RADIO & MODEL ENGINEERING

A Magazine of Technical Accuracy for the Radio Engineer, Dealer, and Manufacturer

Edited by M.B. SLEEPER

RESISTANCE COUPLED AMPLIFIER

ONE STEP OF TRANSFORMER COUPLED AMPLIFICATION IS USED WITH THIS UNUSUALLY EFFICIENT UNIT.

TOOL EQUIPMENT FOR THE RADIO MODEL SHOP OR THE EXPERIMENTER'S LABORATORY.

COMMERCIAL TYPE SETS AND CIRCUITS—THE DAVEN RESISTANCE COUPLED AMPLIFIER.

FIFTH INSTALLMENT OF THE PLANS FOR BUILDING A MODEL 310-FOOT U. S. DESTROYER.

20c a Copy—In England, 1/-

JULY, 1924

Vol. 4 No. 6

Informative and money-saving booklets on radio batteries sent free on request. If you have any questions regarding radio batteries, write to G. C. Furness, Manager, Radio Division, National Carbon Company, Inc., 130 Thompson Avenue, Long Island City, N. Y.

Every radio user should have these books

THEY contain battery facts that it is important for you to know. They are *not* catalogs, *not* advertising pamphlets, but each one tells the story of one kind of battery, what it is, what it does, how to connect it, how you can get the utmost in satisfaction and service out of it.

Do you know why a "B" Battery is necessary? Do you know how much "B" Battery current your tubes use? Do you know what a "C" Battery can do for you? All these things and many more are told in these informative booklets. Many of these facts you can secure elsewhere only by digging through several different works on radio engineering. These booklets present battery facts, in plain language, with a few simple diagrams.

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To take the mystery out of radio batteries, read these four booklets. Write for them today. Remember, they are FREE.

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When you wonder what that station is, turn to this list of Class B broadcasters and their schedules of transmission without waiting to hear the call letters. You can pick the station from its wave-length and the time at which you hear it. Sent. FREE.

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BLUEPRINTS

During the past three years, Radio and Model Engineering has developed a system of making panel patterns and picture wiring diagrams which, as success insurance to the radio set builder, are superior to all others. Below is a selection of blueprints giving the designs of the finest sets which have been shown in R. & M. Each is one hundred per cent good in its class.

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1. DX receiver, a four-tube non-oscillating tuned R. F. set which has an unlimited range, coupled with sharp tuning, making it an ideal outfit for the man who wants the best for loud speaker reception. Set of six blueprints, type 5300..... **$1.50**

2. Portable tuned R. F. set, using four UV199 tubes. This is similar to the type 5300, but smaller and less expensive. It also operates a loud speaker, with perfect quality, up to several hundred miles. Set of three blueprints, 5800..... **$.75**

3. Circuits come and go, but the famous X-1900 three-circuit regenerative set is as popular as ever. Equipped with one tube, this is a splendid outfit for those who play radio golf and want a record score. Set of three prints, type X-1900..... **$.75**

4. T. C. circuit set — Twenty-five cities for twenty-five dollars — it is a one tube UV199 outfit that runs rings around any other outfit at the same cost. With an amplifier it brings in everything that's on the air. Set of three blueprints, type X-4000..... **$.75**

5. Rasla Reflex is the choice for one-tube reflex sets, for it is sharp, has only one tuning control, and works with a UV201-A, making a storage battery unnecessary. The crystal is of the fixed Rasla type. Set of three blueprints, type 5900..... **$.75**

6. Two-step amplifier, a unit which can be added to any receiving set. Takes any type of vacuum tubes. Jacks permit plugging in at each step. This is the most popular and practical amplifier to use. Set of three prints, type 3100..... **$.75**

Special Offers to Experimenters

We still have a few volumes of R and M for 1923. They are handsome books, bound in leather, and chock full of dope that is always useful. They have been advertised at three dollars, but those remaining will be sold at one dollar if the order is accompanied by a year's subscription to R and M, either a new one or an extension.

The new book, Super-Heterodyne Hook-ups, is now ready. This is not a reprint book, by the way. You can buy it at fifty cents a copy, or you can get one without charge by sending in a new subscription to R and M or extending your present subscription.

These offers are only good until September first — so get your order in right now.

M. B. SLEEPER, Inc. A-52 VANDERBILT AVE. NEW YORK CITY

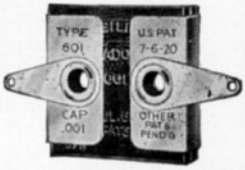
Dubilier Micadons
Make Set-building Easy

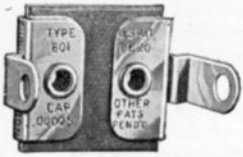
The man who builds his own radio set has the assurance that no matter how he may arrange his transformers, his grid-leaks, his tubes there are regular and special Dubilier Micadon fixed condensers that facilitate his task.

Every circuit requirement is met by some Dubilier Micadon.

Micadon type 601 T has adjustable clips which slip over transformer and other binding posts. Price 45 cents up.

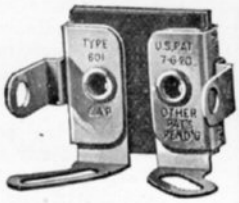
Dubilier Micadon type 601 — standard for straight circuits. Extension tabs facilitate soldering. Price 35 cents up.

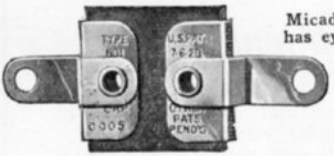




Micadon type 601 G has clips to hold fixed grid-leaks. Price 45 cents up without grid-leak.

Micadon type 601 G-T has clips to hold fixed grid-leak and adjustable clips that slip over binding posts. Price 55 cents up.





Micadon type 601 L has eyeletted tabs that receive the terminals of a variable grid-leak. Price 45 cents up.

A special Dubilier by-pass condenser has been made which eliminates noises and increases signal strength. Used across the "B" battery terminals. Price, 70 cents up.

Dubilier Condenser and Radio Corporation

42-46 W. 4th St. **New York, N.Y.**

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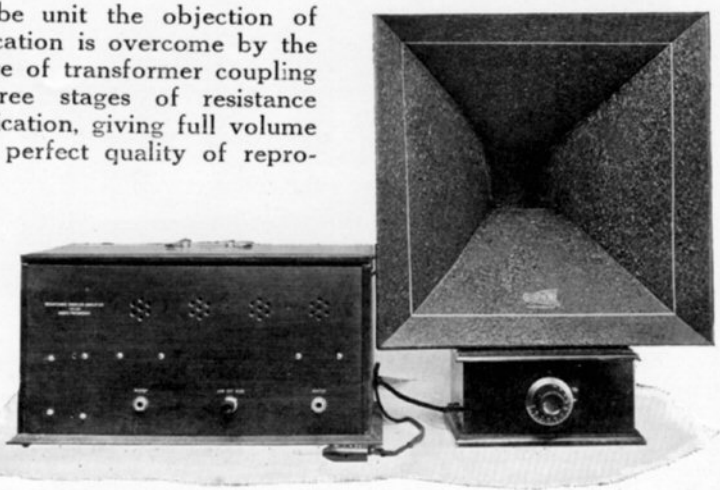
Resistance Coupled Amplifier

In this four-tube unit the objection of limited amplification is overcome by the use of one stage of transformer coupling before the three stages of resistance coupled amplification, giving full volume with the most perfect quality of reproduction.



SO instantaneous has been the popularity of the resistance coupled amplifier that everyone is building this type of unit. Some of these couplers have proved most successful while others have worked indifferently, depending largely upon the amount of data available to the constructor. The resistance coupled amplifier is an excellent instrument, giving good volume increase without distortion.

There is the drawback, to be sure, that the amplification per stage is not equal to that of the transformer type, but the quality is in favor of resistance coupling when the elements and the circuit are correctly designed.

The Type 6200 Amplifier

After a careful study of the two methods of amplification it was decided that the best results could be obtained from a combination of resistance and transformer coupling, the first stage transformer coupled and the three following steps resistance coupled. The reason for this is easy to understand. Since the increase in volume per stage is a constant factor, it is highly important to obtain the greatest possible increase on the first stage. To take simple numbers, suppose an amplification of 6 is obtained with the transformer and 4 with the resistance. Assuming the output of the detector to be 1, increasing this amount by 4 in a four-stage resistance amplifier the amplification is 1 x 4 x 4 x 4 x 4. This gives an amplification of 256 for the four-stage amplifier. On the other hand, with one stage of transformer coupling at the start the amplification is 1 x 6 x 4 x 4 x 4. That gives an amplification of 384.

For local reception, or when telephones are used, one step of amplification is often preferred. Consequently a jack is provided at the first step and another at the fourth step. Instead of using filament control jacks, a Carter jack switch is employed to disconnect the filaments entirely, to light the first tube, or to light all four tubes.

The objection might be raised that any distortion in the transformer coupled stage is multiplied by the amplification in three stages of resistance coupled, but as a matter of fact, the distortion introduced by one stage of transformer coupling is not noticeable. The type 6200 amplifier gives an amplification equal to three stages of transformer coupled amplification but there is no loss in the purity of tone. With three transformers, however, considerable distortion would be introduced.

