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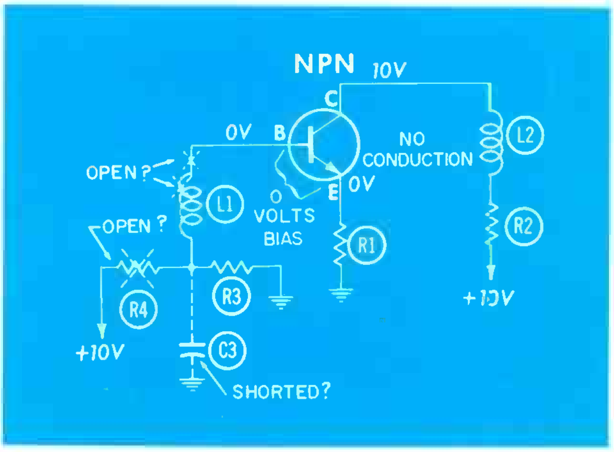
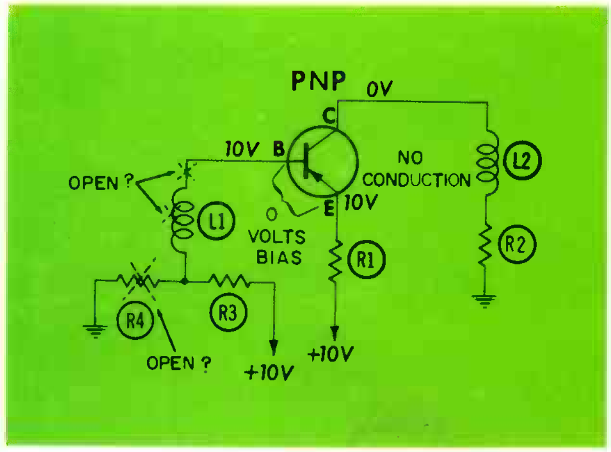
Electronic Servicing

Formerly PF Reporter





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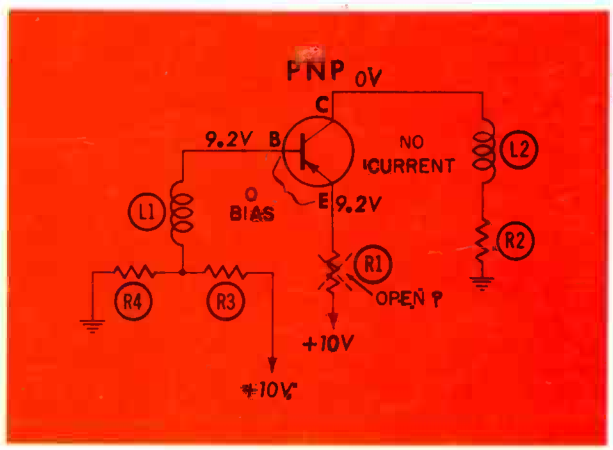

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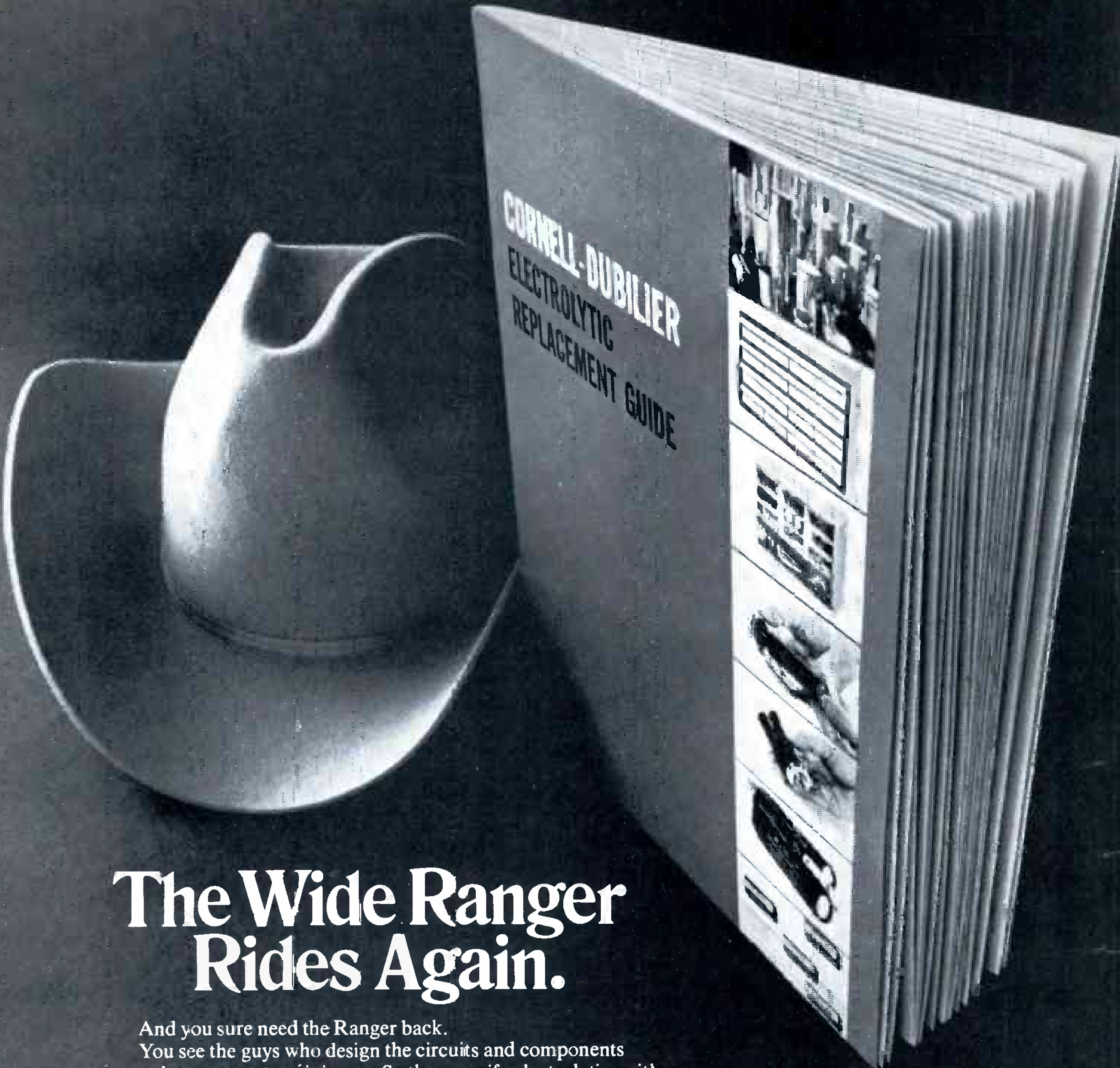
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April, 1969 • Volume 19, No. 4

Electronic Servicing

Formerly PF Reporter

in this issue...

DEPARTMENTS

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Robert E. Hertel, Publisher
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letters to the editor

Dear Mr. Middleton:

Your article titled "Practical Stereo-FM Servicing, Part 3" in the January '69 issue of ELECTRONIC SERVICING was very interesting and worthwhile; however, you have confused me on one point:

Diagrams Fig. 9 and Fig. 10 ("Checking crosstalk between stereo amplifiers," and "Checking crosstalk between inputs of an amplifier") and your descriptions of how to make the tests seem to be the same. Could you explain the difference between these checks and why one of these checks would not serve as well for both?

B. J. Brown
Trion, GA

Mr. Middleton's reply:

It is true that the two crosstalk tests are similar in many respects. However, there is a technical distinction between the two.

Fig. 9 depicts a test of a stereophonic amplifier, in which there is a possibility of crosstalk originating from the common power supply used by the two amplifiers of the system, as well as from stray coupling between the two input circuits.

Fig. 10 depicts a crosstalk test of a monophonic amplifier, in which the only source of crosstalk is stray coupling between the two input circuits. In retrospect, I can state that the text should have been extended to discuss troubleshooting of crosstalk in stereo amplifiers resulting from impaired power-supply regulation. This type of crosstalk is most evident at maximum-rated power output—Bob Middleton.

Info Needed

I recently bought a used WinTronics white-dot linearity generator, Model 160. A request sent to the manufacturer, Winston Electronics, Inc., Philadelphia, for a schematic was returned marked "insufficient address." Do you or any of the readers of ELECTRONIC SERVICING have a schematic for this, or for the following instruments:

Cathode beamer kinescope analyzer, Model CB-5YA, manufactured by Raytronic Laboratories, Cincinnati, Ohio,

Syltron VTVM, Model 303, manufactured by Syltron Electronics,

Frequency Meter, BC-906C, manufactured by Philco Corp., Philadelphia?

Arthur Krasenics
95 Henderson St.
Bristol, CT 06010

I have recently purchased a used G.C. picture tube tester, Model 36-616, for which I need an operation manual. G.C. no longer produces such testers and cannot supply a manual.

If one of the readers of ELECTRONIC SERVICING has a manual for this instrument, I would be grateful for a copy of it.

E. Roberts
969 Blairsbridge Rd.
Austell, GA 30001

I need a schematic or tube-type information on a Precise VTVM, Model 9071. The numbers are worn off the tubes and I cannot determine what types they are.

Bill Turner
805 W. 74th St.
Chicago, IL 60621

Dog-Eared Issues

I would like to compliment you on your fine publication. It is well done and well written. However, I do not like to see articles on two-way radio because I think that it is a separate field.

Your reader survey is a fine idea and the card was well layed out.

I do have one complaint: I received my January issue so "dog-eared" that I can hardly read it. It looks as though the postman used it on every dog in the neighborhood. I would appreciate it if you could send me another copy. I like to file the issues after reading them as they make very valuable reference material.

Michael E. Franzen
Amery, WI

Mr. Franzen, we appreciate the compliments. Long before you read this, you will have received another copy of the January issue.

I'm sure you understand that we have no control over how the U.S. Postal Department handles postal materials, beyond a formal complaint if the situation is widespread and persistent. Perhaps you could mention the situation to your mailman—or even give him a stick with which to defend himself from the neighborhood dogs.

Servicer Speaks Out

I protest the nonsensical number of new tube types and new parts types spewed out each year. The only reason I can think of why the manufacturers would do this is obsolescence. It has to cost them for redesigning and retooling, to say nothing of a series of parts left over. Besides, their product must often wait idly for parts while their image deteriorates. If my image did not also deteriorate, I would not care, but the service-dealer suffers too from this mania for change without reason.

If it is something we must bear in order to have improvement, then we are victims of the capricious-

ness of incompetent engineers who demonstrate that they are actually fumbling for, and stumbling upon, good design. The series of production changes that follows a chassis type bears out this assumption.

The cost of all this must hide in the cost of the product. The consumer should not have to submit to both delay and unnecessary price inflation. Competent engineering should be able to produce a chassis that remains current for at least five years.

I am in the service business because I like the challenge. Unlike Mr. Wolven (Feb., '69, Letters to the Editor), I would not consider limiting my work to sales units only, because that would reduce the number of challenges. But it should be kept in mind that we servicemen could accomplish the exact opposite of what we want. If we protest too much we might end up with manufacturers that have been forced to assume complete operational responsibility for their product. Service would then be exclusively in the hands of company organizations.

Eldon E. Johnson
Miltonia, MN

Negative to Positive

In Mr. Ralph Forke's description of a method used by one of his students for "tongue testing diodes" (Feb., '69, Troubleshooter), the statement was made that current flows from positive to negative.

I was taught that current flows from negative to positive.

Would you please set me straight as to which way current flows so I can either go back to school or continue to service electronic equipment with the same theory I have been using?

Gerald B. McDaniel
Eads, CO

Mr. McDaniel, according to the basic theory of current flow, which I was taught, electrons are negatively charged bodies. Any material possessing a surplus of electrons, therefore, has a negative charge. Any material whose atomic structure has a deficiency of electrons is a positively charged body.

If a negatively charged body and a positively charged body are connected together by a conductor of electrons, such as a copper wire, the surplus electrons in the negatively charged body will flow to the positively charged body, and the flow of electrons will continue until the two bodies possess equal or neutral charges with respect to each other.

Assuming that current flow is, in reality, the movement of electrons through a conductor, current must flow from negatively charged bodies to positively charged bodies. Thus, you may return to servicing electronic equipment—until Mr. Forke's student proves you, I, and the rest of the electronics industry wrong—Ed.

Symphonic Increases Service Rates

Warranty service rate increases ranging from 17 percent to 40 percent have been announced by the National Service Department of Symphonic Radio and Electronic Corporation. The rates apply to authorized Symphonic service agencies.

According to symphonic, the new rates yield an average of $6.366 per hour, based on time studies of Symphonic and other key authorized service agencies.

New Sets Require Service Prior to Delivery

Four of every five new TV sets require service to make them deliverable to consumers, according to the findings of a sampling survey of 50 large retail outlets conducted by the National Retail Merchants Association, as reported in Home Furnishings Daily.

Half the stores surveyed reported that purchasers of new TV sets requested service calls immediately after setup in the home. Factory defects accounted for an average of 25 percent of the call backs, while about 33 percent were the result of the customers inability to properly tune the TV.

Forty percent of the stores surveyed have their own service staff, 40 percent utilize factory service centers and 20 percent use both sources for fulfilling servicing responsibilities.

More than half of the retail outlets complained about late or inaccurate delivery of replacement parts.

Use of IC's May Be Speeded Up

Plastic, low-power integrated circuits (IC's) suitable for use in radio and black-and-white TV will soon be marketed by Motorola for about 20 cents in large quantities, according to a report in Electronic News.

The report stated that "while Motorola expects to make a significant thrust at the domestic market with the new units, the brunt of the marketing effort will be in the Far East, now the hotbed of radio and black-and-white TV production for the United States and European Markets."

"What took you so long?"

UHF Tuning Should be Like VHF

New Methods of tuning UHF TV channels may be in the offing as a result of a recent FCC proposal that VHF and UHF channels "have comparable ease of tuning."

According to a report in Merchandising Week, FCC Commissioner Robert E. Lee feels "that UHF stations are not getting a fair shake so far as receiver dials are concerned."

The FCC says that the "ideal receiver" would have the same set of controls, same tuning methods and tuning aids for both VHF and UHF TV channels.

Renewal Tube Sales Up

Although the total 1968 factory sales of receiving tubes dropped 6.7 percent from the total figure in 1967, receiving tube sales for renewal purposes increased 1.2 percent during the same period according to a recent Electronics Industries Association report.

Admiral Appoints Service Managers

The appointment of David J. Dodge and Albert Tomblin, Jr., to the newly created positions of regional service managers has been announced by Willis L. Wood, general manager of the National Service Division of Admiral Corporation.

Dodge will be responsible for the Eastern zone, which includes Admiral's Boston and Philadelphia branches, plus the Metropolitan division in East Rutherford, N.J., Dodge formerly was manager of the company's Long Island City, N.Y., service branch.

Tomblin will be responsible for service operations at the company's Los Angeles-San Diego and San Francisco divisions. He previously was an electronic engineer.

Astatic Purchases Sonotone Audio Line

The audio products line of Sonotone Corporation has been purchased by the Astatic Corporation of Conneaut, Ohio.

The Sonotone audio line consists of phonograph cartridges, needles and microphone products.

Astatic manufactures cartridges, needles, microphones and other electronic products. ▲

"My shop's been loaded since I got my FCC License...and I could kick myself for not getting it sooner. I'm pulling in all kinds of mobile, marine and CB business that I couldn't touch before; have even had some calls to work on closed-circuit television. I've hired two new men to help out and even with them, I'm two weeks behind."

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What's the best way to get a Commercial FCC License...and still keep up with your work? Thousands of men will tell you, "Cleveland Institute of Electronics."

Men like August E. Gibbemeyer, for example. He was in radio-TV repair work before studying with CIE and getting his 1st Class FCC License. Now, he writes, "We are very happily in the marine and two-way radio business... servicing police and fire departments in three communities, as well as cab companies...and our trade has grown by leaps and bounds."

Ed Dulaney is another example. He started his own part-time service business after training with CIE and passing the FCC License exam. This worked out so well that he then opened a full-time business. Today, he reports, "I manufacture my own two-way radio equipment, with dealers who sell it in seven states, and have seven full-time employees."

CIE has been preparing men like these for FCC License exams since 1934. What's more, CIE backs its Home-Study Licensing Programs with this remarkable money-back offer:

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Interpreting Voltages in Transistor Circuits

Analysis of defects in solid-state circuits and how they affect voltages.

by William C. Caldwell

Defects in transistor circuits can be isolated by voltage measurements in much the same way as defects in tube circuits. The transition from tube to solid-state servicing merely requires a basic understanding of the operating differences between the two types of design.

The following paragraphs provide a detailed explanation of how defects affect the voltages in transistor circuits and how to interpret deviations from normal.

Basic circuits employing both NPN and PNP transistors are shown in Fig. 1. The voltages shown on the elements of these transistors will be considered normal. In the following discussion of the voltage deviations caused by defects in these circuits, we will assume, in each case, that the source voltage has been checked and found to be normal, and no signal is being applied. Voltages will be read with a VOM having a 20,000 ohms-per-volt sensitivity, or higher.

Wrong Base Voltage

Very few defects will cause the base voltage to be far from normal when measured with respect to ground, except those in the base circuit itself. The reason is that the base voltage is usually obtained from a voltage divider; and unless the base is disconnected from this divider, or the divider itself is defective, the base voltage cannot change by a very large amount. Small variations in base voltage do not usually cause the circuit to be inoperative, provided the base-to-emitter is normal.

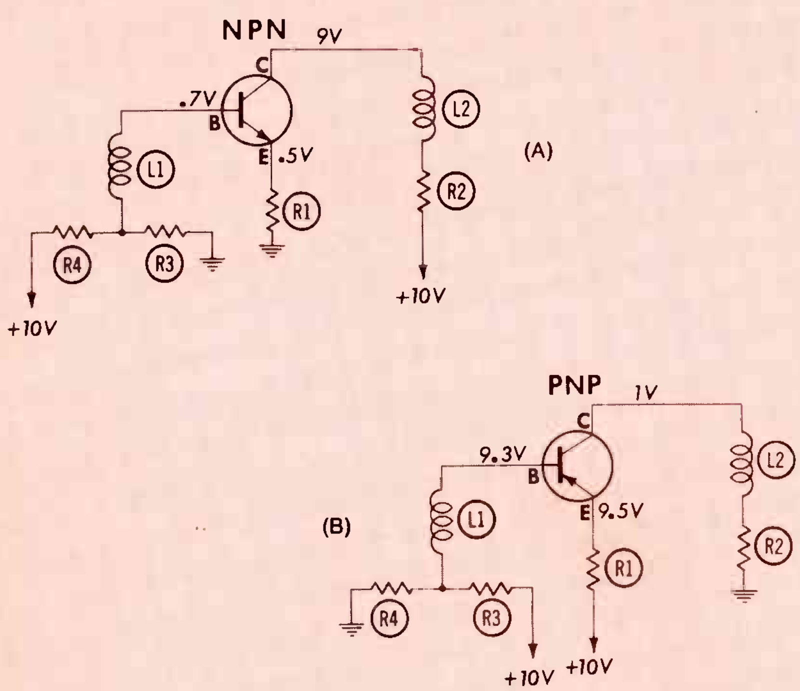

Fig. 1 Schematic diagrams of basic NPN and PNP transistor circuits showing normal voltages. (A) NPN circuit, (B) PNP circuit.

In Fig. 2A the NPN transistor has lost its base voltage, and also its bias between base and emitter. When the base voltage is lost in an NPN transistor, the transistor no longer conducts. Current ceases to flow through emitter resistor R1; so there is no longer any voltage drop across R1. Current through L2 and R2 will also stop flowing, causing the collector voltage to read the same as the positive supply voltage fed to that stage. In other words, a loss of base voltage in an NPN circuit causes loss of conduction, which can also affect the emitter and collector voltages. Possible defects which can cause these conditions are an open conductor in the base circuit, open coil L1, open base resistor R4, or shorted capacitor C3.

If the base lead should open in the PNP circuit in Fig. 2B, the base voltage will go more positive instead of negative. The reason is that the emitter has 10 volts on it and the resistance inside the transistor is very small between the base and emitter. The base, therefore, goes to the emitter voltage when it loses connection with its own voltage divider R3-R4. The base "assumes" the emitter instead of collector voltage because the internal resistance between base and collector is quite high.

The loss of base-to-emitter bias voltage in Fig. 2B causes the current through R1, R2, and L2 to stop. The voltage drop across the

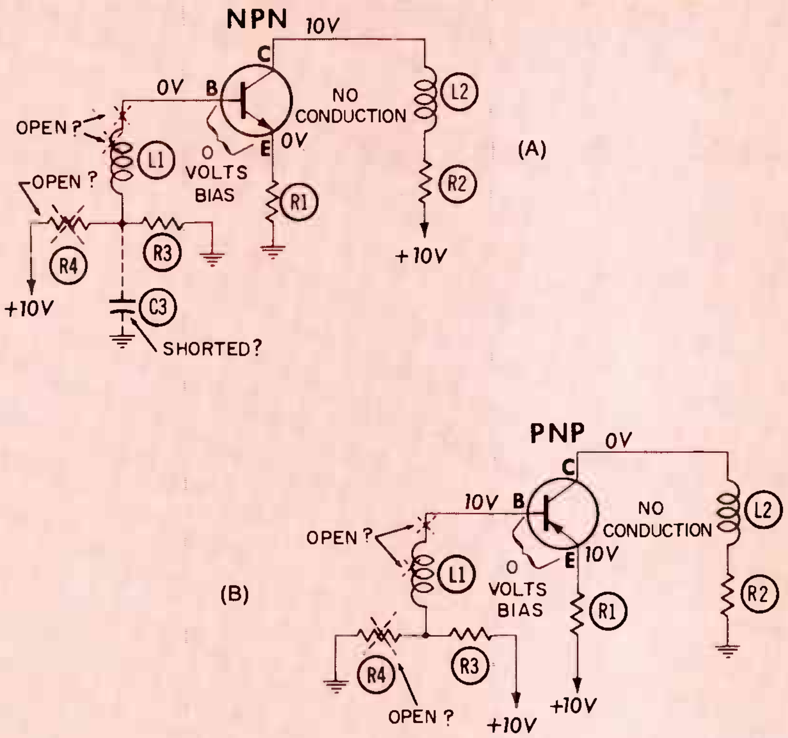

Fig. 2 Effects of open base circuit. (A) NPN circuit, (B) PNP circuit.

