TV RECEIVER SERVICING TECHNIQUES

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STUDY SCHEDULE NO. 63

For each study step, read the assigned pages first at your usual speed, then reread slowly one or more times. Finish with one quick reading to fix the important facts firmly in your mind. Study each other step in this same way.

☐ **1. Introduction** . . . . . **Pages 1-5**

In this section, you learn some basic facts about television servicing.

☐ **2. Test Procedures and Instruments** . . . . . **Pages 5-12**

The methods and servicing instruments used to locate defects in TV sets are described in this section.

☐ **3. Handling TV Service Calls** . . . . . **Pages 12-18**

Here you review the safety precautions you should take in servicing TV sets and learn how to handle the various kinds of TV chassis, then study the various servicing procedures involved in determining and confirming complaints.

☐ **4. Effect-to-Cause Reasoning Applied to Dead Sets** . . . . . **Pages 18-27**

In this section, you learn how effect-to-cause reasoning can be used to determine the probable location of the defect causing various dead-set complaints.

☐ **5. Sync and Sweep Defects** . . . . . **Pages 28-36**

Here you learn what effects common defects in the sync and sweep circuits have on the performance of a set. You also learn how to use effect-to-cause reasoning in locating such defects.

☐ **6. Answer Lesson Questions and Mail Answers to NRI for Grading.**

☐ **7. Start Studying the Next Lesson.**

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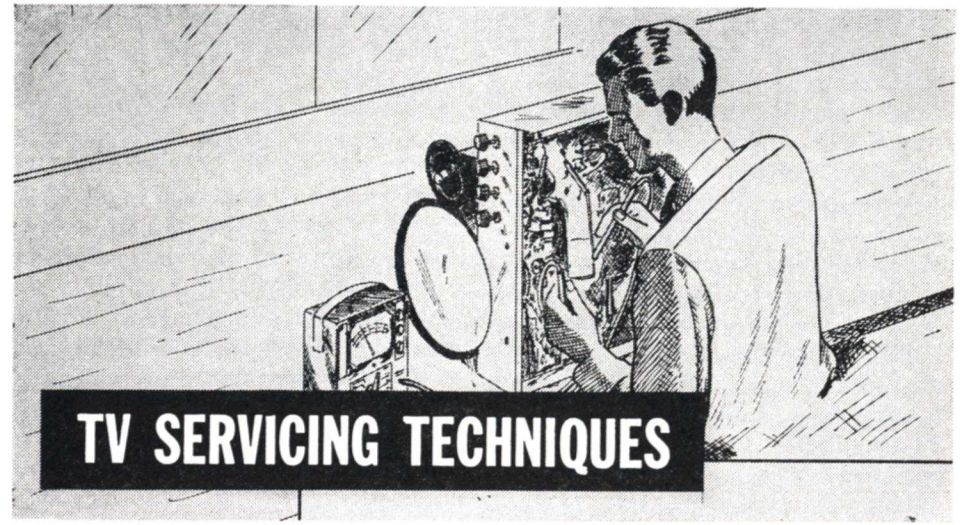


TV SERVICING TECHNIQUES

TELEVISION RECEIVER servicing is in general the same as sound-radio receiver servicing. The same basic troubles exist, the same tools and test equipment are used, and the same general servicing procedures are followed in localizing the troubles. Once the successful *radio* serviceman has learned the fundamentals of television circuits, therefore, he can adapt himself to television servicing without too much trouble. The most successful TV servicemen are today being drawn from the upper ranks of radio servicemen, and this practice will probably continue indefinitely.

We strongly recommend, therefore, that you become an expert radio serviceman before doing any television servicing. Obviously, you will be able to find your way around easier in a 5- or 10-tube sound receiver than in a 20- or 30-tube TV set. Once you have developed your ability to use effect-to-cause reasoning and professional isolation procedures on sound receivers to such a point that servicing them becomes routine, you will be ready to apply your knowledge to the more elaborate television receiver. When you do, you will find that TV sets contain the same kinds of resistors, coils, condensers, and tubes as do sound receivers, plus a few special parts. The same troubles—open circuits, short circuits, and changes in value—occur in all these parts, and the same basic methods of testing them are used.

The use of a large number of stages in a television set makes it somewhat difficult at times to localize the trouble, but in many cases the very complexity of a television set is helpful. As we shall show later in this Lesson, the fact that you have separate paths for the sound, sync, and picture signals will often let you identify the section or even the stage containing the trouble just by watching the picture and listening to the sound. Before you can do so, however, you must have a complete understanding of the circuits involved.

As you know, there are many possible variations of the basic TV circuits. Obviously, you must determine what arrangement of stages is in use in the set on which you are working. In television servicing, therefore, even the expert must rely heavily on circuit diagrams. As we shall show later in this text, the circuit diagram can be

used to speed up the service procedure to a remarkable extent.

However, it is important to have the *proper* circuit diagram. Many sets having the same model number are radically different from each other because improvements have been incorporated in the model after a few thousand sets were produced and shipped. It is not uncommon to find five or six different runs of the same model, some using as many as two or three tubes more or less than others bearing the same model number. Eventually, of course, such radical changing of sets during production will die out; but in the meantime, the serviceman in the television business must make an effort to keep up-to-date with the latest service information. If you handle only one particular line, you can get the information from the manufacturer. If you run or work in a general service shop in which you may be called upon to fix all types of sets, however, you need the television service manuals that cover all sets. These are similar to the radio receiver service manuals with which you are familiar.

In this Lesson, we shall assume that you are a radio serviceman and know the professional procedures that have been described in your Lesson on radio servicing. If you have not yet become expert in these procedures, you must do so to get the fullest use from this Lesson. Even if you are not yet ready for TV servicing, however, you will find the basic procedures understandable and can learn what to expect.

Table 1

6AG5	**6BA6**	**6BG6G**
6AU6	**6K6GT**	**6V6G**
6AL5	**5U4G**	**5V4G**
6SN7GT	**1B3G**	**6AC7**
6J6	**12AU7**	**6W4GT**

Now let's review TV parts and learn more about the kinds of defects that may occur in them.

TV RECEIVER PARTS

Most of the tubes used in television receivers are of the miniature type, because they have low inter-electrode capacities and permit the use of compact circuit arrangements. Two of these are likely to be different from any tubes used in even late-model sound receivers. One is the high-voltage rectifier; the other is the horizontal output tube, which in an electromagnetic sweep system is usually a special type in which the plate lead is brought to a top cap. Table 1 gives a list of the 15 tubes most commonly found in TV receivers; this list will be helpful in arranging a stock. Of course, this list refers to *present* receivers, and there may be changes in the future. Further, these are the *most-used* tubes—not all that are used. TV sets generally use more different tube types per set than is common in sound receivers. In a 30-tube TV set, for example, there may be 17 or more different types of tubes used—only one of most types, but three or four of some of the others. Obviously, your stock must contain all the tubes that are used in the sets you may have to service.

Because tube capacities are made use of in some television circuits, it sometimes happens that a tube will operate in one circuit but will not in another in the same set. A typical example is the case in which tubes of the same type are used as the local oscillator and as an r.f. amplifier. A tube that is used as a replacement for the r.f. oscillator must have internal capacities somewhat like those of the original tube if it is to operate without requiring a realignment of the set. On the other hand, much of the capacity

difference is swamped when the same tube is used as an r.f. amplifier. A tube tester does not show tube capacities, so only a trial of several tubes will permit you to find the best one. Those that aren't usable in one place can be saved for the circuits in which their capacities are less important.

Certain stages are hard on tubes. For example, some of the sweep amplifiers pass rather high peak currents, although their average currents are not much greater than normal for the tube type. However, a tube that is operated in this manner may have a shorter life than it would have in some of the other circuits in the receiver.

Tube defects are by far the most common difficulty encountered in a TV set—far more so than in a radio, both because TV circuits are more critical in their operation, and because many of the other parts that might be expected to break down occasionally are quite commonly oversize in TV sets. For example, it is very common to find practically all of the resistors to be 1-watt or 2-watt sizes instead of the familiar ½- and ¼-watt types that are ordinarily used in radio sets.

Engineers were quite cautious in setting the original ratings for early TV sets because they did not want parts failures and consequent repair bills to set back the introduction of television too much. In addition, not too much was known about the exact limits of parts values for television purposes. It was well known that the eye is quite sensitive to changes in the picture, but it was not very well realized how great a difference in certain part values could occur before the picture was seriously affected. Therefore, most of the resistors were made oversized in their wattage ratings to avoid drifting and changes in value caused by temperature rises. (Heat is more of a problem in a TV set than it is in a radio, because a TV set contains many more tubes, all of which radiate heat.) It has since been discovered that some resistors were made unnecessarily high in rating.

On the other hand, it has been found that certain circuits are even more critical than was originally expected, with the result that some parts have to be held to closer tolerances than is usual in radio receivers. It is rather common to find resistors having 5% and 10% tolerances instead of the 20% tolerances that are acceptable in most radio circuits.

Another change is that the electrolytic condensers used in TV sets are designed to operate under higher surrounding temperatures than are normally found in radio receivers—in fact, they are given temperature ratings in addition to the usual capacity and voltage ratings. For this reason, exact duplicates should be used for replacements of electrolytic condensers in TV receivers.

Many of the paper by-pass condensers used in TV circuits have high voltage ratings—some of them extremely high. An example is the coupling condenser used between the sweep output stage and the deflection plates of an electrostatic tube system, which may be rated at 6000 to 10,000 volts.

The insulation between the plates of most of the coupling condensers and of many of the by-pass condensers is ceramic rather than paper. Ceramic condensers are preferred because they can be very small and yet have high capacity. Their smallness makes it easier to fit them into a crowded television chassis, and minimizes the stray capacity between the condenser itself and the chassis. In addition, their smallness makes it possible to use very short leads, thus reducing the inductive effects of these leads and permitting the condenser to be a more effec-

tive high-frequency by-pass. Some of these condensers, incidentally, look just like resistors. Others are wafers that look like dimes with leads.

Finally, there are a few parts that are found only in TV sets, such as deflection yokes, focus coils, sweep output transformers and blocking-oscillator transformers, to name the most important ones. These special parts are often designed for one particular receiver and must be replaced by exact duplicates if they fail.

Because any disturbance of wire position can be disastrous in high-frequency circuits, you must be sure to put in replacement parts that are of the same physical sizes as the originals and be certain that they are in the same positions and have the same lead dress (position) as the original parts. Because of this requirement, you cannot follow the common radio practice of installing a new part anywhere in the circuit that the proper electrical connections can be made. Further, if there is a defect in only one section of a multi-section part, such as a multiple filter condenser, you must sometimes replace the whole part so that the replacement can be installed in the right position.

It is particularly important to connect a replacement part to exactly the same points as the original. As you learned elsewhere, many tube circuits use separate cathode leads to reduce cathode inductance effects. In such cases, the by-pass condensers must be brought back to the proper cathode terminal to prevent circuit interaction.

Of course, in making a replacement, it is important not to move the wires that are already in the circuit any more than is necessary, because the positions of many of these wires will be quite critical.

At first it may seem that you will need hundreds of special sizes of parts to be able to service the many different TV models. Fortunately, however, TV sets in general follow five or six basic designs used by the leaders, such as RCA, DuMont, GE, Admiral, and Philco; as a result, a stock of replacement parts does not have to be too extensive. Furthermore, television is now chiefly restricted to the larger cities, where the presence of wholesale distributors simplifies the stocking problem. By the time television stations are in the smaller communities, in all likelihood the circuits will be much more standardized than they are now so that not too great a stock will meet most service emergencies.

Although picture tubes have proved to have much longer life than was anticipated at first, they must be replaced from time to time. Since picture tubes are expensive, it is not wise to stock them if replacements are readily available from any nearby supply house or distributor.

Naturally, if you work for or become an official service center for a particular brand of receivers in a particular locality, you will be expected to stock a rather complete assortment of parts for that brand. The manufacturer or his distributor for your locality will help you to select the proper assortment.

TV TROUBLES

In this and the following Lessons, we shall assume that you have been called upon to fix a set that has a definite service complaint. In practice, you will often be asked to fix a set that is simply out of adjustment or that is bothered by outside interference. We shall not, however, repeat here the information given in earlier Lessons on adjusting TV sets and eliminating TV interference.

One thing you must keep in mind is that different brands of sets may differ considerably in their picture reproduction and sound quality. Some sets have very high sensitivity and are intended to operate well in the fringe areas. Others will operate acceptably only in areas where the signal strength is high. If you find that a customer's set is not the type he should have for his particular desires or location, you should recommend a more appropriate one. Don't try to modify his set to make it work—set designing is not your job.

