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OCTOBER 1946

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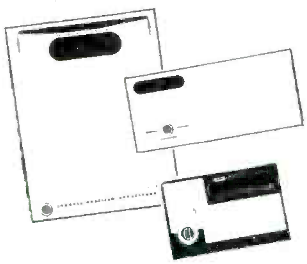

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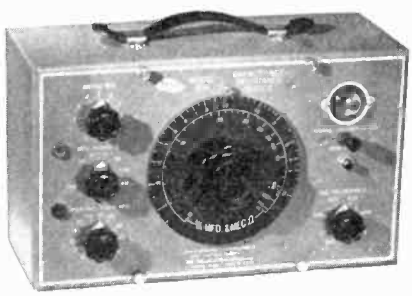

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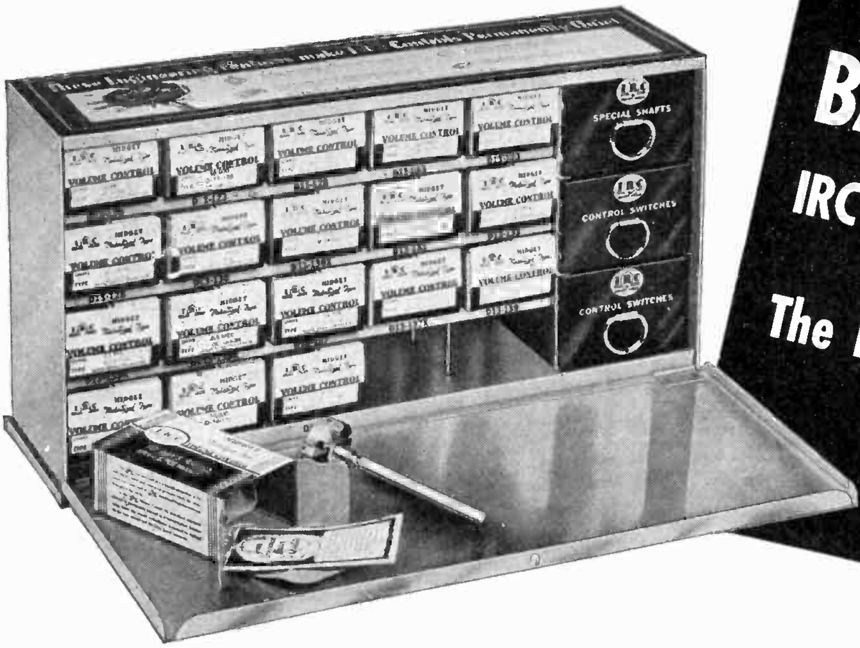

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RADIO MAINTENANCE

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ELECTRONIC MAINTENANCE

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Contents

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CABINET REPAIR

R. G. Ellis
GENERAL CEMENT MFG. CO.

Time spent in learning to do simple cabinet repair work will pay for itself in dollars and cents. This article discusses some of the techniques used.

EVERY SERVICE SHOP should be prepared to refinish and repair cabinets. The ability to do simple repair work on radio cabinets opens to the serviceman another source of income and customer satisfaction. Be prepared not only to make the set *sound* good, but also to make it *look* good. A little extra time spent on a cabinet will be repaid in increased customer confidence and higher earnings for you.

The serviceman does not have to be a professional refinisher, but he should know how to make minor repairs on both wood and plastic cabinets. He should have on hand the necessary polishes and stains to remove fine scratches and equipment to repair small dents and cracks. Fortunately, these materials are not expensive and a small investment will buy all that is necessary.

Cabinet damage can be classified into a number of types. Each of these requires slightly different materials and techniques to repair. It is important that you be able to recognize each of these different types of injuries and what must be done to correct them. The following is a list of the various types of damage usually encountered:

1. Scratches — Fine scratch-like lines on the surface of the finish which do not cut through to the wood.
2. Abrasions—Wider and deeper than scratches and cut through the finish into the wood.
3. Cuts and digs—Severe dents or nicks. Part of the wooden surface removed from the cabinet.
4. Press marks—Caused by pressure having been put on part of the cabinet for a long period of time. The finish is not necessarily removed in this type of damage.
5. Surface discoloration — Marks made by objects such as drinking glass, hot dishes, flower pots, etc.
6. Splitting—Wood pulled apart, usually running with the grain, or at a joint between two pieces of wood.
7. Blisters—Resulting from heat having been applied to the finished surface.

Before discussing how the above faults may be remedied, it may be well to say a few words on how damage may be avoided. When removing a cabinet from a customer's home, the cabinet should be wrapped, preferably in the commercial type pad such as those used by furniture movers. If a pad is not available, a heavy blanket can be substituted. Pad or blanket should be wrapped around the cabinet and properly strapped to keep it in place. Wrap the cabinet up *before* it is moved from the customer's home. There is no method we know of that will lose a customer more quickly than to damage the cabinet of his expensive radio right in front of his eyes.

Be careful when you handle a cabinet in your shop. Do not leave it where something is likely to fall on it, or in a damp or hot place where it may be damaged. Always be sure to inspect a cabinet for accidental damage before it leaves the shop.

In making repairs to cabinets, it is helpful to know something of the woods and finishes used. By far the most popular wood used in radio cabinets and furniture is *walnut*. It is a dark brown, fairly hard, open-grain wood which takes a good finish and is easy to work.

Gumwood is used very often in the cheaper cabinets. It is light brown with a medium grain, light weight, and is very soft. It does not split easily but has a tendency to mar and warp. *Mahogany* is of reddish color with a medium-fine grain. It disfigures more easily than walnut but takes an excellent finish. Most cabinets are constructed of *panel* or *veneer wood.* It usually consists of thin layers of walnut or mahogany glued to the outside surface of a cheaper wood. The different layers of wood are laid so that the grains run at right angles to one another in order to afford strength and minimize warping. This type of construction avoids the expense of solid mahogany or walnut and, if properly made, is lighter and more durable. The combination retains the finish of the better woods, increases the strength, and cuts the cost.

There are other woods, such as *oak, maple,* and *cherry,* which are encountered occasionally, usually in special-made cabinets.

The possible finishes used on cabinets are as follows:

1. Varnish—Clear in color, easily applied by brush or by spray, dries in four to six hours to a gloss finish and is tough and water-resistant.
2. Lacquer—Usually clear in color, dries very quickly, produces a tough protective surface, is critical to apply and easily affected by moisture, alcohol, etc.; spray equipment should be used with lacquer.
3. Shellac—Clear or orange in color, easier to handle than lacquer, can be rubbed down to give the smooth appearance of a lacquer varnish.
4. Enamels—Colored varnishes which are available in a variety of colors. Many modern cabinets are finished in enamels.

The following is a list of the basic materials needed for cabinet repair. This list does not cover everything which can be used but will take care of minor repairs and, as you gain experience, you can add to it.

1. Spatula
2. Alcohol lamp
3. Fine steel wool, pumice stone, or rotten stone
4. Rubbing oil
5. Sand paper—No. 00 or finer
6. Stick shellac
7. Furniture polish
8. Plastic wood
9. Scratch polish
10. Felt pad
11. Shellac stick rubbing fluid

Scratches

Very often a fine scratch requires no more than the application of the proper scratch polish. Apply the polish over the fine scratches with a soft cloth as shown in Fig. 2, and often they will disappear and blend with the surrounding surface. An entire cabinet or piece of furniture can be gone over with scratch-removing polish and made to look like new. These polishes are available for use on both light and dark woods. The lighter colored woods require clear scratch-removing polish, while the darker woods require polish containing the proper stains. After the scratch-removing polish has been applied and the surface rubbed dry, the cabinet should be gone over with one of the accepted wax polishes to renew its gloss.

If a scratch is too deep to be repaired with scratch polish, it will be necessary to fill in the scratch with stick shellac. First, select the proper shade of shellac. Use a slightly lighter shade than the cabinet to be worked on. Heat the spatula over the alcohol flame, and after wiping the spatula with a cloth to remove the carbon resulting from the alcohol, melt a portion of the shellac stick on the spatula and spread it into the scratch until it is completely filled and level with the surface. Fig. 3 and Fig. 4 illustrate the above steps.

Apply the shellac sparingly, as shown in Fig. 5, and avoid getting it on the surface surrounding the scratch. Be careful not to touch the

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Fig. 1 These are the basic materials needed for cabinet repair work. From left to right they are: Rubbing Oil, Spatula, Alcohol Lamp, Wood Glue, Plastic Wood, Scratch Remover Polish, French Varnish, Stick Shellac, Scratch Stick, Stain, Steel Wool, Sandpaper, Polish, and a Felt Pad.

Fig. 2 Applying scratch remover and polish with a soft cloth.

Cabinet Repair

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surrounding surface with the spatula as it will cause damage. Allow the shellac to harden and then remove the excess with a razor blade. Smooth the surface with a piece of felt saturated with shellac stick rubbing fluid as shown in Fig. 6. Fine steel wool, sandpaper or rotten stone can be used to rub down the spot repaired. Rotten stone is superior for fine work. It should be sprinkled on a piece of heavy felt which has been saturated with rubbing oil and rubbed into the surface until the repair is smooth. When the surface has been smoothed, it should be cleaned and polished with a quality grade wax polish.

While repairing a scratch as just described is relatively simple, it is a good idea to practice on an old panel or piece of finished wood until you get the general technique. Make a few scratches on the surface and attempt repairs as outlined above.

Deep Cuts

Deep cuts which have gone through the finish may be repaired in the same way as scratches, with the exception that it is necessary to stain the cut to restore the color. Spirit or alcohol stains are preferred. Spirit stains are the easiest to use because they have a tendency to penetrate better into woods which have been previously finished.

When staining, always use a stain lighter than the surface; it is much easier to add several coats of stain than to lighten a spot which is too dark. Lighter colored stain can be applied, a coat at a time, until the damaged spot matches the adjoining surface. Should the spot become too dark, it may be lightened to some degree by rubbing it with a cloth moistened with alcohol. After staining the cut, proceed as with a scratch, using the scratch stick, etc.

Gouges

Deep gouges may be repaired by filling them in with plastic wood. After the plastic wood has dried, remove the excess plastic wood with a razor blade and smooth the surface with steel wool, fine sandpaper, pumice stone or rotten stone. The surface may then be stained to the proper color. Large repairs of this type sometimes require several coats of varnish or shellac. When applying shellac or varnish, allow plenty of

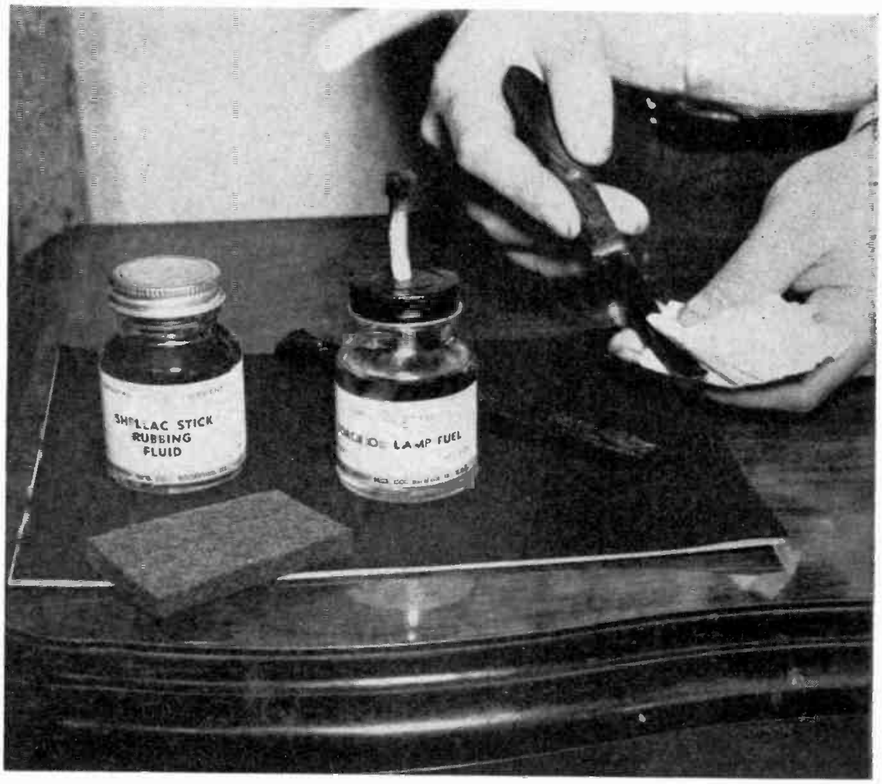

Fig. 3 Wipe the spatula carefully to remove carbon after heating it over the alcohol flames.

Fig. 4 Melt a portion of the shellac stick onto the hot spatula.

time for drying between coats and rub the surface lightly with sandpaper before applying the next coat.

Splits

When a cabinet is seriously damaged, a little more equipment is required. In addition to the equipment outlined previously, you will require glue, clamps, dowel rods, screws, brads and corrugated fasteners. The glue is used to seal surface splits. Apply the glue, press the split together several times with your hands so as to work it in, and then clamp the job together for at least twelve hours so that the glue will set. While the joint is clamped, wipe away the excess glue with a damp cloth.

There are a few cautions which should be observed when gluing a split. Never use a lacquer base cement for gluing a joint adjoining a finished surface since this type of cement is apt to cut into the surface and cause additional difficulties. Use a good grade of regular wood glue such as fish glue or hide glue. Be careful when using clamps; protect the surface at the points where the clamps touch it. When a long split is encountered, it may be necessary to reinforce the joint. This may be done with either wood dowels or corrugated fasteners. When using the corrugated fasteners, work from the inside of the cabinet so as not to mar any more of the finished surface than is necessary. The fasteners should be used after the glue has been applied as described above.

When the wood is thick enough and when the split can be pulled apart (where two pieces join) drill holes and insert wooden dowels to reinforce the glued joint.

When the finish has partially come off the cabinet or is badly disfigured by heat, alcohol, etc., remove the finish from the damaged area as completely as possible, using varnish remover or other suitable material. When this has been done thoroughly, sponge the wood with pure turpentine. To do a good refinishing job, it is necessary to remove all of the old finish. Prepare the surface for refinishing by smoothing it with No. 00 sandpaper or steel wool. When the surface has been smoothed, it is ready for staining. While there are a number of types of stains available, spirit stains are regarded as the best. These stains dry fast and must be applied carefully to obtain a uniform coloring. Always use a stain lighter than the shade desired on the finished work, and apply it in coats until the proper coloring is obtained.

When the cabinet is made of a light colored wood, such as bleached maple, pickled pine, or bleached mahogany, it is often necessary to lighten the surface rather than darken it. There are commercial bleaches available for this purpose. At least two applications should be used. Be sure to follow the manufacturer's instructions carefully. These bleaches can be used on new wood as well as on refinishing jobs.

The trouble outlined above is often accompanied by buckling and splitting when the surface is made of veneer. When such a case is encountered, remove the finish as previously de-

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Fig. 5 Fill in the scratch with the spatula, being careful not to touch the surrounding surface.

Fig. 6 After removing the excess shellac with a razor blade, smooth the surface with a felt pad soaked in rubbing oil.

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scribed; be sure the surface is completely dry and work glue into the surface between the layers of veneer. Apply clamps and allow the work to stand for at least eight hours. When the clamps have been removed, prepare the surface for refinishing by smoothing and bleaching or staining.

Finishing

While the best way to apply finishes is by spray, they can also be applied satisfactorily with a soft brush. As most servicemen will want to use the brush method, it will be outlined in the succeeding paragraphs.

Be sure to choose a good soft brush. After the stain has been applied as previously described, allow it to dry thoroughly and apply a coat of French Varnish or white shellac. Allow the shellac or varnish to dry for several hours and then sand it lightly with fine sandpaper or steel wool. After sanding, wipe the cabinet with a cloth to remove dust and apply a second coat. Repeat this process until three coats have been applied. Four or more coats may be used if desired.

The surface should be given its final finish with steel wool, fine sandpaper, pumice, or rotten stone. The steel wool will give a semi-gloss finish. A flat finish may be obtained by using pumice stone rubbed down with oil as described earlier in this article.

French Polishing

French polishing results in what is considered the most beautiful of finishes. This method was used before spray equipment was available; and, if done carefully, it can produce a smoother, better job than is possible with spray equipment.

Make a pad about two inches across out of soft lint or cheesecloth. Tie the loose ends together on top. Dip it in French Varnish and rub it on the wood with the grain in straight, rapid strokes, using light pressure as shown in Fig. 7. When the surface is completely covered, allow it to dry and then sand it smooth with No. 3/0 sandpaper or steel wool. Repeat the process by applying another coat, allowing it to dry, sanding it smooth, etc. Continue doing this until the surface begins to take on a gloss. When it does, mix a few drops of oil (French Emulsion or linseed oil) with the French Varnish and continue to apply coats with a rotary motion instead of a straight motion. Between

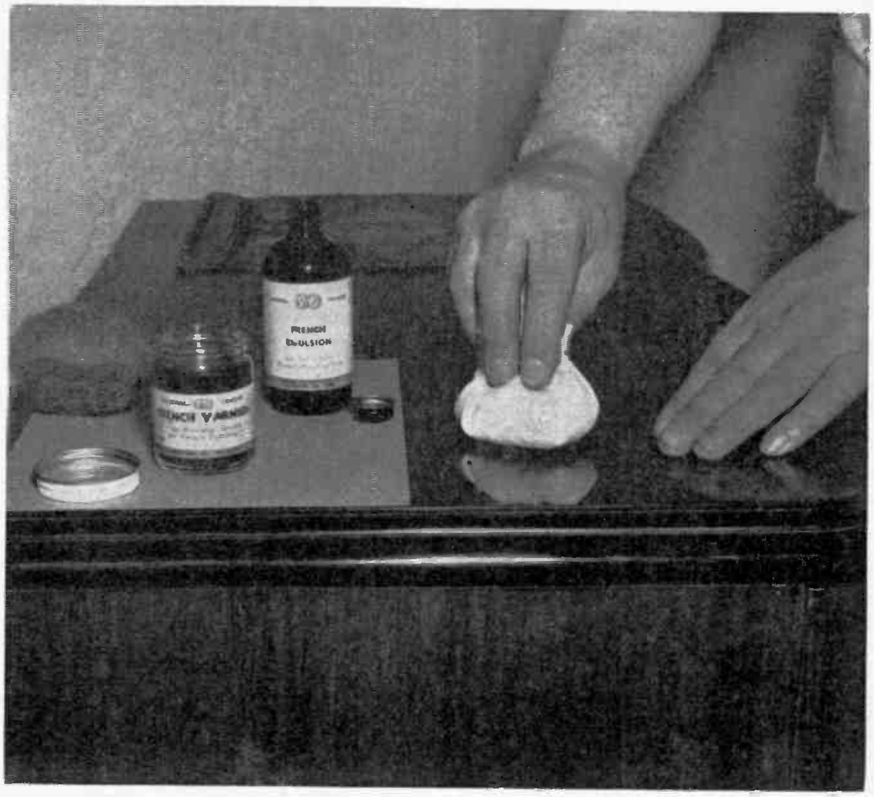

Fig. 7 French finishing. By using French Varnish and Emulsion and applying it as shown, a very fine finish can be obtained.

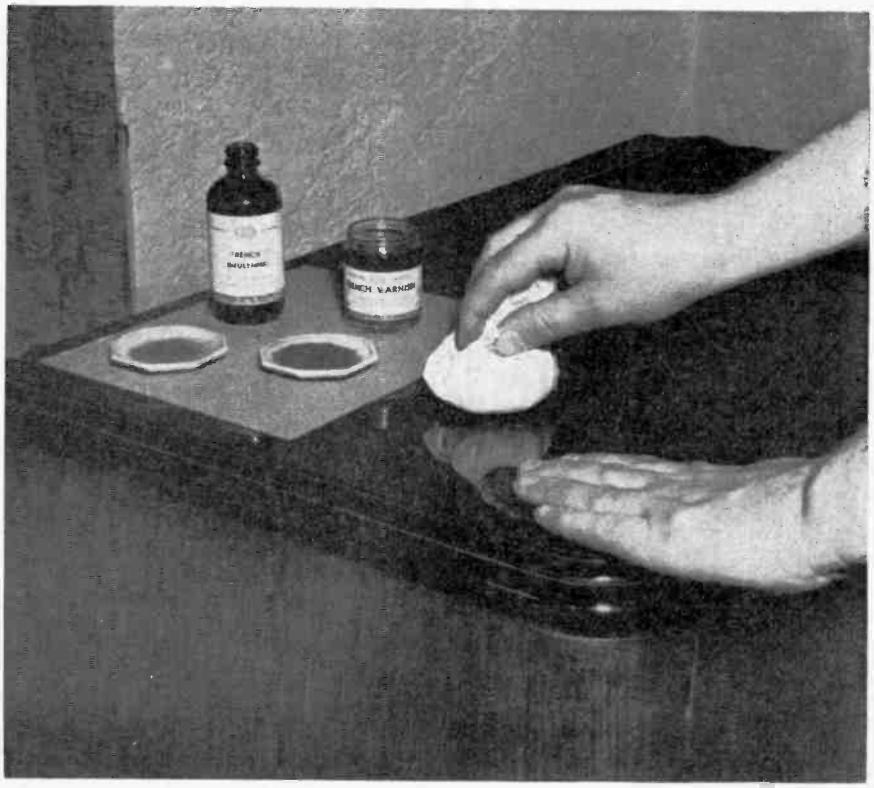

Fig. 8 Finishing by the Dip and Rub method. An excellent finish which is somewhat easier to obtain. It is not quite as fine as a French finish but is entirely satisfactory.

each coat, add a little oil. In this way, the finish will gradually become deep and glowing.

Dip and Rub Method

Another finish which is a little easier to produce and is almost as satisfactory as French polishing is the dip and rub finish. Place two saucers in a convenient spot and fill one with French Varnish and the other with turpentine or linseed oil. Make up a pad as previously described. Dip the pad first into the oil and then into the French Varnish and begin immediately to polish the surface, using a rotary motion and light pressure as shown in Fig. 8. The finish will dry almost immediately and will be practically free from streaks. When the pad becomes sticky, apply more oil and French Varnish and continue to polish.

After several coats, a rich, soft gloss will appear. After the finish has dried for twelve hours or more, it may be rubbed with a soft cloth dipped in linseed oil to obtain an even higher gloss. The dip method may be used to eliminate packing marks, imprints, watermarks and other damage which cannot be taken care of with furniture polish. Always be sure to sand the surface smooth with a fine grade of sandpaper before going to work on it.

Up to this point, we have discussed only repairs to the finish of wooden cabinets. Very often it becomes necessary to make repairs on a plastic cabinet. Special plastic cements are available and can be used to fix minor cracks as illustrated in Fig. 9. Stick shellac can be used to fill in nicks and chips. Heavy lacquer enamels are available which can be used to touch up cracks or damaged spots on colored plastic cabinets.

A cabinet will often need a new grille cloth. The installation is quite simple and requires no explanation. It is a good idea to have available some fabric cement which comes in handy for simple repairs to portable cabinets and instruments.

Fig. 9 Applying plastic cement to a gouged cabinet.

Fig. 10 A complete repair outfit for use in your shop. It contains everything needed for all types of cabinet surface repairs.

Cautions

With a little practice, the average radio serviceman should find it a simple job to make repairs of the type described in this article. There are, however, a number of cautions which should be observed:

When applying stick shellac, always select a color or shade slightly lighter than the desired shade. The spatula tends to darken the shellac. Remember that it is always easier to darken a light repair than it is to lighten one that is too dark.

Always use an alcohol or gas flame to heat the spatula. These flames are the cleanest. Wipe the blade clean before using it.

Be careful not to touch the hot spatula blade against a finished surface as it will cause damage.

Heat the shellac just enough so that it can be worked. If it is too hot, pinholes or bubbles will appear on the surface.

Be sure to clean the surface before applying lacquers or varnishes. Naphtha and gasoline are good cleaners.

Be sure the surface you are about to work on is entirely dry. Do not try to do a refinishing job in a moisture-laden atmosphere. Shellacs and lacquers are best applied in a dry room at a temperature between 70° and 75° F.

