

PHILCO SERVICE SUPERVISOR



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PHILCO UHF DEBUT A SUCCESS IN PORTLAND



120 Television Associate Members of Philco Factory-Supervised Service received up-to-the-minute Shop Practice Instruction in the Television Service School . . . Advanced Training for Professional Servicemen . . . at Appliance Wholesalers, Philco Distributor, Portland, Oregon.

AT 12:01 A.M. Thursday, September 18, the first commercial UHF Television Station KPTV, Channel No. 27, Portland, Oregon threw the switch that began a new era in the field of television broadcasting. With the lifting of the long FCC freeze almost every community in America will soon be experiencing the same pre-program anxiety and excitement that thrilled the citizens in and around the Portland area.

But much more important, to us in the service field, than the Historic 12:01 A.M. September 18, was the lack of confusion on the part of Dealer and Independent Servicemen in Portland. There is a very definite reason for this territory being well organized for service.

In 1948 Portland was scheduled for a VHF television station. At that time the Portland Philco Distributor (Appliance Wholesalers of Oregon) invited all qualified Radio Dealer and Independent Servicemen to attend an 80-hour training school in order that they may prepare themselves for the coming of television. Due to the FCC freeze that VHF station did not have time to get on the air.

(Continued on Page Two)

PHILCO UHF DEBUT A SUCCESS IN PORTLAND

(Continued from Front Cover)

Shortly after that time the Associate Television membership for Philco Factory-Supervised Service was conceived, and 120 servicemen in the Portland area became members of that organization. They received home study courses directly from Philco on subjects that would better prepare them when television became a reality in their area. They received monthly mailings of New Product News, Shop Practices, service manuals and in 1952 began receiving the 24 page Philco Service Supervisor.

Each month the local Distributor received one Television Visual Training Forum on vital subjects from the Service Manager at Philco Headquarters. Those 120 servicemen from Portland were periodically invited into the Distributor's Service Clinic to study the contents of those forums. So through Philco Headquarters and the local Philco Distributor the servicemen were kept close to the television servicing picture.

Then when the FCC released a construction permit to station KPTV the Distributor immediately started the 80-hour television training school — advanced training for professional servicemen — which is a part of every associate member's training. Each of the 120 associate members of the Portland territory were scheduled to attend, and even though the station was on the air within a few weeks from the date their construction permit was granted, almost 100% of the key servicemen in the Portland area had received the latest up-to-the-minute television service procedures and techniques.

The 80-hour service school is now being made available in many future and already existing Television markets. It consists of 40 hours of lecture prepared on microgroove records with illustrations on strip film, which are supplied to the Philco Distributor from Philco Service Headquarters. The 40 hours of lectures are supplemented by 40 hours of Shop Practice which consists

of actually doing on a bench in the school, using television receivers and test equipment, the things they have been told in the lectures.

On Wednesday, September 17, a large service meeting was conducted by the Portland Philco Distributor to discuss the latest information available on UHF, with Factory Headquarter personnel delivering the lectures. Also in that meeting the Philco Service Plan was discussed.

Philco has long put its faith in the local servicemen of an area who have made themselves qualified and have earned a respectful position in their community. For that reason Philco and Philco Distributors feel an obligation to train these servicemen well. Part of that training is accomplished through monthly mailings direct from Headquarters. Part of it is done through 80-hour service schools and Service Clinics at the Philco Distributor Service Headquarters. But all are available through an Associate Membership in Philco Factory-Supervised Service.

If you begin now preparing yourself, you need have no fear of outsiders moving into your market when television comes to your home town. The service business in your community belongs to you. Prepare yourself so the profits from television service in your territory come to your shop.

Our hats are off to Harold Chamberlain (Service Manager of Appliance Wholesalers of Portland, Oregon) and the servicemen of that area for preparing themselves well.

It will be interesting for you to know that Philco UHF equipment is performing better than any competition in the Portland area. The technical and service story on that equipment will be made available to you well before UHF breaks in your market. The first of a series of articles on UHF will appear in the December issue of the Philco Service Supervisor.



The UHF tuning knob and bezel, which replaces Philco medallion when UHF tuner or converter are installed. Since the conception of UHF, all Philco cabinets have had a hole in the center of the control panel, covered with the Philco medallion, for the mounting of a built-in UHF tuner or converter . . . more advanced thinking on the part of Philco Engineers.

SHOP PRACTICES & SERVICE TECHNIQUES—AIR CONDITIONING

AIR CONDITIONING ELECTRICAL
SYSTEM ANALYSIS

To service the Electrical System of a window model air conditioner, such as is shown in figure 1, it is not necessary to have an extensive knowledge of electrical theory. Since the one-half and three-quarter ton air conditioners are basically the same operationally and electrically, the information that deals with the Model 76-H also applies to the one-half ton models.

In diagnosing electrical troubles of an air conditioner, very often there is nothing wrong with the unit or any of the electrical components. The fault lies in the power being supplied to the unit assembly. An air conditioner, to operate properly and give efficient service, must be supplied with a voltage that is within certain limits.

VOLTAGE RATING OF AIR CONDITIONERS	VOLTAGE SUPPLIED TO AIR CONDITIONERS	
	LOW	HIGH
115	106	125
208	193	228
230	208	250

The chart shown above gives the allowable voltage deviations that are permissible to operate the motor compressor without causing damage to it through excessive high voltage or become inoperative through insufficient power.

To properly check the power supply, a volt watt-meter should be used, preferably of the type shown in figure 2. A no-load reading of the line should be taken at the appliance outlet. Then a full-load reading should be made. With the full-load reading, all appliances that may draw current off the line should be operated.

That new television set that was plugged into the outlet across the room last week can very easily be the cause of the low line voltage. The air conditioner should then be operated for ten minutes before a full-load reading is taken. If the line voltage deviation is more than 10%, all other appliances should be shifted to another circuit, or recommendations for an independent circuit to operate the air conditioner should

be made. The wire size for this circuit should be No. 12 American wire gauge, as specified by the National Electrical Code.

Having first determined that the power source is adequate, a quick operational check should be made before removing the decorative cabinet. With the watt-meter in the power line, check first the fan operation and observe the wattage. Then switch to the COOL position and observe the power consumption. A low wattage reading would indicate that the unit was not operating at its maximum capacity. This might be due to a loss of refrigerant from the sealed unit assembly or an inoperative fan motor.

A high wattage reading on the meter might indicate a dirty condenser or filter, a restricted condenser, an inoperative condenser fan or an overcharged unit.

The decorative cabinet and top panel of the air conditioner should be removed to gain access to all of the electrical connections. In the majority of cases, it isn't necessary to remove the air conditioner from its window mounting to do this.

By referring to figure 3 you can see the various components that it will be necessary to check to make a thorough inspection of the air conditioner.

No. 1 is the A.C. service cord and plug.

No. 2 — The power switch.

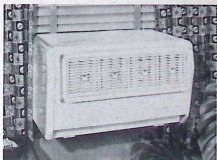


FIGURE ONE—Philco Model 76-H Air Conditioner

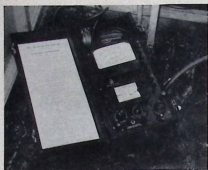


FIGURE TWO

- No. 3 — The starting relay.
- No. 4 — The motor compressor starting capacitor.
- No. 5 — The motor compressor.
- No. 6 — The motor compressor and automatic temperature control terminal box.
- No. 7 — The automatic temperature heater thermostat.
- No. 8 — The automatic temperature control heater and overload protector.

And, of course, the component that doesn't show in this picture, the fan motor.

