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T.V.I. – CAUSE, EFFECT AND CURE – PART II

IN Part I of this article it was stated that T.V.I. could be broken down into two categories—interference caused by a television receiver and interference caused to a television receiver.

With a basic understanding of the cause, effect and cure of interference caused by a television receiver, we shall now direct our attention to the latter of the two categories under T.V.I.—interference caused to television reception. Under this heading there are a number of various causes of T.V.I.—electrical equipment such as motors, generators, welders, office machines, industrial heaters (induction and dielectric), diathermy, household appliances, old-time tungsten lamp bulbs and automobile ignition systems; amateur radio stations; AM & FM broadcast stations and adjacent and co-channel television stations.

For clarification of the above topics, each one will be discussed separately.

(Continued on next page)

T.V.I.—Cause, Effect and Cure—Part II

(Continued from Front Cover)

Figure 9. Household Appliance Interference

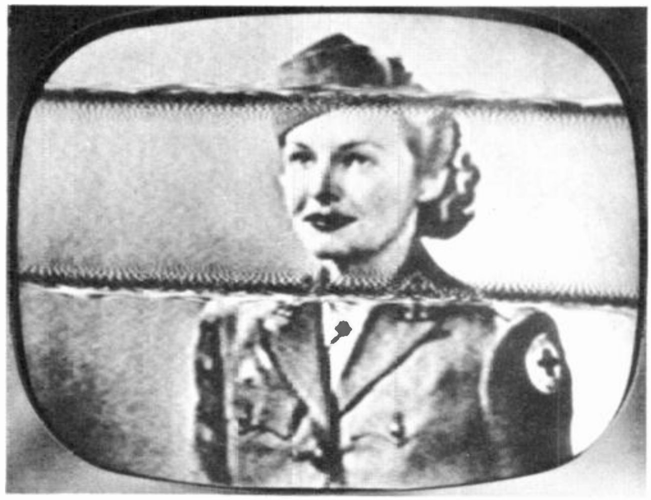


Figure 11. Tungsten Lamp Interference

Electrical equipment of various types is the largest single cause of T.V.I. due to the vast field of devices listed under this heading.

A most common source of television disturbances is electrical home appliances. They will cause an interference pattern on the face of the picture tube similiar to the streaks caused by automobile ignition systems but much more severe, see figure 9. In many cases the disturbance can be minimized enough to permit operation of the appliance and the television receiver both simultaneously by the addition of two condensers (.01 mf to .5 mf) from each side of the A.C. line to the frame of the appliance or ground. These connections should be made similiarly to those in figure # 10. This will reduce considerably any interference getting into the power line, however, there is very little which can be done about radiation from such equipment as shielding is usually very impractical. Therefore, it may be necessary in some cases to discontinue the use of the electrical appliance while the television set is being viewed.

In some older homes it is not uncommon to find an old-fashion tungsten filament light bulb, of the type which used a straight wire filament draped over several supports forming much the shape of the letter "W". These light bulbs can act as oscillators. At the upper end of the supports over which the filament is bent, small deposits of carbon accumulate over the years due to the impurities remaining inside the bulb envelope at time of manufacture. Due to these carbon deposits differences in potential exist at these points and the lamp performs as a dynatron oscillator. Usually the

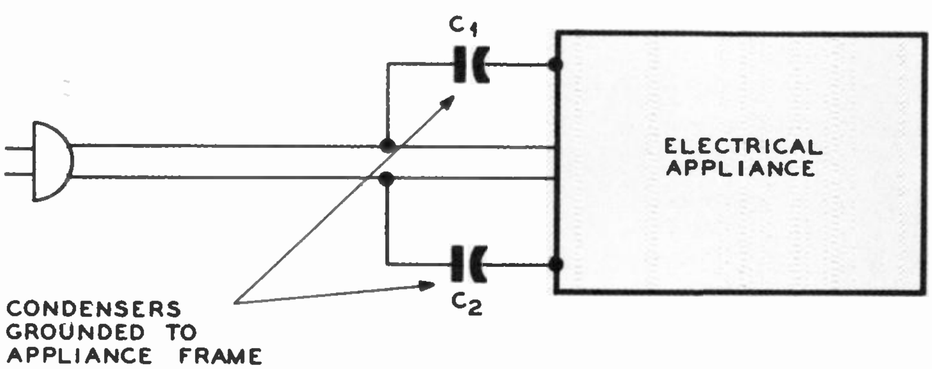


Figure 10. Power Line By-pass Condensers

Figure 12. Auto Ignition Noise

Figure 14. Distributor Suppressor Resistor

frequency at which the lamp oscillates is within the 20 mc IF frequency limits and the harmonics may often fall within one or more of the lower television channels. The radiation from such a lamp has, in some cases, caused considerable interference two to three blocks from the location of the offending lamp. The cure for this is obvious; replacement of the lamp. Figure 11, illustrates just how severe a disturbance can be caused by an old fashion tungsten lamp.

One of the more common types of interference originates from the ignition systems of automobiles, trucks, buses and similar automotive equipment. The results of such interference show on the television screen as small black and white flecks as seen in figure 12. These impulses are found to be strong over a range of frequencies up to 100 megacycles, although they may be particularly strong over a narrow width of frequencies due to some particular wiring characteristics of the automotive equipment. This interference, which can also be noticed in the audio portion of a television receiver increases or decreases in frequency directly in proportion to the speed of the motor, and emanates from the high tension system of the automotive equipment. This system is basically comprised of the spark plugs, spark coil, distributor and associated wiring from which RF energy is radiated, see figure # 13.

The methods followed by the automobile manufacturers in the design of the latest type equipment, which may be applied to earlier equipment, are care-

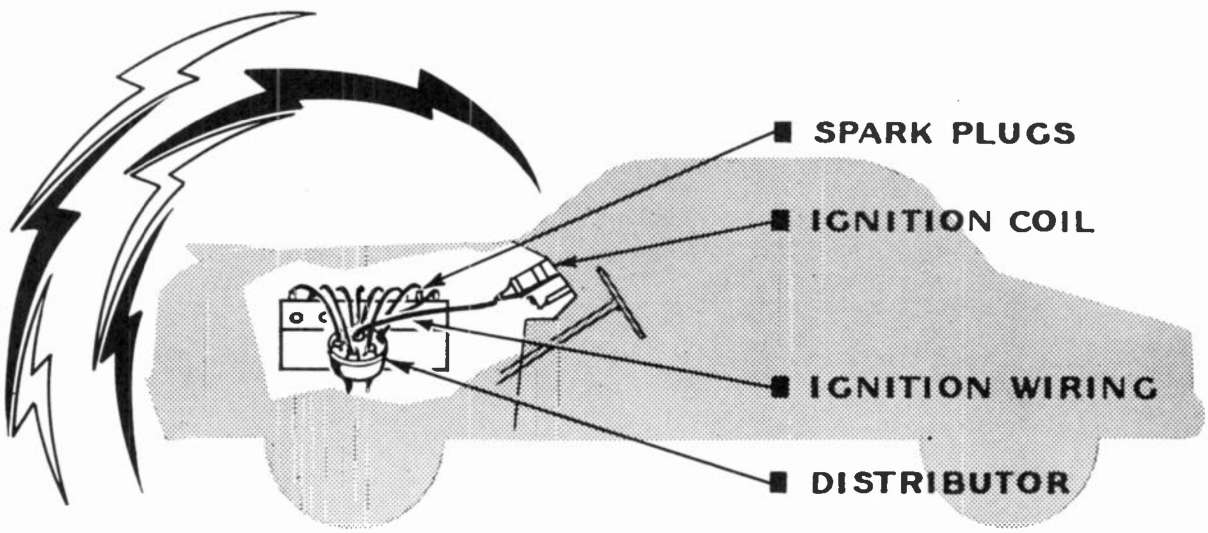


Figure 13. Ignition Interference Sources

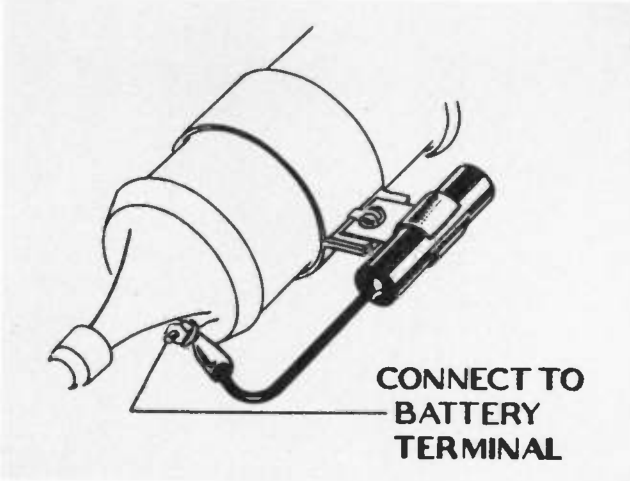


Figure 15. Ignition Coil Capacitor Placement

ful attention to the dress of the leads of the high tension wiring, and the use of capacitors and resistors as suppressors.

A 7000 to 15,000 ohm suppressor resistor installed in the distributor high tension leads, as in figure 14, will reduce possible interference from this point.

Interference which may emanate from the ignition coil may be reduced by installing a metal case type .5 uf. capacitor as in figure 15.

Certain car manufacturers have as standard equipment resistor type spark plugs which are also very beneficial in suppressing interference of this nature.

All of the above suppression devices are available through local sources to the television technician.

Such interference, occuring at the frequencies of the television channels, cannot be eliminated by traps at the television receiver input or on the antenna lead-in for the obvious reason that the interference is occurring at the frequencies of the television channels and any attempts to attenuate the interference, by traps would of course attenuate the channel signal.

Secondly, the interference occurs over such a wide frequency range, it would be extremely difficult to design traps to attenuate this wide range of frequencies.

