

PHILCO SERVICE SUPERVISOR



MAY, 1954

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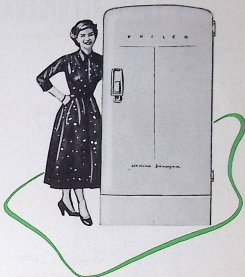
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V-1445 REFRIGERANT SYSTEM REPAIRS

Philco's brand-new, beautifully-styled V-1445 is not only a top-notch freezer, but also an appliance designed for rapid, easy servicing.

Refrigerating circuit-wise, it is divided into two major components, the high-side assembly and the evaporator. The evaporator consists of the refrigerated shelves and associated tubing, and is usually referred to as the "Shelf Assembly".

If the refrigerating system becomes inoperative, the evaporator must be disconnected from the high-side assembly, and the high-side removed. Figure 1 shows the high-side portion of the refrigerating system. (The fan is not a part of the replacement unit.)

A complete charge of oil and refrigerant is furnished with the replacement high-side. The charge is sealed in the system by a dual-valve at the end of the refrigerant lines. Figure 2 shows a cross-section of one of these valves in the closed or bottom-seated position. It is sealed with a cap and gasket.

(Continued On Next Page)

V-1445 REFRIGERANT SYSTEM REPAIRS

(Continued from Front Cover)

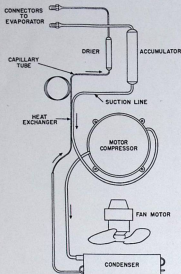


FIGURE 1

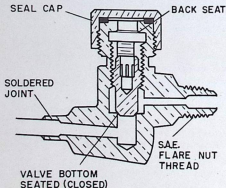


FIGURE 2

To provide an opening between the adapter ports and the dual-valve connectors that lead to the evaporator, the dual-valve body has deep, milled slots cut lengthwise across the threaded portion. These slots are closed to the adapter whenever the valve is back-seated. This allows the refrigerant system to be operated in its normal manner. When the valve is bottom-seated, the slots open the evaporator side of the dual-valve to the adapter ports and close off the motor-compressor section.

Before we delve into the procedures for replacement, let's check and make sure we have the tools and equipment necessary to do the job quickly and efficiently.

First, we must have two valve-adapters. Figure 3 shows one valve with an adapter attached. The adapters provide a means of opening and closing the valves in the assembly without loss of refrigerant. Figure 4 shows two different types of adapters; either may be used with Philco dual-valves.

The dual-valves include two ports for pressurizing and purging purposes. The adapter shown at 4-A has stem extensions that are interchangeable. This type may be used with several types of valves. The square end of the valve-stem extension fits into the adapter, and the splined end engages the stem of the dual-valve.

The adapter shown at 4-B has a continuous valve-stem, and the splined end has been designed to fit a particular type dual-valve.

One adapter should be equipped with the purging tube listed in the following necessary tools and equipments:

1. Halide torch.
2. Prest-o-lite torch for applying heat.
3. Tubing plugs (5/16" and 3/8" to plug the evaporator lines).
4. A set of copper-tube flaring and cut-off tools.
5. Two adjustable wrenches (6" and 8").
6. A ten-pound tank of Freon-22 (moisture content not more than 10 parts-per-million).
7. Purging tube (a short length of 1/4" copper tubing, with 1/4" flare-nut mounted on the tube, a shut-off valve installed near the flare-nut end, and a hose long

enough to carry the refrigerant away from the area and out a nearby window).

8. Pressure gauge.

9. Silica gel drier (this drier must be properly reactivated and kept sealed until just prior to use. At least a one-ounce charge of silica gel is necessary to ensure proper drying. Driers must be reactivated after each operation. To reactivate a drier, open it at both ends and place it in a 300-350 degree oven for 24 hours. Plug both ends immediately after removing the drier from the oven.

If the tools and equipments are all set, let's proceed with removing the old high-side.

Figure 5 shows the rear of a V-1445.

1. Remove the outer cover plate and take out the insulation from the rear cut-out. See figure 6.

2. Apply heat to the inlet and outlet evaporator tubes to make sure they are free of moisture before the system is opened.

3. Check the flare-nuts and make sure they are clean.

4. Back off one of the flare-nuts enough to allow the refrigerant to leak out slowly. A shield should be placed around the flare-nut to prevent the freon from getting into the insulation. This residual freon would make leak testing impossible.

5. Disconnect the evaporator at the flare fitting and plug the open evaporator tubes immediately to prevent moisture and dirt from entering the system. See figure 7.

6. Remove the four base mounting bolts; disconnect the fan motor and relay leads from the wiring terminal strip; and remove the temperature control feeler tube clips. See figure 8.

7. Pull the unit part way out of the cabinet. Do not kink or break the tubing.

8. Remove the fan motor and shroud assembly.

9. Remove the defective high-side from the cabinet and prepare it for crating. Make sure the relay, circuit breaker, and power cord remain with the defective unit.

Now we're ready to put the new high-side in the cabinet.

1. Uncrate the replacement by removing all the screws from each end of the crate, and taking out the screws securing the dual-valve bracket.

2. Remove the bracket from the valve. Check the new unit for leaks using the halide torch.

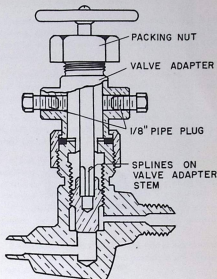


FIGURE 3

FIGURE 4A

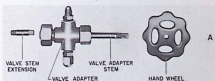
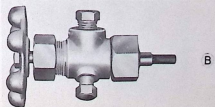


FIGURE 4B



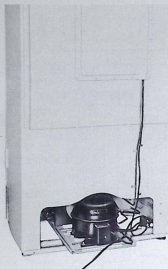
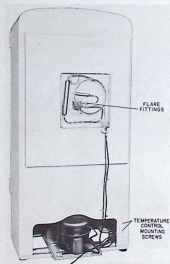


FIGURE 5

FIGURE 6



FLARE FITTINGS

TEMPERATURE CONTROL MOUNTING SCREWS

3. Mount the fan and shroud (removed from the defective unit) to the replacement. Figure 9 shows the replacement unit with the fan and shroud installed.

4. Carefully bend the tubing to the position shown in figure 6.

5. Set the new unit in its mounted position in the machine compartment. Check for leaks. If a leak is detected, do not use the unit.

6. If no leaks are found, remove the valve stem caps, and then install the valve-adapters on the dual-valve as shown in figure 7. Attach the purging line. Check the dual-valve again. If it leaks, bottom-seat the valve immediately. Replace.

7. Connect the leads from the fan motor and relay to the terminal strip. Figure 10 shows correct wiring connections.

8. Secure the unit by installing the four mounting bolts.

9. Remove the plugs from the evaporator inlet and outlet, and dual-valve ports. Immediately connect the flare fittings to the dual-valve assembly. Cap the lines on the defective unit.

10. Clip the feeler tube to the evaporator line as shown in figure 8.

11. Attach a cylinder of Freon-22, a silica gel drier, and a pressure gauge to the valve-stem adapter that leads to the evaporator inlet. See figure 11.

12. Make sure the valve in the purging line is firmly seated. Using F-22 from the charging cylinder

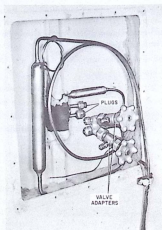


FIGURE 7

pressurize the evaporator tubing to approximately 50 pounds.

13. Leak test. See figure 12. If leaks are found at the flare fittings, retighten the flares. If leaks remain, re-flare the tubing.

14. If no leaks exist, open the valve in the purging line and purge the evaporator. Repeat the pressurizing and purging procedures two more times.

15. After the final purge, remove the purging line and install a cap in its place on the valve-adaptor. Then build up a pressure of 5 pounds in the evaporator.

16. Close the Freon cylinder valve and valve-adaptor ports. Back-seat both valves in the dual-valve assembly. Make sure the valves are turned all the way, because this valve action seals off the valve adaptor from the dual-valve and opens the lines between the unit and the evaporator.

17. Remove the cylinder line, drier and gauge, and then remove the adapters from the dual-valve.

18. Leak test. If no leaks are detected, install the caps with gaskets on the dual-valve. Recheck for leaks. There must be no leaks after recapping.

19. Check the position of the feeler tube. See figure 8. Then install the insulation and rear cover plate. Make sure the permagum seal is continuous.

20. Plug the power cord into the proper power supply and operate the unit. Never operate the unit with the back cover plate removed.