In checking the Electrical System, there are two convenient wiring centers to work from. The motor compressor terminal box and the power switch. By referring to figure 4, it is apparent that the logical place to start checking is at the power switch. Using a volt-ohm

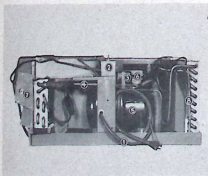


FIGURE THREE

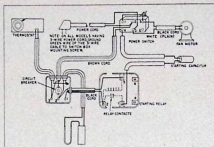


FIGURE FOUR

milliammeter, continuity or voltage checks of the service cord and plug, the power switch and the fan motor may be made. (Figure 5). A test lamp is also useful to check these components. A continuity check of the power cord may be made from the male plug to terminals 2 and 5 of the switch. With the switch in the OFF position, a good switch will show open between terminals 1-2, 2-3, 4-5 and 5-6. From binding post 1 and 5 or 3 and 5, the resistance of the field winding of the fan motor will be indicated by the meter. The field winding of a good motor will be between 3 and 5 ohms. Zero resistance would indicate a shorted motor field.

When checking the fan motor circuit, if the circuit checks good, but the fan doesn't operate when power is applied to it, it is possible, if the air conditioner has been idle for a long period of time, that the motor bearings and shaft have seized due to coagulated oil. All that is necessary to return the motor to service is to disturb the motor armature setting and lubricate the bearings.

The fan motor in the half and three-quarter ton air conditioner serves a double purpose. It drives the evaporator scroll type fan to circulate the room air across and through the evaporator. It also drives the blade type fan and the slinger wheel to cool the condenser and dissipate condensate.

STARTING CAPACITOR

If the starting capacitor for the motor compressor is suspected of being faulty, an accurate procedure would be to substitute it with one of the same rating and type, known to be good. An additional check may be made with an ohmmeter. The starting capacitor is of the A.C. type with a capacity of 300 micro-farads. A good capacitor would have an internal resistance of approximately two to three hundred thousand ohms. A leaky capacitor would read ten to twenty thousand

ohms. A shorted capacitor would show a zero reading and an open capacitor would be indicated by a reading of infinity on a good ohmmeter (20,000 ohms per volt-meter).

COMPRESSOR TERMINAL BOX

From the motor compressor terminal box, a check of the compressor motor, the starting relay, overload protector and the automatic temperature control, if it is incorporated into the unit, may be made.

STARTING RELAY

The function of the starting relay, as the name implies, has the sole function of energizing the motor compressor start winding for a period of one or two seconds when power is applied to the motor compressor. After the compressor motor comes up to 85 percent of its normal operating speed, the relay contacts are opened up permitting the motor compressor to operate normally.

The starting relay, as used in the one-half and three-quarter ton air conditioner, is a voltage type relay that is actuated by a magnetic coil in parallel with the start winding. With the initial current flow in run winding a magnetic field is set up which induces a voltage into the start winding, since the relay field coil is in parallel with it. This same voltage is induced into it causing the relay to be actuated; therefore, closing the switch contacts. As the motor picks up speed it draws less current and the voltage is slowly decreased causing the relay contacts to open.

An ohmmeter check of the starting relay may be made. A check from terminals 2 to 5 (figure 4) will show a very low resistance reading of between .5 ($\frac{1}{2}$) to 3 ohms. A reading taken between terminals 1 and 2 would show infinity on a good switch and zero resistance on a switch that has its contacts stuck closed. For resistance checks the relay should be isolated for there will be inter-action with other components.

MOTOR COMPRESSOR

To quickly and efficiently check the motor compressor, a motor compressor test cord should be used. (Figure 6). With the motor compressor terminal box exposed, remove the wiring harness leads from the motor compressor terminals.

The fused or common lead of the test cord should be clipped to the common motor terminal, the through or run lead to the run winding, and the capacitor lead to the start winding. Connect a starting capacitor that is known to be good to the test cord external capacitor clips. Plug the test cord into the A.C. supply and depress the flyback switch momentarily to start the motor

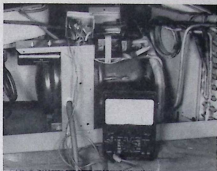


FIGURE FIVE

compressor. Do not depress the start switch for more than three seconds, to apply current to the start winding for a longer period might damage the motor compressor start windings. If the sealed unit motor compressor operates satisfactorily, a leakage test should be made between the sealed unit motor windings and the air conditioner chassis. The electrical ground and the mechanical or physical ground are not common; therefore, a short circuit from the motor windings to the shell assembly might cause a condition of shock, if a short were to exist.

OVERLOAD PROTECTOR

The overload protector is an electro thermal switch which protects the motor windings from excessive heat or current flow. A test lamp may be used to check the overload. With the air conditioner connected for normal operation and the power switch in the COOL position, check across the circuit breaker terminals. When checking a good protector, the test lamp will not light. Lighting of the test lamp would indicate an open overload protector.

AUTOMATIC TEMPERATURE CONTROL

The Model 76-H is equipped with an automatic temperature control to prevent overcooling. Since power companies in certain areas will not allow the use of a thermostatic control for single-room air conditioners, the general practice is to turn off the unit manually when overcooling takes place.

Simply stopping the unit, either by thermostat or by hand, has the disadvantage that, although it prevents overcooling, it does nothing toward preventing humidity build-up. Units equipped with the automatic temperature control are not turned off, but automatically re-

duce the cooling capacity. Therefore, they tend to keep the humidity down, and supply cooled, fresh air at all times without the disadvantage of overcooling.

The operation of the new temperature control is entirely automatic; however, the temperature of the room air at which it starts to function is determined by the setting of the A.T.C. knob on the thermostat. The thermostat is located in the duct that returns the room air to the air conditioner. When the air in the room reaches a definite temperature, depending upon the control setting, the thermostat contacts close. The closing of the contacts energizes a heater that is soldered to the strainer on the liquid line. The added heat causes bubbles to form in the liquid refrigerant, thus permitting less liquid to enter the evaporator. A protector is placed in series with the heater to open the circuit in case of excessive heater temperatures.

The wiring diagram in figure 4 shows an A.T.C. circuit, and how it is connected to the motor-compressor terminals.

A. T. C. HEATER

A check of the A.T.C. heater and overload protector can be made by utilizing a wattmeter and unit test cord. Disconnect the two heater leads (figure 4) from the common terminal and the wire nut in the motor compressor terminal box. Affix the clips of the test cord common and start leads to the heater leads. Connect the external capacitor clips together, plug the test cord into the wattmeter and the meter into the A.C. supply. Depress the momentary contact switch on the test cord and observe the wattage being consumed by the heater element (140 to 250 watts). If no reading

is observed, change the test clips from the heater leads to the spade connector on the overload and heater element. Repeat the test, if the wattmeter indicates that the circuit has opened up before the solder connecting the heater and protector to the strainer begins to melt, the protector is good. If it does not, the protector should be replaced.

A. T. C. THERMOSTAT

To check the automatic temperature control thermostat, remove the power connections from terminal No. 3 and the wire nut (figure 4), in the motor compressor terminal box. Connect an ohmmeter to the thermostat leads.

If the room temperature is not over 75°F., check the thermostat for continuity as follows:

Turn the A.T.C. knob all the way clockwise. The thermostat contacts should be closed under this condition. Next turn the knob all the way counterclockwise. The contacts should now be open; if the thermostat does not function as described above, replace it.

If the room temperature is above 75°F., check the thermostat for continuity as follows:

Run the air conditioner with the power switch set to COOL; then remove the thermostat from its mounted position and place it in the conditioner-air outlet stream. Turn the A. T. C. knob all the way clockwise and leave it in this position. At the end of a two-minute period the contacts should be closed. Then turn the knob all the way counterclockwise. The contacts should open; if the thermostat does not react as described above, it should be replaced.

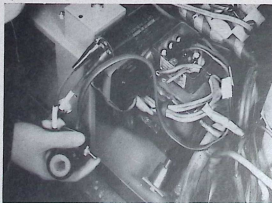


FIGURE SIX

SHOP PRACTICES & SERVICE TECHNIQUES—HOME RADIO

"THE MILLER EFFECT"

The Miller Effect has been known for some time, since 1919, but is generally overlooked and usually misunderstood. An appreciation of the actions of the Miller Effect is a basic necessity for the complete understanding of some of the simplest radio functions.

