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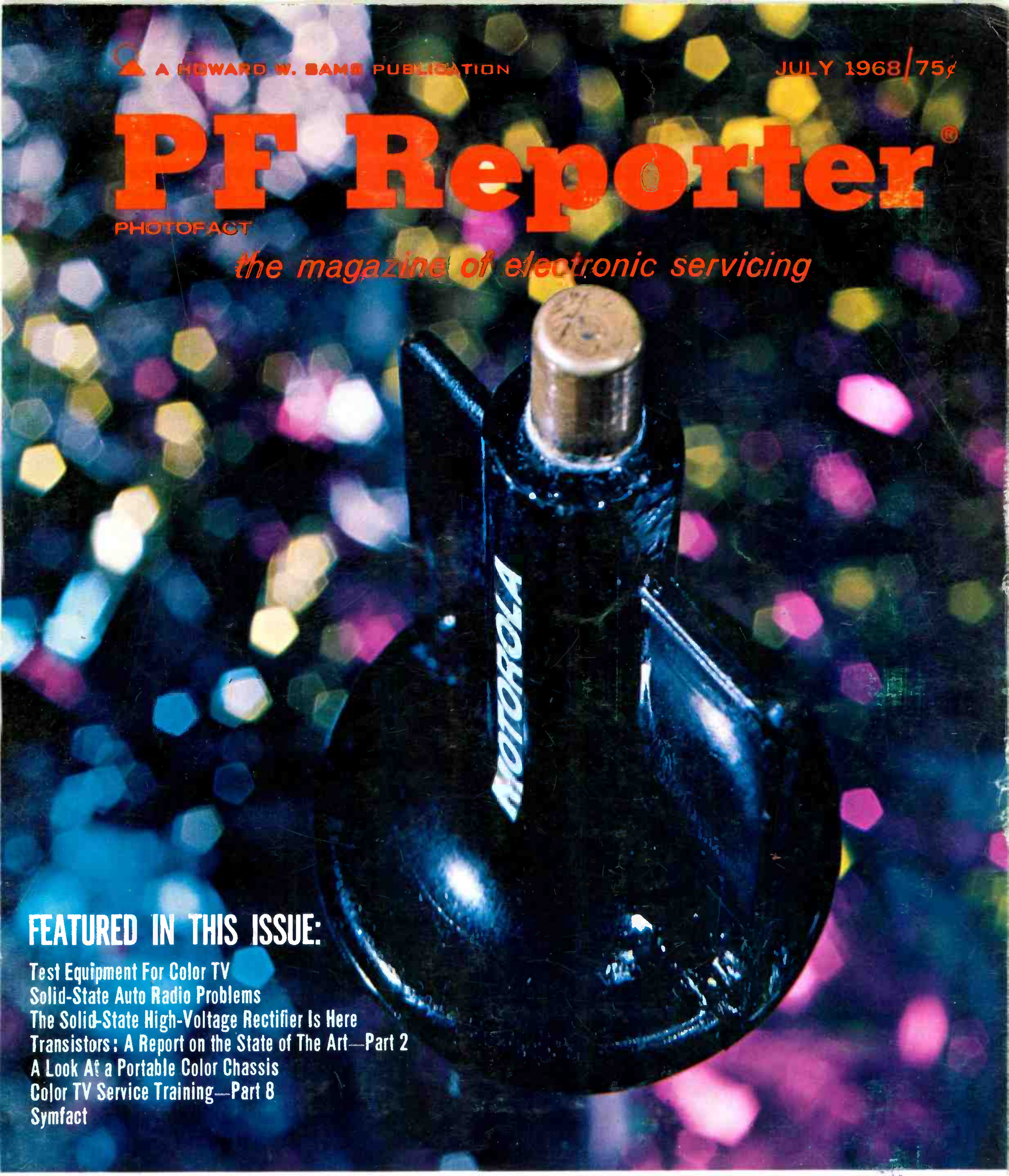
the magazine of electronic servicing



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Test Equipment For Color TV
Solid-State Auto Radio Problems
The Solid-State High-Voltage Rectifier Is Here
Transistors: A Report on the State of The Art—Part 2
A Look At a Portable Color Chassis
Color TV Service Training—Part 8
Symfact

REMEMBER TO ASK—
"WHAT ELSE NEEDS FIXING?"

The name of the game was hide and seek.

The good color picture hides. The viewer looks for it. And sometimes it takes quite a while to find. The good sound drifts, and between rotor and tuning dial the search for a perfect stereo balance begins again.

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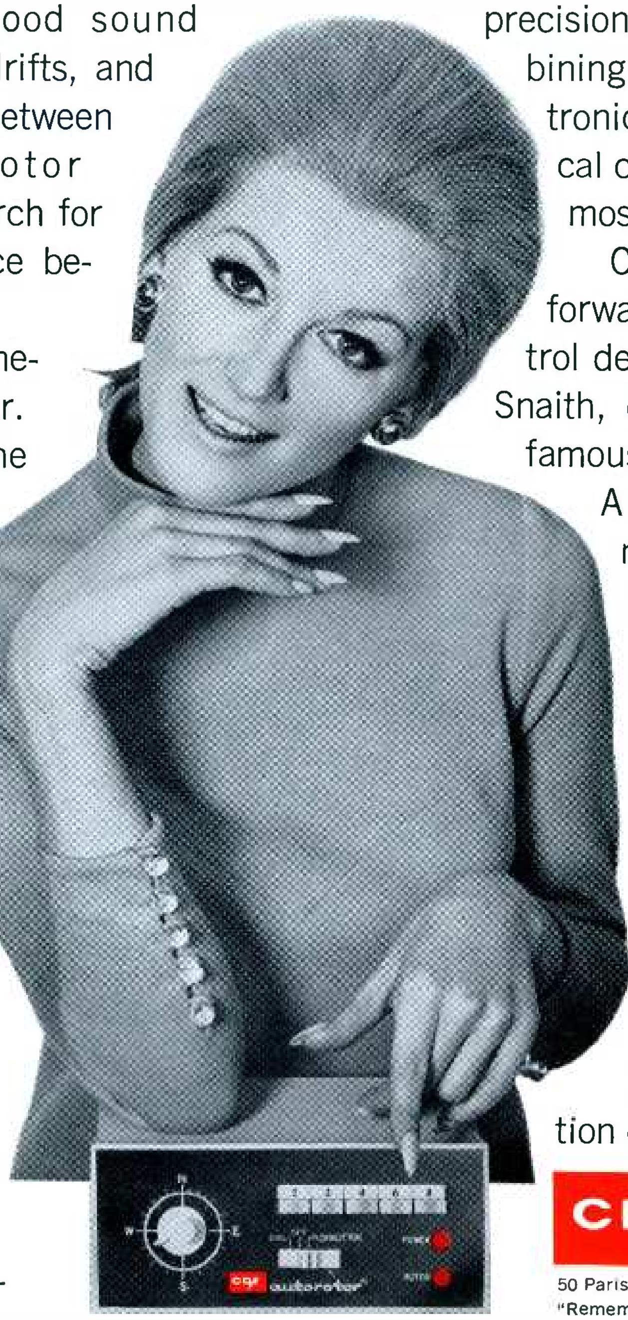

CDE's famous heavy-duty Bell Rotor gives you high repeatability and no antenna drift. It's an all-solid-state, silent operation. The Autorotor system's precision is within 1° and combining it with pushbutton electronic control, not mechanical control, makes it today's most advanced rotor.

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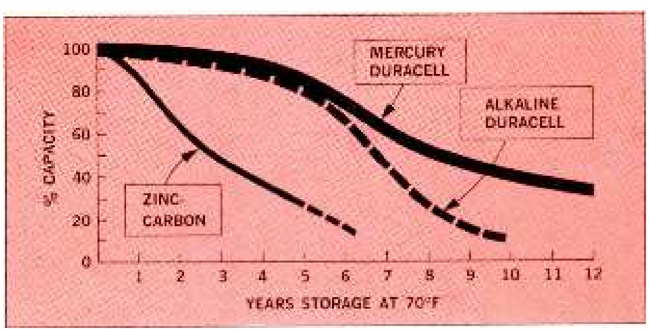
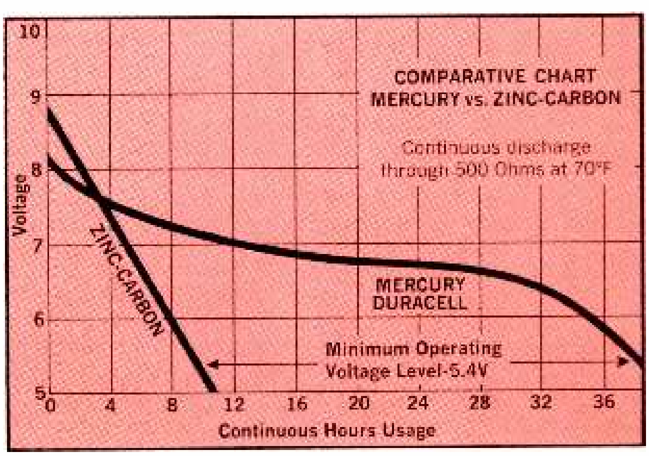
"Remember to ask what else needs fixing"

Circle 1 on literature card

MALLORY **Tips for Technicians**

Tips on selling batteries





Just about every customer who walks into your shop, or whom you see on a service call, is a prospect for batteries. You can get yourself more sales and profits from battery business, by recommending Mercury Duracell® and Alkaline Duracell batteries—the *different* high energy batteries made by Mallory.

Here are some facts about batteries that can help you trade customers up to today's best values in portable power.

Which batteries are best for transistor radios? At the relatively low drain service in most radios, Mercury Duracell batteries are generally the best buy. They actually cost about 15% less per hour of service than ordinary zinc-carbon types. And they give you better listening; their output voltage stays constant throughout life, so you don't drop into the high distortion part of the transistor characteristic. Next best are Alkaline Duracell batteries. Both Duracell types have the further advantage of extremely long shelf life—no appreciable drop in power even after two years. So they can sit idle in a radio instead of dying even when not used, like ordinary batteries.

How about cameras? For the electric eye devices which automatically adjust exposure, there's nothing like Mercury Duracell batteries. They last over a year, and produce highly accurate voltage required for this job. For built-in flash and for electric drive of movie cameras, Alkaline Duracell batteries are far superior to ordinary types. They drive 4 to 5 times more movie footage, and fire about three times more flashes.

What's good for tape recorders? Motor drive is a fairly heavy drain job . . . ideal for Alkaline Duracell batteries. These outlast zinc-carbon by 2 to 5 times in portable recorders.

Flashlights? Toys? For ordinary flashlight duty, the old zinc-carbon is hard to beat. But if you're apt to use a light continuously for long periods, Alkaline Duracell batteries can give steady lighting for up to 10 times longer than zinc-carbon. And they're much safer for emergency use, because they don't die in a few months on the shelf. Toys are real high drain duty; here Alkaline Duracell batteries are a real bargain, for they outlast zinc-carbon types by 5 to 8 times.

Sell your customer on the greater value of Duracell batteries, and you'll make twice as much profit per sale. Get the story on the new Mallory battery merchandise displays from your nearby Mallory distributor. Or write Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

DON'T FORGET TO ASK 'EM "*What else needs fixing?*"

Circle 2 on literature card

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VOLUME 18, No. 7 JULY, 1968

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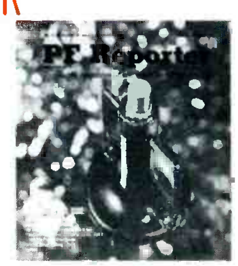

The last color TV hold-out against the relentless and inevitable switch to semiconductor devices has at last given up the ghost. Thanks to the new component shown on the cover this month, it is now possible to design and produce a truly all solid-state color TV. For more on the subject read the article beginning on page 4 of this issue.

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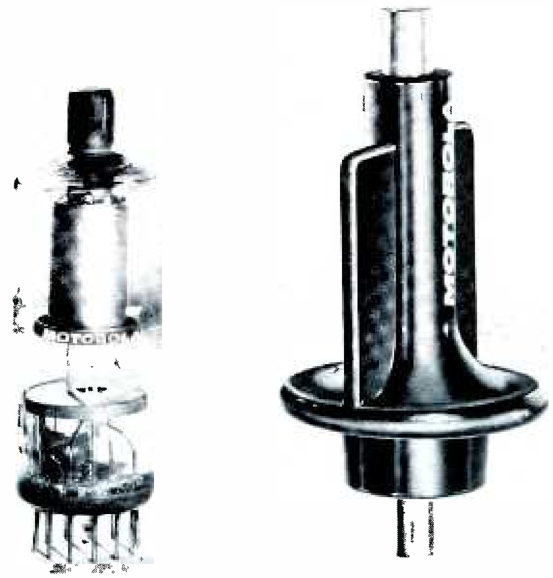
THE SOLID-STATE HIGH-VOLTAGE RECTIFIER IS HERE!

The last holdout in the consumer electronic industry's switch to solid-state components and design has succumbed at last. At a recent news conference, Richard A. Kraft, the product manager of Motorola's Consumer Products division, announced the development, by Motorola, of a solid-state replacement for the tube-type high-voltage rectifier. The new solid-state high-voltage rectifier is shown beside a conventional tube rectifier in Fig. 1.

