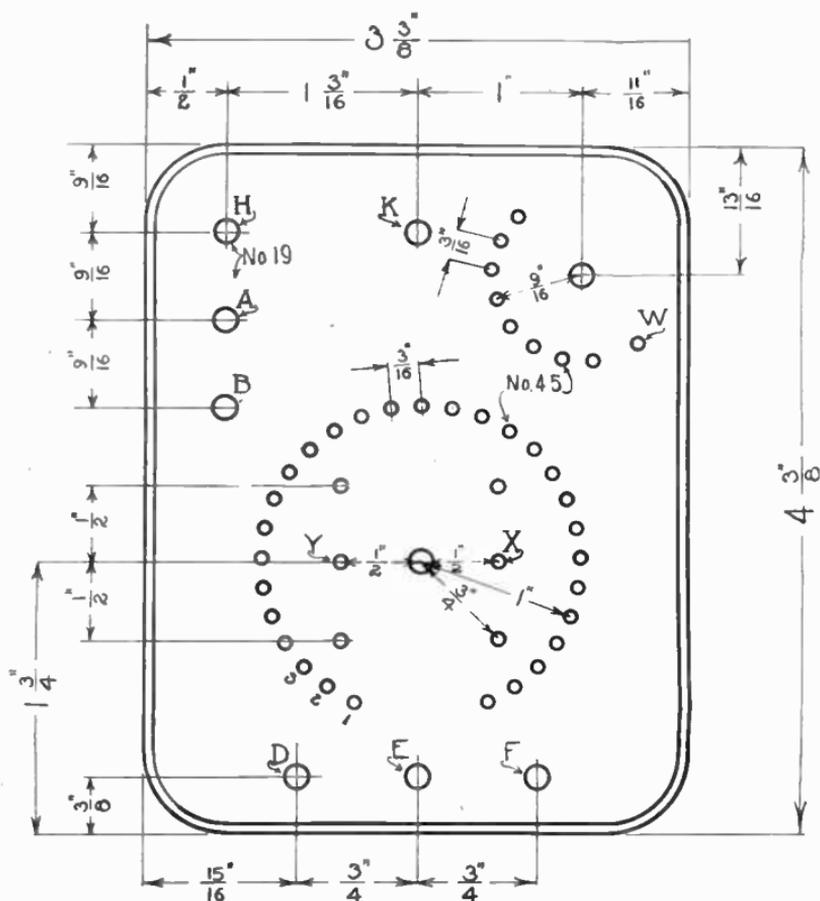


Fig. 1. Lay-out of the panel.

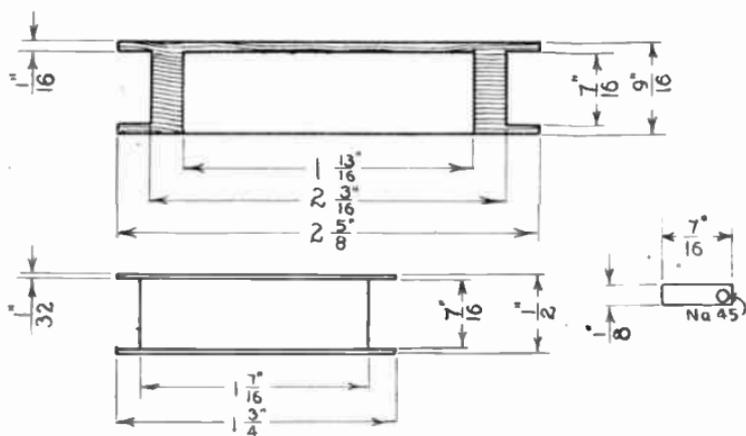


Fig. 2. The primary and secondary coil forms and spring contacts.

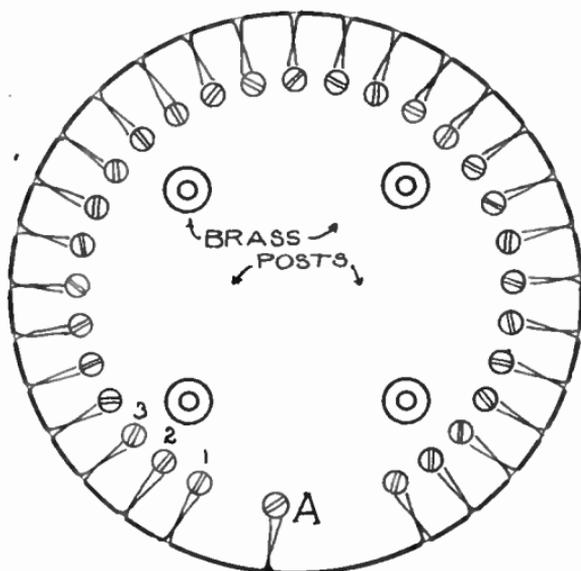


Fig. 3. Showing the upper side of the primary spool, with taps fastened to small screws.

On a lathe, turn 37 brass contacts $\frac{3}{16}$ " long from $\frac{5}{32}$ " round rod and thread them for 2-56 screw. Turn also 4 brass posts $\frac{3}{16}$ " long from $\frac{3}{16}$ " round rod to support the primary. Drill and tap these last all the way through for 2-56 screws. Now from very thin phosphor-bronze cut 29 strips, as in Fig. 2, to be bent and used for spring contacts, Fig. 4.

The detector is of the cat-whisker galena type and is shown

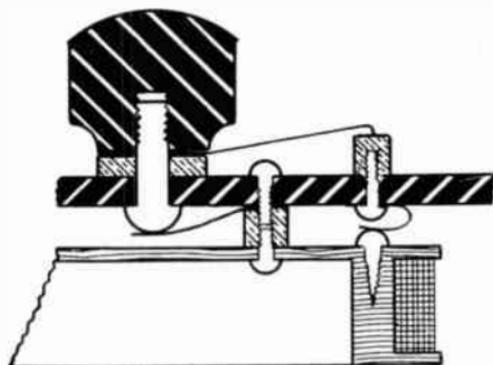


Fig. 4. This shows the spring contacts on the switch points, and the method of assembling.

so clearly in Fig. 6 that it hardly needs to be described. Hole "H" in Fig. 1 is for an 8-23 screw to hold the crystal cups and hole "K" for the detector upright.

