

PHILCO SERVICE SUPERVISOR



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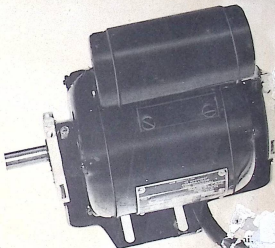
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COMPRESSOR MOTORS



THE subject of compressor motors could be treated in separate articles for the various appliances utilizing them. Since there would be too much repetition in such a method, it was deemed more expedient to agglomerate the material into one article. We hope, in this way, to make a most cogent presentation, and have, therefore, conceived the following exposition for the edification of the PFSS men.

Although there are two types of compressor motors available, the reciprocating and the rotary, PHILCO uses only the reciprocating, thus obviating the discussion of the rotary type.

The reciprocating motor comprises an inherent design characteristics require motion. This is done by two systems, the connecting rod and the scotch yoke. The latter method is used in the compact type motor compressors.

In the PHILCO sealed system the motor is directly connected to the compressor. The motor's crankshaft is virtually an integral part of the motor shaft. The entire assembly is housed in a steel housing.

(Continued on page 10)

It is not our purpose to make a comprehensive study of the entire motor compressor assembly, but it is our intent to limit the discussion to the motor and its various ramifications. The foregoing nebulous information was presented to create a basis for the ensuing discussion.

All motors used in Philco refrigerators, freezers and air conditioners are single phase, alternating current, induction motors. The difference in the motors lies in the starting circuits and their horsepower ratings.

"Single phase", "alternating current", "induction motors". The terms which were used to describe the motors, require further explanation.

ALTERNATING CURRENT

If current flows through a circuit in one direction, stops, then flows in the opposite direction, stops, and then repeats the procedure over and over again, it is said to be alternating current.

The number of times the current goes through this cycle determines the frequency. Most of the current consumed in the U. S. is of the 60-cycle variety. That is, the current changes direction 120 times a second, or goes through the complete cycle 60 times a second. Some sections of the country, such as Long Beach, Calif., have 25-cycle current. See Figure 1, for a visual presentation of the cycle concept.

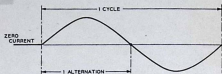


FIGURE 1. Single-phase current—one cycle variation

PHASE

The nameplate of an ac motor also contains information pertaining to the number of "phases". This indicates the kind of alternating current that must be supplied to that particular motor.

Alternating currents can be divided into three classifications; single-phase, two-phase, and three-phase. An elucidation of these types and their manifestations seems pertinent.

Since most of the systems are of the single-phase type, they will be discussed first. Keep in mind that most of the systems supply the various phases of current at 115-volts.

Single-phase power at 115-volts is supplied by a two-wire circuit. If a combination 115- and 230-volts is required, a three-wire circuit is used. This particular arrangement is used on Philco ranges and facilitates the variety of speeds available to the home maker.

Ordinarily, house lighting and appliance circuits are connected to a single-phase supply; for this reason,

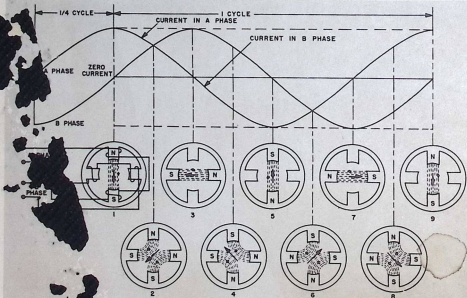


FIGURE 2. Rotating magnetic field of 2-phase, 2-pole motor

all of Philco refrigerators, freezers, and air conditioners used in such places are equipped with single-phase motors.

Single-phase electric power is conventionally represented as a graph or curve similar to the one shown in Figure 1. The graph represents one cycle or two alternations. The current starts at zero value, builds up to a maximum, and then decreases to zero again at the end of one alternation.

The part of the curve above the zero line represents the positive portion of the cycle or the flow of current in the forward direction and the segment of the line below the zero line the negative portion of the cycle or the flow of current in the backward direction. As can be seen, a single-phase current stops and reverses its direction of flow each half cycle.

The basic single-phase induction motor is not self-starting because of the nature of single-phase current, as will be explained later. Special starting devices are required.

Two-phase electric power consists of two single-phase circuits acting together to produce a single power source. Actually, a two-phase motor is one whose stator windings contains two separate single-phase windings. The current in one of the two-phase circuits lags behind the current in the other circuit by a quarter of a cycle.

The lag or time displacement between the two circuits causes the motor winding to produce a rotating magnetic field. See figure 2. This illustration shows how the magnetic field produced by the two currents flowing through the stator windings of the two-phase, two-pole motor is caused to rotate.

The position and the polarity of the magnetic field are shown for each successive $\frac{1}{8}$ of a cycle. The illustration shows one complete rotation of the magnetic field.

The illustration may give the impression that the magnetic-field rotates in steps. This is an erroneous impression derived from the relatively few positions chosen for illustrative purposes. If the position and polarity of the magnetic field were charted for very small intervals of time, the rotation would appear continuous, which, in reality, it is. In an induction motor, the rotational speed of the magnetic field is termed the synchronous speed.

The magnetism produced by a single-phase motor winding has dead spots in it. One of these occurs at each reversal of the current. With two-phase power, things are different. In this system, the magnetic field is continuous because when one of the phases stops to reverse, the other is at its maximum value. Two-phase motors are self-starting because the rotating magnetic field is established as soon as the stator coils are energized. By comparison, in the single-phase motor, this condition is only established when the motor is approaching full speed.

While two-phase motors are not used in Philco appliances, it is their self-starting principle that is of

interest at this time. As previously mentioned, single-phase motors are not self-starting and this inherent deficiency is overcome in single-phase motors of the split phase type by designing them to start on the two-phase principle.

The difference in the design of the running and the starting winding produces a time lag between the currents passing through the two circuits. See Figure 3. While this time lag is not a true two-phase displacement, it is sufficient to produce a rotating magnetic field that will start the motor.

Three-phase power, usually transmitted on three wires, consists of three-phase circuits. In this type of electric power, the displacement or time lag between each phase is $\frac{1}{3}$ of a cycle. Three-phase power is not used in single-room air conditioners, but is mentioned because of its wide industrial application.

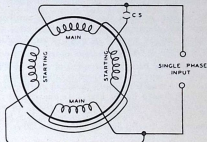


FIGURE 3. Schematic for split-phase motor with centrifugal switch

TYPES OF SINGLE-PHASE MOTORS

Three types of single-phase motors are used in Philco appliances. They are: split-phase, capacitor, and shaded-pole. All three of these are induction motors. That is, they operate on the principle of electromagnetic induction, the same as the power transformer. The part of the induction motor that contains the stationary winding is called the stator. The part that rotates is called the rotor. The laminated stator core with internal slots to receive the motor winding is shown in Figure 4.

Only the stator winding receives the line current. The bar windings of the rotor receive the current by magnetic induction in the same manner as the secondary of a transformer.

The rotor of an induction motor looks like a solid mass of iron, but actually is made of many laminated steel discs. The rotor bars which are embedded in the laminations, are all joined at the ends by the rotor with metal end rings to complete the circuit through the rotor. The bars and end rings provide a low resistance circuit through which the induced rotor current flows.