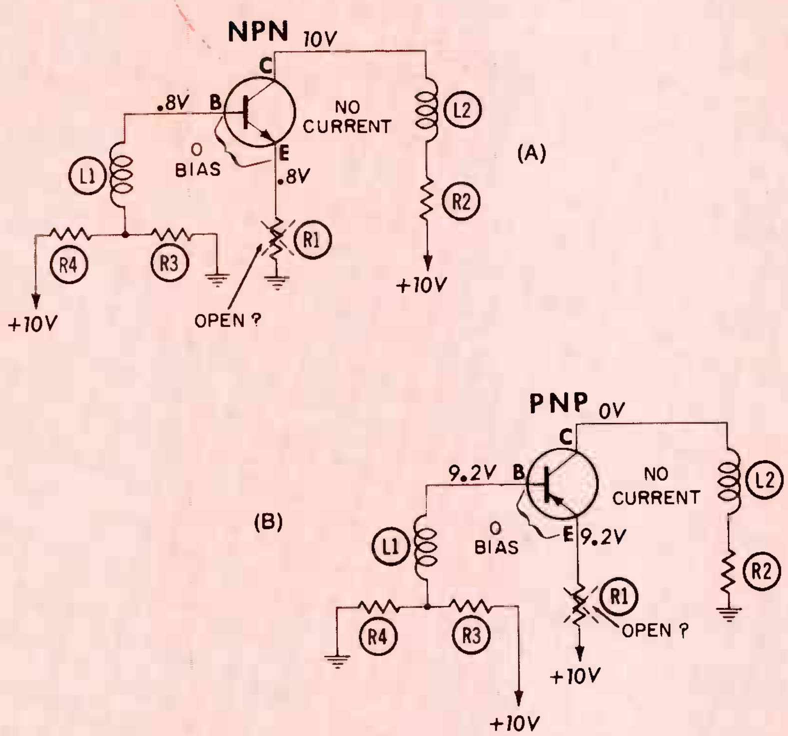

Fig. 3 Voltages produced when emitter circuit is open. (A) NPN circuit, (B) PNP circuit.

resistors therefore disappears, causing the emitter to go to 10 volts and the collector to zero or ground. This set of conditions is due to the open base conductor, open transformer L1, or open voltage-divider resistor R4. The base voltage to ground may not actually read the full 10 volts as shown because of the voltmeter resistance, but it will not be normal. The fact that the base voltage is not normal and that bias has disappeared leads us to suspect trouble in the base circuit.

Loss of Base-to-Emitter Bias

The loss of normal voltage between base and emitter can be due to another defect—namely, an open in the emitter circuit. This is shown in Fig. 3, where emitter resistor R1 or one of its connections has opened. The results are very similar to the open base circuit, except the base voltage now is nearer normal when measured with respect to ground.

In the NPN circuit (Fig. 3A) the base voltage remains very close to normal, rising only slightly because the base current has stopped flowing. The floating emitter now takes on, or assumes, the neighboring base voltage of about 0.8 volt. Again this is due to the very low internal resistance between base and emitter, which tends to keep the voltages very close together on those two elements. Actually, when placed between base and emitter to measure the bias, the voltmeter will read zero or very slightly negative on the base with respect to the emitter. Normally, of course, it is slightly positive.

The transistor cannot possibly conduct while the emitter circuits are open, so no voltage is dropped across collector coil L2 or collector resistor R2. By looking at emitter voltage only, one might assume the transistor is conducting. But here the floating emitter is getting its voltage from the base. This is why it is important to read all voltages on a transistor, including its bias, before making any conclusions about the stage.

In the PNP circuit (Fig. 3B) the emitter resistor has also opened. As might be expected, the floating emitter element takes on the neighboring base voltage through the low internal resistance in the base-emitter diode. The base voltage to ground stays fairly close to normal, since the base is still attached to its voltage-divider resistors, R3 and R4. There may be a slight variation in base voltage because no base current is flowing, but it would appear to be well within normal limits to the troubleshooter.

The emitter voltage to ground might also be considered within normal limits. But when the meter is placed between the base and emitter, the bias will read zero or slightly reversed from normal. Collector voltage to ground reads zero because there is no collector current; therefore, no voltage is produced across L2 or R2.

An open emitter resistor is quite common in power-output stages, where the resistor also serves as a fuse for the transistor.

Remember, when checking the resistance of a resistor or coil in a transistor circuit, that the ohmmeter has an internal battery which will affect the resistance of the transistor diodes. The latter resistance will therefore shunt the resistance being measured. However, whenever a transistor is reverse-biased, its resistance becomes very high. So, when the resistance of the coil or resistor is measured, and the ohmmeter leads are then reversed and the resistance measured again, the resistance reading probably will change. The higher reading will be the one least affected by the transistor. It is, therefore, the more accurate one.

Loss of Emitter-to-Collector Voltage

The loss of voltage between the emitter and collector leads is very easy to spot because all elements appear to have about the same voltage on them. This condition is shown in Fig. 4, where the collector circuit has opened.

In the NPN circuit (Fig. 4A), with an open collector lead, the collector voltage drops to a very low value. This acts like a vacuum-tube circuit with an open plate lead, where the plate voltage drops to zero. In the transistor circuit, however, the collector voltage may not drop all the way to ground because the emitter may still have a slight voltage on it. Collector current, of course, stops flowing. But because electrons cannot flow into the collector circuit, more of them flow into the base circuit and cause an increase in base current. This base current flows through emitter resistor R1, and may now cause a readable voltage drop across R1—in this instance, 0.1 volt.

What happens next is quite interesting. As the collector voltage drops below the base voltage, the transistor becomes a low resistance between base and collector. (The collector diode is now biased forward.) The base-to-emitter diode already had a low resistance; so now the resistance across the whole transistor, from emitter to collector, becomes very low. The collector will take on, or assume, whatever voltage is on the emitter, leaving no difference between those two elements. This condition could be caused by open collector transformer L2, open collector resistor R2, or an open connection in the collector circuit.

The PNP circuit in Fig. 4B has a similar defect, causing all voltages to read almost the same in that stage. However, since the positive side of the battery is connected to the emitter through R1, all voltages go in a positive instead of negative direction.

The emitter voltage goes up slightly because less voltage is dropped across R1, and the base voltage does likewise because the base current increases (see the arrows). The collector voltage assumes the emitter voltage because of the low internal resistance between the emitter and collector elements. Thus, there is no voltage difference between emitter and collector, making this a very easy trouble to spot.

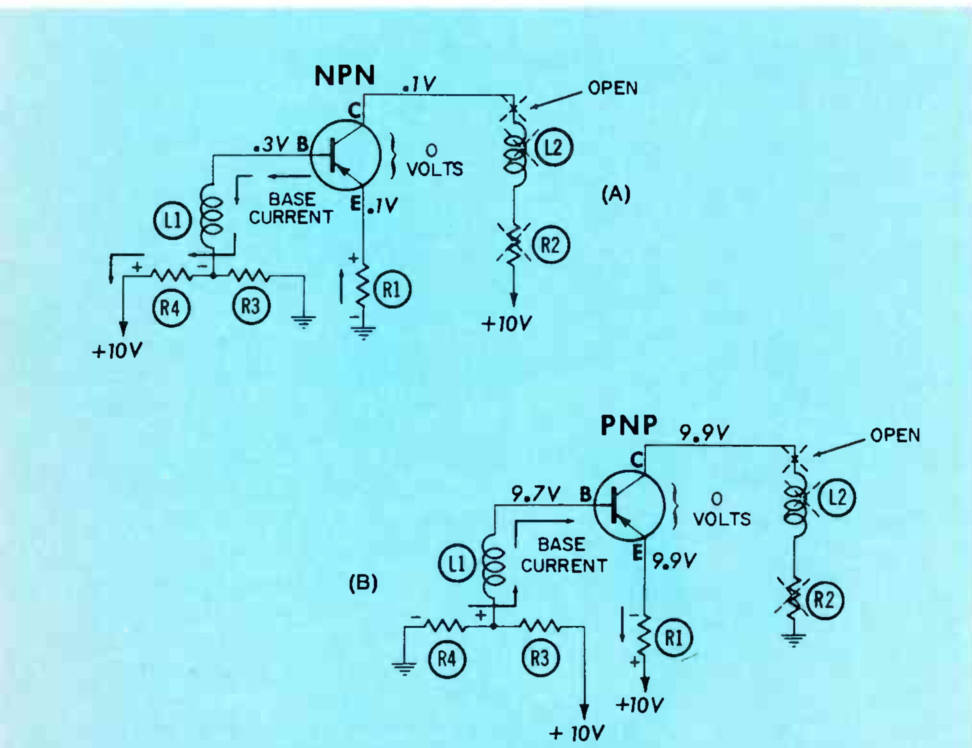

Fig. 4 Effects of open collector circuit. (A) NPN circuit, (B) PNP circuit.

Open Lead Inside the Transistor

So far we have learned what happens to voltages when either the base, emitter, or collector circuits are opened, either by a defective part or by a broken conductor. A different set of voltages will be read, however, if one of the leads inside the transistor should open.

In Fig. 5 the emitter lead has opened in the transistor. The effect of this on the NPN transistor circuit (Fig. 5A) will be studied first. The flow of current through the transistor stops because the transistor has become an open circuit. Since the voltage at the emitter was produced by the normal current flow through emitter resistor R1, the emitter voltage will now drop to zero. Also, since collector current stopped flowing through L2 and R2 in the collector circuit, there will be

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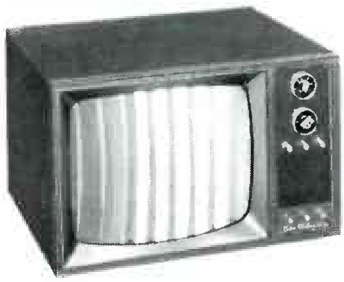

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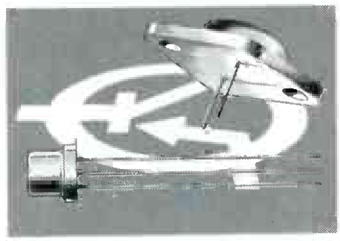

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no voltage drop across them. Collector voltage rises to the full battery voltage of 10 volts. The base voltage is not affected much because it is still connected to its voltage diivder R3-R4. This causes a very odd situation; namely, the transistor has a very high forward bias (0.8 volt) between base and emitter, but shows no sign of drawing any collector current. This is very unusual, indeed, because we would normally expect the transistor to conduct well with such a large bias. This leads us to suspect an open lead within the transistor.

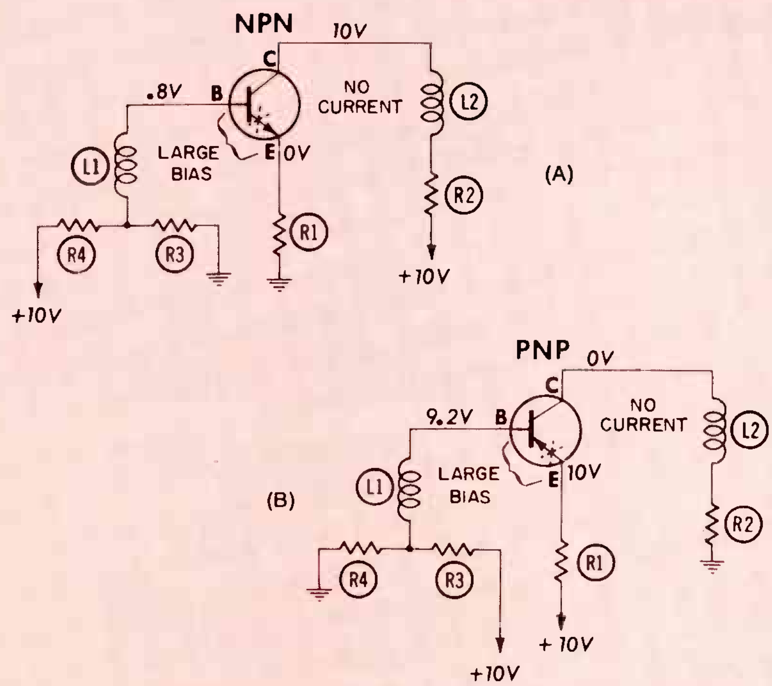

Fig. 5 Schematic diagram showing open emitter lead within transistor and resultant changes in voltages. (A) NPN circuit, (B) PNP circuit.

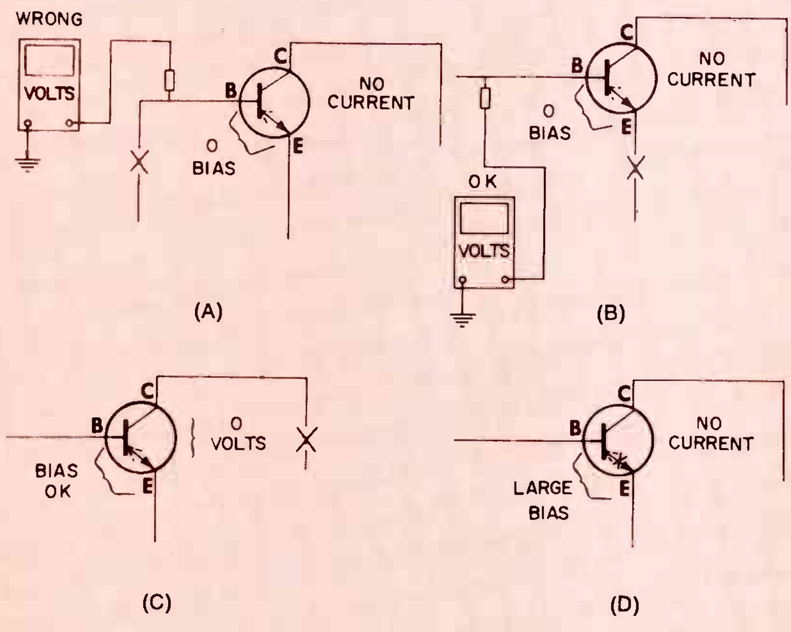

Fig. 6 Effects of open in transistor circuit or within transistor. (A) Open base circuit, (B) Open emitter circuit, (C) Open collector circuit, (D) Open element within transistor.

The PNP circuit (Fig. 5B) demonstrates a similar defect. The base voltage remains very close to normal because it is still connected to its voltage divider, R3-R4. When the transistor is open, however, collector current does not flow; the voltage drops that were present across the emitter and collector resistors disappear. This puts the emitter at the same potential as the supply voltage, or 10 volts. The collector, grounded through L2 and R2, goes to ground or zero volts. The important point is that the forward bias measured between base and emitter is unusually good (0.8 volt); yet the transistor does not conduct. The reason is that a lead is open inside the transistor.

The emitter lead is not necessarily the one that is open. However, if the base or collector lead has opened internally, the voltage will read almost exactly the same as for an open emitter lead. So, whenever the bias voltage is unusually high but the transistor shows no signs of conducting, it is wise to check the transistor itself. This will be explained later.

Review of Open Circuits

We have shown what happens to voltages when a lead opens in either the external circuit or the transistor itself. Now let's review these interesting situations.

Fig. 6 shows a summary of the most important voltage changes that took place with each defect. These changes will tip the troubleshooter off to the part of the circuit where the defect probably lies.

When the base circuit opened (Fig. 6A), the base element lost its connection to the voltage divider. This caused an error in the base voltage when measured to ground. Also, since the internal resistance between base and emitter is relatively low inside the transistor, the floating base element goes very close to the emitter voltage. This will show up when the voltages between elements are measured using the emitter as a reference. The base-to-emitter voltage will read zero. With no bias, the transistor cannot conduct, which will affect the emitter and collector voltages. There will be no voltage drops across the emitter and collector resistors.

The open emitter circuit (Fig. 6B) caused a similar set of conditions, except the base voltage to ground

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was fairly normal. The floating emitter lead, however, takes on the base voltage because of the low internal resistance inside the transistor. This causes the bias, when measured between base and emitter, to read zero, or even slightly reversed from normal in some instances. (The meter may actually go slightly below zero when it should be reading upscale.) This condition also stops the flow of the collector current.

The open collector circuit (Fig. 6C) caused the biggest change in collector voltage. In fact, the collector voltage changed so drastically that the internal resistance of the collector diode (collector-to-base) became very low. This caused a very low resistance all the way through the transistor, and the collector and emitter both went to the same voltage. When the collector voltage is measured with respect to the emitter voltage, this will show up as a zero difference. Such a condition is easy to spot because it is so far from normal. Usually, the collector-to-emitter voltage is the largest one between any two leads of the transistor. Another condition which will cause the emitter and collector to have the same voltage is a shorted transistor. This is a common trouble in power transistor output stages.

The open lead inside the transistor (Fig. 6D) caused a larger-than-normal voltage between base and emitter, but a complete loss of collector current. These two conditions show that something is wrong, because a large bias should normally produce plenty of current. The lack of collector current will be evident by the lack of a voltage drop across the emitter and collector resistors.

Several rules might be made from these observations:

1. If the base voltage is far from normal, the trouble probably is in the base circuit.
2. If the bias voltage when measured between base and emitter is zero or slightly reversed in polarity from normal but the base voltage to ground is normal, check for an open emitter resistor.
3. If there is no difference between the collector and emitter voltages, the trouble may be an open in the collector circuit (or a complete short between emitter and collector; this usually happens to high-power transistors).
4. If a transistor has a better-than-normal bias voltage but no conduction, check for an open within the transistor.

Most of these defects had one thing in common—they produced a decrease in collector current. The next question is, "What could cause an increase in collector current, and how will that change the voltages?"

Leaky Transistor

A transistor which develops a partial short between emitter and collector is commonly called a leaky transistor. It could be due to a partial breakdown in the transistor, or to excessive moisture or other contamination trapped inside.

This is demonstrated in Fig. 7. The NPN transistor (Fig. 7A) has developed a partial short, causing the collector current to increase. The high collector current produces larger-than-normal voltage drops across the collector and emitter resistors, causing a decreased collector and an increased emitter voltage. The base, which is tied to its voltage, may rise above the base voltage, causing a reversed bias between base and emitter. The transistor should be cut off; however, collector current continues to flow through the leakage path between emitter and collector.

A signal fed into the stage will be lost because of the wrong bias polarity between base and emitter, and because the collector current cannot be controlled. The increased collector current, without proper bias, leads us to suspect a leaky transistor.

In the PNP circuit (Fig. 7B) a similar defect has occurred. The partial short between emitter and collector causes increased current and the resulting increase in voltage drops across R1 and R2. This makes the collector voltages more positive and causes the emitter voltage to go down. In fact, the emitter voltage may even swing less positive than the base voltage and put a reversed bias between base and emitter. The wrong bias polarity, in conjunction with the increased collector current, causes us to be suspicious of the transistor.

High leakage is probably the most common defect in small transistors. Large power transistors usually go ahead and completely short, once they start to become leaky. Small transistors, on the other hand, very rarely develop a complete short.

Leaky transistors will not always produce a reversed bias voltage. Mild cases of leakage may cause only a reduction in the normal bias between base and emitter and in the stage gain.

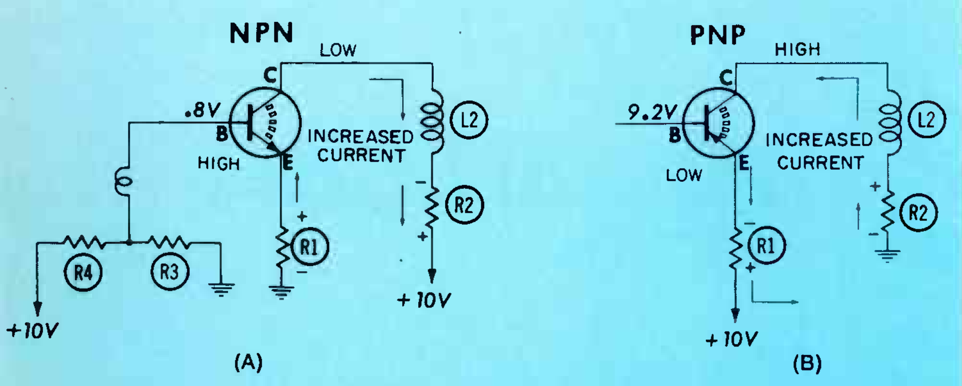

Fig. 7 Element voltages resulting from a leaky transistor. (A) NPN circuit, (B) PNP circuit.

Short in Base Circuit

Transformers have been known to short between primary and secondary. When it does happen, an unusual set of voltages is produced.