The primary and secondary spools are now turned from black fibre. Their dimensions are given in Fig. 2. The large spool should be placed flat against the under side of the hard rubber top in order to mark upon it the location of the contact holes already drilled in the rubber. When these points and the four post holes have been located, drive $\frac{1}{4}$ " round head brass into the spool wall, Figs. 3 and 4. These screws will line up with their respective bronze springs held by the 2-56 contact machine screws in Fig. 4.

The next operation is to wind the primary. Notches are cut into the spool rim, Fig. 3, before beginning the winding which is composed of 90 turns No. 30 enameled wire wound as *irregularly* as possible. Wrap one bared end of the wire around screw A in Fig. 3, catch it in the notch opposite and wind 6 turns around the spool. Then bring the wire up through the second notch, catch it around screw 1 and bring it back down through the same

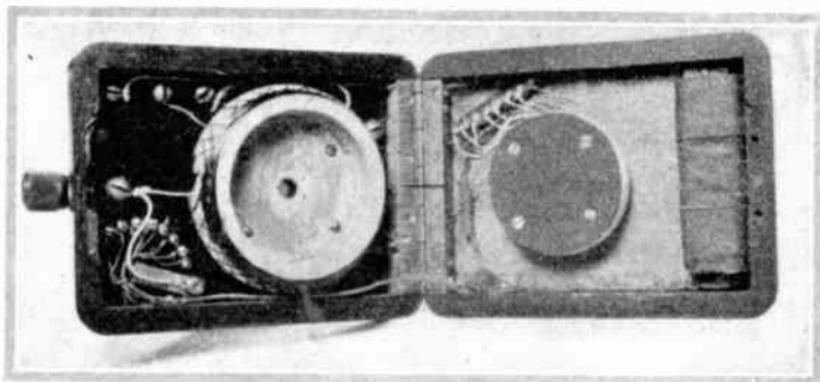


Fig. 5. All the instruments in place, and the cover open for loose coupling.



Fig. 6. The top of the completed pocket receiver.

notch to proceed with the winding. Taps are brought out in this manner to the screws every three turns after the first tap, which includes six turns. Impregnate the winding in wax when com-

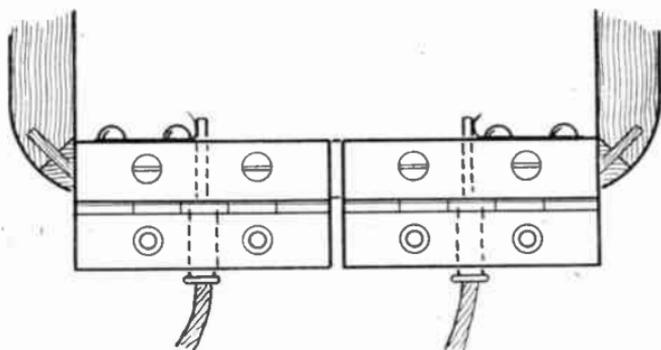


Fig. 7. Connections to the phones are made through the hinges to eliminate moving wires.

pleted to keep it from slipping off the spool when the lower flange is cut away to make room for the secondary taps. (See Fig. 5.)

The four pillars which fasten the primary to the rubber top are fastened with 2-56 screws, as in Figs. 3 and 4, and will line up with the holes in the top, if properly laid out.

The construction of the primary switch is shown in Fig. 4. The switch arm is clamped tightly between the knob and the threaded washer. The screw which holds the parts together is 8-32 round head brass, $\frac{1}{2}$ " long. The spring brass strip which presses on its head is held in place by a 2-56 screw and nut passed through X in Fig. 1. A wire should connect this spring with binding post A (Fig. 1).

In Fig. 3, it will be seen that the start of the primary winding at A is connected with the brass pillar adjacent to it. Now through Y, Fig. 1, put in a 2-56 screw from the upper side of the rubber top. On the under side, clamp with a nut. A piece of thin brass strip which extends to Z (Fig. 1), and has a hole in it which lines up with Z. If now we connect Y to B, we have a connection from B to the start of the primary winding, through the pillar to which A is connected, Fig. 3. Binding posts A and B in Fig. 1 are, of course, for the aerial and ground connections.

The secondary is wound *unevenly* with 112 turns of No. 32 single silk with taps every 14 turns, brought out at one edge of the spool, see Fig 5. The taps are about 8 ins. long and are twisted into a cable which leads to the secondary switch. Enough slack should be allowed on this cable to allow for the opening and shutting of the box when the secondary has been glued to the lower

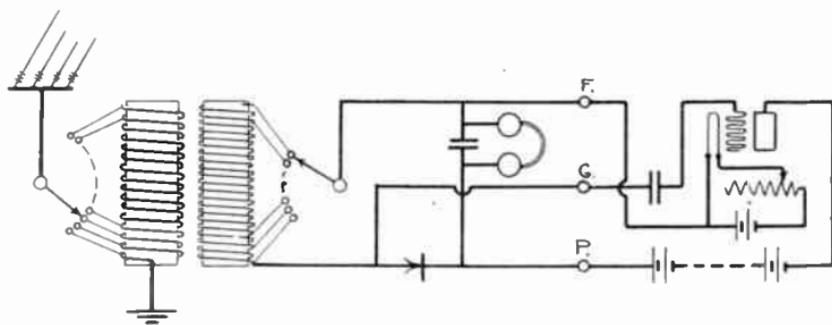


Fig. 8. No switches are needed to change from crystal to Audion detector with this hook-up.

half of the box, Fig. 5. As will be seen, the coupling between primary and secondary may be varied by opening or shutting the case when placed edgewise as in Fig. 5.

The secondary contacts are mounted with 2-56 screws and are connected to their respective taps. The switch and lever are like primary ones, the spring contact for the lever connection being secured by a 2-56 bolt passed through W in Fig. 1.

The phone connections are shown by Fig. 7. A small fixed condenser is secured in the lower half of the box, Fig. 5, and connected across the phones. The binding posts D, E, F, in Fig. 1, are for connecting the set with an Audion. They should be labeled as suggested in the diagram of connections, Fig. 8. When the Audion is used, simply raise the cat-whisker from the galena crystal. It is a good plan to use the hinge, after cutting in halves, for simplifying the connections to phones, condenser, and secondary. By so doing, all loose wires except the secondary cable may be done away with.