The rotating magnetic field set up by the stator winding and the resulting rotor magnetic field interact to cause the rotation of the rotor in starting and running.



FIGURE 4. Induction motor—stator core

Two factors determine the speed with which an induction motor runs: the number of poles in the stator and the frequency of the electrical supply. Since neither of these factors are easily varied, induction motors are not readily adaptable for various speeds.

The relation between the speed of the revolving magnetic field, the approximate speed of the rotor, the frequency, and the number of poles of an induction motor is shown in Figure 5.

The difference between the speed of the revolving magnetic field and the rotor speed is called the slip of the rotor. In some fan motors, the slip is much greater than that indicated by the chart. In the case of the six-pole, 60-cycle motor shown in the chart, the slip is 100 rpm. If the motor is designed with a high-resistance rotor, its slip may be as much as 200 rpm.

SPLIT-PHASE MOTORS

The next portion of the discussion will cover split-phase motors.

There are two general classifications of motors of the split-phase type. One type operates without a capacitor and the other utilizes a capacitor to produce more starting torque. This gives the motor a greater starting ability under load conditions.

Air conditioners use this type of motor, because it is possible that the air conditioner could be restarted before the pressure in the system had time to equalize. A motor without this added torque could not start against the high head pressure.

If the split-phase motor uses a capacitor, it is ordinarily known as a capacitor motor.

NO. OF POLES	60-CYCLE POWER		50-CYCLE POWER	
	Approximate Speed of Motor (r.p.m.)	Approximate Speed of Rotor (r.p.m.)	Speed of Rotating Mag. Field (r.p.m.)	Approximate Speed of Rotor (r.p.m.)
2	3600	3500	3000	2900
4	1800	1750	1500	1450
6	1200	1100	1000	900
8	900	800	750	675

FIGURE 5

The starting torque of all types of split-phase motors is determined by a variety of factors. Some are: the rotor resistance, the relation between the size and number of turns of wire in the starting winding and the size and number of turns of wire in the running winding. In capacitor motors, the starting torque is also affected by the size of the capacitors.

Split-phase motors that operate without capacitors have about 60 percent as many turns of wire in the starting winding as it has in the running winding. The wire used in the starting winding is about six sizes smaller than that used in the running winding.

In capacitor motors, the ratio of the wire sizes and the turns is quite different. In this type of motor, the wire in the starting winding is only about three sizes smaller than that in the running winding. The turns of wire in the starting winding are usually slightly more than that in the running winding. The starting characteristics are improved as the size of the capacitor is increased. At least up to a certain point. The limit lies between 100 and 300 microfarads for motors of fractional horsepower.

The action of the capacitor in the starting circuit can be explained by considering a few basic principles.

If an alternating current flows through coils of wire (such as in the starter winding of an induction motor) it does not keep up with the impressed voltage. A definite displacement of the current in relation to the voltage occurs. The current lags the voltage according to the number of turns in the coil. Since the running winding has a very large number of turns, the current will lag the voltage to a considerable extent.

On the other hand, if an alternating current is first passed through a capacitor and then through the winding, the lag can be compensated for. If a capacitor of the proper size is used, it is possible to make the current lead the voltage. By using the correct size capacitor, the current can be made to lead the voltage by the amount necessary to give the best starting characteristics.

It must be remembered that a definite time displacement between the current in the two stator windings is necessary to produce a rotating magnetic field and the resulting starting torque. The nearer this displacement approaches the two-phase principle the better the starting torque will be.

More about the split-phase motor without capacitor.

This type of motor contains the conventional running and starting windings in the stator with some type of disconnecting switch in the starting winding.

By comparison, the capacitor type motor (used in the air conditioner sealed system) uses the same principle as above, but a capacitor is added to improve the starting characteristics of the motor. In fact, the time relationship between the current in the running winding and the current in the starting characteristics as a two-phase motor, but turns single-phase after the starting winding is disconnected.

There is always a lag between the alternating current that flows through the running winding and the impressed voltage. This relation between current and voltage is true when alternating current flows through any coil of wire. The extent of the current's lag is determined by coil design. And, as previously explained, if a capacitor is introduced into the starting winding circuit, its effect is to cause the current to lead the impressed voltage. If the running winding is designed so that the current lag behind the voltage represents $\frac{1}{4}$ of a cycle, and the starting winding has sufficient capacity effect to cause the current to lead the voltage by $\frac{1}{4}$ of a cycle, then the total phase spread between the two currents sets up a perfect rotating magnetic field ($\frac{1}{2}$ cycle). The capacitor motor starts the same as any two-phase motor.

There is another type of capacitor motor that both starts and runs with a capacitor in the circuit. The starting winding, which is termed the auxiliary winding, remains in the circuit all the time.

When this motor approaches about 80 percent of its full speed, the starting capacitor is disconnected from the circuit and a smaller running capacitor is connected in its place.

The switching action may be accomplished by one of two methods, a centrifugal switch (see Figure 6) or an electrical relay.

There is yet another type of split-phase motor. This motor starts and runs with the same capacitor in the

circuit. It is necessary that the capacity of the condenser be low, and therefore, the starting torque will be low. This limits the use of this particular type of motor to devices such as fans.

The final type of motor is the shaded pole, single-phase type.

It is ordinarily employed on fans and automatic controls that require very little starting torque. It is used extensively because of its simplicity and reliability. It is really a variation of the split-phase type in which the phase displacement is produced by a short-circuited turn of copper enclosing a portion of each pole piece. Out of phase currents are induced in these single-turn copper coils, which are embedded in the pole faces.

There is enough time difference between the copper-coil current and that of the start winding to produce a form of rotating magnetic field. The field is strong enough to produce only a limited starting torque. Since there are no switching devices used, the short-circuited copper coils remain in the circuit and carry a useless induced current while the motor is running.

Figures 7, 8 and 9 are presented conveniently juxtaposed to permit comparison of the various types of motors.

GENERAL TESTS FOR MOTORS

Generally, it is impossible to check the motors used in Philco products because of the sealed condition of the system.

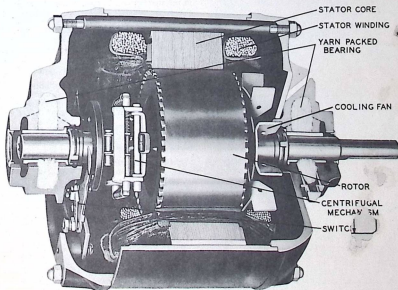


FIGURE 6. Split-phase motor with centrifugal switch

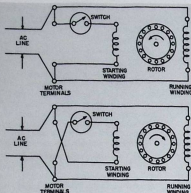


FIGURE 7. Split-phase motor without capacitor

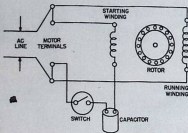


FIGURE 8. Capacitor-start split-phase motor

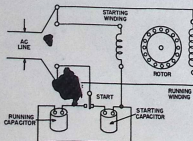


FIGURE 9. Capacitor-start, capacitor-run split-phase motor

Checking the windings for shorts, opens or grounds are the usual limits of the checks that can be made in the sealed system. If the system is cut open for repairs, it is possible to detect burnt windings by the characteristic odor of burned insulation in the freon that escapes.