Prior development of a solid-state, high-voltage rectifier had long been hampered by the fact that the state-of-the-art had not arrived at a product that could withstand the tremendous stresses imposed by the high-voltage requirements of color TV. Such a device must operate reliably under peak-inverse voltage conditions of up to 35,000 volts, as well as being capable of responding in a high-frequency pulse-type circuit requiring a wave-front rise time (to 30,000 volts) of 7.5μ seconds, as shown in Fig. 2.

Solid-state diodes with breakdown voltages ranging from 500 to 1000 volts have been available for many years. These diodes have been used successfully in "stacked" configurations designed to provide high voltage for DC and low-frequency applications. However, stacking such diodes to provide the high-voltage demands of color TV has met with repeated failure. This failure has been due primarily to the fact that wide variations in distributed capacitance, voltage breakdown, and switching time between individual diodes have caused uneven distribution of the TV pulse voltages. Consequently, some of the individual diodes in the stacked circuits were overloaded and eventually broke down.



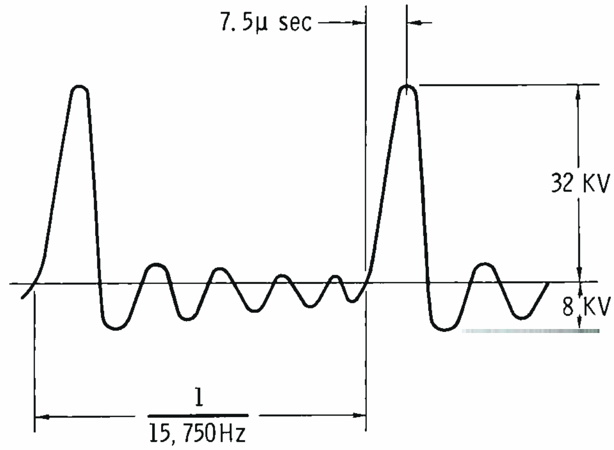


Fig. 1. Size of new rectifier is comparable to tube.

Fig. 2. High-frequency pulse confronting solid-state high-voltage rectifier.

The new Motorola solid-state, high-voltage rectifier is made of silicon rectifier chips of improved uniformity that assures more even distribution of the horizontal pulse voltage. The silicon chips are contained in a humidity and corona resistant package that exhibits much greater mechanical strength than the tube-type rectifier.

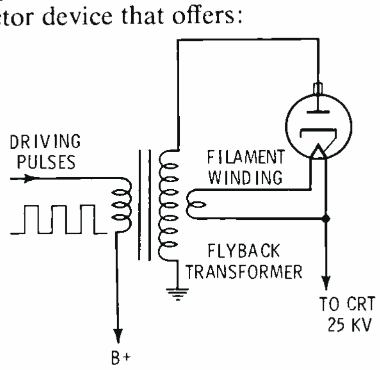
Thus, the glass-type tube, with a heater assembly that creates heat and will eventually fail, has successfully been replaced by a semiconductor device that offers:

1. No heater to burn out.
2. Greater efficiency.
3. Instant warmup.

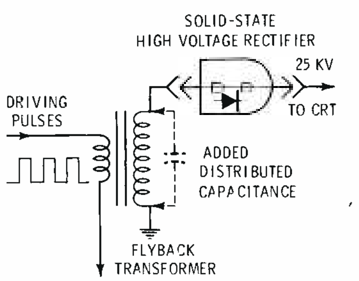
To accommodate the new semiconductor rectifier, the following mechanical and electrical changes have been made in the high-voltage section of Motorola's solid-state chassis (circuitry shown in Fig. 3):

1. A new horizontal-output transformer, with increased parasitic stray capacitance to match the low-capacitance of the solid-state rectifier.
2. Removal of the filament winding, which is no longer required.
3. Mechanical change of the socket to accept the new plug-in, solid-state unit.

The semiconductor high-voltage rectifier is employed in a new plug-in, high-voltage module (shown in Fig. 4) designed for use in Motorola's modular, solid-state color chassis. In addition, the new module can be used to mechanically and electrically replace the high-voltage system employed in earlier Motorola modular, solid-state color chassis. ▲



(A) Tube circuit



(B) Solid-state circuit

Fig. 3. Comparison of tube and solid-state high-voltage circuitry.

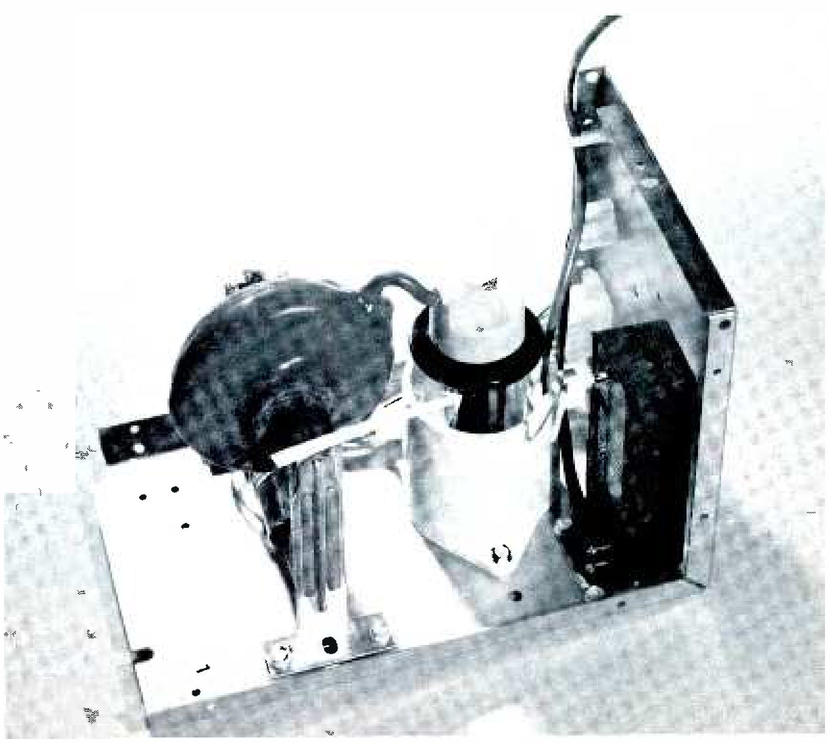


Fig. 4. New high-voltage module for Motorola solid-state color chassis.

Radiation Revisited

We have continued our investigations of the X-radiation phenomena that can be emitted by some color receivers. A General Electric KC chassis was obtained and a 6EA4 (the obsolete tube) was installed. The receiver was set up for normal operation, and a film in a light-tight container was mounted 2" below the bottom left side of the cabinet. The set was then turned on for normal programming, and operated for 30 hours. Fig. 1 shows the pattern of radiation on the exposed film.

Fig. 1. Film shows radiation pattern obtained with 6EA4.

Next, we installed a 6EH4, (the recommended replacement for a 6EA4), reset the high voltage for normal operation, and repeated the film experiment. The resulting exposure is shown in Fig. 2—a blank film.

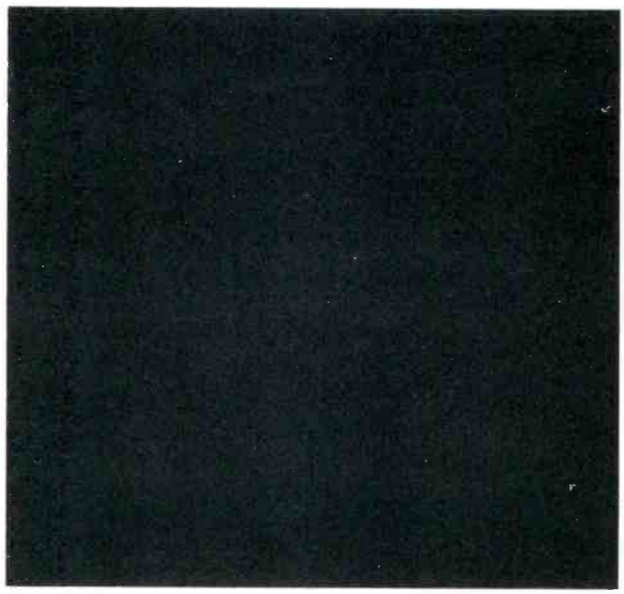


Fig. 2. Same exposure with 6EH4 shows no radiation.

Our conclusion is that the GE modification procedure was quite effective in this case. Furthermore, we conclude that in any case, if you follow the manufacturer's instructions concerning radiation, you can't go wrong. ▲

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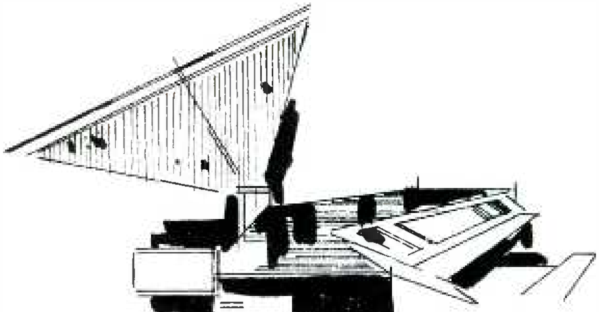


THE ELECTRONIC SCANNER

Color Slides Added to Color TV

A home entertainment product that presents color television programs, color photography slides, or pre-recorded and home-made tapes on the same instrument has been introduced by Sylvania Electric Products, Inc.

Thomas H. Cashin, a Senior Vice President with over-all responsibility for Sylvania Entertainment Products, an operating group of the company, said the new Color Slide Theater " . . . combines the most popular forms of home entertainment into one compact instrument that is convenient to use and simple to operate."

The unit can be operated as a black-and-white or color television set; an "all-in-one" slide projection system with the photographs showing on the screen of the TV set, or as a tape recorder and player. All of the component instruments in the unit can be operated independently.

One unique feature of the theater is that the tape recorder and the slide projection system can be synchronized to prepare slide presentations with taped narrations that also change the slides electronically on cue. The slides also can be changed manually with a remote-control switch held by the viewer.

The slide system uses a circular slide tray that can accomodate eighty 2″ × 2″ color or black-and-white slides. A small cathode ray tube (flying spot scanner) is used to transmit the photograph from the slide to the screen of the TV set.

The scanner "reads" each slide with a rapidly moving spot of light, breaking down each slide into three basic television colors—blue, green, and red. Other components in the slide projection system convert these colors into video signals which are then fed into the TV set and displayed on the screen. The unit has a factory-adjusted fixed focus. The objective lens is set at 50mm, f3.5.

Focusing on the slide is done automatically by the spot scanner. However, it is possible for a viewer to adjust the color control of the TV set to enhance certain hues in a color slide. He also can increase or decrease the brightness of a slide with the brightness control of the TV set.

An additional feature of the slide projection system is that the slides, like color television, can be viewed comfortably in a lighted room. The unit can be changed from television to slide projection operation by a simple push-pull switch and without rearranging furniture or setting up additional equipment for slide viewing.

A microphone provided with the unit permits the user to produce a coordinated slide-tape presentation. To accomplish this, the user describes the slides being shown and then presses a button when he wants the next slide to appear. This "change slide" signal remains on the tape and triggers a slide change during the playback.

The cassette-type cartridge tape recorder contains a record and playback feature; a recording level meter;

a microphone, and the control which provides the means to electronically change slides.

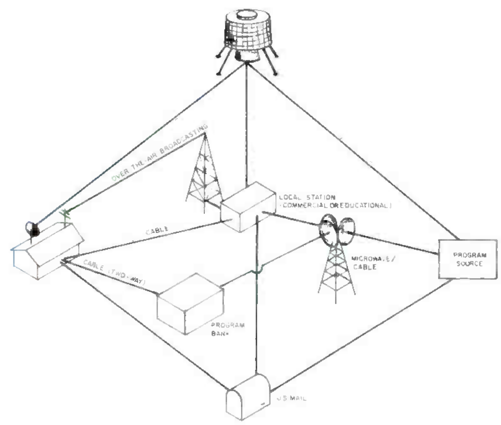
A New Look At TV

Television viewers may soon have a wider variety of programs to choose from as a result of a scientific study recently announced by Spindletop Research, Inc., Lexington, Kentucky. The non-profit research firm has been authorized to proceed on a study for the President's Task Force on Communications Policy, to determine economically feasible methods of offering the television viewer a broader range of programs.

During the next four months, Spindletop will conduct an intensive study of ways to decrease the cost of transmitting television signals from the program's source to the home viewer's set; of appropriate organizations to implement the various alternatives; and of the federal government's proper role in further development of television in the United States.

"At present, a prime-time national television program must have at least seven million of the nation's approximately 58 million households watching, if it is to be profitable," states John A. Dimling Jr., manager of communications/systems research at Spindletop.

Consequently, programs that might appeal to fewer than seven million households are generally not carried. It will be Spindletop's job to identify and analyze



alternatives to the present method of transmitting television signals. A lower cost of transmission could make possible a wider choice of programs than is currently available. Alternate ways of transmitting television signals are illustrated here in a drawing by scientists at Spindletop.