You are quite likely to get a number of calls from customers who misinterpret operating instructions or do not understand the limits of their sets. When you start in business, therefore, familiarize yourself as quickly as possible with the characteristics of the receivers that are sold in your locality so you will be able to set these customers right.

Of course, a TV set amounts to a double receiver containing both a sound and a picture section. Ordinarily, if the picture is normal, but the sound is absent, distorted, or otherwise affected, you can consider that only the sound channel is defective, and you can service it much as if it were just an f.m. sound receiver. In general, we shall assume that you have the ability to run down any such complaints as these, and we shall confine our discussion to service complaints in which the picture is affected.

There are really only two service complaints as far as the video section of a TV set is concerned. Either the set is dead (by which we mean that there is no picture, whether or not part of the set is operating) or the picture is distorted in some manner. There are so many ways in which a picture can be distorted, however, that we shall divide this complaint into the following three classes:

Class 1—picture distortions that are caused by improper adjustment of the controls on the set or by defects that produce the same effect on the picture as a misadjustment does. In this class are all conditions involving sync and sweep defects in which the picture would be normal if the proper synchronization or the proper linearity in the sweep could be obtained. Also included are conditions in which the picture is out of focus, not centered, or tilted.

Class 2—picture distortion in which the picture is normal except for an overlaid pattern or smear that is caused by a defect in the set. A picture that has hum in it or that lacks detail because of loss of low- or high-frequency response caused by defects is in this category.

Class 3—picture distortion caused by receiver mis-alignment. Included here are i.f. oscillation and lack of high-frequency response caused by mis-alignment.

Now, let's take up the basic servicing procedures.

Test Procedures and Instruments

Television receiver servicing can be treated in the same straightforward, logical manner as sound-radio servicing; as a matter of fact, the basic service procedure is the same for both. Fig. 1 gives the 10-step plan for quickly localizing the trouble. Let's consider each of these steps:

1. Determine the Complaint. Your time as a TV serviceman is too valuable to be wasted in unnecessary service calls, so it is important that

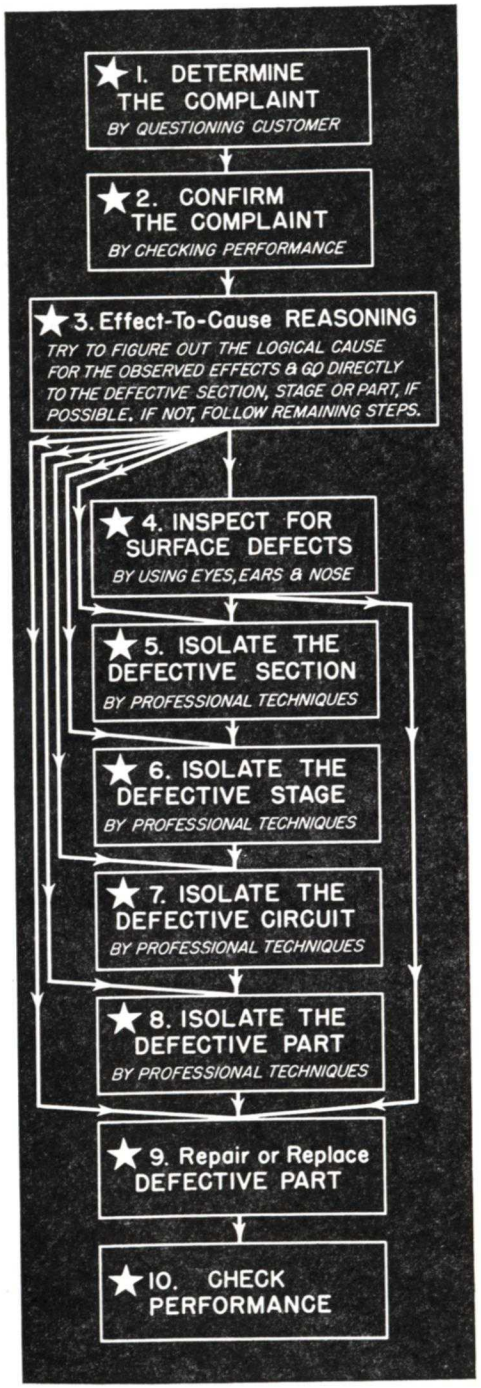


FIG. 1. You will find that this 10-step servicing procedure is as effective when you are locating and repairing defects in TV receivers as it is for radio sets.

you first determine that an actual service complaint exists. If the set owner has called you on the telephone, a little careful questioning may let you diagnose the trouble as something as simple as the fact that the set is not plugged into a power outlet or that the customer is trying to operate the receiver improperly.

In questioning the customer, remember that he does not speak your language; ask questions that will give you the information you need. By asking him to describe exactly what it is he can see on the screen of the tube or can hear from the loudspeaker, you can get a much better idea of the exact nature of the complaint.

If it is impossible to suggest anything over the telephone that the customer might do to localize the trouble himself, you need to know the make and model number of the set (if you do not have this information on file) and must make a service call.

If the customer brings his set into your shop, you will ordinarily plug it in and go on to step 2 at once. Even so, question the customer carefully to determine how the set was performing just before the breakdown that he is complaining about occurred. Some defects will mask others that existed previously. Be particularly suspicious of a dead set, because when you have restored it to life, you may find that another trouble is present that was hidden by the one complained about.

2. Confirm the Complaint. It is best to have the customer himself operate the receiver to demonstrate the complaint. By watching him, you can tell if he just needs further instruction or if an actual defect exists. Once you are sure that the customer has made no error in describing the difficulty and that he is operating the set properly, you can go on to localize the trouble.

You should make sure at this time that the trouble is caused by a defect in the set and not by outside interference. This should not be particularly difficult, since oscillation and internal noise are about the only set defects that will produce an effect on the picture that will resemble the pattern caused by outside interference. The best way to tell whether outside interference is to blame, when you see such patterns, is to try the set in a different location (such as your shop). You might also try a test receiver at the customer's location; however, if the responses of your test receiver and the customer's set are very different, such a test may be misleading. When you have learned enough about the responses of the sets that are common in your vicinity, you will be able to compare the picture on your test receiver with that on the customer's set and determine at once whether any differences you observe are caused by a defect or by the difference in response.

3. Effect-to-Cause Reasoning. Once you have determined and confirmed the complaint, you should try to apply reasoning just as you would in radio service work. Often the indications given by the picture or the sound will lead you directly to the section, stage, circuit, or even part that is defective. Of course, if these indications are so general that reasoning is inconclusive, you must make isolation tests. During such tests, and after each test, however, don't fail to try to re-apply reasoning; every step you can cut out means that you will service the set that much quicker.

4. Inspect for Surface Defects. Although this is given as a separate step, it may well be a part of the confirmation of the complaint or the effect-to-cause reasoning processes. Look for such possibilities as a burned-out tube, plug out of the wall socket, antenna disconnected, etc., before you make any effort to remove the chassis from the cabinet. You will want to see if the tubes light or get warm, sniff for odors indicating overloaded parts, and listen for noises and watch the screen of the picture tube as you rotate the controls while trying the set.

If you find it necessary to remove the chassis, again make a careful inspection. A burned-out resistor or shorted condenser may be entirely obvious once you have the chassis in a position where you can examine the parts underneath it.

5. Isolate the Defective Section. As we shall point out later in this text, many clues may be present that will help to determine what section of the set may be at fault. The fact that both the picture and the sound may be affected by some complaints, whereas other complaints will affect only one or the other, means that you can determine quickly the approximate location of many common troubles. By re-applying effect-to-cause reasoning once you have learned which section is defective, you may be able to go at once to the defective stage, circuit, or part. On the other hand, it may be necessary to make further tests to determine just where the defect is.

6. Isolate the Defective Stage. The same basic professional servicing techniques that are used in radio receiver servicing can be used to check through the defective section to isolate the stage at fault. Once you have localized the trouble to the stage, effect-to-cause reasoning will lead you to make certain definite tests. In particular, unless the trouble is obviously not due to a tube defect, another tube should be tried. Do not depend solely on a test in a tube tester. A tube tester cannot be expected to show if a tube will work as a blocking oscillator or as a horizontal sweep amplifier, for example.

7. Isolate the Defective Circuit. If the trouble proves not to be the tube, and effect-to-cause reasoning does not disclose the circuit or part, then proceed with the usual voltage measurements, continuity tests, and other service procedures for determining the defective circuit.

8. Isolate the Defective Part. Once you have run the trouble down this far, it is usually possible to go right to the most logical part that could be the cause of the trouble. However, it may be necessary to continue the testing procedure within the circuit you have found to be defective until you actually do localize the part. We'll go into these localization procedures in more detail elsewhere, but in general they are identical with the procedures that you have been using on sound radio receivers.

9. Repair or Replace the Defective Part. In most cases, you should use an exact duplicate replacement for the defective part. In some circuits, in particular, the physical size of the replacement is important; you would do well to use the same brand of part in such places. In other circuits, you will not need to use the same brand as long as the electrical characteristics of the replacement are identical with those of the original one. Remember that the tolerances of TV parts are often closer than those of parts used in radio sets.

10. Check Performance. Try the receiver to make sure the customer's complaint has been eliminated. It is always desirable to demonstrate to the customer that his complaint has been corrected and, in cases involving possible misadjusment, to have the customer try out the set in your presence. This will give you an additional opportunity to instruct the customer in the operation of the set and to clear up misunderstandings about the characteristics of the set or its operation.

After you have completed the repair, it is an excellent idea to allow the set to play for a fair length of time to be sure no intermittent defect is present. However, this procedure is not practical when the set is serviced in the home of the customer, (which is a common occurrence in TV servicing), so you may be forced to leave the set in the hands of the customer and thus face a possible call-back in some cases.

SERVICING PROCEDURES

The procedures that are used to localize the defect and to check for the defective part are the same as those you would use in radio service work. That is, you have circuit disturbance, signal injection, signal tracing, stage blocking, etc., as your means of localizing the defect. Naturally, these tests do not operate even in a radio receiver for every single complaint in exactly the same manner, and this is even more true in television.

Circuit Disturbance. For example, the circuit disturbance test can be performed only on a set that has a power transformer and no tube circuits or tube filaments in series, just as in the case of a sound receiver. Anywhere in the path containing the sound system, the circuit disturbance test will operate just as it would for a radio receiver. In the video circuits, however, the circuit disturbance caused by pulling out a tube will result in a flash of light on the picture tube screen. The flash won't get any brighter as you interrupt circuits farther along in the signal chain, so such a test is of value only in the case of a dead set. The test is not greatly used even on a dead set, however, because as we shall show, effect-to-cause reasoning will usually lead right to the defective section.

Signal Injection. Signal injection may be used in the video circuits even though there is no picture, as long as there is a raster on the picture tube. Even a tone-modulated signal generator will produce a pattern (a series of bars) on the picture-tube screen. Generators designed specifically for television service work are modulated so that their signals produce certain characteristic patterns on the picture-tube screen that are useful for television servicing. One such generator, for example, has an output that will produce a series of dots of light that will completely cover the screen if the signal gets through from the point of injection to the grid of the picture tube.

Signal Tracing. The signal tracer with which a great deal of sound radio service work is done does not ordinarily tune to frequencies sufficiently high to be fully useful on TV sets. We can expect that TV tracers will be made available eventually, however. In the meantime, crystal detectors built into probes provide a way of obtaining a signal from a TV carrier that can be amplified by the audio stages of the tracer.

Most of the signal tracing that is being done in TV is with the cathode-ray oscilloscope, because it can be used not only to find out whether a signal is present or not but also to show the wave shape; hence, it is quite useful in running down sources of distortion as well as in locating the defect causing a dead set. A crystal detector probe is used for tracing in the stages ahead of the video detector, but the oscilloscope is used directly in the video, sync, and sweep circuits. A schematic of a typical crystal probe is shown in Fig. 2; more details on the use of the oscilloscope will be given elsewhere.

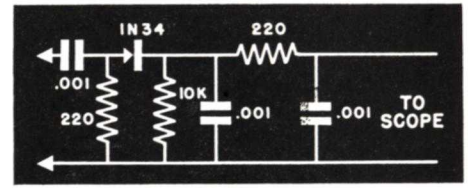


FIG. 2. Schematic of a crystal probe.

As we shall point out, the division of a television receiver into sections in itself provides a certain amount of "signal tracing," and certain other checks can be made within the set to secure the results that signal tracing would give. For example, on a dead set, it is possible to connect a d.c. voltmeter across the video detector load and then to switch from channel to channel by tuning the set. If there is any change in the voltage across the load as the various channels are tuned in, you know that a signal is reaching this point and is being rectified by the detector. The trouble must then be between this point and the picture tube.