To delve more specifically into the general tests for motors, it will be necessary to also discuss tests that are only applicable to motors that are not completely enclosed. Motors such as fan motors.

Tests applicable to all motors:

1. Check the windings for grounds by using a continuity tester. Apply one test lead to the motor housing or motor compressor shell and the other to the motor leads.
2. Check the windings for an open circuit with some form of continuity checker, such as an ohmmeter. Winding resistances are relatively low in ohmic value.
3. If the motor shows neither open or ground windings, make a running test using special test leads that by-pass circuits external to the motor itself.

These test leads must be constructed according to the starting circuit of the motor under test. If the motor uses a capacitor in the start circuit, it is necessary to use test leads incorporating capacity in the start portion of the test circuit.

It must also be borne in mind that the contact switch in the starting circuit must not be depressed for more than three seconds. Otherwise, the motor windings will be damaged.

4. If the circuit breaker in the test leads opens or the fuse burns out; or if the motor heats excessively on the running test, the winding is probably short-circuited and the motor requires replacement.

Tests applicable to accessible motors:

1. Inspect the oil wells to see if the wicking is dry. If dry, the bearing may be damaged.

Remember, however, that some of the later fan motors do not require oiling. If there are no oil wells on the motor, it needs no additional lubrication.

2. Check the bearing by placing one hand on the motor frame and the other on the rotor shaft. Any appreciable wide-wise or up-and-down motion of the shaft means that the bearings are bad and should be replaced.

Indirect tests for motors not operating properly:

1. Check the line voltage supplied by the power company. Although there is some variation of voltage within which limits the appliance will operate, it is possible that there is insufficient voltage for proper operation of the motor.

2. Check the house wiring to make sure there is not inadequate wiring causing a drop in voltage to the appliance.

3. Check for defective electrical equipment operating from the same voltage source.

Defective electrical equipment, such as a motor with a grounded or short-circuited winding, will draw excessive current from the line. It might result in lower than normal operating voltage being supplied to the appliance motor. Replacing or repairing such equipment will correct this condition.

TRANSFORMER OPERATION

It might be well to consider the method of coping with line voltages that are not of the correct magnitude and/or frequency required by the equipment.

This condition is found occasionally in the U. S. and is quite prevalent outside the country.

It might be necessary to operate a 115-volt air conditioner from a 230-volt source, a 208-volt job from a 230-volt source, or a 230-volt model from a 208-volt source, etc.

And, of course, there is always the possibility of frequency variations. In many countries outside the U. S. 50-cycle power is the only kind available. Although the voltage may be of the correct magnitude, the lower operating frequency makes it impractical to operate the appliance from this source.

To correct for improper voltage, incorrect frequency or both, transformers are used.

Since the transformer can in no way alter the frequency of the power passing through it, it must be designed to alter the voltage so that the motor will run properly.

These are two types of transformers in general use. Standard two-coil transformers, and auto-transformers.

The purpose of the transformer is to lower or raise the voltage to the level necessary. The design of the transformer varies greatly and depends upon the type of electrical circuits in which it is to be used.

Figure 10 shows a typical two-coil transformer. It consists of a laminated iron core with one or more coils of wire wound on the core. The coil that is connected to the power source is called the primary. The one that is connected to the load is called the secondary.

The alternating current in the primary winding sets up a varying magnetic field in the iron core. The magnetic field builds up and dies down with each current alternation in the primary. Because of this action, it generates a voltage in the secondary. This voltage in the secondary is an induced voltage created by the expanding and collapsing magnetic lines of force generated by the current variation in the primary. The iron core acts to concentrate the lines of force and to make the transformer more efficient.

The ratio of turns in the primary winding to the turns in the secondary winding determine the amount

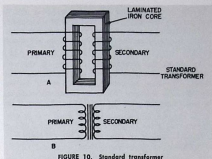


FIGURE 10. Standard transformer

of voltage generated. If the primary has 200 turns and the secondary 400, the voltage will be doubled. On the other hand, if the secondary had 100 turns, the voltage would be half the line voltage.

In the standard type of transformer, the primary and the secondary windings are completely separate entities. This separation is not necessary.

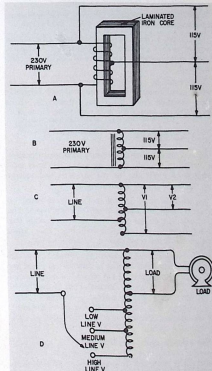


FIGURE 11. Autotransformer

In the autotransformer, the same winding acts as both primary and secondary. This type of transformer is illustrated in Figure 11A and B. It shows the connection necessary to obtain 115-volts from a 230-volt source.

11C shows the position of the taps on the coil for both step-up and step-down transformation. The voltage V1 would be greater, and V2 would be less than the line voltage. The positions of the taps on the coil determine what the secondary voltage will be.

11D shows a multitap autotransformer. It is suitable for connecting to power supplies having a variety of line voltages, or of generating different secondary voltages.

So far, the problem of voltage variations have been considered.

Frequently, the problem of frequency discrepancies occurs. It is a matter of adjusting the voltage of the motor so that it runs properly even though it is supplied with current varying at the wrong frequency.

If the frequency is too low, there will be an appreciable power loss and the motor will not run up to its rated speed. Therefore, the voltage must be boosted to compensate for the lower frequency.

Similarly, if the frequency is too high for the motor, the voltage must be lowered.

This is not to infer that motors can not be run on frequencies that are other than the design frequency. Rather, it is pointed out that there is a method of compensation.

Motors can be run on incorrect frequencies under certain conditions, such as light load and relatively small deviation from the correct frequency. It is always best to correct for such variations, however.

STARTING RELAYS

An automatic switch is necessary to cut out the starting winding on split-phase motors. The two most widely used types are the current type and voltage type relays.

The current type (series coil) may be used on straight split-phase motors, or on capacitor types. The switch contacts are normally open and that current that passes through the running winding also passes through the series relay coil.

The starting current of the motor is very heavy, and the magnitude of the current is sufficient to cause the relay to close, thus putting the starting winding in the circuit. When the motor reaches about 80 percent of its full speed, the starting current is reduced so much that the relay coil can not hold the contacts closed, and the contacts open to disconnect the starting winding from the circuit.

The voltage type (or shunt coil) is used with capacitor motors only. It has the contacts normally closed. The relay coil is connected in parallel with the motor starting winding. When the current is applied to the motor, both running and starting

windings are energized. The voltage across the starting winding and the relay coil will be much less than the line voltage because both are in series with the capacitor. As the motor speeds up, the voltage across the starting winding and relay coil will increase until, at about 80 percent of full speed, the relay coil is strong enough to open the contacts and disconnect the starting winding and capacitor from the circuit. After the starting circuit disconnected, the induced voltage in the starting winding is sufficient to hold the relay contacts open during the running period. If the running motor becomes excessively overloaded, the voltage across the starting winding drops sufficiently to allow the contacts to close and cut the starting winding back into the circuit.

The voltage type relay is used in capacitor motors for certain obvious advantages. An important factor is that the same relay can be used regardless of horsepower and motor speed. With current relays, the current coil must correspond to the current rating of the motor. This necessitates the use of different relays for each motor rating.