Direct satellite-to-home broadcasting, satellite distribution to local stations, community antenna television (CATV), laser beam communication, video home records, and broad-band cable for random access to information and entertainment will be among distribution methods considered by Spindletop.

In addition to assessing the cost and effect of various transmitting techniques, Spindletop will investigate the potential impact of changes on existing organizations and groups, such as present television networks, local broadcasters, advertisers, and program suppliers.

Additional institutions to be considered and evaluated include a fourth commercial network, additional local UHF stations, a national educational television network, a corporation for public television, pay television, and subsidized programs for commercial television.

Spindletop will also give consideration to program cost reductions in such areas as sheduling and technical innovations. Each alternative will be examined in terms of the legal and regulatory changes it would involve as well as its technical feasibility and its cost.

Two-Year Color CRT Warranty

A new two-year color picture tube warranty has been announced by Packard Bell. The warranty will apply, at no extra cost, to all of the company's 1969 color TV models. In addition, the two-year color picture tube warranty can be purchased for 1968 color receivers currently in dealer's stock or waiting to be purchased from distributors. Dealer prices for the new color CRT warranty applied to 1968 models are $6.00 for 14″ and 18″ picture sizes and $7.50 for the 23″ size. A suggested retail value of $10.00 is being placed on the new warranty.

Color Now Available In 12″ and 16″

The color TV industry's first 12″ and 16″ portable models have been announced by Admiral. The Chicago-headquartered company has also introduced its first 14″ portable color receiver.

One of the 16″ models features wireless remote control and is the first color portable so equipped in the color TV industry. The multi-function remote control permits adjusting of color and tint, as well as changing stations, adjusting volume and turning the receiver on and off.

According to Ross D. Siragusa, chairman of the board of Admiral, the new color tube for portable model will be manufactured by the company's tube division and will be made available to the rest of the TV industry. The 16″ color CRT will be available to other manufacturers for $82.00, while the 14″ tube will have a $77.00 price tag. Cost of the 12″ model is to be announced later.

With the addition of the three new color CRT sizes, Admiral's color line offers six CRT sizes ranging from lightweight 12″ portables to big screen 23″ receivers.

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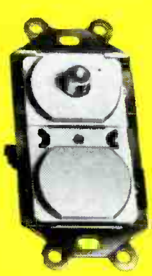

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TRANSISTORS:

A Report On The State Of The Art

Part 2

by Jack Darr

Typical applications of solid-state devices in consumer electronics.

Part 1 of this article covered the evolution of transistors. In part 2 we'll examine some of the different ways transistors are being used.

The transistor has "worked its way" into many circuits. It is being used in some applications because it can do a better job than a tube due to its special characteristics; in other applications the savings in space, heater power, etc., make the transistor particularly useful. Transistor applications in radio and audio circuits are well known; let's see how the transistor is being used in TV and other circuits.

A great many of the circuits we will be discussing are conventional amplifiers. It is their specialized *use* that makes them unique. Triode transistors are often used as video amplifiers, mostly in preamplifier or driver stages. Others work as gates or switches, or in various control circuits. In all-transistor TV sets, transistors are found working as switches, doing the same job a tube once did in an amplifier configuration.

You'll find many applications of biased diodes. Although the diode *is not* a transistor, it *is* a junction device, as is the transistor. Actually, the biased diode is really half of a transistor. Biased diodes may be used as gates, switches, clamps, and even as variable capacitors.

Video Amplifiers

The first triode transistor in American TV receivers came in at the top—in a color TV chassis. Fig. 1 shows the transistor video amplifier used in the middle of the Y channel of Zenith's 23XC36 and 23XC38 chassis. It is a Class A amplifier using common-emitter circuitry between the 6KT8 cathode-follower and the 12HL7 video output stage. This stage has a voltage gain of about 3.

The circuit of Fig. 2 is employed in a Sylvania DO5 color chassis and looks exactly like the circuit in Fig. 1, until you check it more closely. This is actually a dual-purpose stage. The video or Y signal is taken off at the collector and fed through the delay line to the grid of the 10JT8 video-output tube. This is a standard common-emitter circuit, as in Fig. 1. However, note that the color signals are taken off at the emitter and fed to the grid of the color amplifier. So, for the color signals, the stage works as an emitter-follower.

A transistor color killer is used in Sylvania's DO6 color chassis; Fig. 3 shows the circuit. The DC voltage developed across the two resistors in the output of the chroma AGC and killer detector is fed to the base of Q4. A keying pulse from the flyback is fed through diode X17 to the collector. The collector voltage that is developed is fed through a resistor network and a voltage-dependent resistor (VDR) to the cathode of the chroma bandpass amplifier, V14B. In the absence of a color signal, this voltage keeps V14B cut off by developing a high positive cathode bias. Clamper diode X18 is used to hold this bias within the proper limits.

In the same DO6 chassis, a pair of transistors are used to provide noise immunity. The basic action of this circuit is the same as it has always been in tube circuits. A noise pulse is amplified, inverted, and fed to the sync circuits to cancel itself out, thus eliminating false

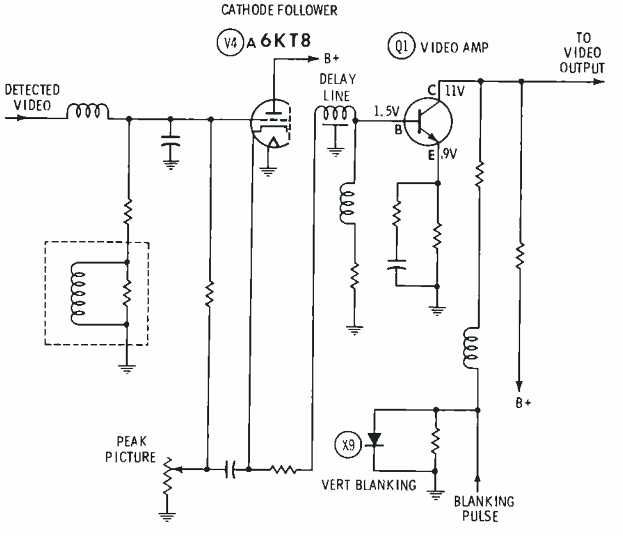

Fig. 1. Transistor video amplifier employed in Zenith chassis.

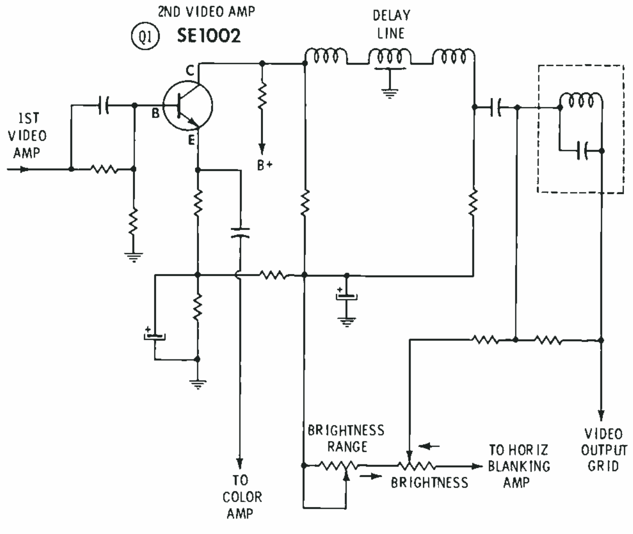

Fig. 2. Sylvania circuit acts as emitter-follower for color signals.

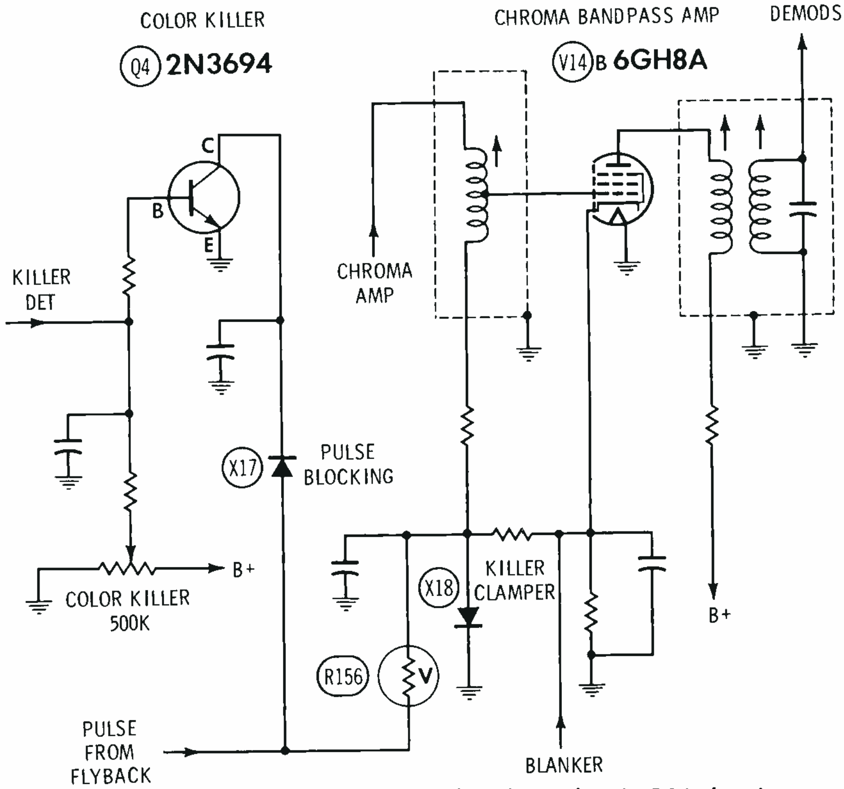

Fig. 3. Transistorized color killer employed in Sylvania D06 chassis.

sync caused by noise. The circuit is shown in Fig. 4. Common-base amplifier Q2 has a video signal fed to its emitter (the input in this circuit). This stage is direct-coupled to Q3, which is a common-emitter stage used as the noise gate. The collector-emitter junction of the noise-gate transistor is the "cathode resistor" of the sync separator tube. When a noise pulse arrives at the base of Q3, the resistance of the collector-emitter junction rises very rapidly, and the sync-separator tube is instantly cut off. In this application the transistor is actually operating as an automatic switch; it opens the sync circuit whenever a noise pulse comes through.

A single transistor and a gated diode is used for the same purpose in the Westinghouse series V-2655 color chassis (Fig. 5). The base of Q2 is connected to the cathode of the AGC tube, and a back-biased diode is connected across the bias resistor of the sync-amplifier tube. The diode is biased by returning it to a +25-volt source.

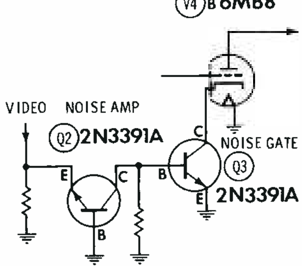

Fig. 4. Transistor noise canceller in Sylvania chassis is similar to tube circuit.

The grid of the AGC tube receives a video signal from the video amplifier. When a noise pulse is received, it appears as a voltage pulse in the cathode circuit of the AGC keyer tube. This causes the noise canceller transistor (Q2) to conduct more heavily. Since the collector-emitter junction of Q2 is a part of the cathode resistance of the sync amplifier, the increased conduction of Q2 causes a greater current flow through R90 which, in turn, developes a higher positive bias on the sync-amplifier cathode, cutting off that tube. Simultaneously, the heavy conduction of the transistor drops the screen-grid voltage of V8A, the AGC keyer tube, and it too cuts off, thus providing a sort of dual-control action.

A completely transistorized video IF strip is used in the Philco 18KT 50 color TV chassis (Fig. 6). Two AGC transistors are used in this chassis as well as a transistorized 2nd video amplifier stage and tuner. The rest of the circuitry is all-tube.

Basically, the transistorized IF strip works just like its tube counterpart; three common-emitter amplifier stages are used. One difference —and one that you'll find in several other solid-state video IF circuits— lies in the application of AGC control voltage to the base of the 2nd video IF amplifier transistor instead of to the 1st video IF stage. However this is basically the same circuitry used in the stacked-IF stages employing tubes. In tube-type

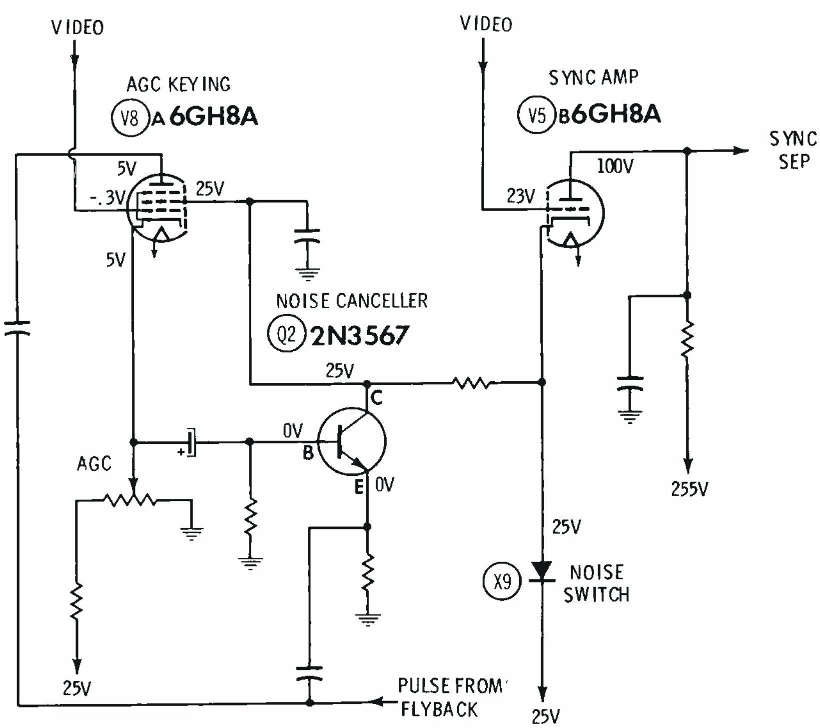

Fig. 5. Noise elimination circuit employed in Westinghouse chassis.

stacked IF circuits, AGC is applied to the grid of the first tube, which then controls the 2nd because of the stacked configuration.