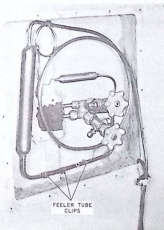


FIGURE 8

21. Make a performance check. This is done by operating the freezer until the temperature of the food compartment becomes stabilized.

After stabilization has taken place, and cycling is occurring, check cut-off and cut-on temperatures. This must be done with the control set in the STORAGE position.

"Cut-off" should occur between -17° and -6° . "Cut-on" temperatures should fall within the -11 to 0 degree range.

So far, we have done a "high-side job" on our V-1445; now let's see how to replace the evaporator or shelf assembly.

A leak anywhere in the evaporator tubing makes it necessary to replace the entire assembly. (The tubing is securely fastened to the shelves, so they must be removed, also.) Procedure for removal is as follows:

1. Remove the rear cover from the cabinet and disconnect the tubing as outlined in the previous procedure for high-side removal.

Remember, even though the high side is functioning properly, it must be replaced to provide a new refrigerant charge.

2. Remove the four hold-down clips on each shelf by taking out one screw from each clip. Then remove the aluminum shelf covers. Take out the removable shelf.

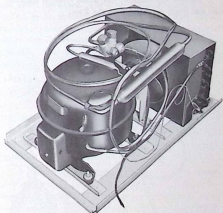


FIGURE 9

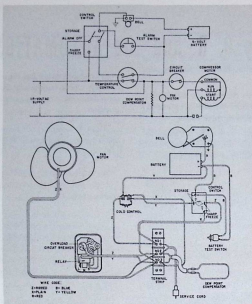


FIGURE 10

3. Remove the polystyrene covers from the rear center of the food liner by driving out the center pin from each nylon rivet. New nylon rivets must be used when the new shelving is installed.

4. Free the tubing from the top of the cabinet liner by removing the six mounting screws.

5. Remove the assembly out of the front of the cabinet and place it carefully on the floor.

To replace the shelf assembly:

1. Carefully remove the assembly from the crate.
2. Reverse the above procedure (removal of the shelves).
3. Connect the new shelf assembly tubing to the new high-side by following the procedures for tubing connections in the high-side replacement.
4. Crate the defective units carefully.

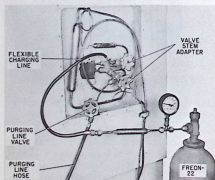


FIGURE 11

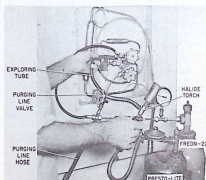


FIGURE 12

The D. R. and the AUTOMATICS

Jim: Hi, Vic.

Vic: Hi, Jim.

Jim: What's new on the Philco front? And don't try to sell me the motor-compressor program again. Bought that one a long time ago. Going all out on it, and the boys really like the idea.

Vic: Well, Jim, guess you took some of the fire out of me. Just hope you're as sold as I am on it.

Jim: Don't worry about that. When Curly came back from school, we could scarcely tie him down. Said it was like the good old days. Turned him loose with the school. Did a real bang-up job.

Vic: Mind if I take a look at your set-up, Jim? Want to send a report back to headquarters.

Jim: O.K. with me, Vic, but before you go out back, how about talking to that new man we've got. You know, Freon Freddy as they call him, wants to get a line on the automatics. Says he works better with things he can understand the workings of. Hey, Freddie, come on over here.

Vic: Hi, Freddy, how's it going?

Fred: Fine, Vic. Not often I get the chance to bend the ear of a Service D. R. Better be set for some tall explainin'.

Vic: Sure, glad to help you on anything I can. Jim says you're a little puzzled by the automatics. Anything special bothering you Fred?

Fred: No, it's nothing special. Just like to get another go around on both types of automatics, especially the new jobs.

Vic: Guess the best thing to do would be to start from the beginning with the system using the solenoid valve and two thermal regulators. That was the system used last year for the first time.

Fred: This year we've got the J-1148, 1149 and 1248 using that system. Right?

Vic: Right, Freddy. Guess you noticed the difference in the controls. The older automatic system has a "Sharp Freeze" position and the new automatics don't.

Fred: That's right. The freezer compartment on the new jobs doesn't go down to 20° below. Is that the reason they put in the solenoid on the older ones?

Vic: Could say it that way. It might be better to say they took the solenoid valve out when they decided to extend the automatics farther down the line. To bring

automatics at a low price, they had to cut the cost so they could do it. By taking out the valve and changing the system a bit, they have given Philco users a fine automatic system at a low price, but without "Sharp Freeze".

Fred: You hit the nail on the head that time. Lots of people who couldn't buy an automatic before buy 'em now and really like what they get.

Vic: Wait a minute, Freddy. I've got some drawings with me and they show the systems real well. Here, these two drawings (figures 1 and 2) show the 20° below system.

Fred: These drawings look like the kind we get in the service manuals. Sure are helpful.

Vic: They are just about the same. Now, see how the older job has two *separately* controlled heat absorbers: One is the conventional evaporator and the other is a cooling plate located at the rear of the food compartment.

Fred: That True Zone plate idea sure seems like a good one. Took me a while to get used to seeing a plate in the compartment.

Vic: I remember hearing once that you could think of the plate as being a part of the evaporator that had been separated and put into a different place. The freezing compartment is completely sealed off from the food compartment so that the temperature in one does not affect the other. The freezer temperature is controlled by its thermal regulator or thermostat. This regulator controls the running of the motor-compressor so that the freezer compartment is the right temperature. Food compartment temperature is controlled by the plate thermostat.

Fred: Can you adjust that plate thermostat?

Vic: Yes and no. It is set at the factory to operate at certain temperatures, but there is an adjustment for altitude variations, though.

Fred: You said the freezer thermostat controls the operation of the motor compressor. So, that means the plate thermostat controls the solenoid valve. Right?

Vic: Right on the button. Remember one thing, however. Lots of people get the operation of the plate thermostat backwards. The contacts are in series with the solenoid valve coil. That means, if the contacts are open the solenoid is not energized and the plunger inside the valve is down and blocking the flow of refrigerant through the by-pass.

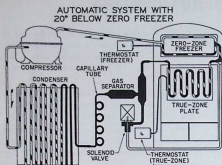


FIGURE 1

Fred: Let's see. This figure 1 shows that. Now all the refrigerant is going through the True Zone plate and freezer evaporator in a series-like arrangement. According to what you have said, that means that the whole refrigerator was warm. The freezer control was making the motor compressor run, and the plate control contacts were open and the valve coil was not energized. I see that O. K.

Vic: Here, Fred, take a look at this figure 2. Now the food compartment has cooled enough so that the contacts are closed and the coil is energized. Now the plunger is up and the by-pass is open. See how most of the refrigerant is now flowing around the by-pass, and only vapor is going through the plate. That's the way the system works when the freezer still calls for cooling, but the plate is satisfied.

Fred: I see what you're driving at. The plate and the freezer evaporator are in series if both need cooling, and if the food compartment is cool enough, the freezer evaporator gets all of the cooling effect since only a small amount of the freon vapor flows through the plate. When the freezer gets to its cut-off temperature, the motor compressor would shut off. That's a nice system, Vic, but what happens if the freezer pulled down faster than the plate and the motor compressor shut off too soon?

Vic: That's impossible because the balance of the control calibration is such that the True Zone plate must be satisfied before the freezer can shut off.

Fred: I see that system good and clear. Now let's start on the new type.

Vic: Well, the new system is simpler and more complicated at the same time. It is simpler because fewer

parts are involved, but more difficult to understand because some deeper refrigeration theory goes along with it. Look at this third figure (figure 3) and tell me what it looks like.

Fred: Let's see. The freon goes through the True Zone plate and then directly to the freezer compartment evaporator. Let me see that figure 1 again. Yep, there it is. Figures 1 and 3 look almost the same as far as freon movement is concerned. Looks like cooling-wise they are the same, right?

Vic: Exactly right. The systems are almost identical. When the solenoid valve is not energized and the plunger is blocking the by-pass there is the same flow of refrigerant as there is in the new system with only one thermostat.

Fred: You said almost identical, Vic. Are you talking about the fact that the 20° below system had the

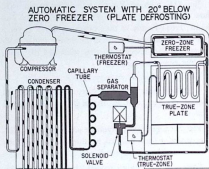


FIGURE 2

valve and the drier and the separator and stuff like that, or are you talking more about that little tube marked "Restricting Tube"?

Vic: That little tube you refer to is the heart of the new automatic system, Fred. And don't think getting the right size and shape of that little piece of tubing was a very simple task.