In applying finishing material or

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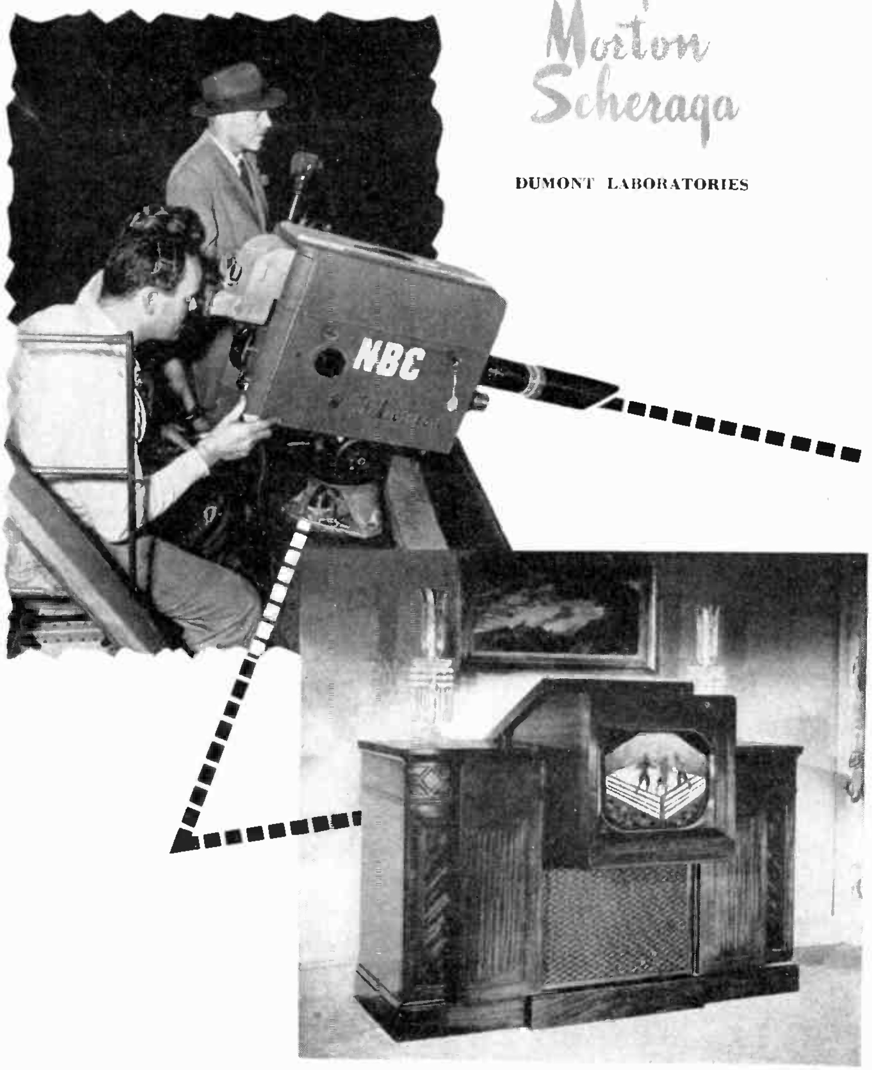
Testing & Aligning TELEVISION RECEIVERS

by Morton Scheraga

DUMONT LABORATORIES



Adjusting the television receiver for proper operation—the first of a group of articles on the subject.

AT FIRST GLANCE, the new circuits and the many tubes and parts required in a television receiver may even discourage experienced servicemen called upon to repair and align a television set. However, with a basic knowledge of television circuit design, and by application of systematic methods of service and use of proper equipment, no real difficulties should be encountered.

Gone are the days of the "screwdriver" technique that carried the serviceman through radio repair work. The television receiver is a complex mechanism that requires the exacting adjustment of many components for optimum performance. The serviceman must remember that the eye is a far more critical element than the ear, and any misalignment of a television receiver will be much more evident than faults in an audio system.

It is the purpose of this article to give the serviceman a definite procedure by which he can attack any television receiver, and to describe equipment that will become a necessary part of the repair shop. No commercial instruments will be recommended at this time since television test equipment is still in the developmental stage. However, several manufacturers will have test instruments for the serviceman by the time receivers are on the market. Improved equipment for television receiver alignment is under development, and its use will be described as it appears on the market.

Perhaps the reader has had the occasion to align a television set. Undoubtedly he used a test pattern which was transmitted over the air for visual adjustment of the image on the kinescope—a procedure that is usually followed. (See Fig. 1.) The use of the test pattern alone for alignment is a hit or miss affair, and in many cases may require undue time and effort if no other technique is understood. A more significant reason for not depending upon test patterns for alignment is that such signals will be on the air only a few minutes a day, and probably even less when television stations increase their number of program hours. Obviously, then, a service shop with several sets to repair and align, each of which may take several hours, must have other means to perform the job. For this reason, methods of alignment will be described which require only instruments with which the shop is equipped. A complete receiver can be aligned on instruments alone, with a few very minor adjustments when the receiver is installed at the customer's home, since field strength and interference conditions will be different at every location in a community.

A television receiver may be broken down into seven basic sections, each of which may be tested and aligned independently. These are (1) the RF section, (2) the Sound Channel, (3) the Picture Channel, (4) the Vertical Sweep Generator, (5) the Horizontal Sweep Generator, (6) the Cathode Ray Tube, and (7) the Power Supply.

To illustrate more clearly the description presented, reference will be made to a typical television circuit, that of the RCA Model TRK 120 receiver shown in Fig. 2. However, wherever necessary, general methods will be explained to cover circuits used by other manufacturers.

Testing and Adjusting the Television Tube

It is on the face of the cathode ray tube that the results of our efforts to align a receiver will be judged. Hence it is important that the television tube be carefully adjusted so that maximum resolution and definition in the picture will be obtained. It is useless to employ a picture channel width of 4 mc unless the size of the luminescent spot produced on the cathode ray tube is equal to, or smaller than, the ultimate detail possible with the 4 mc signal. In the more expensive receivers, such resolution can be obtained only if the gun structure is properly aligned and the electron beam is in focus. On the other hand, receivers employing cathode ray tubes of 10 inches or smaller in diameter are designed for a band width between 2 and 3 mc, for the size of the spot produced in these tubes will permit less picture detail. In order to realize the full benefits of the band width of a particular receiver, the spot size must be made as small as the design of the tube permits.

The type of focusing used in nearly all American tubes at the present time is of the electrostatic variety, but magnetic focusing is also coming into use for it avoids the ion spot (a burn in the fluorescent screen caused by positive ion bombardment) that appears with electrostatic focusing and deflection.

Adjustment of the Electrostatically Focused Tube

It is relatively simple to focus the electrostatic tube. It is done by varying the focus control which is simply a potentiometer connected in series with the bleeder of the high voltage supply (see Fig. 2) which controls the voltage on the first anode. In the electrostatic tube, the focus adjustment should be made with a picture on the tube and may be done at the time that the receiver is installed in the customer's home. Some manufacturers will have this control on the front panel so that the operator can vary the focus himself, depending upon the picture brightness he desires. Other manufacturers place this control on the high voltage chassis at the back of the receiver. In this case the serviceman must adjust the focus for an average brightness condition. If the operator of the receiver should then run the tube at a different brightness level, there will be some impairment of focus, but not appreciable enough to be noticeable. Fig. 3 and Fig. 1 are examples of poorly focused and properly focused tubes.

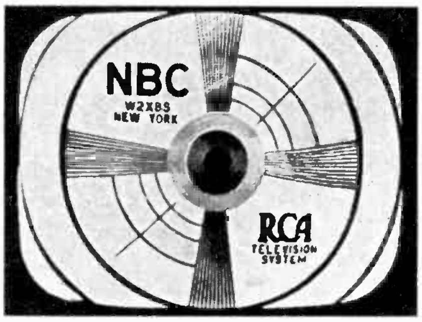


Fig. 1 A normal test pattern.

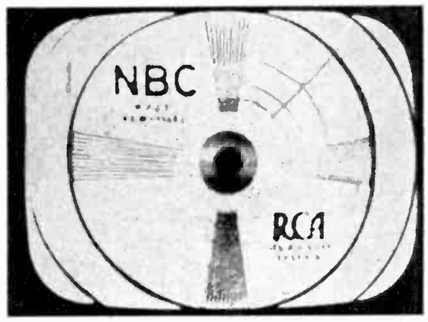


Fig. 3 Test pattern with focus control incorrectly set.

If the cathode ray tube is both electrostatically focused and deflected, there may be another control that will affect the picture resolution, namely the astigmatic control. The latter is used to balance the DC potential on the deflecting plates, or to correct for distortion in the electrostatic field between the plates that may cause astigmatism of the electron beam. This control, if present, will appear at the rear of the receiver, and the serviceman should vary it simultaneously with the focus control to achieve optimum sharpness of picture. There is no need for an astigmatic control in the electrostatically focused tube that is magnetically deflected.

The Magnetically Focused Tube with Magnetic Deflection

This type of tube gives the best spot size and resolution and is found in the more expensive receivers. It is a more difficult operation to align the electron gun properly with the magnetic focus coil. The serviceman should adopt the following procedure: Pull out the vertical and horizontal oscillator tubes in the deflection circuits, so that when the set is turned on, only a spot appears on the face of the cathode ray tube. (Note: Be sure the power is off, and be careful to have the brightness control down

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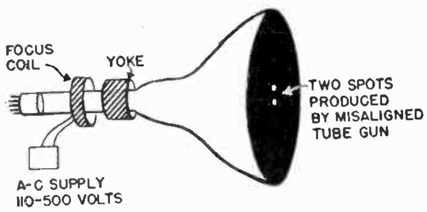

Fig. 4 Alignment of electron gun in magnetically focused tube using the 60-cycle method.

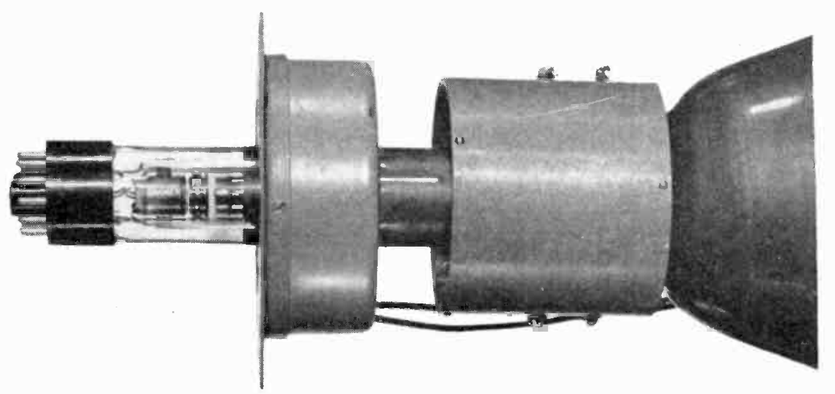

Fig. 5 The arrangement of the focus coil and the deflection yoke on a magnetically focused and deflected tube.

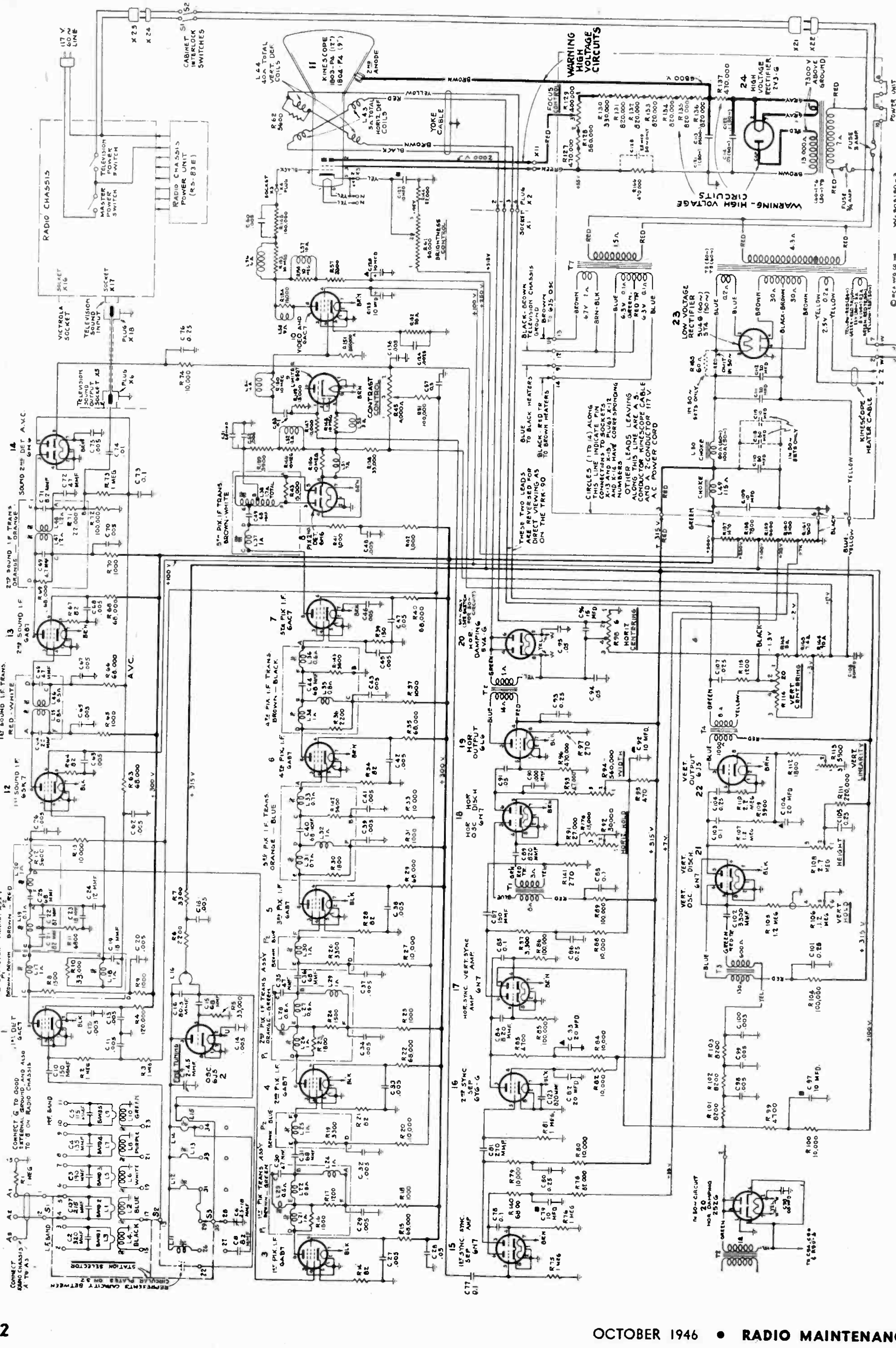

Fig. 2 Schematic diagram of the RCA TRK-120 television receiver.

Testing and Aligning Television Receivers

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to avoid burning a spot on the screen when the power is turned on again.) Disconnect the focus coil leads from their DC supply source and connect the coil across an AC supply. If the focus coil is of low impedance, the line voltage of about 115 volts will be sufficient for this test. If the receiver has a high impedance focus coil, three to five hundred volts will be required, which may be obtained with a step-up transformer. The connections for this test are indicated in Fig. 4. With AC on the focus coil and the set turned on, there will appear on the face of the tube two spots if the electron gun is misaligned. The two spots are produced by the positive and negative peaks of the AC current in the focus coil. The focus coil must then be moved around the neck of the tube until the two spots are superimposed. It is only when this condition is achieved that there will be no astigmatism in the tube and the best spot size will exist. Receivers with magnetic focusing generally have a mounting for the coil which will enable it to be moved in three planes by varying the tension on spring mounts. Fig. 5 shows the location of the focus coil on the neck of the tube. After the spots have been lined up, reconnect the coil to its DC supply, and replace the sweep oscillator tubes. The focus control may now be varied to obtain a sharp picture. This control will likely be on the front panel of the receiver, and can be adjusted by the operator for a particular setting of the brightness control.

With the electron gun in the tube properly aligned, the raster may be oriented so that it will be "in square" with the mask aperture. (The raster is the white rectangular pattern produced by the electron beam sweeping across the face of the tube without picture modulation on the grid.) Fig. 6 shows a scanning raster that is correctly oriented while Fig. 7 indicates an incorrectly oriented picture. In receivers using magnetic deflecting yokes, the latter will need rotation. In order to better observe the orientation, the horizontal width and vertical height should be decreased by adjusting the respective controls until the edges of the raster can be seen (Fig. 8). The yoke should then be rotated until the picture margins are essentially parallel with the mask edges. Fig. 5 shows the location of the yoke on the neck of the tube. It will be noted that the yoke is pushed as far forward as possible. This should always be done to prevent beam cutoff against the walls of the tube near the neck. The above is particularly important in the case of the new short, wide-angled tubes in which the beam is deflected as much as 55°. If the yoke is not as close to the junction of the neck and bulb as possible, the beam will hit the neck at the extremities of the sweep cycle. The vertical height and horizontal width may be set for correct size as indicated later.

In receivers using electrostatic deflection tubes, the tube itself must be rotated until the raster is oriented correctly with respect to the mask aperture. The same technique in adjusting width and height with magnetic deflecting tubes should be used. Note in the correctly oriented raster of Fig. 6 that the vertical return lines, normally blanked out when the picture signal is applied, slope upwards from left to right which indicates that scanning is in the right direction to give a properly related picture.

One final check on the tube remains and that is the measurement of the operating voltages and high voltage supply hum or ripple if trouble from the power supply is suspected. For this purpose a voltmeter with a maximum range of at least 10,000 volts should be on hand to check the high voltage source and filters, and make any repairs that are necessary. (Caution: The high voltages used in television receivers can give a lethal shock. The serviceman should consult the precautions given in the manufacturer's service manual before making any repairs or measurements on the high voltage supply.)

The amount of ripple voltage can be checked with the aid of a test oscilloscope. The vertical plates of the test 'scope are connected through an isolating condenser directly to the power supply bleeder at a point near ground. If a point on the bleeder is chosen at 400 volts above ground, then a 0.1 ufd condenser rated at 600 volts should be used. Knowing the deflection sensitivity of the oscilloscope, the ripple voltage can be computed. The ratio of the ripple voltage to 400 volts

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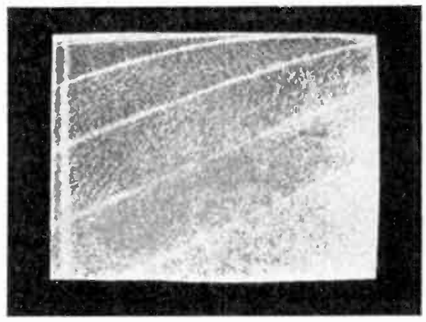

Fig. 6 A correctly oriented scanning raster. Note the angle of the retrace lines.

Fig. 7 An incorrectly oriented picture caused by a misaligned deflection yoke or electrostatic tube.

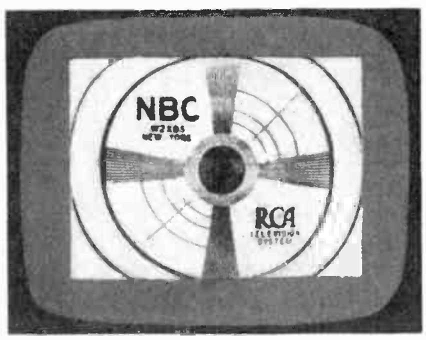

Fig. 8 A test pattern with the horizontal width and vertical height reduced to align the picture parallel to the mask.

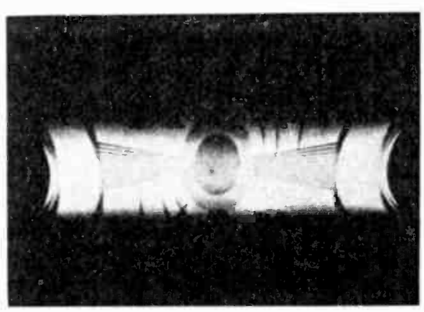

Fig. 9 A test pattern showing the effects of ripple voltage due to a faulty high voltage power supply.

Testing and Aligning Television Receivers

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gives the per cent ripple. This figure should not exceed 1 per cent. Excessive ripple voltages will cause the effect shown in Fig. 9, and will probably be due to defective or open high voltage condensers.

We now have the cathode ray tube operating at its optimum condition, and capable of reproducing the best possible picture that can be fed to it by the other circuits. We turn next to the scanning system which controls the motion of the electron beam across the face of the cathode ray tube and causes it to move in synchronism with the scanning beam in the iconoscope at the transmitter.

The Scanning System

A complete instrument test procedure will be presented here to check and align the sweep generators and amplifiers in the scanning system. The serviceman should adopt such a plan of attack, for with the proper instruments he can secure positive and foolproof alignment of these circuits. He should not depend upon a test pattern, for instance, to adjust linearity. A daily check by the author over a period of several weeks proved that the linearity of the test patterns transmitted by three stations in the New York area varies widely from day to day. Thus if the sweep linearity is adjusted on one day to give a uniform test pattern on one station, on another day or on another station, the linearity may be very poor. The instrument method is the only positive procedure for checking the scanning system; and once these adjustments have been made, no further changes should have to be made when a picture appears on the tube.

Use of Oscillator to Check Linearity and Amplitude

It is possible to test the amplitude and linearity of scanning in both vertical and horizontal directions with the aid of a variable frequency oscillator, the output of which (either direct or by subsequent amplification) has an amplitude of at least 20 volts peak-to-peak and variable frequency from below 60 to above 15,750 cps. The method is shown in Fig. 10. The output of the oscillator is connected between the grid and cathode of the tube and also to the input of the scanning circuit to be tested. In testing the vertical circuit, the oscillator is set at 60 cps, whereas for testing

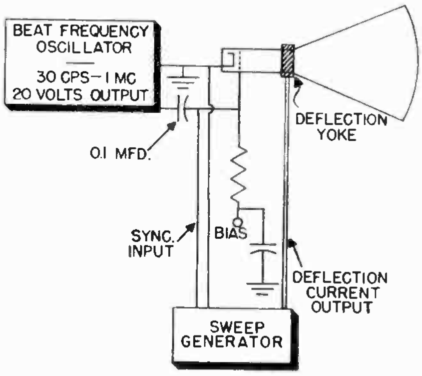


Fig. 10 Method used in checking the linearity and amplitude of the scanning circuits.

the horizontal circuit, it is set at 15,750 cps. In this manner, the sweep circuits will synchronize at the same frequencies at which they will be operating when synchronizing pulses in the video signal are fed to them from over the air.

The Vertical Scanning System

To illustrate the procedure, consider first the vertical scanning circuit. The 60-cps output of the oscillator is applied to the scanning circuit and the frequency control is adjusted until the circuit locks into synchronism with the applied voltage wave. At the same time, the electron beam in the cathode ray tube is modulated at 60 cps. Consequently, the scanning motion and variation in brightness occur synchronously, and the result is a stationary pair of horizontal bars, one bright, the other dark. The scanning circuit is then operating at standard line frequency and all the characteristics of the vertical scanning system can now be checked. The scanning amplitude is indicated by the total height of the scanning pattern when synchronized. If the amplitude is insufficient, the height control may be adjusted to increase the current or voltage (depending on whether electromagnetic or electrostatic scanning is used, respectively). Fig. 11 shows a condition of insufficient vertical amplitude. The importance of having rated frequency in this method will be understood when it is realized that in magnetic scanning, the scanning amplitude depends upon the frequency, while the linearity of sweep varies with frequency in both magnetic and electrostatic scanning. The method also enables the serviceman to pre-set the vertical synchronization

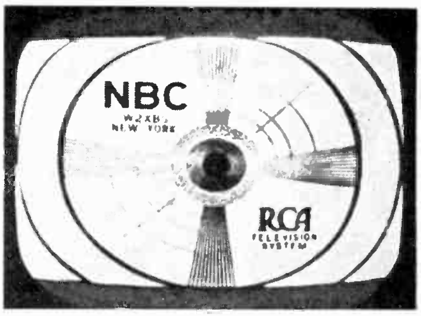


Fig. 11 A test pattern with the vertical height control incorrectly set.