In the circuit shown in Fig. 6, note that the base of the 1st IF transistor is returned to the emitter of the 2nd transistor stage. Thus, when the AGC changes the gain of the 2nd IF transistor, its emitter voltage will change. The emitter voltage is coupled back to the base of the first stage to control its gain.

Motorola's TS-914 chassis uses a transistor as a pincushion amplifier (Fig. 7). Theoretically, a pincushion-corrector circuit is a hairy monster; however, in actual application it's pretty simple. Vertical and horizontal sweep signals are fed to the input. The output, with a waveform looking something like a bow-tie UHF antenna, is used to correct pincushion distortion of the raster by adding or subtracting width or height at the right places. NPN transistor Q1, connected as a common-emitter circuit, feeds the pincushion transformer, L46; the secondary of this transformer is connected in a series with the yoke circuits.

Integrated Circuits

The Integrated Circuit (IC) is now showing up in TV sets. The IC first appeared in TV as the sound IF, sound detector, and audio preamplifier of the RCA CTC21 color TV chassis. The equivalent circuit of the IC is shown in Fig. 8. The sound stages of this set are all-transistor, with two other transistors used in the driver and audio output stages.

The IC is only a "collection" of transistors and associated circuit elements, such as resistors and diodes, mounted on a common base. Tuned circuits are connected externally, as you can see in Fig. 8. We will probably be seeing more applications of integrated circuits in the very near future.

Transistors have supplanted tubes in many cases, and now the transistor itself is being displaced by the IC. The first instance of this was in the Automatic Fine Tuning (AFT) circuitry used in many late model color TV sets.

In the RCA CTC21 series, the AFT circuit employs transistors; Fig. 9 shows the original circuit. This is basically a Foster-Seeley discriminator, as used in many FM radios. Instead of working at 10.7-MHz, this one works at 45.75-MHz, the picture-carrier IF frequency.

The output of this stage is a DC voltage with an S-curve shape, the

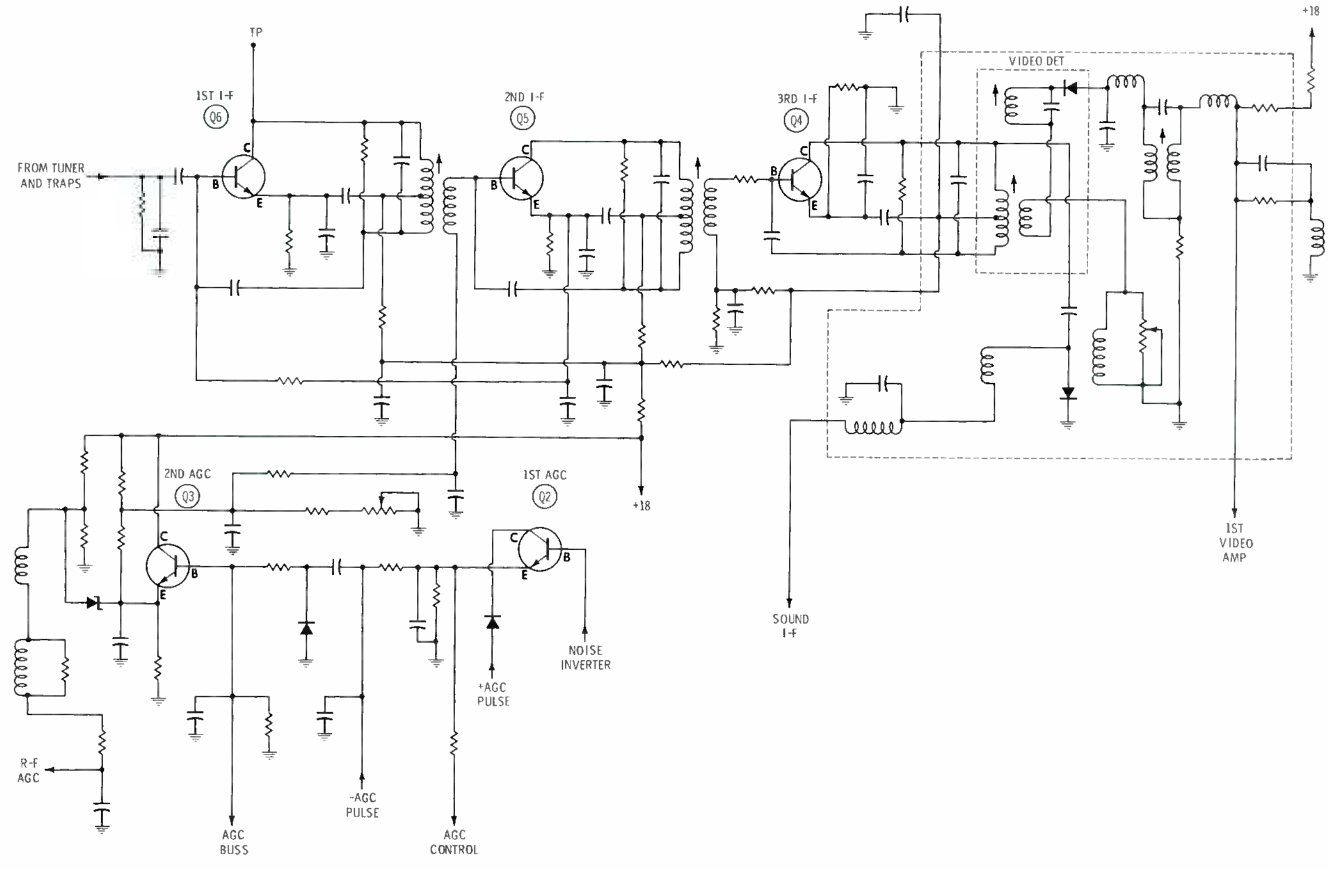

Fig. 6. Philco 18KT50 chassis has all-transistor video IF and AGC circuitry.

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Opportunities in Plants

And there are other exciting opportunities in the aerospace industry, electronics manufacturing, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal Government's FCC exam and getting your License is widely accepted proof that you know the fundamentals of Electronics.

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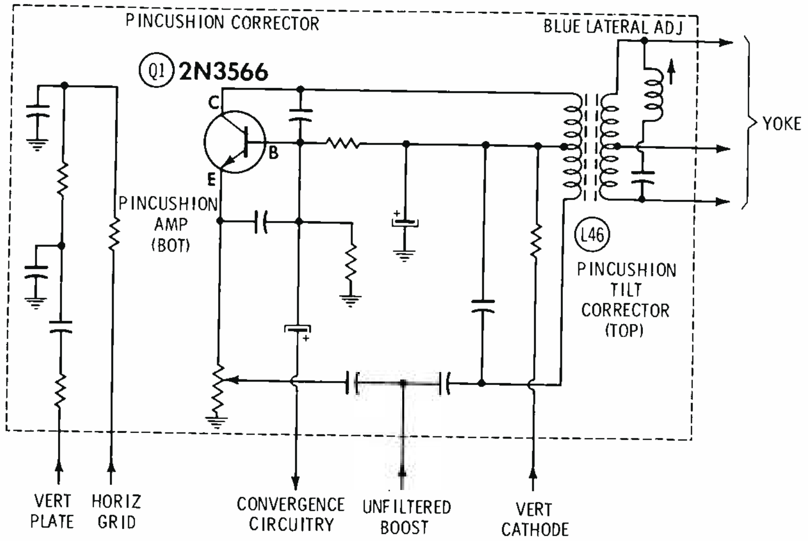

Fig. 7. Pincushion corrector circuitry used in Motorola TS-914 chassis.

"zero-voltage" crossing in the center when the input frequency is exactly right. If the input signal drifts in either direction, it generates a DC voltage; the polarity of this voltage depends on which way the frequency drifts. This correction voltage is used to control the effective capacitance of a varactor diode connected across the tuner oscillator coil; if the oscillator drifts, it automatically will be pulled back to the correct frequency.

The "on-frequency", or reference, voltage in this application is not ordinarily zero. It will be some small value of DC to set the varactor diode at the correct capacitance. This diode has a junction specially made to have a wider than normal depletion layer. By varying the applied DC voltage, or bias, the capacity of this junction can be varied.

The IC AFT

The RCA CTC30 chassis uses the same basic circuitry, but an IC takes the place of the separate transistors (Fig. 10). Otherwise, there is no difference. As in other present-day IC circuits, the tuned circuits are external. Also, all circuit adjustments are the same.

The IC Phono Cartridge

IC's are small; possibly one of the smallest is the unit used in the RCA RP-228 series of record changers. The standard stereo crystal cartridge has its own miniature IC amplifier mounted right in the pickup head. This is a comparatively simple unit using only four transistors—two for each channel, as shown in Fig. 11. The advantage of this unit is the superior matching of the pickup cartridge to the low-impedance input typical of solid-state amplifiers. Reduced noise pickup, etc., is also realized from the high-level output signal.

Varactor-Diode Horizontal AFC

Varactor diodes are showing up everywhere. The Magnavox 908 transistor TV chassis uses one to control the horizontal oscillator frequency. Fig. 12 shows how this is done.

The varactor diode is connected to the output of the AFC phase detector diodes. The DC voltage appearing at this point, resulting from comparison of the phase of the oscillator signal to the transmited horizontal sync, is applied to the varactor diode X37.

This diode is connected across the horizontal stabilizer coil; any variation in its effective capacitance will result in a change of oscillator frequency. The basic action is the same as the AFT mentioned previously.

Biased-Diode Circuits

Biased-diode circuits are becoming more common in TV receivers as well as other electronic instruments. The basic circuit is nothing new (the familiar damper tube is a biased-diode). By putting a certain "charge" on one side of a diode, it can not conduct until the applied voltage on the other side reaches a certain level. This "charge" can be an applied DC voltage or a DC voltage developed

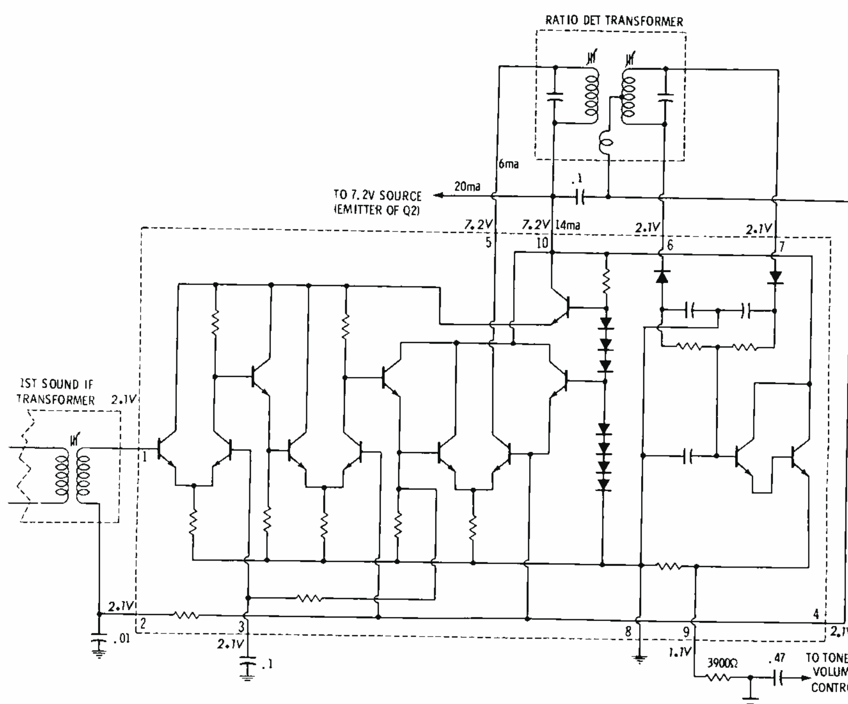

Fig. 8. Integrated circuit sound system first appeared in RCA CTC21 chassis.