Thus it was found that the most practical application of resistance coupling was to use it following a single stage of transformer coupling.

Standard Parts Required

Two panels are needed for this instrument, one 7 by 14 ins. and one 3½ by 13 ins. both 3/16-in. thick. Formica is recommended altho Dilecto or Celeron are satisfactory. The three plate-circuit resistances are of the Daven type, of 100,000 ohms each. For gridleaks three Electrad Variohms were selected to permit an adjustment of the resistance.

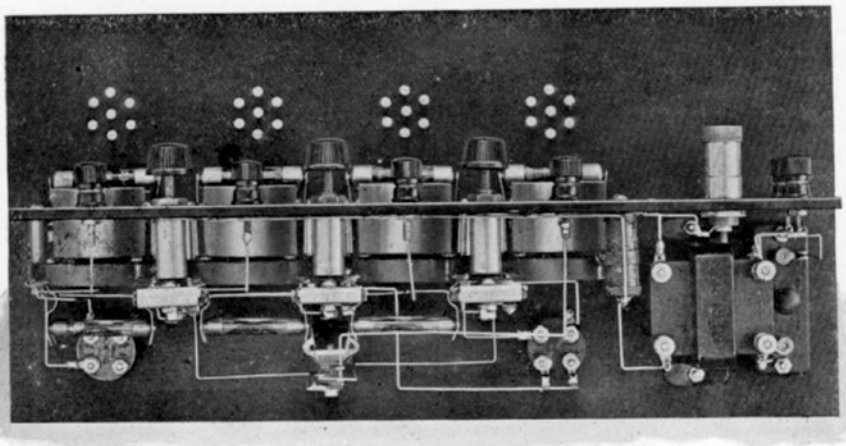


Fig. 1. Note the way in which the Micadons are supported on the Variohms, and the method of mounting the upper and lower parts of the Kantblo.

The other parts necessary are three 0.004 mfd. Micadons, 4 Paragon sockets, a binding post type Kantblo, type AF-6 Amertran, 2 Tri-Jacks, a 0.005 mfd. grid-denser, Carter 4-spring jack switch, 6 Ensign type Eby binding posts, and 4 type 1A Amperites.

The only hardware required are the 8 coil mounting pillars, 11/16-in. long by 5/16-in. diameter, threaded 6-32 clear through, and two right hand and two left hand nickeled angle brackets.

It is important to use Paragon sockets on this set because the spacing between the mounting holes on the base is just the same as the spacing between the holes for fastening the contact springs on the Daven resistance unit.

The amplifier is mounted in an Xcluso cabinet, a very attractive type, covered with leather. It is provided with a handle for carrying purposes.

Drilling The Panels

Figs. 3 and 5 show the front and tube panels at one-half scale. To transfer these dimensions to your panel, multiply each distance by 2, measuring from the bottom of the panel up and from the center line to one side or the other. This is the most accurate way of locating the holes. A very useful hand reamer is made by Stevens & Company. This has a considerable taper so that all the holes can be made with a No. 18 drill and those for the jacks and Variohms reamed out very quickly to the correct size.

After drilling the holes for the peepsights, countersink each one very slightly. This makes the appearance more cleancut. Engraving adds considerably to the attractiveness of the set. If you are not able to get this work done locally, the panel can be mailed to one of the concerns doing this work or it can be ordered already drilled and engraved. A simpler and less expensive way to get the characters on the panel is to use the Bruno transfers.

Kantblo And Amperites

The Kantblo tube protector consists of a mounting which serves as a binding post and also contains a tiny electric bulb. Beneath the panel is a resistance unit. If you unscrew the thumbnut from the upper part you will see the electric light with its tiny coiled filament. Normally this filament is cold and has a very low resistance but the moment the plate circuit is shorted the filament heats up and increases greatly in resistance. Thus it is not possible for enough current to flow from the B batteries to blow out the filaments of the tubes.

Because of the particular construction of this amplifier unit there is not room to put the resistance element in its usual place. Consequently the element is unscrewed from the upper part and mounted separately, as illustrated in the rear view. For that reason a connection is made between the two parts, 22 to 23 in the picture wiring diagram, Fig. 2.

Fig. 5 shows the position of the Kantblo in the circuit. It is always in the negative B battery lead and, consequently, current from the B battery must pass through the Kantblo. Therefore, if any of the connections or the socket springs are accidentally short circuited, the little bulb lights but the tubes are not burned out.

In place of rheostats an Amperite is used

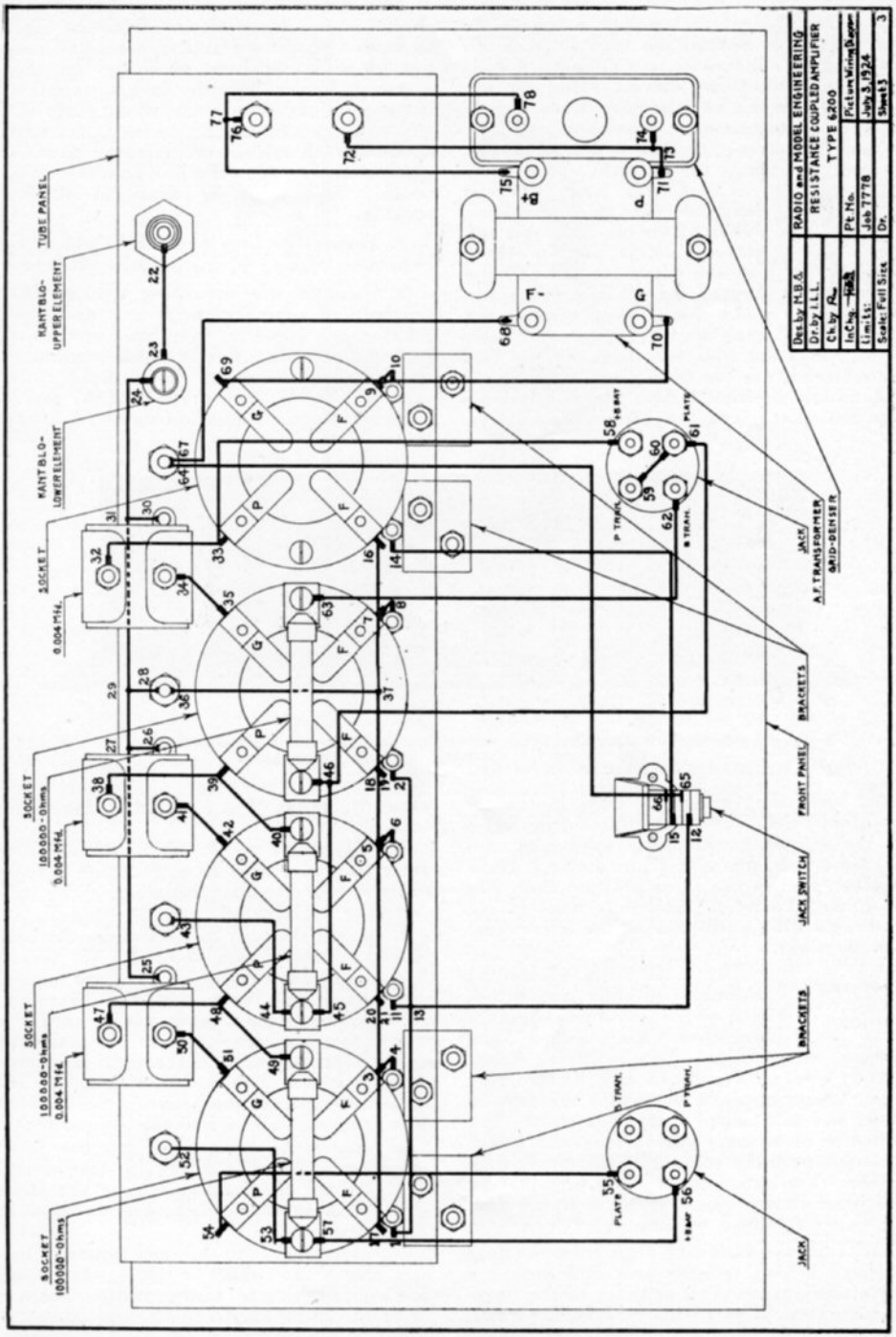


Fig. 2. In this picture wiring diagram the tube panel is tipped up so that you see the under side of it and the rear of the front panel

for each tube. This unit consists of a special wire filament sealed in the tube. As the current increases, the resistance of the filament also increases, maintaining a constant current of the correct value for the tube. When the battery runs down the resistance automatically decreases until, of course, it gets so low there is not enough current to operate the vacuum tube.

Adjusting the Jack Switch

The Carter jack switch is designed for two positions, either off or on. On this set, however, it is used at three positions so that the filaments are off, the first tube is lighted, or all the tubes are lighted. To make this change, remove the pointer and knob and take out the cam. Then file a flat half way between the two flats already on the cam piece. This gives the middle position. Also file a little from the flat that gives the off position. You must bend the springs so that, in the off position, neither of the contacts are closed, in the middle position the spring nearest the frame and the spring just above it make contact, and in the third position both sets of springs connect. You may have to cut and try a little until you get the adjustment exactly right.