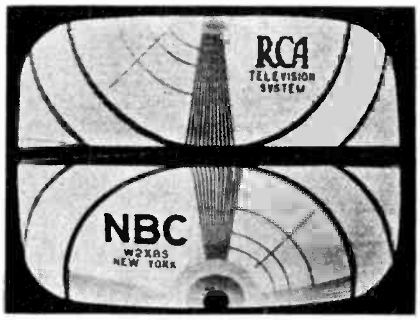
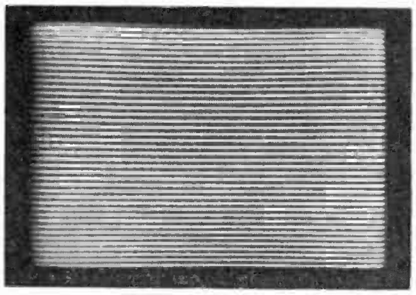
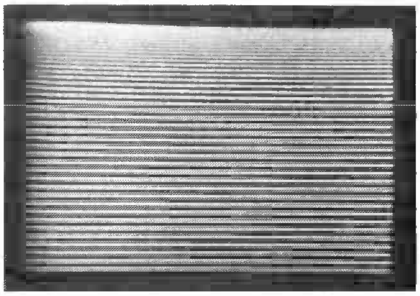


Fig. 12 A test pattern with the vertical synchronization control incorrectly set—the picture moves continually, giving a rolling effect.



A



B

Fig. 13 The linearity test pattern obtained using the method illustrated in Fig. 10 with a 2400 cps signal applied to the control grid and vertical sync circuits. A shows an incorrect pattern, while B is the correct pattern.

Fig. 14 A test pattern with the vertical centering control incorrectly set.

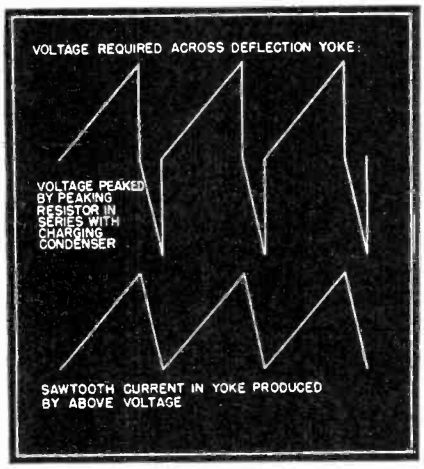


Fig. 15 The voltage and current wave forms required for the magnetic deflection system.

Fig. 16 The fold-over effect caused by improper peaking in the vertical scanning circuit.

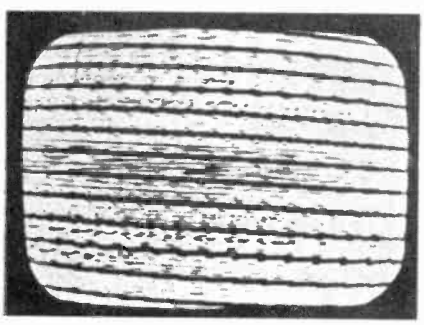


Fig. 17 A test pattern with the horizontal frequency control incorrectly set.

control so that the saw-tooth oscillator is operating at the correct frequency. Fig. 12 shows what happens when the vertical synchronization control is incorrectly set.

When satisfactory vertical scanning amplitude has been obtained, it is then possible to determine the linearity of scanning by increasing the frequency of the beat oscillator successively in steps to the values 120, 240, 480, 960, 1920, 2400 and 3600 cps (or any other multiple of 60). Since these frequencies are multiples of the 60-cps scanning frequency, the scanning circuit will synchronize on every second wave for 120 cps, every fourth wave on 240 cps, and so on.

At the frequency 2400 cps, the scanning circuit synchronizes every fortieth cycle (since $2400/60 = 40$) but the scanning frequency remains at 60 cps. Consequently, the pattern on the screen will be broken up into roughly 40 horizontal bars. Fig. 13 is the pattern that will be seen on the screen. If the vertical scanning motion is linear, these bars will be equally spaced; otherwise, they will display a spread-out or compressed appearance over part of the screen. By adjusting the linearity controls (a receiver may have one or more) in the vertical scanning generator, it is usually possible to obtain substantially equal separation between all bars (these may be checked with a pair of dividers) indicating satisfactory scanning linearity in the vertical direction. It may be necessary to reset the height control while making this linearity adjustment, for in some circuits the adjustment of one will affect the other. The vertical positioning control can now be set to center the raster vertically. Fig. 14 shows what happens when the vertical centering control is incorrectly set.

In receivers using magnetic deflection, one more adjustment must be made in the vertical system. It will be remembered that in order to obtain saw-tooth deflection current in the deflecting yoke, the type of voltage wave must be generated as indicated in Fig. 15. Since the output of the discharge tube is a saw-tooth voltage, the wave form shown in Fig. 15 may be obtained by placing a resistor (commonly called a "peaking" resistor) in series with the charging capacitor. If, due to aging or change in components, this peaking resistor is not the correct value, the current in the yoke will no longer be a linear saw-tooth, and the lines at the top of the raster will begin to fold over into the picture. This condition is shown in Fig. 16. Since most receivers will

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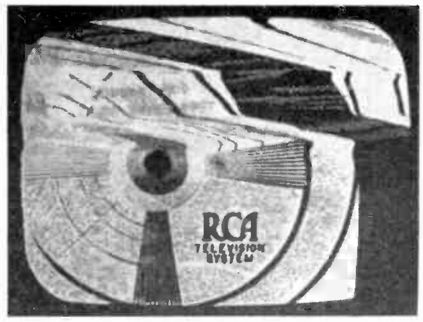


Fig. 18 A test pattern showing the picture tearing due to unstable horizontal synchronization.

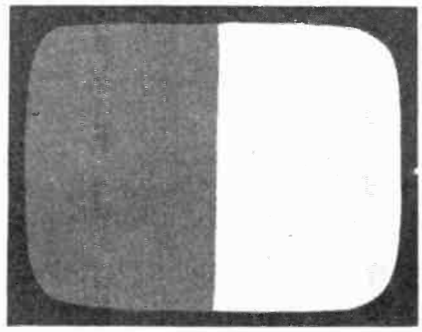


Fig. 19 The pattern produced in the horizontal scanning amplitude test with a 15,750 cps signal on the grid.

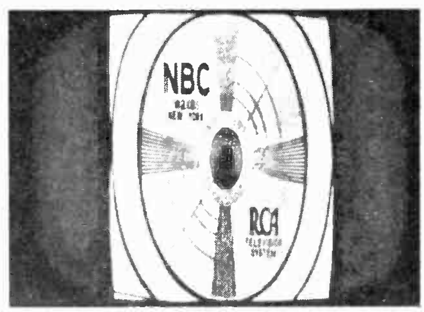


Fig. 20 A test pattern with the horizontal width control incorrectly set.

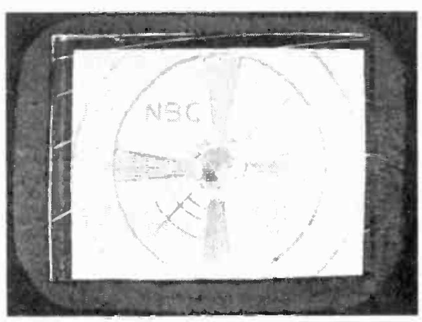
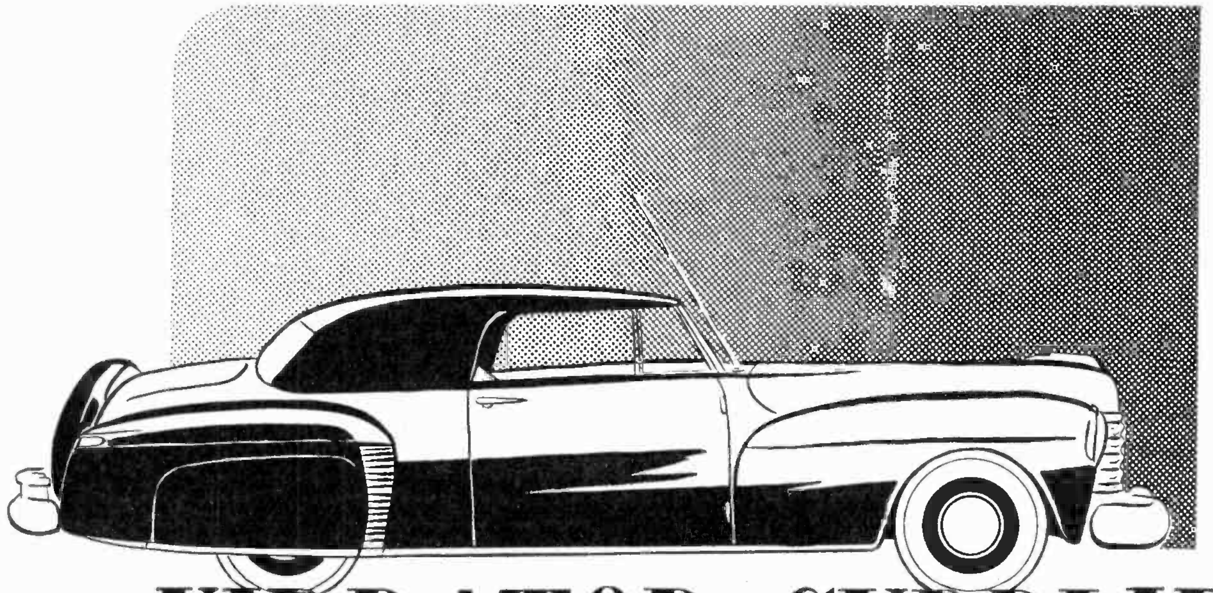


Fig. 21 A test pattern showing the picture size produced by the blanking action.



VIBRATOR SUPPLIES

Peter Markantes

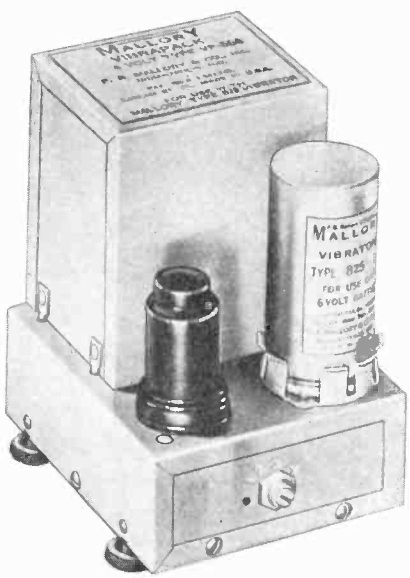
A discussion of vibrator supply circuits

IN THE NEAR FUTURE, with the advent of great numbers of new autobiles, the auto radio business should begin to increase. Since the installation and repair of auto radio receivers will represent a substantial portion of the serviceman's income, it will not be amiss to discuss some of the problems associated with this phase of the industry.

Although, basically, there is very little difference between conventional home receivers and automobile receivers, there are a few distinguishing features that warrant serious attention. Perhaps the most radical departure is represented by the type of power supply used. Accordingly, this article will deal with some basic features of vibrator power packs insofar as they relate to servicing problems. Fig. 1 shows a typical vibrator power supply; almost all auto radios use built-in supplies rather than separate ones as shown.

The fundamental principle of vibrator power pack operation is a simple one. Fig. 2 shows a conventional plate supply system with which any radio man is thoroughly conversant.

Although we are accustomed to thinking in terms of sine wave input to the transformer, it must be realized that the transformer principle still holds even though the input is not a sine wave. In fact, we can generalize and state that voltage and current transformation will occur provided only that the input voltage continuously varies above and below some reference value. The wave shown to the right of the sine wave will be quite suitable. Therefore, in designing a power supply that will deliver plate voltage and current from a 6-volt automobile storage battery, a starting point would be the design of apparatus that will give a voltage waveform (as pictured in Fig. 2) from the battery.



COURTESY OF
P. R. MALLORY & CO., INC.

Fig. 1 A typical vibrator supply.

Fig. 3 illustrates one method of accomplishing the desired result. With the switch in the right hand position, current will flow from A to B; in the left hand position, from B to A. If you can visualize the switching taking place instantaneously, the square waveform will be produced.

A much simpler switching arrangement is possible if the transformer primary is wound in two sections as shown in Fig. 4. Now, with the switch in the right hand position, the flow of current is through the lower half of the primary; in the left hand position, through the upper half of the primary.

All that remains now is to replace the S.P.D.T. switch of Fig. 4 with a magnetically driven switch or vibrator. Fig. 5 shows a typical vibrator. Fig. 6 is a circuit in which a vibrator has been included. Here the arm of the switch has been replaced by a metallic reed "A" upon which is mounted contact 3. When no current is applied, the reed is equidistant between contacts 1 and 2. When current is applied, the coil is energized, attracting the armature and closing contacts 2 and 3.

The closing of contacts 2 and 3 results in a pulse of current through the lower half of the transformer primary. Simultaneously, the coil is short-circuited and de-energized. The reed having been "stretched" out of its center position now "rebounds" with sufficient force to strike contact 1 and send a pulse of current through the upper half of the primary.

The entire arrangement can be assembled in a small amount of space and is generally mounted in a small can with all leads brought to a plug at the base of the can. Fig. 7 shows a vibrator mounted in this manner. The material surrounding the unit is sponge rubber used to absorb vibration.

In another form of interruptor vibrator, an extra set of contacts is provided solely for the coil. These two forms, despite the great number of different pin and plug arrangements that have appeared over the years, are the only forms taken by the interruptor type vibrator.

The power supply is shown schematically in Fig. 8. Note that polarity of the DC output is independent of the polarity of the input.

If the vibrator can change DC to AC, then it can change AC to DC. In other words, a vibrator can be used to replace the rectifier tube. All that is necessary is that primary and secondary vibrators operate in synchronism. The easiest method of accomplishing this is to mount an extra set of contacts on one reed and use the same driver coil. The synchronous vibrator, as this is called, is shown schematically in Fig. 9.

When the reed is in the up position, contacts 1 and 2 are closed. Current flows from A to B in the primary. In the secondary, the current takes the path H-G-E-F.

Note that the polarity of the DC output is now dependent on the polarity of the input. Note that in Fig. 9, reversing the battery terminals (car uses positive ground) results in reversing the polarity of the output. If a set using the vibrator of Fig. 9 had been installed in a Ford (positive ground) it could not work if re-installed in another make of car using negative ground. However, this poses no great problem. If the transformer leads are accessible, all that is necessary is to connect point D to contact 3, and point F to contact 1. This can be done by transposing leads at the vibrator socket, or, if the vibrator can be taken apart, at the vibrator plug.

The vibrator supplies so far shown

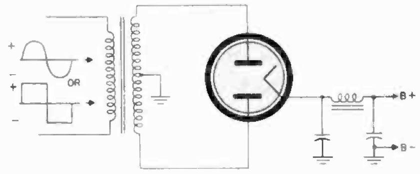


Fig. 2 A conventional plate power supply system.

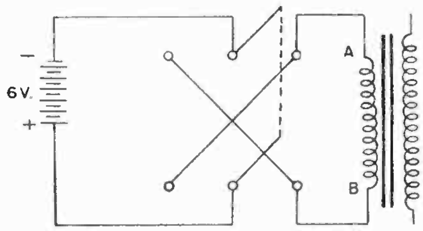


Fig. 3 Switching system used to reverse current flow in a transformer primary.

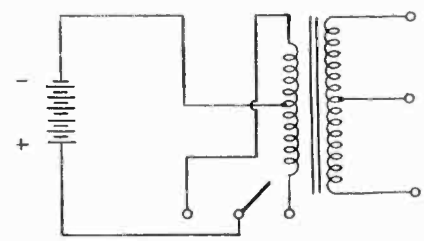


Fig. 4 Switching system used to reverse current flow in a transformer when the primary is tapped.

have been stripped of all but the bare essentials for ease of explanation. Now we are ready to consider some of the other components which are needed for satisfactory operation. Perhaps the most important of these components is the buffer or timing condenser. Let us consider again the action of the contacts and the reed. As the reed approaches one of the contacts, the full battery voltage is applied across the contacts causing a spark to jump across the gap just before the contacts close. Moreover, when the contacts are broken, the magnetizing current (in the transformer) would be broken suddenly, resulting in a rapidly collapsing field and the build up of extremely high voltages of opposite polarity.

By connecting a condenser across the contacts, the spark could be absorbed. By connecting a condenser across the secondary, the condenser could store energy while the contacts were closed, and discharge during the break. A large condenser is required across the contacts, while a small condenser is required in the secondary. However, two condensers are not necessary. By a simple expedient, one condenser can be used to perform both functions. Consider Fig. 10.

The familiar impedance transformation formula

$$\frac{Z_p}{Z_s} = \left(\frac{N_1}{N_2}\right)^2 \text{ yields } Z_p = Z_s\left(\frac{N_1}{N_2}\right)^2$$

If Z_s is capacitive, then Z_p will also

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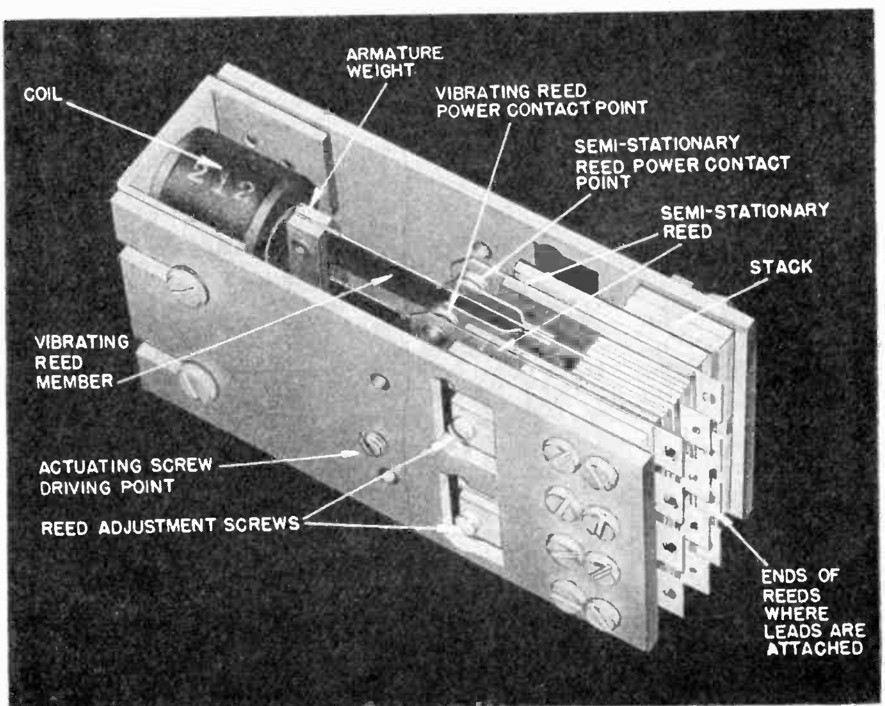

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Fig. 5 A typical vibrator unit.

AFC

BY

MONROE M. LANGE

Melville Radio Institute

Receivers using automatic frequency control are becoming more common. The operation and servicing of this type of circuit are discussed herein.

WITH THE PRESENT ACCENT on high fidelity reception, and the increasing popularity of automatic tuning, it is becoming more essential for the progressive and far-sighted radio serviceman to have a good working knowledge of *automatic frequency control* systems. It is the aim of this article to describe the theory of operation of such systems, and to suggest means of servicing faulty systems.

The need for automatic frequency control, or AFC, in modern broadcast receivers has been occasioned by the increased use of automatic tuning devices. In order for the average listener to derive all the benefits of the engineering skill employed in the design of the receiver, some method must be used to insure accurate tuning. Not only must this tuning be accurate when the station is first tuned in, *but must remain so with continued operation.*

It is common knowledge that the selectivity and amplification of a superheterodyne receiver are governed by the characteristics of the IF amplifier. The performance of this section, in turn, depends on the proper operation of the local oscillator. Any shift in the local oscillator frequency will cause the generation of the improper intermediate frequency, thereby reducing the efficiency of that circuit. Regardless of discrepancies in RF tuning, if the oscillator can be made to differ in frequency from the signal frequency by the exact amount of the IF, the converted signal applied to the intermediate frequency amplifier will be correct. Therefore, since the IF amplifier is fixed tuned, AFC circuits must act to control the oscillator frequency.

What causes the oscillator frequency to shift? Some common causes are temperature and humidity changes, vibration, line voltage variations and operating potential fluctuations. Obviously, it is not economically feasible to use shock-mounting, temperature-controlled chambers, and extremely well regulated power supplies (as is done in transmitters) to overcome these defects. Hence, the need for an automatic frequency control circuit which will compensate for the adverse effects of the above conditions.

The operation of an AFC system depends on two fundamental components: Namely, a discriminator and a reactance (or control) tube. (Notice here the similarity to FM.)

Fig. 1 shows a block diagram of an AFC system. The receiver may or may not have a separate detector, in addition to the discriminator for the development of the audio voltage. However, it is the primary purpose of the discriminator, as far as AFC is concerned, to develop a DC voltage proportional to the deviation of the intermediate frequency from its desired value. It is evident why it has so appropriately been named "discriminator," since the discriminator can distinguish changes in the IF, and compensate for them if necessary. This it does by supplying a control voltage, in the form of a bias, to the reactance tube, which subsequently controls the local oscillator frequency.

Before going any further, it may help if the reader recalls a few fundamentals. First: The frequency of an oscillator is determined by the inductance and capacitance in the tank circuit ($f = \frac{1}{2\pi\sqrt{LC}}$). Second, the plate current and grid voltage of a tube are in phase, while the plate voltage and grid voltage are 180° out of phase, as illustrated by Fig. 2A. Third, the current in an inductive circuit lags the voltage by 90°, while the current in a capacitive circuit leads the voltage by 90°, as illustrated by Fig. 2B and 2C.

It can be seen then, that by introducing a 90° lagging voltage into the grid circuit of a tube, it can be made to act like an inductance, as illustrated by Fig. 2D. If this inductance is shunted across the tank of the local oscillator and varied, the frequency of the oscillator will also be made to vary. What remains to be told is how it is done, and this will now be illustrated with the aid of a few diagrams.

Fig. 3 shows a simple type of discriminator circuit. While there are many variations, the fundamental principles involved are the same. The two secondaries, S1 and S2, are tuned respectively to frequencies higher and lower than the IF, by the same amount. When the intermediate frequency is correct, the voltages across S1 and S2 are equal, and the diodes will produce equal voltages across R1 and R2. Note that the polarity of the two are opposing. Therefore, their algebraic sum will be zero.

If, however, the local oscillator frequency has drifted and the IF is too high (S1 is now in tune), D1 will have a higher anode voltage, and thus will conduct more heavily than D2. The voltage across R1 will be greater than that across R2; and, consequently, point X will be negative with respect to ground. If the IF is too low (S2 is in tune), the process is reversed and point X becomes positive with respect to ground. The AFC voltage has thus been created. Plotting this voltage against variation of the interme-

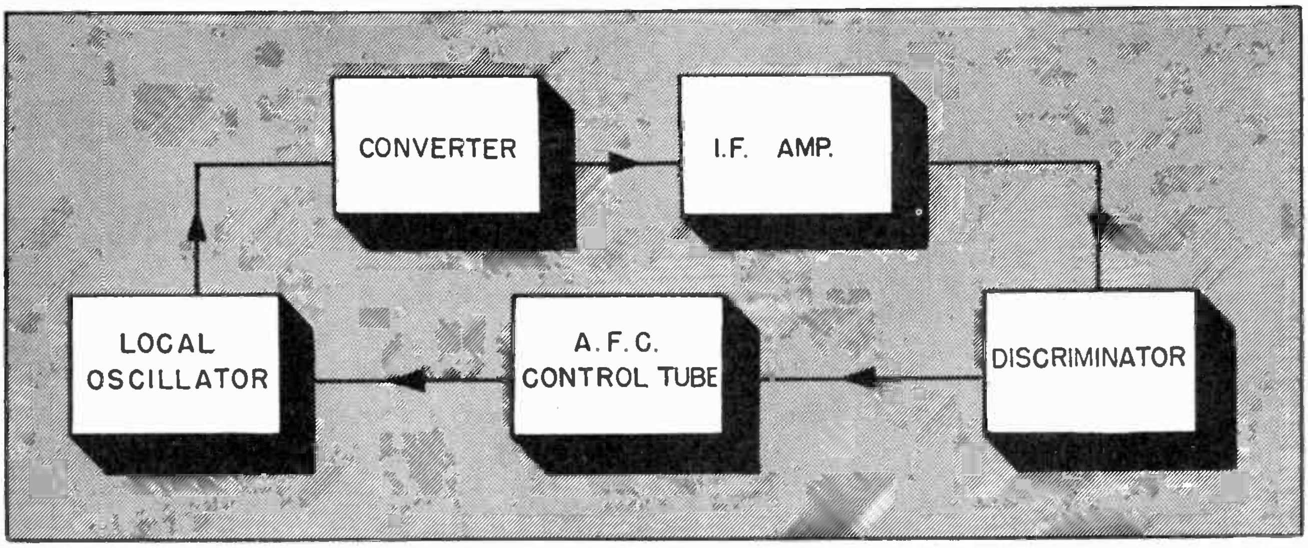

Fig. 1 Block diagram of an AFC system.

diate frequency, the typical characteristic "S" curve of a discriminator, as shown in Fig. 4, results.