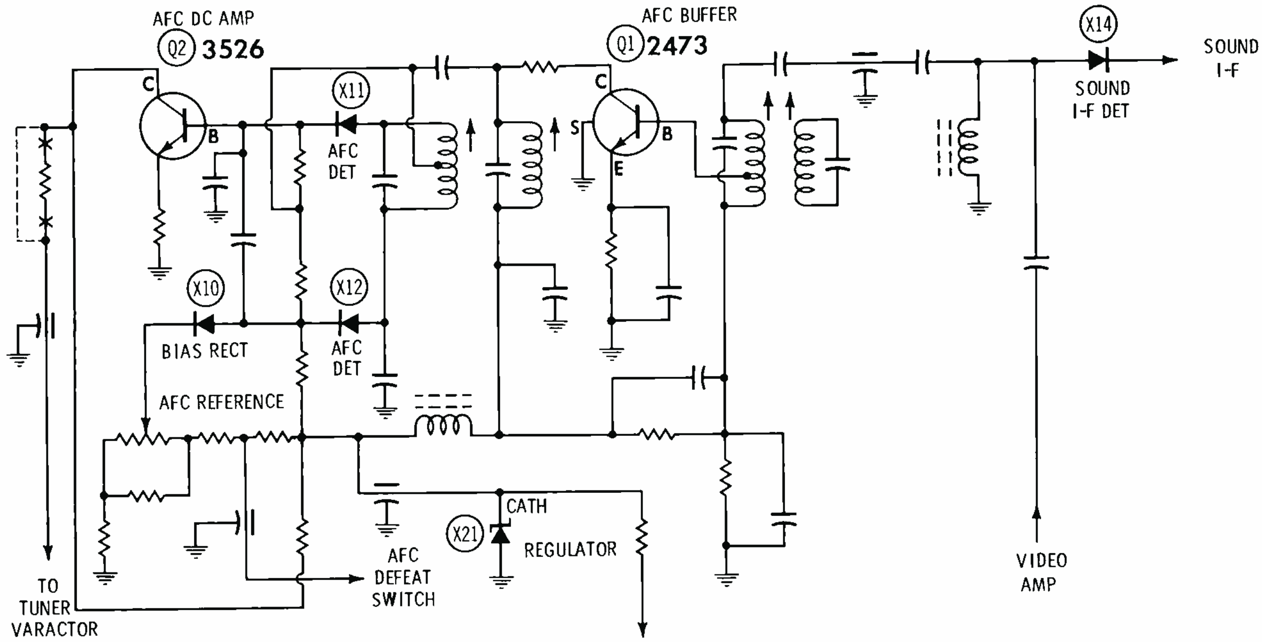

Fig. 9. Transistorized automatic fine tuning circuit is similar to Foster-Seeley discriminator.

from charging a capacitor by means of current pulses (damper action, again).

Biased-diode regulator

The Motorola TS912 and TS 914 color chassis used a biased diode as a high-voltage regulator instead of a tube-type shunt regulator, such as a 6BK4. The biased-diode circuit is shown in Fig. 13. The operation is simple. The horizontal-output tube operates class C. It develops its own grid bias across the grid resistor. This bias voltage determines the conduction of the tube and, thus, the amount of output. So, to control the output, we control the bias.

The grid resistor is divided into two parts: R143, 270K ohms, and R142, 470K ohms. A germanium diode (X15) is connected through a 100K-ohm isolation resistor (R145) to the junction of the two grid resistors. Pulses from the flyback (about 230 volts p-p) are fed to X15 through coupling capacitor C92. The anode of X15 is connected through R144, R10, and R146 to a positive voltage source. The three resistors form a voltage divider from the 370-volt source to ground.

Pulse amplitude will vary with the output of the horizontal-output stage. Conduction of X15 will depend on the height of the pulse and the actual value of bias voltage placed on its anode by the voltage divider.

If the output of V11 should rise because of reduced loading of the flyback (CRT beam cut off or reduced due to a dark scene), the high voltage will tend to rise, and the pulse amplitude also will go up.

This makes the diode conduct more current, which flows through the lower half (R142) of the grid resistance. This, in turn, causes the upper end (toward the grid) to go

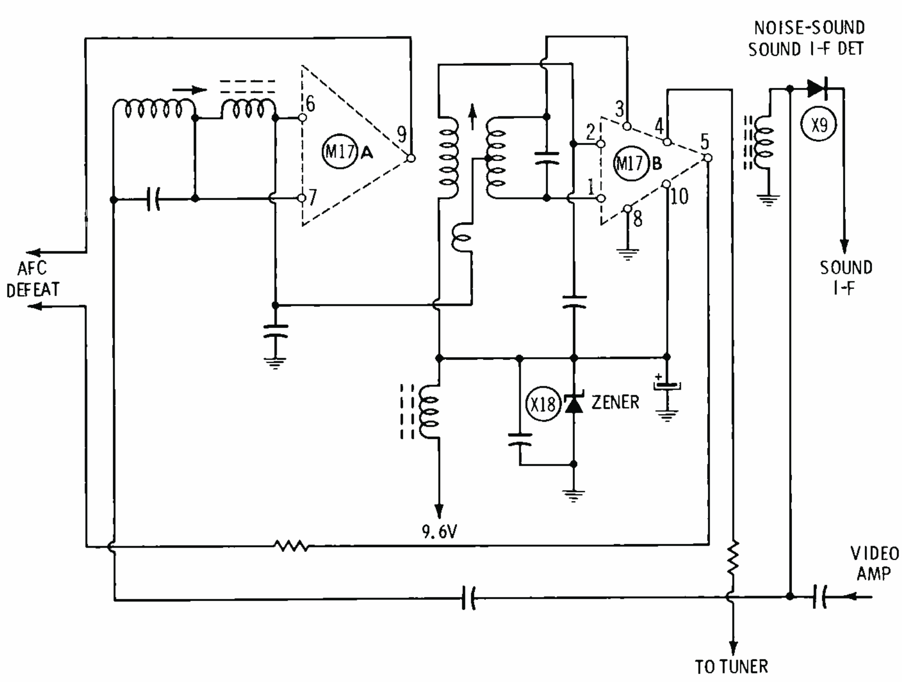

Fig. 10. IC replaces transistors in AFT circuit of RCA CTC30 chassis.

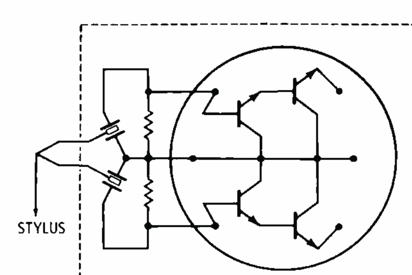

Fig. 11. Phono cartridge using IC.

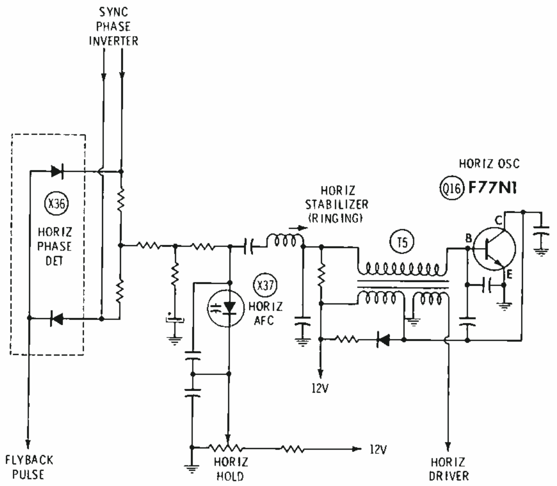

Fig. 12. Varactor diode controls horizontal oscillator in Magnavox chassis.

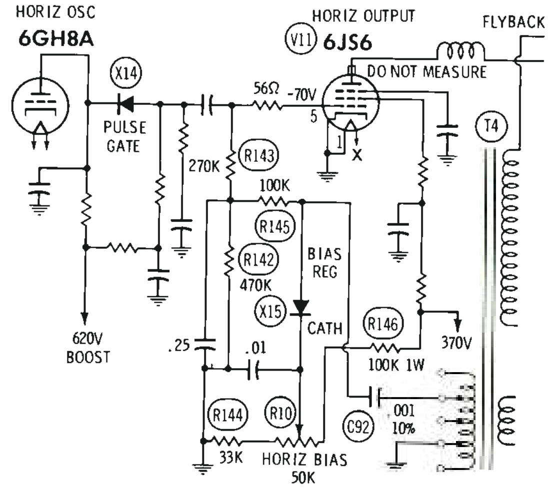

Fig. 13. Motorola high-voltage circuit employing diode as regulator and pulse gate.

more negative. The increased negative voltage on the grid of V11 reduces its conduction, holding the output to its former level.

The reverse is also true: if the screen should go to a high-level white picture (maximum beam current and loading), the pulse output would drop. This, in turn, would cause the grid of V11 to go more positive, and conduction would increase, bringing the output back to the level set by R10.

Diodes are even used as rectifiers in some applications ("rectifier" meaning a device which will conduct current in only one direction). Such an application can be seen in Fig. 13. Notice diode X14 connected in series between the horizontal oscillator output and the 6JS6 grid. This is called a "pulse gate," and has two purposes: first, to prevent any positive-going pulses from getting onto the 6JS6 control grid, and second, to make the horizontal-output tube go into cutoff much more rapidly. This helps to hold down the total power dissipation of the tube, which makes the tube last much longer.

Horizontal Centering Control

A junction diode is used in the horizontal-centering control circuit of Magnovox T931 chassis and some of the earlier ones as well. As you can see from Fig. 14, diode X1 (with the 4.7-ohm resistor shunted across it) can be hooked up in either direction, or left out entirely.

The diode causes a small DC voltage to appear across the horizontal yoke, thus slightly displacing the whole raster in one direction. By reversing the diode, the direction of displacement can be reversed. If no correction is needed, the diode is simply left out of the circuit. "Push-on" terminals allow this circuit to be altered easily.

In the Motorola TS914 chassis, a pair of diodes are connected across the horizontal centering control, as in Fig. 15. X4 and X5, called "pulse amplitude limiters," conduct at a low level at all times. Thus, they serve to hold the DC centering voltage at a constant level despite any change in loading due to brightness variations. So, in this circuit they are acting as "clamp" diodes.

In the next installment we'll take a look at some of the test equipment and new techniques you'll have to use to deal more efficiently with transistorized circuitry. ▲

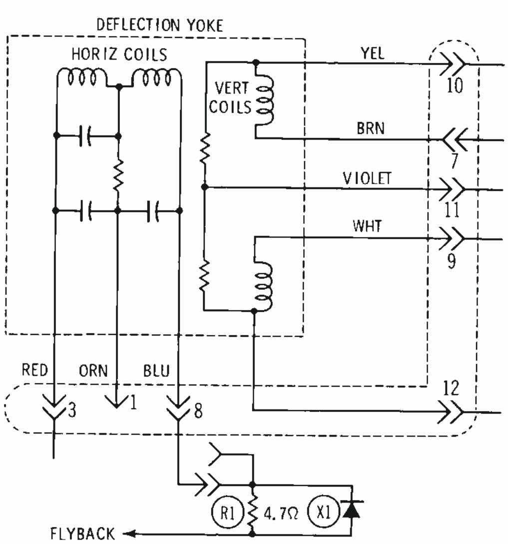

Fig. 14. Magnavox chassis uses junction diode in horizontal-centering control circuit.

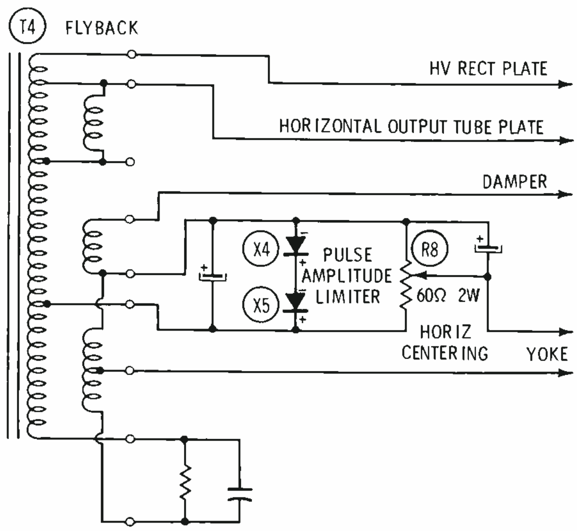

Fig. 15. Junction diodes act as clampers in Motorola horizontal-centering control.

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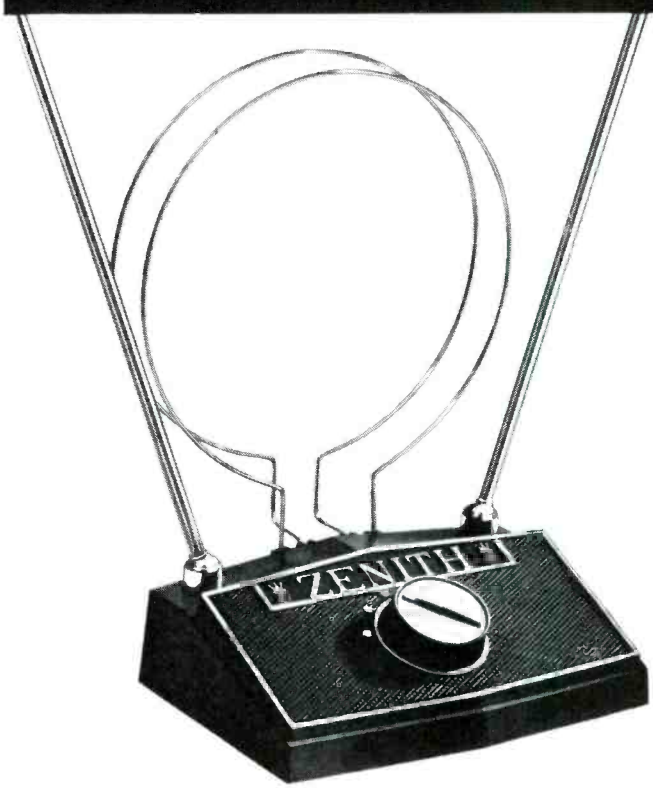

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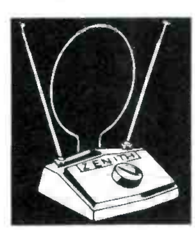

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Test Equipment For Color TV

by Robert Heaton

What you need and how its used.