This effect is the reason for the practice of starting receiver alignment at the output and working back toward the front end. It is the cause of A-V-C detuning on weak stations. Some oscillator circuits depend upon the "Miller Effect" action to sustain oscillations.

The Miller Effect is caused by a combination of the effects of tube interelectrode capacitances. Figure 1 illustrates a triode tube with the two interelectrode capacities involved. Investigating the input circuit as shown, it is at once obvious that the grid-to-cathode capacitance (C_{gk}) will have an effect upon the input circuit. This capacity would, of course, act as a shunt across the circuit, attenuating the input signal.

It is common knowledge that the signal appearing across the plate load is an amplified version of the input signal. This wave form, appearing on the plate, will be 180° out of phase with the input signal. Therefore, the portion of this signal that is fed back to the grid by the grid-to-plate capacity (C_{gp}) will tend to cancel the input signal. This effect is identical to increasing the input capacity of the tube by a value equal to that of the effective grid-to-plate capacity. However, this effective grid-to-plate capacity is not equal to the measured C_{gp} between the tube elements. Since the magnitude of the cancelling signal appearing at the grid is dependent upon the amplification through the tube as well as the absolute value of C_{gp} , it would follow that the input capacity (C_{in}) is a function of the tubes amplification factor.

Let us derive the formula for input capacity. This will explain matters to this point and provide a basis to work from. First, observe the circuit shown in figure 2. The total input capacity will be considered as being the sum of the two above mentioned values; the equivalent input capacity caused by feedback through C_{gp} and C_{gk} . In any condenser:

$$Q = CE \quad (1)$$

where Q is the charge, C the capacity, and E is the impressed voltage. Therefore, the charge on the grid due to the grid-to-cathode capacitance, C_{gk} , is:

$$q_1 = C_{gk}e_s \quad (2)$$

In this equation e_s represents the signal voltage on the grid. From this, the voltage on the plate is equal to $-Me_s$, where M is the voltage gain of the tube from grid to plate. Thus, the difference in voltage between grid and plate is equal to $e_s - (-Me_s)$. This simplifies to the form $e_s(M + 1)$.

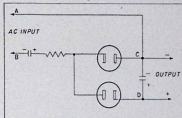
Applying the above to the calculation of the charge on the grid due to the grid-to-plate capacitance, C_{gp} :

$$q_2 = C_{gp}(M + 1)e_s \quad (3)$$

Since both capacitances, C_{gk} and C_{gp} , are effectively in parallel, they may be considered together as a single

CORRECTIONS TO PAST ISSUES:

MAY, 1952. The illustration of the voltage doubler circuit, figure 9, on page 17, should be corrected as shown below:



AUGUST, 1952. The word "parts" occurring twice in the second paragraph of the right hand column on page 16, should be corrected to read "p-o-r-t-s".

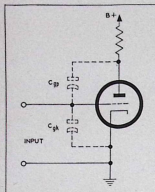


FIGURE ONE—Interelectrode Capacitances Involved in "Miller Effect"

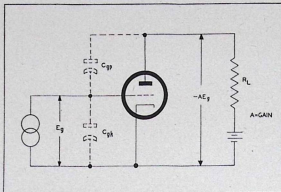


FIGURE TWO—Equivalent Circuit of Triode Amplifier

unit, the input capacitance $-C_{in}$. Therefore, the charge on C_{in} may be expressed as:

$$Q_{in} = q_1 + q_2 = C_{gk} e_s + C_{gp} (M + 1) e_s \quad (4)$$

As Q_{in} is the total charge of the combined input capacitance (C_{in}), the capacitance and its charge will be related by:

$$Q_{in} = C_{in} e_s \quad (5)$$

By combining (adding) equations (4) and (5) we obtain as the equation for input capacitance:

$$C_{in} e_s + Q_{in} = Q_{in} + C_{gk} e_s + C_{gp} e_s (M + 1)$$

which simplifies to:

$$C_{in} = C_{gk} + C_{gp} (M + 1) \quad (6)$$

Equation (6) shows that the input capacitance is determined by not only the distributed capacitances but to a considerable degree by the voltage gain of the stage.

The above discussion applies to tubes and their respective circuits which have a purely resistive plate load. Stages which have a reactive load will be considered later.

The Miller effect can be most satisfactorily illustrated by using equation (6) to calculate the input capacitance of a typical circuit. Taking the circuit values as given in figure 3, and using the published tube characteristics of the 6SQ7, the stage gain, M , will be:

$$M = \frac{\mu R_L}{R_p + R_L}$$

$$M = \frac{100 \times 220,000}{110,000 + 220,000} = 67$$

Substituting the circuit values into equation (6) we obtain:

$$C_{in} = 3.2 + 1.6 (67 + 1) = 112 \mu\text{f.}$$

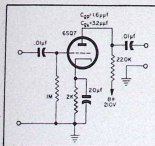


FIGURE THREE—Schematic Diagram of Typical Triode Amplifier

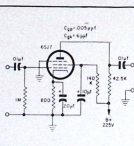


FIGURE FOUR—Schematic Diagram of Typical Pentode Amplifier

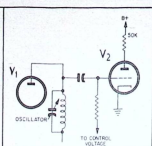


FIGURE FIVE—Schematic Diagram of Circuit Which Produces a Variable Reactance Effect, Using a Triode Tube

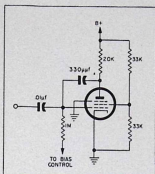


FIGURE SIX—Miller Effect Tone-Control Circuit

The tube, itself, has an input capacitance of only 3.2 μpf , but, when used in the circuit shown, the overall effective input capacitance is 112 μpf . Miller effect accounts for 108.8 μpf of the total, or slightly over 97% of C_{in} . The C_{pk} is almost completely overshadowed by the action of the Miller effect. This explains the shortcomings of high gain triode amplifiers at high frequencies.

Having just demonstrated the failings of triodes due to this phenomenon let us examine the results of the Miller effect on pentodes. The superiority of the pentode tubes, such as the 6SJ7, 6AU6, or 6BA6, can be determined by examining the circuit shown in figure 4. The circuit constants have been chosen to provide a gain equal to that of the circuit shown in figure 3. Substituting these circuit values into equation (6):

$$C_{in} = 6 + .005 (67 + 1) = 6.34 \mu\text{pf}.$$

Thus it can be seen that the increase in capacitance caused by the Miller effect is very small, only slightly over 5.3%, in circuits utilizing these pentodes because of their very low C_{gp} .

Now that we have discussed circuits having resistive plate loads and its effective increase in input capacitance, let us consider what happens if the plate load is reactive. In cases where the plate load is reactive, the phase of the feedback through the grid-to-plate capacitance, C_{gp} , will change, and the effect upon the input will no longer be purely capacitive. With a plate load which contains both reactance and resistance, the Miller effect will be equivalent to a resistance as well as a capacitance reflected back into the grid circuit. The resistance is due to the reactive component of the plate load. The apparent or effective resistance caused

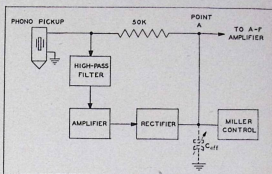


FIGURE SEVEN—Block Diagram of Automatic "Noise-Gate" Circuit

in the grid circuit by the Miller effect can be expressed as:

$$R_{in} = -\frac{1}{C_{gp} M \sin \theta} \quad (7)$$

where:

θ = the phase angle of the load voltage. (θ is considered positive for an inductive load.)

When the reactive plate load is considered, equation (6) must be modified as follows:

$$C_{in} = C_{pk} + C_{gp} (M \cos \theta + 1) \quad (8)$$

Examination of equation (8) will disclose that with a purely inductive load ($\theta = 90^\circ$, $\cos \theta = 0$) the resultant input capacitance will merely be the sum of the two interelectrode capacitances, C_{pk} and C_{gp} . Investigation of equation (7) shows that for the same condition, the effect of the resistive component will be most pronounced (minimum R_{in} , since the denominator will be at its largest value due to $\sin 90^\circ = 1$).