Even better, the audio amplifier itself can be used for signal tracing to a certain extent. For example, the sweep circuits produce audio frequencies. It is possible to use an audio signal tracer to follow from the oscillator through the output of the sweep circuit when trouble is encountered in this section. Alternatively, by using a blocking condenser and a test lead, you can feed the signal into the grid of the first audio tube and thus use the audio amplifier of the television receiver as a tracer.

TV TEST EQUIPMENT

Once trouble has been localized to a stage, you will use a multimeter to

measure voltages and to check resistance just as you would in a radio receiver. As a matter of fact, you can take voltage readings throughout the set to locate the defective section and stage if no other test suggests itself.

The ordinary multimeter that is designed for radio service work is entirely adequate for most of the checking that needs to be done in a television set. In general, it is advisable to have a multimeter that has extended low and high ohmmeter ranges, because TV resistors vary from just a few ohms to 10 megohms and more Most of the modern 20,000-ohm-per-volt multimeters are capable of giving the required ohmmeter ranges.

Vacuum-tube voltmeters are also popular, because their high input resistance makes it possible to obtain more accurate readings in high-resistance circuits.

High-Voltage Readings. The multimeter cannot ordinarily be used to measure the high voltage that is supplied to the second anode of the picture tube. Servicemen get around this in two ways; they make a rough check by determining how long an arc they can draw from the power supply, or else they buy a high-voltage multiplier to go with their multimeter.

In checking a voltage by drawing an arc, a screwdriver with a well-insulated handle is used. The screwdriver blade is touched to some grounded bracket or part on the chassis, then the tip of the screwdriver is brought near the high-voltage terminal, and the spark that jumps the gap from the high-voltage terminal to the screwdriver tip is observed. The distance the spark will jump is proportional to the voltage, and with experience it is possible to guess roughly what the voltage is by this method.

Of course, there is some danger in this method, and it is far more accurate to make an actual measurement. For this purpose, a multiplier like the one shown in Fig. 3 is used. Such a multiplier consists of a high resistance built right in the tip of a test probe made especially for the purpose. This resistance acts as a voltage divider with the internal resistance of the multimeter so that the multimeter range is extended. Of course, the amount of resistance needed in a test probe depends on the sensitivity and ranges available on the multimeter. In general, however, these multipliers are designed to go with 20,000-ohm-per-volt multimeters and extend the range to about 12,000 volts. This is entirely adequate for most direct-view receivers except those using the largest picture tubes.

Courtesy Radio City Products Co., Inc.

FIG. 3. High-voltage multiplier probe.

It is extremely important to realize that this multiplier is engineered for the purpose. The resistance is right at the tip, so that the high voltage is beyond the hand holding the test probe. A ring is on the probe to prevent the fingers from slipping down and possibly touching the high-voltage terminal.

In addition to this high-voltage test probe, it is desirable to use test leads that are intended for use in high-voltage circuits. After a few years of use, most test leads have frayed insulation. Since there is always the chance that a lead will make contact with the high-voltage circuit when you are making measurements, you should replace your test leads from time to time with new ones that have insulation capable of withstanding such voltages. We shall later refer to these as leads with high-voltage insulation. Be sure to remember the difference between

these and the high-voltage multiplier lead that has the built-in resistor.

Tube Tester. A vitally necessary piece of equipment for TV servicing is a tube tester. This can be of the same type as those used for radio receiver servicing, since the tubes are similar. However, it must be a late model, capable of testing the newest tubes, because television receivers use the latest miniature types. As we have said, a tube that tests good in a tube tester will not always work in TV circuits in which the interelectrode capacities of the tube are used as part of the circuit capacity. However, when a tube registers bad in a tube tester, it definitely should be replaced; for this reason, a tube tester is a handy instrument for finding defective tubes.

Oscillators. A signal generator like that commonly used for radio service work is a standard piece of equipment for TV servicing. A man going into television service work should purchase a high-grade signal generator capable of producing frequencies in the TV i.f. ranges from 10 to 50 mc. and of covering the TV bands from 60 to 215 megacycles. When you buy a signal generator for TV service and alignment, get the best one that you can afford. A high degree of accuracy in the frequency calibration is necessary; in fact, some of the best ones are crystal oscillators with crystal selectors or exchangeable crystals. One with a calibrated attenuator, giving output readings in microvolts, is helpful.

In addition to the standard signal generator, a wobbulated or sweep signal generator is highly desirable because of its ability to produce a trace pattern of the over-all frequency response. We shall discuss both types of oscillators in more detail in the textbook on alignment.

In addition to the r.f. oscillators, a good audio oscillator is desirable, and certain other special signal generators such as a cross-hatch unit will prove helpful in many instances. (These instruments will be covered elsewhere.)

R-C Tester. Another standard service instrument that is very much used in TV service work is the R-C tester. It is particularly important to be able to check TV condensers for their capacity and leakage values. The resistances used in many circuits are so high that even a very small amount of leakage in condensers is objectionable. There are only two effective ways of testing for leakage: one is to use an R-C tester, and the other is to measure the voltage developed across a known resistance in the circuit. An ohmmeter is not of much use in measuring leakage: for one thing, leakage resistance is so high that an ordinary ohmmeter cannot measure it; and for another, the leakage will often disappear unless the normal operating voltage is across the condenser.

Signal Tracer. As we said earlier, the signal tracer is not of as wide use in TV work as it is in sound-receiver servicing. However, as demand grows, it is quite likely that signal tracers more useful for TV service work will be developed.

Oscilloscope. An oscilloscope that has sufficient sensitivity and that can pass the wide range of frequencies involved can be very useful in TV servicing. Such an oscilloscope makes it possible for you to see the wave shape in a great number of the TV circuits and thus to determine more definitely what is wrong in many of the troubles encountered. In general, the better the high-frequency response of the sweep amplifiers, the better able you will be to see the square and trapezoidal wave shapes. For alignment work, a high-frequency response out to 100 kc. is adequate, but if the oscilloscope is to be used for examining the video and

horizontal sweep signals, it will be necessary to go out at least to 2 mc. and preferably to 4 mc. The low-frequency response must be good down to 30 cycles also if you are to observe the vertical sweep and sync voltages.

The oscilloscope should be especially designed for television work; in particular, it must have a low-capacity input so it can be connected to circuits without upsetting them too greatly.

Monitor. Finally, a very important piece of test equipment for the shop is a monitor receiver, which can be any TV receiver of good quality. In use, the monitor and the set being repaired are tuned to the same station. By comparing the pictures on the two screens, you can tell whether any distortion you see on the screen of the set that is being repaired is caused by a defect in that set or by the signal being transmitted. Because the quality of the transmitted picture often varies considerably, such a monitor receiver has considerable use.

For some complaints, it may even be desirable to have a small portable set that can be carried along to the home of the customer. However, only practical experience will determine whether an investment in such a set is really worth while in your locality. We shall suggest several uses for monitor receivers as we go along.

Handling TV Service Calls

Before we discuss examples of typical calls to indicate the procedure that you should use in determining and confirming the complaint, let us review the safety precautions that should be taken in working on TV receivers and also point out how the chassis-handling procedures that you must use with TV sets differ from those you have used with radio receivers.

SAFETY PRECAUTIONS

There are two basic dangers in a television receiver: the picture tube may shatter because of the very high forces existing on its surfaces; and the voltage applied to the picture tube is high enough to give a severe shock—perhaps even a fatal one. Early texts have given warnings about both these, which we shall summarize here.

Picture Tube. Do not open the picture tube shipping carton or install, remove, or handle the tube in any manner unless you wear shatter-proof goggles and heavy gloves. People not so equipped should be kept away while you are handling the picture tube. Keep the picture tube away from your body when you are handling it.

The large end of the picture tube bulb—particularly that part at the rim of the viewing surface—must not be struck, scratched, nor subjected to more than moderate pressure at any time. If the tube sticks or fails to slip smoothly into its socket or deflection yoke when you are installing it in a set, investigate and remove the cause of the trouble. Do not force the tube. Refer to the text on the installation of receivers for details on how the tube is installed.

Picture tubes come from the factory in special shipping cartons and should be left in these cartons until you are ready to install them in receivers. This carton can then be used for storing or carrying any defective tubes that you may remove in service work.

Disposing of defective tubes is somewhat of a problem. Of course if the tube is still within its guarantee, you will probably send it back to the manufacturer. However, when tubes are worn out and are out of guarantee, they must be disposed of so that they will not create a hazard to other people. Distributors may take back the tubes and dispose of them for you. If not, it will be up to you to get rid of the tube. One manufacturer suggests that the tube be sealed in its standard shipping carton and that a long spike then be driven into the face of the tube through the carton. The tube will shatter, but the shipping cartons are able to withstand the force of the implosion.

You may see TV servicemen who do not take these precautions. These men are taking the risk of being badly disfigured or blinded by a shattered tube. Don't take chances—follow the manufacturer's recommendations in handling the tube.

Also, don't arrange a window display using an evacuated picture tube. Tube distributors can furnish tubes for this purpose that are not evacuated, or which have had air let in. These tubes cannot then implode, so they are safer for this purpose.

High Voltage. The voltages used in TV receivers are in some instances very dangerous, and any high-voltage supply can deliver at least a severe shock.

It is important to remember that a large charge is built up between the coatings on the inside and outside of the glass of a magnetic picture tube when the high voltage is applied to it. These coatings, which are insulated from each other, form a condenser; in fact, this is used as the output filter condenser in many cases. When the high voltage is removed from the tube, the charge remains, since there is no way for it to leak off. As a result, if you ever touch the high-voltage terminal of the tube at a time when you are in contact with the outer coating or with ground, you can get quite a shock. This shock is severe enough to cause you to drop the tube.

It is necessary to be careful about this charge storage even with tubes that are still in their factory shipping cartons. These tubes are tested at the factory and may not have been discharged—and they are capable of storing a charge for a long period of time. Therefore, the fact that a tube is not in a receiver is no guarantee that it will not have such a charge on it. As a safety precaution, before handling any picture tube of this kind, short it by connecting a test lead (with high-voltage insulation) between the external coating and the high-voltage connector on the tube.

When the high-voltage supply is one of the older types operating from a 60-cycle source, it can cause a fatal shock. The flyback or r.f. supplies used in modern receivers are not as dangerous, but they can give a very unpleasant and severe shock that may cause you to hurt yourself by making you fall or jump back against something.

As a matter of fact, the regular B+ supply in most TV receivers is more dangerous than the high-voltage supply, because so much charge is stored in the filter condensers. As a result of this storage, these supplies can furnish a high current; if you happen to connect yourself across the supply at a time when your skin is damp, it is possible to get a very dangerous shock even though the voltage levels are not excessively high. In other words, you should observe safety precautions constantly when you are working anywhere on a television receiver—not just on a high-voltage supply. Among these precautions are:

When working on a TV set, do not stand on a concrete floor. If the shop has such a floor, stand on a board or other insulating material.

Be very careful not to get yourself in the circuit by having both hands any place where they may complete a circuit through your body. As a safety precaution, "keep one hand in your pocket"—that is, force yourself to use only one hand in making measurements. This is easy to do if you clip one test lead to the chassis, then use just one hand to move the other lead about.

It is extremely dangerous to grab a chassis or part if it starts to fall while you are making a measurement. Therefore, always securely support the chassis and other parts so that there is no danger of making this mistake.

It is advisable to use a high-voltage test probe for measuring in the high-voltage supply rather than going through the risky practice of guessing at the voltage by drawing an arc with a screwdriver. The latter process can easily result in your getting a severe shock.

Watch out for the unusually high voltages in the output tube circuits at the ends of the sweep chains. Not only is there danger of shock—if you forget that the voltages there are high, you can easily ruin your multimeter.

The high-voltage supply is ordinarily enclosed in a shield, except, of course, for the lead that comes out to the tube. If there is a reason for you to work on the high-voltage supply, be very certain that the set is turned off before you remove this shield. The shield in many sets has an interlock switch that will automatically disconnect the set from the power line when the shield is open. When the shield is opened, discharge the high-voltage filter condensers before you touch anything. In discharging the filter condensers, be very certain that you use a test lead having high-voltage insulation and that you use only one hand to do so.

HANDLING THE CHASSIS

A major difficulty in television servicing is getting the television chassis and the picture tube out of the cabinet and setting them up to work on them. (For this reason, it is standard practice to do as much servicing as possible with the chassis in the cabinet.) The easiest set to handle in this respect is one in which the picture tube is supported by brackets on the chassis so that the tube and chassis come out of the cabinet together. More difficult is a set in which the front of the picture tube front is supported by the cabinet; here the picture tube must be removed from the cabinet before the chassis can be taken out. In a set in which the picture tube is completely cabinet supported, the chassis can usually be removed without taking out the picture tube. However, for many service procedures the picture tube must be plugged in and operating, so you must find a way to support the tube in an appropriate position outside the cabinet or to bring the chassis close enough to the cabinet so that you can make the proper connections to the tube.