With this little set I have received 1,500 miles on a 50 ft. aerial using the galena detector. It is practically as efficient as sets of much larger dimensions and the results obtainable with it will amply repay the owner for the trouble of constructing it.

EASY MELTING SILVER SOLDER

Melt together 10 gr. of pure silver and 5 gr. of soft brass. Add to the melted alloy a small piece of white arsenic (arsenic trioxide) and let it cool. To use, break the above solder in small pieces and mix well with calcined borax.

Contributed by V. CAROUSO.

HOW TO UNDERSTAND THE MATHEMATICS OF RADIO TELEGRAPHY

PART II

BY M. B. SLEEPER

Squares. A small figure, placed at the right and above a letter, symbol, or number, signifies the number of times the expression is to be multiplied by itself. That is, a^2 , expressed as "a square," means $a \times a$, or a^4 means $a \times a \times a \times a$. Thus the small 2 at the right of the parenthesis $(XL - XL)^2$ shows that the value of the expression in the parenthesis is to be multiplied by itself, which is $10 \times 10 = 100$. Now we have

$$Z = \sqrt{R^2 + 10^2}$$

$$Z = \sqrt{R^2 + 100}$$

If

$$R = 2,$$

R^2 means $R \times R$, or $2 \times 2 = 4$. Putting this value for R^2 ,

$$Z = \sqrt{4 + 100}.$$

$$Z = \sqrt{104}.$$

It is possible to figure the square root of 104, but from Table I,* the square root can be easily found. Looking at the column headed n , follow down to the number 1.04. If the number of which we wish to find the square root had been 10.4, the square root would be in the column headed $\sqrt{10n}$. The number 104 is equal to 1.04×100 . Now the square root of 100 is 10. Therefore we multiply the square root of 1.04 by 10, to give the square root of 104. If the number had been 1040, we would have looked in the $\sqrt{10n}$ and multiplied the square root by ten.

The square root of 104 is 10.198, or

$$Z = 10.198$$

In squaring a number, such as 2, look in the column headed n and across to column n^2 . The square of 2 is 4. If the number had been 20, or 10×2 , we would have looked for the square of 2 and added two ciphers, giving 400, or if it had been 200, added four ciphers, giving 40,000. In the same way, the square of 179 is 32,041.

* This table, six pages long, was omitted from the magazine. However, it will be sent to anyone, without charge, upon receipt of a stamped, addressed envelope. The table gives n^2 , \sqrt{n} , $\sqrt{10n}$ from 1.01 to 10.00, in steps of 0.01.

Greek Letters. There are only a few Greek symbols used commonly in radio work; these are listed below with their pronunciation and meaning:

- δ , delta = decrement.
- λ , lamhda = wavelength.
- π , pi = 3.1416.
- τ , tau = coefficient of coupling.

The equation for the coefficient of coupling,

$$\tau = \frac{M}{\sqrt{L_p L_s}}$$

is a little more difficult. Here τ is the symbol for the coefficient of coupling, M is the mutual inductance in cms., L_p is the inductance of the primary, and L_s is the inductance of the secondary, both measured in cms. When

$$L_p = 20 \text{ cms.}$$

$$M = 500 \text{ cms.,}$$

$$\text{and } L_s = 12 \text{ cms.,}$$

we can substitute these values,

$$\tau = \frac{500}{\sqrt{20 \times 12}}$$

$$\tau = \frac{500}{\sqrt{240}}$$

Looking under the column headed n in the table of squares and roots, we find 2.40. Since we must multiply 2.40 by 100 to give 240, we will look across to the column headed \sqrt{n} . The square root of 2.40 is 1.54919, and, multiplying by the square root of 100, we find 15.4919 to be the square root of 250. The division line shows that 500 must be divided by 15.4919, which gives 32.28, or

$$\tau = 32.28$$

Proportion. In designing transformers, proportion is used. A

ratio is an indicated division, as $\frac{a}{b}$, or $\frac{4}{2}$. A proportion is made

$$\frac{5}{2} = \frac{10}{4}$$

up of two equal ratios, such as $\frac{5}{2} = \frac{10}{4}$. The two ratios are equal,

for they reduce to the same value. We can also say 5 is to 2 as 10

is to 4. The "is to" means "divided by." The proportion $\frac{5}{2} = \frac{10}{4}$

can be written $5 : 2 :: 10 : 4$. In any such proportion, the product of the two outside terms equals the product of the two inner terms. for $20 = 20$. This is useful when one of the terms of a proportion

is unknown. If we have the proportion $\frac{9}{x} = \frac{36}{12}$, to find the value

of x we will multiply 9 by 12 and 36 by x . Then

$$36x = 108.$$

Dividing 108 by the coefficient of x , we find that

$$x = 3,$$

and this is right, for, substituting the value of x in the original

proportion, $\frac{9}{3} = \frac{36}{12}$.

Suppose that we decide to supply the primary of a transformer with 110 volts, and wind it with 500 turns of wire. If the open circuit secondary voltage is to be 10,000, we will make the proportion

$$\frac{110}{500} = \frac{10,000}{x},$$

for the ratio of primary voltage to primary turns must be the same as the ratio of secondary voltage to secondary turns. The proportion could be written $110 : 500 :: 10,000 : x$. Multiplying the two outer terms and the two inner terms,

$$110x = 5,000,000.$$

Then

$$x = 45,555.$$

Plotting Curves. A number of curves have been given in this book to assist in making calculations. Tables serve the same purpose, but it is easier to visualize the meaning of a curve than of a table. In measuring the capacity of a condenser, for example, the readings may be taken at every 10 degrees of the scale. The results are then recorded by a table giving the capacity at each position of the pointer.