Fred: Seems a little hard to believe that a little piece of tubing like that could be important like you say it is. Show me. I'm from Missouri!

Vic: O. K., Fred, I'll try, but I won't make any promises. Let's go back a little and see what the problems were that confronted the engineers trying to design this model. They had to devise a fully automatic system that would maintain the zero zone temperature in the freezer compartment, and, at the same time, keep

the food compartment temperature in the 38 to 42 degree range. They knew from past experience that if the system was built with the two compartments separated, but refrigerated in a series-like arrangement they would get a temperature difference. However, this difference was not correct and the proper difference in temperature could not be achieved. They then decided that the thing to do would be to cause a difference in the pressures. That is, make the pressure in the freezer evaporator lower than the plate pressure. This would make the freezer operate at a lower temperature than would happen if there was no difference in pressures. The idea of the restricting tube came into being. It took lots and lots of experimenting, but finally they found that a piece of tubing $2\frac{1}{4}$ inches long and of .064 inch inside diameter served the purpose perfectly.

Fred: Glad you told me about that tubing, Vic. Just in case one of these days I have to change a plate in one of these new automatics, I'll know enough to be extra careful about that piece of tubing.

Vic: Hope everyone remembers that little piece of tubing and its importance to the operation of the refrigerator.

Fred: Hate to admit it, but I still don't get all the way this system works. The engineers have found that the proper size of tubing to be used in this system is .064 inch by $2\frac{1}{4}$ inch. That makes sense. The restricting tube keeps a drop in pressure so that there is that necessary temperature difference between the True Zone plate and the evaporator. But why doesn't one or the other of the two heat absorbers go way off the beam if a big load is shoved into the box? Spell that one out for me, Vic, will you?

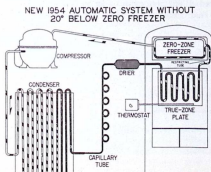


FIGURE 3

Vic: Very good question. Hope I have a good answer for you. Now keep in mind that the operation of the motor-compressor is controlled by the plate thermostat in these newer jobs. The plate thermostat is set to cycle the plate between 0 and 39 degrees. This results in a cabinet temperature of 38 to 42 degrees regardless of climate, season, or usage. At the same time, zero zone freezer temperatures are achieved.

Fred: That 0 to 39 degrees allows for the defrost of the plate. That right?

Vic: Right again, Fred. Now we see that the plate and evaporator are so designed that they will stay within their correct ranges if the refrigerator operates normally. We have also found that because of this design they will tend to follow each other. That is, if the temperature of the freezer compartment should be raised due to a freezer load, the temperature of the true zone plate will also be raised. It might seem that because of this, the temperature in the food compartment would also be raised. However, this is offset by increased run time due to the freezing load. This increase in the run time makes up for the decrease in the refrigerating effect and there is no change in the over all effect.

Fred: Whoa, Vic. Let me try that one on for size. You say that the design of the system — the balance and the restricting tube — make the plate and the evaporator go along sort of hand-in-hand. If the evaporator temperature goes above its normal range, the refrigeration in the plate is reduced, and the lesser amount of refrigeration that occurs in the food compartment allows the motor compressor to operate longer and freeze the load in the freezer compartment without danger of a freeze-up in the lower compartment. Doubt if I could write a book about it, but I think I get the idea. Seems funny having the plate and evaporator following each other. Something new and different, but I think I see that.

Vic: Good man. That is pretty tough to follow, I know, especially the way I tell it.

Fred: Another question comes to mind. Maybe I should say, tell me if I'm on the right track. This thermal stabilizer is in the system whenever the motor compressor is not running. That means you are creating an artificial load to make sure the box cycles enough to maintain 38° to 42° in the cabinet and zero zone in the freezer.

Vic: That is the idea, all right. Another interesting fact about the stabilizer is that it is automatic. That is, if the room temperature was warm and made the refrigerator run more, the stabilizer would be in the circuit less. And, on the other hand, if the room was

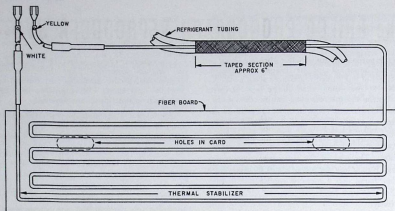


FIGURE 4. Thermal Stabilizer with Taped Section

cold, the stabilizer would be in the circuit more because of the less running time of the compressor.

Where did you learn about the stabilizer?

Fred: Been reading up. Took a look at that J-Line Manual. Noticed that they said that the Thermal stabilizer also makes up for the lack of heat exchanger at the place the tubing from the plate to the evaporator enters the insulation. At least that one short piece of heater that is taped to the tubing. (See figure 4.)

Vic: Glad to see you use those manuals. Most of the men of PFSS like them and use them quite a bit. And, by the way, how has this motor compressor program been going?

Fred: You know how Curly is. That bald-headed bird came back from Philly with his feathers up ready to tear the place apart. He did. Really gave us a good schooling and it has paid off. He's one of the old-

timers who was unhappy to see sealed systems come in. Now that I've been out changing motor compressors I can see why. Not only are the men happy, but the boys in the front office like the idea of the money and less inventory.

Vic: Any complaints or suggestions for us?

Fred: None that I can think of off hand. Might need a new edition of the record on the motor-compressor change. A few of us who were new at the game played that record over and over and looked at that film strip 'til we know them by heart. The record took an awful beating.

Vic: See what I can do about that. If you see one coming your way one of these days, don't think it's one of those flying saucers. Nice talking to you again, Fred. If anything comes up let me know.

Fred: Thanks a million, Vic. See you later.

Manual Corrections

J-Line—PR-2595—J-848 strike number should be $\pm 6062-24$.

E-Line—PR-1910—E-1103 snack box part number should be 8908-32.

The PHILCO PHONOGRAPH REPRODUCER SYSTEM

It is the purpose of this article to bring to your attention the importance of the design considerations and features of our Philco reproducer system. We believe that by presenting some of the facts pertinent to this system and the reasoning behind the development of all the associated components, you, the service technician, will not only gain in knowledge, but also be better convinced of Philco's superior performance. Comparative listening tests made at the Philco Engineering laboratories, under standard home conditions, have proven that our reproducer system is superior. For those who do not have the benefit of this demonstration, we have attempted, through this article, to verbally describe the many reasons for our superiority.

A phonograph reproducer system is made up of three major assemblies: the needle, the cartridge and the tone arm. Where possible, these units will be considered separately; however, each is dependent upon the others and at times must be considered as an overall assembly.

Before becoming involved in the details of construction and operation, let us consider the properties and conditions which must be met by the cartridge and needle assembly for maximum performance.

1. The cartridge must be capable of generating an adequate voltage output over a wide frequency range for the circuit used. The signal to noise ratio must also be high over the entire useable frequency spectrum.
2. The generated voltage output must contain the least possible reproduction distortion. Amplitude levels should be faithfully reproduced as transcribed.
3. The assembly must be capable of tracing the modulation of a groove with sufficient flexibility as to remain at all times in intimate contact with the side walls of the record groove. This property of flexibility in a needle is called compliance and permits low needle pressures. Low needle pressure reduces needle and record wear and is conducive to minimum distortion.
4. The reproducer cartridge should be unaffected by abnormal conditions of temperature and humidity. This requires hermetic sealing.
5. The needle system should have sufficient retractability (another aspect of compliance) to eliminate damage to the record or needle that could otherwise be caused by careless handling.
6. The assembly of the entire reproducer unit should permit assembly of all components without any wide variances from one response characteristic to another. This permits specifications with very close tolerance limits on response.
7. Any reproducer must be properly matched to a tone arm assembly. The resonance caused by the mass of the tone arm and the compliance of the

needle may cause a serious condition of mis-tracking and distortion. Thus, the entire reproducing system, needle, cartridge and tone arm, must in the final analysis be considered as a unit rather than as individual components.

At this point, it should be recognized that in addition to the objectives set forth above, the associated turntable and motor drive system may cause "wow" and "flutter" (speed deviation), rumble, and other extraneous noises which are objectionable for good reproduction. These considerations will not be presented here as they are topics for another article.