In some appliances, particularly air conditioners, it is necessary to use a relay with sequential contacts. If the motor of the compressor and the fan motors were to start simultaneously, the current would exceed the limits set by the local power companies. To eliminate this simultaneous drain, the starting relay is equipped with sequential contacts, and the motors are started consecutively. The opening of the starting contacts on the main motor and the closing of the contacts for the starting of the fan motor are one operation.

OVERLOAD CIRCUIT BREAKER

Philco protects the motors of its appliances by a thermostatic circuit breaker.

The circuit breaker consists of a resistor and a bimetallic disc (See Figure 12) that open the circuit if the temperature becomes excessive.

The breaker's operation is triggered by two sources of heat. First, the heat caused by the motor current passing through the resistive element. The second source is the heat derived from the motor itself. When the motor draws excessive current, or when the circuit breaker becomes warm from any other cause, the contacts will open and stop the compressor motor.

Since the overload circuit breaker is self resetting, intermittent operation of the motor will occur until the condition causing its tripping is removed.

B1-METAL
DISC



FIGURE 12. Overload circuit breaker

ELECTRICAL TROUBLE SHOOTING

Trouble shooting the electrical end of the range is one of the more fascinating phases of range work. It is interesting because it presents a challenge to the service technician—a challenge that can be dispatched with speed and facility if the technician has trained himself thoroughly.

There are essentially two categories of troubles that occur in range electrical circuits: opens and shorts. Occasionally, the trouble will show only a partial similarity to one of these major types. It may be, in essence, only a partial short, or an incomplete open, but if it deviates from the correct reading, it is bound to fall in one of the two classifications. Usually a short is thought of in terms of a circuit presenting no resistance and an open as a circuit showing an infinite resistance.

It is true that a partial is more difficult to uncover, and often is the cause of more trouble than its more complete kin.

Frequently, a partial short will be erratic in its behavior and cause misleading indications. The same is true of the partial open.

Short circuits are the most serious trouble that may occur in electrical circuits. A short, particularly a complete short, sets up a condition of tremendous current flow. This flow can do great damage.

It can cause the wires which carry it to heat excessively and possibly cause a fire. Of course, if the circuit is properly fused, this possibility is virtually eliminated.

Short circuits need not only occur across the source of voltage, but another type of short, grounding, can cause shocks and a wide variety of troubles. Open circuits, on the other hand, are relatively less hazardous. They do not bring about the dangerous conditions prevalent in short circuits.

One of the most perplexing of all the kinds of trouble that occur is the intermittent trouble. This might entail either the short or the open. It is the most difficult type to locate and rectify. Many times it is necessary to let the trouble age for awhile until it gets around to doing a full time job. Often a component will not fail when it is cool, but as the heat is applied, it will open or short and the trouble can be located by indications other than the resistance readings. In such cases, it is important to know the correct operational characteristics of the range so that the trouble can be located easily when the defect makes itself known.

Locating trouble is aided to a great degree, by cer-

tain test instruments. Some troubles are impossible to locate without the use of these instruments.

Probably the simplest and most inexpensive of the test equipments available, is the test lamp.

The test lamp is a device used for checking the approximate voltage of a circuit. It is not as good a test as the voltmeter, but is convenient and sufficiently accurate for a rough approximation of voltage. For instance, on the range, two voltages are normally encountered, 115-volts and 230-volts. The two voltages are readily indicated by the test lamp.

On the 230 volt circuit, the lamp glows brightly. On the 115 volt circuit, its brilliance is vastly diminished.

It is important to make sure that the test lamp is of the proper rating so as to withstand the voltage under test. A test lamp whose rating is too low might be damaged, and could possibly do irreparable damage to the circuit under test.



FIGURE 1. Neon test lamp

ERRATUM

A mix-up in terminology occurred in September's Freezer article. "Latent heat" and "sensible heat" were used erroneously.

The following definitions are presented to clarify the situation.

Latent heat—that heat which brings about a change of state.

Sensible heat—that heat which causes a change in temperature.

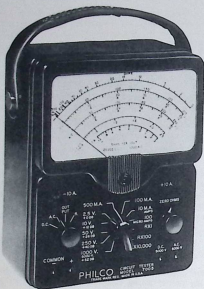


FIGURE 2. Philco Circuit Tester—Model 7005

As it has been mentioned, the test lamp is efficacious only so long as the answer to the problem requires but an approximation of the voltage.

For more precise measurements, it is necessary to use a multimeter. The meter combines three functions in one instrument and in so doing covers every possibility of the troubles that might be encountered.

The three functions are the voltmeter, the ohmmeter, and ammeter. One of the most convenient forms of the multimeter is the Philco Model 7005 Circuit tester.

The ohmmeter is used in trouble shooting electric ranges to indicate either an open or a short circuit and to the degree which the trouble exists. When used as an ohmmeter, the 7005 has its own internal voltage source dry cell batteries. If the test leads from the ohmmeter are shorted together, a path is completed from the dry cells through the meter movement, causing the needle to be deflected full scale. The same effect is produced when a short is encountered. Shorting across the test leads checks to make sure the meter will read the short properly.

It is of the utmost importance that the ohmmeter never be used to measure any part of a circuit so long as voltage is applied. If this warning is not heeded, it is possible to destroy the meter movement, or at least damage it to such an extent that it will not operate with the accuracy required.

The 7005's voltmeter is capable of measuring voltages as high as 5000 volts. For the purpose of range trouble shooting, it will rarely be necessary to use any ranger higher than the 250-volt one. However, if the voltage is not known and there is a possibility of its exceeding 250, set the selector (center) knob to the 1000-volt range first.

If the deflection is lower than 250 volts, select progressively lower ranges until the meter needle rests somewhere between one-third and full scale. If wattage readings are required, the 5007 tester is recommended.

Whether the technician uses the test lamp, or the multimeter, the ultimate success of the trouble shooting procedures lie in the technician's ability to use the equipment efficiently and correctly.

The process of trouble shooting can be readily reduced to a simple and effective system.

"Learn by doing" is often advised, but it is much better to learn by doing with training and understanding of the equipment.

This should be followed by properly analyzing the troubles and noting the indications that lead to the source of the difficulty. In this way the technician builds up a background of information, and trouble shooting becomes more and more facile. Techniques will be developed that will bring about rapid, efficient work involving minimum of time and effort.

The first step in diagnosing trouble would be to take note of the exact indications of trouble. For example, observing that the left-front surface unit does not function on the MEDIUM-LOW, LOW and SIMMER positions of the unit switch gives a definite clue to the origin of the trouble.

The second step is to analyze the possible causes of the particular trouble, and then to select the most likely causes, and start the trouble shooting procedure on that basis.

This is best accomplished by the "process of elimination" procedure.

If the example cited above were followed through with this type of reasoning, it might be accomplished in the following manner.

The unit works properly on the HIGH and MEDIUM positions of the switch, but does not operate on the other positions. What can be deduced from this information?

Since no other indications of trouble appear on the range, the trouble must exist either in the part of the circuit that includes only the left front unit, or in the components that are used in conjunction with this unit.

The unit functions properly on the HIGH and the MEDIUM positions of the unit switch, therefore, the three connections from the heating element to the unit switch must be sound. Proper operation at these two positions cannot be obtained unless all three wires and connections are intact. It also indicates that the two hot wires to the unit switch from the source must be sound.