A very interesting characteristic of equation (7) will be noticed. Since θ is positive for an inductive load, R_{in} will be negative. If θ is negative (as it would be for a capacitive load), R_{in} will be positive. This is caused by the power requirements in the plate circuit. With a plate load that is capacitive more power is required from the grid circuit — similar to adding a resistive load in the grid circuit. With a plate load that is inductive, the phasing is such that the plate power requirements from the grid are reduced, even to the extreme of the plate feeding power back into the grid circuit — similar to something for nothing, a negative resistance.

Consider a tuned circuit in the plate circuit of an amplifier stage. At resonance, the plate circuit will cause a pure capacitance to be reflected into the grid

circuit, when the plate circuit is tuned to a frequency below the signal frequency, the reflected grid component is resistive, and, if the plate circuit is tuned to a frequency above resonance, the reflected grid component is a negative resistance. If the negative-resistance component is larger than the positive grid circuit resistance, the circuit can oscillate.

This tendency toward self-oscillation caused by the reflected negative-resistance explains several actions which are common in radio practice. The tendency toward instability in high-gain amplifiers and the reason why it is easy to cause a high-gain i-f stage to oscillate by detuning the plate circuit are explained by the Miller effect.

APPLICATION

Some of the results of Miller effect will be considered below. It will be noticed that some are very useful while others are detrimental and must be compensated for.

If the action of the tuned-plate-tuned-grid oscillator is examined, it will be found that both of these circuits require that the plate tank be tuned to a higher frequency than the grid circuit. The effect of reflected negative resistance is essential to the function of such circuits. In fact, if the plate tank of either circuit is tuned slightly below resonance, oscillation will cease.

Miller effect is one of the reasons for the practice of aligning a receiver by starting at the output and working back toward the input. If the grid circuit were to be aligned first, adjusting the plate circuit could detune the grid circuit. However, the tuning of the grid circuit will have very little effect upon the plate circuit tuning.

Another factor to keep in mind during alignment is the action of an a-v-c circuit. If a receiver is aligned with a strong signal, a-v-c voltage is large, and Miller effect is minimum (reduced value of M). Then, when weak-signal reception is attempted, the lower a-v-c voltage allows greater gain, which increases Miller-effect capacitance and causes detuning of the grid tank circuits of each a-v-c controlled stage. For this reason, it is standard practice to perform alignment with the weakest possible signal — thus insuring satisfactory weak-signal operation. (Detuning on strong signals would have virtually no detrimental effect, because a large signal loss could be tolerated.)

The Miller effect can be put to good use as a source of variable reactance in a-f-c applications. Figure 5 shows a typical circuit. The plate circuit of V_2 is made resistive, which causes a capacitive grid circuit to be presented to the oscillator (V_1). Thus, the capacitance shunted across the oscillator tank can be varied by

any means that would change V_2 's gain (term M in equation 6). In the circuit of figure 5, the gain is varied by changing the bias. This same circuit could be used as a frequency modulator by driving the control grid with an audio voltage.

A relatively recent application of the Miller effect is found in its use as a tone-control element. Figure 6 shows a pentode circuit with a resistive plate load. The grid-to-plate capacitance is made very large by the use of an actual capacitor. The capacitance appearing between grid and ground will be very largely a function of the stage gain, which is varied by means of a bias control. This bias control could be a remotely-located potentiometer, or it might be the circuit shown in block form in figure 7.

The circuit shown in figure 7 is called a "noise gate" because it has the unique property of filtering out record scratch from an audio amplifier. The phonograph pickup feeds a high-pass filter that allows only signals in the scratch-frequency range and higher to pass (above about 3 kc.). The filter output is amplified, rectified, and used to control the gain of a Miller-type tone-control circuit similar to the one shown in figure 6.

If the recorded music or other intelligence contains no signals in the scratch-frequency range or higher, the output of the rectifier remains at zero. (The rectifier is negatively biased by a small amount so that the record noise itself does not affect the Miller control tube.) Under these conditions, the gain of the control tube is high, and a large effective capacitance appears between point A and ground. This capacitance, in conjunction with the series 50K resistor, limits the frequency response of the system to the point where record scratch is bypassed.

However, when the recorded intelligence does contain components in the frequency band above 3 kc., the high-pass filter passes these components which are amplified, rectified, and applied as bias to the Miller control tube. Under this condition, the capacitance appearing between point A and ground becomes very small, removing the bypassing action and allowing the high-frequency signals to reach the a-f amplifier.

Thus, the only time the "noise gate" circuit allows wide-range response is when the high-frequency signals are sufficiently pronounced to mask the noise.

COMPENSATION

In many cases, the presence of the Miller effect is very undesirable. For example, the variations in a-v-c voltage in a high-gain, i-f section could cause serious detuning. Another example is found in TV i-f sections where the stray capacitance provides the only circuit tuning.

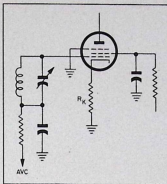


FIGURE EIGHT—Schematic Diagram Showing Method For Neutralizing Miller Effect

Several methods have been devised to overcome the effect. One well-known method is to use neutralization in any conventional form. However, most forms of neutralization are resonant. Another method consists of using a large tuning capacitor to "swamp" out the Miller-effect variations — this method is useless at the higher frequencies. Figure 8 shows the most widely used method of eliminating Miller effect. Here, the action of a degenerative cathode resistor is used to cancel the plate-to-grid feedback. Equation (9) gives the optimum value of cathode resistor.

$$R_k = \frac{\Delta C_a + \Delta C_m}{C_{gk} G_m} \quad (9)$$

where:

ΔC_a = change in input capacitance due to changes in the space charge with bias

ΔC_m = change in input capacitance due to changes in Miller-effect capacitance with bias

G_m = transconductance of tube at maximum gain (minimum a-v-c voltage)

Fortunately, it will be found that the optimum value of R_k is often about 150 to 200 ohms — a value suitable for ordinary cathode bias. Of course, the unby-passed cathode resistor will result in a reduction of gain as expressed in the following equation:

$$M' = M \left[\frac{1}{(1 + G_m R_k)} \right] \quad (10)$$

where:

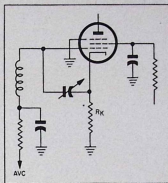


FIGURE NINE—Schematic Diagram Showing Second Method For Neutralizing Miller Effect

M' = gain with unby-passed cathode resistor

M = gain with by-passed cathode resistor

For a typical pentode circuit, the loss in gain caused by the unby-passed resistor will be around 30%, but this can usually be made up by using a smaller value of tuning capacitance to obtain a higher tuned-circuit Q (the smaller capacitor can be used because Miller-effect capacitance changes do not have to be swamped out).

An alternate method of neutralizing the Miller effect is shown in figure 9. The unby-passed cathode resistor is used, but the tuning capacitor is returned to the cathode instead of to the ground end of the inductor. This method of connection enables the use of a cathode resistor of only about 20 ohms. This is because the degenerative signal produced by the cathode resistor is amplified by the series-resonant action of the tuned-input circuit before it is applied to the grid of the tube.

CONCLUSION

The Miller effect should be understood by the service technician since many circuits depend upon its action or are modified so as to minimize its effect. When designing equipment or performing alignment the above actions should be considered. When choosing tubes for a particular operation due thought should be given to the interelectrode capacitances and the "snowballing" action of the Miller effect, especially in the case of triodes. The effect can be compensated for, or neutralized, (and in some circuits it must be) but a great many circuits use it to advantage.