Finally, there are sets in which the chassis itself is divided into a number of sections, each of which is mounted separately. Once the defect has been localized, it may be possible in such a set to remove and service only the defective section without having to take the tube and all the rest of the set out of the cabinet. In other instances, it will be necessary to remove the complete assembly.

Some manufacturers have recognized the problem and have arranged their sets for relatively easy servicing. Some models have cut-outs on the bottom of the cabinet that make it possible to service the sets to a great extent without even taking them from their cabinets.

Removing the Chassis. If it proves necessary to remove the chassis, you should follow the reverse of the installation procedure.

When the picture tube is supported on the chassis, it is usually possible to leave it there and to prop up the chassis so that servicing is possible.

If the tube is partly supported by the cabinet, the tube must be removed before the chassis can be removed for servicing. If the tube is completely supported in the cabinet, it is usually possible to unplug the leads from the chassis to the deflection yoke and focus coil and to remove the chassis without removing the tube. WARNING: In either of these cases, don't operate the set with the coils unplugged or without a picture tube in place. You can service the set (using an ohmmeter), but don't turn on the power until everything is reconnected.

When the trouble requires that the tube be connected and watched during the service procedure, you will have to use your ingenuity to connect parts together and to support the tube. It is necessary to set the chassis up on end so that you can work underneath it. It must be solidly supported in this position so that it cannot fall, and it must be held in such a way that no strain is placed on the picture tube, particularly on its neck.

An important factor to remember in servicing sets with the picture tube in place is the fact that you must never drop tools on the picture tube. Because of this ever-present danger, you should carry out your service procedure with the picture tube well removed from where you are working if it is at all possible to do so. Then, when the defective part has been localized and replaced, you can put the receiver back together to try it out. You may find it practical in some cases to make up a set of extension cables so that the tube can remain in the cabinet or be at a point away from the chassis. Since the cable arrangement depends on the receiver, this system is practical only if most of your work is concentrated on one line of receivers.

TV SERVICE IN THE HOME

Because of the difficulty in getting a set in and out of the cabinet and the possibility of damaging the set or cabinet in carrying it to the shop, it is common practice for a great percentage of TV service work to be carried on in the home.

Occasionally a customer may bring his set to you, but in general the size and weight of the set and its value make the customer reluctant to handle it himself. Therefore, most of your calls will be to homes anyway, and it is logical to carry out as much of the service there as is practical. This is just the opposite of the usual procedure followed in servicing sound receivers, in which it is customary to examine the set in the home only enough to be able to quote a price, and then to take the set to the shop for the repair.

The fact that a great deal of your TV servicing will be carried out in the home of the customer means that you must carry along not only a set of tubes but also a fair stock of generally used replacement parts when you go out on a call. You will need a multimeter with a high-voltage multiplier probe, a tube tester, and an R-C checker as basic equipment. You should also take along a large sheet of canvas or similar material to put down to protect your customer's furniture and rugs while you work. It is becoming a fairly common practice to have practically a completely equipped service shop built into a

truck to go out on calls. Of course, such an elaborate set-up is expensive, particularly for a beginning serviceman.

The bulk and weight of a receiver are usually great enough to make it desirable to have an assistant to help you handle the set. Some service shops do hire assistants for their servicemen. However, the salary of even a laborer is high enough to prevent many from adopting this practice.

Of course, if the repair must be attempted and the necessary parts are not available, or if more extensive test equipment and test procedures are necessary, the set obviously must go into the shop for servicing. The smaller table models are usually carried to the shop in their cabinets, but only the chassis and any other necessary parts of large table models and consoles are taken in.

One item that is not commonly taken along on a service call unless the complaint obviously indicates the need for it is a picture tube. Picture tubes represent a considerable investment, so it is unwise to subject them to possible breakage by carrying them in a truck any more than is necessary.

DETERMINING THE COMPLAINT

When you answer the telephone or talk with a customer about his receiver, remember that he is probably a non-technical man and will probably be unable to describe the complaint accurately until you ask rather direct questions. For example, the customer may say that there is "no picture" when the actual complaint may be that there is no raster whatever, that there is a raster but no picture, or that the horizontal or vertical sync is out of adjustment so that the picture cannot be locked in. Therefore, you'll have to find out from the customer by careful questioning whether he means that he can see nothing whatever, a raster, or a jumbled picture on the face of the tube. Incidentally, the customer won't know what a raster is—he'll probably just say that the picture tube lights up if a raster is present. Additional questioning may be necessary to bring out whether the customer hears a sound or not, and also whether this action is something that is occurring at the moment, happened last night, happened on only one station, or happened on all of them.

Of course, if the customer brings the receiver to you, you will naturally plug it in and see for yourself how it is operating while you are questioning the customer. This questioning isn't a waste of time, because you want the customer to bring out details of the past history of the set so that you will know how it has been operating. It is important to know whether the set has been exhibiting troubles that may be hidden by the present one but that will be apparent when you again get the set into operation.

When you are discussing the set over the phone, you won't have this opportunity to make tests, but you should certainly suggest any test or check the customer might make that will help prevent an unnecessary call. If the set is completely dead, have the customer see that the power cord is plugged in and that the antenna is connected. Suggest that he rotate the front-panel controls—children may turn the controls from their proper settings without the knowledge of the set owner, and he may well believe that something has gone wrong with the set the next time he turns it on. For example, the screen may be blank if the contrast control has been set too high or the brilliancy control too low. The picture may be torn up or completely jumbled if the settings of the hold controls have been changed.

Ordinarily, if the screen of the receiver is completely blank so that no raster or snow can be seen, there is likely to be a defect in the receiver if it is getting power. However, if the set is a radio-TV combination, the picture tube may be cut off because the function switch has been set on radio or phono. Have the customer check this.

On the other hand, if the set is picking up some kind of a signal, and that signal is out of sync or is otherwise distorted or torn up, you should check quickly on your shop receiver to see just what is coming from the station at that time. In many instances a station will be having trouble. Ordinarily, the station will make an announcement that it is having difficulty very shortly after the trouble starts, but once in a while the announcement may be delayed so long that the customer will believe his set is defective. This is most likely to happen when the customer first gets a television receiver and is unfamiliar with television programming.

Of course, in localities where there are other stations that are on the air at the time, you can always suggest to the customer that he try another station if there is any question about whether the trouble is in the station to which he is listening at the time. When reception is poor from only one station, that station is usually at fault.

Of course, if your shop receiver shows that the station is sending out an entirely normal signal, and the customer complains about his reception, something has gone wrong at the receiving location. It is possible for a trouble to appear on only one station if the signal is either very weak or excessively strong at the receiving location. Also, poor contacts in a station-selector switch may cause trouble on only one station.

In questioning the customer, you may find that he turned off his set after some apparent trouble the evening before. Here too, the trouble may have been at the station and the customer may not have waited long enough to find this out. If you know that the station had some trouble the evening before, you can suggest that the customer turn on the set and try it out if the station is on the air at the time he calls. You may suggest this anyway, even when you do not know just what might have happened the night before.

Once your questioning has made it clear that the set is defective, you must make a service call. Here again, TV servicing differs somewhat from radio servicing. There is practically certain to be some radio station on the air at almost any hour at which you are likely to be working. Television stations, however, often present regular programs only during the evening hours and put on programs of test patterns at irregular intervals during the day. You must therefore know exactly when the local stations will be on the air so that you can arrange to make your calls during such times.

If the particular complaint is one that would be easiest to clear up when there is a test pattern on the air, the hours during which you can make your calls will be even more limited. You will have to arrange to carry out your television service calls to suit the station hours; then the rest of your working day can be spent in making such repairs as can be made without a signal or in doing regular radio service work if you are conducting a dual business.

It would be well for you to become familiar with the transmitting habits of the local stations so that you will not be led into assuming a non-existent trouble. For example, many stations send a test pattern that is usually ac-

companied by a tone or other sound modulation. However, this sound modulation may be cut off for a period of about five minutes every half hour or every hour. Therefore, don't think that no sound always means trouble, because the sound may not be being transmitted.

Once in a while you may find that a station is transmitting no picture but is sending out the sync pulses. Either some technical difficulty may have cropped up or the station may be engaged in switching patterns at such times.

You will, of course, become familiar with the characteristics of your local stations after you have been engaged in TV servicing for a while.

CONFIRMING THE COMPLAINT

When you are confirming the complaint, it is best to have the customer demonstrate exactly how he operates the set so that you can see if the complaint could possibly be the result of mis-operation. If the contrast control is turned up too high, the picture will be distorted, or the screen may go completely blank because of overloading. On the other hand, if the contrast control is not turned up high enough, the picture may not sync properly.

Once you have observed the exact operation of the set, you can determine just what class of difficulty exists. This may let you go to effect-to-cause reasoning. You may also look for surface defects, such as unlit tube filaments, and, of course, you should check up to make certain that the set is plugged in, that the antenna is connected, and that any radio-television switch is in the TV position.

Effect-to-Cause Reasoning Applied to Dead Sets

Before it is possible to do much reasoning, it is necessary to know something about the receiver itself. As we said earlier, schematic diagrams of television receivers are important service tools and should be secured if at all possible. Diagrams are necessary because sets often vary considerably in their circuit arrangements and consequently in their defects. For example, a set having one particular kind of high-voltage supply may be able to have a defect that it could not possibly have if a different kind of supply were used.

Therefore, before you can logically reason that there is a defect in a particular section of the set, you must know something about the set itself, which you can learn best from the service data.

Of course, you can make some rather logical assumptions just from the fact that the picture tube is an electromagnetic or an electrostatic type. If it is electrostatic, the set may have a transformerless power supply, it is quite likely to have an r.f.-type high-voltage supply, and may have an intercarrier sound system. On the other hand, if the set uses an electromagnetic tube, it is more common to find a flyback power supply, although a pulse high-voltage supply may be used. The standard sound system is much more likely to be used with such a set also. There are exceptions to all these rules, however, and it is best to *know* just what circuits are in use.

In all complaints involving a dead set, it is important to know what kind of sound system is used and where the sound signal is separated from the video signal.

Fig. 4 illustrates what is known as the standard system. In this kind of set, the sound signal i.f. carrier is 4.5

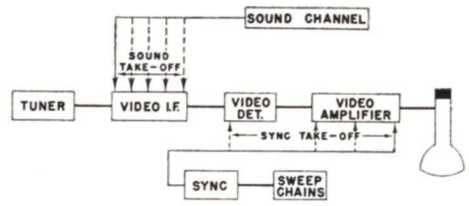


FIG. 4. Block diagram of a standard set.

mc. below the video i.f. carrier, and the sound signal is extracted from the combined signal at some point between the output of the first detector and the last video i.f. stage. The sound take-off point is usually ahead of or immediately following the first video i.f. tube, but it can be after the second or even the third tube. In localizing trouble, it is important for you to know just where this take-off point is, because that tells you just which stages can be involved in particular complaints.

Similarly, it is important to know where the take-off point for the sync signal is. In the most recent receivers, the sync signal is taken from the output of the video amplifier. However, there are many receivers in which the sync take-off is at some earlier point, even as far back as the video detector.

Fig. 5 is a block diagram of a set in which an intercarrier sound system is used. Here, the sound and video i.f. signals come through the same i.f. amplifier to the video detector, where the two i.f. signals beat to produce a 4.5-mc. carrier that has the sound signal on it. It is becoming common practice for the sound take-off to be at the output of the video amplifier, but it may be earlier, at any point beyond the video detector. In such sets, the sync take-off may be at any point between the video detector and the output, with the output connection being the most common in recent receivers.

As an example of why it is important to know where these take-off points are, let's suppose that some defect in a set cuts off both the picture and the sound. The trouble must be between the antenna connection and the sound take-off point or at some point in a low-voltage power supply to which both the sound and video stages are connected. If the power supply is not to blame, you must know the number of stages from the input to the point of sound take-off to make the proper check. On the other hand, if the trouble is with the picture alone and not with the sound, the defect must be between the sound take-off point and the picture tube.

Obviously, the standard set shown in Fig. 4 breaks more handily into sections this way. In a set in which an intercarrier sound system is used,

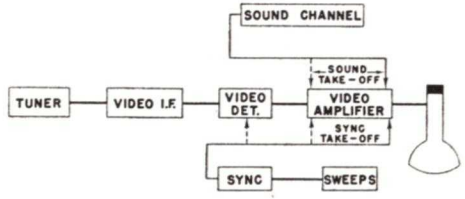


FIG. 5. Block diagram of an intercarrier set.

any trouble in the stages handling the video signal is practically certain to affect the sound signal as well. If the sound take-off is at the output of the video amplifier, there is practically nothing except a defect in the picture tube or in its power supply that could block the picture signal and not affect the sound.