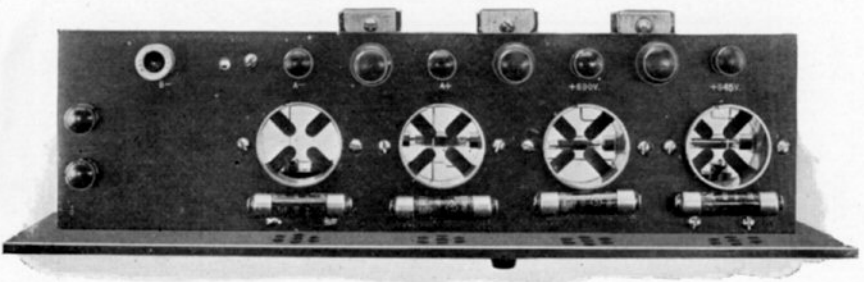


Fig. 6. Looking down on the tube panel you can see the Variohm control knobs and the Amperite filament current regulators.

Assembly And Wiring

The tools required for the assembly of this set are—A set of Stevens Spintite wrenches for round and square nuts, pliers, wire cutters, screw driver, and an American Beauty soldering iron. Always make sure that the iron is clean and well tinned before you start. You will also need some wire solder and Nokorode paste or the regular Kester rosin core solder. You can recognize Kester solder by the pinchmarks which keep the rosin from melting out ahead of time.

1. Take the mounting clips from the base of each Daven resistor unit and mount a set of springs on each of three of the Paragon sockets. Use ½-in. 6-32 R.H. screws, holding them in place by threading them into coil mounting pillars, on the upper side of the socket base. This arrangement is shown in the illustrations. Examine Fig. 2 so as to find out the arrangement and number of soldering lugs which go on these screws. Break off the socket terminals, leaving in place only the short piece into which the socket spring screw is threaded. Between each spring and clamping piece put a soldering lug with the lips pointing downward. This must be done on all four sockets.

2. Fasten the four angle brackets to the base panel, using ½-in. 6-32 R. H. screws.

3. Remove the mounting springs from the base of each Amperite unit and break off the springs where they bend over at the end of the base. Fasten these springs on the base panel, using ½-in. 6-32 R. H. screws and nuts, with the feet of the springs pointing inward instead of outward as they were originally. Put a soldering lug under each nut.

4. Connect 1 to 2. It is advisable to cover this wire with Empire tubing leaving an open space so that this wire can be connected at 13 later on.

5. Mount the four sockets under the base panel, putting ½-in. 6-32 R. H. screws through the base panel into the coil mounting pillars. Be sure that the bayonette slots on the socket tubes are toward the rear of the base panel. That will make the socket contacts come in the right positions. Connect 3 to 4, 5 to 6, 7 to 8, and 9 to 10. These are connections between the filament springs on the sockets to the Amperites.

6. Mount the base panel on the front panel, using ½-in. 6-32 R. H. screws and nuts. Mount the jack switch on the front panel, making sure it is upside down as in the illustrations.

7. Connect 11 to 12 and connect this wire also to 13 where a space was left in the Empire tubing for that purpose. Connect 14 to 15, 16 to 17, 18 to 19, and 20 to 21. In making connections 18 to 19 solder a long length of wire to lug 18. Then solder

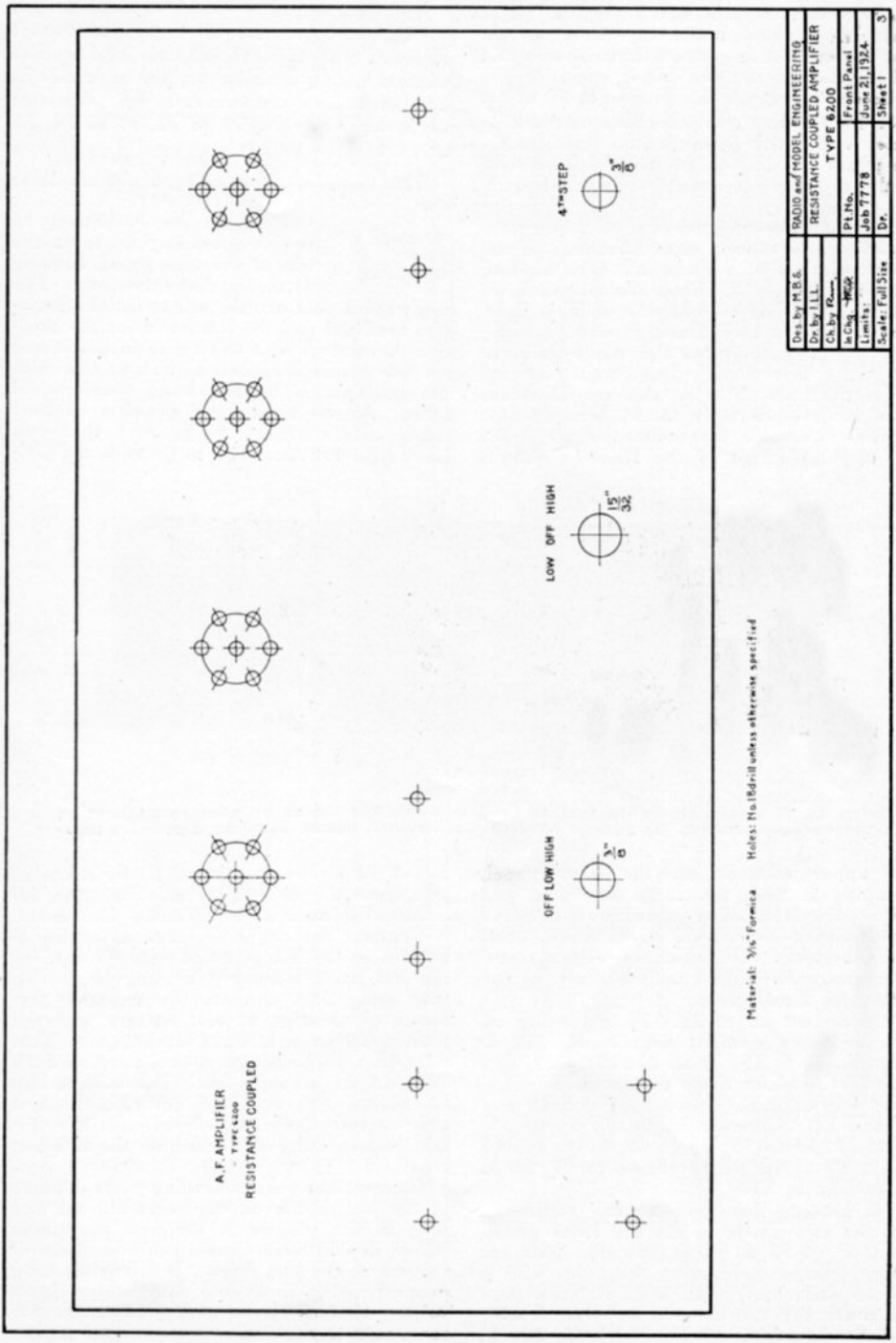


Fig. 3. The front panel at one-half scale. Make all holes with a No. 18 drill except where other sizes are specified.

this wire to the connection 16 to 17. After that joint has been made cut off the wire to just the correct length. Otherwise one end will melt off when the other end in being soldered. Continue this process at 20 to 21.

8. Mount the three Variohms on the base panel with the connection tab under the panel pointing to the right as you look at the set from the rear. Put a soldering lug clamped by a ½-in. 6-32 R. H. screw and nut on one terminal of each 0.004 mfd. Micadon and mount each Micadon on the lower terminal of a Variohm. The binding post nut serves to hold the Micadon in place. Put a lug on each one of these nuts. Mount the six Eby binding posts, making sure that the holes for the wires point in the right directions. Lugs can be used under the nuts altho on this set the wires were soldered directly to the binding post screws. Unscrew the resistance unit from the upper element of the Kantblo, mount the upper element on the base panel, clamping it with the large hex nut, and mount the resistance element under the panel with a ½-in. 6-32 R. H. screw. Put a lug between the resistance element and the panel and another on the screw at the bottom of the element.

9. Connect 22 to 23. 23 is the lug on the resistance element next to the panel. Connect 24 to 25, 26 to 27, 28 to 29, and 30 to 31. Make these connections in the same way as those between 18 and 19 and 20 and 21. Connect 32 to 33, 34 to 35, 36 to 37, 38 to 39, 39 to 40, 41 to 42, 43 to 44, 45 to 46, 47 to 48, 48 to 49, 50 to 51 and 52 to 53.

10. Mount the grid-denser, Amertran and the two Tri-jacks on the front panel. Use 1-in. 6-32 R. H. screws and nuts for the grid-denser, enlarging the holes with a No. 18 drill, and ½-in. 6-32 R. H. screws and nuts for the Amertran. Make sure that the terminals of the Tri-jacks are in the position shown. Put lugs on the terminals of the Tri-jacks and grid-denser.