Over any period of time, a variety of factors upset the balance of proper test equipment required by a service technician (or his shop). In the past, a few basic test instruments were perfectly suitable for servicing the small variety of home entertainment devices on the market. Today, your balance is off if you haven't brought your test equipment (type and quantity) into line to meet the increased variety of products you're required to service. Nothing can match the assurance that comes with having smooth-operating, proper test equipment available to do the job. Take color television, for example. Invariably, color service demands up-to-date test instruments—requiring an appraisal of the latest types available and why they are necessary.

Test equipment manufacturers have recognized the need for modern test instruments. Recent designs—many completely solid state—have truly portable features, permitting maximum usage on home calls with a minimum of effort. These units now come in very compact cabinets, yet perform the same (or more) functions than previous designs. Thus, quality and performance have not suffered.

The number and types of available test equipment accessories is also increasing. Thus, more tests can be performed using the basic instrument—and usually, more easily. Let's look at some of the test equipment and accessories needed for color service. We'll investigate the various features, their applications, and why you need them.

The Oscilloscope

Most service scopes on the current market are designed for color work. Their frequency response is reasonably flat from 10 Hz to 5 MHz—required to properly view waveforms in the color circuits. modern scopes also have good sensitivity—at least 25 to 30 mv per inch of deflection, with high-intensity trace.

A good scope is invaluable for color troubleshooting. The easiest method to isolate a color problem requires only a working knowledge of your oscilloscope and color-bar generator (the latter will be discussed presently).

Many technicians fail to see the servicing advantages of the scope. Often, they don't realize the time-saving features, and problems be-

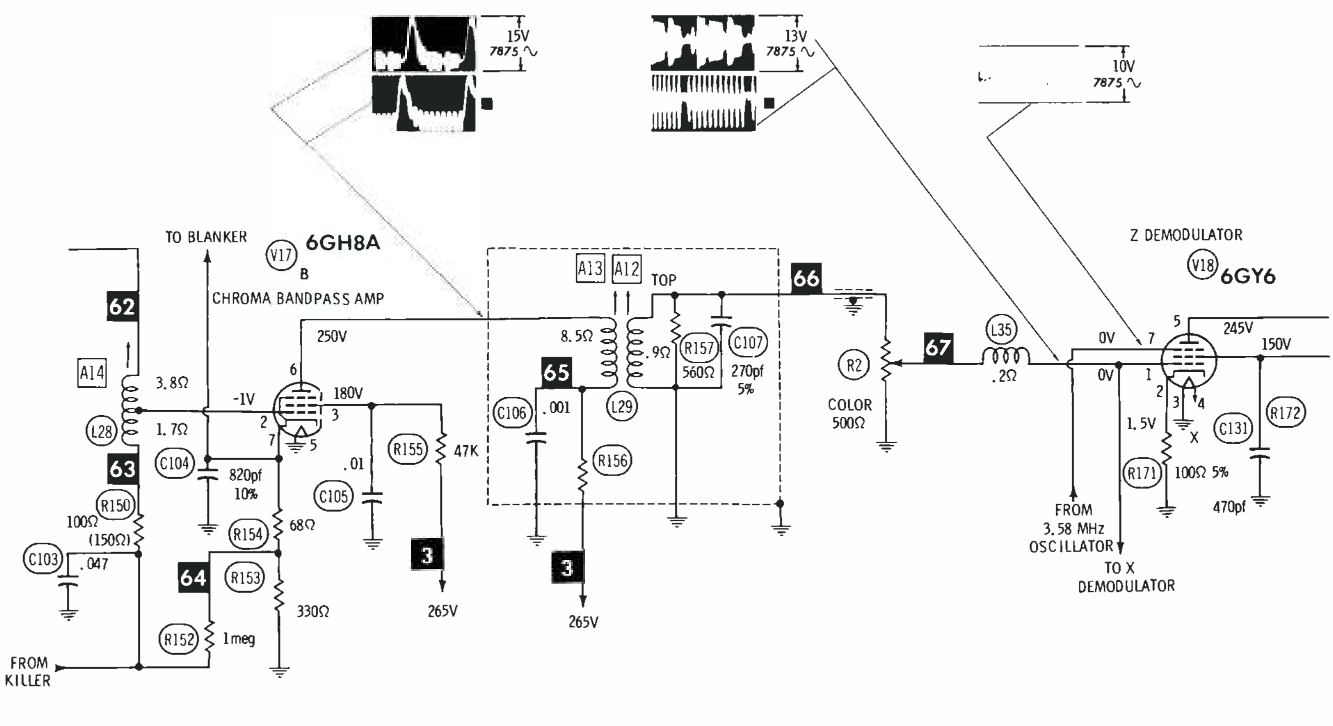


Fig. 1. Scoping for signal loss is a logical procedure.

come dogs when a scope would quickly reveal the trouble. Just to make our point, let's cite a simple example.

Assume a loss of color, with the cause believed to be failure in the bandpass stage illustrated in Fig. 1. How would you first check the stage? Measure voltages? Resistances?

The simplest procedure is to determine the primary information we want, and the fastest way to get it. Since we suspect the bandpass stage, whether or not it will pass a signal is our only concern at this time. All that's necessary to obtain this information is: Connect a color generator to the receiver, and check for presence of the color waveform at pin 6 of V17. One check with our scope, and immediately we know if the stage is capable of passing color. Wait now, we don't care what may or may not be causing color to pass or not pass. Our primary objective is stage isolation. Let's look at the other side of the coin—measuring DC voltages.

We still must apply power to the receiver, and use a voltmeter to check voltage. Remember, we'll be checking for signal loss, using a VTVM—which is less than desirable as a signal indicator. Notice we must measure several points, then judge from our readings whether or not the color signal is passing through V17. Grid, cathode, plate, and screen voltages (a total of four checks) must be read before we can assume the stage is functioning, and even these checks may not be conclusive.

If the color signal is properly passing through V17, however, the scope will provide a definite and conclusive indication. Of course, voltage and resistance measurements are necessary once the trouble is isolated to a particular area. The point is: Use the scope first to isolate, the VTVM to pinpoint.

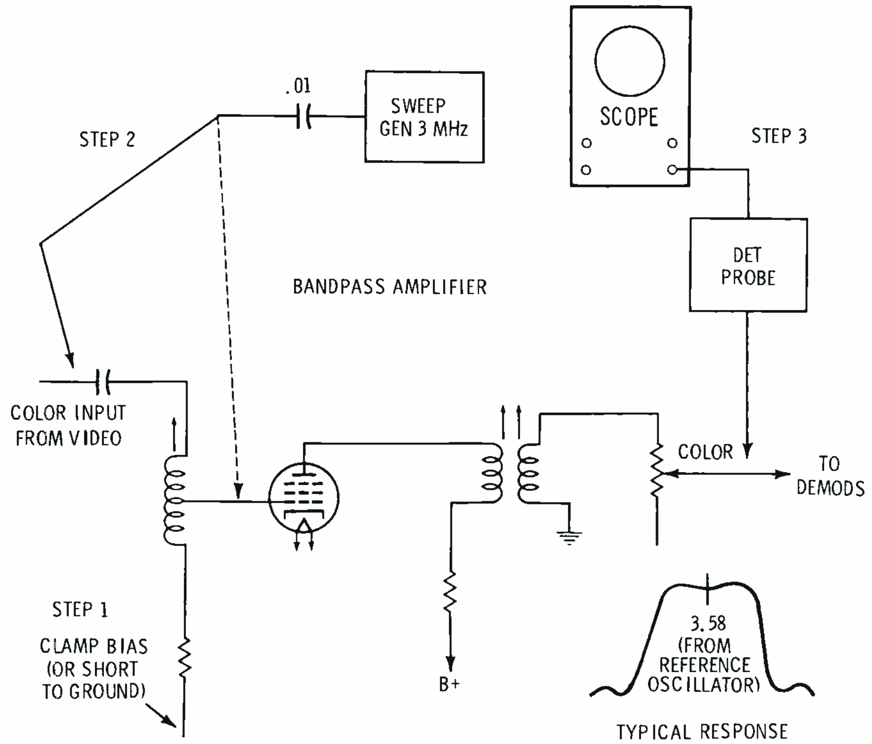


Fig. 2. Checking sweep response.

As previously mentioned, any oscilloscope used for servicing color circuits should have wide-band characteristics—the frequency response of the vertical deflection system should give equal gain to all frequencies up to 5 MHz. Only then will the 3.58-MHz color burst and chroma components receive sufficient gain to be viewed. In addition to signal tracing, the oscilloscope functions as an important tool during alignment of color receivers, as we shall see.

Sweep Alignment Instruments

There is now a wide choice of color alignment gear available. The minimum list of major equipment for color alignment includes a sweep generator, CW (or RF) marker generator, and marker adder—coupled with a good VTVM and a wide-band oscilloscope as indicators. These are the basic instruments for acceptable alignment of the RF, IF, and bandpass stages of a color television receiver. A marker adder is optional, but very convenient when sweep alignment is performed.

Some of the above instruments may be combination types, i.e., both sweep and marker functions in one package, etc. Also, the trend by test equipment manufacturers is to provide additional accessories for alignment gear, to expand the applications and simplify the operation of the basic instruments. Although it's impossible to list all accessories for all instruments, the more common types and their purposes will be discussed presently.

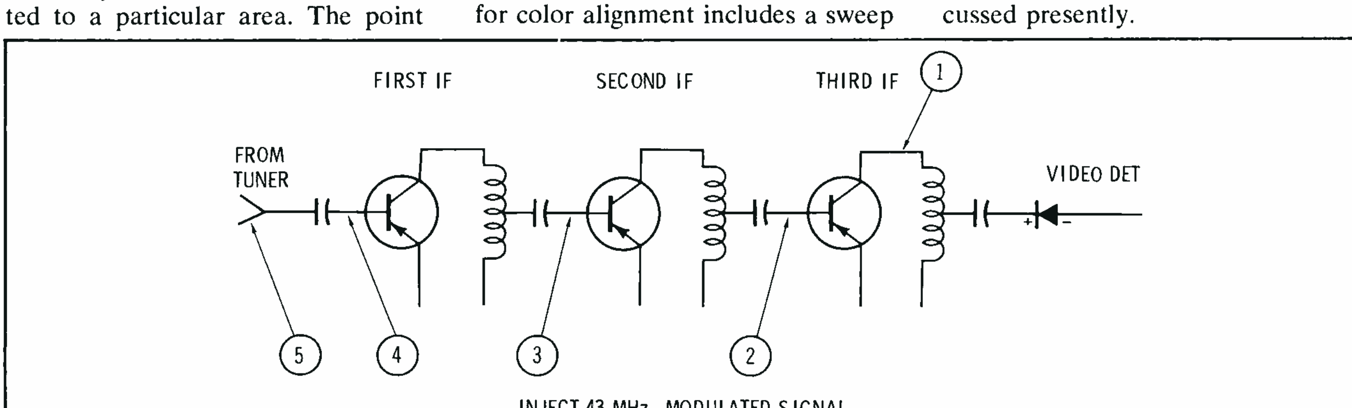


Fig. 3. Signal injection isolates signal loss.

There is also a wide variety of test equipment probes available—some for signal injection and detection, others to extend ranges, etc. When selecting one of these special probes, make sure the probe will match your particular test equipment, and be sure you understand the proper application of the probe.

Alignment gear isn't limited specifically to alignment jobs. As we'll see in the following sections, the sweep and signal generators can be used daily for routine troubleshooting tests.

Sweep Generator

An output in the low video frequency range is a primary requirement of sweep generators for color TV. Color bandpass stages operate in the 3- to 4-MHz area, so the generator must be capable of supplying sweep with a center frequency around 3 MHz. Usually, generators with this feature also supply video sweep frequencies in the 40-MHz range for alignment of video IF stages.

Alignment as a troubleshooting aid is gaining popularity. It's often easier and faster to localize a trouble to a particular stage by performing an alignment check than by relying on conventional troubleshooting procedures. A typical procedure was outlined in a recent article titled "Sweeping Color IF amplifiers" (PF REPORTER, November. 1967). A similar procedure can be used as a preliminary check of bandpass operation when symptoms such as distorted colors, wrong colors, and noisy colors appear—provided your generator has 3-MHz sweep provisions.