As pointed out in the preceding paragraphs, the interference should be suppressed at the source, however, since many older type automobiles, trucks, and buses are still in use in large numbers and many do not have sufficient suppression equipment, there are certain steps which the television technician may follow to reduce the effects of ignition interference. In those locations where automotive traffic is considerable with the resulting interference, the proper placement of the antenna and the routing of the lead-in from the antenna can be an important factor in determining whether the interference will be a bothersome condition to the viewer. Providing that the receiver is located in a fairly strong signal area and ghosts or similar problems are not a primary factor in the antenna's location, the antenna should be mounted to the rear of the roof as far away from the street or

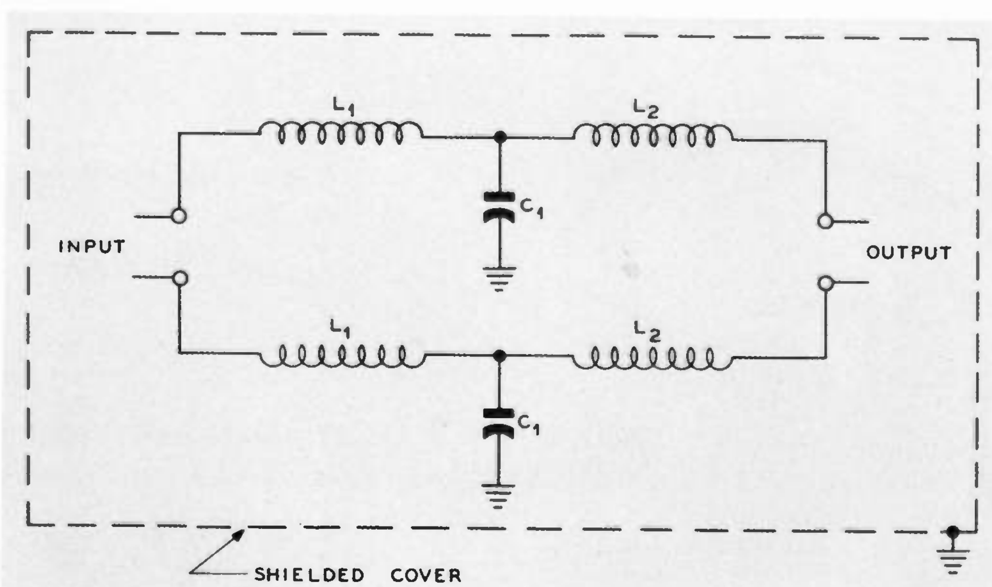


Figure 16. Line Filter

highway as is possible or practical. The antenna lead-in should also be run down that side of the residence farthest from the source of the interference, since the lead-in, particularly twin-lead ribbon types, can pick-up such interference. In very severe cases, coaxial or shielded cable may be substituted in place of the twin lead.

Electrical and electronic equipment used both in industry and the Medical Field can be a source of interference to television receivers due to the radiation of Radio Frequency energy.

Motors, generators, instruments with electrical contacts and sparking electrical devices present such problems and certain steps can be taken to suppress interference of this type.

The particular device should first be examined to determine whether it is defective since repair or replacement may be the simplest correction of the problem. If the device contains electrical contacts which open and close, the contacts should be examined to determine whether cleaning is required, since dirty contacts may be a source of such interference.

Line filters, as close to the offending instrument as is practical, are very effective in preventing radiation through the power lines. A typical line filter is shown in figure 16. The values of L1, L2 and C1 must be determined to attenuate the unwanted RF frequencies. Consideration should also be given to the wire size of L1, and L2, since the filter will be inserted in the power lines and pass fairly heavy current. Variations of this type filter may be necessary in specific problems where a particular RF interfering frequency is very strong.

Shielding the offending machine or instrument may also be necessary in addition to filtering. The shielding may only be necessary immediately around the device or possibly the room in which the offending machine is installed may require shielding with copper screen.

Medical diathermy equipment may radiate RF frequencies which can interfere with television reception, see figure 17. The effect on the screen of the television receiver is evidenced by wavy zig-zagging lines in an up and down motion. Usually this interference is periodic since the diathermy equipment operates periodically.

The design and manufacture of diathermy equipment are controlled by the rules and regulations laid down by the FCC and interference from equipment of

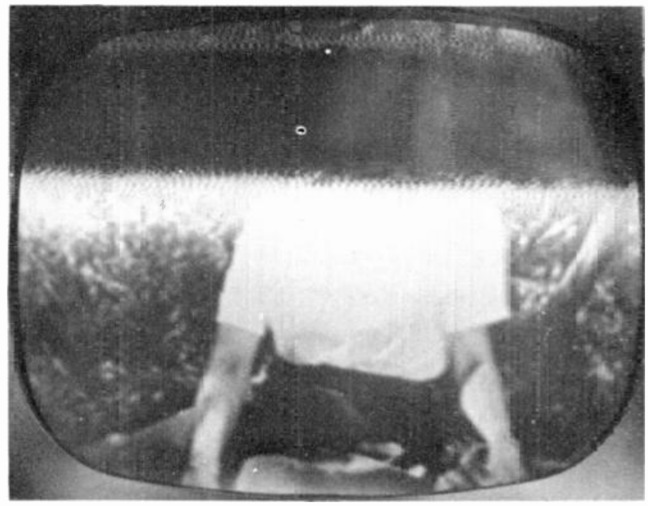


Figure 17. Diathermy Interference

recent design has been greatly minimized by changes in the operating frequency of the diathermy equipment, crystal control of the oscillator for stability and proper shielding, particularly of the output stage to suppress harmonics. Ordinarily it is harmonics of the diathermy oscillator frequency which interfere with television reception, entering at the channel frequency or the IF frequency of the television receiver.

This problem is further minimized in receivers of more modern design due to improved RF amplifier circuits which provide better sensitivity and, therefore, are more capable of rejecting harmonics at the IF frequency of the receiver.

Methods of suppressing interference from diathermy sources involve proper shielding of the diathermy equipment, the installation of line filters to suppress radiation through the power lines and shielding of the area immediately around the diathermy instrument. Diathermy instruments, not having crystal controlled oscillators, may have their oscillator frequencies changed to another frequency that will not interfere with the television channels operating in that particular area. The advice and assistance of a diathermy service technician should be obtained for this purpose.

In certain industrial applications, radio frequency heating equipment is used extensively and such equipment can be a source of interference to television receivers in the vicinity.

The problem becomes more pronounced in view of the fact that some of this equipment is operating on very high power.

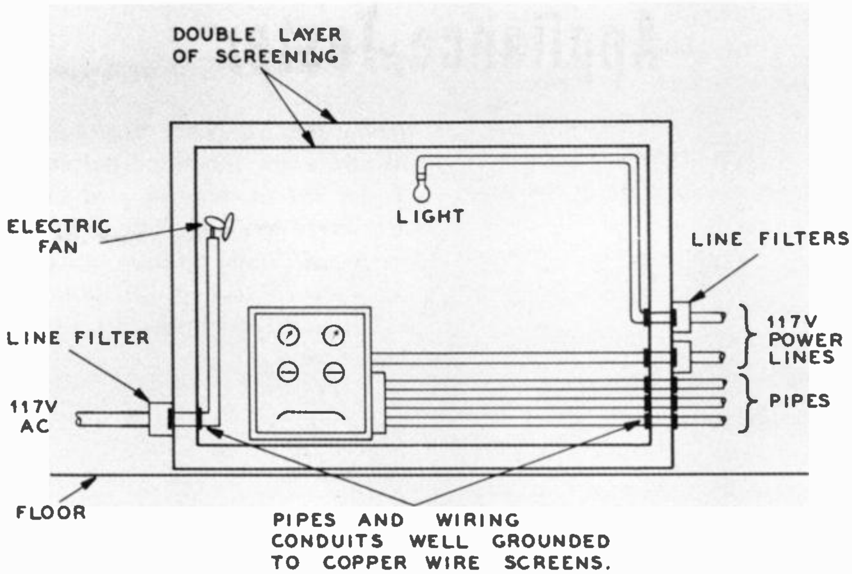


Figure 18. Construction of Screened Cage

The interference is basically due to harmonics of the fundamental frequency of the oscillator. Although radio frequency heating equipment is fairly well shielded during manufacture, due to ventilation and observation holes necessary in this type equipment, various paths are present through which RF energy can radiate.

The methods used to suppress this harmonic radiation are similar to those used for diathermy. These consist of proper shielding of the equipment, the use of line filters and if necessary the complete shielding of the area in the immediate vicinity of the interfering equipment.

Ordinarily it is not necessary to shield the entire room or work area of the offending instrument since the placement of shields on those parts of the instrument from which RF energy is radiating plus the installation of power line filters will usually bring about the desired results. Should it be necessary however, to erect a screen around the work area careful consideration should be given to every possible outlet for RF energy otherwise, the screening will not be effective.

All electrical lines running to or from the screened area should be filtered. Before the screening is erected, consideration should be given to any water or heating pipes leaving the enclosed area including any type of structural metal. Such items are not necessarily ground and should be thoroughly bonded to the screening. It is usually better to use 2 layers of screening and care should be taken to see that all corners and edges overlap several inches. The door to the screened area should be well bonded. The floor under the work area must also be considered in view of the fact that pipes or power lines may be directly underneath and can be excellent points of absorption and radiation of RF energy. Figure 18 shows a typical screen enclosure designed to prevent RF radiation leakage from any point.

This article to be continued in the next issue, and will cover those phases of interference caused by AM, FM, TV and amateur transmitting equipment.

Appliance Tester

FIGURE 1

It may truly be said that a craftsman is judged by his tools and how he uses them. We here at Philco headquarters have long been conscious of this fact. It is our aim to not only provide the serviceman with the latest in serviceman information, but to also make available to him tools and test equipment which will enable him to render quick efficient service.

The latest piece of test equipment is the new Philco Appliance Tester, model 5007. This tester (Fig. 1) permits analysis of overall performance of refrigerators, freezers, air conditioners, electric ranges, and small household appliances. Accurate temperature measurement in degrees Fahrenheit from 100° below zero to 600° above zero may be measured through the use of resistance bulbs for low temperatures and thermocouples for high temperatures. Instantaneous power consumption up to three kilowatts may be measured through the A.C. and D.C. wattmeter. Line voltage from zero to 300 volts may be measured by the voltmeter incorporated in the wattmeter circuit. Circuit continuity may be checked with the self-contained buzzer. The power circuit is protected with a 15 Amp., 230 volts slow blow fuse.

TESTER OPERATION

When making measurements with the Appliance Tester, it should be used in the horizontal position. It can be noted that in some of the pictures in this article the Appliance Tester has been tilted to better illustrate its function. Before using the Appliance Tester the mechanical zero of the meters should be accurately set. This is done by placing the instrument in the horizontal position and adjusting the mechanical set screw located in the bottom center of each meter. Position the meter needle to the zero point on the meter scale.

BATTERY

The resistance bulbs, thermocouple and buzzer circuits are energized by a self-contained 1.5 volt battery, Part No. P-94. This battery should be replaced once a year or at such time as the temperature meter cannot be adjusted to full scale deflection. Adjustment for meter deflection is made by rotating the "Calibrate" control in a clockwise direction with the selector switch in the "B CAL" or the "TC CAL" position.

The battery is replaced by removing the front panel mounting screws. Snap connectors secure the leads to the battery. Make sure that proper polarity is observed when replacing the battery leads.

If negative deflection is shown on the temperature meter, the battery connections are reversed. Prior to replacing the front panel, make sure that the new battery is securely clamped in place.

FUSE

The power, wattmeter and voltmeter circuit is protected by a 15 Amp. 250 volt, slow-blow fuse. This fuse is located on the left hand side of the tester panel (Fig. 1) adjacent to the power socket. The fuse may be replaced by twisting the fuse holder cap one-quarter turn counterclockwise.