In Fig. 8 for example, the transformer in the base circuit has shorted. The base voltage of this stage and the collector voltage of the preceding one go to the same voltage, since they are shorted together. In the NPN circuit (Fig. 8A), this caused the base voltage to go very high. As a result, the transistor conducts very heavily. When the collector current goes up, so does the emitter voltage; meanwhile, the col-

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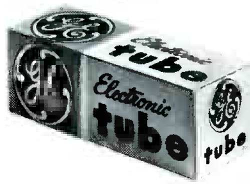
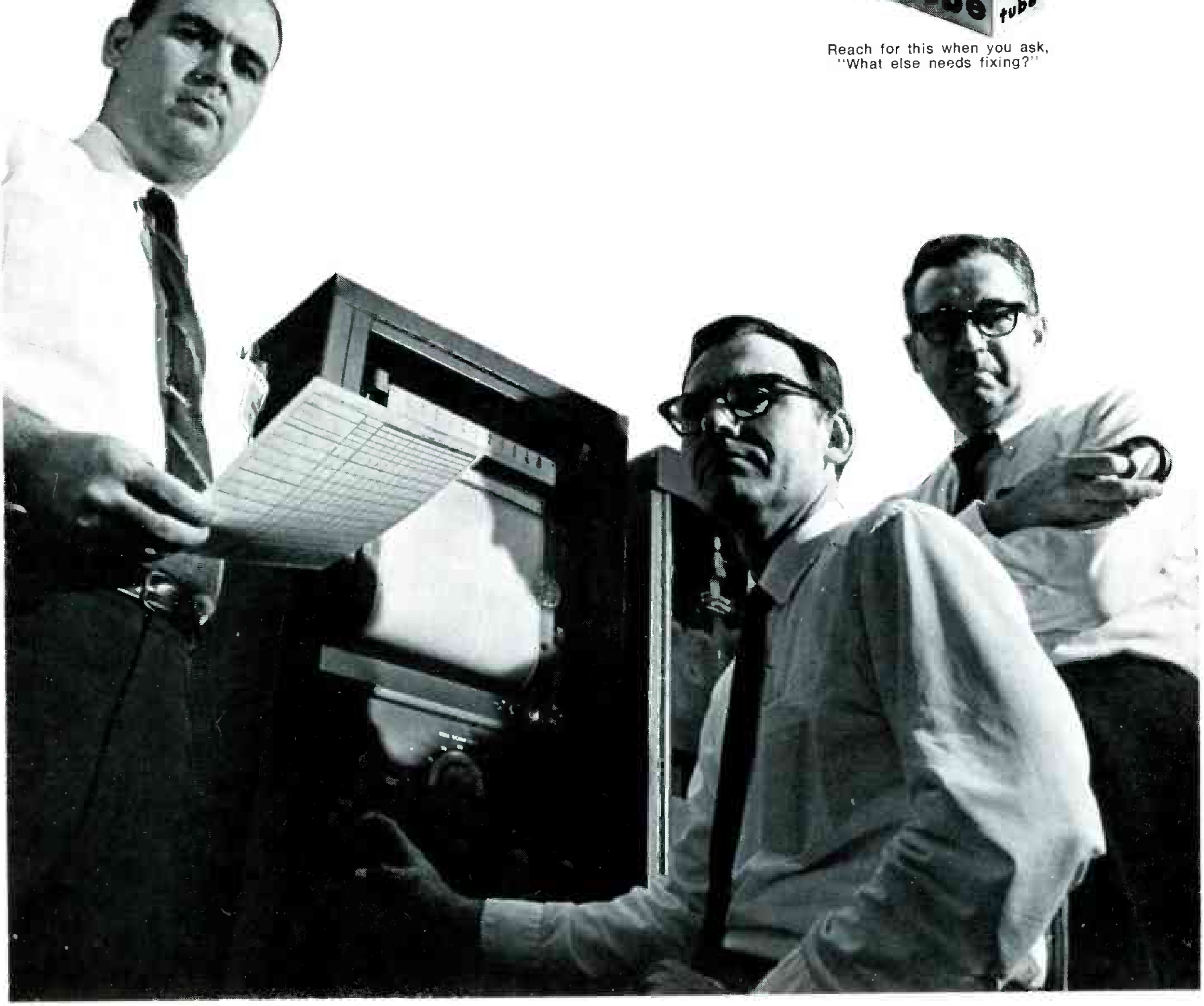


Reach for this when you ask, "What else needs fixing?"



lector voltage drops down from normal. In some circuits the emitter resistor may open because of the increased current through it. In most low-power circuits, this will not happen. The signal, of course, will be lost.

The PNP transistor with shorted base transformer (Fig. 8B) will also conduct very heavily if its base voltage is lowered. Reducing the base voltage on a PNP transistor is like increasing the base voltage on an NPN transistor—the forward bias and conduction will increase. This makes all the elements go closer to the same voltage. In this respect, it somewhat resembles the open in the collector circuit discussed previously. Here, however, the base voltage remained fairly near normal, whereas now it is far from normal.

This again follows Rule 1—"When the base voltage is far from normal (with respect to ground), look for trouble in the base circuit." This is assuming, of course, that the battery voltage is normal.

The table, below left, lists some of the typical circuit defects and what effect they have on the transistor element voltages.

The first column tells whether the base (to ground) voltage is fairly close to normal, or whether it has changed considerably. Note that the only reason for a base voltage to be far from normal is a defect in the base circuit itself.

The second column shows whether the bias voltage between base and emitter will be fairly normal (0.1 to 0.3 volt), and of the proper polarity. Note that there will usually be no bias or it will be reversed from normal if one of the following occurs:

Open base circuit
Open emitter circuit
Leaky transistor.

In case of an open lead inside the transistor, the bias is unusually good, but no current flows.

The third column in the table shows whether or not there will be any voltage difference between the collector and emitter. Note that the only time the answer is "no" is when the collector circuit has opened. A complete internal short between emitter and collector will also cause a complete loss of voltage between those two elements, although that rarely occurs in small transistors.

The last column tells what happens to collector current in each instance. The collector voltage (to ground) and emitter voltage (to ground) are not listed in the chart because they will vary somewhat with almost every trouble. The amount they vary depends on how much the collector current changes and on the resistance values in the emitter and collector circuits.

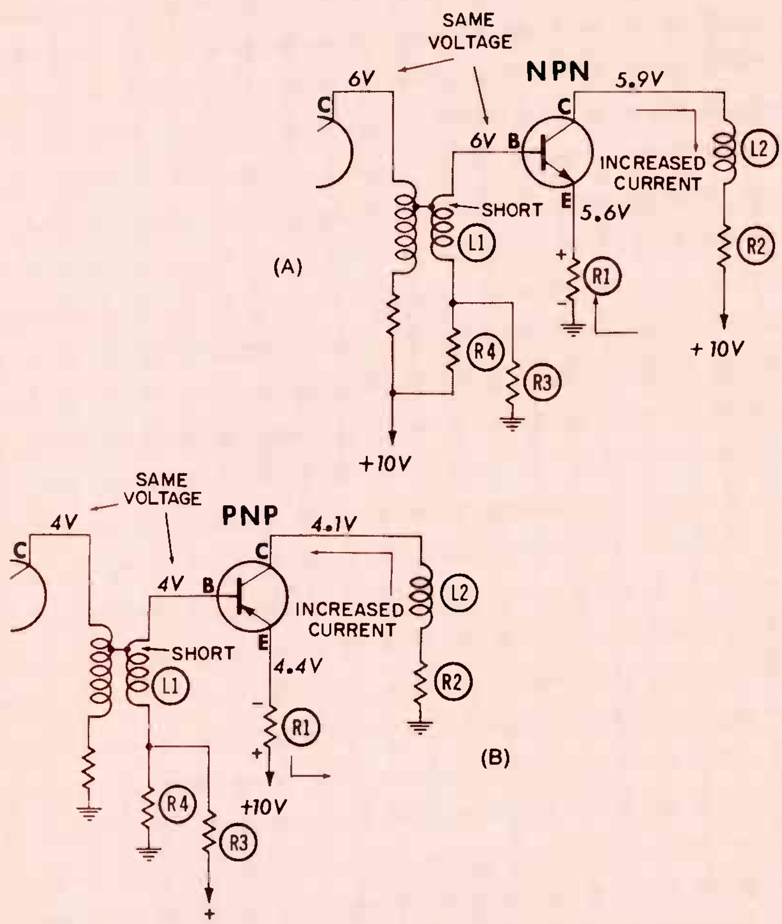


Fig. 8 Effects of a short between primary and secondary winding of coupling transformer. (A) NPN circuit, (B) PNP circuit.

TABLE

Common defects and their effects on voltages

Defect	Base Voltage (To Ground)	Normal Bias B to E?	Will There Be Voltage C to E?	Collector Current
Open Base Circuit	Wrong	No	Yes	No
Open Emitter Circuit	OK	No	Yes	No
Open Collector Circuit	OK	OK	No	No
Open Lead In Transistor	OK	High	Yes	No
Leaky Transistor	OK	No*	Yes*	High
Detuned IF Transformer	OK	OK	OK	OK
Open Capacitor	OK	OK	OK	OK

(OK means within normal limits.)

*Depends on how leaky the transistor is: The base-to-emitter bias voltage usually will decrease or become reversed in polarity, and the collector-to-emitter voltage will be lower than normal.

Open Capacitors and Defective IF Coils

Open capacitors and detuned coils generally have no effect on the DC voltages. Hence, once the trouble has been isolated to a stage, and if the voltages all check normal, it would be well to suspect a detuned coil or open capacitor. IF coils which change the receiver's volume when tapped or heated, or those which cannot be properly adjusted, should be replaced.

Shorted Capacitors

The effect of a shorted capacitor depends on its location in the circuit. Leaky or shorted "A" line electrolytics usually decrease all stage voltages and greatly increase the source current drain. They also may cause motorboating or fluttering and a slight dip in "A" voltage with each flutter.

Electrolytic coupling capacitors, which couple the signal from one stage to another, can usually be spotted easily if they short. Also, the voltage across the capacitor will measure zero, or much less than it should.

Other bypass capacitors, such as emitter and collector bypasses, seldom short. Most shorted capacitors are confined to the electrolytic type. However, a shorted capacitor in the emitter or collector circuit would be very easy to spot because of the voltage reading there. ▲

(Material for this article adapted from Howard W. Sams book titled "Practical Transistor Servicing.")

TROUBLESHOOTING TIP?

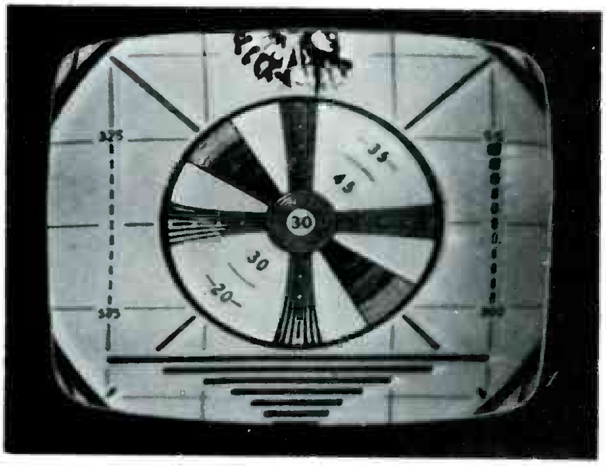
If you've recently run across an unusual trouble symptom and have determined what caused it, pass the info on to other readers by sending it to:

Troubleshooting Tip,
Electronic Servicing
1014 Wyandotte Street,
Kansas City, Mo. 64105

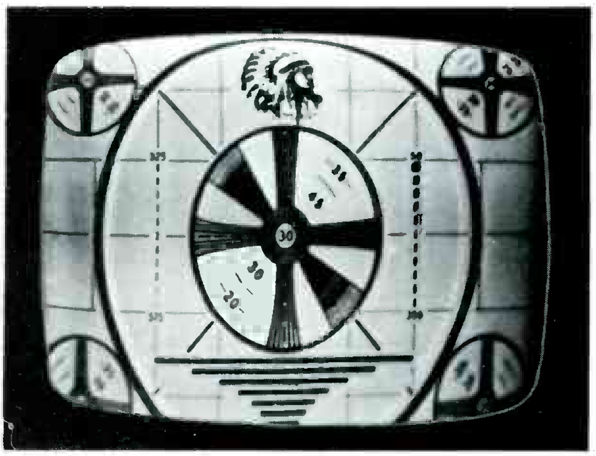
When the troubleshooting tip is published, you will receive a check from ELECTRONIC SERVICING for sharing your servicing experiences with other readers.

PICTURE SYMPTOM QUIZ

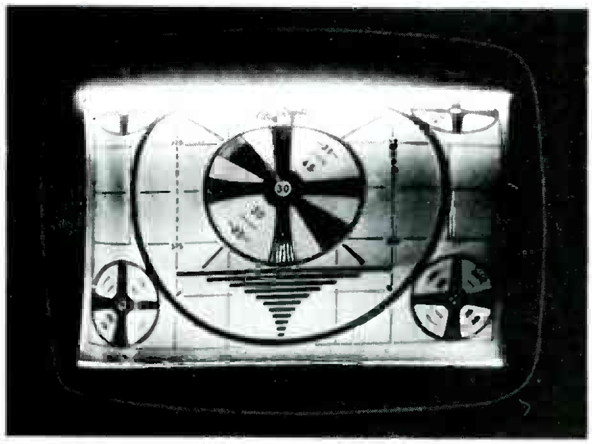
Following are eight trouble symptoms displayed on the screen of a TV. A description of the symptom is included with each photo. Analyze the trouble symptom and determine in which stage or circuit the defect causing the symptom is probably located. Answers on page 33.



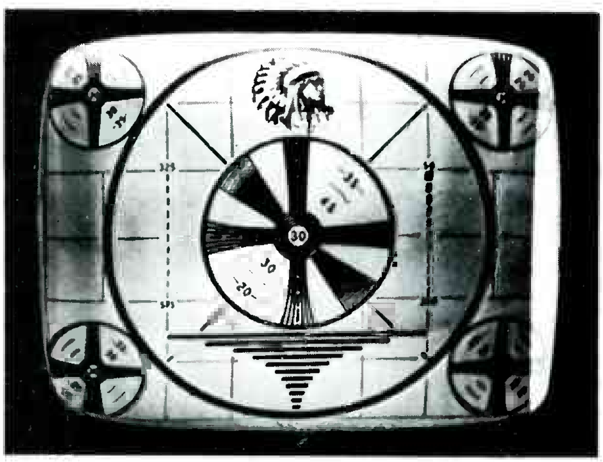
3. Height and width excessive; raster dim; linearity normal.



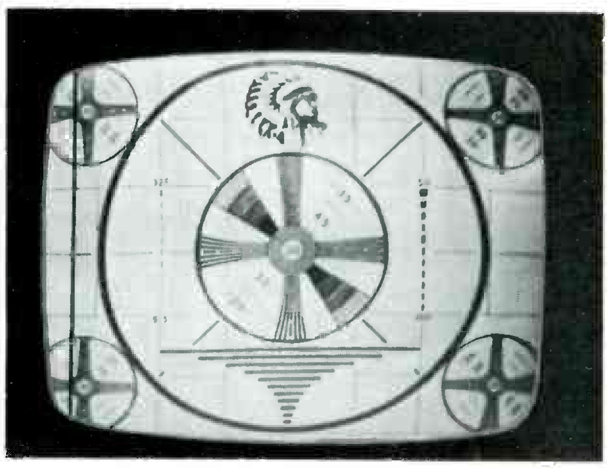
1. Height excessive; raster dim and decentered.



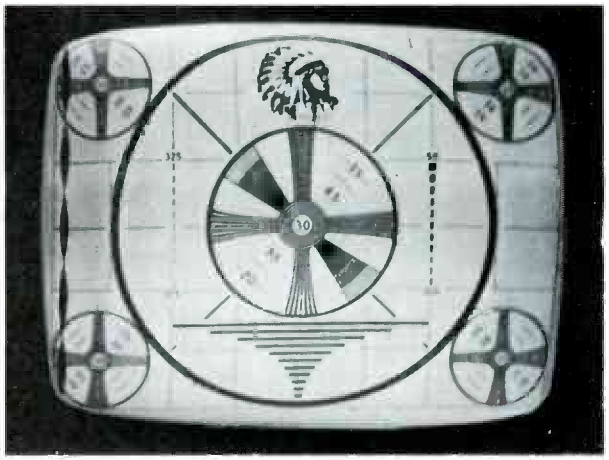
4. Height and width reduced; poor linearity; raster dim.



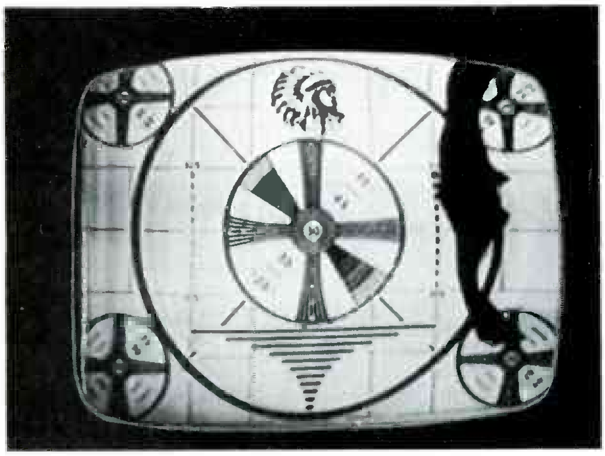
2. Foldover at right edge of screen; raster may be dim.



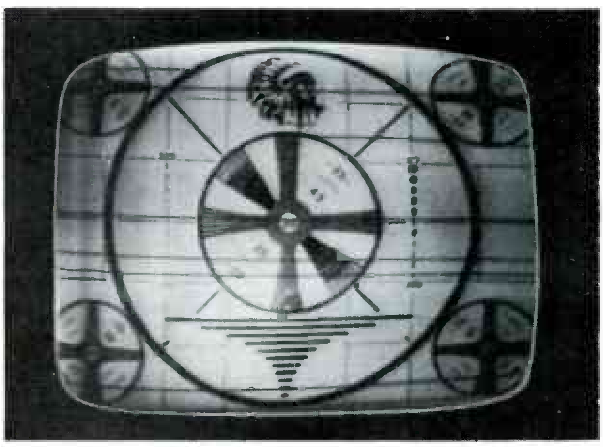
5. Dark vertical line(s) at left side of screen.



6. Irregular vertical line at extreme left of screen.



7. Dark, irregular splotches at right side of screen.



8. Horizontal streaking across entire raster.

Troubleshooting Solid-State AGC

Circuit operation, troubleshooting techniques and common troubles.

By Robert G. Middleton

Various types of AGC systems are found in different transistor television receivers. Simple AGC circuits are in the minority, while amplified AGC is common, and keyed AGC is finding increased usage. You will find that the variation in bias voltage is less in transistor television receivers than in tube-type receivers. Generally, only the first two IF stages are AGC-controlled. The RF tuner may or may not be supplied with AGC voltage. Two types of control are employed; in the most common system, stage gain is reduced by increasing the forward bias on the emitter. In other words, stage gain is reduced by increasing the collector current.

When the base-emitter forward bias is increased, the operating point moves up on the load line (Fig. 1). The collector current increases, and the operating point moves into the saturation region of the transistor characteristics. In the saturation region, note that the characteristics droop and come closer together. Accordingly, the stage gain decreases as the operating point is biased further into the saturation region. However, there is a practical limit to the amount of collector current that may be permitted to flow. As depicted in Fig. 2, excessive collector current causes excessive heat dissipation, which will in turn burn out the transistor. Hence, forward-AGC bias can be applied to a transistor only if there is adequate series resistance in the collector circuit. For this reason forward-AGC bias is not used by some manufacturers.

In the other type of AGC system, stage gain is reduced by biasing the transistor toward collector-current cutoff. When the base-emitter bias is reduced to a very low voltage, the Gm (transconductance) of the transistor approaches zero, as shown in Fig. 3. This method is comparable to AGC control in a tube-type receiver in which the stage gain is reduced by biasing the grid toward plate-current cutoff. As we know, AGC in tube-type receivers is most satisfactory when the tube has a remote-cutoff characteristic. Most transistors do not have remote-cutoff characteristics; hence, the conventional AGC system is less satisfactory with transistor receivers than in tube receivers.

On the other hand, when stage gain is reduced in a transistor stage by increasing the forward bias sufficiently to move the operating point into the collector saturation region, the gain reduction is more gradual; or, we can say that the cutoff characteristic is comparatively remote. Therefore, designers of transistor television receivers often prefer to employ collector-saturation AGC control. The chief disadvantage of this method is the additional series resistance that must be used in the collector circuit. The additional resistance wastes power and lowers efficiency—it also requires a somewhat higher supply voltage.

From the standpoint of practical troubleshooting procedures, it is essential that the following basic principles of gain control be clearly understood:

1. If the collector voltage is held constant, the gain of a transistor decreases as the emitter current is reduced (Fig. 4). If the emitter current is reduced to a very small value, the transistor is then cut off completely. This occurs when the forward-bias voltage between

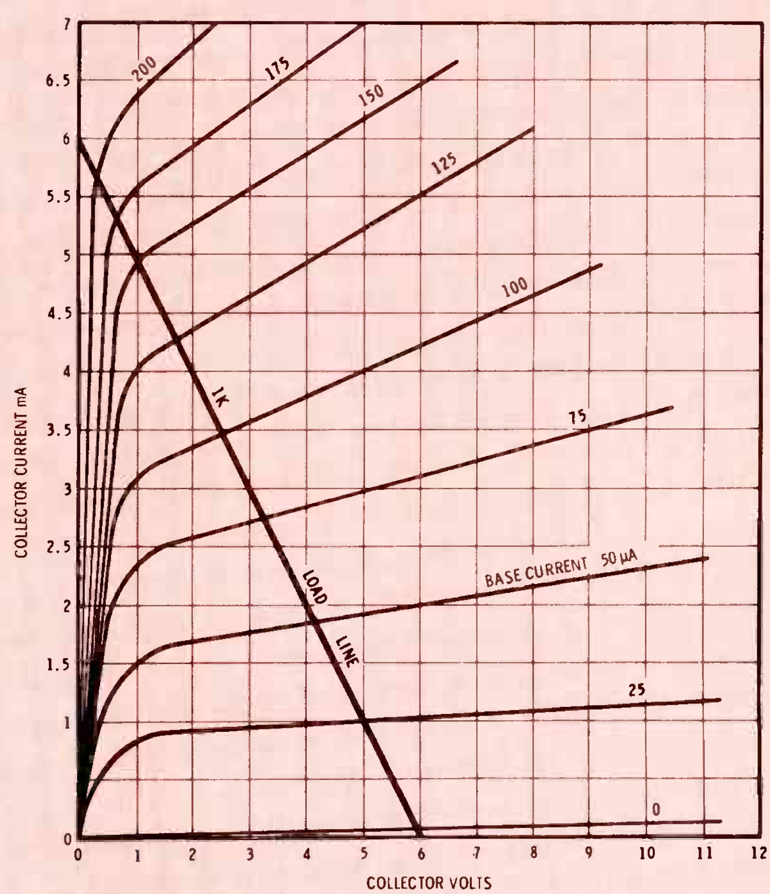


Fig. 1 Gain of transistor depends on operating point, which is determined primarily by base-emitter forward bias (base current).

emitter and base is reduced to zero.