20°.....	.0001 mfd.
40°.....	.000245
60°.....	.00033
80°.....	.00039

100°.....	.00043
120°.....	.00047
140°.....	.0005
160°.....	.00053
180°.....	.00055

By means of this table, a curve can be made, Fig. 3. Take a piece of squared paper, with ten divisions between the heavy lines. On the heavy lines set down the values of the scale reading, as 20°,

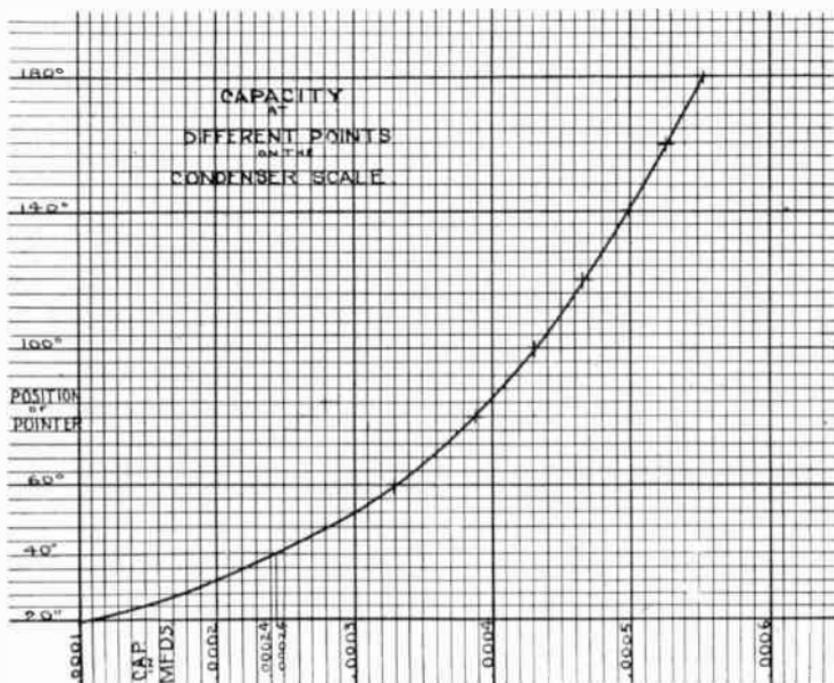


Fig. 3. The use of a curve makes it possible to visualize the meaning of a table of figures.

60°, 100°, etc. Since there are 40° between the heavy lines, each division will equal 4°. In the same way, the capacity values are set off on the heavy lines, as .0001 mfd., .0002, etc. Each small division will equal .00001 mfd. The first reading of the table is 20° — .0001 mfd. Therefore, the point corresponding to these readings will be on the 20° horizontal line, and the .0001 mfd. vertical line. The next point is 40° — .000245 mfd. This will be on the 40° hori-

zontal line. If the capacity value had been .00024, the point would have been on the fourth line left of .0002, or the fifth line if it had been .00025. But since it is .000245, it will lie just between the two. The same method is used in locating the other points. When the series is complete, the points are connected by a smooth curve.

In reading the curve, it may be necessary to determine the capacity at 44° . Since each vertical division is 4° , the point on the curve will be at the line above 40° . This point is directly over .000265 mfd. Curves are so convenient and widely used that an understanding of their use is essential in all electrical work.

An understanding of these elementary principles is sufficient to enable the practical worker and experimenter to solve all the problems in radio work. The more difficult ones, involving calculus and higher mathematics, require measurements which can be made only with very elaborate laboratory work. For this reason, the mathematics used in their solution will not be discussed.

CHEMICAL LABORATORY APPARATUS

BY GUSTAVE REINBERG, JR.

AN ELECTROLYSIS APPARATUS

THE electrolysis apparatus described below will be found fully as serviceable as one of commercial design, with the added advantage that it may be used for those operations which require a porous diaphragm. It can be easily constructed at a small cost by any one having a little experience in glass-working.

Two holes are made diametrically opposite each other near the bottom of an 8 or 9-inch test tube, Fig. 1, in the following manner: The test tube is tightly corked and by means of a blowpipe a flame is directed upon the point where the hole is desired; the air inside of the tube becomes heated and expands, puncturing the tube at the point where the flame has softened it. The hole just made is plugged with a piece of chewing gum and the process is repeated on the other side. Two test tubes having a side outlet near the top should be heated and drawn out at their lower ends, then cut off with a file at the lower end of the constriction, leaving them as shown at *B* and *B'* in the accompanying figure. The ends of their side tubes are fused into the holes in the test tube, which is also done in the blowpipe flame. The joints are kept from collapsing during the fusing with a brass rod filed to a point at one end, with which they are flared while soft. When fusing the

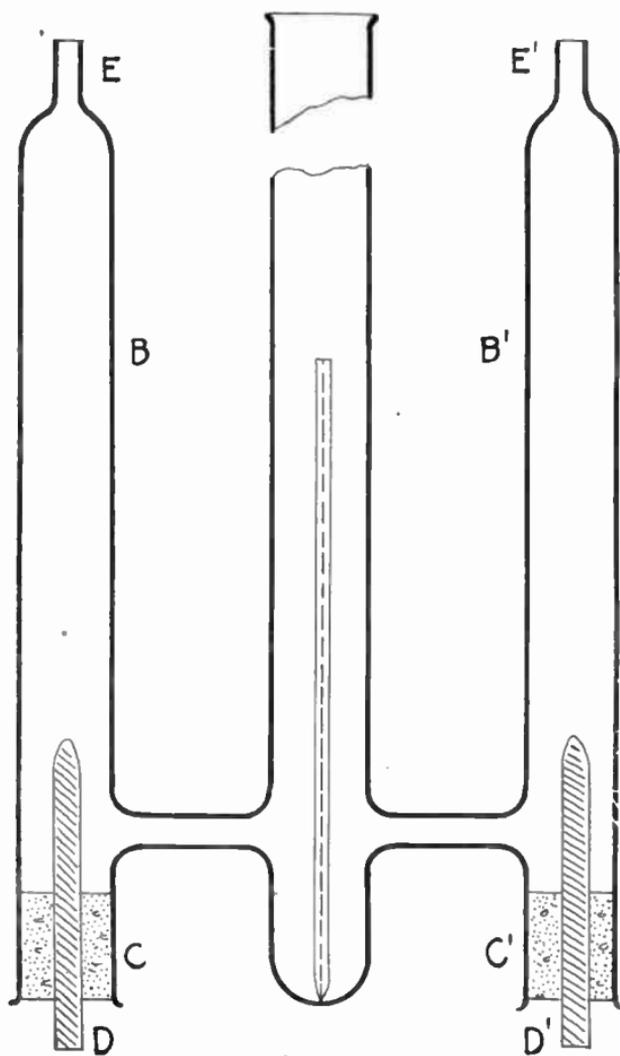


Fig. 1. Electrolysis apparatus made of glass tubing, stoppers and carbon sticks.

first tube the rod is inserted through the hole in the opposite side of the test tube, for the second it must be bent at right angles at the end and manipulated from the mouth of the tube. Stoppers *C* and *C'* are inserted in the outer test tubes, and the carbon pencils *D*, *D'* are the electrodes. Two pieces of rubber tubing fitted with pinchcocks should be attached to the outlets *E* and *E'*.