NEW PRODUCT NEWS—AUTO RADIO

CUSTOM BUILT AUTO RADIO

In the design of a radio we always consider the continued use of satisfactory existing parts. In most cases it is possible to standardize on the service parts used on custom built auto radios from one season to the other more than on most products. This is a big help in the stocking of service parts

as a more flexible inventory may be used on a number of models, thus you greater number of models with a minimum the most commonly used parts and

MODEL ↓	Power Transformer	Output Transformer	Speaker	1st I.F.	2nd I.F.	Oscillator Shunt Coil	
	32-8313-1 32-8314-5 65-0347	32-8316-7 32-8559 32-8315	36-1631-2 45-9739 36-1609-2 36-1613-8	32-4160A 32-4290-1A	32-4240A 32-4161A 32-4293-1A	32-4110-5 32-4110-2 65-0440 32-4110-4 32-4395-1 32-4395-2	312-5131-1
P5206	X	X	X	X	X	X	X
D5207	X	X	X	X	X	X	X
C5209	X	X	X	X	X	X	X
P5106	X	X	X	X	X	X	X
D5107	X	X	X	X	X	X	X
C5109	X	X	X	X	X	X	X
C5110	X	X	X	X	X	X	X
C5111	X	X	X	X	X	X	X
C5112	X	X	X	X	X	X	X
P5006	X	X	X	X	X	X	
D5007	X	X	X	X	X	X	
C5009	X	X	X	X	X	X	
C5010	X	X	X	X	X	X	
PD4908	X	X	X	X	X	X	
C4908	X	X	X	X	X	X	
C4608	X	X	X	X	X	X	
S5123	X	X	X	X	X	X	
S5124	X	X	X	X	X	X	
S5127	X	X	X	X	X	X	
S4923	X	X	X	X	X	X	
S4924	X	X	X	X	X	X	
S4927	X	X	X	X	X	X	

SHOP PRACTICES & SERVICE TECHNIQUES—TELEVISION

DESCRIPTION OF THE TV-80

The TV-80 is of the dual chassis type of construction. The RF chassis is designated by either RF 81 or RF 84, while the power chassis is designated by either PWR H-1 or PWR H-4. A separate sub-chassis mounted on the RF chassis contains the RF amplifier, oscillator and mixer. The RF amplifier uses either a 6BZ7 or a 6BQ7 tube. The oscillator and mixer each use $\frac{1}{2}$ of a 12AZ7 tube. The output of the tuner is a 20 megacycle IF frequency. The tuner feeds a 3 stage staggered tuned IF system utilizing three 6CB6 tubes. The first IF is impedance coupled to the second while the remaining stages are inductively coupled. The output of the video IF system is detected by a crystal detector using a 1N64 type crystal. This receiver uses only one stage of video amplification. A 12BY7 is used as the video output tube. The output from this stage is coupled to the cathode of the cathode ray tube rather than to the grid which is the common practice when using two stages of video amplification. The output of the detector is such as to produce a composite video signal whose sync pulses are negative going and therefore with this signal subjected to the 180° phase shift resulting by passing through the video amplifier stage, the polarity of the signal would be reversed to what is required to grid feed the picture tube therefore the signal is fed to the cathode. The sound system in the TV-80 is of the conventional intercarrier type of sound system. It is taken off in the plate circuit of the video output tube, amplified by one stage of sound IF and then detected by a ratio detector. The ratio detector is $\frac{1}{2}$ of a 6T8. The other half of the 6T8 is the first audio amplifier.

The output from the audio amplifier is fed to either a 6K6 or 6L6 depending on whether the chassis is an RF 81 or RF 84. A large portion of the composite video signal from the video detector is fed to the grid of the pentode section of a 6U8, which is the sync amplifier tube. This stage will amplify and invert this signal. The output of the sync amplifier is therefore composite video information with sync going in a positive direction. This signal is applied to grid 3 of the 6BE6 sync separator tube. Because of grid leak bias being used on grid 3, the developed voltage will clamp the grid at zero volts when the tips of the sync pulses appear at the grid. The remaining portion of the com-

posite video information drives the grid in a negative direction from zero volts.

Due to the cut-off characteristics of this tube when using grid 3 in this manner, the video components of the composite video signal are eliminated and only the sync pulses will bring the tube out of cut-off and into conduction. The result will be negative going sync pulses in the plate circuit in the sync separator stage. A signal is also taken from the video detector circuit and applied to grid 1 of the 6BE6 sync separator stage. This grid is returned to B+ and its bias maintained very close to zero due to a small flow of grid current.

Since the applied signal to grid one is the composite video signal with negative going sync, all noise modulation present within a composite video signal appears in the form of sharp spikes traveling in a negative direction from zero. The time constant of the grid circuit of grid 1 is so chosen as to permit grid 1 to cut off plate current, through the tube, whenever the applied signal goes more negative than sync tip level. A grid-limiting resistor is also incorporated within this circuit so as to prevent modulation of the plate current by video components which are present in this grid circuit. The output of this entire system will therefore be sync information completely free from all noise or interference.

This stage also performs another function. AGC voltage for the tuner and IF stages are developed within the sync separator grid circuit. When the composite video signal appears at grid 3 of the sync separator tube the tips of the sync pulses cause grid 3 to draw current resulting in a current flow through the grid resistors which constitute the voltage divider network for the AGC system. (Figure 1).

The amount of AGC voltage developed will be proportionate to the amount of peak signal which is present on grid 3 of the 6BE6 tube. The AGC voltage for the tuner is delayed by applying a small positive voltage to the tuner AGC buss through a resistor divider network from B+. This positive voltage must be overcome by the developed negative voltage before any negative bias can be applied to the tuner. To prevent any positive voltage from appearing on the AGC buss a diode clamper, located in the 6T8 first audio amplifier,

is tied from the tuner buss to ground. This will act as a short until such time when enough negative voltage has been developed to equalize and exceed the applied positive potential. The final result being that the tuner has no AGC applied in weak signal areas and permits optimum gain and operation by allowing the tuner to be operated wide open. However, when the input signal increases to a specific level AGC takes hold and prevents overload or distortion.

The second half of the 6U8 tube is a triode section. It is used as a sync inverter. The output of the 6BE6 sync separator is negative going sync pulses and is fed to the grid of the sync inverter stage. The sync inverter acts as a phase splitter providing, in its output, both positive and negative going sync information. Since the input to the grid is negative going sync pulses, the information in the plate circuit will be positive going sync pulses. A resistor is located in the cathode circuit of this stage and across this resistor is taken off negative going sync. The plate load resistor is divided into two parts. At the junction of these two resistors is taken off positive going sync lesser in amplitude than that appearing at the plate due to the ratio between the two resistors constituting the plate load for the sync inverter tube. This sync information and the negative going sync from the cathode of the sync inverter stage are fed to the phase comparator circuit. The positive going sync information appearing at the plate of the sync inverter is coupled through an integrating network to the vertical oscillator. The vertical oscillator is a blocking tube type of oscillator therefore requiring a positive sync signal for proper synchronization. The output of the oscillator stage is a saw-tooth shaped wave form which is coupled to the grid of the vertical output stage. Both the vertical oscillator and vertical output tubes are contained in a common envelope, each using one of the

triode sections of a 12BH7. The trapezoidal wave form, which is the output from the vertical output stage, is coupled to the vertical deflection coils by means of the vertical output transformer.