This leads us to the fact that the trouble must lie in the neutral lead-in wire or in the neutral connection in the unit switch itself.

By further elimination, we deduce that the trouble must be in the unit switch itself.

Now we have to find the trouble to verify the deductions we have made. This may be done by visual inspection or by using a testing device.

In this case, it is most propitious to use the ohmmeter. After removing all power from the range, remove the wires from the lugs on the unit switch. This is done to remove any source of error that might be introduced by external circuit connections.

Set up the ohmmeter for proper indications and place the test leads of the ohmmeter from the "N" terminal lug to terminal 1 of the unit switch. If the switch is good, the ohmmeter would indicate a short circuit on switch positions MEDIUM-LOW, LOW and SIMMER. For the particular trouble under consideration, the switch would show an open circuit on these positions and prove the defect in the switch.

The above brief description of a typical trouble shooting routine can be used as a general guide.

To culminate this article, a few general notes on trouble shooting will be added.

Always remember to turn the power off at the main line switch when it is necessary to replace a fuse. This will eliminate the possibility of personal injury.

Remove power from the range when using the ohmmeter to check any circuits.

A test lamp is a good piece of test equipment so long as an approximation is required. It glows brightly on 230-volts and emits a dim glow when exposed to 115-volts.

The many ramifications of trouble shooting could not be covered comprehensively in so short an article. It is hoped that the foregoing information will serve as a basis for the development of rapid, competent trouble shooting techniques on the part of PFSS members.

Philco supplies comprehensive wiring schematics to aid PFSS technicians. Figure 3 shows a typical wiring diagram.

There are times when the trouble-shooting techniques might involve the testing of the circuit for the proper wattages as consumed by the various units of the range. For this reason, we have included a table of the correct wattages that should be found around the various circuits of the range when the operation is correct.

The table has been put on a separate page so that it might be easily removed and placed in a convenient location to expedite its usage.

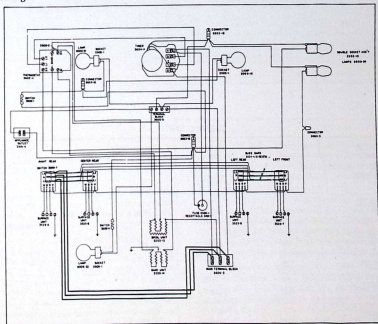


FIGURE 3. Typical wiring diagram

WATTAGE CONSUMED BY PHILCO RANGE UNITS
OVEN UNITS

MODEL	TOTAL BAKE	BAKE UNIT	BAKE BOOSTER	BROIL	HI BROIL	LO BROIL	SURFACE UNITS USED
245	4000	3000	1000	4000			2 STANDARD 6" 2 STANDARD 8"
343	3900	3500	400	3200			3 STANDARD 6" 1 STANDARD 8"
345	3900	3500	400	3200			3 DE LUXE 6" 1 DE LUXE 8"
442	3900	3500	400	3200			2 STANDARD 6" 1 STANDARD 8" 1 STANDARD DEEP WELL
443	3900	3500	400	3200			2 DE LUXE 6" 1 DE LUXE 8" 1 STANDARD DEEP WELL
444	4500	3500	1000		3200	2200	SAME AS 443
444-S	4500	3500	1000		3200	2200	2 DE LUXE 6" 1 DE LUXE 8" 1 JIFFY LIFT
446	3900	3500	400	3200			2 DE LUXE 6" 1 DE LUXE 8" 1 STANDARD DEEP WELL
447	4500	3500	1000		3200	2200	2 DE LUXE 6" 1 DE LUXE 8" 1 JIFFY LIFT
449	4500	3500	1000		3200	2200	SAME AS 447
849	4300	3000	1300		3500	2200	2 DE LUXE 6" 2 DE LUXE 8"

SURFACE UNITS

TYPE OF UNIT	HI	MED	MED-LO	LO	SIM
STANDARD 6"	1100	550	275	140	70
STANDARD 8"	1900	950	475	240	120
STANDARD DEEP WELL	1200	600	300	150	75
JIFFY LIFT	1250	700	310	175	80
DE LUXE 6"	1450	650	360	160	90
DE LUXE 8"	2100	900	525	225	130

PHILCO 1955 "C" LINE HOME RADIOS

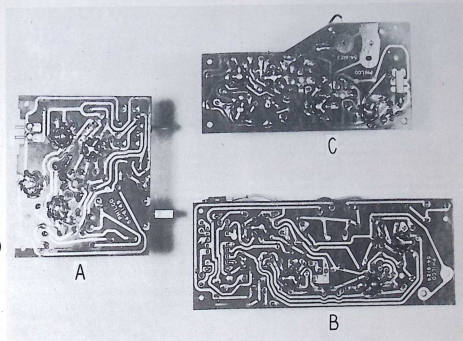


FIGURE 1. "C" Line Radio, printed-wiring panels

The Philco 1955 "C" Line Radio models contain a number of new features and new circuitry which add to the performance, versatility and serviceability of the various models.

There are more than 35 different models in the "C" Line and a number of the models employ the time tested and proved Philco printed wiring process, or printed wiring panels.

There are three basic panels used. Figure No. 1. Panel "A" is used in models 579, 580, 716, 718 and 720. Panel "B" is used in model 663. Panel "C" is used in models 583, 584, 587, 721, 722, 723, 724 and 729. These three basic panels have been so designed that they can be used in more than one chassis type with a minimum of modification, thus resulting in better uniformity and greater standardization with the accompanying improvement in the ease of servicing.

Panel "A" is the basic panel for the new four tube radio chassis. This chassis contains three radio tubes and a rectifier. All of the components except for the speaker are attached directly to the printed wiring panel. Figure No. 2.

An autodyne type first detector, employing a 12AU6 pentode tube is used in this chassis type, feeding a 12AV6 tube as the second detector and first audio amplifier. The output power amplifier stage employs a 50C5 tube to drive the speaker. Half wave rectification is provided by a 35W4 tube.

The magnacore antenna feeds the incoming RF signal to the grid of the 12AU6 autodyne first detector. The circuitry of this stage is such that it performs the action of an oscillator and mixer to produce the IF signal, figure No. 3. No IF amplifier is used in this chassis. An autodyne detector has a high plate

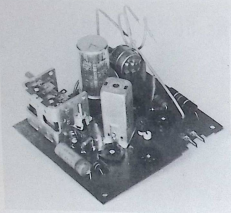


FIGURE 2. Printed wiring panel "A"

impedance, considerably higher than that of a pentagrid converter. Because of this high plate impedance a proportionately high plate load can be used. Thus, with an increase in plate load resistance, the gain of the stage increases. The gain of this type circuit is sufficient to enable the receiver to provide completely acceptable performance with the elimination of an IF amplifier stage.

The signal is then fed to the duo-diode section of the 12AV6, serving as the audio detector. The triode

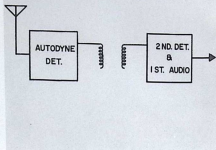


FIGURE 3. Autodyne Detector Coupled to 2nd Detector

section of the same tube is used as the first audio amplifier which in turn feeds the signal to the 50C5 tube used as the audio output stage. A 220 mmfd condenser is connected from the grid of this stage to B minus in order to suppress any parasitic oscillations.