APPLIANCE TESTER USAGE

The application of the Appliance Tester in determining mal-function and the exact point of defect in appliances is so diversified that it would be impossible to list them all in this short article.

VOLTAGE AND POWER MEASUREMENTS

A prime factor in determining the condition of an electrical appliance is its voltage requirements and power consumption. Low line voltage would cause

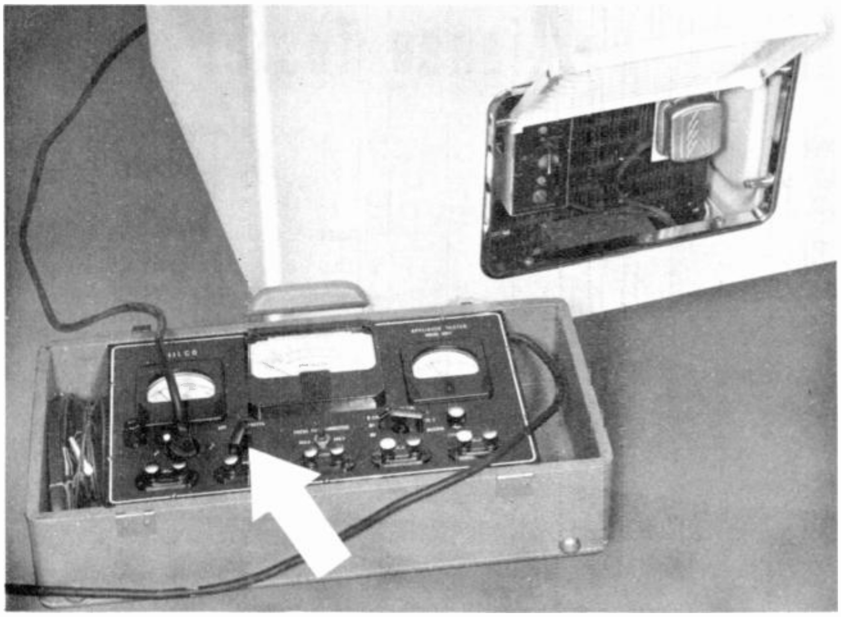


FIGURE 2

the appliance to draw excessive current, thus causing the appliance overload protector to trip. Figure 2 shows the tester being used to check the line voltage and power consumption of a freezer. With the freezer control set to the storage position, plug the tester service cord into the power outlet. Connect the freezer power cord into the receptacle on the meter. Permit the freezer to operate for a short period of time to overcome initial starting surges of the motor compressor. Rotate the wattmeter switch (indicated by the arrow in Fig. 2) to the "ON" position and observe the wattage. The wattage will vary with room temperature, line voltage and the portion of the running cycle at which time the observation is made. At the time of unit cut-off, the wattage indication will fall within the normal operating limits, as specified in the electrical section of the service manual for the model under test.

The wattmeter should only be switched into the power circuit for short periods of time when readings

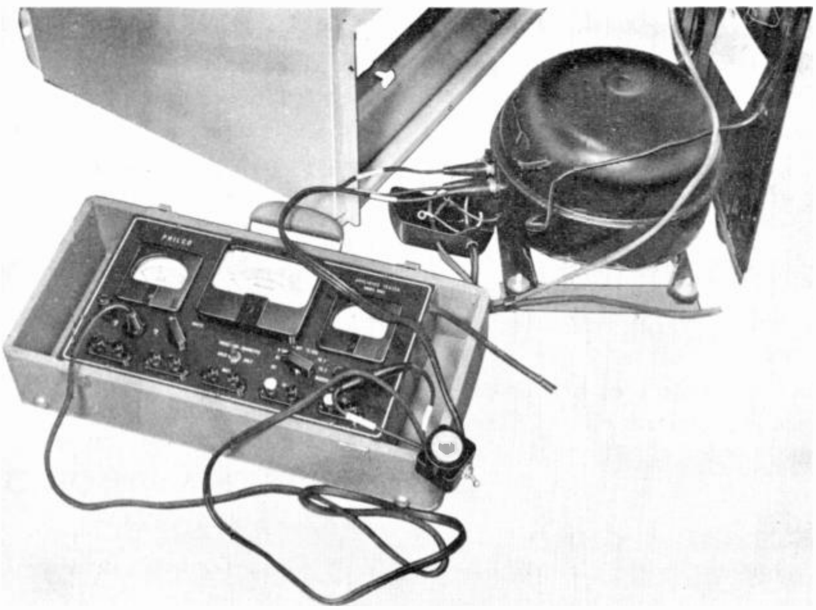


FIGURE 3

are taken. To leave the meter in the circuit at the time when the motor compressor starts will cause damage to it, due to the excessive amount of power required to overcome the inertia of the motor armature.

Another use of the wattmeter may be made, as shown in Fig. 3, where the metered circuit is used in conjunction with a test cord to isolate the motor compressor so that the serviceman can determine if mal-function is caused by a faulty motor compressor or its allied controls and inter-connecting wiring. The procedure of operation of the tester is exactly the same as outlined for a normal power check.

CONTINUITY CHECKING

A continuity check of wiring harnesses, inter-connecting cables and control devices that have no internal resistance may be quickly and efficiently made with the buzzer of the model # 5007 tester. For example, in figure 4 a continuity check of the wiring harness and freezer thermal regulator is being made from the wiring terminal block on the rear of an automatic refrigerator. When using the buzzer, it must be remembered that the test leads be made as short as possible and of a heavy gauge wire to keep the resistance of the wire at a minimum, for if the voltage drop in the leads is excessive, the buzzer will not be supplied with a voltage great enough to activate it.

To make a continuity check, rotate the tester selector switch to the buzzer position. Connect a pair of test leads to the buzzer binding posts in the bottom center portion of the tester panel. When the test leads are placed across an electrical short, the buzzer will be energized.

LOW TEMPERATURE MEASUREMENTS

Facilities for connecting two low temperature resistance bulbs are provided at terminal panels B1 and B2, (Fig. 1). The low temperature range between 100 degrees below zero to 80 degrees above can be read directly on the large temperature meter. There are many conditions under which a temperature comparison check is useful; for example, when checking an automatic refrigerator (Fig. 5), it is desirable to know the food mass temperature in the refrigerator compartment and also the plate temperature of the freezer compartment.

To make low temperature measurements, connect resistance bulbs to binding posts marked "B1" or "B2". The bulbs are equipped with flat cords that fit between the frame and gasket on the door of a refrigerator, so that measurements may be made with the door closed. If two bulbs are used, temperature measurements may be taken at two points without opening the refrigerator.

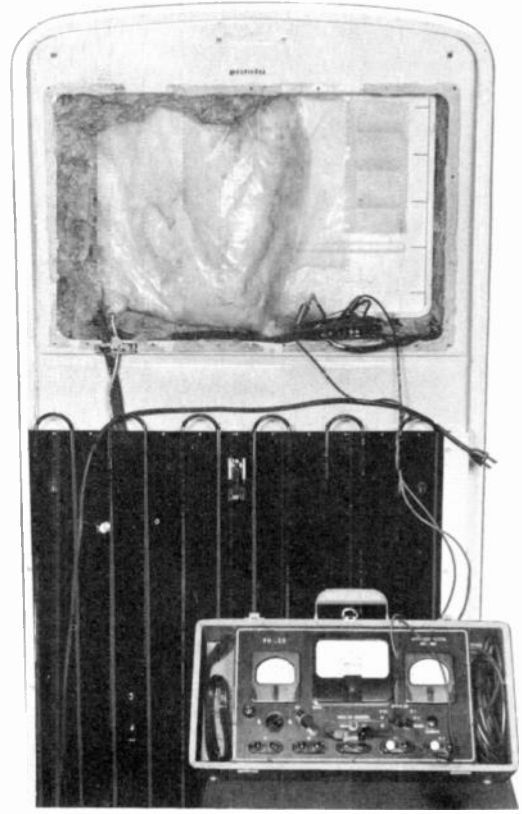


FIGURE 4

Place resistance bulb(s) at the point where temperature is to be measured and leave for at least five minutes to allow temperature stabilization.

Rotate selector switch to "B CAL" and turn "CALIBRATE" control until the meter reads +80F. on the "B" scale, (black).

Rotate selector switch to "B1" or "B2" which will permit temperature measurements to be made for connected bulbs.

Press the push button marked "PRESS FOR CONNECTED BULB ONLY." Bulb temperature will now be indicated on the "B" scale of the temperature meter.

DANGER: DO NOT PRESS PUSHBUTTON WITHOUT BULBS BEING CONNECTED AS DAMAGE TO METER WILL RESULT.

It is not necessary to recalibrate before each reading when a number of readings are being taken. An occasional check, however, is recommended during each set of readings.

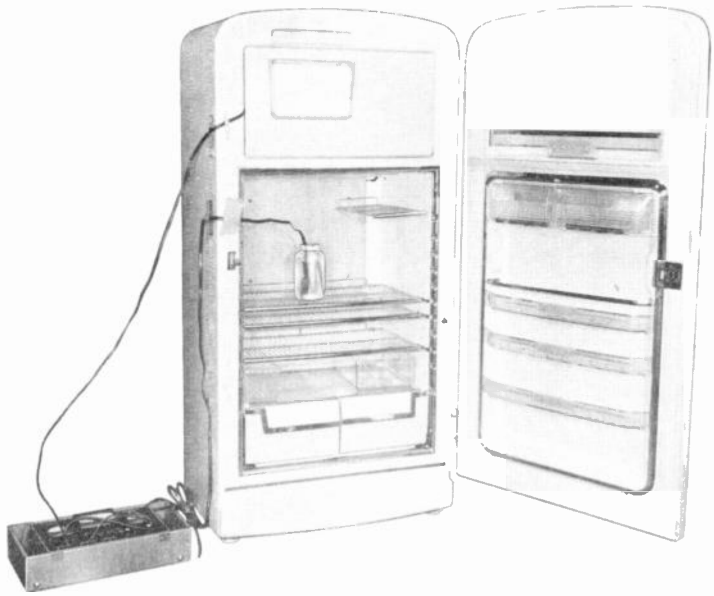


FIGURE 5

Occasionally it is necessary to know the accuracy of the resistance bulbs. They may be quickly and efficiently checked by comparing their readings against a column type pocket thermometer. When checking the resistance bulbs, take at least three readings at three points on the scale: 20 below zero, zero degrees, and 40 degrees above zero.

HIGH TEMPERATURE MEASUREMENTS

The added feature of high temperature thermocouples, makes this instrument very desirable when working on electric ranges and air conditioners of the reverse cycle type, (Fig. 6).