The phase comparator consists of two diodes contained in a common envelope, this stage using a 6AL5. (Figure 2). The positive going sync pulses from the junction of the resistors, which constitute the plate load of the sync inverter, and the negative sync information from the cathode of the sync inverter are approximately equal in amplitude. The positive sync information is fed to the plate of V1 while the negative going sync pulses are fed to the cathode of V2. A pulse from the horizontal output transformer is shaped into a saw-tooth wave form and applied to the cathode of V1 and the plate of V2 which are tied directly together. The phase relationship between this saw-tooth shaped voltage and the positive and negative sync pulses determines the amount and polarity of correction voltage being fed to the horizontal oscillator stage. When the sync signals and the saw-tooth wave forms are in phase, both diodes, V1 and V2, conduct equally causing an equal amount of voltage drop of opposite polarity, due to the current flow through each diode, to be developed across resistor R1. Being equal and opposite in polarity the resultant voltage as applied to the horizontal oscillator in the form of a correction voltage will be zero. If, however, the phase relationship between these wave forms is not proper due to the horizontal oscillator operating either higher or lower in frequency than normal the potential differences between the plate and cathode of V1 and the plate and cathode of V2 will not be equal and therefore one diode will conduct heavier than the other. Depending upon the direction of phase shift, either V1 or V2 will be conducting heavier. This will result in a larger voltage drop across

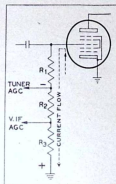


FIGURE ONE

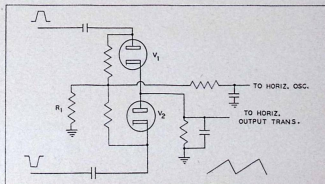


FIGURE TWO

R1 of one polarity than of the other. The difference between the developed positive and negative voltage will be the correction voltage, which after being filtered, is applied to the grid of the horizontal oscillator in order to return this system to a state of equilibrium. If the horizontal oscillator is running high in frequency, the phase difference in the wave forms in the phase comparator will cause V1 to conduct heavier than V2. The correction voltage will be a negative potential which will reduce the frequency of the oscillator. Inversely, if the horizontal oscillator is running slow, V2 will conduct to a greater extent than V1 and the correction voltage will be positive which will speed up or increase the frequency of the horizontal oscillator, again to a condition of equilibrium.

The horizontal oscillator is a multi-vibrator type of oscillator. A multi-vibrator is more stable than a blocking tube oscillator and since horizontal synchronization is normally more critical than vertical the multi-vibrator has been used in the horizontal circuit for better stability. To increase the stability of this circuit even further, a resonant circuit has been placed in the plate circuit. This amounts to a sine wave oscillator and has the effect of a fly wheel.

The output from the horizontal oscillator is coupled to the horizontal output stage which in turn drives the horizontal output transformer and associate circuits. The horizontal output transformer performs two tasks. It provides a means of coupling the horizontal output tube to the horizontal deflection coils. It also provides a high voltage which is applied to the plate of a 1B3 rectifier tube which rectifies this voltage and applies it to the high voltage anode of the picture tube.



FIGURE THREE

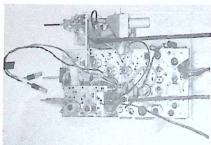


FIGURE FOUR

The low voltage power supply for the TV-80 television receivers consists of a voltage divider utilizing two selenium rectifiers. The filaments of the tubes in both the RF and power chassis are supplied voltage from a filament transformer. That is, with the exception of the high voltage rectifier tube which obtains its filament supply from a winding on the horizontal output transformer.

The TV-80 receiver is of the line connected type of construction and therefore, reasonable care must be exercised when servicing these receivers. It is suggested that an isolation transformer be used. This will eliminate any shock-hazard resulting from this type of construction.

The TV-80, as are all Philco Television Receivers that have been manufactured from the very beginning up to the present day 1953 line of receivers, is ready for UHF. In some portions of the country UHF is already on the air and programming. Philco receivers containing the Philco UHF converters are in these areas providing excellent UHF reception to their owners. The complete UHF installation kit is shown in figure 3. It contains the UHF converter with a pre-amplifier, the wafer switch assembly, all wires and connecting cables pre-soldered and the necessary brackets and hardware. The installation of UHF converters on the TV-80 can be done without removing the receiver from the cabinet or making any additional solder joints. The installed UHF converter is shown mounted in position and ready for operation in figure 4. The simplicity of mounting and installation can readily be seen. A complete detailed description of UHF converters, tuners and their installations will be covered in the near future.

SHOP PRACTICES & SERVICE TECHNIQUES—ELECTRIC RANGES

SERVICING THE OVEN UNITS

In the current line of Philco Ranges, four different types of oven units are used. The bake or lower unit is used in the Banquet or regular oven and is common to all models. The regular broil or upper unit is used in all models that do not have the Jiffy Griddle. For Jiffy Griddle models the broil unit is designed to support a griddle and consequently serves for either broiling or griddle use. In addition to these three types of units, the double-oven ranges, Models 428 and 823, require an extra oven unit for the Thrift oven. This unit is designed to be placed in either the upper or lower position so it can be used for both baking and broiling.

All the oven units are designed in basically the same manner. They are made up by use of a plated steel frame having four parallel bars, to support the heating coil. Each bar has approximately ten spring clips into which porcelain insulating bushings are strung. These porcelain bushings provide an insulated carriage for the coil when it is threaded through them. The back end of the frame as an adaptor plate to which

the terminal block is attached. This terminal block is also made of ceramic material and supports and insulates the ends of the heating coil and the two current carrying terminal prongs. The terminal block also has an extra hole in the center for a prong which is attached to one of the bolts holding the block to the unit adaptor plate. This center prong is used for grounding purposes.

Of the four units shown in the pictures, let us consider the regular broil unit first. It is the only unit which does not require a baffle. It has two uses, one being for broiling and the other to help preheat the oven quickly, in conjunction with the bake coil. When used for preheating it only stays "on" during the first cycle of the thermostat and then drops out of the circuit, while the oven continues to be heated from the lower bake coil only. When used for broiling it stays on continuously due to the top setting of the thermostat and also due to the oven door being left ajar. The door being ajar allows increased air circulation which is necessary for broiling and also prevents the oven from reaching a high enough temperature to have the thermostat shut off. As broiling is accomplished with radiant heat it is necessary to have the coil remain a cherry red all during the broiling operation. The broil unit has a rated capacity of 3000 watts when connected to a circuit of 230 volts.

The other broil unit shown, is the one used in all models that are equipped with the Jiffy Griddle. The frame of this unit is designed so that the coil is carried a couple of inches lower, thereby allowing space to mount the griddle on top of it. As the griddle only extends about two-thirds of the way back on the unit, it was found necessary to fill in this open space with a partial baffle. When broiling with this unit, the Jiffy Griddle should be left installed, so that the griddle and the partial baffle make a level reflecting surface above the broiling coil. This unit uses the same 3000 watt coil as the regular broil unit, but differs in the frame as previously explained. The unit also has a different type terminal block which will be reviewed later in this article.

Now we come to the bake units. Radiant heat is what we want from the broil coil, but for a good baking job, we need heat by convection from the bake coil. Therefore, for proper air distribution we have to install a baffle over top of the coil. Due to the possibility of spill-overs the baffle is designed so that it can be easily removed from the unit by merely turning a

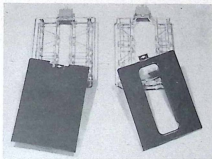


FIGURE ONE—Bake Units

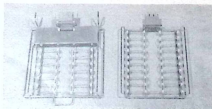


FIGURE TWO—Broil Units

thumb screw, which frees the baffle from the unit. Also for easier cleaning purposes and longer life the baffle is enameled in the same black ground coat porcelain as the oven liner. The bake coil is also designed to operate on 230 volts and has a rating of 2000 watts.

The Thrift oven unit is a double-use unit. By this, we mean it can be used for either baking or broiling. The two unit receptacles in the Thrift oven are electrically hooked up in parallel so that when the Thrift oven thermostat is turned on both receptacles are "alive". This unit also requires an air circulating baffle as it is used in the lower position for baking. Although the baffle is designed differently than the baffle on the regular baking unit, it still performs the same function. When the unit is installed in the top of the Thrift oven for broiling, it is not necessary to remove the baffle. The unit and upper tracks are designed so that the housewife can install the unit for broiling, without the inconvenience of having to first remove the baffle. Due to the size of the oven and as a compromise for both baking and broiling, the Thrift oven unit coil is designed for 2500 watts on the same regular 230 volts power source.