It is next necessary to see how this voltage is used to stabilize the frequency of the receiver. Referring to the block diagram of Fig. 1 again, you will note that the AFC voltage, which is the discriminator output, is fed into the control tube. The latter, since it acts like a variable inductance shunted across the tank of the oscillator, will change its net inductance, and, therefore, its frequency. This is accomplished as follows.

Referring to Fig. 5, the AC component of plate voltage of the reactance tube is obtained from the oscillator grid tank, L and C. Hence, it is in phase with it. Also the alternating grid voltage is obtained from the same source across the voltage divider C1, C2, and R. The capacitive reactances of C1 and C2 are made very low compared to value of R. This is done to make the voltage divider act like a resistive circuit. Effectively then, the current through the voltage divider is in phase with the plate voltage. However, the voltage across C2 lags this current by 90°, and so lags the plate voltage by 90°. Since this same voltage (across C2) is the AC voltage being introduced between grid and cathode of the control tube, the grid and plate voltages are 90° out of phase. As plate current and grid voltage are in phase, plate current and plate voltage are also 90° out of phase, and the tube simulates an inductance.

The final step is to produce a variation of this inductance. This is attained by altering the grid bias of the control tube, thus governing the amount of plate current.

To understand how this variation of inductance is achieved, the characteristics of an inductance should again be reviewed. With a fixed voltage applied, the amount of inductance is inversely proportional to the amount of current, or as the current increases, the inductance decreases and vice versa. The amount and direction of that change are regulated by the output of the discriminator.

All AFC systems are based on the fundamental principles outlined above. Of course, the type discriminator and the phase shifting network will differ in the various kinds of commercial receivers. However, the previous explanation, together with the following hints, should provide sufficient information for servicing.

Some of the common troubles in receivers with automatic frequency

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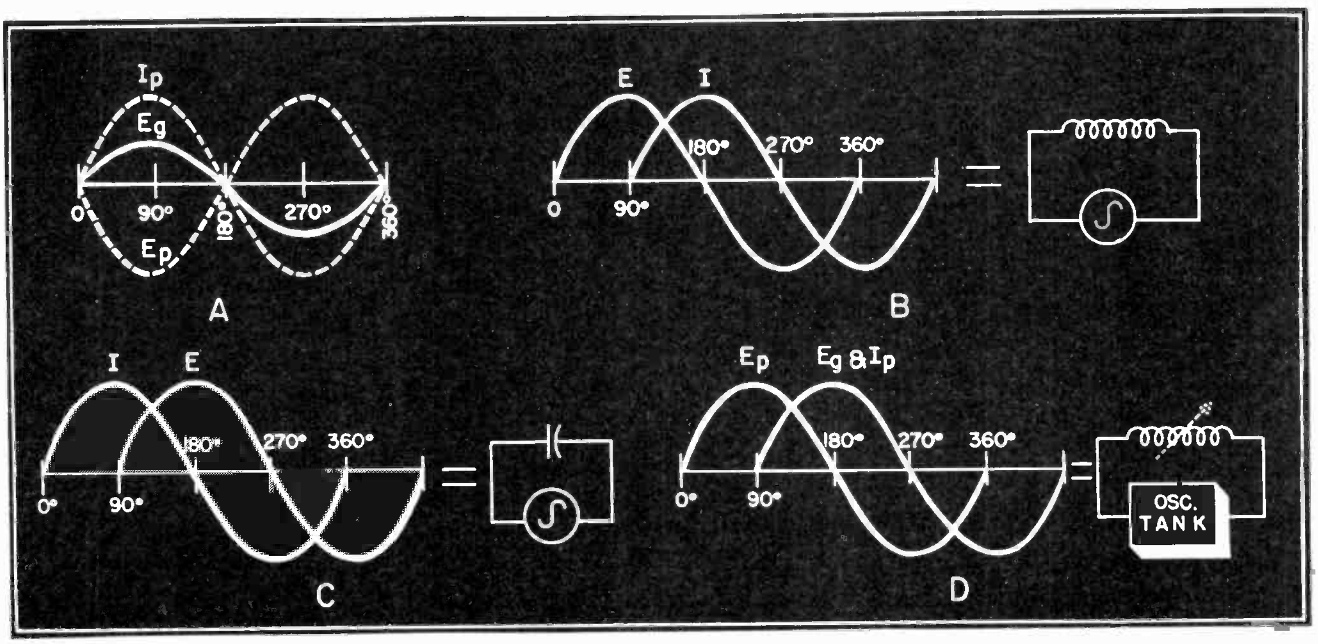

Fig. 2 The voltage and current relationships in an oscillator.

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control are hum, hiss, blasting, high distortion, difficulty in tuning, improper oscillator performance, or the complete lack of AFC action. The succeeding suggestions are based on the premise that the rest of the receiver is operating normally.

As in all troubleshooting, the first step is to localize the difficulty. It must be ascertained that the fault actually lies in the AFC system. This can usually be done simply by turning the AFC switch to OFF, *and removing the control tube from its socket.* If the set has no AFC switch, the AFC bus may be temporarily disconnected. Removing the tube is necessary as the switch usually eliminates only the discriminator. If the trouble disappears, the AFC circuit is definitely at fault.

The test equipment needed for this circuit does not differ from that used in ordinary repair work. An amplitude modulated RF signal generator and a vacuum tube voltmeter suffice. The latter is preferable due to its high sensitivity and non-loading effect upon the critical circuits involved.

To determine whether the AFC is operating at all, a signal at the IF peak should be introduced into the grid of the IF amplifier, and a vacuum tube voltmeter connected to the output of the discriminator. The signal generator should then be varied above and below the IF peak, noting whether or not the reading changes. If it doesn't, the discriminator is inoperative and should be checked by measuring voltage and resistance, as well as testing the tube itself.

Assuming the discriminator is normal, the bias of the control tube should next be measured as the signal generator is swept through the frequency band. This reading should show a change as well, due to the variation in AFC voltage. As a final check on the control tube, it should be noted whether or not its plate current is also varying. This may be done either by placing a milliammeter in the cathode circuit, or by measuring the DC voltage drop across the cathode resistor or plate load. In the latter case, since the bias is changing due to AFC action, the current through the resistors will also vary; and, therefore, so will the potential difference across them. These tests should conclusively determine why the AFC is inoperative.

If it is found that the AFC is functioning, but the receiver has an abnormally low signal-to-noise ratio, that distortion exists, or a hissing sound is heard, defective discriminator transformer trimmers, or their improper adjustment, may be the difficulty. To test these, a signal at the IF peak is applied to the grid of the tube preceding the discriminator. Connect a vacuum tube voltmeter to the AFC output. A zero reading should result. To assure that this is a correct setting, the AFC switch should be turned off and on. If the adjustment is right and the trimmers not defective, no change in this reading will occur. If not, the secondary trimmer probably needs readjustment or replacement. It is helpful to remember that this trimmer, when correct, is usually about halfway between minimum and maximum capacity. This adjustment is very critical and will be mentioned later under alignment.

Hum, when present with the AFC

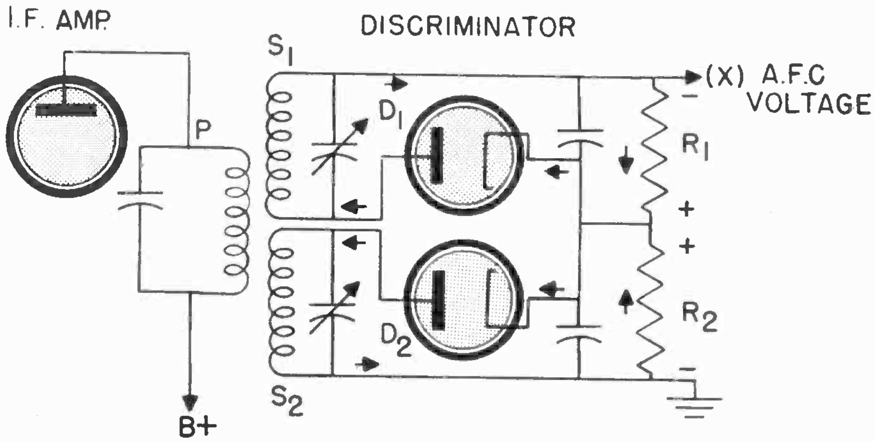

Fig. 3 Simplified diagram of a discriminator circuit.

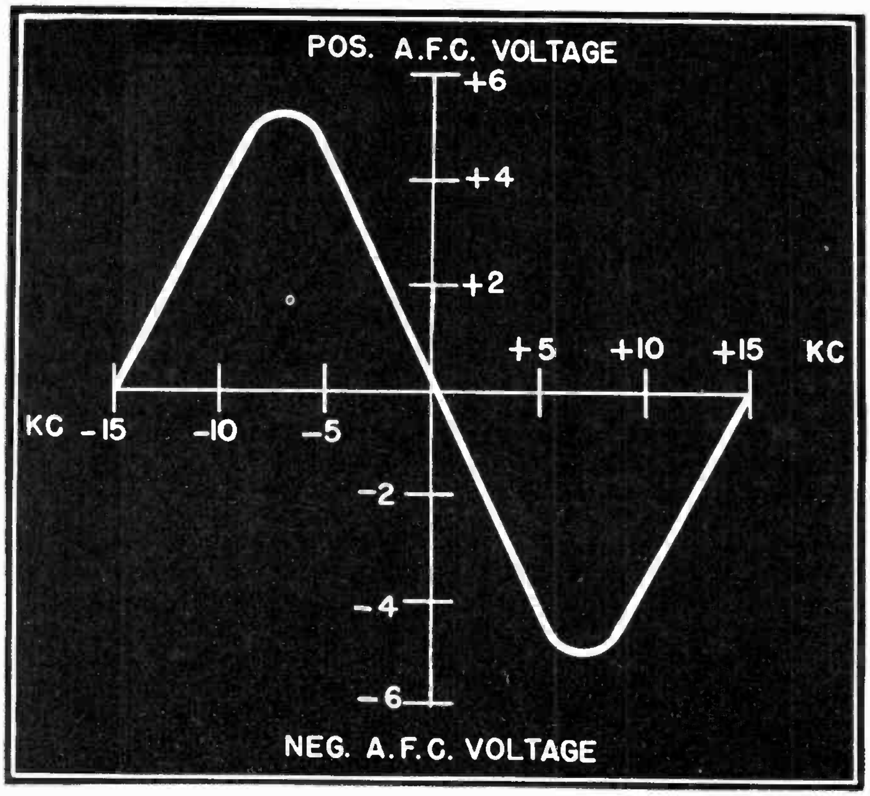

Fig. 4 Typical discriminator output curve.

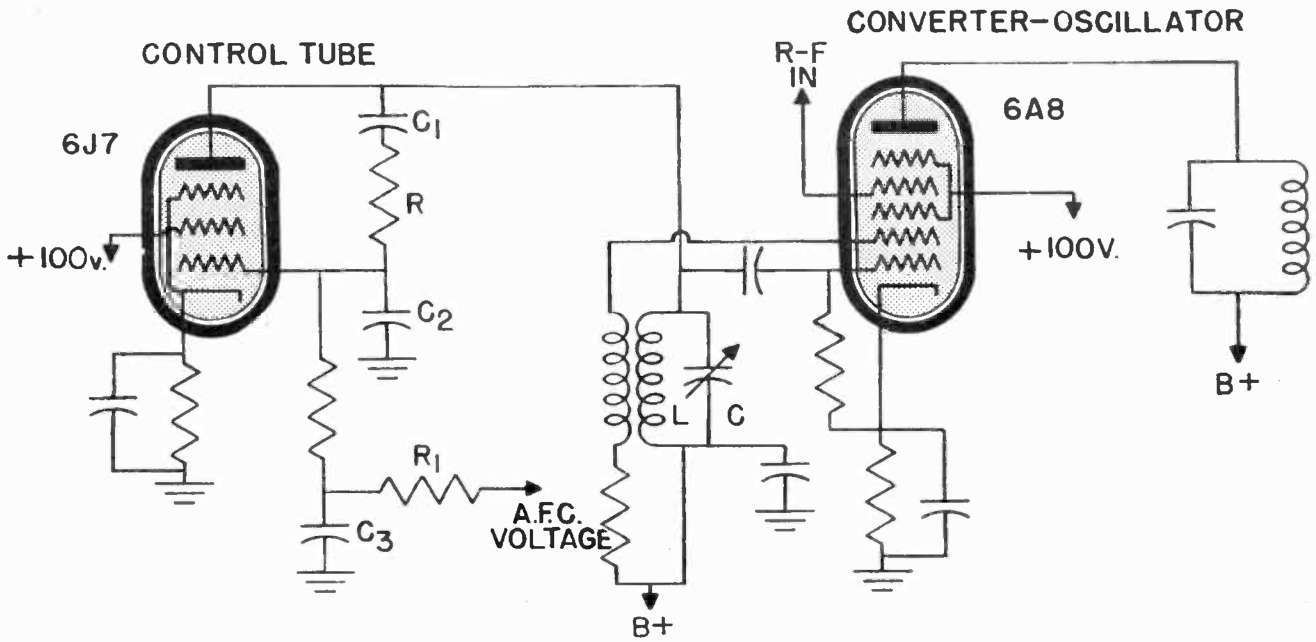

Fig. 5 Simplified diagram of the control tube circuit and the converter-oscillator circuit in a receiver using automatic frequency control.

on, is usually caused by the introduction of a hum voltage into the control tube, thus effectively modulating the oscillator. As for the source of the hum voltage, the usual defects such as imperfect filter condensers (especially where separate filters are used for the plate supply of the control tube), tubes with cathode-heater leakage or shorted filter chokes are to be suspected.

To determine whether the hum is being generated in the discriminator, its bias supply to the control tube can be removed by turning off the AFC switch. If the hum disappears, the source is definitely the discriminator. Frequently, the faulty part in this circuit is the condenser by-passing the ungrounded cathode of the discriminator diode. A good condenser should be shunted from this point to ground as a check. If the discriminator is eliminated, the cause of the hum has been localized to the control tube and can be run down by testing the parts mentioned above.

Another complaint may be blasting when tuning from station to station. This is similar to the symptom observed when the automatic volume control is defective. What actually occurs is that the AFC action brings the signal in before the AVC can take hold. This is due to the AFC time constant becoming smaller than that of the AVC. An open C3 or a shorted R1, in the circuit of Fig. 5, in the AFC feed line is the troublemaker.

Fading or intermittent reception may be due to improper oscillator performance. This can be caused by a faulty control tube circuit, as well as oscillator difficulties. Both the oscillator and reactance tube stages require tubes with a high mutual conductance and they should be checked at the start. The bias voltage of the oscillator may also be measured, with and without the control tube in its socket. If it becomes abnormally low (below 5 volts) when the control tube is inserted, the oscillator tube needs replacing. Even though the oscillator tube may check well, it probably is not strong enough to overcome the slight resistance reflected by the control tube. In cases where the oscillator functions normally, the control tube circuit must be further analyzed for continuity and voltages present.

Except for alignment and defective switches, the main troubles encountered with AFC have been mentioned. Arrangements are usually provided for automatically switching out the AFC while tuning from station; otherwise, it will tend to "drag" a signal from channel to channel. Sometimes switch contacts go bad and must be cleaned.

The alignment procedure does require special attention. It corresponds very closely to the alignment of similar parts in an FM receiver. Also it is important to keep in mind that just as in all other such procedures, the manufacturer's instructions should

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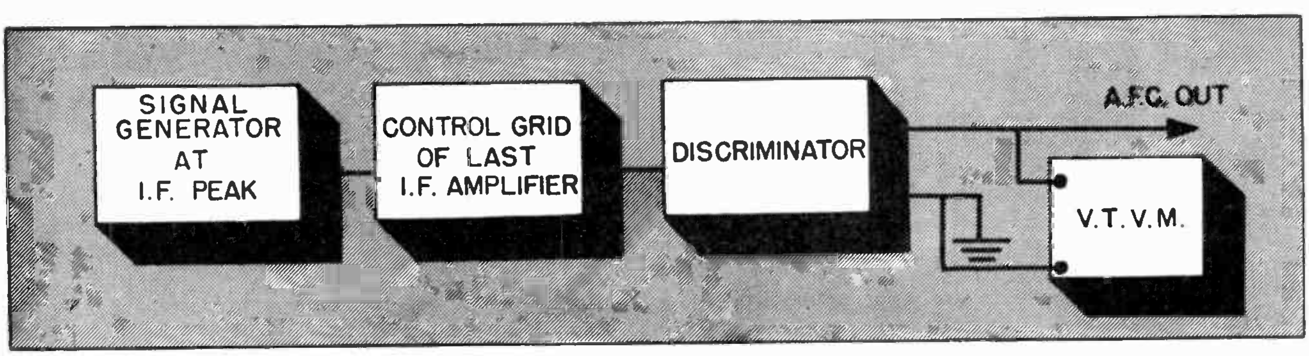
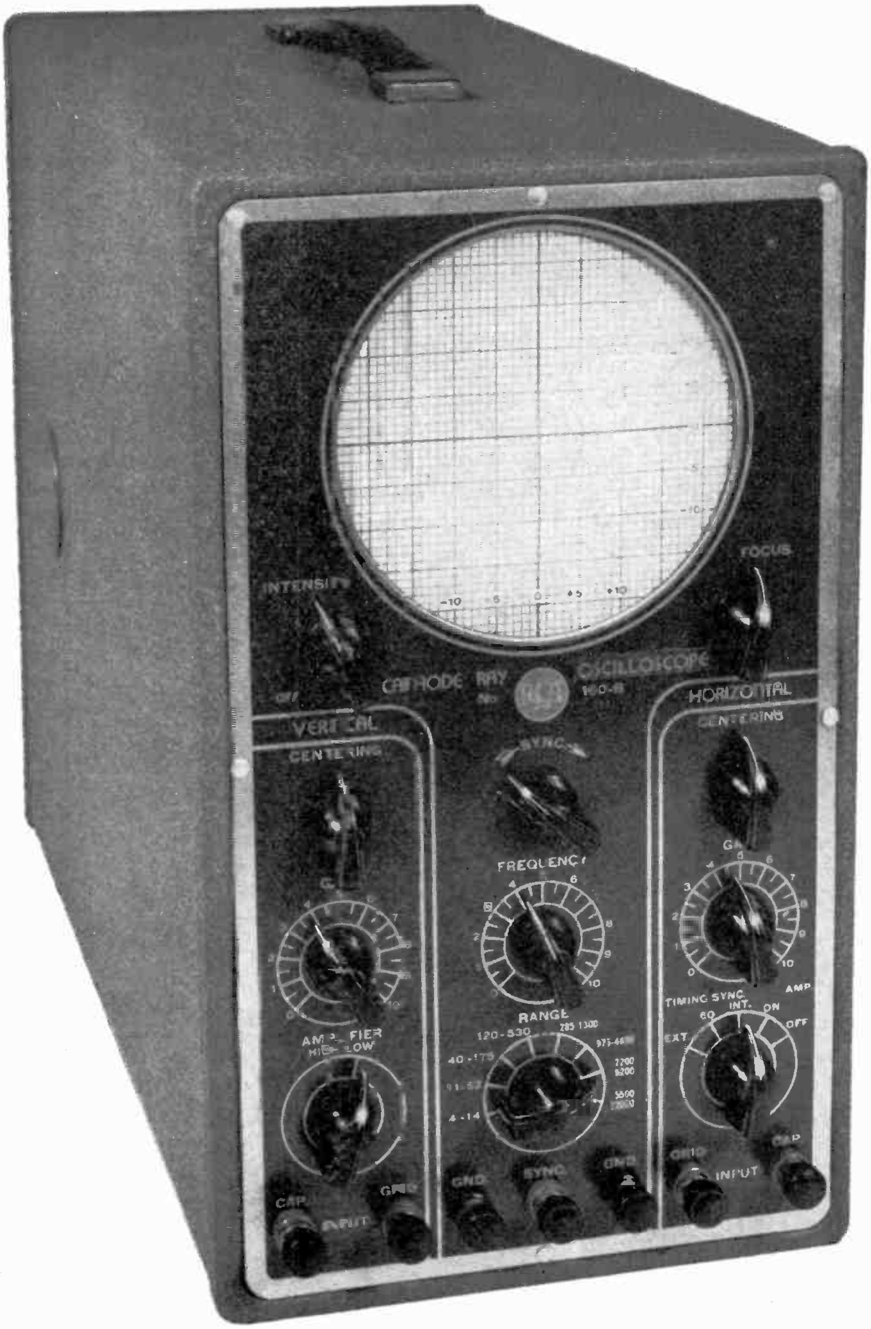


Fig. 6 Connections used for the signal generator and VTVM when adjusting the AFC circuit.

the OSCILLOGRAPH ...how it works

Karl R. Alberts



This is Part Two of a series of articles designed to familiarize the reader with the operation and use of the cathode-ray oscillograph.

THE MOST IMPORTANT and usual use to which the cathode-ray oscilloscope is put is the observation of voltage waveforms. In order that a voltage may be investigated and studied thoroughly, the oscilloscope is made to show, on the face of its screen, a plot or graph of the voltage vs. time. This scheme of presentation is the one which gives most information about a given waveform without the necessity of serious mental calculation to interpret the picture. Fig. 1 shows the units of a voltage plotted vertically against units of time plotted horizontally, so that the resultant graph gives a clear "history" of the waveform from an arbitrary time zero to the end of the wave. One complete cycle of a sine wave is shown.

In order that the oscilloscope be capable of presenting such a graphical picture of a voltage waveform, a voltage whose value at any time is proportional to the elapsed time must be impressed on the horizontal plates in synchronism with the signal voltage to be observed. Then if the signal is impressed on the vertical plates, a time-plot of the voltage will be presented on the screen of the tube.

To see this more clearly, consider the following: Suppose we have a 60-cycle sine wave of, say, 50 volts peak amplitude which we wish to see graphically on the face of the cathode-ray tube. Since voltages are usually pictured as rising or falling in the vertical direction, we impress this voltage between the vertical deflecting plates of the oscilloscope tube. Now, if no voltage is impressed upon the horizontal plates, a straight up-and-down line will result, about two inches long, because the electron beam, and hence also the spot on the tube, is being swept up and down at a 60-cycle rate, with no motion horizontally. If we now impress upon the horizontal plates a voltage of such nature that the spot will move smoothly in linearly from left to right while simultaneously moving up and down in conformity with the information on the vertical plates, the spot will trace out a pattern like that of Fig. 1. If now at the end of the first cycle the spot is made to fly back to the starting point at the left, with little or no loss of time, to "draw" the second cycle, and then the process is repeated over and over at a 60-cycle rate (for

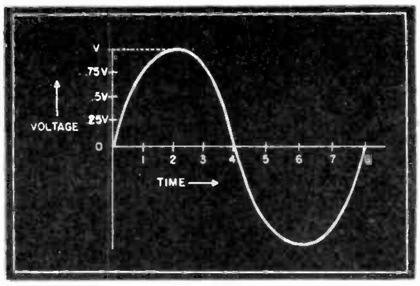


Fig. 1 Voltage units plotted against units of time give a graph as shown above when the voltage is varying in sine wave fashion.

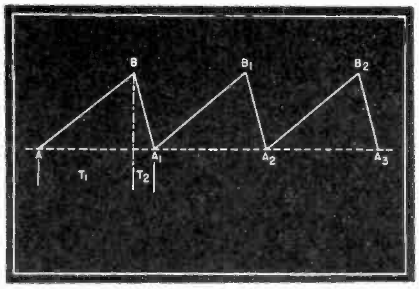


Fig. 2 A saw-tooth voltage of the type shown graphically above is required to form the time base on the face of the cathode-ray tube.