When checking the heating performance of a thermo-cool air conditioner, it is necessary to record the temperature of the room air entering the condenser and also the heated air leaving the same condenser coil. The air entering the coil could be measured with a low temperature resistance bulb or a thermocouple, but it will be necessary to use a thermocouple to record the temperature of the heated air leaving the condenser.

To make high temperature measurements, connect a thermocouple to the "TC1" or "TC2" binding posts only; being certain that the Yellow lead is connected to the Yellow binding post. Two thermocouples may be used to measure temperatures at two points.

Place the thermocouple at the point where the temperature is to be measured and wait at least one minute for the temperature to stabilize.

Rotate selector switch to "TC CAL" and adjust "CALIBRATE" control until the meter reads 600° F. on the TC scale. (Red)

Rotate selector switch to TC1 or TC2 which will permit measurement to be made for connected thermocouple.

It is not necessary to recalibrate before each reading when a number of readings are being taken. An occasional check, however, is recommended during each set of readings.

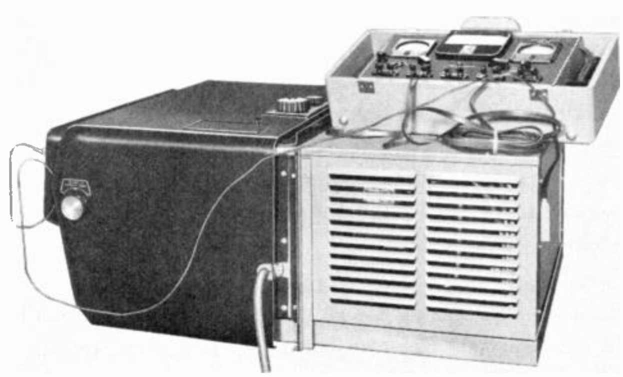


FIGURE 6

Measuring Stage Gain in Auto Radios

During the past year or so we have published in the Supervisor numerous articles on the various uses of the oscilloscope and several on gain measurements; therefore, this material will be partially a recapitulation of previous publications. We are pointing this information specifically towards the 1953 Philco-Mopar sets.

The cathode-ray oscilloscope is a very good method of visually ascertaining the gain of each stage in an auto radio receiver as not only the relationship between input and output voltages is visible but also any distortion can be seen.

The oscilloscope is an instrument for indicating the wave form of a varying voltage. Current as such has no effect on the beam and it is, therefore, necessary to take the signal across a resistance or impedance in order to impress a voltage on the deflection plates.

When used for determining gain, it is really superior to the average A.C. meter except for calibration. If the 'scope can be calibrated, there are several advantages to using it in place of an A.C. voltmeter. One of these is the high input impedance and consequent small loading of the voltage source being measured. Another is the extremely wide frequency range of the cathode ray tube which can be as high as 100 megacycles. Since the beam of the tube is composed only of electrons, its weight and consequent inertia is almost zero and it can follow instantly the variations in voltage common at both audio and radio frequencies.

Unfortunately, the horizontal and vertical sweep amplifiers built into the various 'scopes are generally good only up to about 100,000 cycles. Above this, the amplification drops and at perhaps 200,000 cycles there may even be a loss rather than a gain. In making gain measurements, it is not necessary to consider this, however, as we need only consider the audio modulation and take precautions to keep RF out of the 'scope regardless of the frequency.

As gain is expressed as the ratio of output voltage over input voltage $\frac{(Eout)}{(Ein)}$ and the audio modulation which will be fed to the 'scope will remain at a constant frequency, we need not be concerned with the linearity of the vertical amplifier with regard to frequency or sensitivity, nor need it be calibrated for voltage. In making voltage measurements, only one set of plates—generally, the vertical—and their amplifier is used, but if it is desired to observe wave shape, both sets are used.

In the following procedure, the figures are given for reference only and should not be taken as standards. The gain of a stage may be dependent on the age and emitting capabilities of the tube, the tolerance of the resistors in the circuit, and consequent difference in voltages and the input or "A" voltage to the set. A change of ½ volt on the 6 volt input may result in a change of 18 or 20 volts on the plate of a tube with attendent variation in the plate current.

In order to be sure that the input impedance of the 'scope remains constant with respect to the circuit across which the voltage is to be measured, we recommend placing the 'scope input across the primary of the output transformer (see points "A" and "B" on fig. 1) and varying the input location of the signal from the generator. This obviates the necessity of using a detector probe through the R.F. and I.F. sections.

The 'scope used in the following procedure was the Philco Model 7020 as it contains an accurately calibrated decade vertical input attenuator plus a means of determining voltage if desired.

Step 1—The signal generator should be set on "audio" and also applied directly across points A and B with the 'scope attenuator on 1 (for accuracy, it is recommended that a cross-hatched 'scope overlay of 10 lines to the inch be used). Vary the signal generator output to get a vertical deflection of an inch or so, note the exact deflection in lines covered, and then place the generator output on the grid of the 6C4 phase inverter (point "C" in fig. 1). Change the 'scope attenuator to 10 or 100 as necessary to bring the sweep within the limits of the CRT. Note the deflection, place this quantity over the number of lines first noted and multiply by the setting of the attenuator. The result will be the gain of the phase inverter and the push-pull amplification of the two 6AQ5 tubes. If we were checking a set employing single output, we could check that stage separately, but checking push-pull is not practical as the output from the two tubes is equal to more than twice that of one tube and may range as high as three times in a class "A" amplifier.

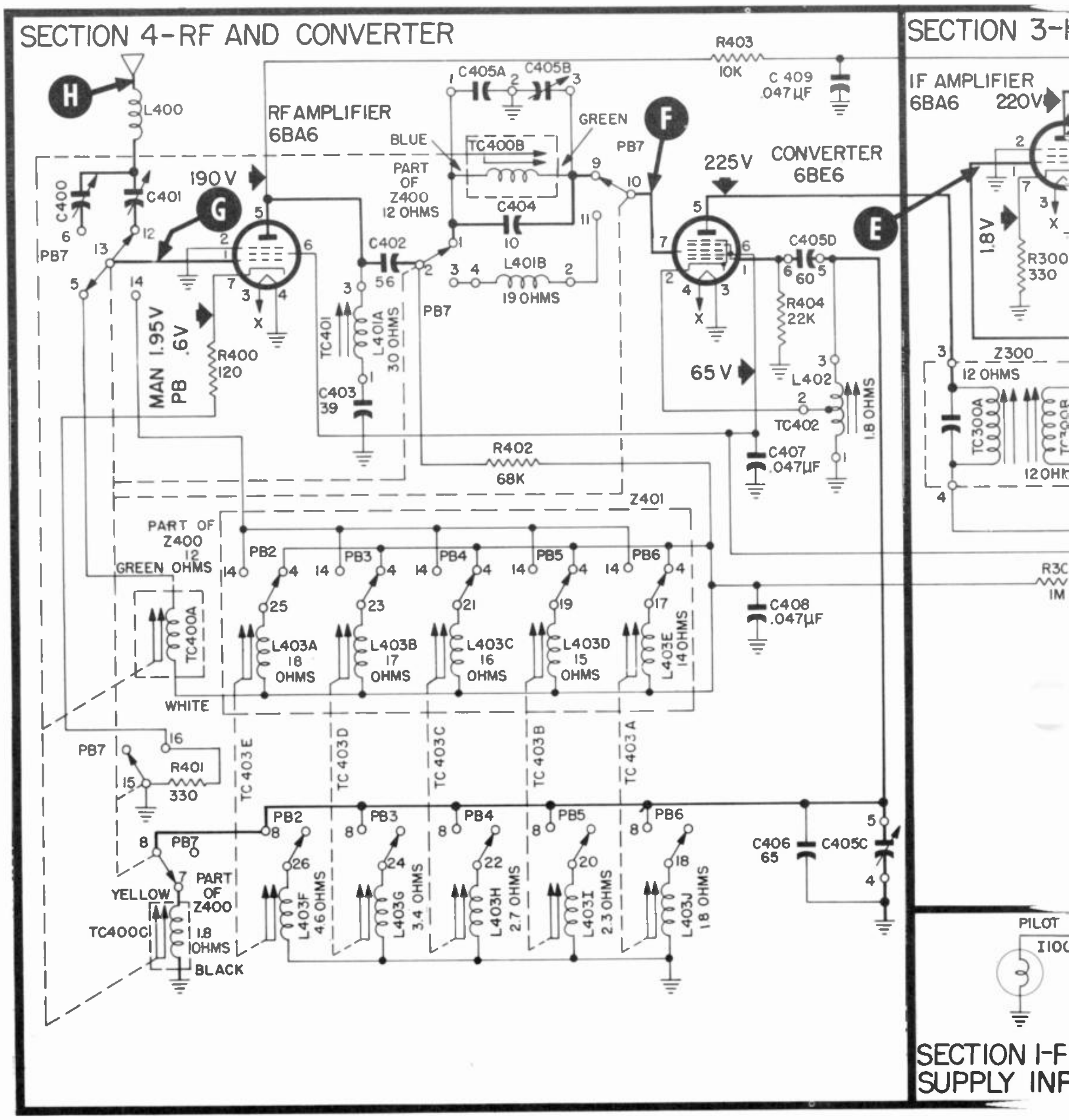
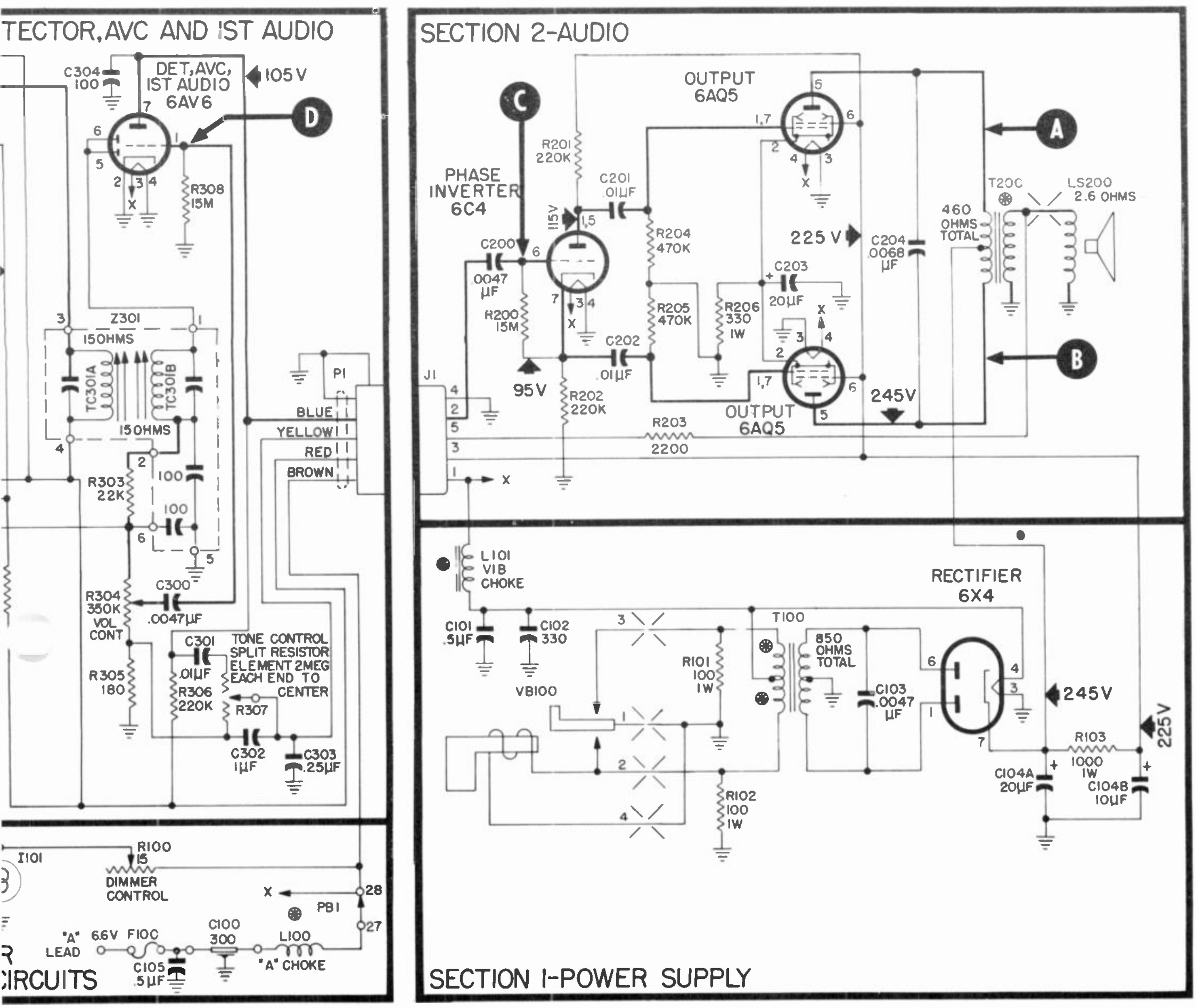