For the collection and testing of small quantities of gas the whole apparatus is filled with the electrolyte and the pinchcocks closed before turning on the current. The gases collect in the tubes *B* and *B'*, causing the electrolyte to back up into *A*. The gases are then collected as desired from the outlets. For the continuous generation of gases the cocks are left open and the gas collected as generated from the delivery tubes, the electrolyte being replenished through *A*. Where a porous diaphragm between the anode and cathode compartments is necessary, the desired material is stretched over a U-shaped rod of glass or heavily shellacked metal of the proper size to fit tightly inside the tube *A*. Such a diaphragm is shown in position in the figure.

With water as the electrolyte hydrogen is released at the cathode (negative electrode) and oxygen at the anode (positive electrode). As water itself is a non-conductor, some ionogen must be dissolved in it to make it a conductor. Sulfuric acid (H_2SO_4) or sodium hydroxide (NaOH) are particularly satisfactory for this purpose as the secondary reactions so adjust themselves that only the products of the decomposition of water are liberated at the electrodes. Chlorine is obtained at the anode by electrolysing preferably hydrochloric acid (HCl), because other chlorides give secondary reactions at the electrodes. Chlorine and sodium hydroxide are made commercially by electrolysing a sodium chloride (NaCl) solution and using a porous diaphragm, and this experiment may be preferred in the above apparatus with a partition of asbestos cloth; the chlorine is liberated at the anode, and sodium hydroxide collects around the cathode, where hydrogen is liberated. With 110 volts a 60 or 100-watt lamp should be placed in series with the circuit.

RESTORING OLD PAINTINGS

The white pigment used on oil paintings is a basic carbonate of lead, $\text{Pb}_3(\text{OH})_2(\text{CO}_3)_2$, commonly known as white lead. The minute quantities of hydrogen sulfide (H_2S) in the air gradually change this compound to black lead sulfide (PbS), and the white parts of the painting assume a brownish-black hue. The white

color may be restored by going over the picture with a solution of hydrogen peroxide, which oxidizes the lead sulfide to the white sulfate, according to the equation $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$.

The process is nicely illustrated by the following experiment: Dissolve about 0.5 grams of lead nitrate in 10 ccs. of water in a test tube, and add 10 ccs. of a 5 per cent. sodium carbonate (washing soda) solution, thus precipitating the basic lead carbonate. Filter off the precipitate, dry the filter paper, and place it with its adhering white lead into a dry test tube fitted with a two-hole stopper. Now pass hydrogen sulfide (generated from iron sulfide and dilute hydrochloric acid) through the test tube. The filter paper will turn black, but is whitened upon immersing it in hydrogen peroxide. A 3 per cent. solution of hydrogen peroxide, sold under the trade name "Dioxogen," is sufficient for all the purposes mentioned above.

IRON COMPOUNDS AND THEIR IMPORTANT USES

Among the important uses of iron compounds may be mentioned inks, blueprints, and pigments. A summary of these uses with illustrative experiments is given below.

The action of inks and of blueprints depends upon the existence of two types of iron compounds, known as ferrous and ferric compounds, in which iron has a valence or combining power of two and three, respectively. Compounds of the two classes vary widely in properties, but each type may, by suitable treatment, be converted into the other form. Ink is composed of ferrous tannate, which is colorless and soluble, but which is converted into the insoluble and jet black ferric tannate upon exposure to air. A dye is added to make the ink visible when first written. To illustrate the action prepare some ferrous tannate by adding a solution of tannic acid to a solution of ferrous sulfate (green vitriol). About 10 ccs. each of 10 per cent. solutions should be used. Divide the ferrous tannate into two parts, to one of which add a few drops of hydrogen peroxide; allow the other to stand a short time. In both cases the ferrous tannate was oxidized to the ferric form, with the attendant change in color and solubility.

Potassium ferricyanide occasions only a brown coloration when added to a ferric salt, but a deep blue precipitate (Turnbull's blue) with a ferrous salt. Certain ferric salts are reduced by light to the ferrous condition as may be shown by the following experiment. To a solution of 4 grams of ferric chloride ($FeCl_3$) in 10 ccs. of

water add an equal volume of a saturated oxalic acid ($H_2C_2O_4$) solution, and divide the mixture into two parts, one of which is kept in the dark, the other exposed to direct sunlight for a few minutes. A few drops of potassium ferricyanide occasions a deep blue precipitate with the exposed liquid but not with the other. In practice the ferricyanide is mixed with the sensitizing solution, so that only washing in water is required to develop the print. A practical "blueprint" paper can be made by coating a non-porous paper with a solution made according to the following formula:

Ferric ammonium citrate (green scales).....	12.5 grams.
Potassium ferricyanide	4.5 "
Water	100 ccs.

The solution should be filtered and applied in a subdued light. The solution spoils with age, so is best prepared immediately before use.

A paper which would give an exact reproduction of the original in black lines on a white ground is much more desirable from many standpoints than the conventional type of blueprint. The paper about to be described possesses the added advantage of printing very rapidly, in from four to six minutes in good sunlight and a correspondingly longer period with less favorable illumination. The sensitizing solution is prepared according to the following formula:

Hydrochloric acid	0.6 ccs. (12 drops)
Gelatin	0.6 grams.
Oxalic acid	0.7 "
Ferric chloride	0.5 "
Tannic acid	0.6 "
Water	30 ccs.