2. If the collector voltage is reduced, the gain of a transistor decreases, regardless of the amount of emitter current. Fig. 5 shows how the gain decreases to zero as the collector voltage is reduced to a very small value.

Let us see how forward-AGC bias, as exemplified by Fig. 5, is accomplished in practice. A PNP transistor is depicted in Fig. 6. Negative AGC voltage is applied to the base, which is the same as applying positive bias voltage to the emitter. (In other words, the emitter and base are forward-biased.) Practically all of the emitter current flows into the collector circuit—the base-to-emitter current is very small. Now, suppose that the AGC voltage increases, thereby applying more negative bias to the base. The emitter then draws more current, and this current flows in the collector circuit. Because of RD, increasing the collector current produces a greater IR drop across RD, and the collector-to-emitter voltage decreases.

As seen in Fig. 5, reduced collector voltage means less gain. This is because low collector voltage operates the transistor in its saturation region. Thus, although the emitter current increases, the transistor gain decreases due to lowered collector voltage. When the collector voltage is made so low that the stage gain is zero, substantial current flows from emitter to base, and maximum current is flowing in the collector circuit. However, the transistor is now operating in complete saturation, and the collector characteristics merge together in this region. Therefore, an AC signal applied to the base produces no signal output from the collector.

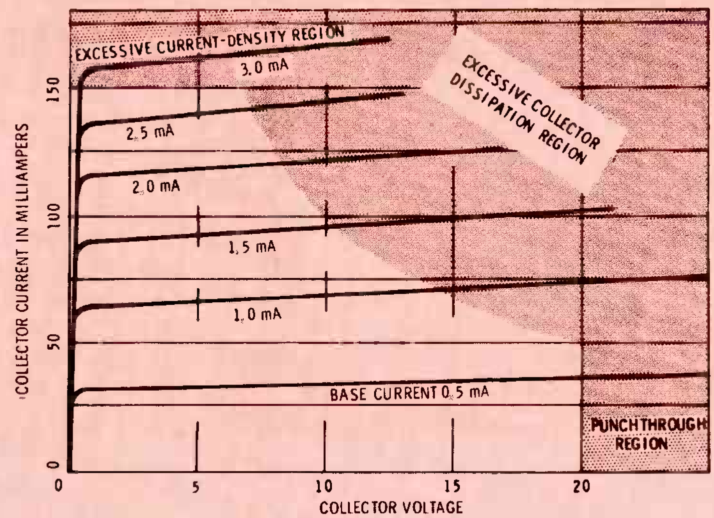


Fig. 2 Operating a transistor so that collector current falls within the shaded area shown here will destroy it.

DC Voltage Distribution

As seen in Fig. 5, the DC voltages in a transistor keyed-AGC stage are quite different from those in a tube AGC stage. In general, the transistor electrode voltages are much lower. The same distinction is found in AGC-amplifier stages, as shown in Fig. 8. The DC voltages specified in receiver service data are the values normally measured with no signal present. As would be expected, DC voltages in AGC circuits may change considerably when a strong signal is applied to the receiver.

Analysis of A Typical Circuit

A typical transistor AGC system is shown in Fig. 9. At first glance it appears that the circuit configuration is quite different from that employed in a tube-type receiver. First of all, transistor Q7 is not a DC amplifier—instead, it is an IF amplifier. However, it is not a conventional IF stage in that it branches off from the main IF section and amplifies the IF signal solely for AGC use. Furthermore, transistor Q7 is keyed by a pulse from the flyback system so that the transistor does not conduct continuously. The keying pulse is obtained from a small winding on the flyback transformer. Thus, the —0.95 volt measured at the collector of Q7 is the average rectified DC voltage developed by semiconductor diode X6.

In this example, the IF amplifier has a center frequency of 42-MHz, and thus, pulsed bursts of a 42-MHz signal are fed to transformer L15. When the input signal level changes, the amplitude of the pulsed bursts also change correspondingly. It is advantageous to amplify the IF signal through Q7, because this provides a larger AGC control range. It is also advantageous to sample the signal, because noise voltages ocurring between keying pulses are thereby excluded. In turn, noise has less effect on the AGC voltage output.

The IF signal output from transformer L15 is fed to semiconductor diode X7. The diode rectifies the IF signal bursts and develops a corresponding DC voltage across C79. Additional filtering is provided by R62 and C80. The base of transistor Q8 is biased by the filtered AGC voltage, combined with DC voltage from the —11.2 volt supply line. In the absence of signal, the base and emitter voltages are obtained solely from the —11.2 supply. Transistor Q8 is connected as an emitter-follower in order to match the comparatively high impedance of X7 to the low-impedance AGC line.

When a fairly strong IF signal is fed to the base of Q7, we find that the collector voltage of Q7 is practically unchanged. This is because Q7 operates as a class-A amplifier. In a class-A amplifier the circuit action is linear, and both the base and collector DC voltages remain unchanged by the application of AC signal voltage. However, the situation is quite different in the AGC amplifier stage. The base and emitter of Q8 obtain DC voltage not only from the —11.2-volt supply, but also from rectifier X7. When a fairly strong IF signal is present, the DC voltages at the base and emitter of Q8 drop to a typical value of —2.3 volts.

If you clamp the AGC line to analyze receiver symptoms, the clamp voltage in this system would range from —3.2 to —2.3 volts. The IF gain is maximum at —3.2 volts. At —2.3 volts, the IF gain is considerably reduced. At somewhat less negative AGC voltage, the IF gain becomes negligible. The bias box must have a fairly low source resistance, because the impedance of a transistor AGC line is low compared with that of a tube-type receiver. Always connect a DC voltmeter across the bias-box terminals, to avoid application of excess voltage to the IF transistors.

Common Trouble Symptoms

Numerous trouble symptoms arise from defects in the AGC system. The following list contains five common symptoms, each of which will be explained in detail.

1. Negative picture (hybrid receivers only).
2. No sound, no picture, raster present.
3. Overloaded picture, often with intercarrier buzz.
4. Weak picture.
5. Picture pulling and brightness modulation.

1. Negative Picture

Negative pictures will be encountered only in hybrid receivers that use tubes in the IF amplifier or that have a tube-type video amplifier. As previously noted, negative pictures result from appreciable grid current. In a hybrid receiver, AGC control voltage may be obtained from a transistor AGC system. In such cases the AGC circuit will be ar-

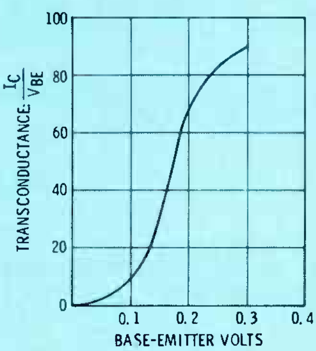


Fig. 3 Transconductance characteristic of a typical transistor.

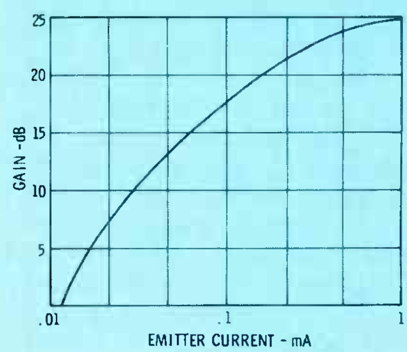


Fig. 4 With the collector voltage held constant, the gain of a transistor decreases as the emitter current is reduced.

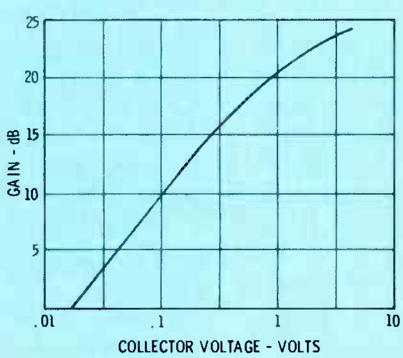


Fig. 5 The gain of a transistor decreases as the collector voltage is reduced (transistor approaches saturation).

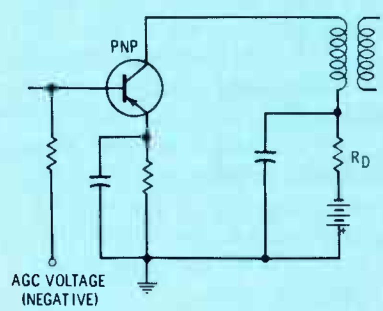


Fig. 6 Increasing negative AGC voltage produces a larger voltage drop across RD.

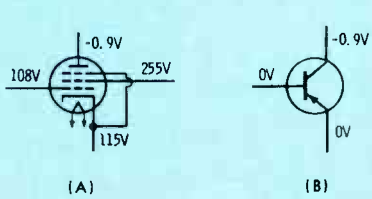


Fig. 7 Comparison of electrode voltages in tube and transistor keyed-AGC stages. (A) Tube keyed-AGC stage. (B) Transistor keyed-AGC stage.

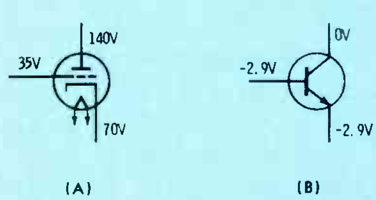


Fig. 8 Comparison of electrode voltages in tube and transistor AGC-amplifier stage. (A) Tube AGC-amplifier. (B) Transistor AGC-amplifier stage.

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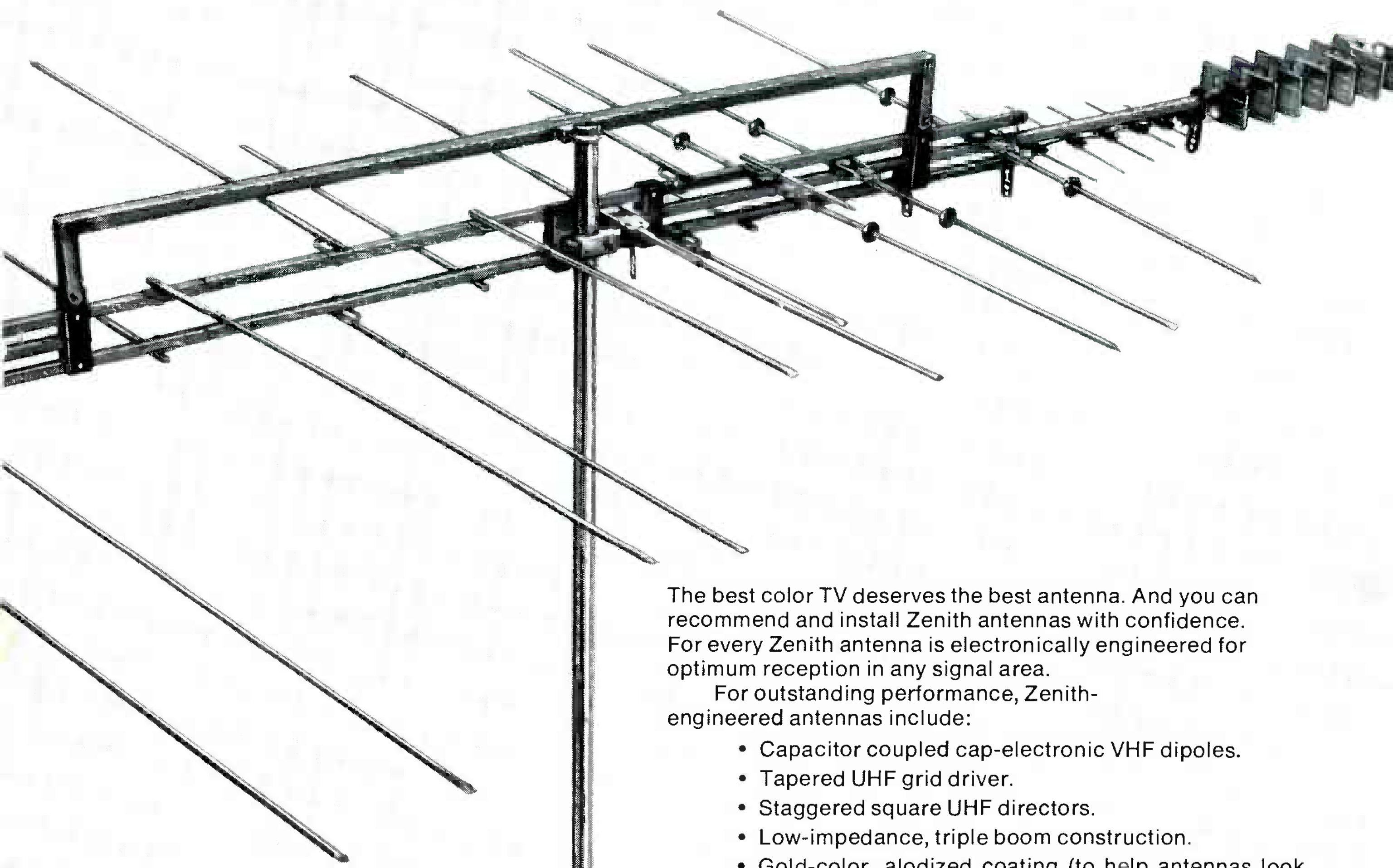

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ranged to provide more negative bias voltage when the IF signal level increases. Observe Fig. 10. Transistor Q1 operates as a keyed-AGC stage. The emitter obtains video signal from the picture detector, the base is fixed-biased at 3 volts, and the collector is pulsed from a winding on the flyback transformer. Hence, the transistor conducts only during the flyback interval.

Note that Q1 in Fig. 10 is connected as a common-emitter amplifier. This configuration is practical because the AGC line to the IF and RF sections controls the grids of tubes that have a high impedance. The 5 volts at the collector of Q1 is obtained chiefly by pulse rectification through diode X4. Now, consider what happens when the picture detector applies video-signal voltage to the emitter of Q1. This is a negative-going voltage that increases the forward bias on the transistor. Thus, when the video signal increases, the collector current increases. Electrons flow from the collector through X4, through the keyed winding, through R14, and through R13. The voltage drop across R13 becomes more negative, and a higher negative bias is applied to the IF strip and RF tuner.

The pulse output from Q1 in Fig. 10 is filtered by C3, R14, and C2. It is evident that any defect in the AGC system which prevents the control voltage from increasing as described, can result in the hybrid receiver displaying a negative picture.

Possible causes of a negative picture are:

a. Shorter C2 or C3.
b. Open X4
c. Leakage from keyer winding to core of flyback transformer.
d. Worn or noisy AGC control.
e. Defective transistor.
f. Off-value resistor (rare cases only).

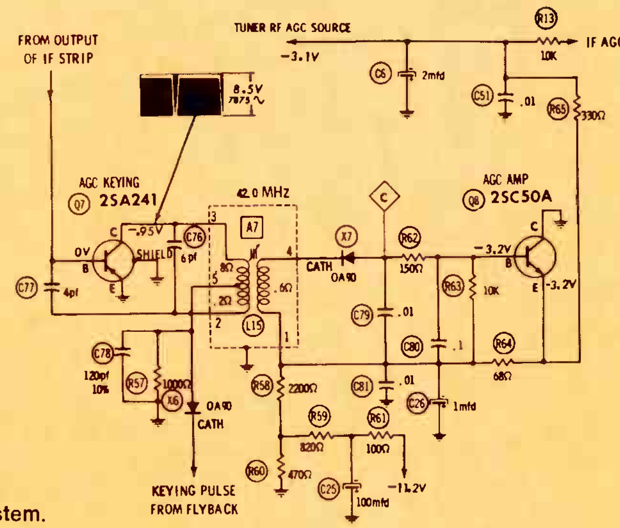


Fig. 9 Schematic diagram of a typical solid-state AGC system.

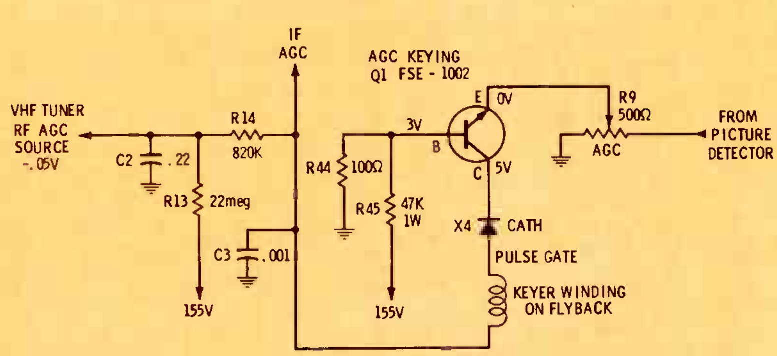


Fig. 10 Solid-state keyed-AGC stage used in a hybrid receiver.

Waveform checks and DC voltage measurements are both helpful in pinpointing the defective component. If C2 or C3 is shorted, the AGC voltage will measure zero with or without a signal. An ohmmeter test will confirm that a capacitor is short-circuited (or leaking substantially). In case X4 is open, the keying waveform will appear only at the anode terminal. You will find little or no pulse waveform at the cathode terminal (connected to the collector of Q1). If there is leakage from the keyer winding to the core of the flyback transformer, the keying pulse will be attenuated or absent; an ohmmeter test will confirm the leakage.

Suppose that the AGC control in Fig. 10 is worn or open. The video waveform at the emitter of Q1 will be weak or absent. An ohmmeter check will confirm the suspicion of a defective AGC control. In case the transistor is defective, the normal DC voltages will not be present—if a junction is open, there will be no current flow and the electrode voltages will be quite different. On the other hand, if a junction is short-circuited, you will measure the same voltage at both junction terminals. Sometimes a junction merely develops a poor front-to-back ratio. In this case the DC voltages will be more or less abnormal, and the AGC output voltage will change only slightly when the signal level is increased.

2. No Sound, No Picture, Raster Present

This symptom can be caused by defects in the RF, IF, or video-amplifier section, as previously explained. A preliminary localization test is made by clamping the AGC line. Then, if normal picture and sound reproduction are obtained, the trouble will be found in the AGC system. A defect is present that cuts off the IF transistors. In the configuration shown in Fig. 9, for example, a very slight negative voltage, or zero volts, would be measured on the AGC line.

With reference to Fig. 9, possible causes of no sound and no picture, due to AGC trouble are:

a. Shorted AGC capacitor (C6, C51, C26, and C81).
b. Shorted AGC transistor (Q8).
c. Solder splash shorting out AGC line.

d. Cold solder joint that opens the —11.2-volt line.

e. Break in printed-circuit wiring that interrupts the supply voltage.

f. Open resistor (R61, R59, or R58).

Capacitors are the most frequent troublemakers. Be alert for small splashes of solder that can often escape notice in miniaturized circuitry. Transistors are long-lived compared to tubes, but this is a possibility. When components have been replaced, there is also a chance of cold solder joints and breaks in printed-circuit wiring due to excessive tugging or mechanical damage. Resistors are least likely to cause trouble; remember, however, that very small-sized resistors can be cracked and broken by careless handling of tools.

3. Overloaded Picture, Often With Intercarrier Buzz

An overloaded picture, if caused by AGC trouble, becomes normal when the AGC line is clamped. If a measurement of the bias voltage output from the AGC section shows lack of adequate control voltage with a normal signal level present, the suspicion of AGC trouble is confirmed. With reference to Fig. 9, diode X6 is a ready suspect. If the diode is open-circuited, the keying pulse is stopped, and the AGC system cannot function. Tranistor Q7 is cut off, and X7 can feed no rectified voltage to Q8. In turn, the AGC control voltage remains at —3.2 volts regardless of the signal level. When X6 is open, and with normal IF signal level present, a direct clue is positive DC voltage at the collector of Q7, instead of the normal —0.95 volt. In this situation, Q8 operates as a diode rectifier for the IF signal, and develops a positive collector voltage.

Possible causes of an overloaded picture, which may be accompanied by intercarrier buzz due to AGC defects are:

a. Pulse diode open (X6 in Fig. 9).

b. Rectifier filter capacitor shorted (C79 or C80 in Fig. 9).

c. Leakage of keyer winding to core of flyback transformer.

d. Break in printed-circuit wiring.

e. Cold solder joint in keying-pulse circuit.

f. Open resistor, such as R57 in Fig. 9 (rare cases only).