A conventional half wave rectifier power supply provides B+. The tube filaments are in series. A "Tube Saver Resistor," which limits the current surges is placed in series with the filament string between the filaments of the 12AU6 and the 12AV6 tubes.

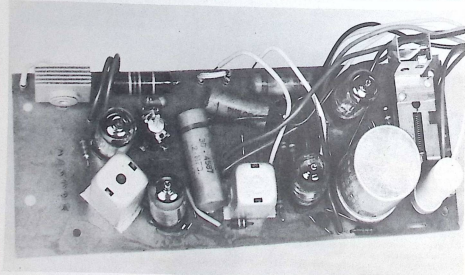


FIGURE 4. Printed wiring panel "B"

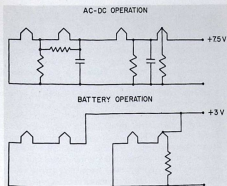


FIGURE 5. Model C-663 filament switching operation

The second basic printed wiring panel is designated as the "B" panel and varies from panel "A" in size, shape and circuitry. Presently only one model contains this panel, the portable model C-663. Figure No. 4.

This model is a superheterodyne employing conventional circuitry. A 1R5 tube is used as the pentagrid converter, the IF amplifier uses a 1U4 tube, a 1U5 tube is the 2nd detector and 1st audio and a 3U4 tube in the audio output stage. B+ voltage is obtained either from a 75 volt battery or from a half wave rectifier circuit using a selenium rectifier since the model can be operated on either the battery or 115 volt AC-DC power.

The tube filaments are connected to a switching arrangement so that during battery operation the

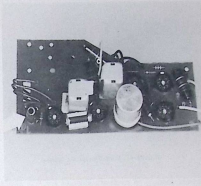


FIGURE 6. Panel "C" oscillator coil

filaments are in series-parallel while on the plug in power line operation the tube filaments are all in series. This arrangement is used to prolong tube and battery life. Figure No. 5.

The third and final printed wiring panel to be discussed is the "C" panel. This particular panel features great versatility since with four small modifications the panel can be employed in 8 different model receivers.

The four modifications can be further classified as two chassis which use oscillator coil "A" and two chassis using oscillator coil "B". The change of oscillator coils is necessary due to a change of variable tuning condensers. Figure No. 6.

Of the two chassis using the type "A" coil, one chassis does not contain a pilot light while the second

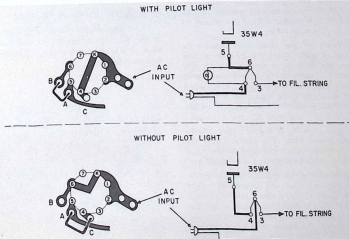


FIGURE 7. Printed wiring panel "C"—pilot light connections

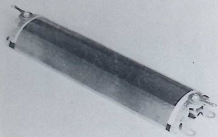


FIGURE 8. Philco Electrostatic Speaker

chassis does. The necessary changes are very simply made as illustrated in figure No. 7. When the chassis is to use a pilot light, a tie strap, located on the 35W4 socket, connects the AC input to pin no. 4 of the socket. A wire jumper is placed between points "A" and "B" which connects pin no. 5 to pin no. 6. In the schematic diagram of figure No. 7, with the pilot light connected, note that the pilot light is placed between pins no. 4 and no. 6 so that it is in parallel with one half of the 35W4 tube filament.

However, when no pilot light is used, the tie strap on the tube socket connects the AC input to pin no. 6, and the wire jumper is placed between points "A" and "C". The jumper then connects pins nos. 4 and 5 on the 35W4 tube socket together.

The only basic differences therefore of the radio chassis using this wiring panel are the position of the tie strap and wire jumper and the oscillator coil type.

The "C" Line, Hi-Fidelity, Phonorama model 1758 and the Hi-Fidelity Phonograph models incorporate a completely new Philco electrostatic speaker. Figure No. 8. This new type speaker is used as a tweeter to extend the high frequency range.

The construction of the electrostatic speaker is basically similar to a condenser. It consists of two metallic plates separated by a thin insulating film acting as dielectric. Figure No. 9. One of the metallic plates is made of aluminum and is rigid. It is shaped in a semicircle of 16 small flat segments. The entire surface is perforated to prevent back pressure on the diaphragm.

The second plate consists of a gold vapor deposit upon a polyester plastic film. The plastic film is the dielectric and is placed across the face of the rigid plate. It is held in place by a spring loaded metal bar.

Due to its construction the speaker exhibits excellent spatial distribution since the segmented design previously mentioned is equivalent to 16 tweeter speakers arranged in a semicircle providing 180 degrees of sound distribution. Excellent frequency range is also obtained, the frequency range extending from approximately 7,000 cps to over 20,000 cps. Figure No. 10.

The speaker functions by the varying of its electrostatic fields. A polarizing voltage is obtained from the plate of one 6V6 audio output tube, through a 4.7 megohm resistor. The resistor and the capacity of the speaker form an integration network that filters the fluctuating plate voltage so that it appears as a constant value DC voltage. Figure No. 11. A second voltage, obtained from the same tube source, through a resistor, condenser and inductance network is the means by which the electrostatic charge between the plates of the speaker is varied in direct proportion to the audio modulation signal. This R-C-L network forms a high-pass filter which passes frequencies only above approximately 7,000 cps. Since the speaker cannot faithfully reproduce the lower frequencies, the high-pass filter prevents these frequencies from reaching the speaker. The filter network is comprised of C_1 , R_1 , L_1 and C_2 in figure No. 11.

The three speed record changers employed in the "C" line are the models M-26 and M-28. These changers feature improvements in both the transient response and frequency response of the crystal cartridge particularly in the M-28 changer which is used in the Philco, Phonorama, High-Fidelity model 1758. With the improved crystal cartridge the frequency range of the Phonorama model extends from approximately 30 cps to 20,000 cps.

Another new feature of the "C" line 3 speed record changers is a 45 RPM adapter-spindle. Figure No. 12. This spindle slips snugly over the standard spindle to accommodate 45 RPM records. The action of the changer, the selecting and dropping of the records is accomplished in the same manner as for the standard records, by the nodding of the spindle. The use of the spindle eliminates the need for record inserts when using 45 RPM records on the changer.

Three speed record player models are also featured in the "C" line, models C-1332 and C-1334. Both of these models are portable types, contained in luggage-type carrying case.

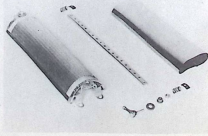
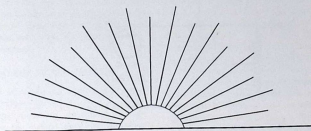


FIGURE 9. Electrostatic speaker components



SPATIAL DISTRIBUTION

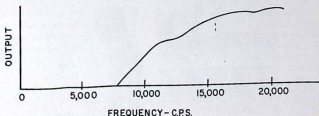


FIGURE 10. Characteristics of Philco condenser speaker

The record player in each model is similar, with a control for $33\frac{1}{3}$ LP, 45 RPM and 78 RPM record speeds. The crystal cartridge employed is the flip-over type for the various speed records.

The circuitry of both models, however, differs in the audio amplifier sections and the power supply. The model C-1334 contains a two tube amplifier section, with a 12AV6 tube as the 1st audio amplifier and a 50L6GT as the audio output. A 35W4 tube is used as the rectifier for the B+ supply. Audio output is three watts.