In a similar manner, the presence or absence of a synchronized raster will help to show whether the defect is between the sound take-off and sync take-off points.

It is well to be extremely cautious in your analysis of TV complaints, because there is a great deal of interlocking of circuits through the power supply in some sets and very much less in others. In sets in which there is considerable interlocking, a defect in one section may affect another entirely separate section.

In one receiver, for example, the audio amplifier stages and the video amplifier stages get their bias from the same source. A leaky coupling condenser in the audio stage will cause distortion; but it will also upset the bias, for which reason the picture will be completely torn up. Since the picture circuits are more sensitive than the sound circuits, you may not even notice the sound distortion at first and may believe that you have only picture trouble.

In another receiver, the focus coil current is made up mostly of current from the sound stages, so a defect in the sound stages will again affect the picture.

If the video stages are a.c. coupled, the brightness is completely under the control of the power supply and brightness control. If d.c. coupling is used, however, an upset in the bias of one of the video amplifier stages may blank out the screen of the picture tube. For example, a lack of bias on the output tube or too much bias on the tube preceding the output tube would cause an increase in the voltage drop across the load resistance of the output tube, thereby driving the grid of the picture tube so far negative that the picture would be blanked out.

The extensive use of decoupling in the plate supply leads also may result in some interesting servicing conditions. If condenser C_1 in Fig. 6 short-circuits, for example, the plate voltage will be removed from tube VT_1. If R_2 is a low resistance, and does not burn out, this short in C_1 will reduce the voltage on the other tubes because of the common coupling back through the B supply. In effect, we have shunted R_2 across the B supply in this case.

If R_2 is of high resistance, or burns out, on the other hand, plate voltage will be removed from VT_1 only and the other tubes will be unaffected. Should R_2 burn out, the plate of VT_1 will be grounded through R_1-C_2 and will also show no continuity back to B+. Watch for dual defects of this kind.

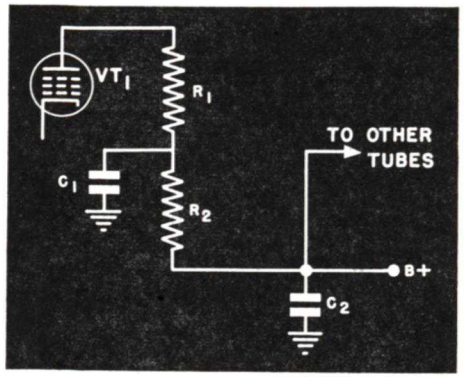


FIG. 6. A short in C_1 may affect other stages.

A more elaborate filtering arrangement is shown in Fig. 7. Here, not only does each stage have its own R-C filter, but also there are other filters for groups of stages. Thus, C_3-R_3 acts as a filter for all of the i.f. stages, each of which also has its own filter. Similarly, C_6-R_6 filters the sweep stages.

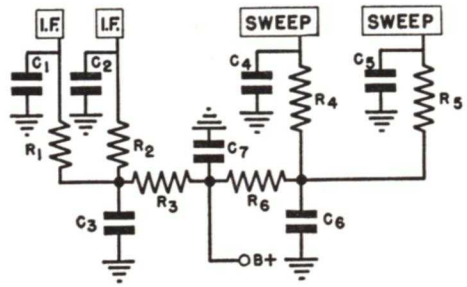


FIG. 7. Filter arrangements as elaborate as this are fairly common in TV sets.

In a case of this kind, a short in condenser C_3 would remove the plate voltage from all the i.f. stages, but a short in either C_1 or C_2 would be most likely to affect only the stage with which it is associated. Similarly, in the sweep side of this circuit, a short in C_6 would remove all the voltage from the sweep circuits. However, if either C_3 or C_6 should short, the other stages in the set may be unaffected if the series resistors R_3 or R_6 are sufficiently high in resistance or burn out as a result of the short.

Another case in which service information can be helpful to you occurs when you get a set in which another serviceman or the set owner has had the tubes out and has replaced them in the wrong sockets. The layout of the set will let you determine whether any such peculiar condition as this exists. Misplacing the tubes may not completely prevent the set from operating but may cause some very unusual operation. For example, in one well-known set, interchanging certain tubes results in apparently normal operation except that the picture is reversed—it is white where it should be black, and vice versa. This comes about because the plate and cathode terminals of the video detector come out to pins that are exactly opposite to the plate and cathode pins of another tube that is used in this set; if these tubes are interchanged, the phase of the output voltage of the video detector will be reversed.

The manufacturers themselves, however, very frequently change tube types because they find that a tube with somewhat different characteristics works better or lasts longer in the set than the one they chose at first. By examining their service notes, you will soon learn which manufacturers are likely to change sets in production this way. Don't always assume that the wrong tubes have been used.

Now that you know some of the reasons why it is necessary to obtain and use complete service information, let's turn now to a consideration of what we shall class as a dead set. First we shall consider the case in which there is no sound but the picture is okay, then we shall take up the cases in which the picture is absent.

NO SOUND—PICTURE OKAY

Most generally, if a TV set reproduces a picture properly, but there is no sound, the trouble is in the sound path between the take-off point and the loudspeaker. Therefore, the trouble must be in the sound i.f., sound detector, audio stages, or loudspeaker. You must remember, however, that misalignment or misadjustment of the fine-tuning control of a standard TV receiver could cause the sound to be absent and yet permit you to get almost a normal picture (unless the set has a.f.c., in which case misalignment or mistuning cannot cut out the sound

without cutting out the picture also). This can happen because the sound i.f. channels are much more sharply tuned than are the picture channels. Therefore, misalignment of the first oscillator or misadjustment of the fine-tuning control may be sufficient to cause the sound carrier to drop out without greatly affecting some pictures. (Naturally, if the picture is a test pattern from which you can determine whether the high or low frequencies are missing, you will see that the picture is really not all that it should be.)

This condition can occur only in the standard set—in a set using an intercarrier sound system, misalignment of the oscillator will not ordinarily be able to remove the sound signal without causing severe distortion of the picture as well. This comes about because the sound i.f. carrier passes through the picture i.f. amplifier in such a set. A misalignment may move the sound carrier off the skirt of the i.f. amplifier response, but such a shift will also cause severe attenuation of the higher frequencies in the picture signal, which is a readily observable condition.

You will sometimes find that the picture is distorted when there is a no-sound complaint. In such cases, look for interaction between sections through the power supply. The audio power output tube, for example, draws a fair amount of current; if this tube becomes defective, the current flow through the power supply may change enough to change the bias on some of the video stages. This could distort the picture.

In general, therefore, if the picture is present and of such quality that the set is apparently not mistuned, but there is no sound, the trouble is probably in the sound section; and it can be run down by any of the methods of localization that you would use on any ordinary sound receiver. This is an example of the use of effect-to-cause reasoning—since the picture is present, we must have high voltage, the picture tube is all right, at least most of the low-voltage supply is operative, and any stages that handle the picture but not the sound signal are apparently working to some extent at least.

If you decide the trouble is in the sound system, you can turn the volume control full on and use circuit disturbance or a similar means of localizing the trouble.

NO PICTURE

The complaint of "no picture" may mean anything from a totally blank screen to a screen showing a controlled raster but no image. The sound may or may not be present.

The various conditions that may be found are summarized in Fig. 8. In brief, this table shows how effect-to-cause reasoning can be used when you have no indications other than what you see on the picture tube and the presence or absence of sound. Let's take a few examples to show how this table was developed.

Blank Screen. When we say that the screen is blank, we mean that there is no image, pattern, raster, line, or spot of light on the face of the picture tube, even when the brilliancy control is fully advanced. Depending on whether or not you get sound, this is the condition that most truly represents a dead set.

If there is no sound, and the screen is blank, the defect has to be one that causes the picture tube to be blanked at the same time that the sound is cut off. This almost certainly means that it is in the low-voltage supply or in the filament circuits. It could not be

NO PICTURE

Picture Tube Indication	Sound	Defect
1. Blank screen No image, pattern, raster, line, or spot even when brilliancy control is fully advanced.	NO	Defect in LV supply or filament circuit.
	YES	Defect in picture tube or in its supplies (LV, HV, or filament).
2. Only a spot of light No image, raster, or line when brilliancy control is advanced. (Indicates picture tube has LV and HV but both sweeps are inoperative.)	NO	Unlocked HV*—Trouble in LV common to both sweeps and to stages between antenna and sound take-off—but not to HV or picture tube. Locked HV**—Combination of shorted horizontal yoke, plus vertical sweep or yoke defect, plus defect between antenna and sound take-off. (Very rare to have triple defect.)
	YES	Unlocked HV*—LV supply to both sweeps. Locked HV**—Horizontal yoke shorted, plus vertical sweep or yoke trouble.
3. Vertical line only No image or raster when brilliancy control is advanced. (Indicates picture tube has LV, HV, and vertical sweep but no horizontal sweep.)	NO	Unlocked HV*—LV supply at some point common to horizontal sweep and to stage between antenna and sound take-off (or to stage in sound section). Locked HV**—Horizontal yoke shorted, plus trouble between antenna and loudspeaker (or in LV supply to these stages).
	YES	Unlocked HV*—Horizontal sweep. Locked HV**—Horizontal yoke.
4. Horizontal line only No image or raster when brilliancy control is advanced. (Indicates picture tube has LV, HV, and horizontal sweep, but no vertical sweep.)	NO	Vertical sweep plus trouble between antenna and loudspeaker (check LV supplies).
	YES	Vertical sweep or yoke.
5. Uncontrolled Raster No image; back-traces visible when brilliancy is advanced. Back traces moving and cannot be locked by hold control.	NO	Trouble between antenna and sync take-off, or between antenna and sound take-off, whichever occurs earlier.
	YES	Trouble between sound take-off and sync take-off or double trouble in sync and video sections.
6. Controlled Raster No image; back traces visible when brilliancy is advanced. Back traces hold or can be locked definitely when hold control is set.	NO	Trouble between sync take-off and sound take-off (requires sync take-off to be first, as in a few intercarrier systems), or defect in both the sound and video sections.
	YES	Trouble betwen sync take-off and picture-tube grid (in video-restorer section).

* Unlocked HV—an r.f. or 60-cycle supply, not tied to sweep.
** Locked HV—a flyback or pulse type that is keyed to the horizontal sweep.

FIG. 8. The table at right shows possible causes of various no-picture conditions.

a trouble in one of the video or sound stages, because the picture tube should still exhibit a raster even if these stages are defective.

Obviously, you should first check to be sure that the set is plugged into a power outlet and that the outlet is delivering power. You can make this check quickly just by looking at the tubes. If the tubes in the set light, power is getting to the set. If the set uses a power transformer, and you observe light in most of the tubes, you can assume that the filament circuits are normal and can go to work on the B supply. If the set uses a filament string, however, it is possible that one string is lighted but that the other one is out because of a burned-out tube or a break somewhere in the string; in this case, it may be that the emission in the picture tube as well as in a sound-handling stage has been affected.

On the other hand, if you have a blank screen but get sound, the defect is almost sure to be in the picture tube or in its supply. When the picture tube filament is in a string with the other tubes, you can usually assume that its filament supply is all right when you get sound, although an unusual arrangement of filaments may be found in some cases that would permit the sound stages but not the picture tube to work. Also, when the low-voltage supply for the picture tube is obtained from the common supply for the other tubes, and the sound section works, you can expect the low-voltage supply to be normal.

There is the possibility, however, that a burn-out at one end of the brilliancy control may not affect the low-voltage supply to any stage other than the picture tube. Don't overlook the possibility of a burn-out of this kind when you find that the picture tube is apparently all right and is otherwise receiving normal voltages. You can be sure that such a burn-out has occurred if a voltage check on the picture tube shows that it is over-biased, and rotating the brilliancy control does not change the bias.

If you suspect the high-voltage supply, you can check it quickly by making an attempt to measure the high voltage at the second-anode connection. Also, if you can see the high-voltage rectifier through the power supply shield, notice whether or not its filament is lighted. If not, either the tube is bad or there is a defect in the circuit that should be driving the tube. If the set has a fly-back supply, something wrong in the sweep circuit would prevent the high voltage from being produced. Watch for fuses in the plate circuit of the sweep amplifier in such cases—if such a fuse has blown, the circuit will not work.

If the high-voltage supply is of the r.f. type, a shorted filter condenser may produce such a drain on the oscillator that the oscillator will stop working, in which case the rectifier tube filament will be unlighted.

On the other hand, if the rectifier tube filament in an r.f. high-voltage supply appears to be normally lighted, but you do not find a high voltage, something is probably wrong in the filter circuit. Since the rectifier filament supply and the high voltage come from the same source (the oscillator tank circuit), this is a logical assumption. However, there is always the possibility that there is a defect in the transformer feeding the plate of this rectifier.