Warm together 20 ccs. of the water, the hydrochloric acid, and the gelatin, until the latter dissolves, then add the other ingredients in the order given, dissolving the tannic acid in the remaining 10 ccs. of water before its addition. It is imperative that the paper be coated absolutely evenly, as otherwise a streaky and not fully developed print results, therefore the following procedure must be adopted. Pour the solution into a shallow pan having at least one straight true edge, then pick up the paper (which should not be over 8 inches wide) in both hands, allowing it to fall in a loop. Lower one end of the paper until its lower surface comes in contact with the solution, then pass the paper along so that every part

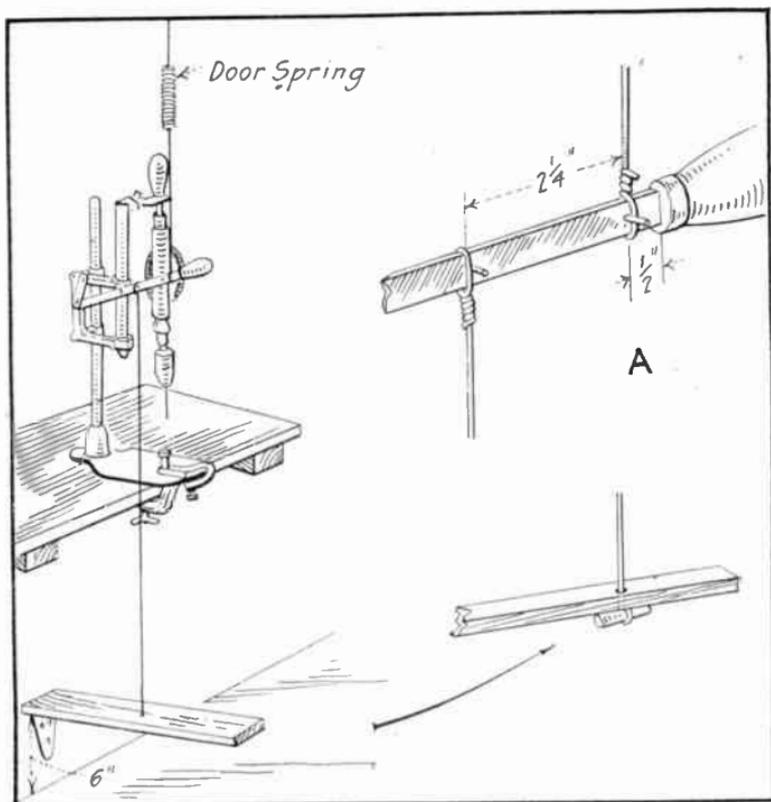
of its under side is coated with the solution, being careful that none of the liquid comes over the back of the paper. Now bring the paper squarely in contact with the edge of the dish, and with a steady motion draw the paper over the edge, thus evenly scraping off the excess liquid. The paper may now be hung up to dry, when it will have a light yellow color. When exposed to the light the exposed parts turn white, and on washing with water the yellow lines remaining turn black. A gelatin or glue-sized paper gives the best results.

Prussian blue is important as a pigment and as laundry bluing. It may be prepared by adding a solution of potassium ferrocyanide to a solution of ferric chloride, when it is precipitated, although it is composed of such fine particles that it appears to be a solution. If the soap is not thoroughly washed out of clothes before the bluing is applied, the alkali of the soap precipitates ferric hydroxide from the bluing, and appears as rust spots on the cloth. This action may be shown by adding some sodium hydroxide (caustic potash) to the prussian blue prepared above.

A FOOT FEED DRILL PRESS

By L. L. LLEWELLYN

I FOUND it next to impossible to use a hand-drill press as the work would continually slip in the clamp while my two hands were engaged in turning the drill and feeding; so I removed the feed lever and drilled a small hole with a 35 drill, $\frac{1}{2}$ in. from the handle and $2\frac{1}{4}$ in. from it; then forced a soft steel wire of the same diameter and about $\frac{3}{4}$ in. long in each hole and replaced the handle. With a plumb-bob I located the point in the ceiling directly over the wire nearest the handle and screwed in a stout hook. I now took some wire of the same kind used in the lever and about 2 ft. long and looped around the lever passing it before the pin on one side and behind the pin on the other, so it wouldn't slip. The other end of the wire looped into the eye of a 20 cent door spring. The drill was raised as high as it would go and another wire looped into the other eye of spring, then enough wire used to connect with the hook in the ceiling to raise the lever arm clear up. I now procured a good clear board 2 ft. long, by 3 in. wide and 1 in. thick, sawed off a bevel on one end and hinged it to the wall 6 in. from the floor, directly beneath the feed lever arm,



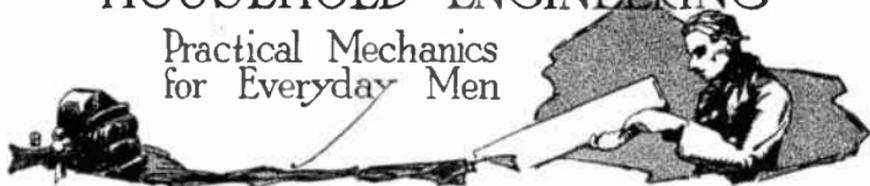
The hand drill press was turned to foot power.

beveled end to the wall. Then I bored a $\frac{1}{2}$ in. hole in the center of the board directly under the second pin in the handle. A length of wire was securely looped around a 3 in. piece of $\frac{3}{8}$ in. cold rolled steel, the other end of wire run up through the hole in board and fastened around the feed lever arm at the pin, with the board parallel to lever, or nearly so. I could now hold the work with my left hand, turn the drill with the right, and feed with my foot on the board. A stool of proper height adds greatly to comfort and stability.

If the wire loops are made about 3 in. long where they fasten to the lever, they can be easily slipped over the handle and removed if necessary.

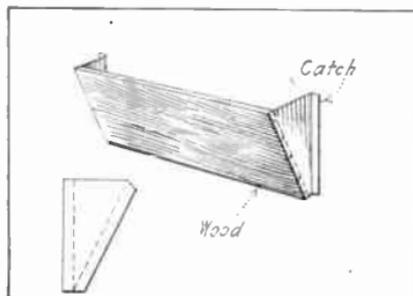
HOUSEHOLD ENGINEERING

Practical Mechanics
for Everyday Men



A VENTILATING ATTACHMENT

Oftentimes when a window is opened slightly, a strong draft is set up in the room, which is dangerous and does not ventilate the room properly either. The air, as it enters the rooms, should be first deflected upward, thus insuring better ventilation



The ventilating attachment.

and circulation of the air in the room. A device to be placed in the window to do this is easily made as follows: A board about three-fourths of an inch thick and eight or ten inches wide is cut just as long as the opening in the window, when the window is raised. Two pieces of galvanized iron, as shown in the drawing, are screwed to the end of the board, one to each end,

with the iron projecting on the same side of the board. The end is then bent outward on each piece, about one-half inch from the end. This is to serve as a hook or catch, which is to be placed in the inside guide of the window. The galvanized iron is quite springy, so that the outside ends can be bent in just a little and placed in the space in the window, where they will be held in place by the outward push of the pieces. The iron should be heavy enough so that a strong wind will not blow them out of the window. When the air enters the window now, it will be deflected upward by the slanting board and the dangerous drafts will be avoided.