A simple three-step procedure is illustrated in Fig. 2. Step 1 is to clamp the killer to open the bandpass stage. Usually, 1 or 2 volts negative will do the trick.

A 3-MHz sweep signal is applied to either test point through a .01-mfd capacitor in Step 2. Step 3 is to connect a detector probe from the scope to the high side of the color control. The typical response illustrated should be present if the stage is operating normally. No external marker source is needed in this quick check, since a "pip" from the receiver's 3.58-MHz reference oscillator will appear (radiated in) at the center of the curve—if alignment is correct. This 3.58 MHz marker at the center is a fairly solid indication that the bandpass is properly aligned.

If two bandpass stages are used, sweep the first, and scope the output of the second, thus checking both stages with one input. Under these conditions, it may be necessary to check service information for bias requirements. The killer may control the second stage and/or one stage may be controlled by ACC circuits, requiring additional bias.

RF Generator

A CW generator used in conjunction with the sweep generator should have provisions for crystal calibration. Accuracy of TV alignment is dependent, in part, on the accuracy of the signal from this instrument.

Marker generators for color servicing must also have outputs in the 40-MHz video frequency range. Some color TV's require peak alignment, and all require trap adjustments—both procedures require pure CW signals from a generator. Among the desirable features found in most modern instruments are provisions for internal and external modulation and special switch-selective outputs at 4.5-MHz sound frequencies. Most types have provisions for insertion of an extra crystal to produce a second marker on the response.

There are many instances where a CW generator can be used for signal injection applications. For example, to locate an interruption in signal path through video IF stages, the generator can be set for 43 MHz with 400- or 600-Hz modulation and coupled via a 1500-pf capacitor to several points in the IF stages. The visible indication on the screen is horizontal black bars. Fig. 3 illustrates this method in a transistor IF system—where stage isolation techniques are needed even more than in tube-type systems. The signal is injected as shown in Steps 1 through 5. Lower the generator output each time the gain from an additional stage is added. Keep the output as low as possible to prevent overloading.

Marker Adder

This unit, sometimes referred to as a "post marker generator," is often considered a luxury. Although not an absolute necessity, it does make sweep alignment easier. When a marker adder is used, the marker signal does not pass through the receiver circuits; instead the marker is added to the response after the sweep signal passes through the circuits under test—thus, the name "post". Usually the marker adder unit becomes a master control center for the sweep and CW generators, controlling output gain and functioning as a scope preamplifier.

The marker adder is gaining in popularity, and more test equipment manufacturers are making them available. Some manufacturers now offer post marker generators with multiple and simultaneous frequency markers, and several points on the response curve can be viewed at one time.

Color Generators

We have noticed in the last few years that color bar-dot-crosshatch generators are producing similar patterns. Some form of color reproducing features are always included along with the general run of patterns necessary for convergence (dots, crosshatch, etc). The choice of color generator is dependent on the customer alone, as many types are available. Compact designs using transistors seem to find wide acceptance, especially battery-operated portable types. These are most useful on home service calls.

As mentioned in our oscilloscope section, the color generator is a necessary part of every technician's color service equipemnt. The color pattern can be used for many checks of receiver operation: To see if the set will reproduce color, to locate faults by signal tracing throughout the color circuits, to align demodulator and color sync stages, and to perform operational checks in the absence of a station signal. It is beyond the scope of this article to cover the many applications of color generators.

Major Accessories

There are a few other units you need to be properly equipped for color service. Some are used separately, while others are used in conjunction with other test equipment.

Video Multimarker

This accessory provides simultaneous absorption-type markers in the low video-frequency range (.5 to 4.5 MHz). The unit is in conjunction with the sweep generator during bandpass alignment and response checks.

RF Modulator

The modulator provides the mixing function, modulating an RF carrier with video sweep frequencies. The resultant signal is used to check the overall response of a color receiver.

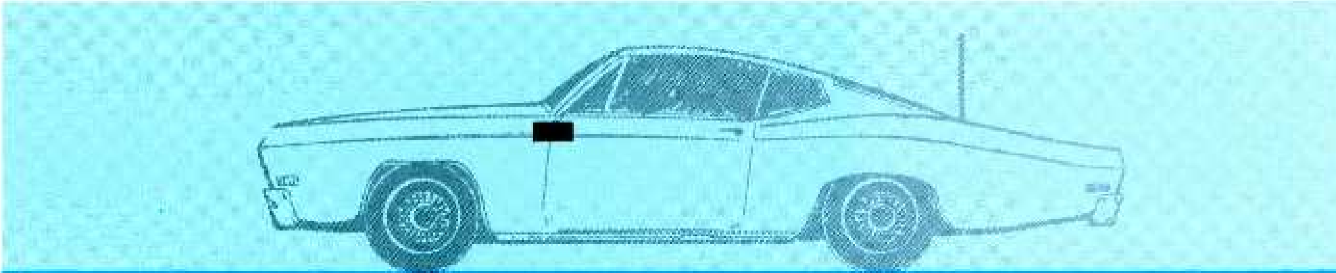
High-Voltage Probe

The recent news regarding radiation from color receivers places more importance on this accessory. The probe actually contains a high-resistance multiplier to extend the voltage range of the VOM or VTVM, permitting direct measurement of high voltage in the 30- to 50-kv range. The important point to remember is to make sure you obtain the correct resistor to match your particular instrument. Several choices are available, and the resistance value is determined by the input impedance of the VOM or VTVM.

Among the new types on the market is a slip-on connector probe to instantly convert from the normal probe to the high-voltage probe, without changing cables. Another new unit is self-contained, having the probe, divider resistor, and meter as integral parts; a separate VOM or VTVM is not needed.

Summary

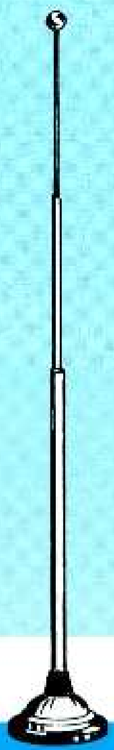
It is impossible to list all of the different types and features available in color test equipment. The scene is changing rapidly with regard to equipment functions, applications, and manufacturing methods. The color receiver is also changing, requiring the use of special equipment for profitable service. If color servicing is a part of your business, you'll want to keep abreast of changes in test equipment—in addition to changes in color circuit engineering. It is wise to frequently review the basic requirements of color test equipment—for easier servicing and more profit. ▲



Solid-state Auto Radio Problems

by Homer L. Davidson

A review of case histories provides practical servicing information.



Solid-state auto radios are easy to repair. With only a handful of test instruments and know-how, one can solve even the most difficult intermittent auto radio problems. If you know how the transistor performs in a circuit, even the loudspeaker symptoms can become most significant.

A VTVM, an RF-audio signal generator, and a transistor tester are the three most valuable instruments for auto radio servicing. Of course a power supply, antenna, and test speaker are also necessary, but are not, strictly speaking, test instruments. An in-circuit transistor tester and a scope are also valuable test instruments, but are not required on every job.

Now, assuming we are properly equipped and trained, let's examine some case histories to see how easily solid-state auto radios can be repaired.

Squealing Ford

When a Ford Model 5TBF was first turned on, there was a constant squealing sound. The squeal was tunable and appeared on either side of a broadcast station. The radio was pulled from the car and hooked up on the bench.

In auto radios incorporating tubes, constant squealing can be caused by a shorted RF, converter, or IF tube, or by improper bypassing of screen and cathode circuits. Poor filtering in the power supply is another possibility. In most solid-state auto radios, the causes of squeal are the same.

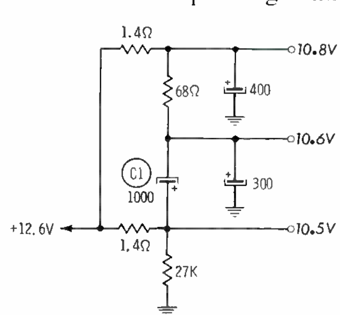


Fig. 1. Open C1 caused squeal.

Starting at the front of the receiver the RF, converter, and IF transistors were checked in the circuit and found to be normal. The next step would have been to check all bypass capacitors, but since they were located under the PC board, the power supply was checked first.

In the solid-state power supply, you will find electrolytic capacitors with extra large capacitance. When shunting a suspected filter capacitor, it is best to use a 1000-mfd unit with attached alligator clips. Be sure to observe polarity, since filters are found with either positive or negative as the common lead (outside terminal).

In this set, the defective part was a 1000-mfd capacitor (C1 in Fig. 1) tied between the 10.6- and 10.5-volt supplies. The 10.6-volt supply feeds the RF, converter, and IF amplifier stages; the 10.5-volt source supplies voltage to the base of the 1st AF amplifier.

Intermittent Old Faithful

This intermittent problem involved a Delco Model 983873. Sometimes, the radio would quit while playing, other times it would never start to play at all. (When pulled in for servicing, all 1963 Model Delco auto radios should be checked for this trouble.)

First, connect the radio to a bench power supply, antenna, and test speaker. Remove the metal cover and look for a red-painted trimmer screw in the converter stage. As a preliminary test, simply press down on top of the red set screw with an insulated tool. If the oscillator trimmer capacitor is defective, the radio will begin to play. (If the radio is operating, pressure on the set screw will cause the volume to either increase or decrease.)

When repairing this condition, it is best to first remove the power transistor cover that covers the back and bottom portion of the radio chassis. This will give better access to the soldered connections of the tuning assembly. Move the power-output heat sink assembly out and away from the radio, leaving all wires connected.

To remove the defective capacitor assembly, take out the three self-tapping screws holding the PC board. Also, remove the three ¼-inch nuts over the tuning assembly. Next, unsolder the six tab connections on the tuning coil assembly. (See Fig. 2.) Use care, to prevent breaking the metal tab coil connections or the corners of the PC board. With a desoldering iron, melt the solder and, at the same time, suck up the molten solder from each connection. These metal connections belong to the tuning assembly, and each has a fine wire going to a tuning coil. Be careful not to bend the metal tabs back too far, as you might break off the small coil wires. If a desoldering iron is not handy, set the auto radio on end with the coil tabs at the bottom. Then melt the solder with a heavy duty iron and remove the excess solder with the iron tip. Use the same method for removing the oscillator trimmer capacitor from the PC board. Be careful not to damage the PC wiring with excessive heat from the soldering iron.

While the PC board is removed from the chassis, check all transistors with an in-circuit transistor tester. It Is much easier to check and replace any defective transistor while the PC board is loose.

Next, check the winding of each tuning coil for continuity with an ohmmeter. In the event you break the leads while unsoldering the coils, repairs are easier while the PC is dismounted. Also, test the power-output transistor before replacing the back cover.

Realign the auto radio using a modulated RF signal generator. This step is always necessary after any parts are changed in tuned circuits. Check the tuning dial for correct settings of local broadcast stations. Touch up the alignment of the two IF transformers. Finally, check the dial light before buttoning up the auto radio.

Vibrating Motorola

No doubt about it, there seemed to be a bad speaker in this Motorola TM 296 M model. With low volume, the auto radio played perfectly; however, on a strong station, vibrations increased. When the volume was increased, the music would cut in and out. But checking with a test speaker proved the speaker was not the trouble after all.

To isolate the trouble to a particular stage of the receiver, the top connection of the volume control was removed, and a separate signal tracing amplifier attached. The music still vibrated, proving the trouble was in the front end of the auto receiver. All RF, converter, and IF transistors were checked in-circuit and found to be good.

Signal tracing the front end of an auto radio can be difficult at times. Each stage in this set was signal-traced, but the defective still was not located. Then each IF stage was checked for poor wiring connections by pushing around on the PC board. Finally, by pushing on each bypass capacitor, the defective one was located. It was C14 (See Fig. 3.) This .047-mfd capacitor bypasses the emitter circuit of the RF amplifiers. The same clear plastic capacitors have been found to be intermittent and leaky in several other solid-state auto radios. Do not overlook them for possible intermittent troubles.

Tough Dog Merk

When this Mercury model 6TMM came into the shop, it had made the rounds. The radio had been in two separate shops for repair—into one shop twice and the other one three times. The radio had just returned from the factory repair depot for another try but was still intermittent.

The customer complained of stations slowly fading out. The broadcast stations would start to fade at the top of the dial, and they would slowly go, one by one, on down the dial. This clue pointed to the converter stage.

Not only had the converter transistor been replaced, but both IF transistors were also brand new. The new converter transistor was removed and another new one was installed just to be sure. The radio played perfectly until the shop was locked up for the evening.

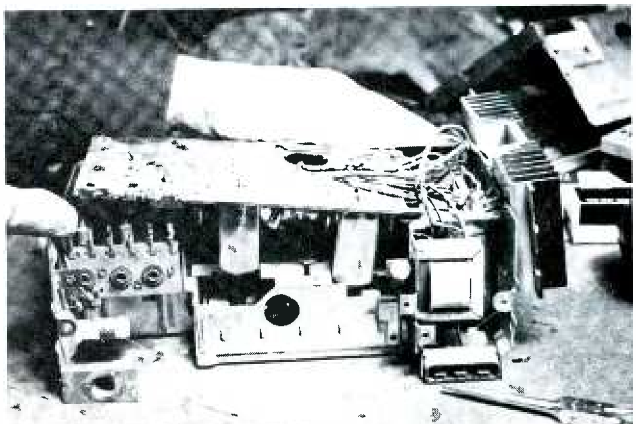


Fig. 2. Six metal tabs hold tuning unit in place.