If you find high voltage, and apparently find the low voltages to be normal, and there is no indication of trouble in the filament string, the picture tube itself is about the only remaining possibility if the set uses a.c. coupling in the video amplifier. In this case, try a new picture tube.

If d.c. coupling is used in the video amplifier of the set, however, it is possible for an excessive voltage across the plate-load resistor of the output tube to over-bias the picture tube so much that the screen will be blank. Such an excessive voltage may be the result of a defect in the output tube, a lack of bias on this tube, or an over-bias on a previous stage that is d.c. coupled to the output stage. Voltage readings will usually disclose the source of trouble in this case. Don't overlook the possibility of a defect of this kind in a set that uses d.c. coupling if nothing appears to be wrong with the picture tube and its power supplies.

Spot of Light. In another kind of no-picture complaint, there is no image, raster, or line when the brilliancy control is advanced, but there is a bright spot in the center of the screen. When you observe this condition, turn the brilliancy control down at once—the tube screen will be burned in the center if you allow this spot to be present more than a few seconds.

Since a spot of light can be produced, both low and high voltages are applied to the picture tube to form a beam, but both sweeps are inoperative.

Let's assume that we have no sound with this spot-of-light condition. We next have to determine whether we have a locked or an unlocked high-voltage supply. As you have learned, a locked high voltage is a fly-back or pulse type that operates from a sweep circuit; an unlocked type, such as an r.f. supply, is independent of the sweep.

As shown in the table in Fig. 8, if we have no sound and an unlocked high-voltage supply, the defect has to be in a low-voltage circuit that is common to both sweeps and to the stages between the antenna and sound take-off, but not to the high-voltage circuit nor to the low-voltage supplies for the picture tube (because the latter defects would prevent the spot from being formed). Such a defect might be a shorted by-pass or filter condenser in one of the B+ circuits that does not cut off the low voltage applied to the picture tube. Wherever the short exists, it must have cut off the supply to both the sweep chains and to at least one stage handling both picture and sound signals.

If the set has a locked high-voltage supply, the horizontal sweep circuit must be working up to the point where the high-voltage supply is taken off. If it is a fly-back supply, the only trouble that could exist in the horizontal supply that would not block the high voltage would be a shorted horizontal yoke. In addition, there would have to be a defect in the vertical sweep chain or the vertical yoke and a defect between the antenna and the sound take-off. Thus, there would have to be a double or triple defect to produce the conditions of no sweeps and no sound in a set using a locked high-voltage supply, for which reason such a set is unlikely to exhibit this complaint.

If there is a spot of light and the sound is reproduced normally, the trouble must be in the low-voltage supply to both sweep circuits in a set having an unlocked high-voltage supply. This could be the result of a condition like the one we mentioned in connection with Fig. 7—in which a short in condenser C_6 cuts off the voltage to the sweep circuits, but because R_6 has sufficient resistance or burns out, the voltage supply in the other stages is unaffected. Of course, this kind of trouble can occur only if

the two sweep circuits come from a common point, as they do in Fig. 7, and is therefore likely to be rare.

In a set that uses a locked high-voltage supply, the horizontal sweep circuit must be working up to the high-voltage supply for a spot to be produced on the picture tube screen. The lack of a sweep again means that there must be a short in the horizontal yoke plus some defect in the vertical sweep chain or yoke. It is likely that both the vertical and the horizontal yoke windings are short-circuited.

Vertical Line Only. If there is no picture or raster when the brilliancy control is advanced, but a thin, bright, vertical line is formed on the picture-tube screen, the picture tube has low voltage and high voltage, and the vertical sweep signal is present, but there is no horizontal sweep.

If the set uses a locked high-voltage supply, the lack of a horizontal sweep combined with the presence of high voltage again means that the horizontal yoke must be shorted. If there is no sound, there must also be some other defect.

If no sound is present, and the set has an unlocked high-voltage supply, a defect in the low-voltage supply is blocking operation of the horizontal sweep chain and of some stage between the antenna and the sound take-off or of some stage in the sound section. If sound is present, the trouble must be in the horizontal sweep chain.

Horizontal Line Only. In the converse of the previous condition, there is no picture nor raster when the brilliancy control is advanced, but a bright horizontal line is formed. The presence of this line indicates that the picture tube has low voltage and high voltage, and that the horizontal sweep is working, but that the vertical sweep is not working.

If sound is produced, the trouble is definitely localized to the vertical sweep or the vertical yoke. If there is no sound, there may be some defect in the B supply circuit, or there may be a defect in the vertical sweep plus some other defect in one of the sound-handling stages.

In any of these cases in which the trouble is apparently in the sweep circuits, voltage measurements may disclose the difficulty, or you can use an oscilloscope as a signal tracer, working from the sweep oscillator to the output. In the latter case, you can observe the wave shape as well as determine whether the signal is getting through each stage of the sweep chain.

Since the sweep voltage is an a.c. signal, it can be followed by an a.c. vacuum tube voltmeter. The sound section itself can be used as a signal tracer to a certain extent, particularly through the vertical sweep circuits. If you connect a test lead fitted with a blocking condenser between the grid of the first sound amplifier and your test point, you will hear a 60-cycle hum from the vertical sweep circuit and a very high-pitched squeal from the horizontal circuit if they are working properly. You can start from the sweep oscillator and follow the signal through to the output with your signal-tracing test lead.

Uncontrolled Raster. In still another no-picture complaint, there is neither a picture nor "snow," but the screen is covered by a normal raster when the brilliancy is advanced sufficiently. The back traces for the vertical sweep are easily visible, and these back traces are moving and cannot be locked by the hold control.

The presence of the raster indicates that the picture tube is getting normal low and high voltages and that both sweep circuits are working. However, since the raster is uncontrolled, the sync signal is not reaching the sweep circuits or is not able to control them.

If there is no sound, the trouble must be in some stage between the antenna and the sync signal take-off or between the antenna and the sound take-off, whichever occurs earlier. Thus, in a standard set, in which the sound take-off is in the video i.f. section and the sync take-off is somewhere in the video amplifier, the trouble has to be between the antenna and the sound take-off to block the sound channel. On the other hand, if the set uses the intercarrier system, and the sync take-off is ahead of the sound take-off, the trouble has to be ahead of the sync take-off to produce the uncontrolled raster. An open antenna lead or an oscillator tube that is not working are obvious possibilities that you should check first.

On the other hand, if you find an uncontrolled raster and no picture, but the sound is normal, the trouble is probably between the sound take-off and the sync take-off points. Otherwise, there must be a double defect—one in the sync chain and one in the video stages as well.

Trouble between the sound take-off and the sync take-off is more likely than a double defect in a standard set, in which the sound take-off is at or near the first i.f. stage and the sync take-off is at or near the output of the video section. A dead stage in the video i.f., video detector, or video amplifier sections would be what you should look for.

Controlled Raster. Finally, it is possible to have a no-picture complaint that is like the previous one except that the vertical retrace lines hold or can be locked by manipulating the hold controls. In this case, we say the raster is controlled.

It is particularly important to learn by experience the difference between an uncontrolled and a controlled raster. If the set has very stable sweep circuits, an uncontrolled raster may look like a controlled one because the back traces will stand still for an appreciable period.

If there is a controlled raster but no sound, the stages up to the point of the sync take-off must be all right, so the defect must be between the sync take-off and the sound take-off. Such a condition can occur as the result of a single defect only in a set in which the sync take-off occurs first—in other words, only in a set in which an intercarrier system is used. In a standard set, in which the sound take-off is first, the fact that there is a controlled raster but no sound means that there must be trouble in both the sound and the video sections. If there is any low-voltage supply common to these two sections that might become defective without affecting other stages, you should check this supply and its bypass condensers first.

If sound is present, along with the controlled raster, only the picture signal is missing. There must therefore be trouble somewhere in the video amplifier or restorer stages between the sync take-off and the grid of the picture tube.

In this discussion, we have gone into considerable detail to show you just how reasoning can be used when the complaint is "no picture." As you have learned, the characteristics of the pattern produced on the picture tube indicate at least which sections are not defective and may indicate which one is. The presence or absence of sound and the type of power supply (which you can find out from the diagram) are also sometimes helpful in showing what is wrong.

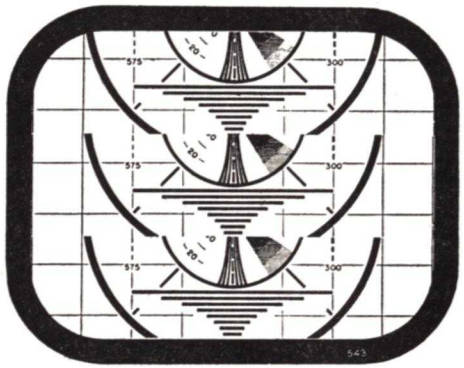
Sync and Sweep Defects

There are a number of defects that occur in TV sets in the sync and sweep circuits. The complaints that we are going to cover in this Lesson are all conditions in which a picture is present in some form on a direct-view set but is jumbled, rolling, non-linear, or otherwise distorted. Although these are not the only complaints that are caused by the sync or sweep circuits, they are by far the most common ones. In general, the sound should be normal in each of these conditions.

Many of these complaints can be caused by a misadjustment of a control. When you are attempting to clear up such a complaint, therefore, your first step should be to try adjusting the control that might cause it before condemning any portion of the set. If such an adjustment cannot clear up the trouble, or if it can be cleared up only at the very end of the control's range, you can safely assume that either some other adjustment is needed or there is an actual defect.

In the following section, we shall describe the complaint and indicate to what extent the defect causing it can be located by using effect-to-cause reasoning. The exact method of running down the trouble will depend on conditions. Obviously, if you can locate the defective section at once, there is little need for making a series of tests elsewhere. If you must run it down, on the other hand, an oscilloscope will probably be the quickest means of localization. The use of the oscilloscope for this purpose will be described in another Lesson.

Let us now discuss some typical troubles and find out just what may be indicated by each of them.



Courtesy Belmont Radio Corp.

FIG. 9. Rapid vertical rolling.

VERTICAL ROLLING

When the vertical sweep chain is working but is not synchronized, either because of a sync chain defect or because of improper adjustment of the hold control, the picture will move up or down. This is usually called "vertical rolling." If the hold control is far out of adjustment, the vertical movement will be quite rapid, and there will appear to be a number of picture segments moving (see Fig. 9). As the control is brought nearer to the proper setting, the picture will drift slowly up or down on the screen. Its appearance at an instant when it is just halfway out of position will then be as shown in Fig. 10.

Obviously, the first step to make in attempting to correct vertical rolling is to try adjusting the vertical hold control. If readjusting this control causes the image to lock in properly, and it remains locked, in all probability the vertical hold control was just misadjusted.

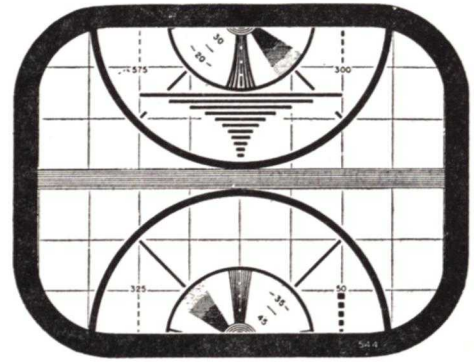
On the other hand, if you can get it to hold for only a short period of time, or if it tends to hold very near the end of the control's range, one of several possible defects may exist.

If the vertical hold control must be adjusted to one end of its range before the picture will hold, probably the value of some part in the grid circuit has changed. On the other hand, if it syncs near the center of the control range, but then does not hold, either the sync pulses are not reaching the vertical sweep oscillator because of a sync chain defect, or poor low-frequency response somewhere in the circuit is causing trouble.

The vertical sync signal, as you know, is a 60-cycle pulse. If the low-frequency response is reduced in any section handling this sync pulse, it may be wiped out; if so, a vertical hold cannot be obtained for very long. In such a case, adjust the hold control until the picture stands still, and carefully examine the test pattern you see. If there is a smearing or blurring of this pattern, the video amplifier probably has poor low-frequency response of the kind that may be caused by an open low-frequency compensating condenser or by a defective coupling condenser.

On the other hand, if the picture is not excessively smeared, but the retrace lines are visible while the picture is standing still (they will show while the picture is moving), observe the vertical and horizontal wedges of the test pattern. If the lines that are vertical in the test pattern are blacker than those that are horizontal, poor low-frequency response is indicated again, but this time it is more likely to be caused by improper alignment of the video i.f. amplifier. This may come about either because the trimmers are incorrectly adjusted or because an adjacent channel trap has drifted out of adjustment so much that it is too near the picture carrier frequency and is therefore reducing the low-frequency response. (We are assuming proper tuning and normal settings of the brilliancy and contrast controls.)