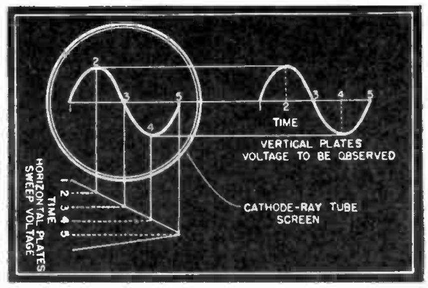


Fig. 3 A graphic illustration of the relation of the vertical signal and the horizontal sweep voltages.

that happens to be the frequency of the signal being observed), then a single stationary pattern will be seen on the screen of the cathode-ray tube, similar to Fig. 1, with no flicker, because of the fact that the spot is tracing out the complete pattern at a rate greater than 15 times per second.

The voltage required on the horizontal plates to produce this motion of the beam is called a "sweep" voltage (also referred to as a time-base voltage) because it sweeps the beam across the tube. The sweep voltage is a "saw-tooth" voltage because it resembles in shape the tooth of a saw. Fig. 2 shows a typical saw-tooth voltage. Time t_1 is the time it takes the voltage to rise from *a* to *b* and drive the spot from left to right. Time t_2, known as the "fly-back" time, is the time required for the voltage to return to a_1 (same level as *a*) and drive the spot back to its starting point from right to left. Time t_2 is shown much enlarged; in actual practice, it is very small, which means that very little time of the cycle is required for the spot to be returned from right to left. This results in the spot's return trace being dimmer in intensity than its forward trace, since the faster the spot moves across the screen, the less time there is for any one spot on the screen to become fluorescent as the result of the passing of the beam over it. (Sometimes, in order to blank the return trace completely, a square-wave voltage is developed in one of the sweep amplifier tubes, having a negative portion equal in time to t_2; when this voltage is impressed on the grid of the cathode-ray tube, complete blanking results for time t_2.)

The correlation of vertical signal voltage and horizontal sweep voltage can probably best be understood by a study of Fig. 3.

The Sweep Generator

There are many methods by which an accurate saw-tooth sweep voltage can be generated. Among these are the hard tube relaxation oscillator, the arc tube (or neon tube) relaxation oscillator, the thyratron sweep generator, the multi-vibrator, and the blocking oscillator. Of these, by far the most widely used in oscilloscopes is the thyratron type. The thyratron is a gas-filled triode in which, once the grid voltage is raised to cut-off value, the tube fires and produces a very low plate-to-cathode voltage which is then sensibly independent of any further grid voltage changes. The only way for the tube to stop conduction is for the plate to drop to a value lower than that necessary to support ionization of the gas within the tube. Fig. 4 shows the thyratron sweep generator circuit used in the DuMont Type 208B oscilloscope, a simple and rugged instrument. (The RCA-158 is similarly recommended for simplicity and ruggedness.) Fig. 5 is the complete circuit diagram of the Dumont Type 208B which is referred to in this article.

As shown, the coarse frequency switch can select any one of eight different condensers or a short circuit (which is the OFF position). For any condenser position, assume the grid to be at zero volts DC, the cathode at about +3 volts (through the voltage divider circuit from B+ to gnd.). Therefore, starting at zero time, the

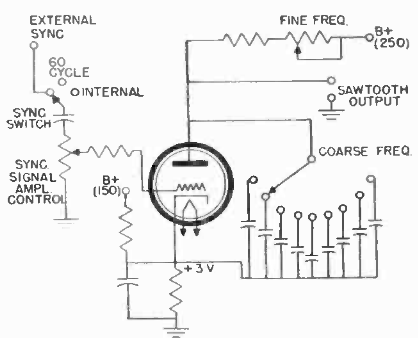


Fig. 4 Thyratron sweep generator circuit as used in the DuMont 208B oscillograph.

condenser between plate and cathode starts to charge to +250 volts through the plate resistor and potentiometer. A condenser charging wave is an exponential waveform the leading edge of which is essentially linear. The condenser charges toward B+ until it reaches that plate potential which will fire the tube when the grid bias is 3 volts. As soon as this occurs, the tube fires, forming a low resistance path between plate and cathode, and the charged condenser discharges rapidly through the tube until the voltage falls to the de-ionizing voltage of the thyratron, when conduction stops and the tube becomes an open circuit again. The condenser then starts to charge again to B+ and the process repeats itself. Fig. 6 shows a graphical representation of the thyratron action.

It will be noted that the small portion of the condenser's charging wave which is used is quite linear and is generally saw-tooth in shape. The steepness of the charging wave depends on the capacity and resistance in the charging path, which determine the "time constant" of the wave. A larger condenser or a larger resistance makes a longer time constant, which means a greater time is taken for each cycle, or that there are less cycles per second. Thus the frequency of the saw-tooth, or the rate at which the spot will be swept horizontally across the screen, can be varied by switching condensers (coarse frequency adjustment) and by varying the setting of the potentiometer in the plate (fine frequency adjustment).

Synchronization

It is necessary, if a complete picture of the signal is to be seen on the cathode-ray screen, clear and steady, without moving or flickering, that the horizontal sweep voltage and the vertical signal voltage be absolutely synchronized with each other.

The exact theory of synchroniza-

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tion of oscillators is a rather complicated affair and need not be gone into in great detail here. It is obvious that if the grid voltage in the oscillator above is changed, the frequency will change slightly because the tube breakdown voltage which the condenser must reach is made lower if the grid is raised, and higher if the grid is lowered. In the first case, the cycle would be made shorter (resulting in more cycles per second or higher frequency) and in the second case, the cycle would be longer (resulting in less cycles per second or lower frequency). If a small portion of the signal to be placed on the vertical plates is fed also into the oscillator sweep circuit through the external synchronism terminal and the Sync. switch set to External, the small signal will be fed on to the thyratron grid, and change it slightly each cycle, in the correct direction, so that the exact synchronism between the signal and sweep frequency will result.

In many cases, it is desired to view more than one cycle of the signal on the screen at the same time. The sweep must then be synchronized at some frequency lower than that of the signal. For example, if two cycles are to be observed, the sweep frequency must be exactly half the signal frequency. This is obvious, since the sweep cycle must take exactly twice as long as one signal cycle in order for two signal cycles to appear on one sweep. If five signal cycles are to be shown, the sweep frequency must be one-fifth the signal frequency.

If the Sync. switch is set to 60 cycles, a portion of the line voltage is fed into the oscillator. If the oscillator is then adjusted to some frequency near 60, it will lock in at 60 cycles exactly.

In the Internal Sync. position, the thyratron grid is connected to a point in the vertical amplifier circuit so that the signal under investigation can be stopped on the screen, when neither of the other two switch positions can be used.

Normally a minimum of Sync. voltage should be used (i.e., the Sync. control potentiometer should be turned as low as possible) because over-synchronization results in distortion of the pattern on the screen.

The Horizontal Amplifier

Only a small portion of the condenser charging voltage is used as the saw-tooth sweep, in order to get as linear a sweep as possible. This voltage is too small to drive the spot across the face of the tube; it must, therefore, be amplified. This is accomplished by the horizontal deflection amplifier, which in the DuMont 208 Oscilloscope consists of two triode stages (double-triode 6F8G) followed by a push-pull stage of two 6V6's. The two triodes are cathode followers. The action of such circuits will be described later. The output of the 6V6 tubes is direct coupled to the right and left deflecting plates of the cathode-ray tube.

The reason for using push-pull output from the horizontal amplifier to the deflecting plates, rather than using a "single-ended" tube to drive the left plate and ground the right plate (or vice versa) will be apparent from the following argument:

If the right plate were grounded and the left plate had a positive potential placed on it, the electron beam would be pulled to the right. Now, the beam is of appreciable width, even though it has been concentrated by the focussing and accelerating anodes. Hence, the outer electrons in the stream will be accelerated by the deflecting plate's positive voltage more than the inner ones will be.

The deflection plates act somewhat like an accelerating anode. Hence the outer electrons, having been given a greater speed than the inner ones, will not be deflected as much as the

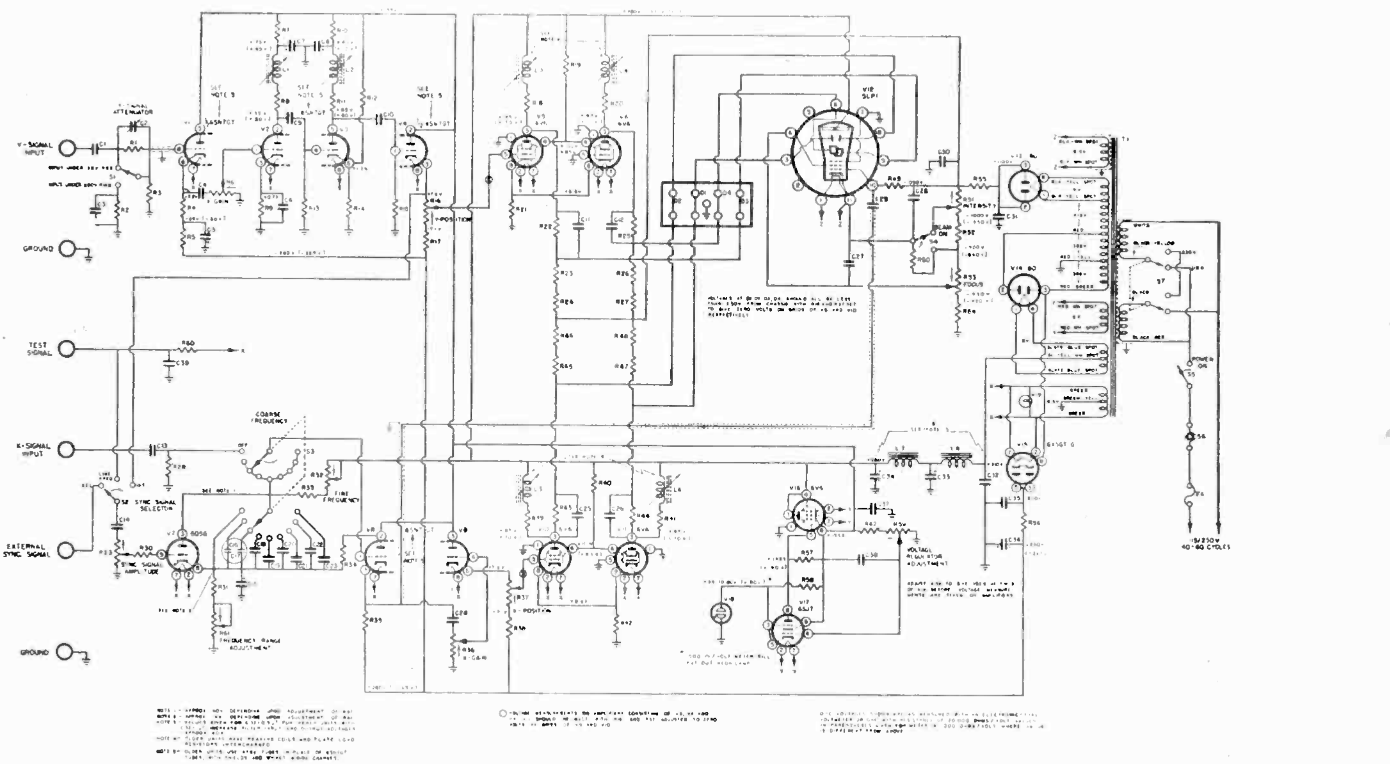

Fig. 5 The complete circuit diagram of the DuMont 208B oscillograph.

inner ones, and the electron beam which, before the deflecting plates, was focussed to strike the screen in a fine spot, will now converge somewhere inside the tube and will strike the screen in an unfocussed "blob." The sweep line will then appear as a line which is sharp in the center and unfocussed at the ends, the defocussing progressing with the distance from the center of the screen. With push-pull applied to the deflecting plates, the right plate goes negative when the left plate goes positive, and by the same amount. Therefore, the overall average voltage of the horizontal deflecting plates is zero, and no net acceleration (and hence no defocussing) will result.

Push-pull drive is accomplished in this way: The voltage to be amplified is applied to the grid of the first 6V6. There will then appear across the common cathode resistor for the two 6V6's a voltage half the size of the applied voltage, but in the same phase. The grid of the second 6V6 being grounded, this tube effectively sees an impressed grid-to-cathode voltage equal to half the original input voltage, and out of phase with it. Since the first tube has a grid-to-cathode voltage equal to half the input voltage (grid-to-ground), the two 6V6's therefore have equal but out-of-phase grid-to-cathode voltages, and their outputs will consequently also be equal and out of phase. Thus, if a positive saw-tooth wave is produced in one plate, a negative one will be produced in the other.

Position or centering control (i.e., moving of the entire screen pattern right or left to a fixed position) is accomplished by a potentiometer which determines the grid bias on the first 6V6 output tube.

The voltage gain through the horizontal amplifier is about 40 to 45. The horizontal gain control is a potentiometer in the cathode circuit of the first tube. It determines the amount of signal fed onto the second grid, rather than actually varying the gain of the amplifier. Thus, the amplifier can be made always to operate over its linear region, no matter what the setting of the "gain" control.

Fig. 7 is a simplified schematic of the horizontal and vertical amplifiers used in the DuMont 208B.

The Vertical Amplifier

In order to observe small signals on the cathode-ray screen, an amplifier is interposed between the input terminals and the deflecting plates. For large amplitude signals, provision is made for connecting directly to the deflecting plates. The amplifier is usually a video amplifier with constant gain over a wide frequency band, uniform phase shift over that band, and linear amplification. The amplifier is made a video amplifier because the oscillograph, being a versatile instrument, must be capable of passing all the frequencies of a complex wave. The DuMont 208B oscilloscope and types like it have vertical amplifiers with band widths in the order of 100 kilocycles. Other more advanced types (for more highly specialized testing) have amplifiers with bands of a megacycle or more.

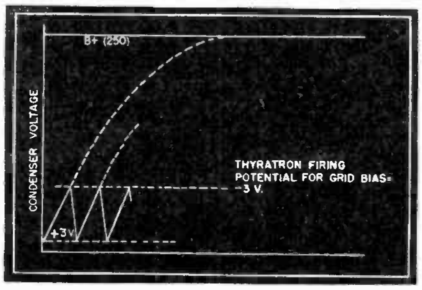

Fig. 6 Graphical illustration of the action which takes place in a thyratron tube.

To observe signals of widely different amplitudes, the model 208B has a switch marked "under 25V." and "under 250V." with different attenuations for signals falling within the two classifications.

The amplifier itself consists of an input cathode follower stage followed by two conventional triode stages. A cathode follower has a high input impedance and a very low output impedance (the input is grid to cathode, the output is across the cathode). The low output impedance and the almost distortion-less action of the cathode follower is obtained at the expense of gain, for the gain is 1 or less.

The two triode stages employ series coil compensation (inductances in the plate circuits to increase the voltage at higher frequencies and thus compensate for the deteriorating effect of stray and distributed capacities). These two stages are followed by another cathode follower stage. The output of the latter is fed to two 6V6's in push-pull, exactly as for the horizontal amplifier. The 6V6 tubes feed directly onto the vertical deflecting plates as shown in Fig. 7.

Position or centering control (i.e., moving of the entire pattern on the screen up or down to a fixed position) is accomplished by a potentiometer which determines the grid bias on the first 6V6 output tube, just as for the horizontal positioning circuit.

The voltage gain through the vertical amplifier is about 2000. Vertical gain control is accomplished in exactly the same manner as for the horizontal channel.

Power Supply

The power supplies of an oscillograph must furnish (a) high voltage to the cathode-ray tube, (b) various plate supply voltages and bias voltages for the amplifier and sweep circuits and for the intensifier electrode of the cathode-ray tube (if it has one). In most oscillographs, the high voltage (1000-2000 volts) used between the cathode and accelerator anode is applied as a negative voltage to the cathode with the second anode grounded (this effectively makes the second anode positive with respect to the cathode). This is done because the deflecting plates, being placed after the second anode, must be at the

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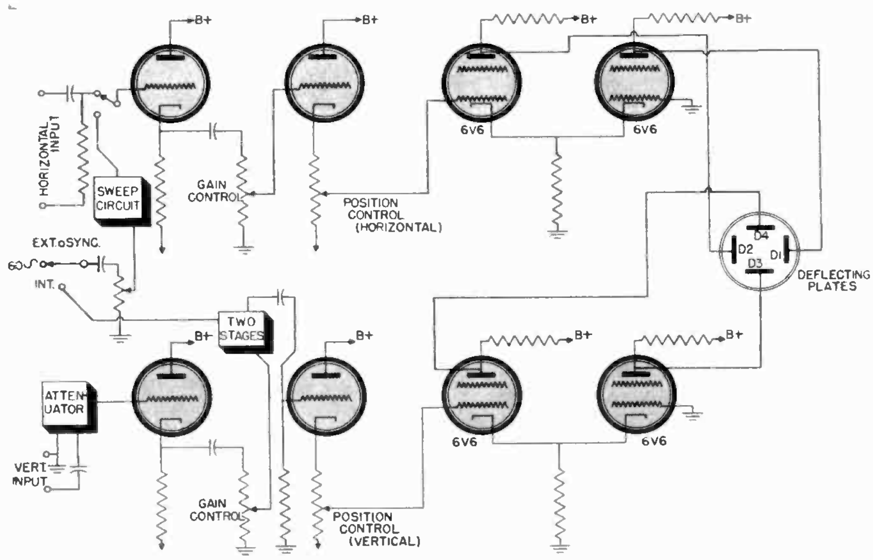

Fig. 7 Simplified schematic diagram of the horizontal and vertical amplifiers used in the DuMont 208B.

KNOW YOUR V.T.V.M.

Walter Weiss

Chief Electronics Engineer
Hickok Electrical Instrument Co.

A discussion of some of the less frequent uses to which an electronic voltmeter can be put.

TODAY, WITH THE FIELD in electronics ever expanding, particularly in the realm of frequency modulation and television, there is an increasing demand for testing units which are versatile in both the types of test that can be made and the range over which a given test can be made. The inherent value of an electronic volt-ohm-capacity-milliammeter is appreciated by those familiar with its use, and every one is aware of its common uses in servicing electronic equipment—that is, the measurement of heater voltage, power supply outputs, plate and grid voltages, capacities, resistances, etc. The story which certain types of measurements can tell is often missed.

In this article, the use of an electronic test instrument is analyzed with respect to measurements not usually made when servicing a typical superheterodyne receiver; but which, if understood and used, are very valuable in such work. The test procedure used will, in general, be the same for both FM and AM receivers, the main difference lying in the frequencies of operation and the addition of the limiter and discriminator stages in the FM receivers.

AC-AF Voltmeter

There are two common types of electronic, or vacuum tube, AC voltmeters: Those with the normal test lead, such as the Hickok Model 203 shown in the title in which the AC is fed to the instrument before rectification; and those with a probe and cable assembly, such as the Hickok Model 125 shown in Fig. 1 in which the AC is rectified in the probe and the rectified AC is fed to the instrument.

Briefly, rectification in either case is brought about as follows: AC fed in through C1 places a positive charge, equal to the peak AC voltage, on C1 during the positive portion of the positive half-cycle (heavy line, Fig. 2). This charge, in turn, causes the tube to draw current as electrons flow from the ground, through the cathode, to the positively charged plate. During the remainder of the positive half-cycle and the following negative half-cycle, the capacitor discharges very slightly to ground through the bleeder resistor, R1. The resultant negative DC voltage at the plate of V1 remains, with respect to ground, at essentially the peak value of the AC voltage applied.

The input capacity of an AC voltmeter equipped with a normal test lead will be between 100 and 200 uuf while one using a probe will be between 5 and 10 uuf. The difference in the use of the two types will lie, of course, in the characteristic input impedance of the voltmeter at any given frequency with a possible resultant loading effect if unsuitably used.

All of the following tests are made with a steady signal being fed to the receiver. Reference is made to Fig. 3 in discussing these tests.

1. *Transformer Turns Ratio.* In general, the check of the speaker proper is a tonal check but the voice coil or speaker transformer may be checked with the AC voltmeter. The transformer will be a step-down impedance matching transformer whose turns ratio can be determined by comparing the primary and secondary voltages, since the turns ratio of a transformer is directly proportional to the voltage ratio.

2. *Checking By-pass Condensers.* Since it is the function of by-pass condensers C5, C6 and C8 of the cathode circuit, and C4 and C9 of the screen grid circuit, to provide a low impedance to AC voltages, a check with the AC voltmeter showing any appreciable voltage across these condensers is an indication of either a defective or too low a value condenser. With this method, capacitances can be checked under actual operating conditions which is often more convenient than removing the capacitor from the circuit.

3. *Checking Coupling Condensers.* As shown with C1, C10 and C11, capacity coupling is often used in coupling two stages. These coupling condensers can be checked by measuring the AF voltage on both sides of the capacitor. The voltages should be the same; if they are not, it might be an indication that the capacitor is open or of too small a value.

4. *Checking Electrolytics in Power Supplies.* Most power supplies use an electrolytic condenser ahead of and also following the filter choke. If these condensers are normal, the voltage at the input side of the filter choke should be 10-15 volts over that at the output side. Voltages in excess of these will result in hum which is the probable indication that these condensers are defective.

5. *Stage of Phase Inversion.* It is

often desirable that the audio output stage be a push-pull stage which necessitates a preceding stage of single-ended input and double-ended output. A stage of phase inversion will permit such a circuit and is illustrated in Fig. 3. As the input to the grids of V4 and V5 (push-pull stage) must be of the same voltage value for correct operation, it follows that the plates of the tube of the preceding stage must have the same output.

To obtain this condition, the output of the first triode section of the tube V3, feeding the grid of V4, is fed across a resistance voltage dividing network consisting of R3 and R4 in series, with the ratio of the resistors, or voltages, being that of the gain of the section. That is, if the gain of the first section of V3 is 10, the ratio of R3 + R6 to R6 will be 10:1. The grid input to the second section of V3 is thus the same as that of section 1; and, if the two sections are the same, the outputs at the plates should therefore be the same. As the input impedance of the AC voltmeter is such that it will have a negligible loading effect on the circuit, the AC voltmeter may be used to measure the grid voltages of V3, the plate voltages of V3 (or grid voltages of V4 and V5) and the plate voltages of V4 and V5, checking the operation of the stage of phase inversion.

6. *Gain per Stage.* The gain of any stage of AF may be determined by comparing the input voltage on the grid with the output voltage on the plate of the same tube. If the tube is a triode, a gain of 10-25 may be expected; if a pentode, the gain may approach 100.

The electronic AC voltmeter, regardless of type, is normally not a suitable instrument for making gain measurements in the RF or IF sections of a receiver as the input capacity of either type is sufficiently great to upset the tuned circuit under test to such an extent that any reading obtained would be without meaning as far as actual operating values are concerned. However, it may be used if it is only necessary to know that a voltage exists at a given point.