An overloaded picture with intercarrier buzz is often accompanied by horizontal pulling, as illustrated in Fig. 11. Overload results in compression or clipping of the sync pulses, which prevents the horizontal-AGC system from locking the picture tightly. Suppose that X6 in Fig. 9 is shorted. In this case, the keying pulse will still be applied to the collector of transistor Q7, but the only rectifying action in the circuit will be that of collector-junction action. Consequently, the DC voltage at the collector will be subnormal, and will measure about —0.2 volt. The DC voltage at the base of Q7 will become positive instead of zero—it will measure about 0.04 volt. In turn, the output from transistor Q7 will be weaker and the AGC control voltage will be subnormal. Overloading will occur in the IF amplifier, and picture bending will be prominent. Since the overloading is less severe than when X6 is open, intercarrier buzz occurs only when a strong signal is present. The same symptom can be caused by leakage in C76, and this capacitor should be checked in case it is found that X6 is not shorted. Transformers such as L15 seldom cause trouble unless they have been mistuned. However, if the other components are cleared from suspicion,

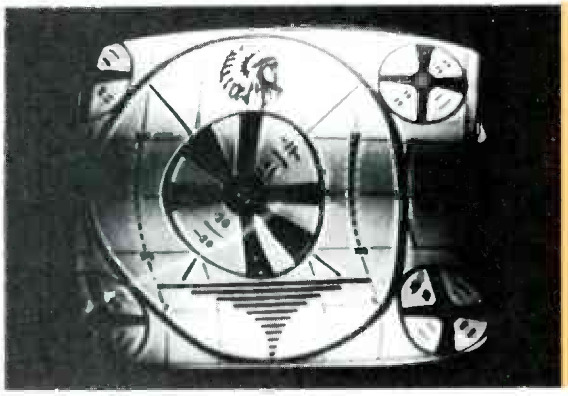


Fig. 11 Example of overloaded picture accompanied by horizontal pulling.

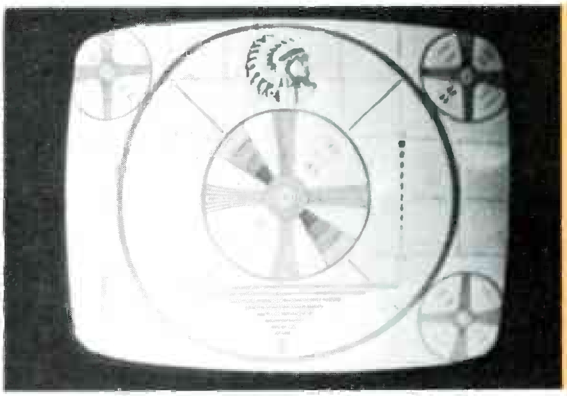


Fig. 12 Low contrast with brightness modulation is the trouble symptom displayed here.

Fig. 13 Brightness modulation accompanied by picture pulling.

the transformer should be checked. A defective transformer will refuse to peak normally at 42 MHz.

4. Weak Picture

When a low-contrast picture is caused by AGC trouble, clamping the AGC line will restore normal picture reproduction. Measurement of the control voltage will show that the AGC output is greater than normal for the prevailing signal level. A systematic check is required to pinpoint the defective component. Measurements of DC voltages at the transistor terminals provide useful clues.

With reference to Fig. 9, possible causes of a weak picture due to AGC trouble are:

a. Leaky AGC capacitor (C6, C51, C26, and C81).
b. Leaky AGC-amplifier transistor (Q8).
c. Open neutralizing capacitor (C77).
d. Resistor increased in value (R8 and R9).

Leaky capacitors are the most common troublemakers. However, if you must dig deeper, check the AGC-amplifier transistor. If Q8 (Fig. 9) is leaky, the DC voltages at the base and emitter will be subnormal due to excessive loading imposed by leakage to ground via the collector. In a typical trouble situation the base and emitter voltages are only half their normal value. Another useful clue in this situation is intercarrier buzz accompanying the weak picture.

A weak picture can result when C77 in Fig. 9 is open, because transistor Q7 is no longer neutralized. The stage becomes regenerative, and L15 resonates at a frequency higher than 42 MHz. In turn, reduced signal voltage is fed to X7. If the defect in C77 is overlooked, an attempt to obtain normal operation may be sought by realigning L15. However, this does not produce the desired result. As the slug is turned into the transformer, L15 resonates at 42 MHz, but the stage then becomes an oscillator instead of an amplifier. Oscillation results in excessive 42-MHz voltage being fed to X7, and the picture symptom is suddenly reversed. Instead of a weak picture, an overloaded picture is displayed on the picture-tube screen.

Off-valve resistors are less commonly encountered, but this possibility must not be overlooked. Suppose that R61 in Fig. 9 has increased in value. In this case, the picture will have low contrast, and a hissing noise will be audible in the sound. Measurement of the DC voltages at Q8 provides the preliminary clue; both the base and emitter voltages will be subnormal and in a typical trouble situation will measure only —1 volt. Again, consider a trouble situation caused by an increase in value of R65 in Fig. 9. The DC voltage measurments show an excessive voltage drop across R65. Although the emitter end of the resistor has a higher voltage than normal, the AGC-line end of R65 has lower voltage than normal. An ohmmeter check confirms that R65 has increased in value.

Next, consider a weak-picture symptom when a transistor AGC section is used in a hybrid receiver. With reference to Fig. 10, a weak picture is caused by excessive output control voltage from the AGC circuit. The most likely culprit is AGC control R9. When the control becomes worn, it can develop excessively high resistance near the grounded end. The control will then lack adequate range, and excessive video signal will be fed to the emitter of the transistor, regardless of the control setting. An ohmmeter check will confirm the suspicion of a defective AGC control.

5. Picture Pulling and Brightness Modulation

When picture pulling is caused by AGC trouble, the contrast usually will be excessive, although there are occasional exceptions, as previously noted. In any case, clamping the AGC line will restore normal picture reproduction if the AGC system is actually at fault. Brightness modulation often accompanies picture pulling. Abnormal screen brightness occurs across the portion of the pattern where pulling is greatest. What happens is this: the sync pulses of the video signal fall out of step with the keying pulses from the flyback transformer in the AGC keying stage over the pulling interval. In turn, the output control voltage varies over the pulling interval. A scope check on the AGC line will show the presence of AC voltage along with the DC control voltage.

Possible causes of picture pulling and brightness modulation due to AGC trouble are:

a. Pulse filter diode open (X6 in Fig. 9 and X4 in Fig. 10).
b. Pulse filter diode shorted.
c. Leaky neutralizing capacitor (C77 in Fig. 9).
d. Break in printed-circuit wiring (pulse diode circuit).
e. Cold solder joint (pulse diode circuit).
f. Solder splashes in pulse diode circuit.

Brightness modulation can also occur due to AGC trouble without a picture-pulling symptom. For example, if R65 in Fig. 9 increases in value, the contrast will be low and brightness modulation will become apparent, as illustrated in Fig. 12. The bottom portion of the picture is excessively bright, while the top portion is comparatively dark. To confirm that brightness modulation is actually being caused by AGC trouble, clamp the AGC line. If the brightness-modulation symptom disappears, we know that the trouble will be found in the AGC section.

Brightness modulation can occur in any portion of the picture. For example, Fig. 13 illustrates brightness modulation chiefly through the center of a weak picture that is pulling, as a whole, to the right-hand side of the screen. If the AGC line is clamped, the symptoms disappear. Accordingly, the trouble is caused by a defect in the AGC section. With reference to Fig. 9, the most likely cause is transistor Q8. Leakage from collector to base can cause this picture symptom, which is accompanied by buzz in the sound. The DC voltages at base and emitter measure lower than normal.

However, practically the same symptom can be caused by an increase in value of R61 in Fig. 9. Again, the DC voltages at base and emitter of Q8 measure much lower than normal. Brightness modulation occurs in Fig. 13 because the picture is being pulled. In turn, the sync pulses of the video signal are not exactly in step with the keying pulses from the flyback transformer. The AGC keying stage does not supply a completely steady output voltage as the picture is scanned from top to bottom. This variation in AGC output produces the brightness modulation. ▲

(Material in this article adapted from Howard W. Sams book titled "Servicing Transistor TV.")

Answers to picture symptom quiz on page 22.

1. Low emission in the horizontal output tube caused a decrease in high voltage which, in turn, caused the increased height. Since the horizontal-sweep voltage was also reduced, the width did not increase. The key to this trouble is the combination of increased height and a dim raster.

2. Gas in the horizontal output tube caused the foldover at the right of the raster. Horizontal nonlinearity accompanies this trouble symptom in many receiver designs.

3. Low emission in the high-voltage rectifier or a defect in the high-voltage circuit caused the "blooming" symptom portrayed in this photo. Normal linearity is the key to the cause of this trouble symptom, together with an increase in blooming as the brightness level is increased.

4. Low emission in the low-voltage rectifier (or defective low-voltage semiconductors) reduces the plate and screen voltages to the vertical and horizontal sweep stages, causing the symptom displayed here. Some receiver designs display more severe nonlinearity in conjunction with this trouble symptom than that indicated in the photo.

5. Parasitic oscillation in the horizontal output tube caused the "Barkhausen line" displayed on the left edge of the screen in this photo. In many cases more than one dark, narrow line is displayed. Such lines can often be minimized or eliminated by replacing the horizontal output tube. Often, several tubes will have to be tried before the lines are eliminated.

6. The ragged vertical lines at the extreme left of the screen in this photo are called "spook" lines and are caused by radiation from the deflection circuits, which is picked up by the RF and/or IF circuits in the receiver. These lines often can be minimized or eliminated by replacing the damper tube, or in extreme cases, by replacing RF chokes in series with the heater, cathode and/or plate circuit of the damper tube.

7. The dark blotches, or splotches, at the right of the screen in this photo is a "snivet," which is another result of parasitic oscillation within the deflection circuits of the receiver, in this case the damper. Replacing the damper will often cure this trouble; however, several tubes may have to be tried before the snivet is eliminated. Severe cases may require that parasitic-suppression resistors (about 50 ohms) be mounted at the damper socket and in series with the plate and cathode leads of the damper tube.

8. Arcing in the horizontal output, high-voltage or damper tubes is the most probable cause of the streaking evident on the screen in this photo. Other sources of arcing that can cause this symptom, although not so likely, are the vertical output or picture tubes and corona arcing in and around the horizontal sweep or high-voltage sections. In some cases, static or noise picked up by the antenna system can cause this symptom; disconnecting the antenna lead-in from the receiver is one positive check for this source of the trouble. ▲

Circle 15 on literature card

bookreview

Know Your Tube and Transistor Testers: Robert G. Middleton, Howard W. Sams Co., Inc., Indianapolis, 1969; 144 pages, 5½" x 8½"; softbound, $3.50.

Up-to-date information on the design and applications of tube and transistor testers, including service-laboratory and kit-type units. Written for the service technician.

How To Select and Install Antennas: Lon Cantor, Hayden Book Co., Inc., New York, 1969; 105 pages, 5⅜" x 8¼"; softbound, $3.95.

Text covering the mechanical as well as the electronic aspect of selecting and installing color and b-w TV antennas (VHF and UHF), FM stereo antennas and MATV systems.

Includes information on how to mount and stack antennas; choosing the right installation materials, lead-in and preamplifiers; and provides special consideration of local, fringe and near-fringe reception problems.

Circle 16 on literature card

Admiral's K10 Hybrid Color Chassis

by Ellsworth Ladyman

Conventional and field-effect transistors are combined with vacuum tubes in this manufacturer's new color chassis.

Admiral Corporation has introduced a new hybrid color chassis utilizing a combination of FET's, transistors and vacuum tubes. Because of this, servicing procedures will vary from section to section.

To reduce the possibility of damage occuring in one section while working on another, Admiral has designed two etched-circuit boards: One contains the solid-state circuitry; the other, the vacuum tubes. These etched boards are separated into zones by heavy white lines. Each zone is identified by a large white letter designating the section.

- A—Video IF
- B—Sound, AGC, and video amplifiers
- C—Chroma amplifiers
- D—Chroma oscillator and color killer, color burst amplifier, and color demodulators
- E—Vertical
- F—Horizontal
- G—Convergence
- H—Miscellaneous chassis components
- U—UHF tuner
- V—VHF tuner

This coding system also makes it easier to find the components on the schematic. Resistor RC64 on the wiring diagram will be found in zone "C", with the number "64" written beside it on the board.

Circuit Description

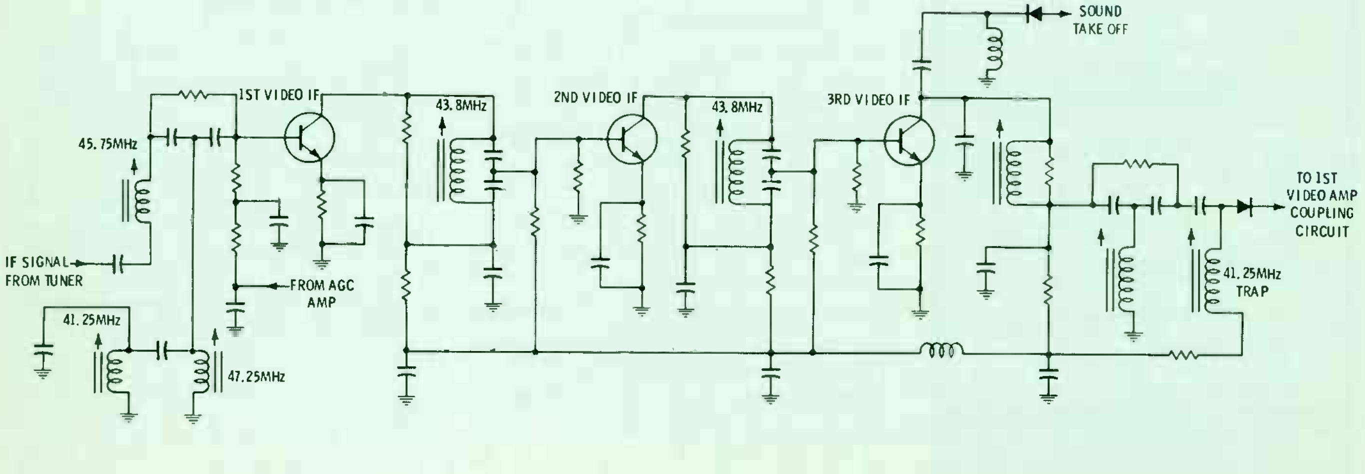
Admiral chassis K10 is comprised of twenty-six transistors, twenty-four diodes, seven vacuum tubes and a CRT. The transistors are used for all signal-processing functions, while the vacuum tubes are used in circuits that have heavier power requirements.

Power Supply

The power transformer is used only for the transistor circuits, although it does have a 6.3-volt AC tap to supply filament voltage to the CRT. A line choke is used to prevent any unwanted RF signals from entering the various circuits through the source voltage.

Video IF Strip (Fig. 1)

The outputs of the first and sec-



ond video IF transistors are applied across tuned coils. These coils are shunted by a pair of capacitors to form a capacitance voltage divider. The input signal for the next stage is obtained from the junction of these capacitors. This configuration results in the proper impedance match for efficient signal transfer. The sound "take-off" is from the collector of the third video IF.

Sound Circuits

The sound section consists of the sound takeoff, sound IF, oscillator limiter, ratio detector, audio driver and audio output stages.

Oscillator Limiter

The oscillator limiter stage is self-oscillating, with the frequency determined by the incoming signal from the sound IF stage. This incoming sound signal serves as a "sync" signal for the oscillator

Fig. 1 Three-stage transistorized video IF employed in Admiral's K10 hybrid chassis.

limiter. Because of the dependency of the output of the oscillator on the incoming signal, the output of the oscillator does not change in amplitude and is, therefore, a very effective limiter stage. The output of the oscillator limiter is then applied to the ratio detector.

AF Sound Circuitry

The AF sound circuitry has two direct-coupled transistors driving an output transformer. A voltage dependent resistor (VDR) is connected across the primary of the audio output transformer to prevent damage to the receiver if it is operated with the speaker disconnected.

The output transistor is mounted on the end of the chassis, utilizing the chassis as a heat sink. A mica wafer isolates the collector (transistor case) from the chassis, resulting in a potential of 105 volts DC on the transistor case.

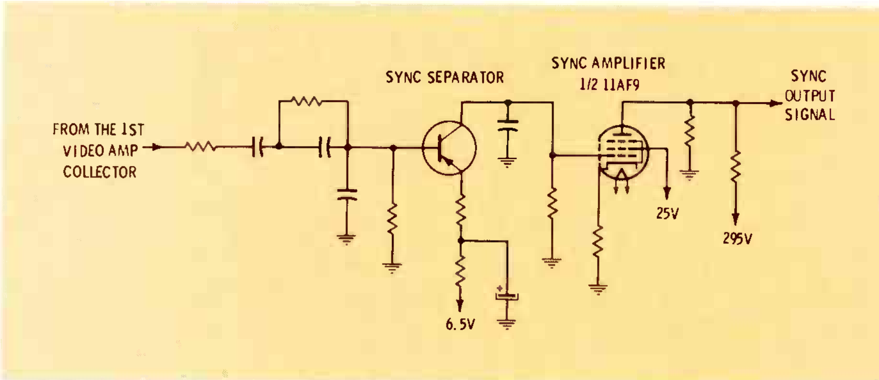


Fig. 2 Transistor and vacuum tube are mated in sync separator/amplifier section of K10.

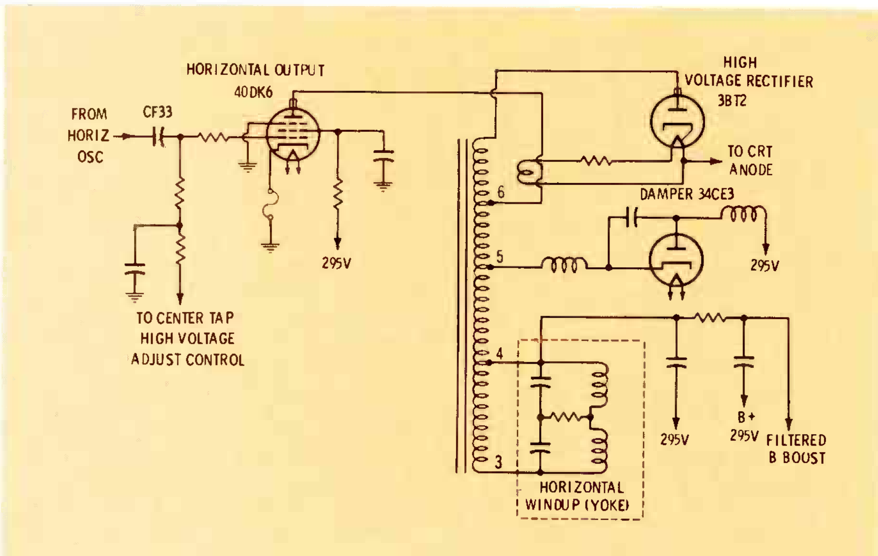


Fig. 3 Fuse in cathode circuit of horizontal output stage provides overload protection for horizontal output and flyback.

Sync and Sweep

A transistor is used as a sync separator with its output driving a vacuum-tube (11AF9) sync amplifier (Fig. 2). The sync output voltages are taken from the plate and applied to the vertical and horizontal circuits.

The horizontal phase detector and horizontal oscillator are similar to those used in previous Admiral models.

The horizontal output stage (Fig. 3) operates as a controlled switch. It conducts during half of the scan line, and is cut off the other half. When drive pulses are applied to the grid coupling capacitor (CF33), grid rectification produces an extremely high negative grid voltage.

When the output tube conducts, heavy current flows through the flyback windings. At the end of the line scan, the output tube ceases conduction, and the flyback field collapses, providing the flyback pulse. This pulse is stepped up by the high turns ratio of the high-voltage transformer windings. It is then rectified by the high-voltage regulator which provides the high CRT anode potential. As the collapsing flyback field shifts into its negative

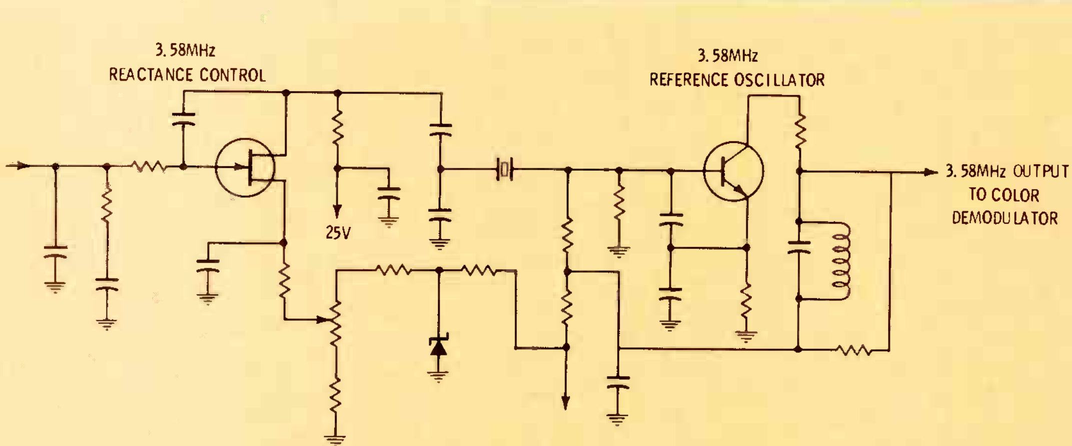


Fig. 4 Field-effect and conventional NPN transistors serve in the reactance control and chroma reference oscillator section of the K10's chroma circuitry.

half cycle, the damper tube becomes forward biased, causing a strong damper current to flow. The yoke current will then increase and conduct in the same direction as the output tube. The damper causes the beam to sweep the remaining half line.

Simultaneously, the boost capacitor is charging up to boost level. The dampered flyback field will produce an output that is added to the B+ potential. This boost voltage is filtered and used to supply the CRT screen voltage, vertical oscillator plate and vertical output bias requirements.

The horizontal output circuit is protected by a fuse in the cathode of the horizontal output tube. This circuit protection, which hasn't been used in a few years, saves the flyback. The HV regulation is provided by a "pulse feedback" circuit.

Chroma Oscillator

The reactance control stage provides (when necessary) a correction voltage to the 3.58-MHz subcarrier oscillator (Fig. 4). An N-channel junction field-effect transistor (FET) performs this function. Because FET's are susceptible to damage from static discharges and arcs from the CRT, care must be exercised when working in this area. One method of testing is to check for the presence of voltage on the gate of the FET when the 3.58-MHz oscillator is slightly off-frequency. Check operating potentials on the gate, drain and source, and compare the readings to the voltage values shown on the schematic.