Since the tracing of the modulated record groove by the needle is the initial action in the sequence of sound reproduction, we shall first consider the needle and its requirements. The point of the needle should be shaped, polished, and sized for least record wear and best reproduction. Accepted industry standards have established a hemispherical needle point for maximum interpretation and minimum record wear. Maximum polish is also imperative. Best reproduction is obtained when the radius of the needle tip is of such size as to

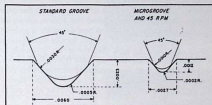


FIGURE 1. Needle Tip to Record Groove Relationships

allow the needle to ride halfway down the side walls of the groove, as shown in figure 1. Were the needle tip radius too large, the needle would ride the top edges of the groove and cause rapid wearing of the record and the needle, quick deterioration of response quality, and very poor tracking accuracy. Were the needle tip too small in radius, the tip would ride the bottom of the groove, and would pick up excessive amounts of noise and distortion found at the bottom of the groove and also cause rapid needle wear. The standardized dimensions for needle tips are .003 of an inch radius for standard play records and .001 of an inch radius for microgroove recordings. Proper reproduction cannot be expected using needles with compromise radii dimensions or with a so-called universal type of stylus using one radius for playing all types of records.

In the beginning of this analysis, let us concede that a perfect recording can be made. Let us also consider a hemispherical point as being the perfect shape for a stylus. The information recorded on this record is in

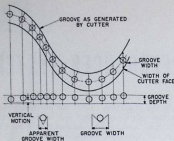


FIGURE 2. Vertical Needle Motion as Caused by Variable Groove Width

the form of a "V" shaped groove. The path this groove follows mainly determines the desired intelligible information to be reproduced. This groove was originally formed in the master by a cutting stylus which has a flat front surface of triangular cross section. Such a tool, when modulated laterally in the process of recording, creates a variable groove width which is dependent upon the angle between the groove direction and the lateral excursion with groove velocity of the modulation. Tracing this groove with the specified hemispherical point, having an effective circular contact area, introduces a degree of amplitude distortion. This type of generated distortion is not as simple as at first indicated, but is actually made up of three distinctly different components. They are mutually perpendicular in reference to the record groove and are, namely: "radial", "vertical" and "tangential". For purpose of illustration, let us look at the groove, see figure 2. When the curvature of the needle radius is greater than the groove curvature created by the modulation, then it can easily be seen that the stylus is unable to fit within the smaller curvature. See figure 3. It, therefore, can't be expected to accurately interpret this portion of the information. This is called "radial" distortion and is one of the factors which sets the high audio frequency limit.

As previously stated, the modulated groove varies in width when being traced by a standard stylus which is effectively a circle. This condition requires the stylus to rise and fall twice for every cycle inscribed in the groove. See figure 2. This is called "pinch effect", a form of vertical distortion.

The third type of distortion, mentioned as "tangential" distortion, is commonly ignored by pickup designers and, therefore, seldom discussed. This type of distortion appears only in a stylus system permitting a degree of freedom in fore and aft motion or compli-

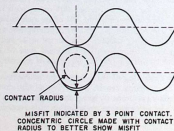


FIGURE 3. Misfit Indicated by 3-Point Contact

ance in the direction parallel to the groove. This undesirable motion produces a type of phase modulation leading to a very serious type of distortion particularly unpleasant in musical selections.

These conditions exist to some degree with all needle systems, especially the "radial" type of distortion. The latter two can be minimized to the extent of inaudibility through skillful designing.

All of Philco's recent designs have reduced these tracking distortions to a new low for the industry.

The control of all point radii on every needle is maintained to the lowest specified tolerance limits with 100% inspection using a 1000 power projection microscope. Philco has continually refused to sacrifice quality in reproduction through the use of universal styli for playing all types of records. For maximum performance and minimum radial distortion, a three mil radius (.003" r) stylus is required for playing standard 78 RPM records and a one mil radius (.001" r) stylus for playing microgroove 33 1/3 RPM records. The most commonly used universal stylus has a two mil radius (.002"). Since the top of the groove in long-play records is only .0025" (2.5 mils) wide, this universal stylus will ride at the top of the groove. In the case of standard 78 RPM groove, the width at the top is .006" and the specifications permit a radius at the bottom of the groove up to as much as .0025". This permits single point contact with the bottom of the groove and causes "skating" and consequently "radial" distortion, rather than the desirable sidewall, two-point contact.

The "pinch effect" previously mentioned introduces an undesirable vertical motion to the needle. This effect can be likened to a rough ride over a corduroy road. Riding over such a road in a wagon, devoid of springs, makes more noise and is much rougher on the rider than riding over the same road in a modern automobile having proper shock absorbing suspension. This same analogy is just as true with phonograph pickups having no vertical compliance as characterized by the heavy, straight needle and one having sufficiently damped vertical compliance as exemplified by the light-weight, bent and offset needle designed by Philco. The straight needle type of pickup is very noisy and exhibits a distorted output in addition to being very destructive to the record and needle's point material.

When a needle reproduces a tone of 15,000 cycles per second it must actually vibrate at this frequency. In doing so, the stylus of this needle must reverse the direction of its motion 30,000 times per second. It is easy to realize that the forces of inertia developed would be prohibitive unless the mass of the needle system is of an infinitesimal amount. The only available constraining force provided in a good system is the vertical needle force of approximately 5 grams. Philco's system is unique in the extreme care with which it is designed to overcome these problems. Research knowledge obtained from the jet engine industry has been drawn upon for selecting the material used for supporting the stylus for playing microgroove records. No metal has yet been discovered with greater tough-

ness and lighter mass than this material originally developed for turbine blades.

It has also been found that even the needle shaft which supports the tip for playing the standard groove must be different from the needle shaft which supports the microgroove tip. Therefore, two different types of metals are used, one for each of the two separate styli. This is because maximum compliance at minimum mass is always the ultimate objective in Philco's needle design.

It has been found that the rate of needle wear on a vinylite record is not the same on a given type of precious metal point as it is on a shellac type of record. For this reason, Philco uses one type of precious metal for the needle tip which plays the microgroove records and a different type of precious metal for the tip which plays the standard shellac records.

Because of the very exacting specifications to which Philco's needles have been designed, great care must be taken in manufacture and testing to maintain all of these specifications. This is the reason why only a genuine Philco replacement needle will perform properly in a Philco pickup cartridge.

The reproducer, to be used in conjunction with the needle system, is the next item in the reproducing sequence of sound from a record. There are many different kinds of reproducers, but they all may be divided into two basic types, namely: amplitude and velocity. The amplitude devices, as indicated by their name, are sensitive to excursion of modulation while the velocity devices are conversely related to the amplitude type by being more sensitive to increasing frequency.

Contemporary recordings are cut with amplitude characteristics up to about 400 cycles. Beyond this frequency, recording is made with velocity characteristics. For this reason, 400 cycles would be called the "turn-over" point in this recording. These recording characteristics necessitate special types of compensation for a pure amplitude device or a purely velocity device to play back with original recording characteristics. Since most types of phonograph pickups are either velocity or amplitude devices, each must operate into compensating or equalizer circuits.

The novel construction of the Philco cartridge combines both of these characteristics. It is a true amplitude device up to the frequency response of a record which is normally the turn-over point. At this point, it diverts from the character of a normal amplitude device and exhibits the characteristics of a velocity device. This novel type of operation results in an overall flat frequency response without special compensation or equalization networks when playing conventional records.

The drive system of a pickup is that mechanical coupling or linkage which transfers the vibrations, picked up by the stylus and needle, to the transducer element. In the case of Philco's pickup this includes the needle holder or chuck, the mounting of the chuck to the cartridge and the linkage between the chuck and

the desired point of flexure of the piezo-electric element. The drive system of this pickup is designed to result in a low "Q" system having excellent transient response characteristics. This means that if a tone burst of sound is reproduced at any frequency in the audio spectrum, it will be reproduced accurately, without any "hangover" or reverberation. Recent techniques developed at Philco have, for the first time, permitted study in transient response of phonograph pickups at frequencies which may extend to twice the top frequency audible to the ear. This method of transient response analysis employs the above mentioned tone burst signal applied to the pickup stylus. The resultant response can then be viewed on associated cathode-ray tube equipment.

Examples of transient waveforms are shown in figure

4. This technique has enabled Philco to design for minor variations of accepted construction and establish a degree of uniform quality which has formerly been considered impossible. This has also been conclusive evidence that no pickup on the market will more faithfully reproduce with a minimum of extraneous noise as the Philco "Phonorama" pickup cartridge.

The establishment of a low "Q" system, which is a system void of resonant peaks, necessitates sound mechanical construction and proper damping of the mechanical members. This technique of proper damping has escaped its due consideration by many of the competitive types of so-called hi-fi pickups. As a concrete illustration, sticky, rubber-like material is commonly used in small cubes on needles and moving elements to lower the "Q" of such systems so as to prevent resonant peaks and their attendant distortion. This material serves the purpose quite well at low audio frequencies. At high audio frequencies this material becomes stiff and unyielding, resulting in a non-linear transformation of mechanical to electrical energy. Good transient response can never be attained at high frequencies with this type of construction. It is interesting to note that all Philco cartridges and needles do not contain any of this material.