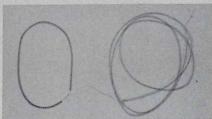


FIGURE FOUR—Cells

The breakdown view shows the parts of the bake unit. The coil has been previously stretched to the approximate required length and is shown strung about half way through the unit. To thread in a replacement coil, it is necessary to maintain tension through each porcelain bushing right up until the ends are secured to the terminal prongs. If the coil is not strung snugly, it will sag too much and will become grounded when heated up. Care should be exercised so that a good tight connection is made on each prong and also that the wire insulators are installed properly where the coil enters the terminal block.

The coil picture shows a broil coil closely wound as it comes off the coiling machine and the same coil is also shown after it has been stretched, ready to be threaded into the unit. These coils are made of a Ni-chrome resistance wire and different sizes or gauges are used for the different wattages. The following table shows how long each coil should be stretched before they are ready to install:

The broil coil—3000 Watt—approximately 121"

The thrift unit coil—2500 Watt—Approximately 84"

The bake coil—2000 Watt—approximately 74"

These lengths will still allow the coil to be installed without any slack or sag, so when threading them always keep the coil under a progressively slight tension. The coil should be started at the front of the unit frame, evenly divided, and each end threaded back toward the terminals.

In checking an oven unit, a broken porcelain bushing will sometimes be found. To install a new bushing it is only necessary to disconnect the end of the coil which is nearest the broken bushing. Then remove the coil back as far as the defective bushing and install a new one. A replacement bushing can be pushed or tapped lightly into the spring clip.

On servicing any oven unit, after examining the coil and noting if the prongs are fully inserted, the next place to check is the oven unit receptacles. Philco uses two types of receptacles as shown. The right one is

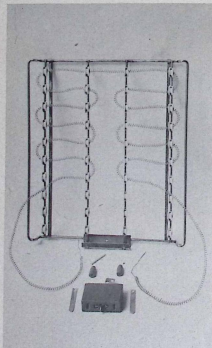


FIGURE THREE—Unit Parts

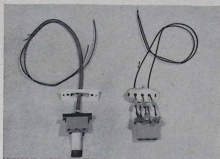


FIGURE FIVE—Receptacles

the regular receptacle which is used for all bake units, all Thrift oven units, and all standard broil units. The receptacle shown on the left is the one used on all broil units, which are combined with the Jiffy Griddle. This receptacle travels in and out with the unit when the unit is used in either broiling or griddle positions. The spring sheath protects the wires and allows them to flex up and down behind the guard, which is installed on the back of the range.

The same type of spring contacts are used in both receptacles. In one of the receptacles, the spring contacts have been pulled out to show how they are shaped. When they are pushed into the receptacle housing, they stay under tension so that a good snug connection is made against the oven unit prongs, when they are inserted. On both receptacles the center spring contact is grounded by use of a short wire which is connected to the back range frame.

The spring contacts are serviced from the back of the range. They are accessible by loosening the cover plate, and then they can be pulled out from the receptacle. Both types of cover plates are shown. The plate for the Jiffy Griddle and broil unit has two extra holes which support the receptacle track rods, and an oval hole for the spring sheath to slide through. If any difficulty is encountered in re-installing this plate, it may be necessary to hold the metal housing in place until one screw is inserted. The metal housing, which is surrounded with oven insulation, is the passageway for the traveling receptacle and extends from the oven liner to the back frame. The two screws which hold the cover plate are anchored to tabs on the metal housing.

Oven spring contacts will give years of service if properly installed and used. When they burn out prematurely, it is usually caused by either a loose lead wire connection, or the oven has been used a lot without having the oven unit pushed in far enough to have the terminal prongs make full contact. When installing a

new contact, it is good practice to cut off about an inch or more of the lead wire and make a new connection. On most ranges the lead wires are long enough so that this can be done. When a spring contact has been hot enough to burn, most likely the connection loop of the lead wire is also burned and has become brittle.

One important service operation, and one which is often required on a new range installation, is the leveling of the Jiffy Griddle. A picture of the right hand griddle unit front support is shown. The griddle and broil unit rests and slides on these right and left hand supports. They are designed so they can be adjusted up or down by merely loosening and tightening the screws. A small carpenter's or dime store level should be used when leveling the griddle. No housewife will be happy with her griddle if the grease runs to one side.

When the oven is to be cleaned, the oven units should be removed. To remove the bake unit, the regular broil unit, or the Thrift oven unit, it is only necessary to take hold of the unit with both hands and pull it out from the oven. To remove the griddle and broil unit, slide the unit as far forward as it will go, then lift up on the front of the unit and pull it out from the oven. This procedure is all that is necessary on early models, but on later ones it is necessary to release a spring clip before the unit can be removed. This spring clip holds the receptacle housing to the oven unit terminal block. To release this clip, first remove the two broil glass from the tracks, then reach up under the unit and hold the clip while pulling the unit apart from the receptacle.

Both Philco broil units, and the Thrift oven unit which can be used for broiling, have the patented Broil-Under-Glass feature. This consists of two tracks fabricated to the unit frame, into which two pieces of specially treated glass can be installed. Each track has a hole in the front end for mounting a retaining wire to hold the glass in place. To remove the glass, just pull out the retaining wire.



FIGURE SIX—Griddle Support

SHOP PRACTICES & SERVICE TECHNIQUES—REFRIGERATION

THE SINGLE AND DOUBLE DOOR AUTOMATIC DEFROST REFRIGERATOR

In June of this year, Philco Corporation introduced their first Single Door Automatic Defrost model refrigerator to the buying public.

Previously, all information issued through Philco Factory-Supervised Service, for the automatic defrost type refrigerator, has been that which applies to the double door models.

We now have incorporated into the design of the new Single Door, Automatic Defrost Refrigerator, all the desirable features that exist in the Double Door models, plus some entirely new features that have been developed by our Engineering Department.

The Duplex Refrigerators are of the 8, 10 and 12 cubic foot models. The Single Door, Automatic Defrost refrigerator is the Model G-928, which has a storage capacity of 8.7 cubic feet.

Figure 1 shows the Model G-1228, which is an example of the Double Door refrigerators, which incor-

porates automatic defrost. The defrost function of the refrigerator is brought about by an electric heater element affixed to the top plate of the evaporator and one suspended below the bottom plate. Control of the power circuit to the heater elements and the sealed unit refrigeration system is maintained through an automatic clock controlled switch in a recessed housing in the back wall of the evaporator. The timer clock actuates the timer switch at approximately 2:00 A.M., at which time the heater circuit is energized and the sealed unit control circuit is opened. When the temperature of the evaporator reaches a predetermined level, a heater thermostat cuts the defrost heaters off. The refrigeration unit is permitted to remain idle, which allows any heavy frost accumulation to continue to melt. At the end of a 25 minute defrost period, the timer switch is again activated, changing its position to open the defrost heater contacts and close the motor compressor power circuit, causing the refrigerator to resume its normal cooling operation.

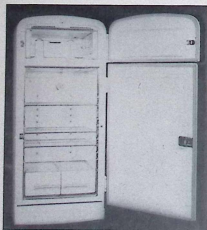
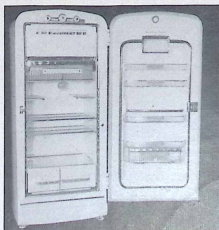
**FIGURE ONE****FIGURE TWO**

Figure 2 pictures the Single Door Refrigerator Model G-928. The automatic defrost system in this refrigerator is achieved by heater elements which are controlled through a clock mechanism.

The heater on the top of the evaporator and the one mounted below the evaporator have been redesigned to give better radiation and transfer of heat.

TIMER OPERATION

The timer clock and heater thermostat in this refrigerator have been combined to make a compact assembly. It has been installed behind the top front cabinet breaker strip for convenience of the customer. This location permits easy access for resetting of the control, as can be seen in figure 2.