Contributed by FRANK SAHLMANN.

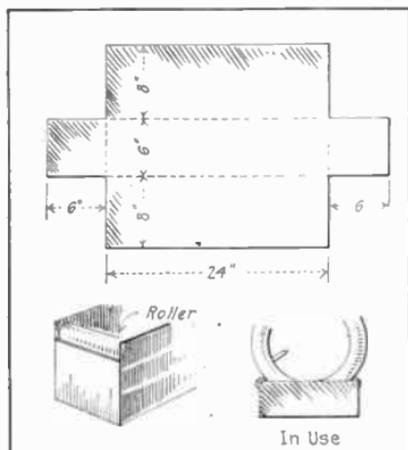
YELLOW SHELLAC

Dissolve white shellac in pure alcohol and in the filtered solution add 2 per cent. by weight picric acid and 1 per cent. boric acid. After drying, this shellac will show a beautiful yellow finish.

Contributed by V. CAROUSO.

TANK FOR TESTING INNER TUBES

It is often difficult to locate slow or pin-hole leaks in inner tubes, the usual method being to immerse the tube in water. This is very inconvenient when no special tank is handy for the purpose. The easily construct-



The test tank is made of sheet iron. The testing tank described herewith will make such tests quick and sure.

From galvanized iron or roofing tin, cut a piece to the dimension given in the cut. Bend up the four flaps and solder the edges forming a rectangular box measuring 24 x 8 x 6 in. It will be noticed that the ends are one inch lower than the sides.

In the spaces thus formed two rollers are placed. These rollers may be made from several large spools with their heads removed, or by drilling a hole

through 6-in. pieces of $\frac{3}{4}$ -in. dowel rod. The rollers are held in place by an iron rod threaded at the ends, and fitting into holes in the sides of the box. The rod is held in place by means of nuts screwed onto the ends. An alternative would be to pass a cotter pin through a hole in either end.

The tank may be painted, or left plain as desired. Filling it two-thirds full of water and by running the inner tube through, tiniest leaks are indicated by air bubbles.

Contributed by T. W. BENSON.

TO BLACKEN ALUMINUM

Rub the surface with fine sandpaper. Then apply a thin coat of olive oil and heat it over an alcohol or bunsen burner. The oil evaporates in a few seconds, giving the surface a grayish-black color. By repeating the process two or three times this will turn to a perfect black.

Contributed by V. CAROUSO.

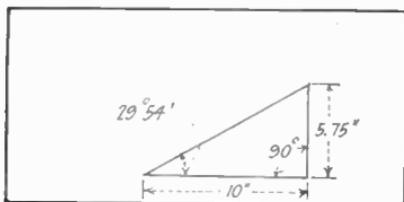
A DEAD BLACK VARNISH

Dissolve 30 grams of shellac in 500 c.c. of water to which 15 grams of borax has been added. When the dissolution is complete, add 15 grams of glycerine and mix well. Color the varnish with 60 grams of aniline black. For photographic apparatus, this varnish is supreme.

Contributed by V. CAROUSO.

LAYING OFF ANGLES TO THE FRACTIONAL PART OF DEGREES

The fractional part of a degree is somewhat difficult to read from ordinary semi-circular protractors, but with the use of a table of "Natural Tangents," both accuracy and speed are attained. From handbooks containing these tables it will be found that the tangent of 29 degrees and 54 minutes (the angle required) is .5750. The tangent of an angle represents the alti-



One example of this system. tude in inches of a right triangle whose base is 1 in. long. Therefore, if we make a base 10 in. long, the altitude for the given angle will be ten times the tangent, or 5.75 in., as shown in the illustration.

Contributed by H. B. WRIGLEY.

TO CLEAN MARBLE

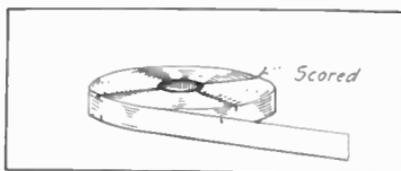
Wet the place to be cleaned by applying cold water, then wash with a solution of one-half cupful of oxalic acid to a quart of cold water. Care must be exercised not to leave the acid around where children can get it, as it is highly poisonous. Let the solution stand on the marble

for a while, then wash well with clean water. If the marble is not perfectly clean, repeat the process, but be sure to have the marble wet when you apply the acid.

Contributed by MARY F. SCOTT.

A TAPE KINK

The annoyance of having the edges stick when using friction



Score the roll on both sides.

tape may be eliminated by slightly scoring both sides of the roll with a sharp knife. This will cut the threads which cause the layers to stick.

FOR CLEANING VARIOUS SUBSTANCES

Oil marks on wall paper: Apply paste of cold water and pipe clay, leave it on all night and brush off in the morning. Iron rust may be removed from white goods with sour milk.

A slice of raw potato will remove all vegetable stains from the hands if rubbed in well.

A soft rag and sweet oil will remove finger marks from furniture.

Contributed by H. G. FRANK.

A CHAT WITH THE EDITOR



MOTORISTS—A WARNING!

ATENTION has once more been directed to the real and comparatively little known danger arising from the unburned gases in the exhaust from an automobile engine. This time we hear of the death of a Philadelphia man who permitted his motor to run after the car had been driven into the garage. The weather was cold, and he closed the door for a few minutes. His body was found later.

The writer of this has repeatedly warned his friends and acquaintances of this danger which is ever present and which gives absolutely no warning. The peculiar poison in this unburned exhaust gas is all the more deadly because it has no recognizable odor and neither can it be detected by any other means available to the layman.

The point, however, is this: Why worry about finding some means to detect the gas? Instead, take the precaution never to permit your motor, or any other internal combustion engine for that matter, to run a minute inside a closed room without adequate provision for the instant removal of the exhaust gases.