As with most control circuits, the reactance control does not operate when the subcarrier oscillator remains on frequency. Varying the feedback correction voltage from the color phase detector or changing the setting of the reactance control potentiometer will initiate conduction in the FET. This changes the tuning, or phase, of the 3.58-MHz subcarrier oscillator.

Color Demodulation

Color detection is accomplished using —(R-Y) and —(B-Y) signals. The output of the demodulators is then inverted and amplified by the color difference amplifiers, and becomes R-Y and B-Y.

The demodulators are essentially electronic switches with the 3.58-MHz subcarrier signal directing their operation. The amount of conduction is determined by the amplitude of the chroma signal delivered to them by the bandpass amplifier.

The color demodulators used in the K10 chassis are PNP transistors. The chroma signal from the bandpass amplifier is applied to the emitters of the demodulators through a resistive voltage divider network. The switching signal (3.58 MHz) is fed to the base of each demodulator. Under these conditions, the negative-going peaks of the 3.58-MHz signal will cause conduction, and an amplified color difference signal will be present on the collectors of the demodulators.

To control the time of demodulator conduction, the 3.58-MHz signal is coupled directly to the —(R-Y) demodulator and through a

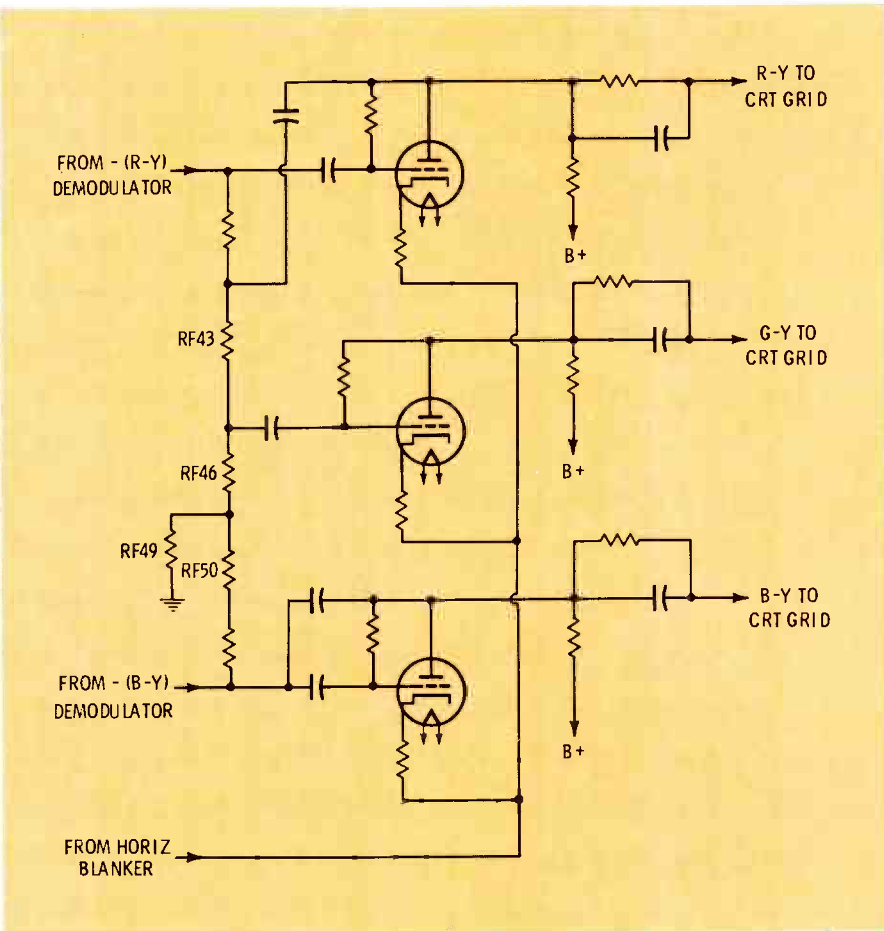


Fig. 5 Triple-triode 8AC10 performs color-difference amplification function in Admiral's hybrid chassis.

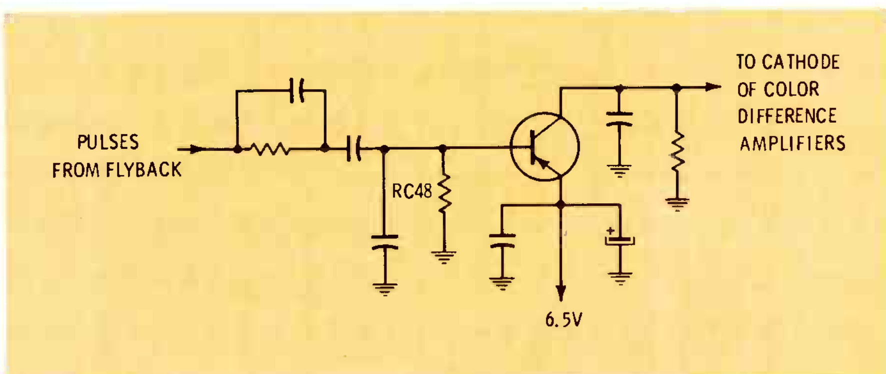


Fig. 6 Cutoff of transistorized horizontal blanker during horizontal retrace drives cathodes of color difference amplifiers more negative; difference amplifiers become saturated and their plate voltage decreases, biasing off CRT grids.

phase shift network (90°) to the —(B-Y) demodulator. The 3.58-MHz signal present on the collectors of the demodulators is trapped out by a capacitance/inductance network.

Color Difference Amplifier (Fig. 5)

The color difference amplifiers are housed in a three-section triode tube, type 8AC10. The outputs of the color demodulators are fed through the difference amplifiers, and the signals are amplified, inverted and applied to the CRT red, blue and green grids. The —(R-Y) and —(B-Y) signals come directly from the demodulators, and the —(G-Y) signal is formed by a matrix circuit comprised of resistors RF43, RF46, RF49 and RF50.

Horizontal Blanker (Fig. 6)

To accomplish horizontal blanking, each color difference amplifier is biased off during horizontal retrace time. A negative blanking pulse is applied to each color-difference amplifier cathode, causing heavy conduction through the triodes, producing a high-amplitude pulse on the CRT grids. The color difference amplifier is driven into saturation, the plate voltage is decreased sharply, and the CRT is driven into cutoff. This action results in some signal detection, which provides a measure of DC restoration to the CRT.

The horizontal blanker stage cuts off the CRT during horizontal retrace time by driving the color difference amplifier into saturation. The PNP transistor acts as a switch at the horizontal rate.

During the horizontal scan time, the horizontal blanker conducts strongly, due to the biasing action of the base resistor, RC48. During the retrace interval, a positive pulse from the flyback transformer drives

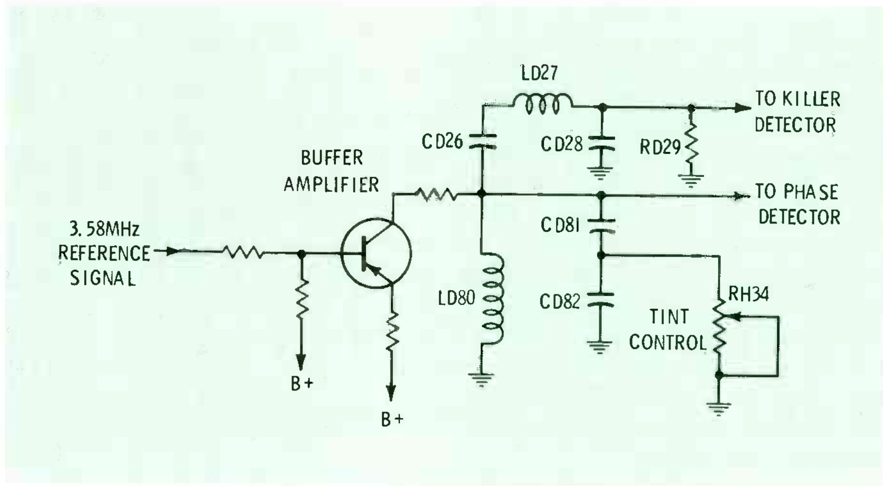


Fig. 7 Transistor buffer amplifier supplies 3.58-MHz reference signal to color-killer and phase detector diodes.

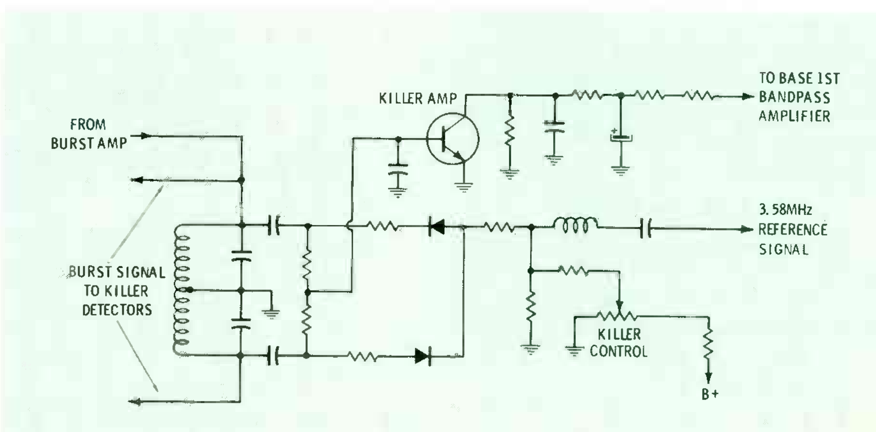


Fig. 8 Color-killer and associated detector circuitry.

the base-emitter junction into a reverse-bias condition, and the transistor becomes an open switch. The collector voltage decreases to zero.

When the cathode bias voltage of the color difference amplifier is removed (horizontal blanker collector at zero volts), the color difference amplifiers are driven into saturation. The plate voltage decreases sharply, cutting off the CRT grids.

3.58-MHz Reference Feedback System (Fig. 7)

A buffer amplifier (3.58-MHz reference feedback amplifier) supplies a 3.58-MHz reference signal for the color-killer detector diodes and the phase detector diodes. The color demodulator diodes control the phase of the redeveloped chroma subcarrier.

The 3.58-MHz signal is coupled to the base of the buffer amplifier. The tint control, RH34, and capacitors CD81 and CD82, connected across inductance LD80, are connected in the collector circuitry and alter the phase of the output signal, controlling the color demodulation when the tint control is varied. Inductor LD27, capacitors CD26, CD28 and resistor RD29 restore the phase of the reference signal applied to the killer detector.

Color Killer System (Fig. 8)

The color-killer amplifier cuts off the first bandpass amplifier when no color information is present in the received signal. When no color information is present, the color-killer amplifier conducts heavily, driving the first bandpass amplifier to cutoff. This prevents color noise from contaminating the b-w picture.

When color information is present in the signal, the detected burst signal is applied to the base of tthe killer amplifier. When the killer amplifier is cut off, no killer bias is applied to the first bandpass amplifier and it is free to amplify the chroma signal.

When color information is not present, a positive voltage, derived from the color-killer control (connected to the 25-volt line), supplies forward bias to the killer amplifier through the color-killer detector diodes.

When color information is present, the color signal is detected and a negative voltage is developed to cancel the forward-bias voltage ▲

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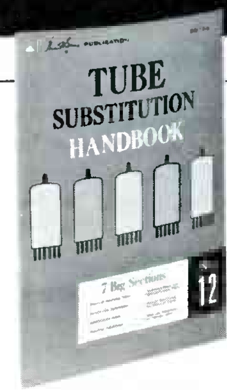

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Included are the older tubes that will substitute directly for the new tubes. This information supplements the sections in the Tube Substitution Handbook for American Receiving Tubes and Picture Tubes.

basing diagrams

The basing diagram for each new tube will help you in the servicing of new receivers when service literature is not available.

typical characteristics

The typical, or average, characteristics of each new tube can be of great help when troubleshooting new circuits.

easy reference

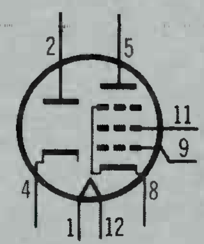
The direct substitution list will be cumulative each month. Thus, only the latest edition need be carried in the Tube Substitution Handbook.

33HE7

Pentode—Horizontal output
Diode—Damper
Filament—33.6V @ 0.45A (11 sec)

		Pentode
E_P	=	130V
E_{SG}	=	130V
E_G	=	−22V
R_K	=	---
I_P	=	60 ma
I_{SG}	=	2.8 ma
G_m	=	8800 μmhos
M_μ	=	4.2

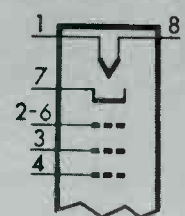
Diode—PIV—4200V @ 200 ma



12FS

19GEP4

Protection—Banded
Deflection—114°
Filament—6.3V @ 0.45A (11 sec)
Grid 2—400V



8HR

d

Direct Substitutions

To Replace	Use	To Replace	Use
5MQ8	*	16LU8A	16LU8
6AG9	6AL9	18AJ10	*
6AK10	*	31AL10	*
6AL9	6AG9	32HQ7	*
6MQ8	*	33HE7	*
8AL9	*	12DEP4	*
8KR8	*	12DHP4	*
8LS6	*	19GEP4	*
9AK10	*	19HNP22	*
10LY8	*	22TP4	*
16BX11	*	22ZP4	*
16LU8	16LU8A	25ALP22	*

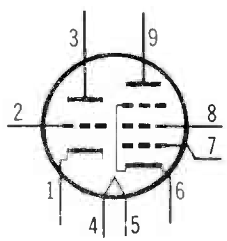
*No substitution at present time.
Twelfth edition of Tube Substitution Handbook now available at your distributor.

General Specifications

8KR8

Pentode—Video Amp
Triode—General Purpose
Filament—8.0V @ 0.6A (11 sec)

		Pentode	Triode	
E_P	=	200	125	V
E_{SG}	=	100	---	V
E_G	=	---	---	V
R_K	=	82	68	Ω
I_P	=	19.5	15	ma
I_{SG}	=	3.0	---	ma
G_m	=	20,000	10,400	μmhos
M_μ	=	---	46	---



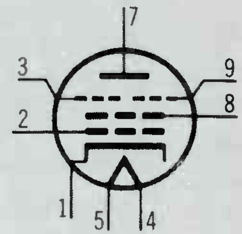
9DX

b

8LS6

Pentode—Video Amp
Filament—7.7V @ 0.45A (11 sec)

E_P	=	110V
E_{SG}	=	110V
E_G	=	---
R_K	=	65Ω
I_P	=	14 ma
I_{SG}	=	3.2 ma
G_m	=	11,000 μmhos
M_μ	=	36

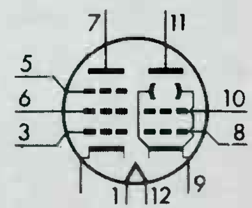


9GK

18AJ10

Pentode 2—FM Detector
Pentode 1—AF output
Filament—18V @ 0.315A (11 sec)

		Pentode 1	Pentode 2	
E_P	=	145	150	V
E_{SG}	=	110	100	V
E_G	=	−7	−4	V
R_K	=	---	180	Ω
I_P	=	34	2.8	ma
I_{SG}	=	6.5	3.5	ma
G_m	=	5600	2400	μmhos



12EZ

c

The RCA Model WV-500A VoltOhmyst is a solid-state electronic voltmeter. It is a compact, battery-operated, portable instrument, well suited for use by the electronic service industry. It is rugged enough to withstand the abuse of service calls, yet sensitive enough to do the job on all phases of electronic servicing where VTVM's are called for.

General Description

The VoltOhmyst is capable of measuring DC voltages ranging from 0.01 to 1500 volts, AC peak-to-peak voltages of complex waveforms ranging from 0.5 to 4200 volts, and resistance values ranging from 0.2 ohms to 1000 megohms.

Eight ranges are available for DC measurements, including an extremely useful 0- to 0.5-volt range. Seven overlapping ranges cover the AC rms and resistance ranges. Accuracy on both DC and AC measurements is ±3% of full-scale deflection.

The 11-megohm input impedance on all DC ranges of the VoltOhmyst permits the instrument to be used indiscriminately throughout most home-consumer electronics circuits without fear of loading down a circuit, yet is not so high as to effect stability.

Theory of Operation

The input voltage (derived from either the AC/DC voltage divider or ohms divider networks) is applied across the base electrodes of transistors Q3 and Q4 (see Fig. 2), with positive signals to the base of Q3 and negative signals to the base of Q4. The transistors present a near infinite impedance.

This extremely high impedance is accomplished through control of a positive feedback network comprised of resistors R31A, B and R32A, B. Transistors Q3 and Q4 function as preamplifiers driving the bases of transistors Q1 and Q2. Transistor stages Q1 and Q3 provide amplification of positive-going signals, while Q2 and Q4 act on negative portions of the signal.

Negative feedback through resistors R28 and R29 add to the high impedance at the bases of transistors Q1 and Q2. This function prevents excessive loading of the emitters of transistors Q3 and Q4. The outputs of Q1 and Q2 are applied to the 50-microampere meter movement.

A control (R30, a factory adjustment) connected in the collector circuits of transistors Q3 and Q4 is adjusted to balance the output of transistors Q3 and Q4. This is an adjustment made at the factory prior to shipment, and should not be re-adjusted unless the transistors are replaced. R21, the Zero Adjust control (located on the front panel), is used to balance the amplifier output (zero-meter) with no input signal applied.

Two isolation resistors, R33 and R34, function to isolate and protect the amplifier circuit. Bypass capacitors C5 through C10 function to protect the meter circuitry from any extraneous AC pulses.

Tests on our service bench proved the WV-500A performed with normal accuracy through the useful life of the batteries (if the batteries had any life at all, accuracy was singularly unaffected).

DC Measurement

The DC voltage input is applied through an isolation resistor in the probe (W6-410A) to a voltage divider network (range selector), resistors R11 through R17. Voltages derived from this network are coupled to the meter circuit.

AC Measurement

When the VoltOhmyst is operating in the AC mode, the input signal is applied across a full-wave, peak-to-peak rectifier comprised of rectifiers X1 and X2 and associated components. The values of the components comprising this circuit are chosen to provide a relatively long time constant. When the input signal swings negative, capacitor C3 charges through diode X1 to the negative peak value of the voltage. As the input signal swings positive, capacitor C4 charges to a value equal to the sum of the positive and negative peak values. Due to the relative long time constant, the voltage across capacitor C4 is maintained at the peak-to-peak value of the AC input signal. This signal (now DC) is applied to the voltage divider network, and then to the meter circuitry.

Fig. 1 RCA VoltOhmyst, Model WV-500A, solid-state electronic VOM.

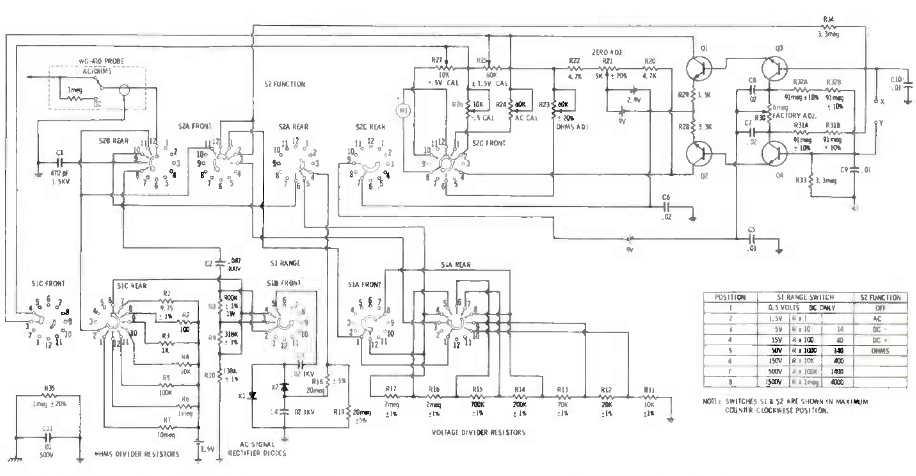


Fig. 2 Schematic diagram showing circuitry of RCA VoltOhmyst, Model WV-500A. Courtesy RCA.

Resistance

The battery voltage (1.5 volts) is applied through the selected ohms divider network (R1 through R7) to the external (unknown) resistance under test. A voltage divider is formed by the selected range resistor and the unknown resistance. The output of this divider network is applied to the meter circuitry.

Calibration

The internal calibration adjustments of the WV-500A require calibration only if the transistors or other major circuit components are replaced.

Internal Balance Adjustment

1. Check the mechanical zero position of the pointer. If necessary, reset mechanical zero.
2. Use a jumper wire to short together points "X" and "Y" on the back of the circuit board.
3. Turn function switch to "—DC VOLTS" and range switch to "0.5V DC". Adjust ZERO control to bring meter pointer exactly to "0". Check for correct zero setting by switching function switch from "+DC VOLTS" to "—DC VOLTS"; the pointer should not shift.
4. Set the function switch to the +DC position, and remove the shorting jumper from test points "X" and "Y". Adjust R30, the "FACT ADJ ONLY" control to bring the meter pointer to "0". Again, check for correct adjustment by switching the function switch from "+DC VOLTS" to "—DC VOLTS"; the pointer should not shift.

DC Calibration

1. Turn the function switch to "—DC VOLTS" and range switch to "0.5V DC", and the probe switch to "DC". Adjust ZERO control to bring meter pointer exactly to "0".
2. Connect the ground lead to a voltage source of 0.5 volt DC. Connect the probe to the positive terminal of the voltage source. Adjust the "+5V CAL" control to bring the meter pointer to exactly the full scale "5.0" mark on the 0-to-0.5 scale.
3. Turn the function switch to "—DC VOLTS." Remove connections to voltage source (reset ZERO control if necessary). Reverse the polarity of the 0.5 volt source (this is done by reversing the probe connections). Adjust the "—0.5V CAL" control for full-scale meter deflection.
4. Set the function switch to the "+DC VOLTS" position, and the range switch to "1.5V CAL" control for full-scale meter deflection.