This timer thermostat switch assembly is operated by a clock-driven cam, shown in figure 3 as No. 1. This cam makes one revolution every 24 hours. At approximately 1:00 A.M., the cam allows the contact arm (4) to fall into the cam recess, which closes the heater contacts and opens the unit circuit contacts. The common contact arm does not move appreciably at this time since it is held in place by lever (3). With the closing of the heater contacts, the heater elements are energized, causing the evaporator temperature to rise. The increased evaporator temperature causes the gas in the temperature limiter feeler tube to expand, which in turn causes the thermostatic bellows to exert a downward pressure on the adjustable arm assembly. When the temperature of the evaporator rises to between 50 and 55 degrees Fahrenheit, the adjustable arm has been moved down enough to unlatch lever (3) and allow

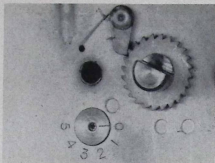


FIGURE FOUR

line, the wattage indication will show very high in the vicinity of 1000 watts, which will indicate that the switch has completed the heater circuit. Permit the clock to rotate the timer switch shaft, by observing the wattmeter, when the evaporator temperature rises to between 50 and 55 degrees, the wattage indication on the meter will reduce to between 160 and 230 watts, which would indicate that the heater circuit has been opened and power has been restored to the sealed unit assembly.

A bench check of this assembly may be made by immersing the heater thermostat feeler tube in a pan of ice water until it is thoroughly chilled. Then turn the timer dial counterclockwise, proceeding slowly, after midnight is reached. Continue to turn the dial slowly until a click is heard at approximately 1:00 A.M. A continuity check at the timer assembly terminals will show that the heater circuit is closed (terminals 2 and 3) and the unit contacts (terminals 3 and 4) should test open. If these check conditions are not apparent, the feeler tube and bellows have probably lost their charge. If the heater thermostat has lost its charge, the unit will run but the evaporator will not be defrosted.

To check the calibration of the heater thermostat, immerse the feeler tube into a cold water bath in which a thermometer has also been placed. The heater contacts should open and the unit contacts should close when the water reaches a temperature between 50 and 55 degrees Fahrenheit.

For each additional 1000 feet above sea level, the heater thermostat will operate 1 degree lower than the value stated in the preceding paragraph. For example: at 4000 feet elevation, the control will be activated between 46 to 51 degrees instead of 50-55 degrees.

To adjust the thermostat for various elevations up to

5000 feet, remove the timer from behind the top breaker strip and use a No. 3 or 4 Allen Set Screw Wrench, turn the adjustment pointer (figure 4) to the desired altitude. The calibration figures represent thousands of feet. If the refrigerator is located at an elevation of 4000 feet, set the pointer to No. 4.

ELECTRICAL COMPONENTS

The Super Power Sealed Unit Assembly, which maintains the freezing cold temperatures in the evaporators and refrigerates the storage compartments of these refrigerators, are all similar. They have been designed to deliver more than the required power to safely maintain adequate temperatures in the refrigerators.

To check and service the Super Power Unit, refer to the section of the service manual titled: Super Power System for the Philco Refrigerator.

The various control and operating components of the Electrical System for the Double Door Refrigerators are shown in figure 5. These components are similar in all the Duplex models, with the exception of the variations in size and heating capacity of the heater elements.

Arrow No. 1 points out the cold control, which is a thermostatic switch for the control of the Sealed Unit Assembly.

The feeler tube and bellows of this control are charged with a refrigerant, a rise in temperature in the evaporator where the feeler tube samples the temperature and causes the confined refrigerant to expand.

The bellows applies pressure on the switch armature, causing the unit contacts to close, which completes the motor compressor circuit. As the temperature is reduced, the expanded refrigerant in the feeler tube and bellows condenses, reducing the pressure on the switch

armature. This permits the switch to open its contacts, which discontinues the motor compressor operation.

Arrow 2 indicates the upper defrost heater element. This calrod type heater element is clamped to the top surface of the evaporator.

When the defrost heater circuit is energized, this element radiates 150 watts of heat, which is transferred to the evaporator by thermal conduction.

The Arrow No. 2 shows the timer housing and timer wiring panel. This point is the control and distribution center for the Automatic Defrost System of the refrigerator. The 115 volt, 60 cycle clock, contained in this housing, operates the switch mechanism which controls the flow of current to the defrost circuit or the Sealed Unit Assembly.

Circuit testing of the Duplex models is greatly simplified since all auxiliary circuits may be checked from the timer housing wiring panel. This wiring panel may be made accessible by removing the rear cover plate,

sufficient insulation and the fiber-board cover on the rear of the timer housing. The individual control circuits may be easily isolated at the wiring panel, by disconnecting from their terminal screws.

Arrow 4 points out the heater thermostat which is a temperature sensitive device whose function is to open the defrost heater circuit when the evaporator reaches a predetermined level. This control operates on the same principle as the temperature control, but the switch is arranged so that it will open its contacts with a rise in temperature.

The temperature limiter is indicated by Arrow No. 5. This current limiter is a bi-metal switch in series with the heater elements. It is incorporated into the defrost heater circuit to open the circuit if the temperature of the evaporator becomes excessive. It is a mechanical circuit breaker which will reset itself after a short cooling period, and it should remain closed during the normal defrost period. This temperature limiter is adjusted to open its contacts when the temperature in the evaporator reaches 136°F.

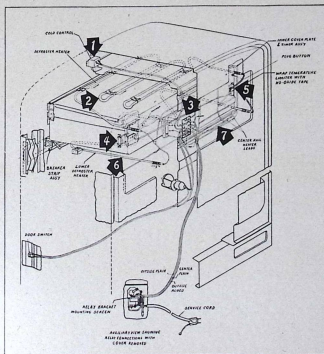


FIGURE FIVE

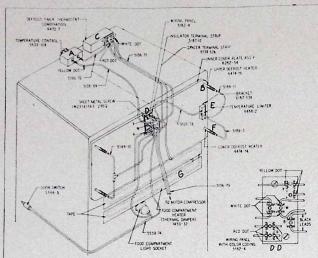


FIGURE SIX

A temperature this high could only prevail in the evaporator if the heater thermostat and the timer clock motor should fail in the defrost position.

The next Arrow is No. 6 which points out the lower defrost heater. This heater element is of the calrod type. It is suspended under the bottom plate of the evaporator. When energized during the defrost cycle, it radiates 600 watts of heat to melt any frost formations on the lower section of the evaporator.

Arrow No. 7 shows the cabinet heater or thermal damper. This damper operates in conjunction with a mechanical damper to control the internal cabinet temperature. When energized, it sets up a thermal block in the immediate area at the rear of the evaporator to retard the flow of cold air down the back of the food tank.

In the Electrical System of the refrigerator Model G-928 there are comparable components, as outlined in the preceding paragraphs (figure 6). The letter "A" designates the cold control. This temperature control has been redesigned to give more accurate control settings. It is calibrated to ten operating positions plus the OFF setting. At the letter "B" is terminated one end of the top heater element which has been reshaped to give better heat distribution without using any addi-

tional power (150 watts). The electrical cables are connected to this heater element with spade type terminals and spring connectors. The letter "C" denotes the timer thermostat and switch assembly which has been reviewed earlier in this publication. The letter "D" indicates the wiring panel which serves the same function as the timer wiring panel. "DD" shows an enlarged view of this control wiring point. This terminal panel utilizes spade connectors and spring fasteners for ease of installation and service.

In addition, it has a color coding for ease of identification when disconnecting or connecting the various control circuits.

The letter "E" points out the temperature limiter. The function and operation of this limiter is exactly the same as those used in all other refrigerators.

At point "F", one terminal of the lower defrost heater is shown. This heater element has been redesigned to give better heat radiation to the bottom area of the evaporator. Shown at the letter "G" is the food compartment heater or thermal damper. This wire heater element is connected across the temperature control, so that it is operating at all times so that the unit circuit is energized and the cold control contacts are open.