11. Connect 54 to 55, 56 to 57, 33 to 58, 59 to 60, 61 to 46, 62 to 63, 64 to 65. Run this wire through the hole in the other contact spring terminal on the same side as 65 and make a connection at 66. Connect 67 to 68, 69 to 70, 71 to 72, 73 to 74, 75 to 76 and 77 to 78.

This completes the wiring of the amplifier unit.

Testing And Operating

Connect the A battery to the two binding posts at the left of the tube panel, looking at the set from the front. The right hand post of this pair is for the negative terminal and the left hand for the positive A battery. Put the tubes in place and set the filament control switch at the middle position. The left hand tube should light. At the right hand position all four tubes should light. Make sure that you have type 1A Amperite to go with the UV-201-A or C-301-A tubes. If, by mistake, you have the 6-V-199 Amperites, the resistance is too high to light the filaments.

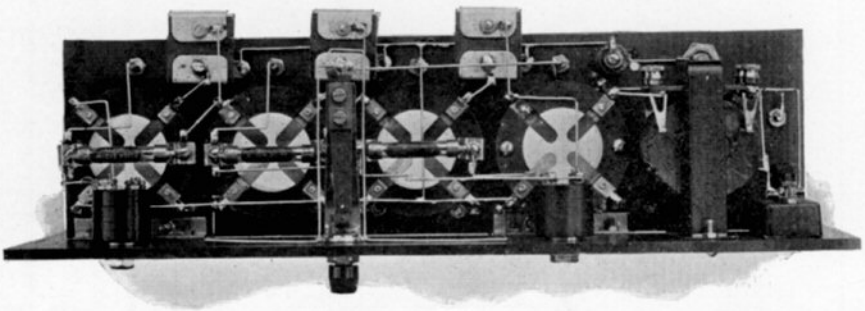


Fig. 4. This view shows the method used to mount the Daven coupling resistances on the Paragon sockets. Be sure to have the jack switch upside down as it appears here.

Connect the negative terminal of the B battery to the Kantblo and plus 45 volts to the left hand B battery binding post. To that same post connect the negative terminal of another 45-volt battery and the positive to the right hand binding post. That puts 45 volts on the first two tubes and 90 volts on the second tube. The volume can be increased by using 90 volts for the first unit instead of 45 and 45 volts for the second unit, putting 135 volts on the two last tubes.

Connect the output binding posts in place of the telephones on the receiving set and plug in the phones at the first step jack. There should be a considerable increase of volume at the first stage. If this is working properly plug in at the fourth step jack. Adjust the gridleaks and grid-denser for maximum signal strength without noise. Then you should have all the volume you want for ordinary reception.

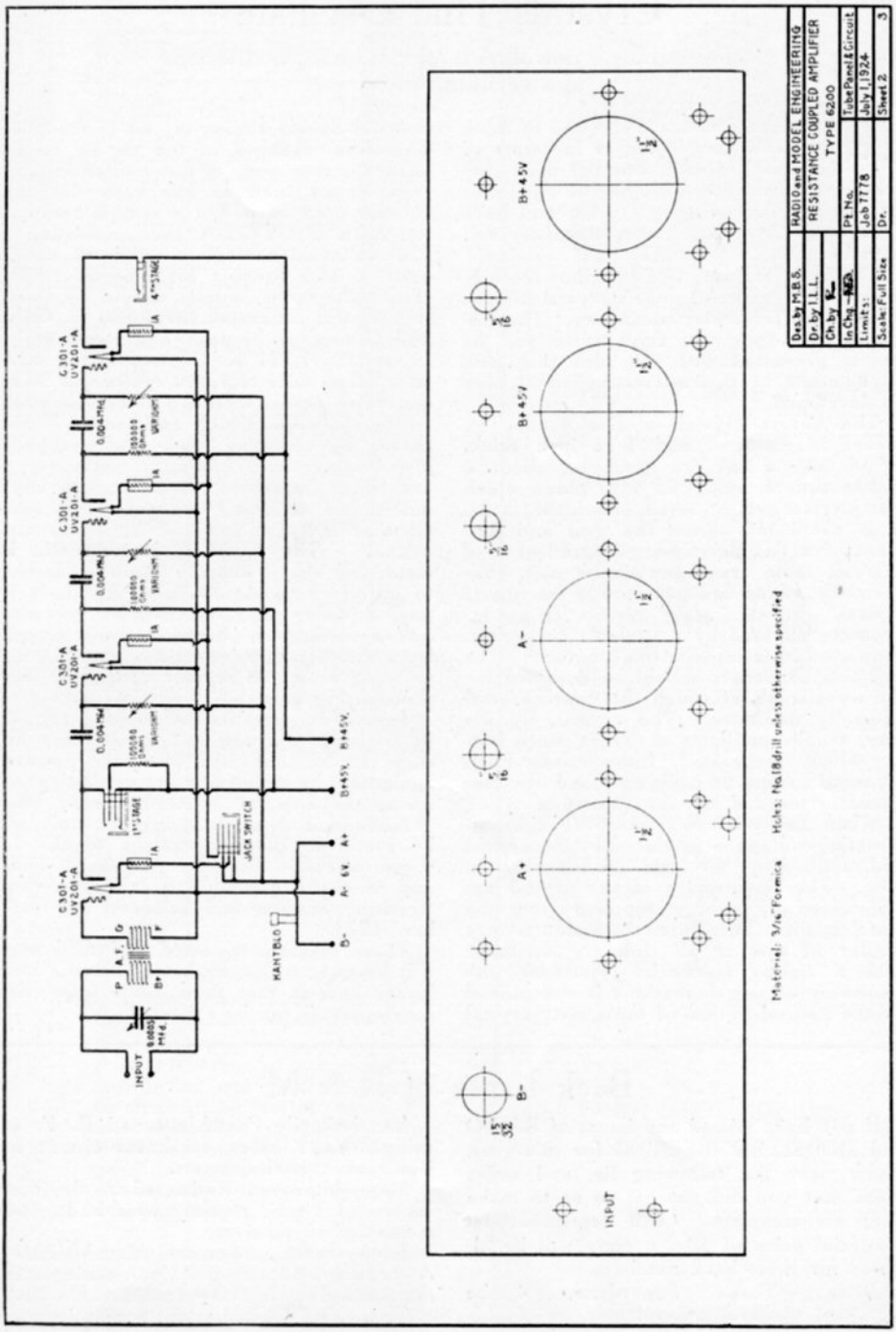


Fig. 5. One-half scale drawing of the tube panel, and the schematic wiring diagram illustrating the circuit system employed.

Crystals That Oscillate

Describing a new device for producing oscillations in a vacuum tube circuit

MANY radio men are inclined to think of radio developments in terms of current practice, but the most successful experimenters are those who have gone into fields outside of radio and have brought in new things from chemistry and physics.

The General Radio Company has recently developed a mounted quartz crystal for use in standard frequency oscillators. The following description of this device and its use is presented with the idea that new applications of this interesting effect may be developed.

The quartz crystal, a disc about 1¼ inches in diameter and 1-16 inch thick, is set into a bakelite mounting about 2 inches square, equipped with plugs which can be inserted in small individual jacks. It is connected across the grid and filament of a vacuum tube. A gridleak and a small radio frequency choke coil, connected in series, are put around the quartz crystal. In the plate circuit is an inductance shunted by a variable condenser, connected in series with the B battery. The coil and condenser should be designed for the wavelength at which the quartz crystal naturally oscillates. The crystal, by the way, usually oscillates at two or more fairly widely separated frequencies. Each mounted crystal is calibrated and the frequencies marked on the mounting.

When the tube is lighted, a slight alternating voltage is produced by the crystal and applied to the grid of the vacuum tube. These vibrations of the crystal are maintained by energy supplied from the plate circuit. Therefore, the action is very similar to that of an ordinary oscillator with a tickler feedback. However, the frequency of the oscillations is determined by the natural period of the quartz crystal and not by the tuning circuit in the plate. Therefore, changes in the circuit do not affect the frequency of the oscillations.

A circuit such as has been described can be used as a low powered transmitter, with a UV201-A tube operating at 150 volts on the plate, while a similar outfit is also suitable for reception. The plate voltage, of course, should be lower. If a crystal calibrated for 1,500 K. C., or 200 meters, is used at one outfit and a crystal for 1,501 K. C. used at the other end, a beat note of 1,000 cycles will be set up. Two outfits of this sort can be worked both as transmitting and receiving sets, merely by changing from low voltage to high voltage and cutting the phones in and out. Interference will be very slight indeed and no tuning will be required since all that is taken care of by the quartz crystal The 1,000 cycle note will be clear and sharp because there is nothing to introduce harmonics, nor will there be any tendency to interfere with receiving sets operating on broadcast wavelengths from the objectionable harmonics which are so often set up in regular undamped wave transmitting sets.

In addition to the use of the crystals in a simple low-powered transmitting set, they can be connected with high powered equipment by amplifying the oscillations set up in the first or master-oscillator tube.

Additional data on quartz crystals will be found in the Proceedings of the Institute of Radio Engineers for April, 1922, and in the Proceedings of the American Academy of Arts and Sciences, for October, 1923.