AC Calibration

1. Set the function switch to "AC", the range switch to "50V", and the probe switch to "AC/OHMS". Adjust ZERO control to bring meter pointer exactly to "0".
2. Connect the ground lead and probe to an AC voltage source of 50 volts rms. Adjust the "AC CAL" control to bring the meter pointer exactly to the full-scale "5.0" mark on the 0-to-5.0 scale.

Accessories Available on Separate Order

Crystal-Diode Probe

The RCA WG-301A crystal-diode probe may be used with the VoltOhmyst to extend the frequency range to 250 megahertz. This probe circuit consists of a germanium rectifier and an RC network. The crystal-diode probe, which connects to the WG-410A probe and cable, eliminates the need for an extra cable.

The WG-301A can be used in RF circuits to measure sine-wave voltage values up to 20 rms volts in the presence of DC voltage as high as 250 volts. The over-all frequency range of the probe is from 50 KHz to 250 MHz. All RF voltages are read from the DC scales in terms of rms volts for sine waves. For example: A reading of 5 volts DC indicates that the sine wave being measured has an rms of 5 volts. The all-over accuracy of the WV-500A, when used with the WG-301A, is ±10%.

High-Voltage Probe

RCA WG-411A high-voltage probe may be used to measure DC voltages as high as 50,000 volts. The probe uses the WG-206 multiplier resistor, (1090 megohms) to present an over-all voltmeter input resistance of 1100 megohms. With a multiplying factor of 100, the VoltOhmyst provides six full-scale positions: 150, 500, 1500, 5000, 15,000, and 50,000 volts. Do not measure voltages higher than 50,000 volts, because the maximum voltage rating of the probe might be exceeded.

The extremely high impedance of the WG-411A is especially desirable when it is necessary to measure voltages found in phototubes, Geiger-counter tubes, television, and other high-impedance circuits which would not function properly if loaded down by a low-impedance voltmeter. The WG-411A high-voltage probe offers distinct advantages in high-voltage circuits as well as low-voltage circuits characterized by high impedance or poor regulation.

Current Measuring Adapter

The WG-361A Current Measuring Adaptor permits the WV-500A to be used for measuring direct current from 1 microamp to 5 amps in six ranges. ▲

RCA MODEL WV-500A

DC Volts Ranges:
.01 to 0.5, 1.5, 5, 15, 50, 500, 1500

AC Volts Ranges:
rms—0 to 1.5, 5, 15, 50, 150, 500, 1500
Peak-to-peak—0.5 to 14, 42, 140, 420, 1400, 4200

Ohms Ranges:
Seven ranges, 0.2 to 1000 megohms

Accuracy:
±3% for full scale on both AC and DC

Input Impedance:
DC—11 megohms (all ranges)
AC—0.83 megohms shunted by 70 pf (1.5, 5, 50, 150V ranges); 1.3 megohms shunted by 60 pf (500V range); 1.5 megohm shunted by 60 pf (1500V range)

Frequency Response:
± dB 30 Hz to 3 MHz

Maximum Input Voltages:
DC voltages with no AC voltage present—1500V
AC voltages with no DC present.
rms for sine waves—1500V
peak-to-peak for sine waves—4200 volts
peak-to-peak for complex waves—2000V

Combined AC and DC voltages:
Sum of DC voltage and AC peak voltage—2000V

Meter Movement:
50 ua DC current for full-scale deflection

Power Requirements:
Ohms—one 1.5V "C" cell battery

Metering Circuit:
Three 9-volt batteries.

Size (HWD):
6⅞" x 5¼" x 3⅛"

Weight:
3½ lbs.

Price:
$75.00

Making a business out of service

the third in a series

Manufacturers plan to stay in the servicing business—and to expand—but, indicate that they believe there will be a continuing demand for the independent to service products their firms manufacture as well as the electronic products turned out by other firms.

By Wendall J. Burns and J.W. Phipps

Manufacturer owned and operated service centers

A MASTER JOURNEYMAN checks in the sets as they are brought into the center, and works near the phone to be available when technicians in the field call in with a problem. This technician, George Jones, has a workbench nearby, within easy access of the shop desk, and telephones. He is one of five technicians at this center who recently was given the 'master rating.'

The servicers of electronic home entertainment products today are faced with five distinct challenges:

(1) Increasing sophistication of circuit designs
(2) Increased number of new sets in use
(3) Larger variety of products being marketed
(4) Consumer demands for quicker and more efficient servicing, and better execution of warranties
(5) Shortage of trained electronic technicians

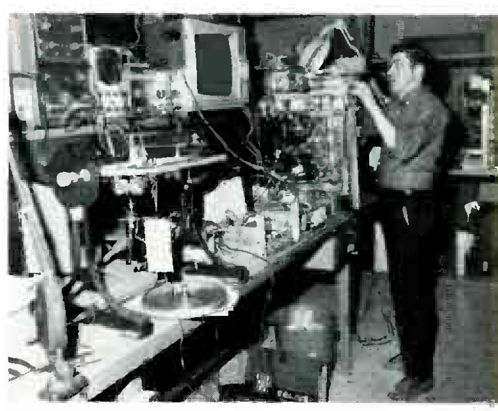
These challenges are prompting changes in the electronic servicing business. Traditional methods of conducting an electronic servicing business are being reassessed in terms of what changes are required to meet the demands imposed by such challenges. New approaches to operating a service business have evolved.

The two most significant new methods to date have been analyzed in two recent issues of **Electronic Servicing:** A high-volume independent business was reported on in the January issue, and a franchised system of independently owned service centers was presented in the March issue. Both are departures from the traditional, limited-volume approach to independent servicing that has been the mainstay of electronic home entertainment product servicing for over 25 years.

Manufacturer-owned and operated service centers have been in existence for about the same number of years, and today are faced with the same challenges that confront the independent servicer.

We will analyze in this issue the methods of operation and philosophies of the management of two manufacturer-owned and operated service organizations. It is intended that this analysis will enable you, the reader, to put into perspective the present role played by these manufacturer service companies, what they are doing to meet the challenges of the present, and what they foresee and are planning for in the future.

WORK BENCHES are steps away from the 'in' rack.



RCA SERVICE TECHNICIANS use only this firm's test equipment, and service only the consumer products that it manufactures.

RCA Stresses Readiness for New Products

To assure service for RCA products already in the homes of the consumer, and to prepare men and facilities to service an ever-greater volume of ever-more sophisticated consumer products coming onto the market.

This has been the two-fold task of the RCA Service Co. since 1946, when the company founded its first factory-owned and operated service centers—in Los Angeles, Chicago, and New York.

L.G. Borgesen, now division vice-president of RCA Consumer Products' Service, who opened the first center in Los Angeles, explains tasks the service company faced then—and now.

The first job, undertaken in 1946, was to put into operating condition the pre-war TV sets, introduced in 1939 and sold in three major markets—New York, Los Angeles, and Chicago.

In addition to repairing the long-neglected pre-war sets, the technicians had to change the frequency on all sets to comply with an FCC ruling on frequency allotments.

"The people said they had nobody to go to," Borgesen said. "We felt that if we were going to get TV off the ground at all, we were going to have to do the servicing.

"It was a similar problem when color TV came along. A high percentage of the broadcasters switched to color almost overnight, and it would have been impossible to have provided service without a nation-wide organization prepared to handle it in volume."

In view of constant innovations in the home entertainment field, and with a continuing uncertainty as to availability of trained technicians, this company continues in the servicing business for the same reasons it entered the business to begin with, this RCA official indicated.

EACH BRANCH 'ON IT'S OWN'—"All of our branches are required to make a profit. We operate completely separate—as a separate division—and, we have no support from any other part of the company. We have to stand on our own two feet," Borgesen said.

RATE OF GROWTH—The number of RCA service centers has fluctuated between 155 and 165 in the past 10 years, now numbers about 165.

"As to how many branches we may have, as to our rate of growth within the next few years, I can't really tell for sure," said Borgesen. "We keep analyzing the market. We haven't really expanded, other than to open additional branches in cities where we were already operating. For example, at one time we had only one branch in Los Angeles, but, now we have quite a few there. If the centers get too big, we split them, and give better coverage."

PROFICIENCY OF TECHNICIANS—More products, new designs, and comparatively fewer trained men to service them are problems that RCA shares with the whole industry, Borgesen believes.

"The basic problem in the whole industry is due to the rapid expansion of color, more sophisticated sets and more service requirements on a national basis just because there are more products in the customers' homes than there were five years ago.

"I think that the number of calls per set will drop, due to increased reliability, but the overall service demand in the industry will increase due to the increased number of products in the average home."

TRAINING—The caliber of the people coming into this business now is not what it was five to ten years ago—so, a lot more training is required, according to this company official. "We foresaw this problem and decided we would have to train people, and we set up six training centers in the U.S." The centers are in Miami, Philadelphia, Detroit, Los Angeles, and New York.

"We've felt we have to provide this training for our own people just to insure service for all customers that presently have sets, and for all those buying new sets. Although the independents are doing a good job of taking care of a lot of it, there is so much business that there is room for everybody in it right now, and it is necessary in order to properly take care of the customers' needs.

"From everything I hear—from the independent service people, and from the manufacturers—everybody is squeezed by the lack of good qualified technicians coming into the industry. That's why we've got to take the bull by the horns—as have some other manufacturers—to get men trained."

"The vocational schools are turning out very few technicians for this industry. Their graduates would rather go into computers, or fac-

THE BRANCH MANAGER, W. A. Sharp, inspects repaired sets in the 'out' rack, which forms a wall of the service area. Inside technicians place the chassis in this rack when tagged and completed. The racks are open on both sides, making it easier for the sets to be stored by the benchmen on the one side, and picked up on the other side by the outside man on his way to the service truck.

tories, or other types of work. They're not coming into this business," he said.

COURSE GIVES PRACTICE—Courses at these training centers are highly oriented toward the workshop type of education, whereby the men actually service sets. 'Bugs' are put in the sets for the men to diagnose, and repair. There are some lecture sessions, but the emphasis is "learn by doing".

Courses are also provided at the RCA training centers for experienced RCA employees. They come for periods of one to two weeks, depending on their needs—and get training on bench service, transistorized sets, or in some cases familiarization with new products so they will be prepared before the product hits the market.

Customer relations is also an important part of the training for employees at the training centers, as well as continuing orientation in this respect at the branches.

PARTS AVAILABILITY—Due to the sheer numbers of parts, the factory-owned centers face the problem of TV parts availability at the centers and on the service trucks. Admittedly, the parts problem for the manufacturers' centers is not as great as it is for the independents, but even so, it is a factor that demands precise planning and control. The service centers purchase parts from the same sources as do all RCA distributors, Borgesen explained.

"The last count we made, there was something like 23 thousand individual parts numbers for RCA sets. And, with more instruments in the field, and with design changes, there will be more and more parts," he added.

"We study this all the time and try to put the part in the technician's kit that he uses most of the time, but, it's obvious that he can't carry 23 thousand parts."

Each branch has its own inventory. A stock man maintains an inventory card on each item. He orders parts in accord with whatever supply level has been established for each type. For example, a branch keeps in stock a three-month supply of tubes, and a two-month supply of kinescopes.

'Setting Service Standards'—a GE Goal

GE's company-owned and operated electronic service facilities were first introduced during World War II, but real development has come within the past decade. The company now operates 76 of the centers, and plans to have about 100 of them functioning by 1973.

"The company established its own factory service facilities to establish standards for speed and quality of service," according to R.J. Kalember, general manager of GE's Product Service Dept. He explained the objectives and methods of the company-owned servicing facilities in an interview with **Electronic Servicing:**

"We have a national organization, and we have some rather sophisticated systems of measuring our performance, and of measuring customer satisfaction. We actually process every one of our job tickets through a computer, and we measure the factory service organization on how well customer satisfaction is achieved in three basic areas:

"**Speed of service**—We aim to complete 80 percent of the service calls by the day following the service order. We use that as a measure. That's our goal.

"**Dependability**—that is, arrival of the serviceman at the home within the time-span set. When a service call is taken, the call-taker and customer agree upon a 4-hour span of time for the serviceman to show up. We meet about 90 percent of our promises in regard to the time of a man's arrival. We count as a 'mis-promise' any occasion when the serviceman shows up in advance of the time-span agreed to—just as much as if he showed up late.

"**Technical competence**—This is measured by how many calls are completed on the first trip. We target for 85 percent. We also measure our service quality by a customer survey taken on about 5 percent of our service calls. We ask the customer to measure us on how we perform as to quality of service, cost of service, appearance of the serviceman, and so forth . . .

"So, we are able to judge performance by our own measurements and from the customers' measurements also," Kalember concluded.

But Kalember is quick to point out there are other sources of service for GE products.

"My responsibility is to be sure that the consumer gets the best service possible. Service is available from three sources—factory service centers, authorized independent service companies, and the dealers. I think these three will always be a factor in the marketplace. I don't agree with those who say that the day of the independent is limited.

"We also accept responsibility for making sure there are training facilities available to all these servicing units," Kalember asserted.

A GLANCE AT CONTROL board by girls taking service orders lets them know when a technician can respond to a call. Each number (1-10) across the top of the control board indicates a serviceman and area he covers.

Columns of vertical figures at left indicate time ("59" is the code for today, "60" means tomorrow, "62" means day after tomorrow). Column of figures at right is for technicians with TV capability. When appointment is made, the time segment indicated on the board is lighted green. Column of figures 1-10 at left indicates appliance technicians. Appointments for them are indicated by a red light. The lights are for ease of control by the order takers. When order is taken, the girl passes it on to the dispatcher in adjoining room. (Soon, a conveyor belt will be installed to carry orders to the dispatcher mechanically.)

Men in the company-owned facilities are generally trained in the shop where they will work.

Communications to the dealers regarding training programs is good, Kalember explained. Training sessions are held monthly throughout the nation by GE for independents. GE service counselors in some areas even take the yellow pages of the telephone book, and mail out notices to every TV service facility, advising of the monthly training meetings. There are 175 of these service counselors or tech specialists who hold training meetings all over the country.

In areas served by independent distributors, the distributors hold training meetings on a regular basis.

INVOICES PROVIDE MANAGEMENT DATA—Detailed operational data is taken from the servicemen's invoices and tabulated by a computer system for guidance in keeping the individual service centers operating efficiently, and for other management objectives. The data helps plan the stocking of parts and to plan other factors of servicing. The information is not only for directing factory-operated centers, but also for guidance of independents who service GE products.

Martin Waring, product service manager for GE's South Central District (Kentucky, Southern Indiana and part of Tennessee) gives credit to the computerized data for permitting the volume and quality of service performed.

"We wouldn't be able to do it without computers. They give us the information that lets us manage the business," he said.

DISTRIBUTION OF MANAGEMENT DATA—The company's SDA (Servicing Dealers' Assistance) program provides a quick and broad channel for helping the dealers and independents keep up-to-date and apply management information gleaned at the factory centers. The company also uses this information to suggest parts stock.

Standards and methods are passed on to independents through the SDA program, which sponsors activities throughout the country for authorized contractors as well as service men unaffiliated with GE.

These activities are conducted by the GE and Hotpoint service clubs. The club meetings include training sessions as well as some social activities and are planned to foster an 'esprit de corps' as well as to establish an atmosphere of professionalism, a company official explained.

Standards of the factory centers are suggested goals for the independents and not rigid rules, the GE spokesman stressed. Also, service counselors make individual calls on the servicing agents to help keep up standards of service.

PARTS AVAILABILITY—The GE spokesman explained one way GE helps its servicing agencies to avoid parts shortages:

"We have a program called GAP (guaranteed annual parts usage) which recommends an ideal supply of parts based on product population in an area—and, on our experience with the product.

"We say to the servicing agent 'You should have this amount of each part. We guarantee that these parts will be a good investment. If you don't use them, we will buy them back.' "

To insure ready availability of parts, GE has regional parts warehouses, and to back that up has established a highly automated parts depot at New Concord, Ohio. This depot ships parts via air freight when necessary.

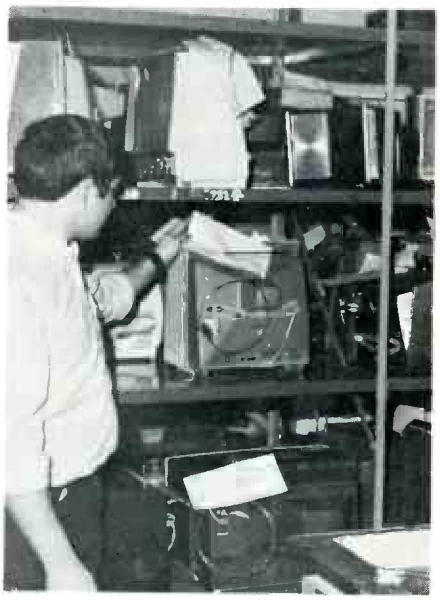
TRAINING—New employees of GE factory centers are trained at the centers.

"The men are trained right here," District Manager Martin Waring said. "When we take in a new man, we will work him with experienced technicians and give him classroom training on different models, new features, etc. After a man comes out of a school of electronics, and goes to work for GE, he would probably be kept working in the shop for about six weeks before he is sent out on service calls. We feel all our men should reach a high degree of efficiency at the end of two years."

In some geographical areas, it is more difficult to recruit new personnel with electronics background, Waring said. The solution, he said, has been to find men with aptitude and "train them from scratch."

THE RADIO DISPATCHER has control board (lower right) that corresponds to the one in order takers' office. Here he checks service orders to locate the truck nearest a customer's home. Note microphone over his desk which he uses to direct servicemen. Also on his desk is a time-clock to stamp orders that have been taken. This communications' center handles an average of 160 calls a day.

PROCESSING TECHNICIANS' INVOICES from four service centers in GE's Southeast district in addition to the service center in Louisville is the work of these three girls. In addition to balancing technicians' deposits of cash or checks as indicated on invoices, the girls code the invoices for computer input. The product service manager of the district, Martin Waring, said information on the invoices, which is later compiled by computer, "gives us the information that lets us manage the business."



THE WALK-IN SERVICE SECTION keeps three men occupied most of the time. There is no uniformity in the design of these centers. Here, the dutch door at entrance to walk-in section provides easy communication between customer and technician. An average of 15-18 "completes" pass across these benches and storage racks each day. The section for servicing portable electronic products has its own set of test equipment. Same-day service is offered here.

Service appliances, too

Both the GE and RCA centers also service household appliances as well as electronic home entertainment products. Most, but not all of the RCA Service Centers act as the tech servicing agent for Whirlpool appliances in their areas. The GE service centers are geared to service Hotpoint appliances. Although Hotpoint is a GE brand, the Hotpoint and GE sales organizations are separate, it was explained.

Servicing the appliances helps to eliminate the problem of 'peak' seasons, it was explained, as there is more demand for appliance service in the summer, when demand for service on TV and stereo is lighter. Not all the technicians are expected to have capability in both TV and appliances, however.

Pricing

In one midwest city (where the cost of living is within one percent of the national average) RCA's charge to the customer is $12.95 for color and $10.95 for b-w. In the same city, GE has a basic home service charge of $9.95 for either color or b-w If the GE technician does more than diagnose the set, $3 of the $9.95 is applied to the overall charge. If he only diagnoses it, the full $9.95 is charged.

What is the future of the independent?

In conversations with the men who direct the factory owned and operated service centers, this subject came up. Here is what they have to say about it:

R. J. Kalember, general manager of GE's Product Service Dept.—"I don't agree with those who say that the day of the independent is limited. My responsibility is to be sure that the consumer gets the best service possible. Service is available from three sources—factory service centers, authorized independent service companies, and the dealers. I think these three will always be a factor in the marketplace."

L. G. Borgesen, vice president of RCA's Consumer Product Service, whose responsibility is the operation of the RCA factory service centers —"I don't think any manufacturer will ever get to the point where he will service all the sets he manufactures. Our policy has always been: The dealer has a choice. We have a service company, and we are out selling and promoting business. But, the dealer has a freedom of choice as to whether he will operate his own service facility—and the customer has a freedom of choice—and the independents still have the major share of the business. We (RCA) get only a small percentage of the total service business that's being done.

"I see nothing that tells me that the independent serviceman is going to be in any different fix five years from now than he is today. The problem is going to be getting men trained to handle all the business."

It was pointed out that it would be uneconomical for a manufacturer to establish service centers for its own products within reasonable distance of all potential customers. Also, it would be impractical, for example, for the owner of a portable set to take it 8-10 miles or more to a factory center to have it serviced if he could go to an independent servicer closer to his home.

Take the problem of travel time from the service center by the technicians, as cited by Borgesen: "Normally, we don't like to serve beyond a 25-mile radius because of the travel time involved. When a technician is riding in a truck a high percentage of the time, we are not reimbursed for that time, and we can't make any money." ▲

troubleshooter

Oxidation Causes Pulling

The raster of a Magnavox U47-005 chassis displayed horizontal pulling, as if modulated by hum.

While checking in the horizontal oscillator circuit, I discovered that placing a small amount of pressure on any component on the printed-circuit board changed the amount of horizontal pulling displayed by the raster.

I turned the set off, loosened the screws holding the printed circuit to the chassis, then retightened them. When the set was turned on again, the raster had returned to normal. Apparently, oxidation had built up between the ground connection on the circuit board and the chassis.

JOHN W. KOZUBAL

Schenectady, NY

Compression At Top

I would appreciate your advice on the following problem: The top of the picture of a Magnavox T908 chassis is compressed leaving about a 4-inch black stripe at the top. Manipulation of the bias, height and linearity controls results in spreading the picture vertically, but with an objectionable white line across the top.