The model C-1332 contains a one tube audio amplifier with an output of 1 watt. The tube employed

is a 25L6 with the filaments in series with the 90 volt phono-motor. A selenium rectifier is used in the power supply. Figure No. 13.

The turntable is held in place by a "C" clamp and removal of the turntable exposes an opening in the turntable shelf which permits easy replacement of the 25L6 tube.

Both players, the C-1332 and C-1334 contain a spring loaded 45 RPM adapter spindle, which depresses when a standard record is placed on the turntable to permit the standard spindle to engage the record.

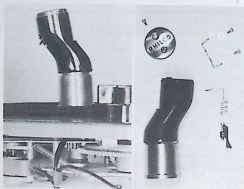
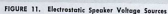
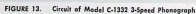


FIGURE 12. 45 RPM spindle shown mounted end with component parts.



NEW PHILCO TELEVISION CIRCUITS

(Part 1)

The 1955 "C" Line Television Receivers feature a number of new circuits not used in previous Philco models. In this article the new circuits will be discussed in order to provide the Service Technician with adequate knowledge of their functions so that the technician, should the need arise, may accurately and rapidly service the receivers.

AUDIO OUTPUT STAGE-TV-300 CHASSIS

The first circuit to be considered, is the audio output stage of the TV-300 chassis series. Although the stage itself is a conventional audio output amplifier employing a 6W6GT tube, the method by which the plate and screen voltages are obtained, in addition to the tube's relationship with the IF stages should be clearly understood by the technician.

If we refer to the service manual covering the TV-300, PR-2812, the circuit diagram shows that the cathode resistor of the 6W6GT tube, instead of being returned to ground, is connected through decoupling networks to the plates and screen grids of all of the receiver's IF stages and also to the screen grids of the video amplifier and the horizontal output stage. Figure No. 1.

Effectively, therefore, the 6W6GT audio output tube is in series with the plate and screen grid circuits of all of the IF stages and the screen grids of the video amplifier and horizontal output tubes. Since the plate and screen grid of the 6W6GT tube are fed by the B plus supply of approximately 260 volts and the cathode circuits of the IF stages are returned to ground, the entire network may be considered as a series of resistances across the power supply, from B+ to ground. The B+ voltage, consequently, will divide itself proportionately across this network. In this manner, at the junction of the cathode resistor and the plate and screen circuits, a B+ potential of approximately 140 volts is obtained and is employed as the B+ supply voltage for the IF stages. Figure No. 2. A B+ voltage is fed to the grid of the 6W6GT tube through a resistor divider network to raise the DC voltage level of the grid close to that of the cathode and thus maintain proper bias of the tube.

Another important action takes place in the circuits of this stage. We mentioned previously that these circuits appeared as a series of resistances across the power supply. However, we must consider both the 6W6GT stage and the combined IF stages as variable resistances, since as the respective tubes conduct to a

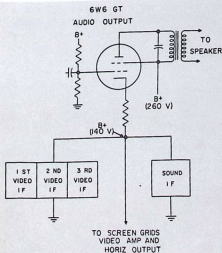


FIGURE 1. TV-300 Audio Output Stage

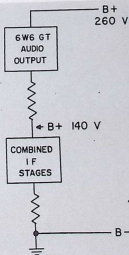


FIGURE 2. Voltage Division of Audio Output and IF Stages

greater or lesser degree the resistance that they represent in the circuit is also changing proportionately. In order to understand the effect this will have on the circuit, let us consider the 6W6GT audio output stage as one variable resistor and the entire group of IF stages, since they are in parallel, the other variable resistor. Figure No. 3A. It is important to note that since this is a series circuit the current is constant.

The load resistance of the 6W6GT tube is indicated by R_p and its cathode resistor as R_k . The plate load resistance of the combined IF stages is indicated by R_{pi} . The cathode resistance of the IF stages has not been indicated for purposes of simplifying the illustration. All of the values of components do not represent actual values but were further chosen for purposes of illustration.

Figure No. 3A represents the normal distribution of the voltages with an assumed current flow of one milliamper. The B+ supply voltage of 140 volts to the plate circuits of the IF stages must remain relatively constant for the stability of the stages.

However, let us assume that very weak signal conditions prevail and the AGC voltage which has been biasing the grids of the IF stages backs down permitting the stages to increase conduction and draw 2 milliamperes of current. It is therefore apparent that one of the series resistances has changed its value. Figure No. 3B. The resistance which has changed value, of course, is that representing the combined IF stages.

This action would normally cause a drop in the B+ supply voltage of 140 volts causing possible instability of the circuits in the IF stages.

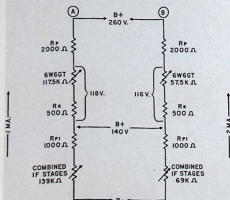


FIGURE 3. Circuit Voltage Regulation Provided by 6W6GT Tube Action

However, the increased current flow to the cathode of the 6W6GT audio tube, since this is a series circuit, drives the cathode more negative, changing the bias on the tube and increasing the current flow through the tube proportionately, thus effectively reducing its resistance in the circuit. Immediately the voltages are redistributed across the circuit and the 140 volt B+ potential is maintained. Figure No. 3B.

Note that this action causes the plate voltage of the 6W6GT tube to drop, however the drop in voltage has a negligible effect upon the normal audio amplifier action of the stage. In this manner the 6W6GT tube regulates and stabilizes the voltage throughout the circuit.

VERTICAL OSCILLATOR-TV-300 CHASSIS

The vertical oscillator section of the TV-300 chassis, which employs a blocking oscillator, also features circuits which were not previously incorporated into Philco receivers. In Figure No. 4 the circuitry of the vertical oscillator stage is illustrated. Note that an auto-transformer is employed in the oscillator, between the grid and cathode to ground. Also, note that the incoming vertical sync signal is fed to the cathode tap on the autotransformer.

For proper service of this section of the receiver the technician should understand the operation of the oscillator and the method employed for triggering or synchronizing.

The basic function of the blocking oscillator is to provide rapid changes from full conduction to beyond

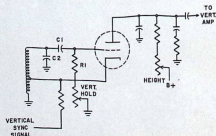


FIGURE 4. Vertical Oscillator Section—TV 300 Chassis

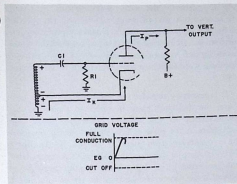


FIGURE 5. Full conduction period of oscillator

cutoff and again to full conduction at controlled time intervals.

As $B+$ is applied to the plate of the triode tube, current begins to flow from the cathode to the plate. The current flow through the cathode winding of the transformer induces a voltage in the grid winding in such polarity as to cause the grid to be driven positive with respect to the cathode, further increasing the initial current flow until full conduction occurs. Full conduction lasts for only an instant. Figure No. 5.

Due to the inductive action of the transformer windings, a reversal of the current flow occurs which in turn causes a reversal of the grid and cathode potentials. The grid is then driven in the negative direction beyond cutoff and the current flow is stopped.