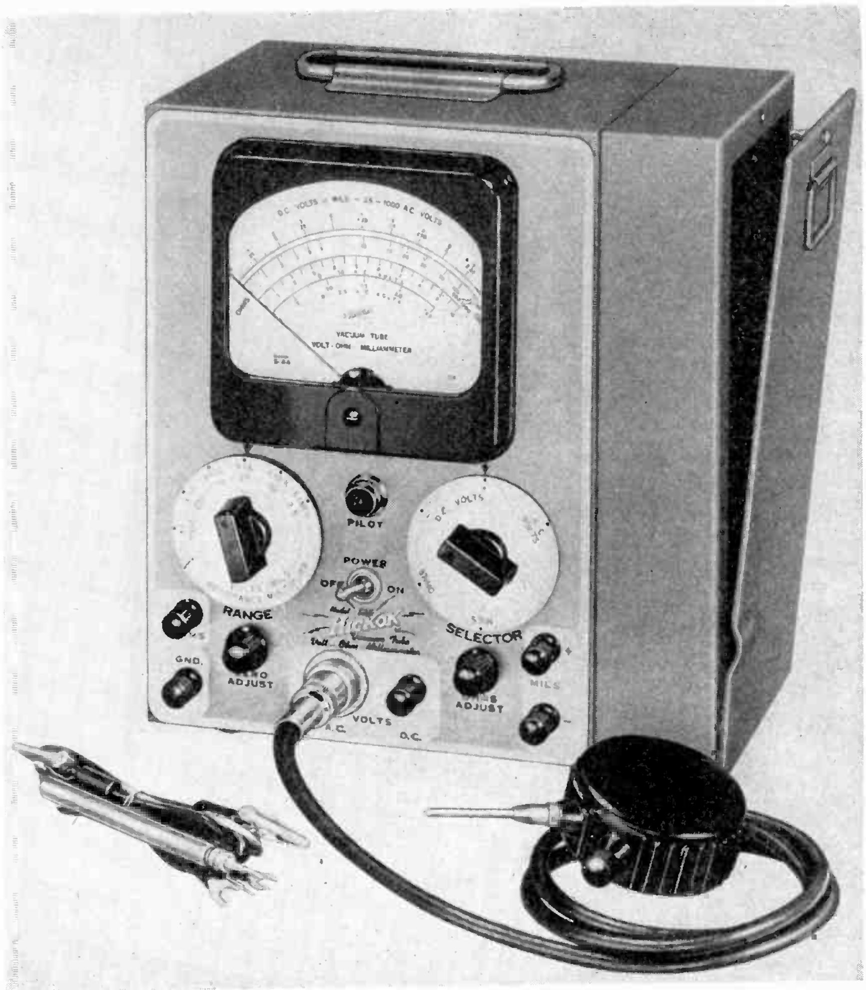

Fig. 1 **The Hickok Model 125, an electronic voltmeter which is equipped with a probe which rectifies the AC to be measured.**

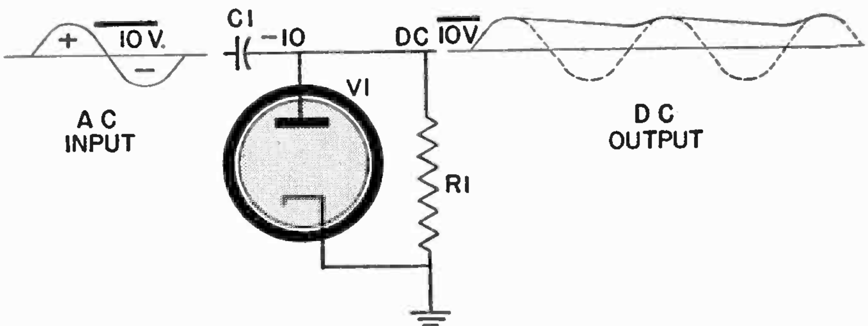

Fig. 2 **The AC input is rectified by the diode and fed to the meter circuit.**

DC Voltmeter

Many times the DV voltmeter is used to measure B+ voltages, grid bias, etc., only, without thought of other possible measurements which tell as useful a story of the operation of a receiver as the AC voltage measurements.

1. *Checking the Local Oscillator.* The local oscillator may be checked for oscillation throughout its entire range by connecting the DC voltmeter to the grid of the oscillator. With the DC voltmeter connected, rotate the main tuning dial of the receiver throughout its entire range. There should be very little variation in the grid voltage. The voltage appearing will depend upon the design of the circuit but it should be fairly constant for any given oscillator. In general, this voltage should range from 10-50 volts, negative with respect to ground. No signal at a given position is a probable indication of shorted plates of the tuning condenser.

2. *Current Determination.* Any current can be determined by measuring the voltage or IR drop (where I = current in amperes and R = resistance in ohms) across a resistor whose value is known, by the simple application of Ohms Law, $E = IR$ or $I = \frac{E}{R}$.

3. *FM Receiver Alignment.* A very practical and time saving application of this method of determining current

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Know Your V T V M

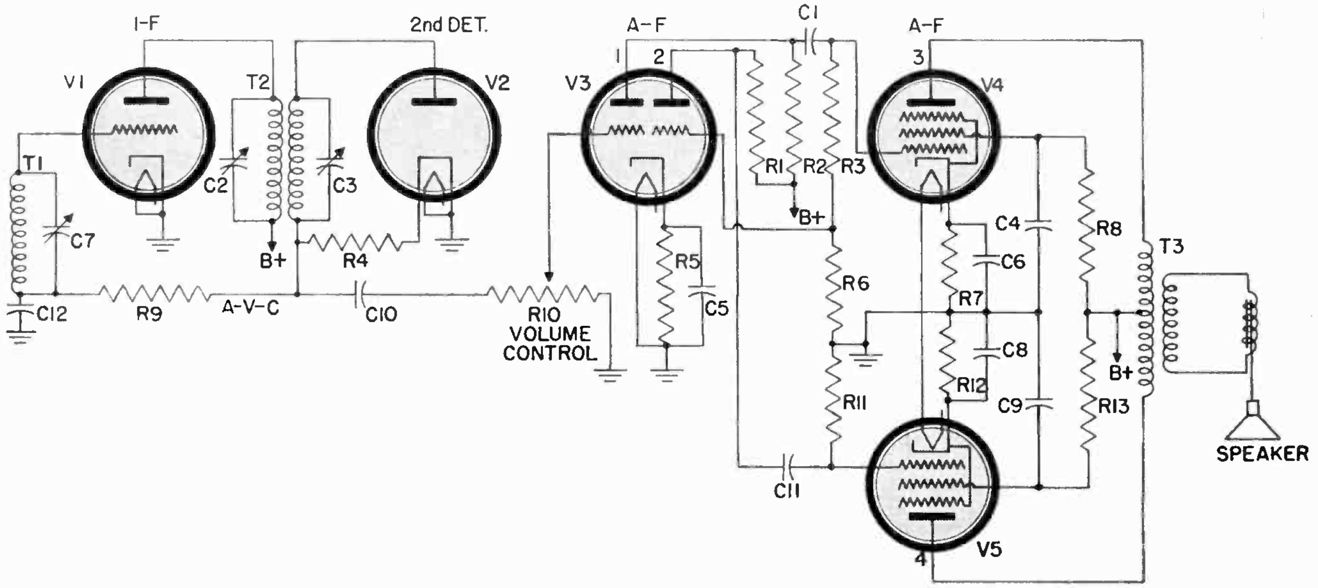

Fig. 3 Partial diagram of a superhet receiver using a phase inverter and push-pull output.

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is found in the alignment of frequency modulated receivers. Without discussing the operation of an FM receiver in detail as that is outside the scope of this article, it is found that alignment of RF, IF and discriminator stages will be indicated by maximum current through the limiter load resistance and zero current through the discriminator load resistance. As an ammeter is a series meter, its use of necessity means breaking the circuit under test to insert the meter. This can be avoided by connecting the DC voltmeter across the limiter load, R3 of Fig. 4, and aligning the RF and IF stages until maximum voltage is indicated; then connecting across the discriminator load, R1 and R2; and, with condenser C9 of the secondary of the discriminator transformer detuned, adjusting the tuning condenser C8 of the primary for maximum voltage across the load; and, for final alignment, adjusting the tuning condenser C9 for zero voltage across the load.

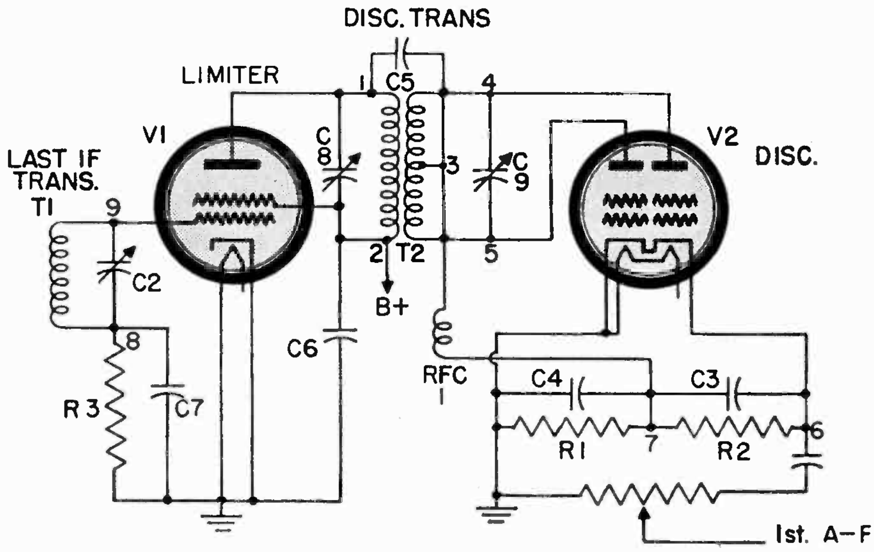

Fig. 4 Partial diagram of a typical limiter and discriminator circuit.

4. *AM Receiver Alignment.* In AM receivers, it is possible to align RF and IF stages by connecting the DC voltmeter across the load resistance of the second detector and AVC circuit and aligning for maximum indication. This method will, in general, be found to be more satisfactory than the use of an output meter in most cases as the volume control can be set at its minimum, eliminating unnecessary noise while aligning a receiver. It also eliminates any possible error due to AVC operation during alignment. This error is due to the fact that, unless the signal input to the receiver is at such a low level that the AVC does not operate, the AVC will automatically tend to compensate for improper alignment. The use of the DC voltmeter in the AVC circuit eliminates the necessity for disconnecting the AVC circuit.

5. *Battery Voltage Measurements.* The DC voltmeter can be used to measure the voltages of "A" and "B" batteries; but as the input impedance is high, care should be taken that the batteries are measured under approximately normal load conditions. If the normal load is not available, a load of at least 100 ma should be imposed on "A" batteries and 25 ma on "B" batteries. The resistance necessary for such loads can be determined from Ohms Law, $R = \frac{E}{I}$.

Ohmmeter

The electronic ohmmeter circuits commonly used today will measure resistances up to over 1000 megohms. The ability to measure such high resistances will permit the ohmmeter to be used to measure leakages of condenser, terminal strips and coil forms as well as the high resistance components used in modern receiver design.

In making resistance measurements, it should be remembered that, in order to obtain a true value, the resistor

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Battery Replacement

R. C. Clock
Burgess Battery Co.

Determining the number of operating hours left in a battery for replacement purposes.

NOW THAT DRY BATTERIES are again available and the radio set manufacturers have gone back into production of portable models, the radio serviceman will have increased service work on portable and other battery operated radio sets. On service work of this nature, one of the first things to determine is whether the batteries need replacement.

Probably the most satisfactory method for determining whether the batteries have been discharged to a point where replacement is required is to read the closed circuit voltages of the "A" and "B" batteries under loads corresponding to the drain of the radio set. This may be done with the batteries in the set with the set turned on, or with the batteries removed by draining the batteries through the resistance values specified in Table I. The closed circuit voltage readings should be taken after the batteries have drained for about ten minutes.

If the closed circuit voltage of either the "A" or "B" battery is near the value for the appropriate battery as given in Table I, the battery should be replaced.

The question frequently arises as to how much useful service life remains in a partially discharged battery. This is more difficult to determine since there are no meters available to give this value directly. The closed circuit voltage readings may again be used to obtain a good estimate of remaining service life. The drain to which the battery has been subjected must also be known. For the preparation of these tables, the drains used for the "A" and "B" sections are those that will probably apply to a majority of radio sets.

In Table II are listed some of the more common battery types with various manufacturers' designations. First, refer to this table to determine the Bureau of Standards cell sizes used in the "A" and "B" batteries. Next, refer to Table III to the corresponding Bureau of Standards cell size opposite the drain at which the battery has been discharged. The estimated remaining hours of service

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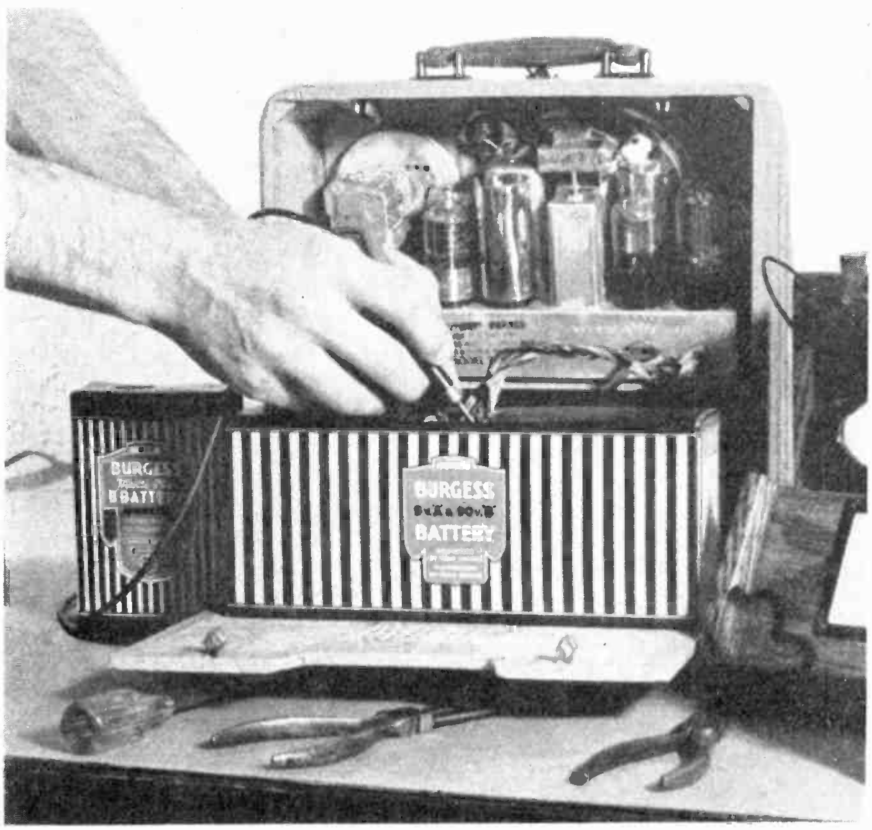
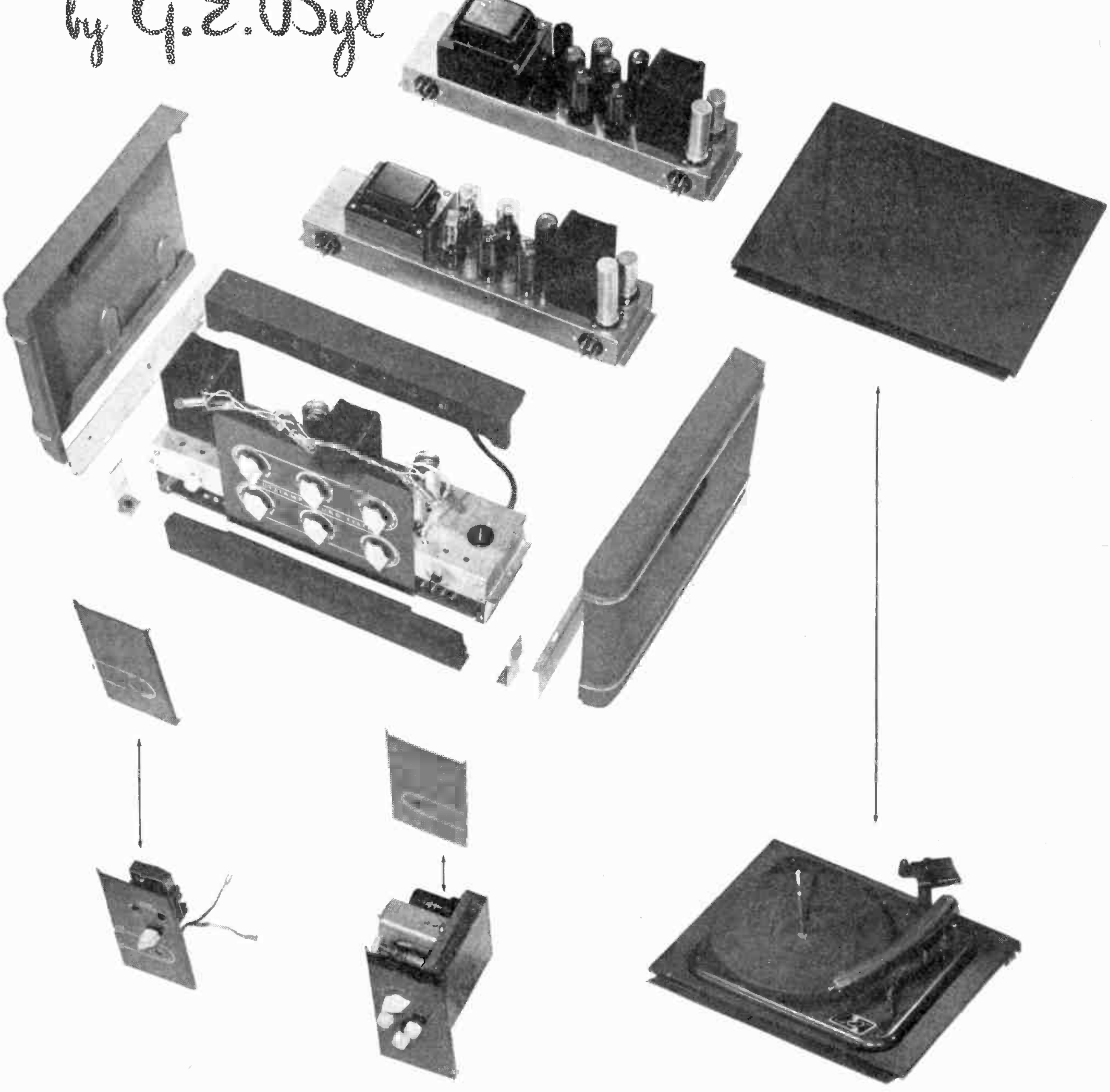


When it is possible, a battery should be given a voltage check in the set while it is in operating condition.

LET'S *Explode* THE MULTIAMP

by G. E. Byl



The Multiamp—a new idea in amplifier construction which gives a high degree of flexibility.

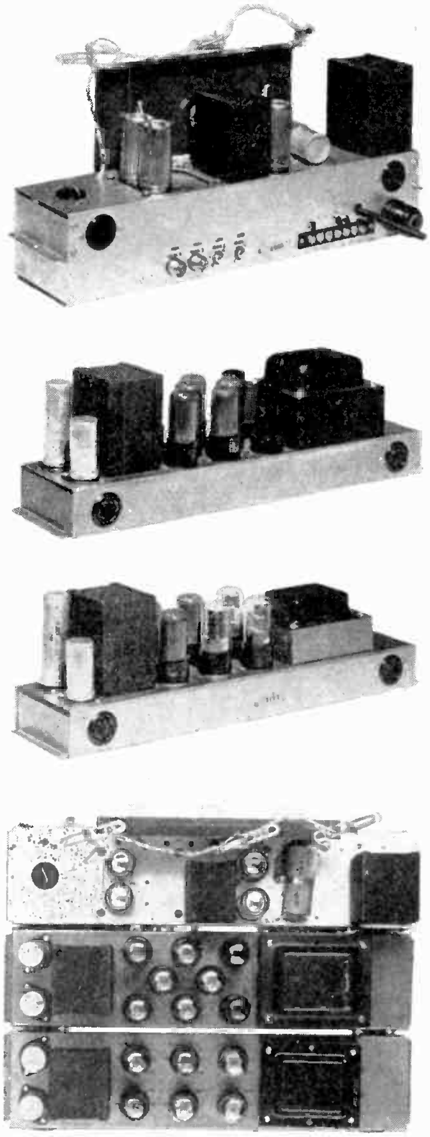


Fig. 1 The three upper units, a four-channel input unit, a 30-watt amplifier stage, and a 40-watt amplifier stage are plugged together as shown by the photo at the bottom to make a complete 75-watt amplifier.

HERETOFORE IT WAS NOT CONSIDERED feasible to list as standard stock equipment one system with a power output range of from 30 to 270 watts or with facilities for special plug-in phono attachments, tuners, output indicators, special inputs, etc. PA equipment for the larger sizes with special input facilities and other features which vary greatly with each particular installation were considered to be in the special custom-built class. PA equipment of lower output was not expandable, and was unusable when more power was required. When phono or other attachments were required, the assembly became unreasonably unwieldy.

With this newly designed system of plug-in units, it is possible to start with a basic 30 watt unit and to assemble quickly many different kinds of what would ordinarily be custom-built installations ranging from 30 to 270 watts output and with various kinds of attachments. Facilities for phono players, automatic record changers, output indicators, recorders, and other devices are available and may be included or added later in a stacked cabinet assembly. Through the use of additional plug-in power output units of 30 and 45 watt sizes, up to 270 watts may be realized —enough audio power to fill almost any stadium, ball park, or transportation terminal, if properly distributed by use of a sufficient number of speakers. Flexibility of output is provided through the availability of fifteen output impedances that facilitate the matching of any conceivable combination of speakers or lines. The fifteen output impedances are: 1.3, 2.7, 4, 5.3, 8, 16, 125, 167, 180, 200, 250, 415, 460, 500 and 600 ohms. These output stages and their power supplies are built as integral plug-in units requiring only a screwdriver to add to or subtract from the overall output wattage of the amplifier.

The Multiamp series provides inputs to accommodate up to four microphones and two phono pickups. The high gain stages are shielded from the output and power stages, resulting in surprisingly low hum level. Separate controls are provided for bass and treble reproduction in order that either the high or low frequencies may be attenuated or accentuated without affecting the opposite frequency range. By attenuating both of these controls, it is possible to limit the response of voice frequencies for maximum intelligibility.

The basic amplifier unit has been so designed that it is possible to include record player, record changer, and monitoring indicator, all in one compact unit, with all controls on the same front panel within easy access of the operator. Modern streamlined design is used throughout. Indirect lighting is provided for panel illumination. Input and output jacks and connectors are recessed so that no unsightly cords obstruct the front of the amplifier. Recessing of these plugs and connectors also eliminates the possibility of damaged plugs and connectors. Carrying handles are cast into the aluminum ends, adding to the streamlined modern design and eliminating protruding handles. A chart, with all output impedances, is permanently screened on the bottom cover plate of each unit.

Optional equipment available consists of: (1) a six-channel input panel for installations which require two additional mikes, (2) output indicator, (3) record player top, (4) record changer top. A tuning unit will be added to these accessories shortly. Any one or all of the above accessories may be mounted within or on top of the amplifier cabinet requiring no additional cabinets or extra space.

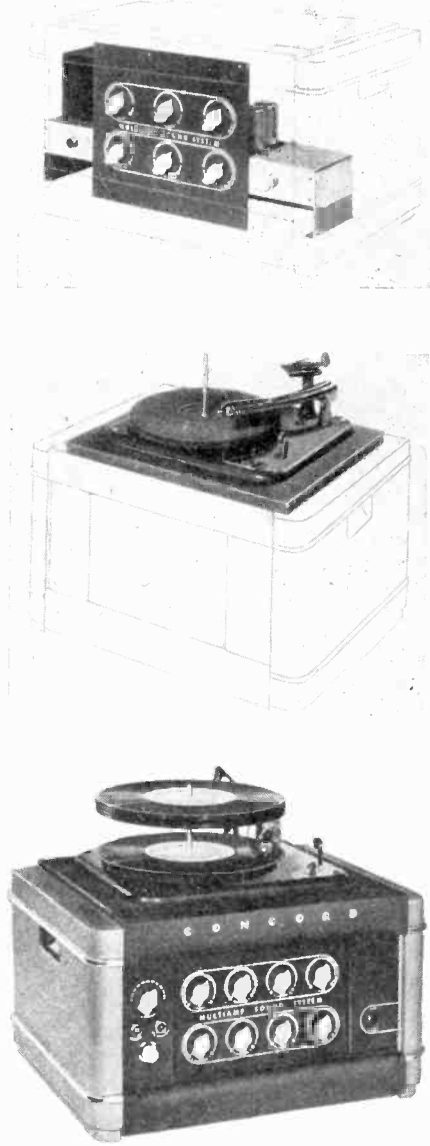


Fig. 2 The upper photo shows how the input unit is placed in the cabinet. The center photo shows the record changer top which can be added to the unit in place of the regular top cover. The lower photo is of a complete amplifier equipped with record changer and six-channel input.

The output indicator is of new design and enables the operator to monitor remote speakers to maintain proper output level. It provides a much closer check on the output of the amplifier than the usual meter; and, in addition, may be readily interpreted by the inexperienced operator. Essentially, it consists of two neon indicators, one marked "Normal" and the other marked "Overload." Fig. 3 shows the circuit used. A cali-

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Testing and Aligning Television Receivers

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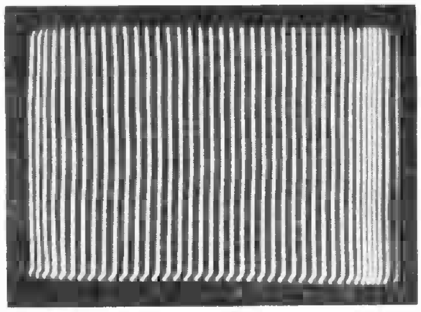
have a fixed resistor for "peaking," it will be necessary for the serviceman to use a variable resistor to determine the correct value, after which a fixed resistor may be used. Of course, this will have to be done only if the resistor or condenser, or some other component in the discharge tube becomes defective.