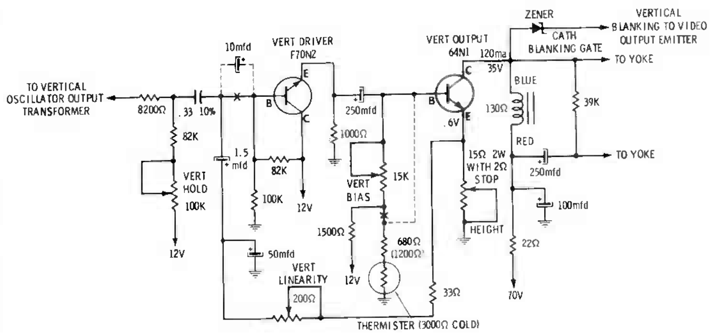
My experience in servicing transistor television is limited. The combination of transistors and printed-circuit boards make me hesitant. I would like to approach this problem in such a manner as to disturb a minimum number of components.

WILLIAM E. GIEGERICH

Kings Park, NY

I am in complete agreement with your approach to transistor servicing, the less a circuit is disturbed through probing, soldering, etc., the easier the repair. However, transistor servicing is identical to any other type of electronic servicing. Serving procedures call for a gathering of evidence aimed at isolating the defective component and eliminating good components from further consideration.

I would suggest, as the first step, a waveform analysis of: the signals at the base of the vertical driver, base of the vertical output, and the collector of the vertical output. Check these waveshapes carefully for both shape and amplitude. This trouble symptom many times is indicative of a defective electroytic, particularly in the base circuit of the vertical driver stage and output circuit of the vertical output stage.



Red and Green Missing

An RCA CTC17X chassis produced only blues and a "sickly yellow" during color broadcasts—red and green were missing. Black-and-white tracking appeared to be normal.

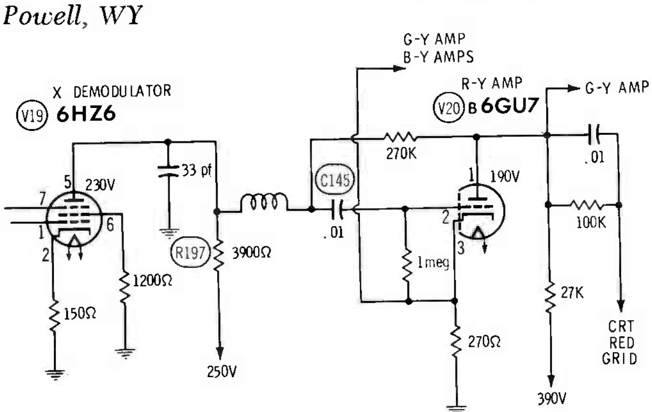
Voltage measurements uncovered a high positive voltage on the grid of the R-Y amplifier (normally a small negative voltage). The cause of this abnormal voltage was found to be a shorted coupling capacitor, C145. Both C145 and the R-Y amplifier tube were replaced but the original trouble symptom—red and green missing—continued.

Scope checks of the outputs of the chroma demodulators revealed that the Z demodulator output was normal, but there was no output from the X demodulator, V19. The level of the inputs to both demodulators appeared normal. The phase relationships of the signal inputs to the demodulator grids was checked by using the sync signals present at the phase detector diodes. The phase relationships proved to be normal.

Attention then was focused on the circuitry of the X demodulator, V19. It was discovered that plate load resistor, R197, had decreased in value to about 30 ohms (normally 3900 ohms). Replacing R197 returned the set to normal operation.

GIL DUGGER

Powell, WY



Picture Missing, High Voltage and Boost Low

An RCA CTC31A chassis produced normal sound, but the picture was missing. High voltage measured 5 kv (normally 20 to 24 kv) and boost measured 425 volts (normally 800 volts).

Preliminary checks revealed that the horizontal output tube was drawing 329 ma (normally 220 ma). The efficiency coil would dip, but would not bring the current below 329 ma. All DC voltages on the horizontal output tube were within tolerance. Drive signal at the grid of the horizontal output had proper shape and amplitude.

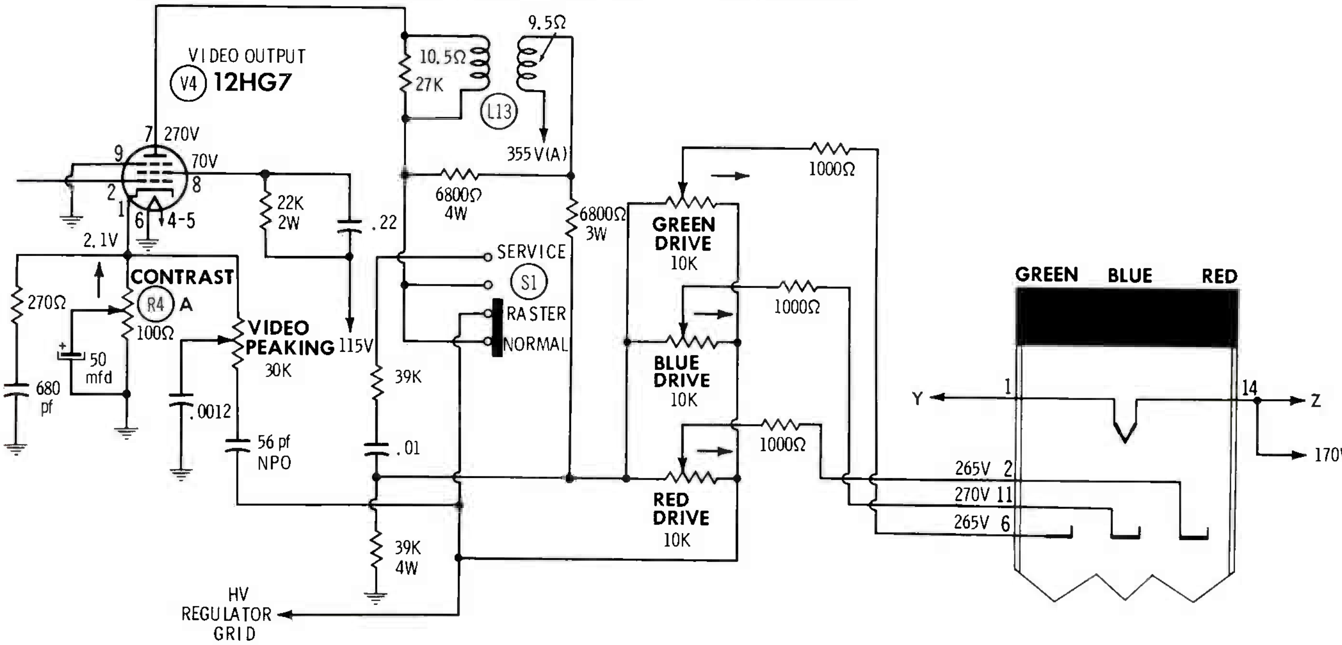
Removing plate cap from 6BK4B high-voltage regulator did not affect abnormal voltage and current readings. All components in the high-voltage section were checked, but no defects could be found.

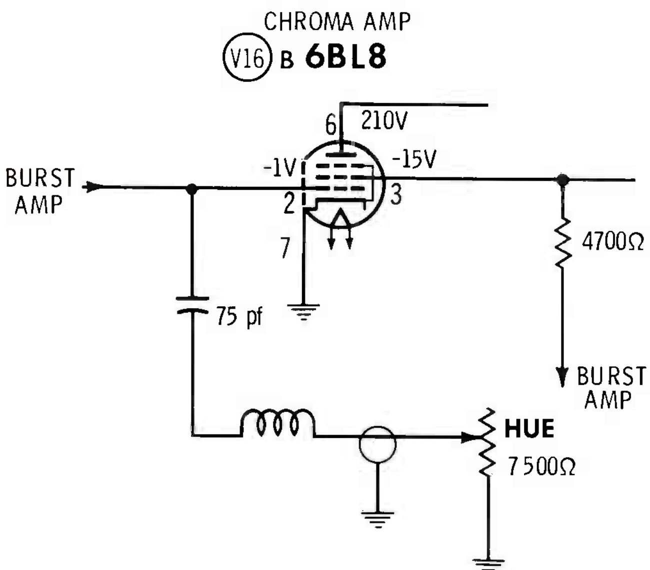
Removing the picture tube base socket restored high voltage to normal. Measurement of DC voltages at the picture tube base revealed that the cathode and screen voltages were well below normal. Tracing back to the source of cathode voltages uncovered the trouble: The secondary of the video output plate transformer, L13, was open.

Replacing this transformer restored the set to normal operation.

Edwin Crawford

Chicago, IL





Intermittent Color Sync

A Motorola TSA914 chassis displayed intermittent color sync (barber poles). To receive any color at all, the color killer had to be turned up to the point where the color indicator light remained illuminated during black-and-white broadcasts.

Changing tubes did not have any effect on the trouble symptom, so I started measuring voltages. When the meter probe was placed on the screen grid (pin 3) of the chroma amplifier (V16B), the barber poling stopped and color returned. When the probe was removed, the barber poling started again. Thinking there was a bad solder connection, I resoldered all connections associated with pin 3, but the trouble symptom remained.

Turning the chassis to its upright position, I noticed that there is a metal shield around V16. The shield is soldered to the chassis. Removing the shield revealed the cause of the trouble: During the manufacturing of the chassis, when the shield was soldered to the chassis, a small sliver of solder had run under the shield and was touching pin 3 of V16B. Removing the sliver of solder eliminated the barber poling, and the set was restored to normal operation after the color killer was readjusted.

A. Delecaris

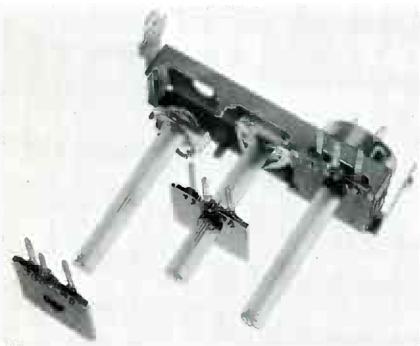
Salida, CO

product report

for further information on any of the following items, circle the associated number on the reader service card.

Replacement Control System
(40)

IRC, division of TRW Inc. announces a new replacement control system for standard-design two and three section side-by-side or strip controls. These controls are found in the majority of today's b-w and color TV sets. Designated Striptrol, it enables a dealer or distributor to assemble an exact replacement for these controls within minutes using only a pair of pliers or a medium size screwdriver.



The entire new system consists of 3 adjusters, 8 housings and 29 elements. Additional parts will be added, if and when the demand calls for them.

IRC has published its own replacement guide for the Striptrol system. It presently covers 35 trade names, 154 part numbers and 420 control sections. They intend to add to this guide periodically, keeping it updated with new replacements as they become available.

Two dealer assortments including a 12-drawer steel cabinet, dividers, pre-printed labels and set-up instructions are available. Assortment 38, for the small dealer, is $26.20; assortment 39, for the larger dealer, is $64.90. Individual components are also available.

Coaxial Cable Assemblies
(41)

Amphenol Distributor Div. of Bunker-Ramo Corp. introduces a new line of coaxial cable/connector assemblies.

The initial line includes five pretested RF cable assemblies. The 3-foot, RG-58/U type polyfoam with PL-259 connectors on both ends sells for $2.70; a 20-foot length with PL-259 connectors at both ends is $3.89; a 20-foot length with a PL-259 connector on one end, spade lugs on the other sells for $3.40; a 50-foot length of RG-8/U

type polyfoam with PL-259 connectors on both ends is $11.20; and a 100-foot length of RG-8/U polyfoam with PL-259 connectors on both ends is $19.10.

All come in display packages.

Harnessing System
(42)

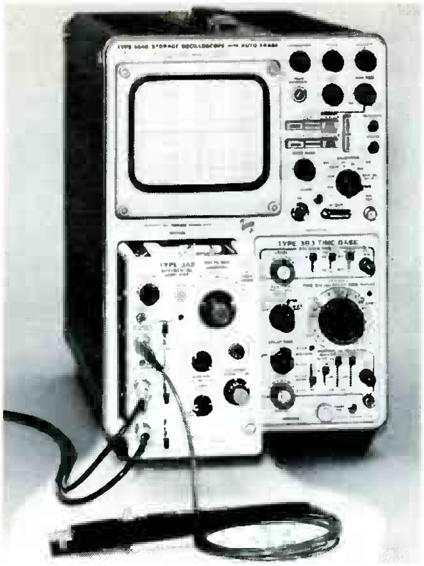
The Cradleclip harnessing system is introduced by **Electrovert's** Components Div.

The system consists of binders and extensible clips for unsupported wiring, and cradles and extensible clips for supported wiring. Both binders and cradles are molded of special nylon; the extensible clips are molded of Neoprene. They provide complete insulation and resistance within a temperature range of approximately —76° to 212° F.

The prices for a bag of 100 range from $6.66 to $94.50 for the cradles, $4.55 to $53.10 for the binders, $3.17 to $45.83 for the clips, and $8.14 to $55.50 for the cradles and clips depending on amount ordered.

DC Coupled Plug-In
(43)

Tektronic, Inc. introduces the Type 3A9 Plug-In designed for sta-



bility and ease of use in difficult low-level measurement areas. The unit is an all solid-state unit with a protected FET input stage. Basic deflection factor is 10 uv/div., DC coupled, with a bandwidth of DC to 1 MHz. DC drift is specified at 10 uv/h, DC coupled, with constant line voltage and temperature. Displayed noise is 12 uv or less, tangentially measured at full bandwidth. It also has an AC current probe input. The price is $490. An optional P6019 AC current probe is priced at $75.

Oscilloscope
(44)

Leader Instruments Corp. introduces the model LBO-52B 5″ oscilloscope with a bandwidth of DC to 10 MHz and features hybrid circuitry. The 10 mv/cm sensitivity makes it especially suitable for examining low-level signals found in tuners and IF amplifiers.

The highly linear wide sweep range has automatic synchronization. The vertical and horizontal inputs are direct-coupled with push-pull amplifiers for distortionless display. The unit provides vectorpattern display for color TV circuits to view patterns at the chroma detector and to align the chroma section of color TV.

The power is supplied by 115V @ 50/60 Hz, 85V amps. The unit measures 10½″ x 8″ x 16½″ and weighs 24 lbs. The price is $199. ▲

advertisers' index

catalogs literature

ANTENNAS

100. *Finney Company*—FINCO Color Spectrum catalog describes freqeuncy dependent antennas.

101. *Kreckman Co.* — Catalog No. 6970 describes the Kreco vertically polarized omnidirectional antennas for base station use.

AUDIO

102. *American Geloso*—8-page brochure describes microphone and microphone accesories.

103. *Concord*—16-page 1969 catalog describes applications, features and specifications of the complete Concord line of tape recorders.

104. *Switchcraft* — Catalog C-502B describes their complete line of audio connectors, standard microphone connectors, adapters, RF connectors, Y connectors, AC receptacles and phone jacks.

105. *Telex*—8-page Brochure, BI-2166, covers over 30 general communications and dictation headphones plus accessories.

COMPONENTS

106. *Hunt Corp.*—16-page brochure lists Hunt quartz crystals, ovens for control of frequency response in various fields including communications.

107. *Jensen* — Jensen Automotive Loudspeaker Replacement Guide covers model years 1960-1969 and lists replacement loudspeakers for all American and foreign automobiles.*

SERVICE AIDS

108. *Dazar Mfg. Corp.*—Forms 848, 810 and 864 describe the Dazor three-tube fluorescent floating-arm lamps.

109. *Henry Mann Inc.*—8-page color brochure describes their full line of specialized storage bins for electronics production areas.

SPECIAL EQUIPMENT

110. *Concord*—6-page brochure, "Video Accessories," covers complete range of accessories for video tape recording and closed circuit television systems.

TECHNICAL PUBLICATIONS

111. *Howard W. Sams*—Literature describes popular and informative publications on radio and TV servicing, communication, audio, hi-fi and industrial electronics, including 1969 catalog of technical books on every phase of electronics*

TEST EQUIPMENT

112. *Sencore*—12-page catalog, Form No. 458, features five completely new test instruments, including a sweep and marker generator, combination oscilloscope/vectorscope, color generator, and two transistor/FET testers.*

TOOLS

113. *Brookstone Co.*—24 page catalog describes hard-to-find tools, including electronic pliers, with detailed descriptions and illustrations of each tool and its application.

114. *Plato Products, Inc.*—28-page catalog describes soldering iron tips with drawings of tips in diameters from 1/8" to 1 1/8".

115. *Wassco*—Catalog #105-A3 describes a new unit for control of most resistance-type soldering and thermal wirestripping.

***Check "Index to Advertisers" for additional information.**

RCA's triple play
three terrific values free with your purchase of RCA entertainment receiving tubes

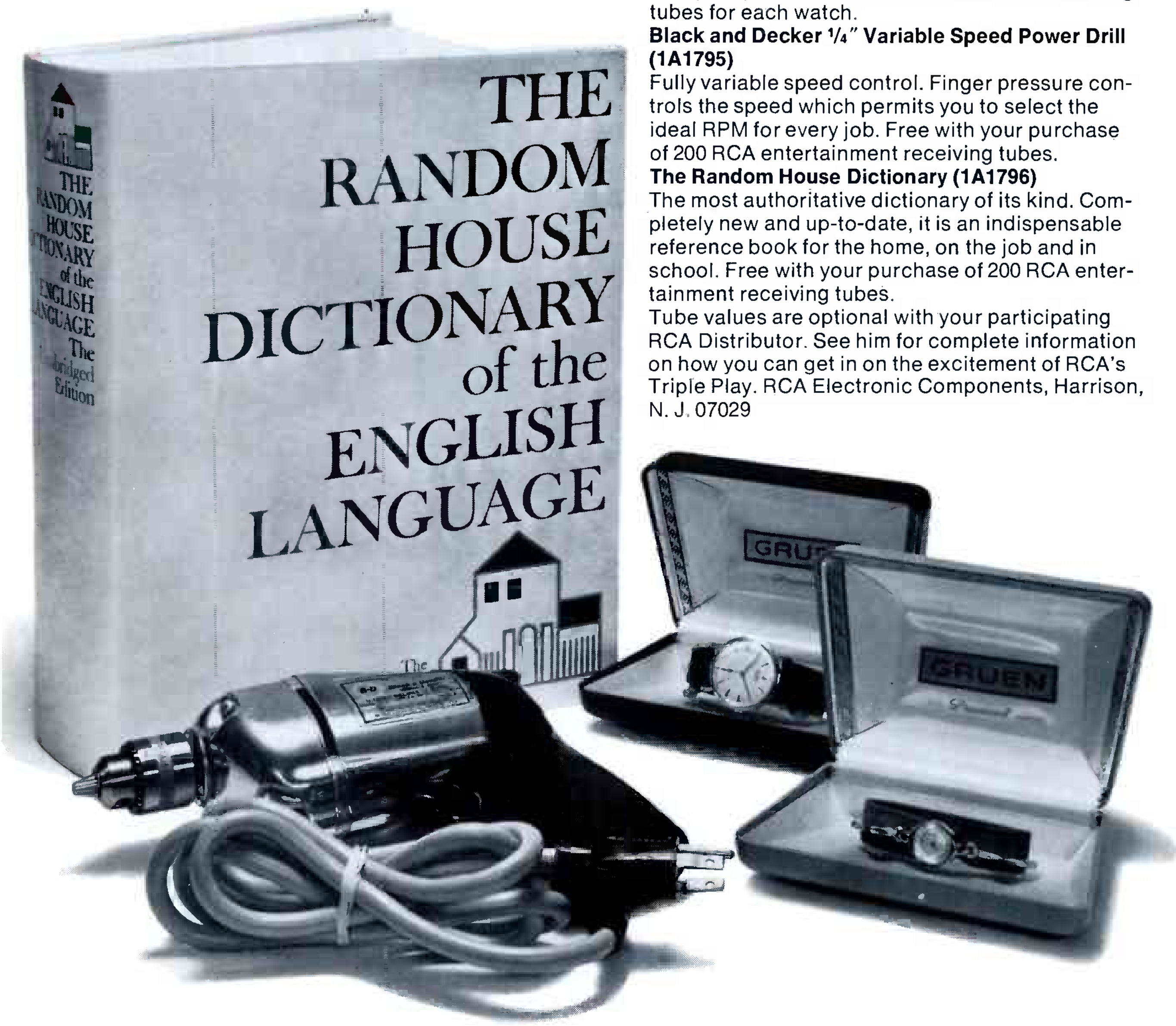
RCA

Precision® Gruen Wristwatches. Men's (1A1793) and Ladies' (1A1794)
Both have 17 jewels, Swiss movement, "Incabloc" protection with unbreakable main spring. Free with your purchase of 275 entertainment receiving tubes for each watch.

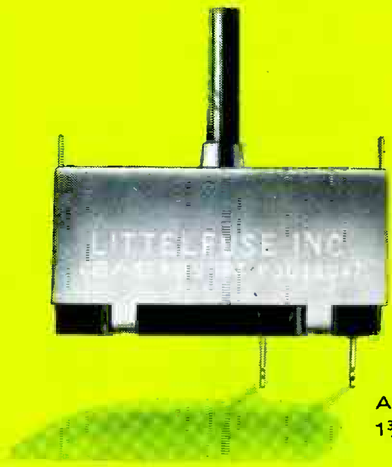
Black and Decker 1/4" Variable Speed Power Drill (1A1795)
Fully variable speed control. Finger pressure controls the speed which permits you to select the ideal RPM for every job. Free with your purchase of 200 RCA entertainment receiving tubes.

The Random House Dictionary (1A1796)
The most authoritative dictionary of its kind. Completely new and up-to-date, it is an indispensable reference book for the home, on the job and in school. Free with your purchase of 200 RCA entertainment receiving tubes.

Tube values are optional with your participating RCA Distributor. See him for complete information on how you can get in on the excitement of RCA's Triple Play. RCA Electronic Components, Harrison, N. J. 07029



Introducing a Complete Line of Littelfuse Quality Circuit Breakers



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