Nothing in nature is more perfect and exacting in its construction and reaction to physical motion than a

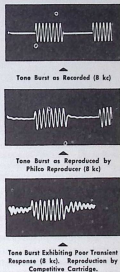


FIGURE 4

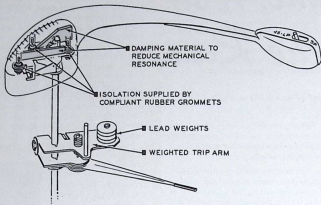


FIGURE 5. PHILCO Tone Arm System

crystal. A crystal is exacting to the dimension of one molecule and serves as an ideal structure when associated with its piezo-electric phenomena. The inherent weakness of such a device when used for phonograph reproduction has been their susceptibility to decomposition, resulting from humidity found in the atmosphere. Philco's experience with earlier designs pointed out the imperative need for a housing and drive system which could be hermetically sealed and thus protect the entire unit from the elements. This feature is included in all Philco pickup designs. Proof of this feature has been repeatedly demonstrated at various Conventions, showing Philco's record changer playing continually under water. No other record changer manufacturer can repeat this performance.

Although each detail of the needle and cartridge must be carefully engineered and manufactured, these two items alone do not necessarily make a satisfactory reproducer system. As important as these two items may appear, the tone arm system is just as critical and should be designed and fabricated with the same degree of care.

Philco's tone arm system is patented and used only by Philco. This unique suspension system is different from any other tone arm at any price. All tone arms, which are used for supporting pickup assemblies used in playing phonograph records, exhibit a natural swinging resonance. This resonance results from the length of the tone arm, from its pivot point to the needle tip, associated with the effective mass of the complete tone arm system and the compliance of the needle employed. This resonant condition presents a problem to every designer of a record playing system. The reason is that the tone arm resonance causes a

bad peak in the response at the frequency of this mechanical resonance. The resultant high amplitude at this frequency causes mistracking and groove jumping.

Philco has overcome this objectionable feature, commonly found in other tone arms, by isolating the tone arm spindle from the tone arm proper through highly compliant rubber members and attaching lead weights to the trip arm assembly. This system is shown in figure 5. This weighted trip arm, when coupled through the compliance provided by the rubber grommets to the tone arm system, results in a resonance of each system. The resonant frequencies of each system are so adjusted mechanically that no peak in electrical response results. Thus, the tone arm system is effectively freed of its mechanical resonance.

In the preceding discussion we have attempted to show the care with which Philco designs and manufactures their phonograph reproducer system. Not only is careful attention paid to the control and operation of each component through production but the entire reproducing system is electrically and mechanically balanced for maximum frequency response characteristics. Thus, it is of prime importance, for the preservation of original quality, to use only Philco replacement units which are specified for that particular model record changer. Each pickup cartridge type is designed to operate only with a particular type of needle; each tone arm is specifically engineered for use with a given type of cartridge and needle assembly.

Philco's phonograph reproducer system is engineered to surpass all competition and you men of the Philco family should always be eager to demonstrate this system with complete confidence in any hi-fidelity system.

Home, Home of the Range

Usually, little or nothing is said about range construction, unless, it is to cuss it. Let's change that a bit, and discuss it, instead.

The few problems we might encounter that could be attributed to construction are usually caused by some oversight on the production line, and are not a fault of the over-all manufacturing process. A good look at the rigorous control, close inspection, and precision of assembly of the range line will bring this point home with great force.

Out in Mount Clemens, Michigan, Philco's Electric Range Division has a real snazzy plant for manufacturing ranges—ranges of consistently superior quality.

Most of us have been in a factory and know how much order exists amid all the apparent confusion of clanking conveyors and beeping lift trucks. It is always interesting to visit a factory, and especially enjoyable to watch activities in a modern plant such as Philco's "ranger."

Now, we described this plant as being "real snazzy", and that means it is the finest and most advanced in manufacturing techniques of range factories in the nation, one with all the modern devices and facilities necessary for efficient production. Let's see what makes this plant such a pace-setter.

First of all, it was designed and constructed solely for range manufacture. This gave designers a chance to start from scratch in design and layout. It also afforded builders the opportunity to work from the ground up and build into this plant all the features the production engineers deemed necessary. Mount Clemens is not a hodge-podge, modified soup factory, but truly an efficiently designed and effectively constructed plant—23 acres worth.

Secondly, all the modern advances of production have been incorporated. Figure 1 shows this quite clearly. Parts are being carried by a conveyor system; something not too unique in itself. But take a look at



FIGURE 1. Process Control System

the lower left-hand corner of the picture. Those boxes are the "brains" of the outfit; they are the electronic controllers. These controllers assure the precise timing and correct determination of the manufacturing processes necessary to meet the high quality standards Philco has set. This control panel is one of many such centers throughout the production line. It typifies the means used to assure uniformity and quality.

We might add, that the planning for the location of the plant helps maintain its high production rate. A major railroad and a network of highways surround it and keep a continuous stream of raw materials pouring into the factory, and a steady flow of ranges going out to America's home makers.

Basically, the story of range manufacture is the story of steel. This rugged metal is used in almost all range parts. Two types of steel are used by Philco: regular high grade sheet, and a special enameling sheet steel. This latter type is required for all porcelainized parts.

As the steel arrives at the plant, huge overhead cranes swoop down and whisk it into the receiving warehouse. Here it is inspected and catalogued, then carried to locations determined by its gauge and type.

Let's see. Here's a stack. Sign says, "18 gauge

enameling steel." Let's follow some and see what happens to it along the way.

First stop is the shearing machine. Here the sheet is cut into pieces of definite length and width, then piled on a skid or pallet. A lift truck chugs up; zoom goes the pallet; and we're off.

Soon a press is banging the blank into a semi-finished shape. Well, what do you know! Beginning to look like we're on the oven door panel assembly line. Looks like one of those giant-sized doors for the "Dream Oven." Wonder if it will be used on a 30- or 40-inch range?

One piercing and trimming press later, two door handle holes and turned-up edges appear. Next press is the last, and edging and corner trimming are completed. So much for the press room.

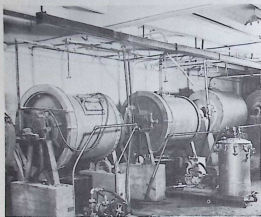


FIGURE 2. Frit Pulverizing Mills

Don your dark glasses and we'll watch the gang spot-welding the brackets used to join the inner and outer door panels. Welding assures perfect alignment and great strength.

The metal finishing department gets the next shot at the panel. Any welding marks are ground off, and edges and rough spots are smoothed.

Now, fabrication is completed and the panel is ready for the cleaning or "pickling" department.

Webster's dictionary says, "pickle is a bath of acid to cleanse surfaces of castings." Let's see what kind of a pickle our panel gets into.

The cleaning operation is automatic. Conveyors carry the parts through a "U" shaped series of vats and booths. Perched in wire baskets suspended from the conveyor, the panels are subjected to pressure sprays of

alkali, acid, water, and neutralizing solutions. After the final treatment, the parts are carried into a drying oven from which they emerge ready for porcelain enameling.

The panel now is removed from the pickling conveyor basket and put on the enameling line. First operation along the enameling line is hand-dipping the piece into a tank of enamel slip. Enamel slip? What's that?

Enamel slip is a very finely ground porcelain frit mixed with water and "aged" in agitating vats. And what is frit? That's a substance used to give density to porcelain.

Frit comes from a smelter in a coarse granular form and is essentially a vitreous compound composed of several minerals. Philco buys smelted frit, then gives it a good going over in our milling department, pulverizing (see figure 2), filtering, mixing, then storing the slip, as the processed frit is called. The mill prepares both the ground coat enamel slip and the white finish enamel slip, and stocks a good supply of each for use by the enameling department.

Hey! Where's our door panel? Oh, yes, just got dipped in the slip and zipped to an oven on the conveyor. This oven, gas-heated to approximately 250 degrees, removes almost all the water from the slip mixture and leaves the enamel frit adhering to the panel in a dry bisque or powder form.

Upon emerging from the drying oven, an additional ground coat of slip is added to each corner of the panel to make sure these spots are completely covered. Corners naturally get a good going over during use, and it is essential that they get an extra good porcelainizing. The two handle holes get a cleaning out to make sure they won't clog during the process of fusing the enamel to the panel.