FIGURE 1

The gain in the phase inverter for this set is .9 for each side of the inverter, so the output gain may be determined by dividing 1.8 into the total gain already computed.

Step 2—Leave the connections as they are, return the 'scope attenuator to 1, and reduce the signal generator output to obtain a usable deflection and note the amplitude as in Step 1. Place the generator output on the grid of the 6AV6 first audio tube (Point "D") and proceed as in Step 1. The result of this calculation will give the gain of the 1st audio stage.

Step 3—Set the generator to the intermediate frequency with modulation on and determine the percentage of modulation as it appears on the 'scope when connected directly to the 'scope. This percentage, as a decimal quantity, should be divided into the final result in the same manner as was done with the phase inverter gain in Step 1. Now proceed as in Steps 1 and 2, using point "E" as the point of signal injection. Calculate gain as previously and divide by modulation percentage. The answer in this case was approximately 56.



Step 4—It is now necessary to switch to a radio frequency and we must know the change in output of the signal generator when changing from the i-f to r-f. Inject the i-f signal previously used into the scope through a crystal probe and with the attenuator set at 1. Next, switch to an r-f of 800 KC and compare the output as a ratio $\frac{\text{Erf}}{\text{Eif}}$. Remove the probe and re-connect the scope to points A and B. Set the generator and the radio tuner to 800 KC (be sure the radio is on "Dial") and inject the signal at Point "F". Calculate the gain as in previous steps and divide by $\frac{\text{Erf}}{\text{Eif}}$. For this stage we obtained a conversion gain of about 60.

Step 5—Now inject the signal through point "G" which will give the gain of the RF amplifier which, in this case, was 5.

Step 6—For the last step, inject the signal through the antenna socket. This will give the gain of the antenna stage, which was found to be about 10.

Consolette Installation

FIGURE 1

The Air Conditioner article which appeared in the June issue of the Service Supervisor outlined the procedures to be followed in preparing the casement and double-hung windows for a Consolette Air Conditioner installation. In this, the second portion of that article, the installation procedure is completed.

UNCRATING AND INSTALLATION

To prepare the consolette air conditioner for installation, remove the crate by extracting the nails from the bottom of the side panels. Lift the case straight up from the base skid of the unit, taking care not to mar the cabinet. Remove the protective paper bag which covers the air conditioner. Take off the carton containing the leg kit and mounting hardware. Do not remove the base skid from the unit at this time.

From the left hand side of the cabinet, untie the shipping tape from the fresh air door panel. Remove the panel by pulling it free from the retaining spring clips (Fig. 2).

Remove the four cabinet mounting bolts which secure the cabinet to the unit through the mounting brackets. Lift the cabinet up approximately 1½" to clear the control knobs (it is not necessary to remove the control knobs when removing the cabinet) and slide it forward off of the unit. There will be a slight restriction to cabinet movement, due to snug fit of the rear cabinet seal gasket against the unit.

Remove the air filter; this may be done by raising it a fraction of an inch and then pulling it out of its recessed mounting.

With the cabinet off and the filter removed, the two data plates showing the electrical specifications for the air conditioner are accessible. Check the voltage and frequency specifications to make sure they correspond to the electrical service provided in the building.

Remove the motor compressor shipping bolts (hold-down). In the models 180J and 184J, one bolt secures the outer compressor bracket, as shown in figure 3. The compressors in the models 1100J and 1104J have a hold-down bolt securing each of the two compressor mounting brackets. Use a 9/16" socket and extension to remove the shipping bolts. Access to the heads of the bolts are gained through the air filter opening. With the bolts removed, insert the plugs provided in the hardware bag to seal the holes to block any air flow through them. Replace the air filter.

Affix the rear leg mounting bracket to the bottom center of the unit with two ¾" long bolts, two star-lock washers and two washers.

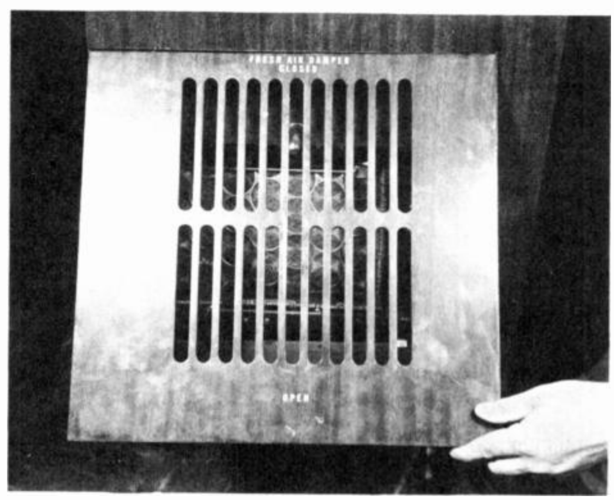


FIGURE 2

Lay the unit on its back, as shown in Figure 4. The shipping skid holds the bottom of the unit free of the floor to permit mounting of the legs. Insert the two metal fill pieces into the two welded front leg mounting brackets, so that the wide flange at the top of the fill pieces will extend out over the upper front portion of the leg mounting bracket. Install the legs by sliding them into the brackets from the bottom; with the fill pieces from the outside of the leg. The front of the legs is determined by the metal wrap around trim pieces which should be positioned to face the front of the cabinet. The bottom of the legs which will rest on the floor must be parallel to the bottom pan of the unit. If they do not show this relation to the pan, they must be interchanged. To adjust the legs to their approximate height, obtain the leg length by measuring the distance from the floor to the lower edge of the window adaptor, subtract 19¼" from this figure, and the remainder is equal to the leg length from the unit bottom pan to the floor.

For the front legs, push the metal fill pieces down into the brackets until the top flange rests against the bracket top. Install the 1½" bolt and tighten it to lock the leg securely in place. The rear leg is secured in position by firmly tightening the two bracket mounting bolts.

Carefully place the unit up on its legs and remove the shipping support which is bolted across the rear of the unit. Remove the four skid mounting bolts from the underside of the unit. Care should be observed to prevent the skid from dropping down and marring the cabinet legs.

Move the unit to the window adapter to check for proper air duct height. Remove the unit from its installed position to make any necessary adjustments. With the correct unit height established, drill a hole in each of the front legs at the bracket hole and two holes in the rear leg. Insert a wood screw in each hole to maintain exact leg height. Replace the cabinet, taking care to have the two top cabinet hooks engage the rear mounting brackets on the top rear of the unit. Firmly tighten the cabinet mounting bolts.

Install the fresh air damper handle into the fresh air damper slide, and then latch in the fresh air damper panel.

Place the air conditioner in the installed position (Fig. 5) and insert two sheet-metal screws in each side of the air duct where the duct joins the window adapter.

Insert the power cord into the power receptacle and operationally check the unit. Never operate the air conditioner with the adapter storm cover closed.

ELECTRICAL CONNECTIONS

Ordinarily, a Philco Air Conditioner that is rated for operation on 115 volts, may be connected to the power line in a home or office by inserting the power-cord plug into a nearby wall or baseboard receptacle. When this is not practicable, *do not use* ordinary appliance cord to make an extension, as the wires within this type of cord are too small. The correct power cord is a 2-wire cord, Philco Part No. 45-1500, or a 3-wire cord, Philco Part No. 45-1502-3.

FIGURE 3

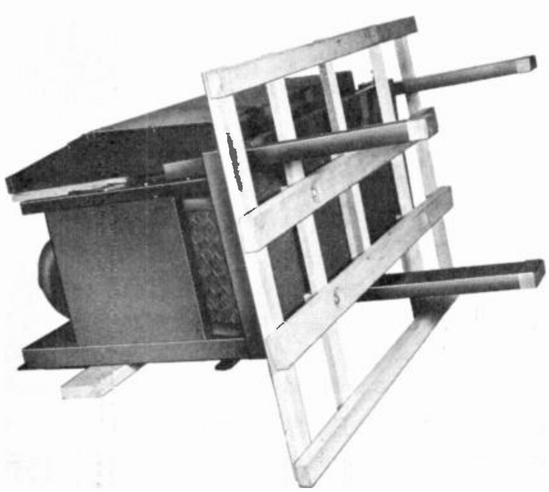


FIGURE 4

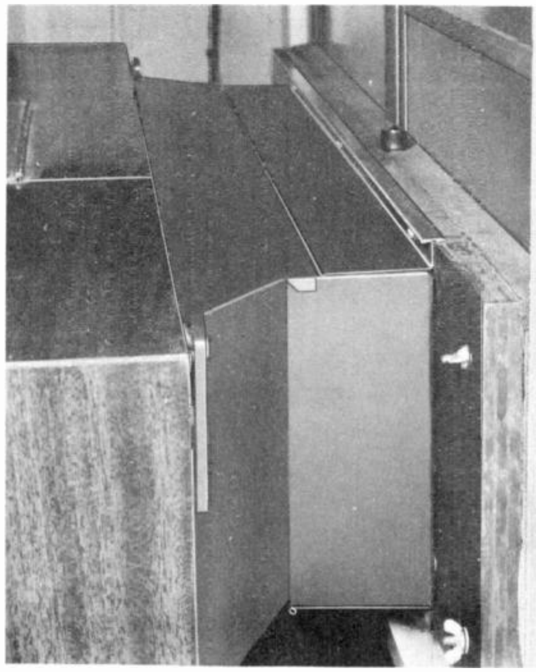


FIGURE 5

In some cases the house wiring between the entrance box and the receptacle may be inadequate; if so, the voltage at the air conditioner may be too low. This condition may cause the motor circuit-breaker to function and stop the air conditioner. In addition, overloaded electric lines constitute a fire hazard.