These crystals, mounted and calibrated, will be put on the market within the near future and at that time, some interesting developments can be expected.

Back Issues of R & M

If you have missed any issues of RADIO and MODEL ENGINEERING for this year, check over the following list and order those that you did not get so as to make your file complete. Until September 1st a special price of 10c. a copy will be allowed for these back numbers.

January—Tuska Superdyne, 4-tube Monotrol, oscillating wavemeter.

February—7-tube super-heterodyne set, Cockaday Receiver.

March-April—Portable tuned R. F. set using UV199 tubes, Harkness circuit for Diode or crystal detector.

May—Improved Rasla reflex, the most successful 1-tube receiver ever built, 100-meter Sodion receiver.

June—Sodion reflex set using UV201—A amplifier, the Bestone V-60, tuning filter for cutting out interference.

These copies will be sent promptly upon receipt of your order accompanied by a money order or postage stamps.

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Vol. IV JULY, 1924 No. 6

EDITORIAL

THE sympathy of every radio man will be extended to Mr. Neely, editor of the properly esteemed Radio in the Home, whose son has been sacrificed to the development of our contemporary science—aeronautics. Progress in research and engineering makes tremendous demands upon those who shoulder the task of adding to the convenience and comfort of the public which takes up so lightly the use of great achievements, but when, in future years, the safety of air travel is an accomplished fact, we must remember the men with whose lives experiments and tests have been made to overcome the uncertainties of passage thru the sky.

Whatever our individual sympathies, the newest decision concerning the rights to the uses of the oscillating audion circuit, altho it leaves much undecided, must bring to Dr. de Forest a feeling of satisfaction well earned. Irrespective of the legal rights and wrongs, the Doctor has received small recompense for the tremendously important contributions he has made to radio. It is unfortunate, perhaps deplorable, that the man who is the greatest individual contributor to radio as we now enjoy it should have spent so much time thinking of inventing in relation to patents rather than developments.

When are we going to have a real receiving set—Don't misunderstand this question. It does not refer to the ultimate outfit. It concerns only mechanical design. From this point of view, a radio set is as different from a typewriter, for example, as a lathe from a machine shop. Because of limited production and the need for continuous changes, sets now are made of assembled units rather than as unit machines. Some day, however, when a company with sufficient financing and distributing facilities realizes the extravagances of present day designs, we shall have a radio machine to sell at a fraction of present day prices.

Did you ever stop to think that a typewriter, washing machine, phonograph, and calculator are cheaper than most radio sets? Ask the manufacturer and he will say that the cost of his radio set is high because of the big investment in tools and fixtures, the amount of materials, the expense of the cabinet, or the difficulty of assembly. Yet tools for a radio set amount to only a fraction of those required for a typewriter, the materials are cheaper than for a washing machine, the cabinet is nothing compared to that used on a phonograph, and the assembly is far simpler than for a calculating machine.

The reason for this situation is that radio sets of commercial design are not made as units, but as assemblies. A typewriter isn't made up of parts sold at Woolworth's, nor is a washing machine an assembly of things sold in hardware stores. Examine any type of set and you will find dozens of parts which can be combined in such a way as to cut down the number of parts by fifty to ninety per cent. The cost of present sets is high because there are too many items to handle, to assemble, to get out of order, too much awkwardness for the application of fast assembly methods. Rejections and repairs come from little, fussy things which can't be made to stay put—which should be eliminated.

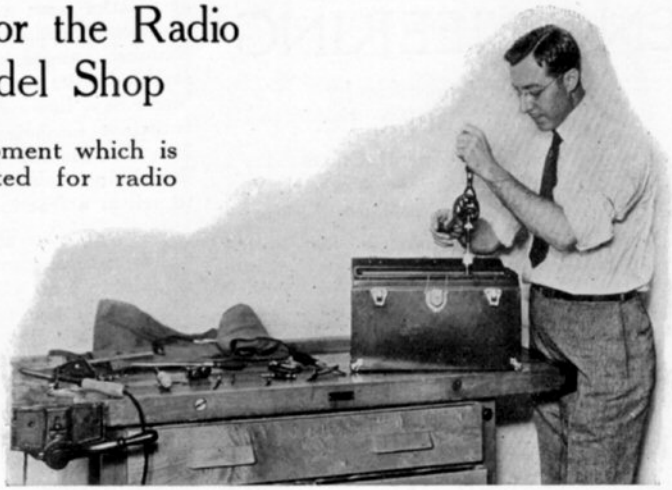
A factor which boosts prices considerably is the expense of returning faulty sets to manufacturers. Much of that comes from putting models into production before the design has been thoroughly tested, but right design will overcome the development of faults after the sets have been O. K'd at the bench.

If it is not possible for a manufacturer to completely revise the design of his equipment, much can be done in the direction indicated for, judging from current practice, more thought is given now to the circuit than to the set as a radio machine.

M. B. SLEEPER, Editor.

Tools for the Radio Model Shop

Suggestions for equipment which is specially well adapted for radio construction work.



THE radio model shop, whether it is actually what the name implies or whether it is merely a corner in an experimenter's laboratory, should have a first-class set of tools. and tools designated for this particular purpose only. As an adjunct to a shop, there should be a complete outfit available at all times so that it will not be necessary for those who are making testing equipment or special models to hunt all over the works for the tools they should have at easy reach. Similarly the experimenter should not allow his tools to be used for household duties for small things particularly have a habit of disappearing.

At home or in the shop a good workbench is necessary. An excellent type is shown in the accompanying illustrations, a bench equipped with a vise big enough to take large panels and at the same time small enough for much of the delicate work, altho a little 2½-in. vise makes an excellent auxilliary. The drawers in the bench can be used for holding tools and supplies as well as some of the work in process.

In the first illustration a Hammacher-Schlemmer roll kit is illustrated. This is an excellent outfit for those who want something inexpensive and at the same time complete. In this kit are all the necessary small tools from hand drill to soldering iron, including a combination square, scriber, dividers, machinists' hammer, drills, screw driver, pliers and cutters, and Spintite socket wrenches.

With this outfit practically all radio construction work can be done. Moreover, this serves as an excellent start for those who want to accumulate a complete set of tools.

There are other things. of course, which are needed to make the work easier and faster. A Millers Falls hacksaw and a set of fine blades is required for sawing panels and metal parts. Do not get coarse blades for it is impossible to saw Bakelite neatly with the coarse size. A Goodell-Pratt brace is heavy enough to carry large sized drills and panel cutters or fly cutters. Speaking of fly cutters, a set of these tools, made by Stevens & Company, are most useful for making ¾, 1, or 1½-in. holes in panels. Another type puts a beaded edge around the outside of the hole.

Altho a hand drill is satisfactory for sizes up to one-fourth inch, the electric drill illustrated is much better for that work. It looks rather large, yet it is extremely easy to handle as it weighs very little. This particular type is manufactured by the Black & Decker Company. Because of the ease with which it can be handled there is no trouble in locating the holes accurately.

A set of taps and dies with the necessary holders can be purchased, or particular sizes can be bought individually. With these, drills are needed of sizes for slipping and tapping. Also the sizes of ¼ in., ⅜ in., and 15/32 in. should be purchased, as well as a ⅜-in. countersink.

An absolutely essential item is the combination square. A 9-in. Starrett combination square, equipped with a protractor and centering head, covers most requirements altho it is well to have the 12-in. and 4-in. sizes in addition. A protractor for the 9-in. square is all that is necessary for getting special angles such as those for the mounting of Neutrodyne transformers.

The tool chest is a particularly important adjunct to the shop equipment, for tools can be kept in good condition only by putting them away neatly in a place where they will be secure from dampness. This chest is built of mahogany, and has eight felt-lined drawers. A small bench grinder solves the problem of keeping drills, cutters, and edge tools properly sharpened.

Two or three sizes of dividers and at least one size of inside and outside calipers should be obtained. The best type are those with the round legs, manufactured by the Starrett Company. Two other important items from this concern are the pocket scriber and automatic center punch.

An assortment of three or four Nicholson files will take care of such things as smoothing panels and small brass parts. Have at least one file with smooth edges.

Screw drivers should be selected carefully for the cheap kind very quickly work loose from the handle. For larger screws the Yankee screw driver is recommended, while for small things a special type is made by the Clark and Tilson Company. Klein or Smith and Hemenway pliers can be relied upon to hold their temper and keep their shape. It is best to get good pliers and cutters for, unless these tools are well made and properly tempered, the jaws will soon meet at angles instead of coming together perfectly.

Good tools should be kept in a regular machinists' tool chest. The chest shown in the accompanying illustration is made by Hammacher-Schlemmer. This is a very good chest for storing away small tools. Other types are manufactured by the Union Tool Chest Company.

For keeping drills and edge tools sharp a small hand grinder is essential. The grinders manufactured by the Goodell-Pratt Company are excellent for this purpose.