These last two operations are carried on with the panel again dangling from the conveyor. Another gas-fired furnace (this one at a sizzling 1500 degrees) is the next stop for the panel.

This intense heat causes the enamel to become a molten mass and fuse to the metal panel. After leaving the furnace and cooling, the surface has a smooth, Textured Grey, glossy finish. This coating is carefully inspected for complete covering of the part. If the part is properly processed, it is then placed on a low conveyor and rides under the automatic sprayer (figure 3), where the white finish coat is applied.

Again we are confronted by a precision machine. This sprayer, automatically controlled, covers the part with a smooth, even coating. This is done by spraying

from a controlled-flow nozzle moving with a graceful oscillating motion. This coating of the top portion of the panel is done with such care as to assure the unexcelled beauty, ease of cleaning, and long life Philco demands. The sides of the panel receive a coating of this same finish by hand spraying.

This finish coat requires the same fusing process as the ground coat. It goes through a dryer oven, has the handle holes cleaned again, then continues on through the firing oven furnace. One extra operation previous to firing is required, however. When the panel comes from the drying oven, a template is placed against the panel and the frit is wiped off along the top edge. This enhances the appearance of the door, and makes the edge (showing the ground coat) more chip-resistant.

The coating is heated to the necessary 1500 degrees, and, after it has cooled, gets another close look-see by the inspection department. If the panel passes this strict inspection, it is placed on mobile trucking rack and wheeled into the "Subassembly Station for Doors." This truck rack is constructed of soft wood and accommodates 52 pieces without danger of marring the finish.

In the door assembly department, matching inner door panels, brought in by similar racks, are waiting. These inner panels have been put together with hinges, gussets, and braces, and have been enameled with the ground coat only.

Time out! Let's not pass over this ground coat used on the inner door panels without pausing to notice a thing or two about it. Used to be that these parts got a black or dark blue coat, but not now.

The parts get a special finish. Satin-Titanium is what they call it. Small flecks of the pure white type finish are mixed with the dark base, and the result is this superior finish that gives such good visibility and that extra touch of beauty to Philco's trio of fine ovens: "Dream," "Banquet," and "Thrift."

Assemblers receive an inner and outer panel, as well as handles, mounting screws, and batts of insulation. First assembly operation is attaching the door handle to the outer liner by mounting two screws from the inside. Then, the fluffy fibreglass insulation is installed. The inner door panel is placed on a bench vise and the outer door panel is placed over it. (See figure 4.) The panels are then fastened together by four door screws with trim washers.

The completed door assemblies are plunked

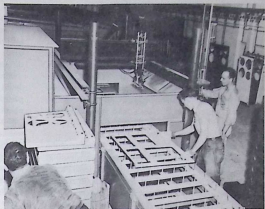


FIGURE 3. Automatic Enamel Sprayer

into traveling pans of an endless conveyor. They pass near the final assembly line at the door-hang point. All the final assembler has to do is reach out, snag one of these door assemblies, and mount it to the range.

Our Dream-sized door is now on the conveyor, and there it goes! Right into the hands of the man on the 40-inch range assembly line.

Let's see how the mounting procedure is carried out.

The front frame of the range has two slots provided for clearance of the door hinges, and two hinge support brackets. The two hinges are passed through the slots, and the hinge bearings are set on the hinge support brackets. Installation is completed by hooking the door coil springs from the range base to the special holes in the hinges.

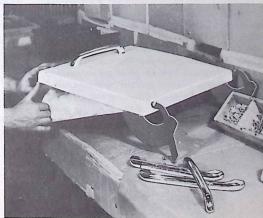


FIGURE 4. Oven Door Assembly

After the completed range is thoroughly inspected, it is securely crated and shipped.

Well, so far we've traced part of the case history of our door panel. And, although we didn't follow it into the kitchen of its proud and pleased owner, we got a very encouraging report about our panel. Owner sounded very happy, but wanted us to make sure we let everybody in on the full story of that durable, glistening white exterior. Let's take that suggestion and find out a little bit more about the story of porcelain finish.

The term "porcelain," when used in reference to the finish of an electric range, can often be misleading. To best describe the finish used on modern Philco ranges, we should say it is a vitreous porcelain enamel. (Frequently a lacquer synthetic enamel is used.)

Philco's porcelain enamel is fused to the metal panels as a consistently-composed unit, and is one of the best of this type finish yet devised. Its hard, glossy surface is nonporous and very durable. Lactic acid as found in sour milk and vegetable juices does not affect this finish as it does so many others. Citric acid, another trouble-maker for finishes, has very little effect on this rugged coating.

As we have seen, the vitreous porcelain finish is of two different types: the first, or ground coat, is dark blue or black with flakes of satin titanium; and the second, or finish coat, is a pure white. Although all of the white panels have two fired coats of the vitreous porcelain enamel, other parts, such as the oven liner, front frame, inner doors, broiler pans, and baffle receive one coat of durable ground-coat vitreous enamel. The thinner the coat of enamel, the better it is able to withstand injury.

The ground coat, which is composed of a mixture of chemicals, performs the important function of developing adhesion to the steel. While it is the cobalt and nickel oxides that impart the color to the coating, their main job is to act with the other chemicals to develop the necessary adhesion. The materials that go into the vitreous porcelain are pre-mixed and smelted, and the result is a coarse, granular compound called frit. The frit is then mixed with water and ground to an extreme fineness. The grinding and mixing operation is performed in large rotating drums. A great amount of heat is generated during this procedure, so

it is necessary to spray the drums with water to get rid of the heat. It is interesting to learn that this milling operation reduces the frit particles to such a small size that only a very few of them will not pass through a screen with 40,000 holes to the square inch.

After milling, the frit is called enamel slip. To make doubly sure of its purity, the slip is screened and passed through magnetic separators to eliminate any metal particles that might be present.

We mentioned that the steel used for porcelainizing was of a special type. Some complicated physical and chemical properties of this metal make it the best for this type of work. The gauge of the steel also varies, and its thickness is determined by the part of the range it is used on. The top working surface is made of steel that is approximately 0.062 inch thick, or 16 gauge. Other parts, such as our door liner, are made from sheets of steel that are of 18 and 20 gauge size.

The parts that are to be porcelainized have to have special attention given to their design with respect to the curvatures and strength of flanges involved. All curves or bends are kept to more than $\frac{1}{4}$ inch radius whenever possible. These design considerations reduce the possibility of warpage and twisting of the parts during the firing operations.

It is difficult to impress people with the importance of the cleaning or pickling part of the overall operational procedures. All dirt, grime, and grease must be completely removed and the part completely dried.

Most ground-coating is done by dipping! The part is completely dunked into the ground-coat slip, and is then hung on racks designed to maintain the parts at a predetermined angle. This allows the enamel to flow off the part at such a speed that a constant thickness of the coating is maintained. Ground coatings should be from .008 to .012 inch thick.

We've already gone into the firing procedures, so the only other thing we would like to mention, is the fact that the major difference between the white and dark enamels is in the chemicals used. White enamel uses an oxide of titanium instead of the oxides of cobalt and nickel found in the ground coating.

Now that we have gotten a better look at the ways and means of making these Philco ranges, we should appreciate that famous Philco quality all the more.

TELEVISION SERVICING IN THE SHOP

Many television service calls can be readily handled in the home. However, there are cases where a preliminary examination of the receiver indicates the existence of either an obscure trouble or a problem which dictates that extensive repairs must be made and which could not be performed in a practical manner in the home. The problem also may be such that a complete and careful alignment is necessary, or the trouble may be of an intermittent nature, therefore, requiring more than a reasonable length of time in making corrections. Under circumstances such as these, it usually is advisable to remove the receiver to the shop for bench repairs.

The technician should use his own judgment in deciding what service jobs can be performed in the home and those which require shop bench service. Ordinarily the technician's service procedures are limited in scope, in the home, by the customer's presence, possible damage to furnishings, and a minimum of tools, special jigs and equipment. The best policy is to remove the receiver to the shop if the symptoms indicate that the trouble cannot be found and corrected in a reasonably short time.

If it is considered necessary to remove the receiver to the shop, the technician should be tactful when informing the customer of his intentions.

Some television receiver owners are of the opinion that the main reason for the technician taking the receiver to the shop is to present an exorbitant repair bill, or perform some illegitimate service on the receiver without his knowledge. Consequently, it is the best procedure for the technician to clearly state his reasons for taking the receiver from the home. The technician should explain that it is not possible for him to take along on his call bulky or elaborate test equipment, and that such equipment must be used only in the shop. The customer should be informed that the problem, although not serious, requires the use of this specialized test equipment.