The condenser C_1 which became charged during the initial current flow period momentarily holds the tube beyond cutoff until the charge on the condenser leaks off through resistor R_1 . This is illustrated in figure No. 6A from points A to B. The interval represented by points A to B is the period during which the condenser discharges and the grid rises out of cutoff.

As the grid reaches conduction level, the tube again rapidly rises to full conduction, the autotransformer again causes the voltage reversal and the entire process is repeated.

The plate voltage waveform during this period is shown in figure No. 6B. Note that during the period that the grid rises to full conduction, the plate voltage drops to a minimum. When the grid voltage drops down beyond cutoff due to the reverse E.M.F. of the autotransformer the plate voltage rises to maximum, since the current flow to the plate is cut off. The plate voltage remains at maximum, while the grid

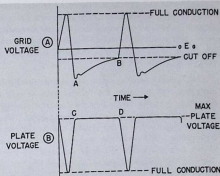


FIGURE 6. Oscillator grid and plate voltages

condenser C_1 is discharging and the grid rises out of cutoff to the point of conduction. This period of maximum plate voltage is indicated in figure No. 6B as the interval between points C and D.

The grid of the tube is now being driven positive again, the tube is conducting and the plate voltage drops to minimum. As can be seen from the illustration therefore the wave form at the plate is rectangular in shape.

The conduction period of the oscillator is controlled by the natural oscillation rate of the circuit, while the cutoff period is controlled by the time constant

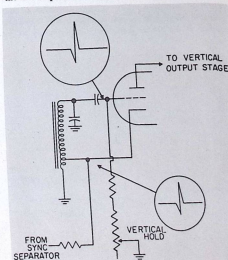


FIGURE 7. Action of autotransformer on sync pulse

formed by R_1 and C_1 . In the receiver circuitry therefore a variable resistor is placed in series with the grid resistor R_1 in order to control the oscillator frequency or in other words to shorten or lengthen the discharging period of the condenser C_1 indicated as the period A to B in figure No. 6A.

The oscillator requires a positive pulse for synchronizing purposes, however, the vertical pulse from the sync separator plate feeding to the oscillator through the integrator network is a negative going pulse. The negative pulse is fed to the cathode tap on the autotransformer. The inductive and transformer action of the autotransformer causes a large positive overshoot on the sync pulse at the same time amplifying the pulse to the grid. Figure No. 7. The positive overshoot part of the pulse is used to trigger the oscillator.

Actually the incoming sync pulse is differentiated by the autotransformer action to form the positive overshoot on the pulse. Condenser C_2 on the grid side of the autotransformer is part of the integrator network.

The wave shape in the output of the oscillator is very important since this is the wave shape that will be amplified by the vertical output amplifier for application to the vertical deflection coils. Remember that the waveform applied to the vertical deflection coils must be such that a linear vertical sweep is produced otherwise the reproduced picture will be distorted vertically. The vertical deflection of the electron beam requires that it move evenly down the screen to the bottom and then return rapidly to the

top consequently the wave shape should be similar to a sawtooth shaped wave. However, the vertical deflection coils are, in effect, a series inductance and resistance. In view of this if a pure sawtooth voltage were applied to the circuit, the current wave through the coils would not be a linear sawtooth wave. Figure No. 8.

It is necessary therefore to preshape the wave form from the oscillator plate in order to overcome this characteristic of the vertical deflection coils. The waveform at the plate is first shaped into a sawtooth by a condenser from plate to ground, C_2 in figure No. 9, since it is rectangular in shape as it comes from the oscillator plate. A second shaping network is added, a condenser and resistor in series to ground, C_3 and R_2 . This network further shapes the wave so that in its final form it appears somewhat like a trapezoid.

The shaping network therefore provides a combination of waves to form the trapezoid wave having a linear rise or shape. Figure No. 10. In figure No. 10A, the sawtooth wave is formed by the action of the condenser C_2 in the plate circuit of the oscillator. In figure No. 10B the effect of the series condenser-resistor circuit, C_3 and R_2 , is illustrated. In figure No. 10C, we have the desired trapezoid shaped wave resulting from the combination of the two shaping circuits, which when applied to the vertical deflection coils will provide a vertical sweep that is sufficiently linear to give a relatively undistorted vertical trace.

Part 2 of this article to be continued in the next issue.

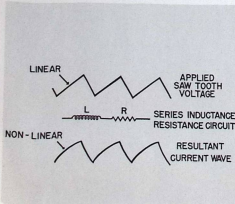


FIGURE 8. Effect of sawtooth voltage applied to series L-R circuit

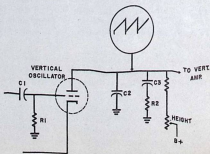
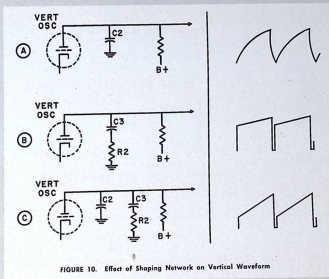


FIGURE 9. Vertical oscillator output wave shape





This month . . .

EUGENE M. KAMINSKI, Service Manager for Artophone Corporation, St. Louis, Missouri, has spent 18 years in Refrigeration and Air Conditioning service. Included were 2 years in the Navy as a refrigeration and air conditioning technician on a battle repair ship. Since the war, Gene has been with Artophone, one of the largest independent distributors in the midwest and winner of the "all-year-round" sales award at the last Philco Convention.

Your Service Manager says ...

... you all know how it was in the Army—if you were a mechanic in civilian life, they made you a cook; if you were a cook in civilian life, they made you a mechanic. If you investigated, you found that they wanted things done the "Army Way", and it was easier to teach a man a new job than to "unlearn" him of his old way of doing things and "relearn" him the Army Way.

All of which brings me to a point that every serviceman should keep in mind. Regardless of how much refrigeration knowledge a serviceman may have, it is still advisable that the procedures set forth in Philco's Service Bulletins be followed to the letter when repairing a sealed refrigerator, freezer or air conditioner unit in the field. Habits formed on open-type units can be costly when applied to the more delicate sealed mechanisms.

Out of the picture is that screw-driver and pliers mechanic who can change only a complete sealed unit. Today's serviceman must have a working knowledge of what takes place *within* that unit.

Philco has started the ball rolling with its unit repair program, and the industry can see its merits. This is being accomplished with Philco's PFSS (Philco Factory-Supervised Service) and is available to all dealers through their distributors. Organized training sessions are being conducted by many distributors to further the working knowledge of each dealer serviceman. These sessions are not only of extreme value to the inexperienced, but they act as a refresher course to the old timer.

At Artophone, the Service Department works on the theory that good service is what sells the next Philco Appliance. Even the smallest dealer can benefit from good service. For instance, he has sold twelve refrigerators in a small town and one fails. If his response to that service call is prompt and efficient, and if repairs are made on the job, he has sold good-will. On the other hand, had the call been delayed some two or three days before being made, and another delay incurred waiting for parts which were not properly ordered, he has fostered ill-will. This could easily have been avoided had this serviceman used good judgment and signed up for PFSS, thereby having the proper service manual from which to order. Without them he has undermined the leadership and sales quality built into every Philco product, for, in a small town, bad news travels fast.

Refrigeration service is on the upswing. Come on, fellows, get into it in the right way while it is still in the infancy stage and enjoy the profits it will reap in the future.

URL a