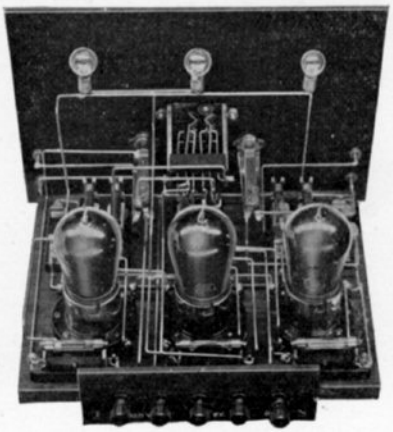
Every shop must have a soldering iron. For regular work there is the American Beauty iron, a type widely used because of the even temperature it maintains. A very important feature of this iron is that the tip does not screw into the heating element. It is simply a length of $\frac{3}{8}$ inch copper rod held by a set screw. The type using the threaded tips have the disadvantage that, after a few months in use, the threaded part becomes so tight that it cannot be unscrewed but breaks off. Then it is almost as expensive to repair the iron as it is to buy a new one. An excellent soldering iron for very light work is made by the Post Electric Company. It is very small and can be used for soldering when the metal parts are not so large that they conduct the heat away too rapidly.

A coil winder can be made up very easily from a Goodell-Pratt polishing head. A crank is fitted on one side, and on the other side a disc of the correct size to take the tubing. A simple device can be arranged for holding the tube at the opposite end. With a little ingenuity this winding rig can be equipped with a Veeder revolution counter. Be sure to get the non-ratchet type for the counter must indicate when the winder is wound off, in case too many turns have been put on as well as to indicate when the wire is wound on to the tube.

While this list of tools can be augmented considerably, it covers all the ordinary requirements for radio construction. There are other things, of course, which are most useful, such as a Dalton lathe for special turning or a little Goodell-Pratt lathe for winding coils. However, those are things which are found only in the more elaborately equipped radio model shops.

Daven Resistance Coupled Amplifier

Describing the design and circuit of the new Daven resistance amplifier unit, the first of this type to be put on the market.



AT the present time, the position of the radio frequency amplifier might be compared to that of balloon tires, a great deal is said for this type of amplifier by those who use it and much is said against it by those who do not. After all, it will be necessary for the public to decide for or against the resistance amplifier, and this decision may be made without full regard for the efficiency of the device, as there have been several examples in the radio business of good equipment which has not become popular and poor equipment which has been widely used.

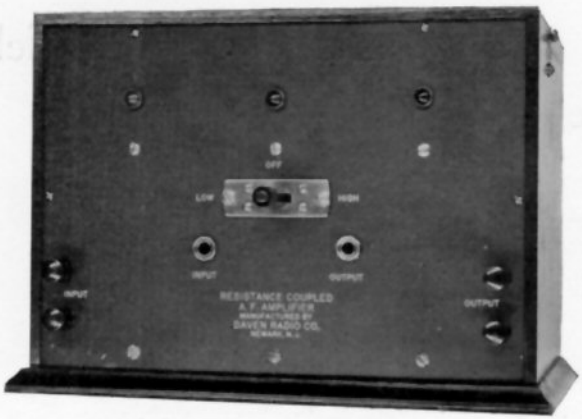
The Daven resistance coupled amplifier shown in the accompanying illustration is designed to be used with any receiving set that is equipped with an audion detector. It is equally efficient on regenerative or non-oscillating type receivers. The amplifier is equipped with three tubes, preferably C-301-A's or UV-201-A's. Tubes of different filament characteristics cannot be used because of the automatic regulation of the filament current.

On the front panel are binding posts and jacks for input and output, with a switch at the center by means of which one or three steps of amplification can be cut in. This switch not only controls the filament circuits but transfers the telephones from the plate of the first tube to the plate of the last tube. In place of the usual peep-sights, there are small electric bulbs, drawing a negligible current, to show that the vacuum tubes are lighted. An automatic current control device is in series with the filament of each tube, maintaining a constant current in each circuit. These units take the place of rheostats.

The rear view shows in detail the arrangement of the instruments. Standard parts are used throughout. The control switch is of the Federal anti-capacity type, jacks are of Carter manufacture, the sockets are from the Adams-Morgan Company, and binding posts of Eby design. At the front of the base panel you will see the Daven resistance units, consisting of a coupling resistance element and gridleak, with which Dubilier micadons are employed.

The wiring diagram shows how these parts are connected. The input binding posts are in parallel with the input jack so that connections can be made to the binding posts or plugged in if that method of connection is preferred. If a loud speaker or telephones are used for reproducing they can be plugged in at the output jack or additional amplification hooked on to the output binding posts. This makes an excellent unit, by the way, to be used before a Western Electric power amplifier because the distortionless quality of the amplification produced by resistance coupling provides perfect control to a power amplifier without the distortion which would be introduced by two or three steps of transformer coupled amplification.

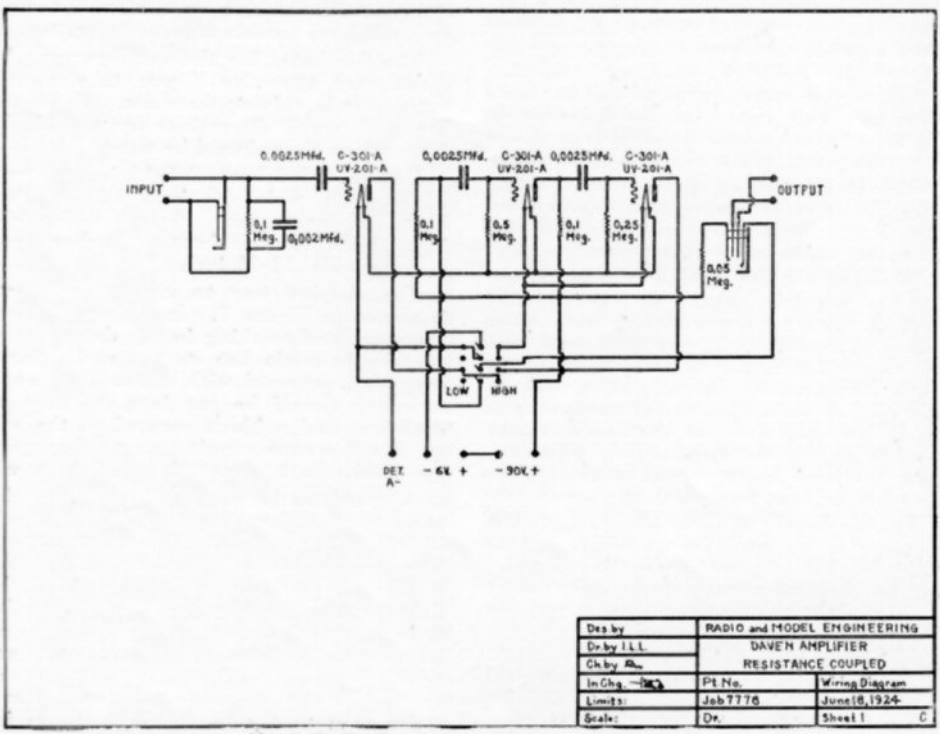
Tracing out the circuit you will see that, when the switch is thrown to the low position, the phones or loud speaker are connected to the first tube and only the first tube filament is lighted. On the high side the output is thrown over to the plate of the last tube and all filaments lighted. Moreover, this switch controls the detector filament, cutting it out, as well as the filaments of all the amplifier tubes, when the switch is in the center position. This is very convenient as it obviates the necessity of any additional switching to turn off the detector.



A neat and efficient instrument is the Daven resistance coupled amplifier. Another type, of less expensive construction, is now available, equipped for three or for four stages of amplification. Since the increase in volume per stage is directly dependent upon the amplification factor of the tubes, UV-201-A's must be used for best results.

The arrangement of this set allows for changes in the plate and grid circuit resistances altho the values indicated in the wiring diagram have been carefully chosen by experimenters as being those which give the greatest volume.

A very interesting arrangement is provided for controlling the detector tube, which, of course, is fitted into the receiving set itself. The B battery terminal is already connected to the A battery through the detector or tuning circuit; this connection is not made on the amplifier. The minus A battery wire must be disconnected from the detector and joined to the binding post marked DET A-. Then when the filament control switch on the front of the panel is in the center or off position all tubes go out. If this were not done it would be necessary to switch off the detector tube separately.



Schematic wiring diagram and circuit constants for the Daven amplifier.

Construction of a One-Eighth-Inch Scale Model 310-Foot U. S. Destroyer

Part 5. Information on the details of the after part of the destroyer, of which a scale drawing is shown

IN Fig. 11 there is a one-fourth scale drawing of the after part of the destroyer. Here you will see the positions of the mast, deck house, searchlight, 4-in. R. F. gun, torpedo tubes, coffee rings, and life boats.

Dimensions have been given already for the R. F. gun, searchlight, steering wheel, and binnacle. The flagstaff can be arranged in the same way as the one at the bow.

Referring back to Fig 4 you will see just how these fittings are arranged, and by working from Fig. 4 and Fig. 11, at the same time, you can get the dimensions for the torpedo tubes and the life boats. These drawings will be supplemented by detailed photographs in addition to those which appear at Figs. 1 and 3.

Notice the arrangement of the auxiliary antenna. This runs from the spreader on the after smoke stack, shown in Figs. 7 and 9, to the mast, and is secured by halyards.