The customer may naturally wish to know what the cost will be for this shop service. The technician should not attempt to be vague in answering this question, but should answer in a satisfactory manner in order to gain the confidence of the customer. In most cases, the experienced technician should be able to give a reasonably close estimate of the price and time involved in the repair. The ability and

proficiency of the technician in localizing troubles and quoting estimates with a reasonable degree of accuracy should be a part of his training, since these assets greatly aid in developing good customer relationships.

If it is not possible to give an estimate, as may be the case in some instances, the reason should be given to the customer with the explanation that the technician will call the customer from his shop after he has determined the trouble and will then be able to estimate the cost and the time involved, before proceeding with the repair. This, of course, will not be necessary, if the customer does not desire information of this nature but authorizes the removal and repair of the receiver without any stipulations.

The service technician's shop, just as his personal appearance and deportment in the home, can be an important factor in establishing customer relations. A disorderly shop, poorly equipped, or hidden from the customer's view will obviously do nothing to enhance the service technician's reputation in the eyes of a customer who may visit his establishment, perhaps to discuss a service problem.

How and where the shop is located will, of course, depend upon the physical aspects of the building. Although it would be desirable to have the shop located in plain view, this is not always possible. Regardless of where the shop is situated it should be so designed and maintained that a standing invitation can be offered to all customers at any time to visit the shop and examine the facilities. Under no circumstances should the non-technical activities of the shop

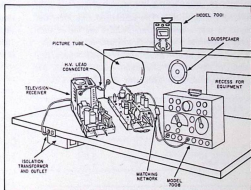


FIGURE 1. Bench Alignment for Either Alignment or Trouble-Shooting Procedures



FIGURE 2. Philco Model 7008 Precision Visual Alignment Generator

be made a mystery to the customer. Such an attitude on the part of the service technician can lead to the customer's distrust of the technician's ability as well as doubt as to the quality of service rendered.

How the shop is equipped will, of course, determine the efficiency with which the technician is able to handle the more difficult service problems in receivers brought to the shop.

It is not necessary for the shop to be equipped with elaborate and very costly laboratory equipment in order to provide efficient and rapid shop service, although such equipment would certainly be desirable if it is within the means of the technician.

The basic test equipment that should be available in a good shop set-up should permit the technician to handle practically any service problem of a shop nature in an expedient manner. The reliability of the equipment is far more important than its elaborateness. The equipment should include a reliable oscilloscope with a wide-band amplifier. The wide-band amplifiers employed in television receivers require the use of such an instrument to view the circuit action.

The amplitude—modulated signal—generator method of RF and IF alignment requires a good RF signal generator. The generator should cover a range

from 10 to 100 megacycles, with a 400 cycle Audio Modulation output. The output RF signal should be strong enough to measure in micro-volts.

A sweep-frequency signal generator should be available, which has a range sufficient to cover the video IF range, the audio IF channel, the audio carrier, the video carrier, and the adjacent audio carrier. This generator will be necessary for sweep-signal method of alignment of the IF sections of the receiver and for tuner alignment.

A vacuum-tube voltmeter with an RF probe will be necessary for high RF voltage measurement.

Another very versatile instrument which is necessary for the service shop is a volt-meter with the following features: a resistance of 20,000 ohms per volt on DC, a normal high voltage range, AC voltage, resistance, and amperage measurement features.

A vacuum tube tester of the type owned by most service technicians should be adequate for shop use.

The necessary insulated alignment tools and special alignment jigs should also be available in the well equipped shop. The alignment jigs, available from the manufacturers, provide a means of connecting the test equipment to the receivers properly. Thus, they eliminate false indications of trouble which can arise from improperly connecting the test equipment to the receiver.

The technician can, of course, add any special pieces of equipment which he feels will be of assistance to him in his servicing procedures, such as a cathode ray tube checker, a frequency meter, a grid-dip meter, equipment for measuring inductive and capacitive reactance, and a linearity generator.

An orderly arrangement of the bench equipment for either alignment or trouble shooting in the shop is shown in Figure 1. The equipment illustrated are a Model 7001 Vacuum Tube Voltmeter and a Model 7008 Visual Alignment Generator. The Model 7008 is a versatile compact piece of test equipment which incorporates in a single unit an RF generator, with modulation facilities, crystal calibrator, sweep (FM) generator, and an oscilloscope, see Figure 2.

Since shop service requires accuracy as well as efficiency, such equipment as may require it, should be accurately calibrated.

The RF signal generator should be calibrated to the frequencies of the sound RF carrier and the video RF carrier for all television stations operating in the locality. This calibration can be performed in an accurate manner, by zero-beating the output of the signal

Peak-to-Peak Volts	R-M-S Volts
100	35.4
50	17.7
25	8.8
10	3.5
5	1.8
2	.7

FIGURE 4. Relative Value of R-M-S Volts to Peak-to-Peak Volts

generator with the signals from various stations. The signals are fed through a television receiver and the zero-beat is observed on an oscilloscope. The type of receiver employed in this calibration set-up must have a design which permits detuning of the local oscillator until the frequency of the sound signal passes into the video channel, and thus causes sound to appear in the picture. Figure 3 shows the set up of equipment in order to calibrate a Philco Model 7170 Signal Generator. The signal generator lead should be coupled loosely to the antenna input leads to the receiver so that the incoming signal is not too strong making it difficult to obtain a good indication of zero-beat. The signal level should be maintained at approximately 1 volt, peak to peak, at the output of the video detector.

The signal generator may be calibrated to the video RF carrier frequencies in a similar manner. The signal generator output, again unmodulated, is beat with the video RF carrier and the near-zero beat is observed as a minimum indication on the oscilloscope. The signal generator should be equipped with a vernier scale for these calibrations.

The signal generator settings should be recorded for future use to establish test signals at the sound RF carrier frequency or video RF channels for all stations in the area.

The oscilloscope is the most versatile of all the test instruments in the shop. It can be used for various purposes; alignment, visual trouble shooting of the receiver circuits, waveform comparisons and reading peak-to-peak voltages.

In order to use the oscilloscope for peak-to-peak voltage measurements, the instrument must be calibrated if the calibration method is not a feature of the particular oscilloscope. The calibration is performed by determining the vertical gain control settings for a specific amount of deflection, when measured values of R-M-S voltages corresponding to the desired peak-to-peak values are applied to the vertical deflection plates of the oscilloscope. The vertical gain control scale should be calibrated for 100 volts, 50 volts, 10 volts, and 2 volts, peak to peak. It is first necessary to determine what voltmeter readings are equivalent to the above peak-to-peak voltages since the ordinary AC voltmeter reads R-M-S voltage. The R-M-S voltage readings when multiplied 2.828 will result in the equivalent peak-to-peak

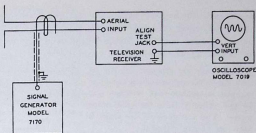


FIGURE 3. Test Setup for Calibrating Generator Vernier Scale to R-F Carriers

values. The scale of R-M-S volts to equivalent peak-to-peak volts is given in Figure 4.

An AC voltmeter, a 20,000 ohm voltage-dividing potentiometer and a line transformer, for isolation purposes, may be used to calibrate the oscilloscope. The horizontal sweep of the oscilloscope should not be used. The set up of the equipment in order to calibrate the scope is illustrated in Figure 5.

The potentiometer is adjusted for a reading of 35.4 volts on the AC meter which is equivalent to 100 peak-to-peak volts. The vertical gain control of the oscilloscope is then adjusted to obtain one or more inches of vertical deflection, depending upon the size of the scope. Lines should then be drawn with a wax crayon horizontally across the scope screen at the top and bottom of the one-inch or more vertical trace, see Figure 6.

The setting of the vertical gain control necessary to give the one-inch deflection should be marked 100 volts at the pointer settings.

The potentiometer is then adjusted until the meter reads 17.7 volts, the vertical gain control is adjusted again for one-inch deflection and the gain control pointer setting is marked 50 volts.

Although the vertical deflection standard is given above as one-inch, this of course, would be for a small screen oscilloscope. A vertical trace of several inches can be employed on the larger scopes. The crayon

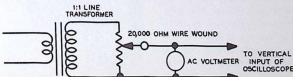


FIGURE 5. Wiring Diagram of Setup for Calibrating Oscilloscope Vertical-Gain Control

markings can also be placed on the celluloid graph screen that usually accompanies the scope instead of directly on the cathode ray tube face.