In cases where the installed wiring proves inadequate, or where maximum protection against overloaded lines is desired, it is advisable to follow the recommendations of an electrician familiar with the local electrical code. The size of the conductor wires should be as shown in the Electrical Specifications Table.

The installation of air conditioners rated to operate on 230 volts will usually require an electrician to install a separate 230-volt circuit and an appropriate outlet.

FUSES FOR POWER LINE

Special attention should be given to the size and type of fuse used to protect the power-line circuit to the air conditioner. Time-lag fuses, which embody the protective features of a motor-overload circuit breaker, are available under the trade names of Fusetron, Fustat, Therma-A-Trip, and Temre. When protective devices such as these are used, the air conditioner should operate satisfactorily if the fuse rating is in accordance with the Electrical Specifications Table.

After the air conditioner has been properly installed and connected to the power source, it is ready for use. Complete details for operation are given in the Operating Instructions furnished with each air conditioner.

PERIODIC INSPECTION

The importance of regular, periodic inspection should be stressed to the customer, since minor troubles may thus be detected and remedied before they necessitate major repairs. Impress upon him that your service organization is trained and equipped to render this service at a nominal charge, and that upon request, his name will be placed on your rotating service-record card system. These periodic visits to the customer's home prove profitable in another way, for quite often other appliances in his home require attention.

Phase Inversion Circuits

The purpose of this article is to present the various circuits which may be used to drive a push-pull audio output stage.

It is necessary, when operating two tubes in a push-pull audio output circuit, to provide some means of splitting the single audio signal into two inputs 180° out of phase. As provided from the voltage amplifier, the audio signal must thus pass through some circuit or device which will split the signal and present the two signals to the push-pull grids in opposite phase. This is, of course, necessary for the proper action of the push-pull output circuit.

One of the oldest, simplest and best-known systems is that shown in figure 1 in which a transformer is used. This transformer is constructed so that the primary impedance matches the required plate impedance of the driver tube and the secondary is divided or centertapped into two halves so that the signal across each half is equal in magnitude but opposite in phase to each other. When this circuit works into a push-pull circuit that operates class "A" (no grid current), the voltage gain of this stage is approximately equal to the tube's amplification, μ, times the transformer step-up ratio. In figure 1A is an example of combined resistance and transformer coupling. This circuit is called shunt-fed due to the method of supplying B+ to the driver plate through a resistor load and then coupling the signal through a condenser to the transformer primary. This method is used where the driver tube draws considerable current so that this d-c current will not flow through the transformer primary. This prevents the d-c current from magnetizing the core and causing a reduction in the value of primary inductance below its rated, no-current value. This also helps the low-frequency response. The gain of this circuit, when used with low μ triodes, is equal to the tube gain as a resistance coupled amplifier times the step-up turns ratio of the transformer.

While not used to any great extent in commercial work, the circuit shown in figure 1B can be useful as a temporary or emergency replacement for the conventional center-tapped secondary, input transformer. In this circuit, an ordinary, single secondary input

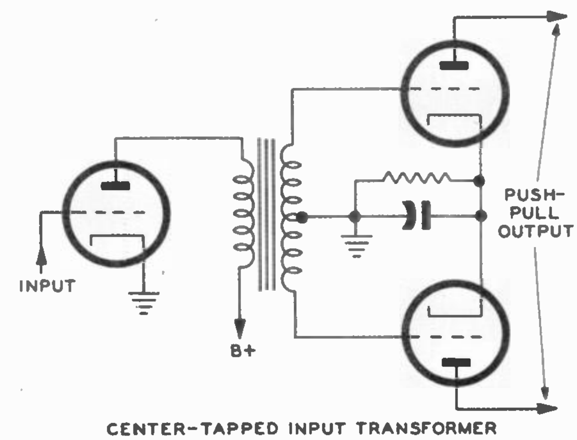


FIGURE 1

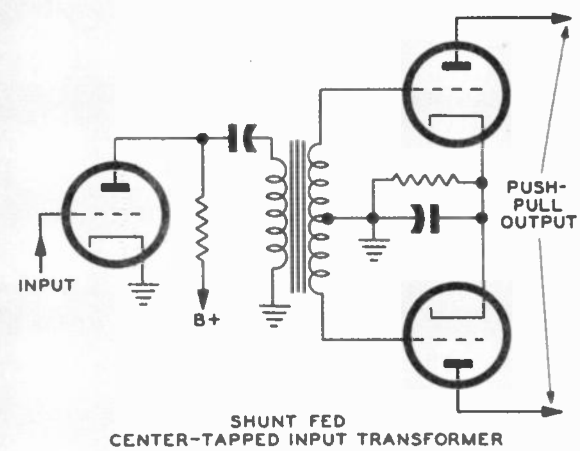


FIGURE 1A

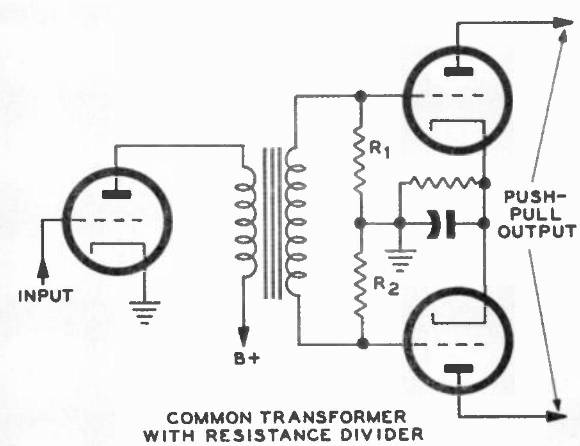
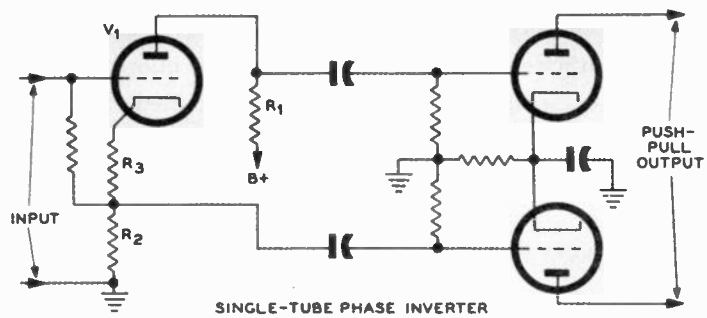
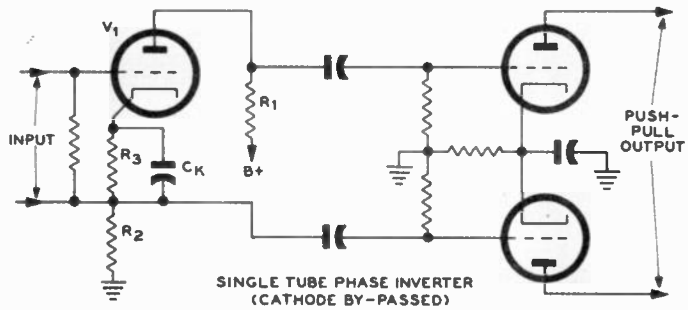


FIGURE 1B



SINGLE-TUBE PHASE INVERTER

FIGURE 2



SINGLE TUBE PHASE INVERTER (CATHODE BY-PASSED)

FIGURE 2A

transformer is used, the phase inversion is accomplished by a resistance divider connected across the secondary and center-tapped so that it may be grounded. The value of R_1 and R_2 are quite important since they reflect back into the primary to form a load on the driver tube. The value of this reflected load in the driver plate circuit is equal to $\frac{R_1+R_2}{N^2}$, where N equals the step-up turns ratio of the transformer. To illustrate this loading of the driver tube by the secondary resistors, consider R_1 and R_2, each equal to 150,000 ohms, and a step-up ratio of 4:1 for the transformer. The load reflected into the driver plate circuit is then $\frac{300{,}000}{16}$ or 18,750 ohms. This resistance is less than some tubes are able to operate with, without severe distortion, so that it may be necessary to increase R_1 and R_2 until the driver plate load is up to a satisfactory level. There is, however, a maximum limit to R_1 and R_2. This is determined by the highest amount of grid circuit resistance permitted with the output tubes. It is thus obvious that this circuit places much more resistance in the grid circuit than would a center-tapped transformer. One drawback with this system is that severe distortion may result if the tubes are driven to the point where they draw a small amount of grid current.

In the above systems using transformer coupling, the transformer must be so designed as to present audio-voltages to the push-pull grids that are equal in magnitude and 180° out of phase to each other over the complete frequency range of the system. It is rather difficult to design a transformer that will fulfill the above requirements perfectly, especially to keep the two output voltages 180° out of phase over any considerable audio frequency range. In addition to the difficulty of design, a good input transformer is quite expensive and of considerable bulk and weight which obviates their use in small sets where a saving in space and weight is of importance.

Fortunately, there are a number of phase-inverter circuits which utilize tubes and resistive capacitive coupling. In many cases, these methods are to be preferred to ones using iron core transformer because excellent frequency response may be obtained at comparatively low cost.

One of the simplest forms of vacuum tube phase inversion is illustrated in figure 2. In this circuit, V_1 is the phase inverter tube. It may be any common triode having an indirectly heated cathode. The tube is operated as an amplifier and delivers a signal from both the plate (as normal) and from the cathode (as a cathode follower). The value of R_1 and R_2 are equal and the two resistors act as though in series to form the tube's load. The action is quite simple, as follows: When the grid signal causes the current through the tube to increase, the plate voltage decreases (because the increased current caused a greater drop across R_1, the plate load) and the cathode voltage increases. Due to the equality of resistance of R_1 and R_2 and since in a triode operated as a class A voltage amplifier, the plate current and the cathode current are identical, the plate and cathode signals will be of equal magnitude and 180° out of phase. R_3 is much smaller than R_2 and acts as a bias resistor.

The gain of this stage from the inverter input to either of the push-pull grids is a bit less than unity. In a practical circuit, it is normally about .9 for each side of the output or a total gain of 1.8 times from the inverter grid to the total input (grid to grid) of the push-pull stage.