The main antenna appears as a single wire but it is of the regular 4-wire type. Fig. 2 illustrates the arrangement of the spreaders which carry these wires.

Working out the final details of the fittings is largely a matter of ingenuity and skill in handling the soldering iron, small pieces of sheet metal, wire and wood, and the clever application of paint to finish the parts attractively. The original model, by the way, is on display at the showroom of H. E. Boucher, Inc., so that readers who want to go over the original from which this data has been taken can examine it when they are in New York City.

For the benefit of those who want to buy as many of the small fittings as possible the following list is given of the things which can be obtained already made up.

2—1⅜-in. anchors.
1—⅛-in. scale capstan.
12—white metal bitts.
3—¼-in. white metal ventilators.
2—3/32-in. ventilators.
1—double ended 3-in. lifeboat.
2—square stern 3-in. lifeboats.
3 prs. 2½-in. davits.
48—2-ball staunchions.
2—⅛-in. search lights.
2—⅛-in. yacht gimbals.
61—3/16-in. airports with glass.
14—¼-in. airports with glass.
12—⅛-in. single blocks.
1—1-ft. length anchor chain.
2—1¼-in. propellers, three blades.
2—⅛-in. flat struts for propeller shafts.

When you select the wood for such parts as the torpedo tubes, masts, and life boats, if you are going to carve them out yourself, get straight-grained pattern makers' pine. Otherwise, in making up the small things, you will have trouble from splitting.

The life boats for the destroyer can be made very attractive if you take a little extra care in carving them out. Following are the overall dimensions for the blocks from which they should be cut:

Double ended boat, 2 9-16 inches long, 23-32 inch wide, ½ inch thick. Port boat, 2¼ inches long, ⅝ inch wide, 9-16 inch thick. Power boat, 3 inches long, ⅞ inch wide, 11-16 inch thick.

The simplest way to make these boats is shown in Figure 8. Instead of carving them out and working in the details, they are simply made flat on top and painted grey as if covered with canvas. A small screweye should be put into the boat at each end and a block secured to the eye to take the rope running up to the davits by which the boat is raised and lowered.

A particularly realistic touch can be given to the destroyer if the hull is hollowed out enough that one or two small electric lights can be put inside. Then if air ports fitted with glass are used the lights will show through. In addition, with a little extra work, lights can be fitted into the search lights. It is better to have wires running out from the underside of the hull which can be connected to batteries than to try to fit the batteries inside the hull itself.

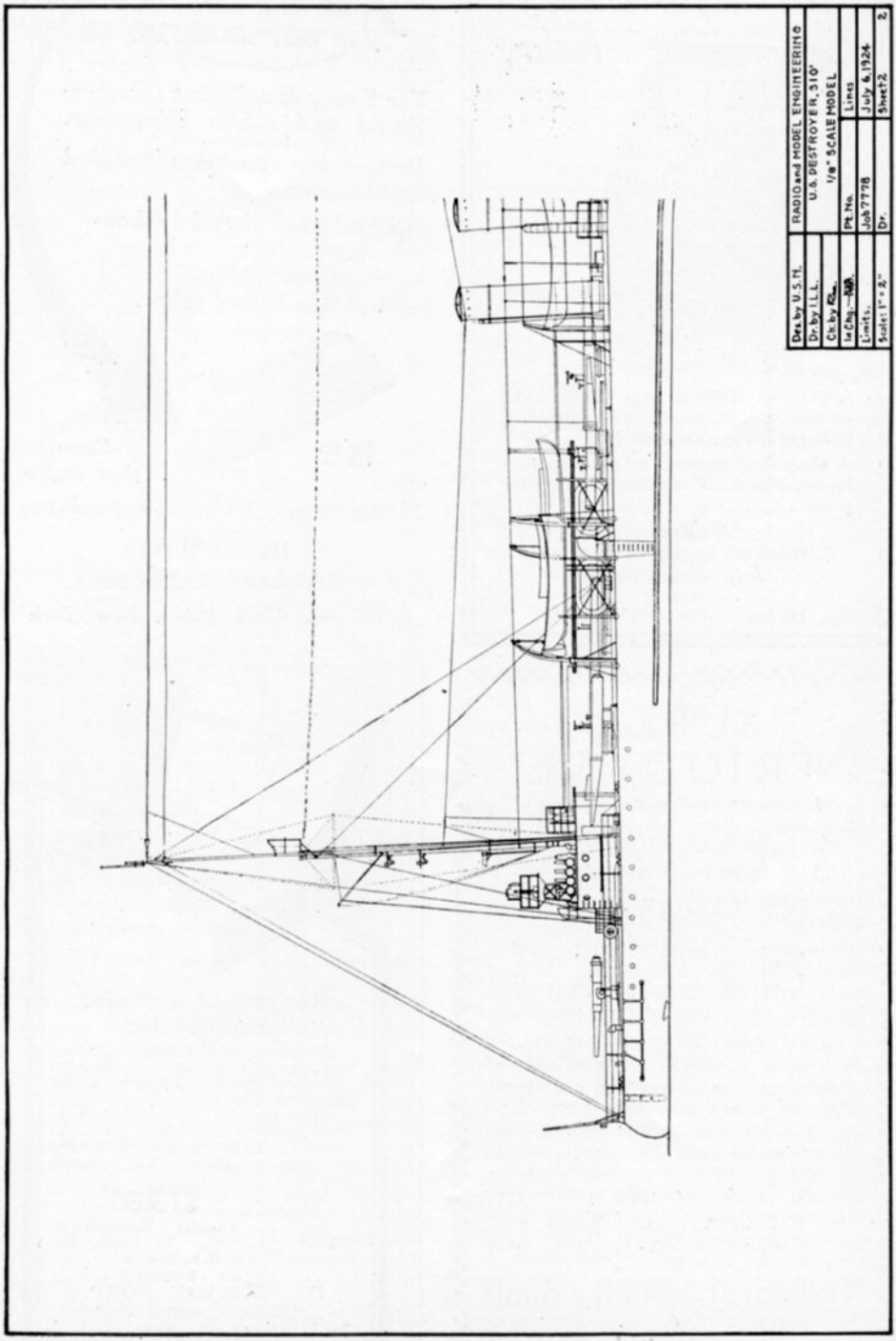
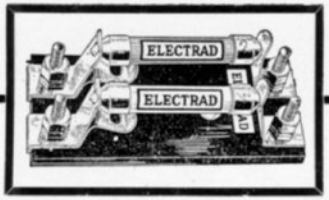


Fig. 11. One-fourth scale drawing of the after half of the 310-ft. destroyer.



Resistance Coupled Amplification

For purity and clearness of tone, for absolute perfect reception and control of volume, nothing can equal resistance coupled amplification—when you use Electrad Resistance Units. Audiohms for variable resistance and Certified Leaks for fixed units.

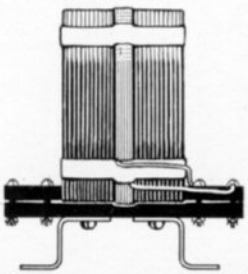
On sale everywhere—Audiohms, $1.50, mounted. Certified Leaks, 50¢.

Just Try an Audiohm Across the Secondary of Your Transformer

ELECTRAD, Inc.

428 Broadway, N. Y.

PICKLE BOTTLE COILS!



The only way to make an inductance more efficient than the Single Layer Coil on a tube is to remove the tube —to remove the dielectric absorption. The Bureau of Standards winds coils on frames. PICKLE BOTTLE COILS are ENTIRELY SELF-SUPPORTING.

Built according to the specifications of M. B. Sleeper. For the portable Tuned R. F. 5800 Receiver and Sleeper Wave Trap. Most efficient as Radio Frequency Transformers and Coupling Coils. Price $2.00 each. $4.00 complete pair. At your dealer or direct.

Eastern Coil Corporation
22 Warren St. New York City

for Radio FIL-KO PARTS

New!

$2.00 AT YOUR DEALER

FIL-KO-STAT
SCIENTIFICALLY CORRECT RADIO RHEOSTAT

With battery switch

If you want perfect control of any tube in any type hook-up—D X stations you never heard before—silent tube operation—maximum signal strength—longer tube and battery life—you *must* use the Filkostat. Battery switch attaches to regular mounting screws. No extra holes to drill. *No extra price to pay.*

New!

50¢ AT YOUR DEALER

FIL-KO-SWITCH
SCIENTIFICALLY CORRECT

Simple--sturdy--sure

"Current on or off at the touch of your finger." Positive in action, simple in design and sturdy in construction. single hole mounting. Equipped with terminal screws and solder lugs. All external metal parts polished and nickel-plated and perfectly insulated from terminals.

New!

$1.50 AT YOUR DEALER

FIL-KO-LIGHTNING ARRESTER
SCIENTIFICALLY CORRECT

With $100 guarantee

Backed by the makers $100 guarantee with a promise to replace or repair your set should the Fil-Ko Arrester fail to work. Its shielded Bakelite insulation prevents leakage losses in your antenna circuit. The makers guarantee it. Live radio dealers carry it. You buy it and *know* that your set is safe.