These steps are repeated for the remaining R-M-S voltage values and upon completion peak-to-peak voltages can be read directly from the oscilloscope screen. The usefulness of the scope is therefore greatly extended.

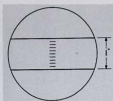


FIGURE 6. Scope Tube Marking for Peak-to-Peak Voltage Measurement

When any piece of test equipment is connected to the receiver, the proper jig or adaptor must be used. This prevents the possibility of oscillation or standing waves being set up in the connecting cables which can give false or misleading information in the test readings. Either the Service Manual covering the particular receiver model or the instruction book accompanying the piece of test equipment will give complete data on the test jigs that should be used. Figure 7 shows a test jig employed in the IF section of certain model Philco Receivers.

The trouble shooting procedures employed in the shop are similar to those employed in the home with the exception that a more detailed procedure is followed in the shop.

The technician should remember that although time is important in servicing either in the home or in the shop, accurate servicing and correction of the problem are of greater importance in the shop for ultimate customer satisfaction.

The trouble-shooting procedure basically consists of localizing the trouble to a functional section or group of related stages, then isolating the trouble to the defective stage in that section, and eventually narrowing the search down to the particular defective part or component.

It is necessary for the technician to be acquainted with the signal paths through the receiver to apply this method effectively. The signal path either forward or backward through the circuits of the receiver, can be followed by means of signal tracing or signal substitution. The oscilloscope is employed in signal

tracing to observe the signal through the various paths in the receiver. In signal substitution, a signal from a generator is injected into the receiver and its effects are observed at the speaker or picture tube. In this manner the defective stage can be easily located and, in conjunction with resistance and voltage checks, the defective component can be located.

Alignment of the television receiver is not a difficult task if alignment of the circuits is undertaken separately, in the right order, and with the proper equipment. The alignment procedures as specified in the Service Manual covering the respective model receiver should be followed. Alignment of the receiver may be necessary if a part is replaced which is vital to the tuned circuits in the receiver, or if tubes are replaced which would cause the alignment to shift or change. Aging of components or parts may also produce a need for realignment. Ordinarily, the quality of the picture received will give sufficient indication whether alignment will be required, particularly when a test pattern is available as means of checking picture quality.

When the receiver is ready for return, the customer should be informed and arrangements made for someone to be available to accept delivery of the receiver. It might be well at this time to inform the customer of the charges and explain what has been repaired on the receiver. A brief explanation in as simple terms as possible, outlining the exact nature of the trouble and the extent of the repairs will usually satisfy the customer. Since the customer will expect to be advised of the nature and extent of the repairs it is always good policy to provide such information. Careless statements which may cause customer dissatisfaction with the receiver or reflect on the quality of the service rendered should naturally be avoided by the technician.

The same good business practices, that would be employed in service calls to the home, should also prevail for service performed in the shop. These business practices include properly equipped and organized shop facilities, tact and courtesy in handling the customer, and adequate technical knowledge for prompt, accurate and efficient service.

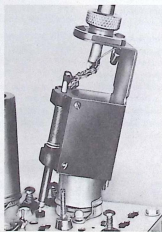


FIGURE 7. I-F Jig, Part No. 45-1470

OSCILLATOR TROUBLES

Many quite competent radio technicians will shy away from a radio which has a suspected oscillator defect, or they will take the defeatist attitude of "I hope I can fix this." On other types of troubles they would probably feel certain that they could locate and fix the trouble without too much grief. It is hoped that this article can take the bugaboo out of many repairs of this type.

The first thing of course is to make sure the trouble is in the oscillator. When this has been done by elimination of the other stages, establish whether the oscillator is or is not working. Measure the plate voltage of the oscillator. Now ground the grid and notice whether the voltage goes down or not. If it does go down, the oscillator was probably working. To make certain check the grid bias with a VTVM or oscilloscope. If the bias is zero it is not working; if it is negative and normal, it is working. The efficiency of operation can be determined by the relationship between what the bias should be according to the schematic, and what it actually is.

As the output of an oscillator varies with the frequency, a weak oscillator may cut off at one or both ends of the dial and operate satisfactorily in the middle although the actual output, even when operating, will be considerably lower than under optimum conditions. This decreased output can be the result of poor emission (Remedy: change the tube), low B plus, or defective grid resistor. Because of the above possibility, it is best to check oscillator operation over the full length of the dial.

Let us assume now that the oscillator on a Model P-5406 is not working on manual push button. The tube is found to be OK so the trouble must lie with the other components. The first suspect might be the oscillator shunt coil. This may be open or partially shorted. An open coil will kill the oscillator and a partially shorted one will either kill it or shift the frequency beyond the adjustable range. To check the coil it is best to unsolder one end, as a resistance check of the uninterrupted circuit places both the oscillator coil and the shunt coil in parallel. It has been found that, in manufacturing the coil, the enamel of the winding sometimes is not cleaned off sufficiently and a poor electrical connection to the lug results. If in doubt, put a soldering iron to all lugs and soldered connections in the circuit.

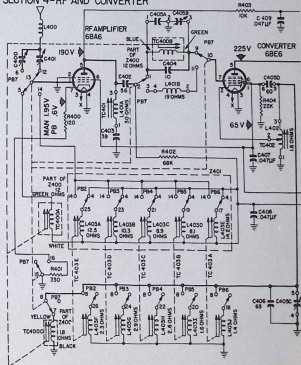
Figure 1 is the complete RF and converter stage of the current Philco-

Mopar auto radio used in Plymouth, Dodge and Chrysler cars. If the above steps have been followed without results, check condensers C405A, B, C and D, C407 and C406. If no positive indication of defect can be found, check C407 and vary C405B and C to be sure that the mica has not broken. This can result in intermittent operation which is sometimes very hard to detect. If a set operates properly on the bench it is almost impossible to be sure that it has been fixed and the serviceman can only keep his fingers crossed when the set goes out to the customer.

Sometimes condensers will open because of humidity, sometimes heat and sometimes cold will cause them to open. It is advisable to find out, if possible, what the conditions were when the set cut out in the car. It may be a good idea to put a box over the set and let it play for several hours or all day. This will cause a considerable rise in operating temperature and the offending part or connection may show up. Sometimes placing the set in a freezer for several hours before operating will give results.

When repairing a Philco-Mopar set remember that there are five push-button oscillator coils and one manual oscillator coil. Unless you know just what the complaint is, it may be any one which is causing the trouble. Also remember that if you find the oscillator is not working, the trouble is definitely located and you can work from there.

SECTION 4-RF AND CONVERTER





This month . . .

EARL QUALLS has been associated with appliances and service for eleven years, the past four years having been devoted exclusively to electronics with Shobe Inc., Memphis, Tennessee. These views of Mr. Qualls relate to the serviceman and customer relationship, or the sales side of service.

Your Service Manager says ...

The service business is growing very rapidly and we, as service technicians, must be able to grow with it, not only in technical knowledge and ability, but also in the customer relations or the sales end of service.

Most every day brings something new in the field of electronics and appliances. Each year model changes present new circuits or mechanisms that must be mastered by the service technician if he is to give efficient and dependable service.

By the same token, each new purchaser of an appliance or electronic product effectively becomes a new field for the service technician to study and try to understand.

Each product owner is a different personality. The first impression they get of a service technician is usually a lasting one and quite often will mean the difference between a happy, satisfied user or a dissatisfied one.

Whether it be a dealer's, or an independent service technician, he must realize that the owner has paid his hard-earned money for a product and in turn expects that product to be the best in the world. When they have trouble the service technician must often resell the product to the owner. If he has not sold himself and his service, it will be very difficult to resell the owner on the product.

We all know that word-of-mouth advertising is one of the best forms of advertising we can get. Satisfied customers will give you this, thereby increasing your sales and service volume.

Let's sum it up—to earn their confidence and assure you of satisfied customers you must:

1. Listen courteously to their complaints and not dismiss them without making an effort to satisfy the customer, regardless of how trivial the complaint may seem to you.
2. Where repairs are made, be fair in your labor charge and charge for parts replaced only.
3. If necessary, spend a few minutes longer in the customer's home so that you may leave them happy and satisfied with you and your service.

When you have gained the customer's confidence in you and satisfaction in your service, you will then see these things come to pass:

1. Your sales and service volume will constantly increase.
2. The number of call-backs will greatly decrease.

The combination of the above means more profit now and assures your future in the service business. Let's all try a little harder to have ALL our customers happy and advertising for us!