If the picture appears relatively normal as long as it is holding in sync, but vertical sync is not maintained, there is some trouble in the sync chain itself. Since the horizontal sync is



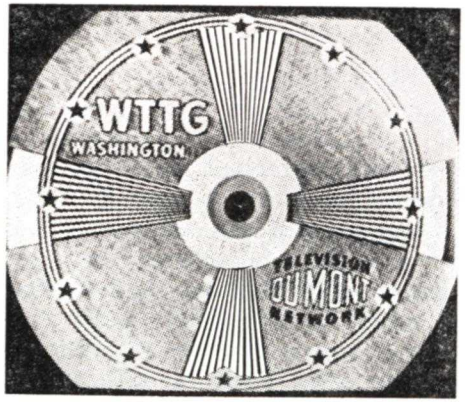
Courtesy Belmont Radio Corp.

FIG. 10. Slow vertical rolling.

apparently holding in all right, the defect must be in a circuit that handles the vertical sweep only or in a coupling condenser. Remember that stray capacity across an open coupling condenser may be able to pass the relatively high-frequency horizontal sync pulses but would offer too much impedance to the lower-frequency vertical sync pulses.

Interlace. An improper setting of the vertical-hold control or a lack of vertical sync may also cause poor interlacing. When this condition occurs, the horizontal lines "twin": that is, the lines of one field trace over those of the preceding field instead of falling between them. This gives a coarser picture and produces a moire pattern on the lines in the horizontal wedges of a test pattern, as shown in Fig. 11.

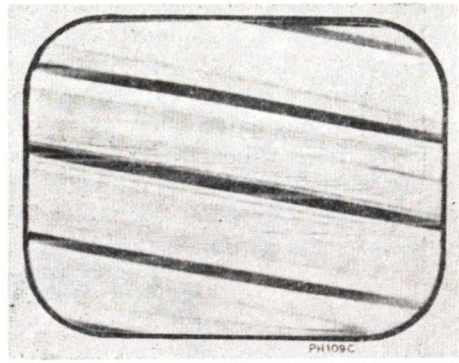
As we said, this effect can be caused by improper adjustment of the vertical-hold control, in which case it can be remedied by a slight readjustment of the control. However, it can also



NRI TV Lab Photo

FIG. 11. Poor interlace.

be the result of a defect. If the horizontal sweep output can get back to the input of the vertical sweep through a common coupling—perhaps through a power supply connection—it may throw off the vertical sync so that this condition occurs. If the set did not originally exhibit poor interlacing, a loss of capacity in a by-pass or filter condenser may cause it to appear. The small 7″ electrostatic sets, which have very high horizontal-sweep voltages and perhaps not too much filtering,



Courtesy RCA

FIG. 12. Extreme misadjustment of the horizontal hold.

often exhibit poor interlacing even when they are new. Fortunately, it is rather difficult to notice the effect on a 7″ tube.

HORIZONTAL ROLLING

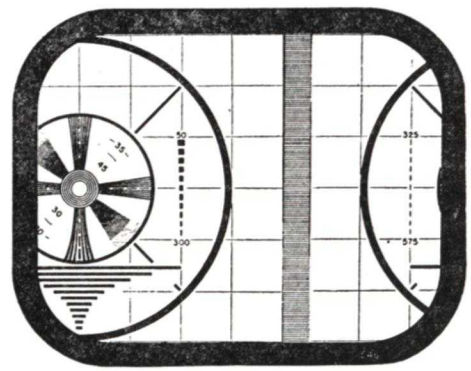
Lack of horizontal sync will cause the picture to roll to the right or left. If the horizontal sweep is far off, the picture will be torn up rather completely—to such an extent, in fact, that there will be practically no semblance of a picture on the screen.

As the horizontal-hold control is brought nearer the right adjustment, the picture tube will exhibit a number of black, slanting, roughly horizontal lines with extremely distorted pictures between them, as shown in Fig. 12. The number of these lines will decrease as the correct adjustment is approached. In a set using a locked horizontal hold, the number of lines can be reduced to 3 or 4; then further adjustment of the hold circuit will make the picture snap into sync. In a set using an unlocked hold, it may be possible

to eliminate all lines and produce a series of pictures moving slowly sideways, as shown in Fig. 13, before the picture is brought into sync. In some sets, you may get a tearing at the very top of the picture, as shown in Fig. 14, when the picture is almost but not quite perfectly synchronized. (Excess contrast will also cause this; be sure the contrast control is set properly.)

The possible causes of loss of horizontal sync are much like those causing loss of vertical sync. If the hold control will lock the picture in near the middle of its range and will hold it in over a suitable range, misadjustment of the hold control is probably all that was the matter.

The range over which the horizontal-hold control should hold the picture in is usually considerably wider than that of the vertical control, because most modern sets have some form of locking circuit for the horizontal sweep. With any of these locking circuits, a misadjustment of the locking-range control or of the horizontal

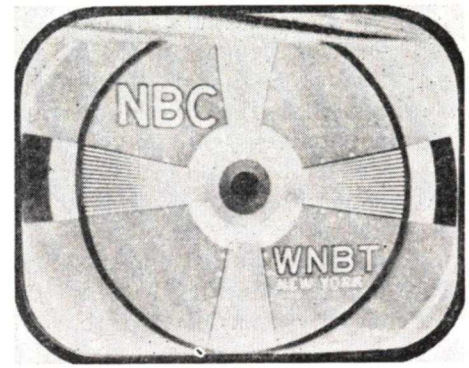


Courtesy Belmont Radio Corp.

FIG. 13. Slight misadjustment of unlocked horizontal hold.

a.f.c. circuit (where one is used) may produce the same effect as a severe misadjustment of the hold control. In such instances, the first thing to do is to set the hold control as recommended in the manufacturer's instructions, then to adjust the locking-range control to see if the picture can be made to fall into sync. If so, then this is all that is the matter, and the manufacturer's instructions for completing the adjustment should be followed.

On the other hand, if no adjustment of the locking-range or horizontal-hold



Courtesy RCA

FIG. 14. Slight misadjustment of locked horizontal hold (or excessive contrast).

control will let you sync the picture more than momentarily, the sync pulses are probably not reaching the locking circuit. If the picture is normal during the moments you are able to keep it in sync, there is a defect in the sync chain, because anything that would wipe out the horizontal sync pulses in the video circuits would affect the picture very severely.

If the trouble is just a tearing at the top of the picture, it may be that improper operating voltages in the video amplifier or in the sync chain are causing clipping of the sync pulses. The cause of the tearing can usually be located by checking these voltages. If this fails to reveal the defect, trace the sync pulses through the video and sync circuits with an oscilloscope to find where their shape changes.

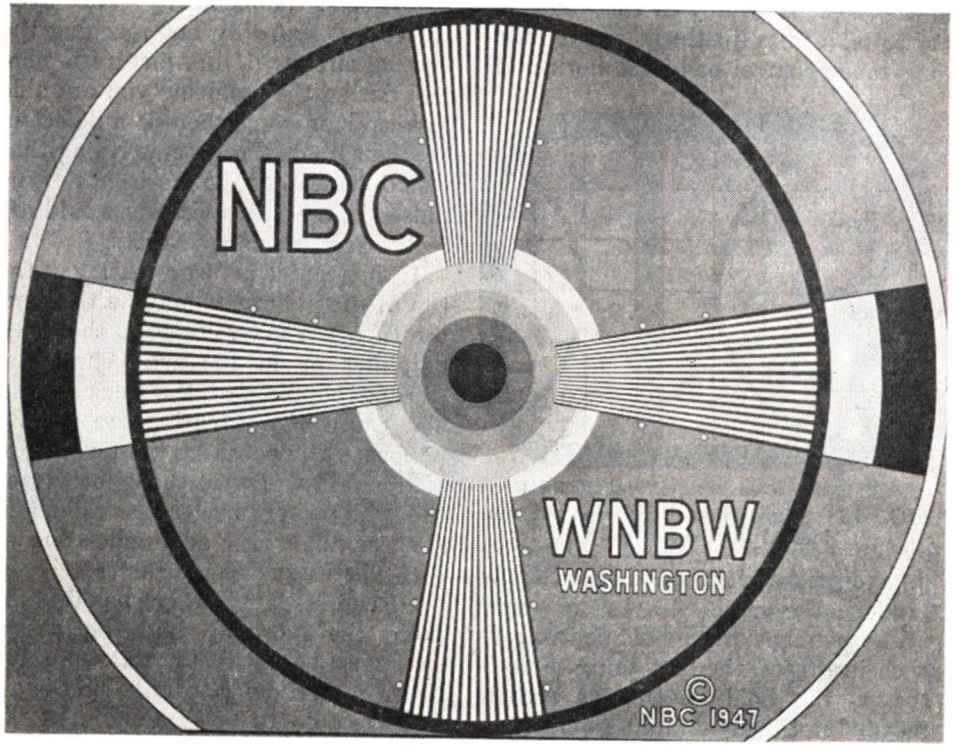
Of course, it is always possible for both the vertical and horizontal sweeps to be out of sync at the same time. A dual defect of this kind is almost certain to be something in the sync chain.

NON-LINEAR PICTURE

Fig. 15 shows a "perfect" test pattern. When the size and linearity controls are adjusted properly, as shown here, the line wedges are all equal in length, and the circles are perfectly round. When this test pattern is adjusted by means of the size controls to be perfect for the mask of the set, the large black circle should exactly fit the viewing mask in the vertical direction. and the outermost white circle should approximate the width of the picture.

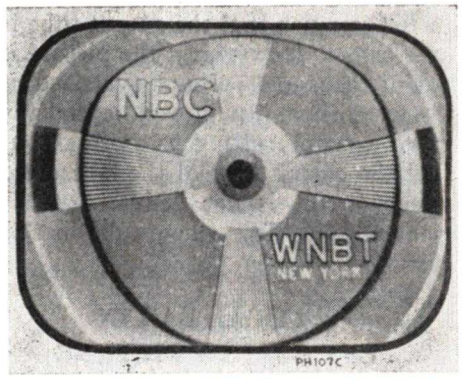
Adjusting the size controls of an electromagnetic set may throw the pattern into a distorted shape, because there is an interlocking between certain linearity controls and the size controls. Poor vertical and poor horizontal linearity are shown in Figs. 16 and 17 respectively. The outer circles are anything but round in these figures. Ordinarily, a careful readjustment of the linearity and size controls will allow you to correct such conditions. If you find that it is impossible to correct the distortion, however, the vertical or horizontal amplifier tube is defective in some respect or is not receiving proper operating voltages.

Incidentally, remember that you cannot check the plate voltage of the horizontal output tube in a set using electromagnetic deflection. You can make a check of the B+ voltage but not of the voltage at the plate, because the operating voltage at the plate is masked by the very high pulses fed back from the fly-back transformer. In fact, it is dangerous to make such a measurement—these pulses are high enough to ruin an ordinary multimeter and give you a severe shock. Pay particular attention to the bias and screen voltages as well as to the B+ voltage applied to this tube.



Courtesy NBC

FIG. 15. A photograph of the standard test pattern used by many stations.



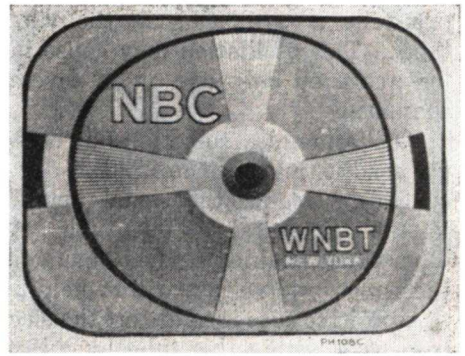
Courtesy RCA

FIG. 16. Poor vertical linearity.

In sets using electrostatic deflection, both the horizontal and vertical linearity may be poor if any of the coupling condensers used to couple the sweep circuits to the picture tube are defective.

A sort of dual non-linearity in both directions, producing a picture in which neither the sides nor the top and bottom are parallel, may be the result of an improper adjustment of the focus coil or ion trap magnets. Check the positioning of these as well as that of the deflection yoke if you observe such a condition.

Of course, you should not expect absolutely perfect linearity on any set. The picture tube itself may introduce a certain slight amount of non-linearity, and you have no absolute assurance that the station is transmitting a perfect pattern.



Courtesy RCA

FIG. 17. Poor horizontal linearity.