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"The Knobs Can't Come Off"

New Improved Model

13 Styles Engraved

"Read'em"

(Copyrighted)

Manufacturers of radio sets are invited to write for a sample of this new model of the "Read 'em" Binding Post, considered to be the finest post made, both in quality and appearance. Retails at 15c.

THE MARSHALL-GERKEN CO.,
Toledo, Ohio.

Resistance Coupled Amplification

The tone quality from a **Daven Resistance Coupled Amplifier** is the most perfect known to the radio art.

The **Daven Resisto Coupler** illustrated, greatly simplifies the construction in building up one of these distortionless amplifiers.

SOLD EVERYWHERE $1.50

Read our Booklet "RESISTORS —THEIR APPLICATION TO RADIO RECEPTION," by Zeh Bouck.

PRICE 15c.

DAVEN RADIO CORP.
"Resistor Specialists"
11 Campbell Street
Newark, N. J.

LARK

An accurate reproduction of the Cape Cod boats, 18 ins. overall, 6 in. beam, 200 sq. in. sail area.

Price complete.....$10.00

CURLEW

Racing sloop, 30 ins. overall, 7½ in. beam, 590 sq. ins. sail area. The most popular model among model racing enthusiasts.

Price complete.....$25.00

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Boucher Boats

Are perfect reproductions of the larger craft, not only in appearance but in sailing qualities. In no sense ordinary "toy boats," they are real sport to sail because they can be handled just like the big ones.

The Boucher line includes both sail and power boats, sold complete or as construction sets. They are described in catalog 507, a copy of which will be sent without charge upon request.

BOUCHER, INC.,

Retail Store and Show Room,
415 Madison Ave., New York

Kellogg DX Head Sets

No. 69A

Kellogg DX head sets are known wherever radio is in the air. They are built for long service, sensitiveness and extreme lightness in wearing. Handling does not affect their tuning. They have Kellogg solid Bakelite shells and are furnished with the Kellogg famous receiver cords of which many hundreds are in use today in the telephone field.

The magnets are of special tested steel and hardened by our own special method which controls the heat and time electrically and mechanically, eliminating any possible variation as when manually controlled.

The magnet windings are of great accuracy, the mountings, end plates, wire, insulation, etc., are of the highest grade and of the best material suited for the purpose.

They are specially valuable when used with portable receiving sets. This year, as never before, portable sets will be used in camps, summer resorts and outings.

Ask your dealer to show you these easily adjusted head sets.

No. 69A 2400 ohms $8.00
No. 74A 1000 ohms 5.00

USE — *is the Test*

KELLOGG SWITCHBOARD & SUPPLY COMPANY

1066 W. Adams St.
Chicago, Ill.

Standardized Parts List

The materials used to make up the set described in this issue were supplied by the following companies. The manufacturers whose names appear below will be glad to send you bulletins describing other products which they make. Please mention R & M when you write them.

PARTS FOR THE RESISTANCE COUPLED AMPLIFIER

Type	Name	Price
	Adams-Morgan Company Upper Montclair, N. J.	
30	4—Standard base sockets...	$4.00
	Amplex Instrument Labs. 57 Dey St., New York City	
5	1—0.0005 Grid-denser	1.25
	American Transformer Co. 173 Emmet St., Newark, N. J.	
AF-6	1—1 to 5 ratio A. F. transformer	7.00
	Brooklyn Metal Stamping Co. 718 Atlantic Ave., Brooklyn, N. Y.	
A	2—Tri-jacks	2.50
	Carter Radio Co. G-209 So. State St., Chicago, Illinois	
4	1—4 spring jack switch....	1.30
	Daven Radio Corp. Newark, N. J.	
X	3—100,000-ohm resistances.	1.50
50	3—Resistance mountings....	1.05
	Dubilier Condenser & Radio Corp. A-48 West 4th St., New York City, N. Y.	
601	3—0.004 mfd. Micadons	1.50
	H. H. Eby Mfg. Co. X-40 South 7th St., Philadelphia, Pa.	
Ensign	6—Ensign binding posts	1.20
	Electrad, Inc. 428 Broadway, New York City	
RM	3—Variohms	2.25
	James Goldmark Co. B-83 Warren St., New York City, N. Y.	
W	1—100 ft. spool of Wirit....	.92
	Kantor Mfg. Co. A-120 Broadway, New York City	
BP	1—Kantblo	1.50
	Poster & Company 26 Barclay St., New York City	
154	1—7 x 14 x 3/16 in. Formica panel	2.49
A-98	1—3½x13x3/16 in. Formica panel	1.45
	Radiall Company 320 W. 42nd St., New York City	
1A	3—Amperites for UV 201-A tubes	3.30

Miscellaneous Parts

Type	Name	Price
58	3—Pkgs. of 25 tinned soldering lugs	$.60
22	2—Right hand nickeled angle brackets	.20
185	2—Left hand nickeled angle brackets	.20
14	8—Coil support pillars.....	.64
63	5—Pkgs. of 10 ½-in. 6-32 R. H. nickeled screws.....	.60
49	2—Pkgs. 10 6-32 nickeled nuts	.16
143	1—Pkg. of 10 1-in. 6-32 R.H. nickeled screws.....	.14
		$35.75

BLUE PRINTS

6200	Set of three full-size blue prints for the 6200 amplifier	$.75

AUXILIARY PARTS

	Eastern Radio Manufacturing Co. **National Carbon Comany,** Long Island City, N. Y.	
763	Small 22½-volt B battery....	$1.75
766	Large 22½-volt B battery....	3.00
767	Large 45-volt B battery.....	5.50
771	4½-volt variable battery....	.70
6810	50-amp. storage battery 6-volts	15.00
	Stanley Patterson West & Hubert Sts., New York City	
843	Deveau Gold Seal Phones, 2200 ohms	6.00
	Deveau Gold Seal Phones, 3200 ohms	8.00
	Perfectone Radio Corp. 1-490 Broome St., New York City	
DT	Perfectone loud speaker	15.00
	Clark and Tilson, Inc. 1-A East 42nd St., New York City	
W	Automatic drilling template.	1.00
	Pacent Electric Co. A-22 Park Pl., New York City	
40	Universal phone plug	.50
51	Twinadapter for two plugs...	1.00
	Stevens & Company 395 Broadway, New York City	
T-71	Set of 3 Spintite wrenches for hexnuts	1.00
T-825	Set of 3 Spintite wrenches for round nuts.....	1.00
T-580	Reamer for ⅛ to ½ in. holes	1.50

WANTED

ONE of the most interesting opportunities ever offered to a radio experimenter is that of working in the Radio and Model Engineering laboratory at Darien, Conn. A young man is needed as the personal assistant of Mr. Sleeper, to work under his direction in the development of equipment to be described in the magazine.

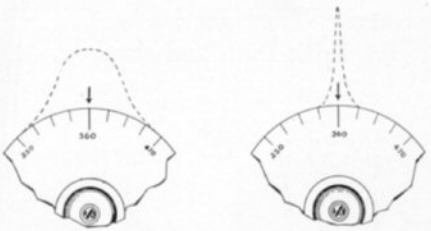
In the most agreeable surroundings, a pleasant country town on the Connecticut shore, practically everything is available in the way of equipment for radio work. Every encouragement will be given individual initiative, and every opportunity for establishing a reputation in the radio field.

The man to be selected for this work must be about twenty years old, preferably with some college training. He must be a skillful draftsman, must have the knack of doing everything in just the right way, untiring in pursuing each problem to a conclusion, and thoroughly devoted to his work without regard for time-clock working hours. Ability to use the English language is essential. The salary to be paid during the first six months will be very small, but, at the end of that time it will be substantially increased. Beyond that, the right man for the work will be able to earn much more than is paid in any of the commercial laboratories.

In your application give your age, experience, nationality, religion, and state just what you want to work into as a permanent future. Each letter must be written by hand—not typed.

Improve your set with an ACME "lowest loss" condenser

Because of low losses and sharp tuning practically all the currents on the antenna can now be used

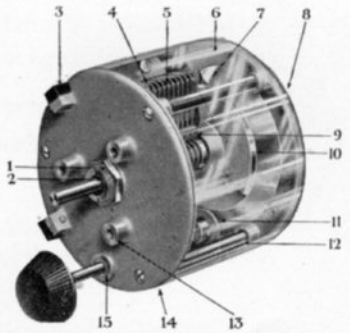


Which one is your tuning circuit —*the hump or the peak?*

HERE are the curves of two tuning circuits. The hump has a high loss condenser and the peak a low loss condenser. Both receive broad-casting, but the peak receives local and distant stations without interference, while the hump receives only the nearby stations with interference. The new Acme Condenser will change your tuning circuit from a hump to a peak.

The Acme engineers have been working for two years to bring out a condenser which would give to Radio experimenters sharp tuning and minimum losses. The new Acme Condenser has these fundamental advantages and also has many new improvements in structure and equipment. See the illustration with explanation, and for more information, write to us for booklet — "Amplification without Distortion," which contains many diagrams and helpful hints on how to build and get the most out of a set.

ACME APPARATUS COMPANY
Dept. RM7 Cambridge, Mass.



1—Steel brass cone bearings adjustable.
2—Lock nut for bearing.
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