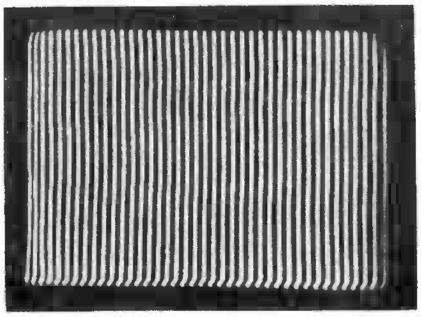
It will be remembered that all these adjustments were made while the sweep system was synchronized at 60 cps by the oscillator, without the need for any "over-the-air" test pattern.

The Horizontal Scanning System

A very similar procedure is followed for testing the performance of the horizontal scanning generator. The same connections (Fig. 10) are used. The beat frequency oscillator is set to 15,750 cps. The frequency control of the scanning generator is then adjusted until it falls into synchronism with the applied 15,750 cps. If the synchronization control is not set correctly, the conditions indicated in Figs. 17 and 18 will result when a picture is received. The scanning pattern will then exhibit two vertical bars, one bright, the other dark. As in the vertical case, the half wave of applied voltage that makes the grid positive produces the bright bar, and that which makes the grid negative, the dark bar (see Fig. 19). When the synchronized frequency is obtained, the scanning amplitude is adjusted as before, until it has the proper value (which is roughly four-thirds that of the vertical scanning amplitude). Fig. 20 shows a picture with the horizontal width control incorrectly set. Actually, the serviceman is guided in setting the amplitude by the mask aperture of the receiver. In so doing, both the vertical and horizontal amplitudes should be set just a little greater than the mask aperture to allow for the few lines that are blanked in the vertical and the portions of the lines that are blanked in the horizontal when video signal is applied to the grid of the cathode ray tube. See Fig. 21 for the action of blanking on picture size.



A



B

Fig. 22 The linearity test pattern obtained with a 630,000 cps signal applied to the control grid and horizontal sync circuits. A shows an incorrect pattern while B is the correct pattern.

To test the linearity of the horizontal scanning motion, the oscillator must have its frequency increased to a large multiple of 15,750 in order to produce a sufficient number of lines on the screen. To obtain a pattern, say, of 40 vertical bars (Fig. 22), a frequency of 630,000 cps is necessary. Most oscillators do not have the wide range in the upper frequencies (that is, frequencies up to 630,000 cps) necessary to test linearity in the horizontal scanning circuit. It is, however, relatively simple to build a single tube oscillator for this frequency or another multiple of 15,750 cps with 20-volt output. This single frequency is sufficient to determine the linearity by the methods just outlined. The horizontal centering control may be set now. Fig. 23 shows the effect of an incorrectly set centering control.

It may be found that no setting of the horizontal linearity controls can attain a linear deflection. In this case the damping tube may have failed, which would result in the type of picture indicated in Fig. 24. (Using the instrument method, the vertical bars will overlap.) Another cause for non-linearity may be the failure of a horizontal deflection circuit component, such as the charging resistor in the discharge saw-tooth generator circuit. It may be off-value or defective, leading to a non-linear condition as illustrated in Fig. 25. More often such a condition will be caused by the horizontal output tube and this tube should first be changed. Low line voltage or off-value output tube plate load resistors can cause poor horizontal distribution. Since component parts of such circuits necessarily are a result of design and production economies, all resistors and capacitors have values within certain plus or minus tolerances. Hence, in making a repair in the circuit, if the tolerances should happen to add up in the wrong direction, a non-linear saw-tooth deflecting voltage may be produced causing horizontal or vertical crowding or stretching of picture elements. The serviceman must therefore exercise necessary discretion in making changes in these circuits.

This completes the adjustments that control the motion of the electron beam across the face of the tube. In the next issue, we will discuss the alignment of the circuits which bring the picture information into the receiver and amplify it to the proper level at which it is applied to the grid of the cathode ray tube to modulate the electron beam. ✓ ✓

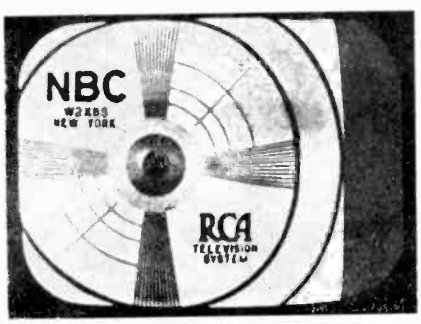


Fig. 23 A test pattern with the horizontal centering control incorrectly set.

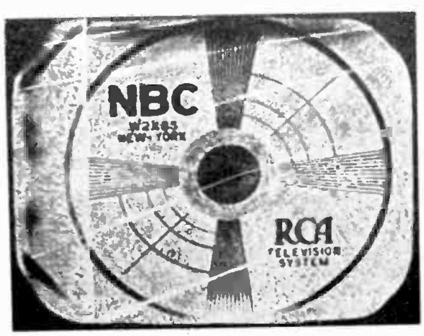


Fig. 24 A test pattern showing the effect of failure of the horizontal damping tube.

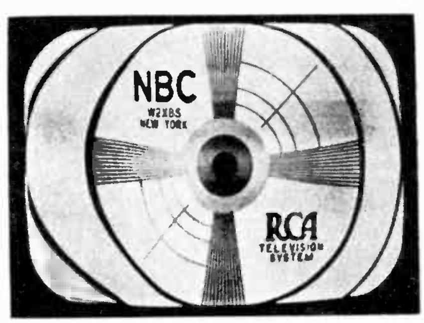
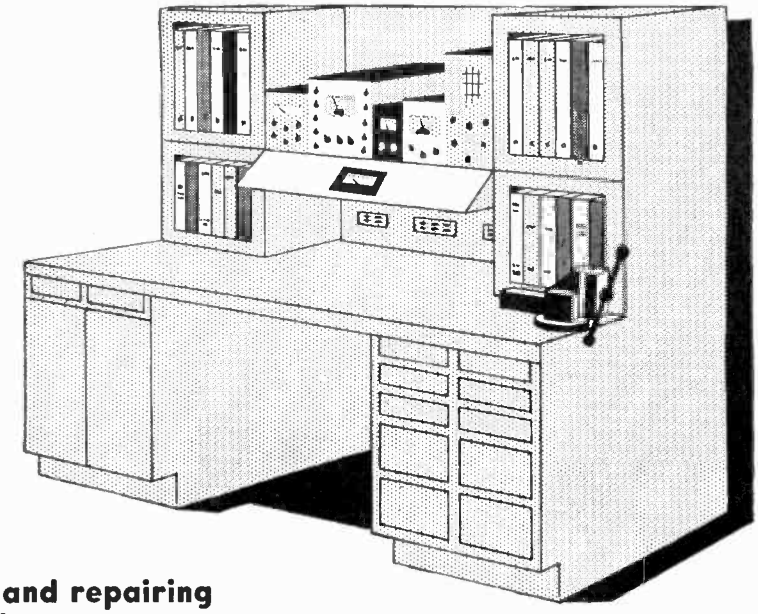


Fig. 25 A test pattern showing non-linear horizontal deflection.

The Radio Service Bench



Suggestions for checking and repairing phonograph motors

Max Alth

MORE PHONO MOTORS are being switched on these days than have ever been before; and, consequently, more of them are finding their way to the service bench.

Motors turn up with various defects; and while the repair may be different in each case, we have found it to be a good practice to go over the entire motor, starting with the bearings.

Dismantle the motor, wash the bearings and the felt pad oilers out with kerosene, or carbon tet. Polish the shaft or shafts with two hundred sandpaper. Do not use emery cloth as emery is a conductor and may find its way into the commutator slots. Reassemble and check for clearance and centering. Move the bearings to center if necessary and possible, and file down any irregularities on the rotor or pole faces. The rotor must be centered if it is to deliver an even torque. This is especially important when the drive is transmitted through a set of gears. Uneven torque may cause chattering; and when the point of minimum torque coincides with the point of maximum load on the record changer, the motor may stall.

The copper induction disc rotors should be set equidistant between the poles. If they happen to be bent, they may be straightened by using two pieces of wood and a mallet. The discs need not be perfect as they revolve at a low speed, and with plenty of clearance.

Remove the brushes and/or the fly ball governor and spin the rotor. It should turn freely.

If the motor uses brushes, check them. Note whether or not they are free in their holders, whether they fit the commutator properly, and whether any hard spots have developed. Check the spring tension. Check further by placing a low voltage and a voltmeter in series with the brushes as shown in Fig. 1. Turn the rotor slowly. The meter needle should flick but slightly. If a brush has to be replaced, the new brush should be ground to fit. Wear it in against a piece of sandpaper wrapped around the commutator.

Check the commutator for wear. It should have a smooth dark brown copper oxide sheen, and the mica insulation between the commutator bars should be below the level of the copper. If the commutator is but slightly roughened, it can be smoothed by wrapping it with a strip of sandpaper as shown in Fig. 2 and turning it against the paper by hand. If it has been deeply gouged, it will have to be turned down on a lathe. The operation can be performed on any

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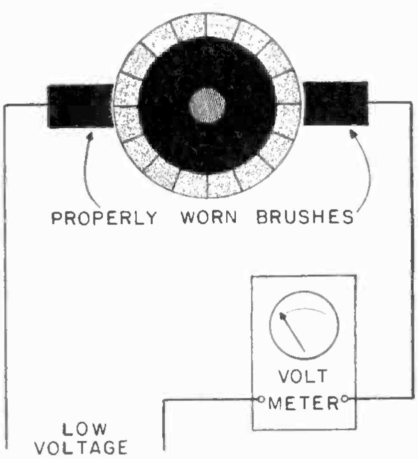


Fig. 1 Connections used for checking the brush contact of a phono motor using a battery and a voltmeter.

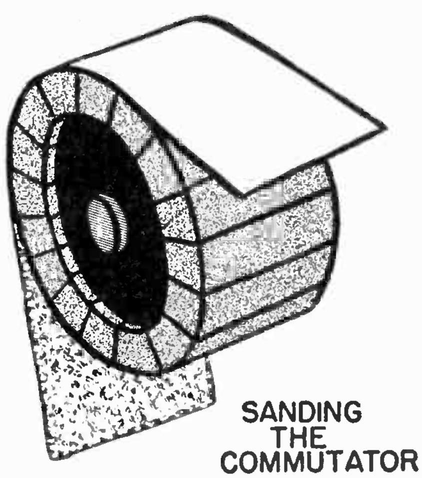


Fig. 2 Method used to smooth the commutator with sandpaper.

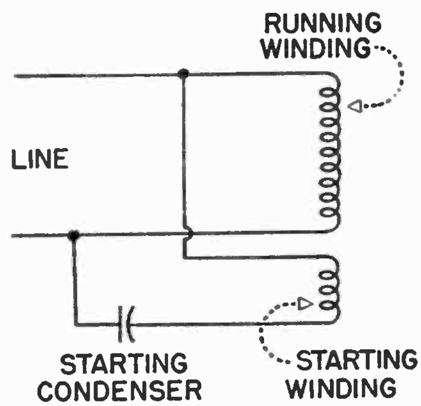
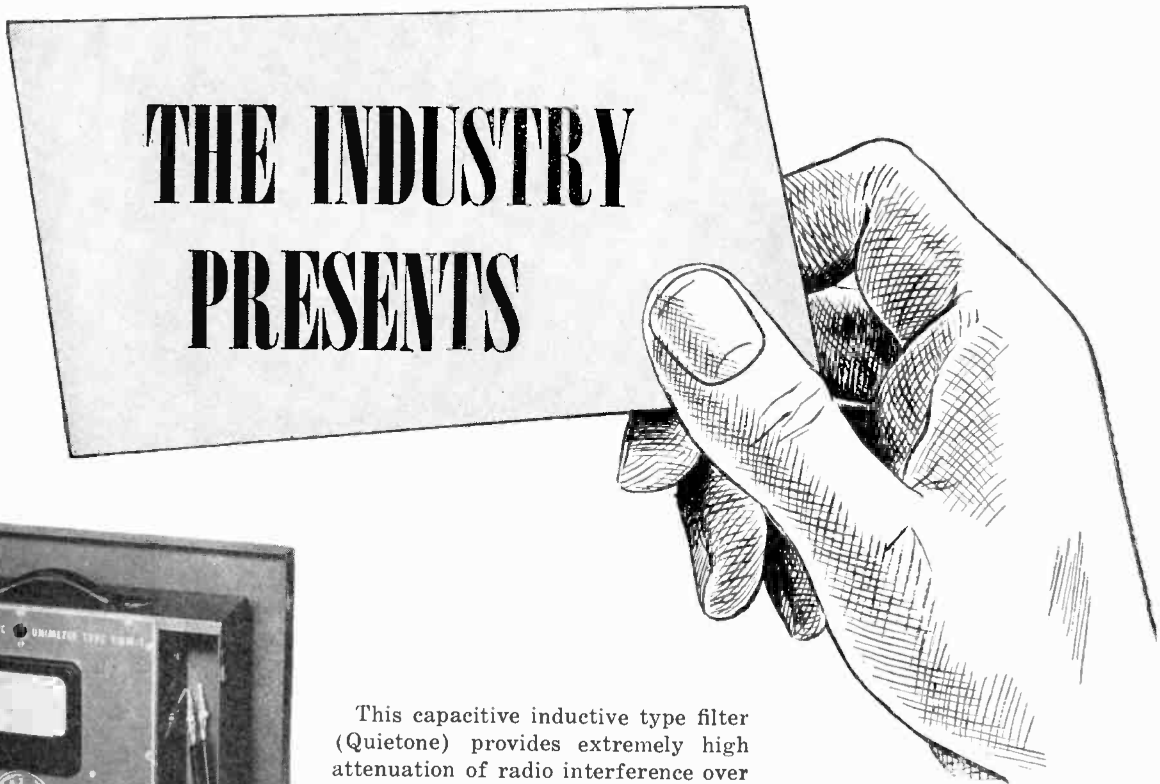


Fig. 3 Circuit used in a split-phase motor. The winding with the condenser in series is the starting winding.

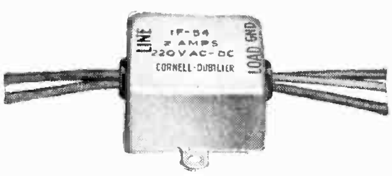


THE INDUSTRY PRESENTS

PORTABLE UNIMETER

A new 12-pound multi-range measuring instrument, Type YMW-1, has been announced by the Specialty Division of General Electric Company's Electronics Department. Rated at 20,000 ohms per volt, the new unimeter measures volts, ohms, current and decibels, and has a single rotary selector switch.

All operations, except the 50 microampere current range reading and capacitor for output measurements, are available without changing the test leads to various jacks. A separate two-position switch handles AC or DC volts.



INTERFERENCE FILTER

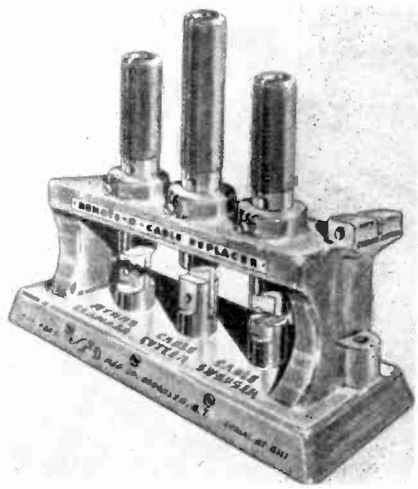
Radio noise energy created by the operation of fluorescent lamps and other types of electrically operated machines and appliances can be effectively eliminated by the hermetically sealed IF-54 interference filter of Cornell-Dubilier Electric Corporation, South Plainfield, N. J.

This capacitive inductive type filter (Quietone) provides extremely high attenuation of radio interference over a wide frequency range, and its compactness lends itself to simple and easy installation in a variety of positions. It is rated at 2 amperes, 120-200 volts AC, and is wax-filled and impregnated.

CRYSTAL MICROPHONE AND STAND

Comet Model 902 is a combination crystal microphone and desk stand announced by Electro-Voice, Inc., South Bend, Ind., for home-recording, sound and communication fields. It is molded in one piece of high impact, butyrate plastic in deep gray, is light weight but virtually unbreakable under normal use.

This microphone provides smooth, wide-range response and exceptionally high output. Frequently response is substantially flat from 70 to 7,000 cps. Output level is 48 db below 1 volt/dyne/cm^2 open circuit. Voltage developed by normal speech is .0394 volt. Impedance is Hi-Z. It can be used with any standard amplifier employing high impedance input, and is particularly suitable for home-recording, economical PA systems, paging and amateur radio communications.



REMOTE-O-CABLE REPLACER

The 1946 model of the Remote-O-Cable Replacer, just announced by the JFD Manufacturing Company, Brooklyn, N. Y., is useful to the serviceman in transferring radios from old automobiles to radioless new car models. It swages shafting to prevent unraveling, cuts shafting to exact length, and replaces old and new fittings on new shaftings.

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DuMont proudly presents the

NEW Type 274

CATHODE-RAY OSCILLOGRAPH

SPECIFICATIONS

INPUT IMPEDANCE: Vertical-direct 5 meg. 60 μμf; amp. 1 meg. 70 μμf; Horizontal-direct 5 meg. 80 μμf, amp. 5 meg. 30 μμf.

FREQUENCY RANGE: Sine wave response (at full gain) uniform within ±20% from 20 to 50,000 c.p.s., down less than 50% 100,000 c.p.s.

DEFLECTION SENSITIVITY: Amplifiers at full gain 0.65 r.m.s. volt/in., direct ±18 r.m.s. volts/in.

LINEAR TIME BASE: Variable from 8 to 30,000 c.p.s. Synchronization from vertical amplifier or external signal.

POWER SUPPLY: 115 volts, 50 to 60 cycles a.c. Power consumption app. 50 watts.

TUBES: All tubes, including 5BP1-A CRT, included.

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Vibrator Supplies

→ **From Page 17**

be capacitive. In other words, a condenser C_2 connected in the secondary will reflect capacity into the primary. What is the relation of C_2, the secondary capacity, to C_1, the reflected capacity? Substituting in the above equation, we can write

$$\frac{1}{2\pi f C_1} = \frac{1}{2\pi f C_2}\left(\frac{N_1}{N_2}\right)^2$$

from which

$$\frac{\dfrac{1}{2\pi f C_1}}{\dfrac{1}{2\pi f C_2}} = \left(\frac{N_1}{N_2}\right)^2$$

and

$$\frac{C_2}{C_1} = \left(\frac{N_1}{N_2}\right)^2 \quad \therefore \quad C_1 = C_2\left(\frac{N_2}{N_1}\right)^2$$

which shows that a condenser in the secondary has the same effect as a condenser $\left(\frac{N_2}{N_1}\right)^2$ as large in the primary.

If, for example, the secondary has 40 times as many turns as the primary, a .01 condenser in the secondary will have the effect of a 16 ufd condenser in the primary.

Another point of significance is that the size of the condenser is very carefully calculated so that for the particular frequency, transformer characteristics, etc., it will perform its functions efficiently. If a replacement is needed for the buffer, the exact replacement is required since any deviation from the original value will be multiplied by the turns' ratio squared.

Moreover, vibrator replacements must be made judiciously. A replacement vibrator of different frequency from the original will require a different size buffer condenser.

Other components are built into the vibrator power pack in order to suppress RF interference caused by transients. "Hash" causes an effect very much like ignition interference and tests for the presence of hash must be made with the motor shut off. Although hash is considerably reduced by the use of electrostatic and electromagnetic shielding, RF filters are necessary for complete suppression.

Fig. 11 shows the complete power supply. Note the liberal use of RF filters in the leads to the vibrator, filaments and B+. C_3 is the buffer condenser. C_1 is of special interest. This type of condenser is known as a "sparkplate." When first developed, it consisted of one or more metal plates separated by paper insulation and riveted to the chassis. More recently mica insulation has been used. This unit does an excellent job in suppressing interference.

Great progress has been made in the development of vibrator power supplies and vibrators. Today, vibrator failures, as such, are rare. In most every instance, vibrator failure is due to the failure of associated equipment, a fact which should be borne in mind when making repairs.

Perhaps the most common source of trouble is the buffer condenser. Called upon to withstand high voltage surges, it is a very likely source of trouble after it has aged. Many conscientious servicemen will replace it regardless of tests whenever a set is being serviced.

Another source of vibrator failure is the failure of components such as filter condensers, tubes, which will cause high B+ current drain. An increase of only a few milliamperes of B+ current will cause an increase of as much as one ampere or more through the vibrator contacts. If the defective vibrator shows effects of overheating, look for trouble elsewhere before replacing. In some cases of overload, the heating may be so intense that the vibrator contacts are fused together causing set fuses to blow. Sometimes the overheating causes the reed to lose its temper (the customer will tell you that the set will play only when kicked or banged).

An excellent check which will save

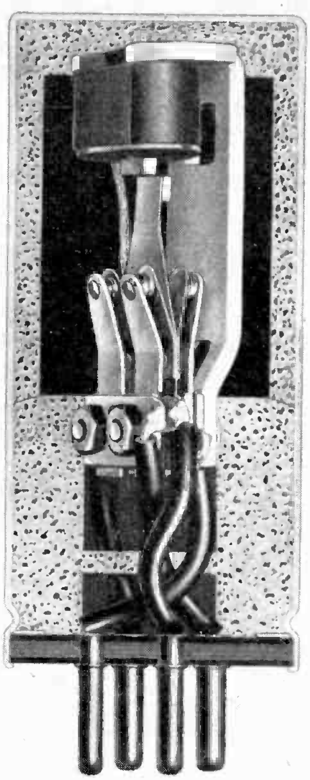

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Fig. 7 A can-type vibrator unit. Sponge rubber is used to absorb vibration. The unit plugs in a socket in the same way as does a vacuum tube.

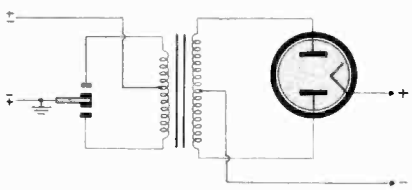

Fig. 8 A rectifier tube is connected to the secondary to rectify the voltage stepped-up by the transformer, thus giving high DC potential in the output.

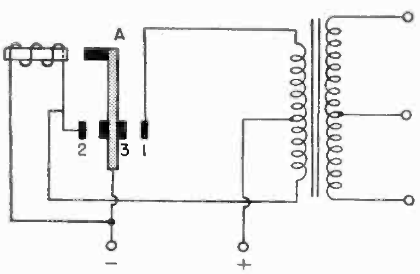

Fig. 6 The primary circuit of a vibrator supply.

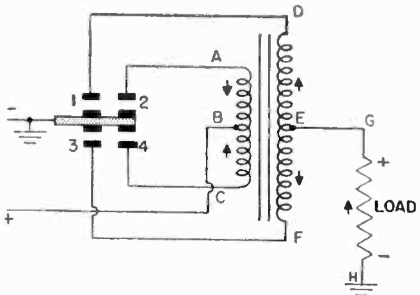

Fig. 9 A circuit diagram for a synchronous type vibrator supply.

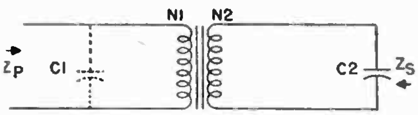

Fig. 10 The buffer condenser C2 connected across the secondary N2 reflects capacity C1 across the primary N1.

many "call backs" consists of placing an ammeter in series with the hot lead. If, with a replacement, the input current exceeds by as much as

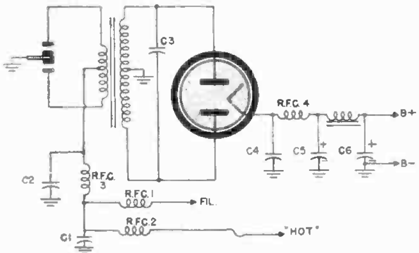

Fig. 11 Complete Power Supply.

one ampere the manufacturer's rating, as given in most manuals, look for trouble in other sections of the receiver. ✔ ✔ ✔

Know Your VTVM

→ From Page 28

must not be paralleled by any other resistance. In most receivers, isolating a resistor from other resistance components may often be accomplished by turning off the power and thereby effectively opening all circuits through the vacuum tubes.