Degeneration or negative-feedback is introduced by the un-bypassed bias resistor and the fact that the input is applied between the grid and ground. This degeneration has three beneficial effects. These are: reduction of harmonic distortion, improvement in frequency response and creating a high input impedance. The input impedance is about 10 times the value of the grid resistor. It is unnecessary to bypass R_3, because it is considerably smaller than (R_1+R_2) and the loss of gain through the omission of the cathode bypass is negligible. If the value of μ of the triode is quite small, it may be advantageous to bypass the cathode because R_3 would then be comparable in value to R_1 or R_2. Thus, it is better to use a triode tube having a reasonably high μ so that the degeneration may be increased with the attendent reduction of distortion.

This circuit has excellent frequency response and quite low distortion. There is some slight im-balance between the two outputs at high audio frequencies caused by the heater to cathode capacity but this is not an appreciable disadvantage.

If it is possible to feed the input to the grid and cathode instead of from grid to ground, the degeneration will be eliminated and the full gain of the tube will be obtained. This circuit is shown in figure 2A. In this circuit, the input is floating and thus will be particularly apt to have hum as the gain of the tube would amplify the hum from its own cathode. This circuit is not used to any extent, since the increase in gain is not a sufficient advantage, considering the increase in hum and distortion and the decrease in frequency response.

Either of the above forms of phase inverters, as illustrated in figures 2 and 2A, may hum. This happens when the triode in use is of the high gain type. The hum is caused by the large difference of potential between the cathode and its heater. This trouble may be considerably reduced by operating the heater from a separate transformer filament winding which has a d-c voltage superimposed on the a-c so that the average filament voltage is approximately that of the cathode.

A third system of phase inversion is that which uses two tubes as drivers, the second driver obtaining its input from the output of the first, each driver feeding only one of the push-pull output tubes. There are different methods for obtaining the grid voltage for the second driver (or the phase inverter). The circuit illustrated in figure 3 is a good example. Here, the grid voltage for V_2 is obtained from the grid load resistor of V_3. The action is as follows: V_1 receives the audio signal from the preceding stage, amplifies it, and passes the signal on to V_3 of the push-pull stage. V_2 obtains its input from an appropriate point in the grid circuit of V_3 (the signal at this point is 180° out of phase with the original signal E_s), amplifies the signal, and presents the signal to the grid of V_4 in proper phase opposition to the signal at the grid of V_3.

The circuit components must be so balanced that the signals appearing on the grids of V_3 and V_4 are of equal magnitude. V_1 and V_2 are identical in characteristics and they have a common bias circuit (often the two tubes are enclosed in the same envelope and may have a common cathode). The plate resistors are equal in value, and the tap point on the grid resistor of V_3 must be such that the voltage obtained for the grid of V_2 will cause the output of V_2 to be equal to the output of V_1. The value of R_2 (thus establishing the proper tap) can be calculated from this formula: $R_2 = \frac{R_1+R_2}{M}$ where M is the stage gain of V_1. The final adjustment of R_2 must be done with the circuit in operation so that the proper balance between the inputs to V_3 and V_4 is obtained.

The gain of V_2 is equal to unity. In this circuit very little hum is introduced because the cathodes are nearly at ground potential. Each tube, V_1 and V_2 is required to drive only one grid of the push-pull stage.

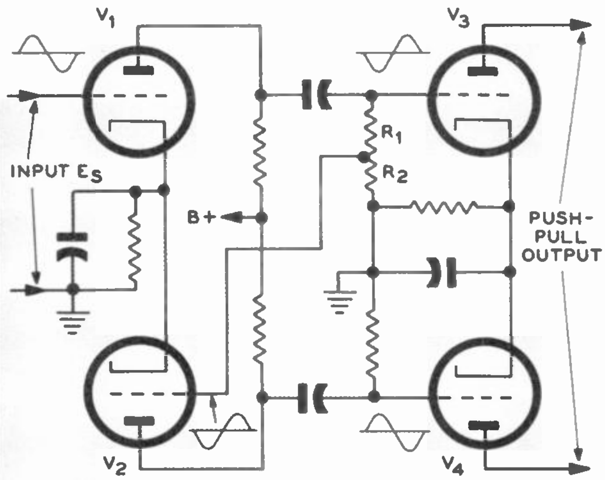
A variation of the circuit above is shown in figure 3a. Here the grid voltage for V_2 is obtained from a point on the plate resistor of V_1 instead of from the grid resistor of V_3. In this system, the magnitude and phase of the V_2 grid voltage will vary less with frequency.

The proper input voltage for V_2 is obtained by setting $R = \frac{R_p}{M_{v2}}$ where R_p is the plate resistance of V_1, M_{v2} is the amplification of V_2, and R is the portion of R_p between the tap and the B+ side. Since R depends upon the amplification factor of V_2, correct balance will be had only when R is adjusted for a given tube. Therefore, it would be advantageous to use the self-balancing phase-inverter as shown in figure 3b.

In this self-balancing circuit, the amplified voltage from V_1 appears across R_3 and R_5 in series. The voltage drop across R_5 is applied to the grid of V_2, and the amplified voltage from V_2 appears across R_4 and R_5 in series. This voltage is 180° out of phase with the signal from V_1 so that push-pull output is attained. The portion of the signal from V_2 that appears across R_5 is thus opposing the voltage from V_1 across R_5. This reduces the signal applied to the grid of V_2. The negative feed-back thus obtained acts to regulate the signal to the phase inverter tube, V_2, so that the output voltages from both tubes are effectively equal.

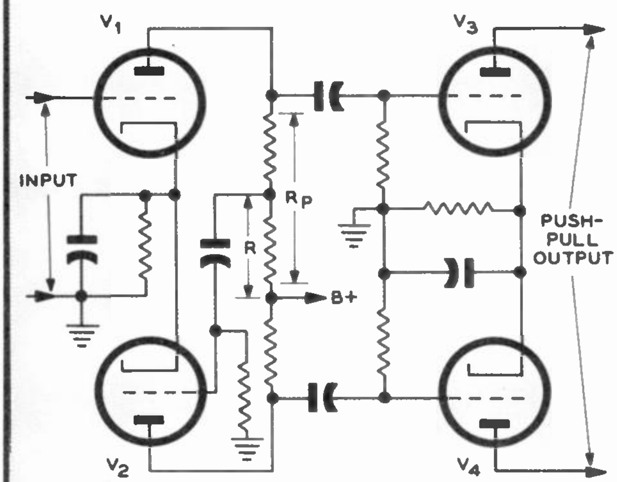
The gain is slightly less than twice that of a single tube operated under similar conditions.

The value of R_5 is not critical and in average circuits will range from 0.1 to 0.5 of the grid resistors of the output stage. Tube variations caused by replacement of V_1 or V_2 are automatically compensated for by the negative feed-back action across R_5.



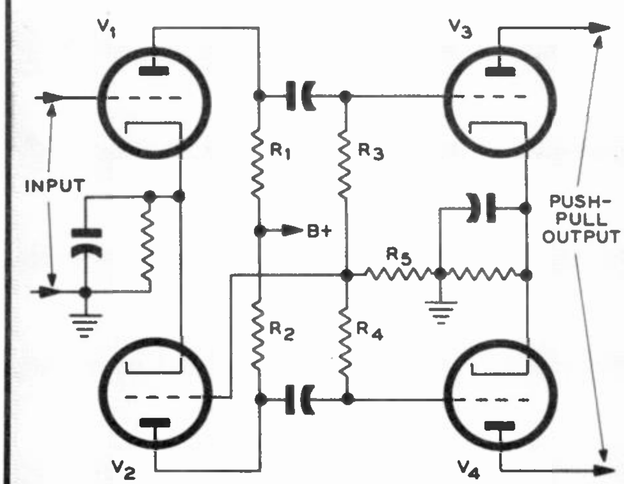
DUAL TUBE PHASE INVERTER (TAPPED GRID)

FIGURE 3



DUAL TUBE PHASE INVERTER (TAPPED PLATE)

FIGURE 3A



SELF-BALANCING PHASE INVERTER

FIGURE 3B

Cooking By Wire

Today, electricity provides one of the fastest, most modern means of cooking ever made available to the homemaker. Over the years, cooking speeds have been stepped up tremendously from wood, to coal, to kerosene, to gas, and now to electricity. But, many of us remember when electricity wasn't considered a fast means of cooking. As a matter of fact, any one of the old style flame type ranges was actually much faster than the original electric ranges. This was due to the crude heating units and particularly the inefficiency of the resistance coil or element.

A review or history of the development of modern heating elements is a rather interesting story. Oxygen which causes rust or oxidation was the great bugaboo of the early heating coils. A piece of iron wire, a nail, or the discarded tin can—all of them coated with rust are familiar things. They all become rusty for the same reason—oxidation. That is why, to preserve them, they are painted or given a galvanized metallic coating, something which cannot be done to a heating coil.

When iron is wet or hot it seems to be most susceptible to the attack of oxygen, which forms a coating we know as rust. If a piece of iron should be heated until it is red hot, the oxygen combines with it very readily and the rust is formed more rapidly. Less and less pure iron remains until finally it crumbles to pieces. This is what happens to a grate that burns out and it is also what happens to an electric iron that has burned out.

Up until the summer of 1905 electric irons burned out so frequently as did all other electrical heating devices, that they were practically of no use. But with a new discovery, this problem was solved.

The job was to find a metal that could withstand the attack of oxygen. It was a hard problem, for all metals that men knew anything about grew rusty and brittle and finally broke, when heated for more than a few hours. Along about this time a discovery was made whereby a wire made of an alloy or a combination of metals could scarcely be rusted at all. Furthermore, this wire became very hot when electricity was passed through it. So, it was the ideal material for electric heating elements.

The heating element wire now so widely used, is made of a mixture of two metals. One of them is Nickel, with which everyone is familiar and the other is a metal called Chromium. It was found the best combination of these metals for heating elements to be approximately 4 parts of Nickel to 1 part of Chromium.

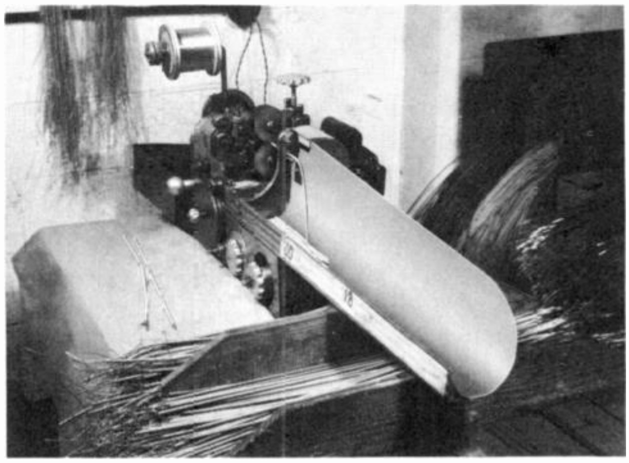


FIGURE 1. Wire Coiling Machine

It is of some interest to note that this metal is so tough and hard, in one stage of its manufacture, it is necessary to make use of diamonds. In the form of wire, the metal is reduced from a large to a smaller size, by pulling it through a hole drilled in a diamond. This new wire is not only mechanically hard, but it is also very "hard" to melt. For example, in manufacturing it, a pouring temperature of around 2800° fahrenheit is required.