MULTIPLE OR FOLDED IMAGES

A rather rare but nevertheless possible complaint is one in which either the horizontal or the vertical sweep operates at half or twice the normal frequency. If the horizontal sweep operates at a half-normal frequency, you will get two complete pictures of full height, side by side. If the vertical sweep operates at half-normal frequency, you will have two short, full-width pictures, one above the other. Such an effect can be produced by an increased resistance in the grid circuit of the sweep oscillator or by a radical change in the value of some other part in the oscillator circuit.

If the horizontal oscillator speeds up so much that it operates at twice its normal frequency, the right-hand half

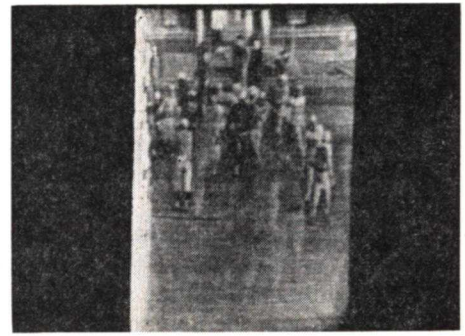


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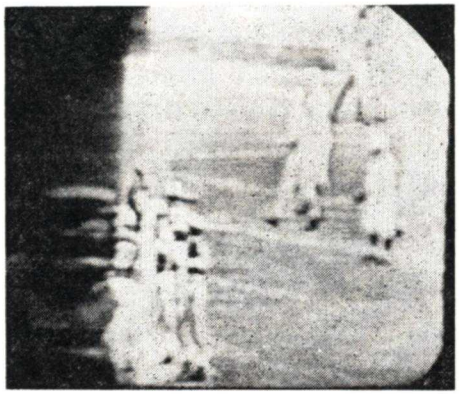
FIG. 18. Folding caused by reduced plate voltage on horizontal output tube.

of the picture will be folded over on the left-hand half. Similarly, if the vertical oscillator operates at twice normal frequency, the bottom of the picture will be folded over on the top. A drop in the resistance of the hold-control network or some unusual tube defect are the only likely causes of this condition.

There are several other defects that will cause a partially folded picture. Fig. 18 illustrates one example. In this



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Folding caused by a defective damper tube.

case, the picture becomes smaller than normal and there is a folding over on the left edge. This is the result of a reduction in the plate voltage applied to the horizontal output tube. A somewhat similar effect can be caused by a defective damping tube or by an improperly shaped horizontal sweep voltage (which would normally occur only because of changes in part values or operating voltages in the sweep chain).

A somewhat similar partial fold at the very top of the picture is usually due to an improperly shaped vertical sweep voltage.

In receivers using electromagnetic deflection, a fold-over in the form of a heavy white vertical line at the right edge of the picture may occur when

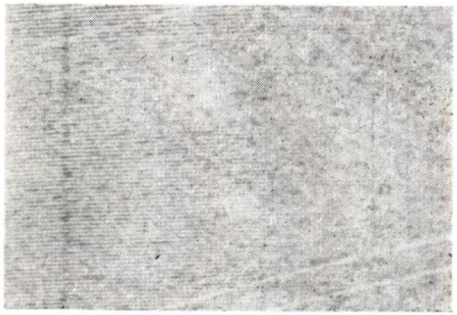

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FIG. 19. Oscillation in horizontal output tube.

the horizontal drive control is misadjusted so much that the output tube is overdriven. However, if the picture is out of focus and perhaps oversized at the same time, it may well be that the drive control setting is normal but that the output tube of the horizontal sweep circuit is not delivering sufficient output. Try a new tube in this case.

VERTICAL BAR IN LEFT HALF OF PICTURE

When a black bar somewhat resembling a rope appears at the left

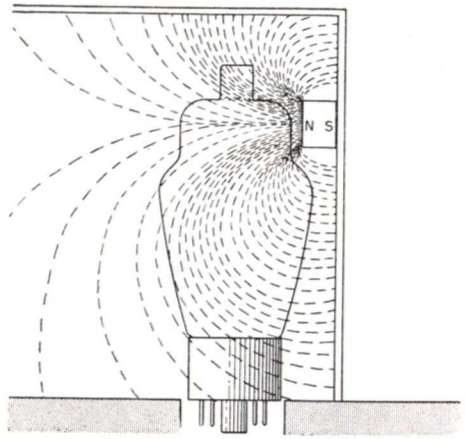


FIG 20. A magnetic field can be used to eliminate oscillation in the horizontal output tube.

side of the picture, as shown in Fig. 19, the horizontal sweep amplifier output tube is oscillating in the v.h.f. range. This oscillation may cause interference on only one or on several channels.

Oscillation may sometimes be cured by readjusting the horizontal drive control to reduce the signal applied to the horizontal output tube. At other times, making a slight change in the screen-grid voltage will be helpful.

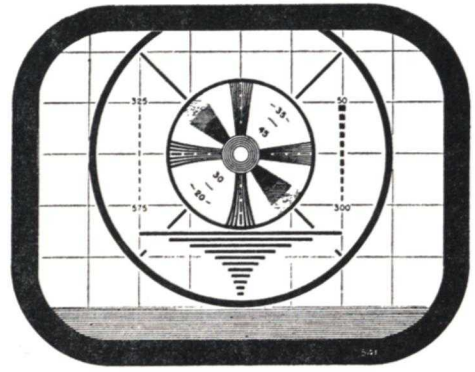
A positive cure is to distort the electron path within this tube by means of a magnetic field. One way of

getting this field is to mount a bar magnet near the tube on the shield of the high-voltage container. When the magnetic field for this magnet passes through the tube, as shown in Fig. 20, the electron paths are distorted so that oscillation is unlikely to occur. Some servicemen use ion-trap magnets around the tube or near the tube to produce the desired field.

Remember—for your own safety, do not open the shield around the high-voltage supply while the circuit is on. Install a magnet only when the supply is not working.

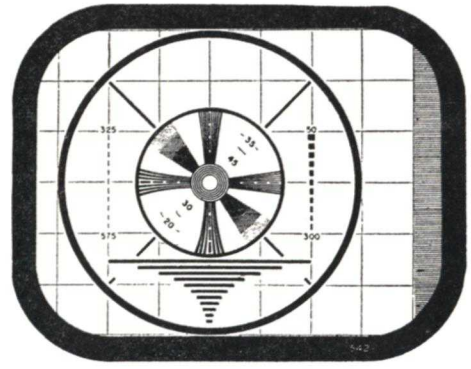
PICTURE NOT FITTING THE VIEWING MASK

When the picture is not centered properly in the viewing mask, so that



Courtesy Belmont Radio Corp.

FIG. 21A. Picture off center vertically.



Courtesy Belmont Radio Corp.

FIG. 21B. Picture off center horizontally.

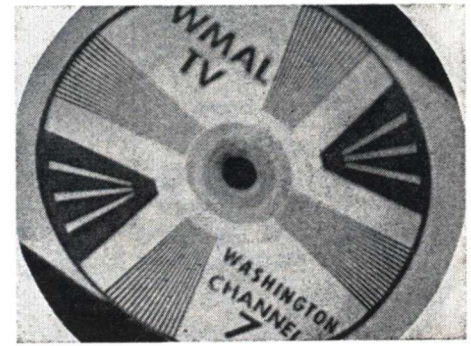


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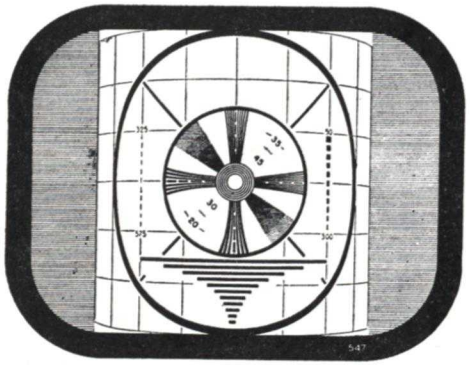
FIG. 22. Tilted picture.

it is too high (or too low), as shown in Fig. 21A, or is off-center to the left or right, as shown in Fig. 21B, you can usually bring it back to the right position by adjusting the centering controls. If not, it is possible that either too little or too much current is flowing through these controls. In a few receivers, the condition of the audio tubes may affect this adjustment because their plate currents pass through the centering controls.

In sets that use electrostatic tubes, leakage in the coupling condensers between the sweep output tubes and the picture tube will also cause an off-center picture that you may not be able to bring back to the right place with the centering controls. Suspect that such leakage exists if the picture is centered properly when the set is first turned on but then gradually drifts off center.

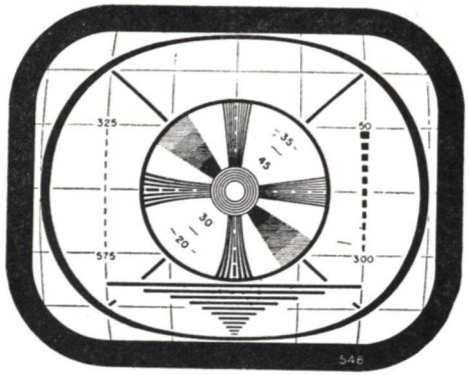
If much leakage develops in these condensers, the sweep output tubes are likely to be damaged. Damaged tubes are usually indicated by the fact that the sweep is not wide enough to give a full-size picture in one direction or the other.

A tilted picture (Fig. 22) usually means that the deflection yoke is rotated from its correct position or, if an electrostatic tube is used, that the tube is not oriented properly with respect to the mask.



Courtesy Belmont Radio Corp.

FIG. 23A. Picture too narrow.



Courtesy Belmont Radio Corp.

FIG. 23B. Picture too wide.

IMPROPER SIZE

Pictures too narrow (A) and too wide (B), but proper in height are shown in Fig. 23. Notice that the picture is relatively linear; it is "spread" one way or the other, but the wedges in each pair are equal in length. When the horizontal size control is adjusted, the picture may become non-linear; but the linearity controls should restore the image to normal.

If an adjustment of the size control will not bring the picture up to normal, the output from the sweep involved must be below normal. Improper operating voltages or defective amplifier tubes are the likely causes.

Similarly, the picture may be too short or too high if the vertical size control is misadjusted.

A picture too small in both directions usually indicates a low-voltage supply defect.

In practically all of the cases we have described, the complaint is caused by a misadjusted control or by a defect in the sync or sweep chain. Localizing these defects is, as we have said, most easily done with an oscilloscope. The oscilloscope not only lets you determine whether or not a.c. signals are present—you can also see the wave shape and thus determine when it gets distorted or changed in any manner. For these reasons, the oscilloscope is rather widely used in TV servicing, as we shall point out in another Lesson.

Lesson Questions

Be sure to number your Answer Sheet 63RH-2.

Place your Student Number on every Answer Sheet.

***Send in your set of answers for this Lesson immediately after you finish them,* as instructed in the Study Schedule. This will give you the greatest possible benefit from our speedy personal grading service.**

1. Why are ceramic condensers widely used in TV receivers?

2. If the screen of a TV set is completely blank even with the brilliancy control fully advanced, and there is no sound, what section or sections of the set are probably defective?

3. If only a spot of light is produced on the screen of a TV set that uses a locked high-voltage supply, but there is sound, what is the most probable defect?

4. If only a horizontal line is produced on the screen of a TV set, but there is sound, what section or sections are defective?

5. In what kind of a set can a single defect produce a controlled raster but no sound?

6. If a coupling condenser opens in a circuit that handles both the vertical and the horizontal sync pulses, which kind of pulse is more apt to be blocked?

7. What effect is produced on a test pattern by poor interlacing?

8. If no adjustment lets you sync the picture horizontally for more than a few moments, but the picture is all right when it is in sync, where is the defect?

9. What simple remedy will cure the condition that produces a rope-like black bar at the left side of the picture?

10. If the picture is properly centered when a set using an electrostatic picture tube is first turned on, but it then drifts off-center and cannot be brought back with the centering controls, what is probably wrong?

Be sure to fill out a Lesson Label and send it along with your answers.

LABEL FOR NEW LESSON

Please be sure to fill in and ENCLOSE ONE LABEL WITH your answers to EVERY LESSON you send for grading. We use this label to send the next lesson due you. Some new lesson texts will have several blank labels inside the back cover; others won't have any, so save the extras to use.

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DANGER AHEAD!

Today, events move at a rapid pace. New ideas, new processes, new products are brought forth daily. You must keep abreast of this tide if you are to stay in business, because nothing is more fatal than to become out-of-date.

To understand new developments, you must learn the fundamentals in your chosen field and must *remember* them. And, *remembering* facts is the catch—how many things have you learned with great difficulty only to forget them within a short time? How much do you remember *clearly* from your early "school days?"

There is only one way to fix ideas in your mind and that is to USE them! If your work does not make full use of your knowledge, then you must review and review and review. You cannot afford to stop the processes of memorizing and learning. If you do, you will find facts slipping away from you; your key of knowledge will become rusty and useless —it won't open the door to your future!

J. E. Smith