Some resistors, especially those of a value above one megohm, may have a voltage coefficient, that is, the ohmic value of a resistor may change with the voltage across it.

The extremely low resistances which may be measured by an electronic ohmmeter will often permit the detection of shorted turns in transformers, especially in those cases where the manufacturer has given resistance data on transformers and coils.

Capacity Measurements

Modern television and electronic equipments operate in the high frequency ranges which necessitate low capacities of approximately 5-10 uuf. The capacity range in the Model 203 is such that it will measure down to one uuf and up to 1000 uf. This will permit the checking of any capacitor which might normally be used.

In a good many cases, trouble in receivers, especially hum and distortion, is caused by bad electrolytics, and a great deal of time can be saved if the electrolytics are checked first. In most cases, the electrolytic will be so connected in the circuit that it is almost imperative to disconnect it before making a measurement. In checking the electrolytic, it is always desirable to first charge the capacitor at its rated voltage and then discharge it completely before making a measurement.

In cases of distortion, check the coupling and bypass condensers of the audio stages as they quite often cause trouble when their capacity decreases appreciably below their rated values. Loss of sensitivity in a receiver can be caused by improper value or defective capacitors used in the RF circuits.

Inductance Measurements

While inductance measurements are not common in most radio servicing, provisions are made for such measurements with the Model 203. As the capacity measuring circuit is based on impedance, and since inductances can be measured in terms of impedance, the capacity circuit is used for both measurements. Many manufacturers supply data on audio and RF chokes so measurements may be made for comparison purposes.

Current Measurements

Milliampere measurements in radio receivers presuppose, in general, the unsoldering of a joint and the breaking of a connection. As most currents can be measured by the measuring of the IR drop across a known resistance, as previously discussed, it would be easier and faster to make the current determinations in this manner where possible. A milliammeter should be used in the measurement of electrolytic condenser leakage. The current should never exceed one milliampere per microfarad with the condenser operated at its rated voltage.

There are other uses to which an electronic voltmeter can be put. These are only a few of them. The more familiar you become with your test equipment and its uses, the more valuable it will be to you. ✔ ✔ ✔

Let's Explode the Multiamp

→ From Page 31

brated dial enables the operator to set the output level at a predetermined value of the total amplifier output. When this pre-set level is reached, the first neon indicator lights. When preset point is surpassed, the second neon indicator will light, indicating that the output of the amplifier has exceeded the predetermined level. This enables a very close overall check to be kept on the amplifier; even though the speakers are located in remote positions. The indicator may also be used with other makes of amplifiers if the simple instructions provided with it are followed.

Power Output Stages

Power output stages come in two basic sizes, 30 and 45 watts. They are built with male plugs on the front and female plugs on the rear, so that any desired number of power units can be plugged together to secure up to 300 watts (or even more). Thus, with a few basic units, you can supply any required power desired. If you have a number of units on hand, a dynamic test for required output can be made. It is very convenient to add or subtract and thus get the correct power which, in some cases, cannot be judged in advance by even the best engineer. The system is especially suitable for those who wish to start in a small way and eventually build up to a large system without costly discards.

Phono Top

The phonograph unit consists of a conventional type phonograph mounted on a top panel, with a crystal pickup, and all cables and connectors for plugging it into the amplifier. The top panel of the amplifier is removed, and interchanged with the phono top.

A special socket is provided on the

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Let's Explode the Multiamp

→ From page 39

pre-amplifier for plugging in a small radio tuner. This tuner has its own volume control so that all of the regular channels are available for phonos and microphones. A monitor jack is provided for tuning the radio with headphones.

Either one of two input sections may be used with any of the equipment described. A four- and a six-channel input are available. Both units have identical controls as follows:

1. *Volume Controls.* Individual volume controls are provided for each double action, and can either raise or lower the high frequency response. It is especially useful in removing scratch without eliminating too many of the high frequencies. The high frequencies give life and timber to a program and should not be removed, except when necessary. The numbers on the dials of the two-tone controls increase in reverse directions. Whenever it is found necessary to cut drastically with one tone control, it is generally found best to balance the tone with the other control. A theoretical balance is reached when both tone controls are set at the same number. This rule does not hold for all installations, but it should be kept in mind when making tone adjustments.

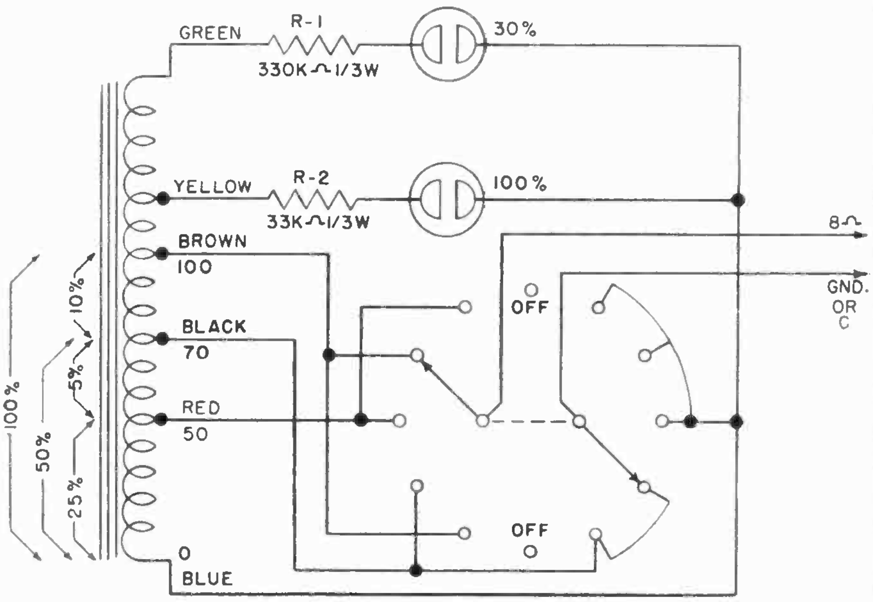

Fig. 3 The circuit used in the output level indicator.

channel with complete mixing of all programs from each channel. Because of the high gain of these amplifiers in normal operation, the controls operate about one-third on.

2. *Bass Tone Control.* The bass tone control changes the entire pitch of the voice, without changing the volume of the voice. The control has an extremely wide range; and, therefore, must be carefully adjusted. When starting up a system, the control is turned straight up until everything is in operation, then it is moved slightly until the speech is distinct and clear. Wide range control of this type has many advantages when used on rental jobs. Because of the poor acoustic conditions often encountered, it sometimes becomes necessary to cut the bass quite drastically in order to get away from "boominess."

3. *Treble Tone Control.* Like the bass control, the treble control is

The power output units employ a unique circuit which, by the use of a simple voltage dividing system, makes possible greatly increased power tube output. It also makes the tubes less susceptible to failure due to overload and lessens the effects of mismatch of output impedances.

These and other features of the Multiamp make it of definite interest to everyone engaged in public address work.

Industry Presents

→ From Page 34

HEAVY DUTY EXPANSIVE BIT

This new tool made by Bruno Tools, Beverly Hills, Cal., is designed with a straight shank for use in an electric drill or drill press. It drills holes 1½" to 3½" in wood, covering this

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Battery Replacement

→ From Page 29

can be read under the previously determined values of closed circuit voltage.

The closed circuit voltage values in Table III are given as closed circuit volts per cell. For example, a nominal 4.5 volt "A" battery consists of three cells connected in series. If the closed circuit voltage reading for the battery is 3.6 volts, this is equivalent to 1.2 volts per cell. Similarly, a nominal 45 volt "B" battery consists of 30 cells connected in series. If the closed circuit voltage reading for the battery is 33 volts, this is equivalent to 1.1 volts per cell.

TABLE I
Dry Battery End Point Voltages

	Nominal Voltage	External Load Resistor	Approximate Closed Circuit Voltage Below Which Radio Will Not Operate
'A' Batteries	1.5 volts	5 ohms	1.0 volts
	4.5 volts	75 ohms	3.0 volts
	6.0 volts	100 ohms	4.0 volts
	7.5 volts	125 ohms	5.0 volts
	9.0 volts	150 ohms	6.0 volts
'B' Batteries	45.0 volts	5,000 ohms	30.0 volts
	67.5 volts	7,500 ohms	45.0 volts
	90.0 volts	10,000 ohms	60.0 volts

TABLE II
Determination of Dry Battery Cell Size

Nominal Battery Voltage		Manufacturers Designation				Contains Bureau of Standards Cells Size	
'A' Unit	'B' Unit	Burgess	National Carbon	Ray-O-Vac	General	'A' Unit	'B' Unit
1.5	90	17GD60	748	AB82	60DLIIL	G(17 in par)	D
1.5	90	6FA60	—	84	60A4L	F(6 in par)	A
9.0-7.5	90	G6M60	754	AB878	60B6F6/5	G	BB
9.0-7.5	90	F6A60	—	AB994	60A6F6/5	F	A
1.5	—	2 Uni-cel	950	2LP	D cell	D(2 in par)	—
1.5	—	4F	742	P94A	4FI	F(4 in par)	—
4.5	—	G3	746	P83A	3H3	G	—
6.0	—	F4PI	—	P694A	4F4	F	—
—	45	Z30	738	P7R30	V30AA2	—	AA
—	45	A30	—	430P	V30A	—	A
—	45	M30	482	P7830	—	—	BB
—	45	B30	762	P5303	V30B	—	B
—	67.5	XX45	467	P4367	W4BA	—	N

TABLE III
Remaining Capacity of Partially Discharged Dry Batteries

Bureau of Standards Cell Size	Approximate drain at which battery was discharged	Estimated remaining hours of service to 1.0 volt per cell endpoint when closed circuit voltage per cell at indicated drain is: 1.4 volts	1.3 volts	1.2volts	1.1 volts
G (17 in par)	0.250 amp.	600 hrs.	300 hrs.	150 hrs.	50 hrs.
G	0.050 amp.	190 hrs.	150 hrs.	100 hrs.	60 hrs.
F (6 in par)	0.250 amp.	170 hrs.	110 hrs.	70 hrs.	30 hrs.
F (4 in par)	0.250 amp.	120 hrs.	90 hrs.	60 hrs.	25 hrs.
F	0.050 amp.	165 hrs.	120 hrs.	80 hrs.	50 hrs.
D (2 in par)	0.250 amp.	11.5 hrs.	10 hrs.	7 hrs.	3 hrs.
N	0.006 amp.	55 hrs.	45 hrs.	25 hrs.	10 hrs.
AA	0.008 amp.	80 hrs.	65 hrs.	40 hrs.	20 hrs.
A	0.008 amp.	160 hrs.	110 hrs.	70 hrs.	40 hrs.
BB	0.008 amp.	160 hrs.	110 hrs.	70 hrs.	40 hrs.
B	0.008 amp.	185 hrs.	130 hrs.	80 hrs.	50 hrs.
D	0.008 amp.	550 hrs.	200 hrs.	125 hrs.	60 hrs.

AFC

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be followed implicitly.

There are many methods of alignment depending on the equipment to be had. These include an AM signal generator, an FM signal generator, an oscilloscope, a vacuum tube voltmeter or a milliammeter. As the AM signal generator and VTVM are generally available, let us discuss the use of these.

First of all, the receiver should be aligned in the usual manner with the AFC off. After that has been accomplished, the AFC is ready for adjustment. Fig. 6 shows the connections required.

The first adjustment is made at the primary trimmer of the discriminated transformer. If no diagram is available, it may be distinguished by the fact that it is much less sensitive than the secondary trimmers. The secondary trimmer has the greatest effect as a slight change will alter the delicate balance of the whole circuit, while the primary adjustment only insures maximum transfer of energy to the secondary. The primary trimmer is adjusted to obtain a maximum

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MORE BACK NUMBERS

Our first announcements of the availability of back numbers of RADIO MAINTENANCE brought a response much greater than we anticipated. As a result we are continuing to comply with the demand of radio servicemen for these back issues. We don't know how long we may be able to fill orders for the earlier issues as the supply is dwindling fast, so if you are anxious to get them send in your request as soon as possible.

OCTOBER 1945
ANTENNAS FOR FM AND TELEVISION
BUSINESS MANAGEMENT FOR THE RADIO DEALER
RADIO MAINTENANCE FOR AVIATION
USING THE SIGNAL GENERATOR AND OSCILLOGRAPH

JANUARY 1946
THE PROBLEMS OF ORGANIZATION
TELEVISION RECEIVER INSTALLATION
RADIO MAINTENANCE IN AVIATION
USING THE OSCILLOGRAPH FOR DISTORTION MEASUREMENTS

FEBRUARY 1946
MODERN BENCH CONSTRUCTION
SYMPOSIUM ON TEST EQUIPMENT
FUNDAMENTALS OF VACUUM TUBE VOLTMETERS
REPAIR OR RECONDITIONING

MARCH 1946
TROUBLESHOOTING TELEVISION RECEIVERS
APPLICATIONS FOR LOW COST SIGNAL TRACER
RADIO REPAIRMEN'S ASSOCIATIONS
RADIO SERVICE ALONG THE AIRWAYS

APRIL 1946
PA SYSTEMS
A MIDGET AUDIO FREQUENCY OSCILLATOR
IF I WERE A SERVICEMAN
AN EQUALIZED AMPLIFIER FOR MAGNETIC PICKUPS

MAY 1946
P A SYSTEMS
TEST PANEL FOR THE MODERN BENCH
RINGING THE BELL

JUNE-JULY 1946
FUNDAMENTALS OF TELEVISION
VOLUME CONTROL TAPERS
THE ELECTRONIC VOLT OHMMETER
VECTOR ANALYSIS

AUGUST 1946
AVC CIRCUITS
FM TROUBLESHOOTING
TELEVISION RECEIVER FUNDAMENTALS
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RADIO MAINTENANCE MAGAZINE
460 BLOOMFIELD AVE.,
MONTCLAIR, N. J.

Please send me the back numbers checked here.... I am enclosing 25c for each copy.

- ☐ OCTOBER 1945
- ☐ JANUARY 1946
- ☐ FEBRUARY 1946
- ☐ MARCH 1946
- ☐ APRIL 1946
- ☐ MAY 1946
- ☐ JUNE-JULY 1946
- ☐ AUGUST 1946

Total amount enclosed $.............

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ADDRESS ____________________

CITY ____________________

ZONE __________ STATE __________

AFC

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reading on the vacuum tube voltmeter, either positive or negative. If no deflection is noticeable, the secondary trimmer should be changed slightly, as it may be in resonance.

When maximum deflection has been obtained, the secondary may be tuned. The correct setting of this is indicated by a zero reading on the meter. As previously mentioned, this adjustment is very critical. The true setting can be checked by the fact that the meter remains at zero as the AFC switch is turned on and off. Be sure that the zero reading is not obtained at either minimum or maximum capacity.

To check the alignment, tune in a strong station with the AFC off. Then, with the AFC switch on, rock the tuning condenser to both sides of the station. If the AFC is operating properly, the same signal quality will be received from approximately 15 kc either side of the correct frequency.

The customer should be told that, although AFC does compensate a great deal for inaccuracy of tuning, it must be used correctly. The time devoted by the serviceman in giving instructions as to the correct method of operating the AFC circuit is time well spent. It will mean a well satisfied customer and result in a reputation for good, friendly service.

Service Bench

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small metal lathe.

Check the fly ball governor; see that all the springs are in place, that the moving sleeve which holds them is free, and that the braking disc is smooth and unscored. The leather brake shoes should be oiled lightly.

Reassemble the motor. The bearings and the worm gear driving the fly balls should be oiled sparingly with light machine oil. The other gears should be greased. Some servicemen prefer a mixture of graphite and grease. Now give it the juice.

If the motor is dead, check for an open field or a brush stuck in its holder and not making contact. If it hums, give it a spin by hand, and if it runs once it has been brought up to speed by hand, the starting circuit is at fault. Fig. 3 shows the circuit used in a split-phase motor, the type which uses a starting winding. Check the winding for a break; and if it shows good, check the starting condenser for an open or short. Its function is to provide out of phase current to the starting winding. If it is shorted, the starting field will be in phase with the running field and there will be no starting torque. If the motor hums but can only be turned with difficulty, the bearings are loose and the magnetism is freezing the rotor against the field. If it starts weakly, check the capacity of the starting condenser. It should be between 1.0 and 1.5 ufd. Too small a condenser prevents sufficient starting current from flowing. The current should be between .64 and .8 amperes. The normal ambient temperature rise of a motor is 60° to 100°. This means that a motor usually runs too hot to touch—a point some customer may bring up.

If the motor runs after it has been brought up to speed manually, but has insufficient power to pull its load, the running winding is open and it is operating on its starting winding.

If the motor starts only when the armature is in a certain position, there is an open in the armature

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Service Bench

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winding. This can sometimes be corrected by short circuiting the open coil with a piece of wire or a drop of solder between the commutator segments. The segments connected to the open winding are adjacent to one another. Fig. 4 shows the way in which the windings are connected to the segments. The speed of the motor will be affected slightly, but this can be corrected by the means provided, and the motor returned to service.

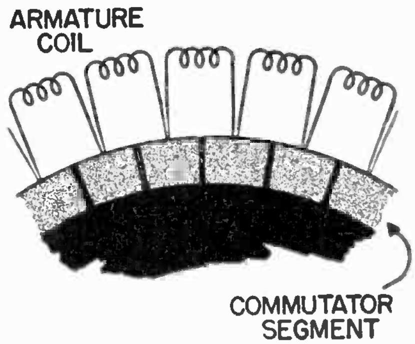

Fig. 4 Armature connections used in some types of phono motors.

The motor speed should be checked with a stroboscopic disc on the turntable. Wows are usually caused by off-center or unbalanced rotors, an unevenly worn driver or idler pulley, or unequal fly ball springs. These springs are quite critical in their action and should be replaced when suspected. A change of speed after some fifteen or more minutes of operation is caused by an intermittent short in the field. This can be checked by applying pressure to the coils by means of a screw driver or similar tool. The change in speed will be immediately apparent. Field coils may be replaced by coils commercially manufactured for the purpose, or by coils wound by the serviceman himself from data secured by dismantling the original. ✓ ✓ ✓

The dial lamp is small but important . . . Read about it in the November Issue

Cabinet Repair

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glue, give each coat a chance to dry thoroughly. Don't try to rush the repair by cutting down on the time between coats.

Practice on old cabinets until you are sure of your technique. Don't make your first attempt on a customer's expensive cabinet. You may have unfortunate results.

Fig. 10 shows a complete refinishing outfit for use in the shop.

If you follow the instructions outlined in this article and spend a little time practicing, you are sure to obtain gratifying results. You will often find the opportunity to repair a small scratch or dent as shown in Fig. 11 and make yourself another customer. Scratch sticks and polishes can often be sold to your customers who have seen you improve the appearance of their radios. You can create the best of good will by polishing every cabinet after you have finished the radio repair job and your customers will be more satisfied and willing to pay your bill.

Fig. 11 This handy scratch stick will help make customers.

Industry Presents

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range with two cutting blades in addition to the fixed cutter or center lip which cuts away the material at the center around the improved, diamond-shaped screwpoint.

VIBRATOR INVERTER

A new vibrator inverter, designed to permit operation of AC phonographs on DC, is now in production by Electronic Laboratories, Inc., Indianapolis.

The unit can be installed under the turntable or in a corner of the phonograph cabinet. It measures 4½" x 4" x 2¼", weighs 14 oz., has an input rating of 115 volts DC and an output of 110 volts, 60 cycle AC, with a maximum load capacity of 25 watts. It may also be used with timing devices, electric razors and similar equipment having small synchronous motors and low wattage requirements.

RADIO-PHONOGRAPH-RECORDER

The Jefferson-Travis "Masterpiece" is a high-fidelity FM and AM radio and phonograph with record changer, plus the new long playing tape recorder which takes programs off the air with no in-person supervision. By setting a clock on the console panel to the time of the program desired, the owner may leave and the recorder will turn itself on and take the broadcast

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The Oscillograph . . . how it works

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same average potential as the second anode in order not to change the acceleration rate of the electron stream, since the deflecting plates are directly coupled to their respective amplifier output tubes, if they were at an average potential of +1000 to +2000 volts, their output tubes would also be so, resulting in a very unsafe and otherwise unsatisfactory operating condition.

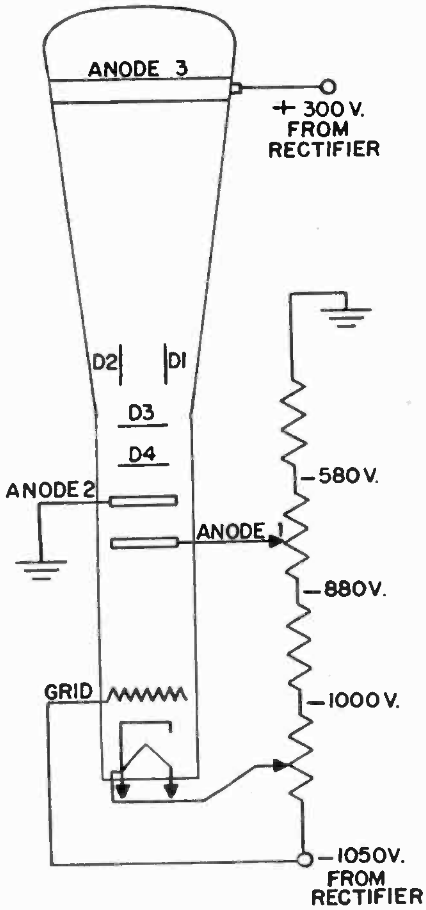

Fig. 8 Typical voltage dividing system used in cathode-ray oscillographs.

The typical arrangement of voltages shown in Fig. 8 shows that grid-to-cathode volts can be varied from 0 to 50, focus anode-to-cathode volts can be varied from 200 to 500 volts, the accelerator anode is grounded, and the intensifier anode is at +300 volts.

Industry Presents

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off the air, switching off automatically when the program's time has elapsed.

Records may also be added to the owner's collection by means of the recorder and phonograph. For "live talent" recording, a microphone attachment is employed. Only sapphire needles are used for both recording and playing purposes.

In November The first article on the use of the Oscillograph will appear.

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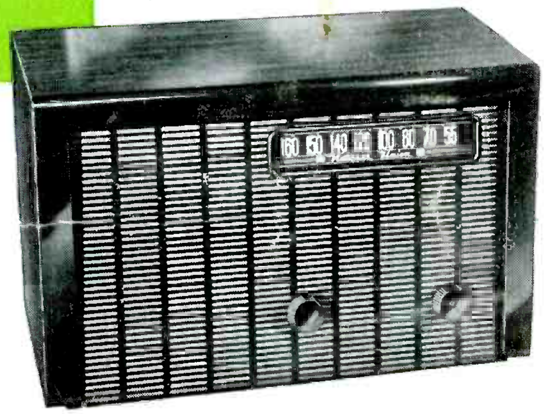
3

National Union Announces an

EXCLUSIVE RADIO MERCHANDISING PLAN for Service Engineers

PRESENTATION MODEL No. G619. *6 Tubes. AC-DC. Tuned R.F. Stage. Superheterodyne Circuit. Loop Aerial. Automatic Volume Control. Illuminated Slide-Rule Dial. Standard American Broadcasts. Mahogany Veneer All-Wood Table Cabinet, 13" x 8¾" x 6½".*



COMPANION MODEL No. 571. *5 Tubes. AC-DC. Superheterodyne Circuit. Built-in Antenna. Automatic Volume Control. 2-Gang Air Condenser Tuning. Illuminated Slide-Rule Dial. Standard American Broadcasts. Walnut Veneer All-Wood Table Cabinet, 13 5/16" x 7⅝" x 8⅛".*

HERE IT IS AT LAST! The radio line thousands of service engineers have been waiting for—yes, the radio that has *everything* the service trade needs to cash-in on today's big pent-up new set demand.

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And now N.U. RADIO SETS are here—for the same service men who have so long known and used other N.U. products—and have found the N.U. way of doing business a better, more profitable one for their special type of operations.

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