This goes also for the garageman. Who has not seen a crowd around a car inside a garage when a motor is being tested out? The operator may "race" the engine for reasons best known to himself. At some portion of the time when the spark is being advanced and the throttle opened, there will be literally gallons of deadly poison in gaseous form thrown into the atmosphere, for such is the inherent principle of the machine. Should anyone be standing directly in the path of the exhaust, nothing but an act of Providence could prevent his inhaling a few breaths of this subtle poison. Fortunately, the exhaust in its normal condition is so foul that few are sufficiently hardy to withstand it. This probably accounts for the comparatively few deaths from this cause.

HAS YOUR SUBSCRIPTION EXPIRED?

THIS is the first number of a new volume of our little magazine. The original family which gave the publication its start will want to know that the charter subscriptions beginning with December, 1915, expired with the last issue. It is to these loyal boosters and supporters that our remarks are offered.

We shall not sing our own praises in an effort to convince you that we have made good our promise to you. You are the best judge of that. We will say, however, that your little magazine has had an adventurous year of existence and that many of our most ambitious plans have had to be carried out gradually and some have had to be abandoned temporarily just through force of circumstances.

In the last issue the American Society of Experimental Engineers made its formal debut to the followers of the new **EVERYDAY ENGINEERING**. With the prestige of this Society and the co-operative assistance it will bring, we shall be able to give you a magazine of peculiar worth the coming year.

We want you with us this year and every year to come. If the magazine has interested you and helped you during its first year of existence, it will do so doubly the second. On another page you will find a subscription blank. Will you use it and give us a chance to show you how good a how-to-make and how-to-do magazine can be, particularly when it is edited by one of you and when most of its published material comes from your ranks?

ARE YOU A BUILDER OF MODELS?

YOU will find in this issue two photographs and a brief description of a model submarine built by Mr. Miller Patterson of St. Louis from directions given in former issues of this publication. Mr. Patterson's work is significant in that it shows a determination to succeed in his chosen hobby.

This radio-controlled submarine was the first model of such elaborate detail and difficult construction ever to be offered to the model engineers of this country in so far as we are aware. The demand for the back numbers of the magazine containing these articles was so great that the entire edition of each was soon exhausted and we have never succeeded in filling all of the orders for these copies.

To date we have learned of some fifty-odd models in course

of construction in various parts of the country. We have had photographs of the hulls and, in some cases, of various devices ready for installation. Mr. Patterson has, however, the distinction of being the first to complete his model, put it in operation and send us the photographs of his handiwork.

Surely there must be many model makers who build models as ambitious as this. We have answered hundreds of inquiries relative to this one model submarine. If you are a builder of models in gratification of a hobby, write us; we want to hear of your successes, your difficulties. We will not admit of your failure, for who knows but we may be able to remove the difficulty and turn failure into success?

THE NEXT ISSUE

THIS little magazine is getting to be too limited in its number of pages to permit us to give you all of the good things we have in store. That accounts, sometimes, for articles being left out, thereby arousing your ire with just and sufficient cause.

We have seen Prof. Houghton on the firing line and when he writes us that he's up to his ears and can't possibly get through the dope for the next issue in time, we have to swallow our disappointment and wonder what *you* will say. You usually say it, you know. And even if it does hurt, we like to hear it for this tells us you follow the articles.

Then again, there are other causes for disappointment. Every feature article published in this magazine is written from *actual experience*. Know what that means? You may take six months to build a device we describe in one issue. We have to build it in a month, and then suppose it does not work? It has to be built over again. It may work well but at the last minute we may discover a better, easier, cheaper way to do the same thing. You buy this magazine for the authoritative, dependable *information* it contains, not for plausible suggestions. This publication is, or should be, the clearing house for the information you need. That is what we aim to make it and that is one of the reasons why we have held over the second part of the article on the physician's high frequency equipment. We have found a way in which the D'Arsonval current can be strengthened materially with no increase in current consumption or discomfort to the patient. There is not time to make photographs and drawings for this issue, so it must wait for the next. Is not the delay justified?

The TECHNICAL ADVISER



The object of this department is to answer the questions of readers who may experience difficulty in the construction or use of apparatus described in the magazine. The columns are free to all readers whether they are subscribers or not, and questions pertaining to matters electrical or mechanical will be answered in the order in which they are received. If the reader cannot wait for an answer to be published he may secure an immediate answer by mail at a cost of 25 cents for each question.

76. V. O., Naugatuck, Conn., asks where he can purchase a selenium cell, or where he can get a book on this subject.

Ans.—We have made attempts to buy reliable selenium cells, but they have all failed. There is no manufacturer in this country who makes selenium cells, at a moderate price, which are worth buying.

Moreover, there is no book on the construction of selenium cells. You will find, however, a brief description of this device in "Wireless Transmission of Photographs," by Marcus J. Martin. You can buy this book from EVERYDAY ENGINEERING. The price is one dollar.

Selenium can be purchased from Eimer and Amend, 18th St. and 3d Ave., New York City, but in its crude state it is worthless for electrical work. Roughly, a cell is made of a porcelain tube, wound with two bare wires close together. Then the selenium is melted and smeared in a thin coating over the wires. After this, the cell is put in an annealing oven, or placed over a heater, at a temperature which

IS YOUR STORAGE BATTERY STARVED

?



Prof. Houghton Says:

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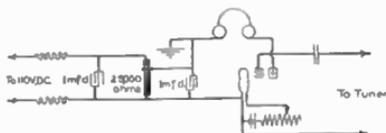
WM. J. MURDOCK CO.

50 Carter St.,

Chelsea, Mass.

keeps the selenium just below the melting point. After several hours, the cell will be so annealed that the resistance will be low enough to pass a current of electricity. The longer the annealing, the lower the resistance. The two wires, covered in the selenium, act as the two sides of the circuit.

77. A. E. G., Portland, Ore., wants to know if he can put 110-volt alternating current through a rectifier and a rheostat to use in place of the A and B batteries of an Audion. Ans. It is im-



possible to use rectified current, or even ordinary direct current from a generator, on the Audion detector. Both the A and B currents must be from batteries. Otherwise there is great interference which renders the Audion inoperative. Dr. de Forest has patented a system for using 110-volt direct current from a generator. A diagram is given here to show the elements of the system. Any experimenters who try out the circuit should let us know, that we may publish the results of their work.

78. C. J. H., New York City, has (1) a storage battery which has not been used for two years, and wants to know if it is still in good condition. Ans. If the battery was first fully charged, then emptied and thoroughly cleaned in the distilled water before it was put away, it should work again after it has been