Before the development of the chrome and nickel alloy wire, heating elements were made of such materials as pure nickel wire, or nickel combined with copper, or with iron—all of which burned out in a disappointingly short time.

It is interesting to know why our present-day element wire is so durable. Like all metal, it does oxidize a little bit, but the rust that forms on it, is unlike all other rust. It does not flake off, but is in the nature of a tight skin, adhering very strongly to the metal. It happens also to be of a very dense character—so dense in fact that the air cannot pass through it. Hence, it acts as a protective coating for the wire, and prevents further rusting or oxidization.

GENERATION OF HEAT BY ELECTRICITY

The resistance in an electrical circuit limits the flow of current, because of the internal "friction" occurring within the conductor as the moving electrons collide with each other, and with other electrons in the circuit. This friction causes heat to be developed and all conductors have some resistance which varies according to the type of conductor. When heat is actually desired, resistance elements are connected into the circuit. The resistance wire or element is usually wound into a coil similar to an expanded coil spring, to obtain better concentration of heat. The coil is then strung in a predetermined manner to obtain the best distribution of heat, as done in our oven units.

CONTROLLING ELECTRICAL HEATERS

The heat output from a heater element or an electric range is controlled by one of three methods, depending upon the location and purpose of the element as follows: (1) by changing the amount of voltage to the element; (2) by changing the effective length of the resistance wire in the element; (3) by intermittently connecting the entire element to the voltage supply. A combination of the first two methods is used for controlling the heat of the electric range surface units, and the third method is used for controlling the heat of the oven.

MOUNTING AND USE OF HEATER COILS

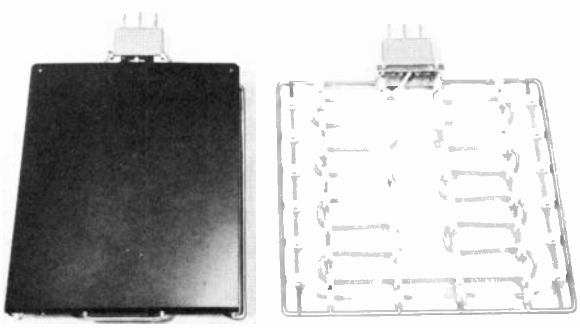


FIGURE 2

The above picture (Fig. 2) is a view of one of our oven broil-griddle units. This photo is a good example of how we make use of nickel and chrome resistance heating wire, wound into a coil to produce heat either for grilling or broiling in the oven. The unit has two separate coils, each with one separate terminal and each connected to one common terminal. On the broil-griddle unit the main coil is rated at 2200 watts and is always actuated whenever broiling or using the griddle. The other coil is a lighter one, rated at 1300 watts and has variable uses. For broiling it is always "on" in conjunction with the 2200 watt unit, and it is also "on" in the griddle "high" position, thereby giving a total of 3500 watts for either operation. When the griddle dial setting is turned to low, then the 1300 watt coil drops out of the circuit and the griddle continues to obtain its heat from the 2200 watt coil only. The 1300 watt coil also has another function, since it is used as a sort of booster coil used in conjunction with the lower or bake coil in the oven. When the thermostat is set for any bake temperature, the bottom bake coil and the upper unit smaller coil, both work with each other and cycle on and off together, as the oven requires more or less heat.

In the non-griddle models the wattages for the upper or broil unit are somewhat different than the foregoing wattages given for the broil-griddle unit. The large coil in the non-griddle broil unit is rated at 3000 watts and the small coil at 1000 watts. In these models both units come on together for broiling, making a total of 4000 watts, and the 1000 watt coil is also connected with the lower bake coil for baking operations.

The coils are carried and supported in the oven unit frame by small porcelain bushings. These bushings are held by spring clips and should one ever require replacing, it can be done by unstringing the coil back to the broken bushing, installing a new bushing and then replacing the coil again. Oven coils can also be replaced in the field by merely removing the porcelain retainer and then the unit prongs from the ends of the coil. The coil should be stretched according to the following table and restrung in its original pattern.

FIGURE 3

Before installing replacement coils they should be stretched to the lengths given in the following table:

JIFFY-GRIDDLE MODELS

2200 coil—stretch to approximately 73 inches.
1300 coil—stretch to approximately 75 inches.

NON-GRIDDLE MODELS

3000W coil—stretch to approximately 92 inches.
1000W coil—stretch to approximately 45 inches.

BAKE UNITS

3000W coil—stretch to approximately 78 inches.

DEEP WELL COOKERS

On Philco range models equipped with the standard cooker, but not the jiffy-lift type, open coil elements are also used.

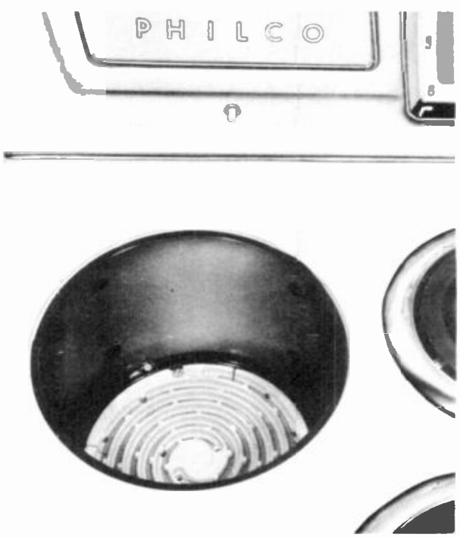


FIGURE 4

In this adaptation of open coil elements, a ceramic brick is used to mount and support the coils instead of winding them through porcelain insulators, as in the oven units. Two coils of fine heating wire rated at 600 watts each at 230 volts, are used for a total wattage of 1200 when the cooker switch is turned to the "high" position. The cooker switch has two voltages of 115 and 230 connected to it and by the utilization of the two voltages and switching the circuits through one or both coils, a choice of five different heats is obtainable from the unit.

The most likely cause of failure in the deep well cooker, is due to spillage of liquid on the coils, when they are red hot. The large rim on the deep well kettle affords protection of spillovers, but sometimes due to carelessness or other reasons, water or other liquid will be spilled on the coils, and one or both may have to be replaced.

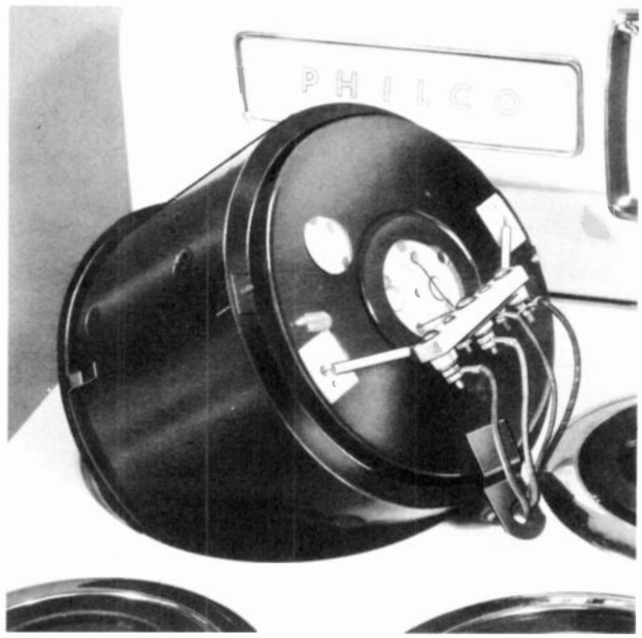


FIGURE 5

To replace a coil, the complete deep well assembly has to be lifted out of the opening in the table top and inverted to get at the coil terminals, which are open and accessible on the bottom of the cooker. The replacement coils are shipped just as they come off the factory coiling machine and have to be stretched to approximately 24" before placing them, under tension of course, around the grooves in the refractory brick, where they are mounted.

The open element coils used in Philco ovens and deep well cookers vary in size from 18 gauge to 26 gauge. It is interesting to note that the higher wattage coils use heavy gauge wire, and the lower wattage coils use a lighter wire. The 3000W oven unit coil is made from 18 gauge wire, while the 600W cooker coils are made from 26 gauge wire. Heater element coils are, of course, also used in the range surface units, but here they are imbedded in an insulation compound and encased inside a metal sheath, which is a different story and will be reviewed in a future article.

This month . . .

NELSON REED, Philco Service District Representative for the Eastern Division, gives us his ideas on the importance of membership in Philco Factory-Supervised Service as it applies to the ever growing television market. Nelson joined the Philco family in 1947, served as Television Service Representative for Philco Distributors, Buffalo, Television Service Manager for Philco Distributors, Erie, and in 1952 assumed his present duties.

In my opinion . . .

. . . UHF might well be the pot of gold at the end of your service rainbow. Look at it this way: suppose you're either in a VHF market now, or way out in the fringe area, or just plain out! You're going to get a UHF station in your locale pretty soon, maybe next week, next month, who knows? The way that construction permits have been going out, you may be next. To the consumer it's "Hurrah, we're getting a television station." To you, the service technician, well, you know what it means! It means that there is going to be a heavy demand for intelligent and efficient service. It means that there will be many dollars spent for that kind of service. The pot of gold!

Will you be prepared to provide that kind of service so that you can get your share of those dollars? You just can't drop everything and rush to Portland, to Youngstown, to any of the other UHF markets already in action! So where's the rainbow? Mister, your Philco Factory-Supervised Service membership is all the rainbow you need! Let's call it "packaged experience"!

Already your Distributor has started PFSS clinics to bring you stories from these active UHF markets. No trial or error, but actual experience. Philco's "know-how" passed along to you by means of your PFSS mailings. Like battlefield communiques your PFSS membership keeps you in touch at all times.

And don't forget—Philco Factory-Supervised Service has kept you well supplied with "basic info" such as home study lessons, schematics, and other technical literature. PFSS has made available to your Distributor an 8-hour course so that you may add to your skills and understanding.

Remember that the diamond in the Sales Department's advertising tells the consumer about Philco Factory-Supervised Service. And your Distributor has advertising mats, uniforms, and other service aids that will help you to make your PFSS membership known to the consumer.

And taking all this into consideration, it's my opinion that when UHF comes to your area your PFSS membership will be the rainbow to that pot of gold!

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