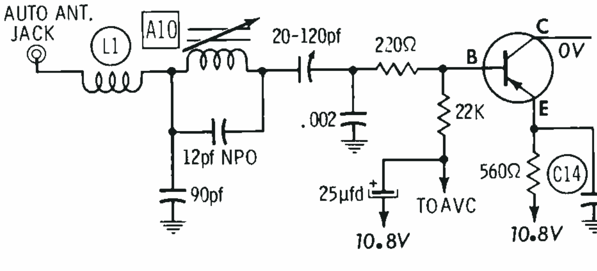
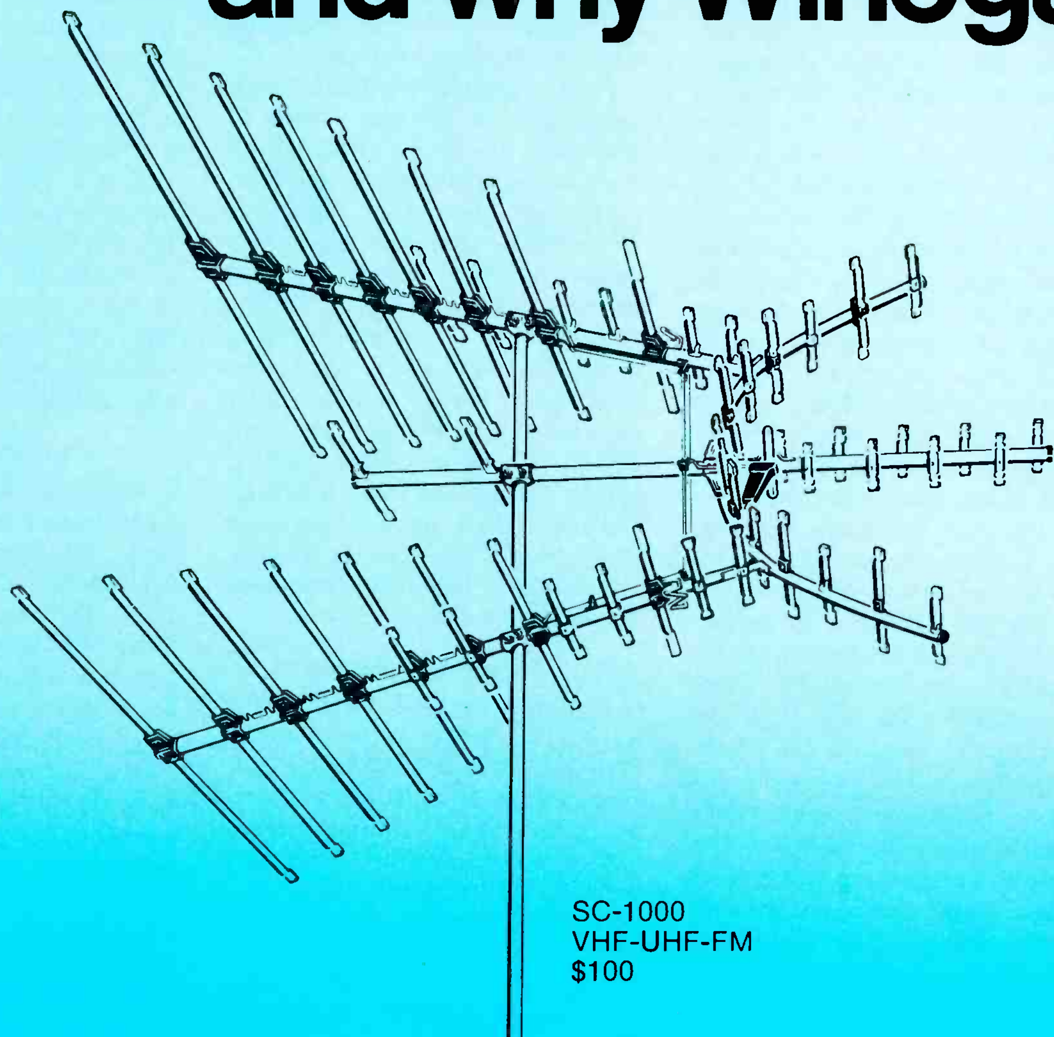


Fig. 3. Defective C14 caused misleading symptoms.

The new SC-1000 versus and why Winegard



When we created the $100 super powerful, super fringe Super Colortron SC-1000, we figured it would be a long time (if ever) before anybody could design an 82-channel VHF-UHF-FM antenna anything like it.

And we still figure it that way.

But what we have done is create a VHF-FM antenna that's just as revolutionary. And just as profitable.

The $100 SC-2000, with higher gain than any other VHF-FM antenna on the market.

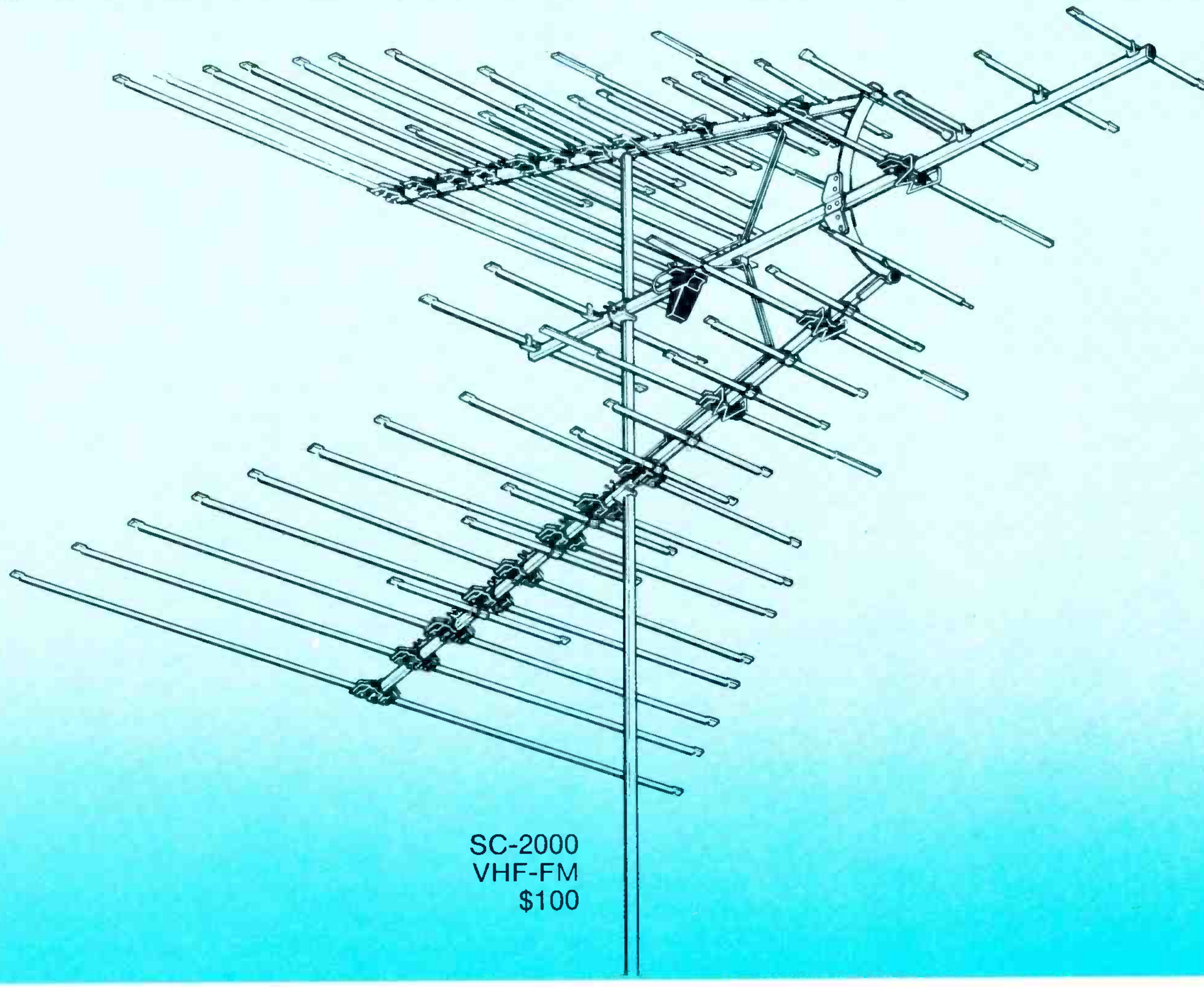
The SC-1000 and SC-2000 have a lot of features in common, including their price. And uncommon to any other antennas, anywhere. At any price.

And since they're meant to complement, not compete with each other. Winegard dealers can't lose, can you?

Get all the facts.

Call your Winegard distributor today. And write for Fact-Finder #261.

the newer SC-2000, dealers can't lose.



EXCLUSIVE SC-2000 ELECTRONIC AND CONSTRUCTION FEATURES

Exclusive New Compact "Wedge" Design...Plus New Vertical Beam Phasing On Each VHF Channel: Vertical Beam Phasing on all VHF channels means there is no signal pickup from above or below the antenna. It means interference from such sources as airplanes, cars and diathermy machines are shut out. And it means that ghost signals are highly rejected. And that's not all. The VHF capture area is doubled and power gain over a conventional single bay is doubled. The vertical beam is flattened and elongated and spurious vertical lobes are eliminated. All that, and the SC-2000, with its unique "Wedge" design, is still vastly shorter and more mechanically stable than any other configurations would have to be to come close to the gain of the SC-2000.

Exclusive Patented* VHF Director System: Absorbs VHF signal and focuses it onto the collector elements. Helps give the SC-2000 pinpoint directivity to knock-out ghosts, smear and snow. *U.S. Patent No. 2700105, Canada No. 511984.

Long Distance FM & FM Stereo Reception Bonus: Comparable to the results you get with a 10 element FM yagi.

Exclusive "Impedance Correlators": Provide perfect 300 ohm VHF impedance match and produce more signal gathering power per inch of antenna—and also contribute to making the SC-2000 extremely compact.

Exclusive Built-In Cartridge Housing: Integral part of the antenna keeps downlead connection weathertight. Accepts Winegard's solid state cartridge preamplifiers, color spectrum filter, etc. A truly great Winegard innovation.

Exclusive Ellipsoidal Boom: Strongest boom ever used on a TV antenna. All elements of antenna are special aluminum alloy 40% stronger than used on most antennas.

Genuine Gold Anodized Finish: The only permanent gold finish on any antenna. Sunfast. Protects against corrosion and fading. Lasts years longer.

. . . plus Gold Anodized finish; exclusive High Tensile Aluminum Elements; exclusive Wrap-Around Insulators; exclusive Wrap-Around Mast Clamp; exclusive Winegard Gold Bond Performance Guarantee and new 2-Year Replacement Warranty.

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Early the next morning, the radio played normally during the local news, but within two hours the radio cut off (this station was located at 1400 kHz on the dial). Slowly a broadcast station at 1050 kHz faded away. After a few minutes, a local station at 540 kHz also left the scene.

One thing for certain, something was changing in the oscillator circuit. Cutting out of stations at either the high or low end of the radio dial can nearly always be traced to the converter transistor. But this transistor was a new one.

A modulated 262-kHz IF signal was injected at the collector terminal of the converter transistor. The modulated tone could be heard from the speaker. When the same signal was connected to the base circuit, the radio popped on. Stations could be tuned in over the complete broadcast band.

The condition of the PC board indicated that several technicians had attempted repair. All wiring connections were checked and touched up. Prodding and prying around on the board, and also on the oscillator trimmer capacitor, turned up nothing fruitful.

From previous experience, I knew the trouble was either in the base or emitter circuit of the converter transistor. The radio was left to play for several hours until the stations started to fade out. Then each resistor and capacitor in the oscillator circuit was pushed. Results were finally obtained by placing the hot tip of a soldering gun to the bypass capacitors. C10, a .005-mfd bypass capacitor in the emitter circuit of the converter, was the defective one. See Fig. 5.

The clear plastic-coated capacitor was removed and checked with a capacitor tester. When cold, the capacitor showed no leakage or change in capacitance, but with the hot tip of the soldering iron near one end, the capacitor would slowly open. The capacitor was replaced and the radio returned to normal operation.

Noisy Bendix

A Bendix 5BV model came in with a combination of double symptom of intermittent and noisy reception. The owner said that sometimes this radio would play for weeks without acting up, but when it did act up, it was so noisy you could not bear to listen to it.

The radio was pulled and hooked up to the bench power supply. When we turned it on, a rushing noise drowned out even strong local stations. To isolate the noise symptom, the top of the volume control terminal was grounded. Both the noise and the station disappeared, so the defective component that produced the noise appeared to be in the RF or IF sections of the radio.

A quick in-circuit check of the transistors was made, and they appeared normal. To isolate the circuit further, the second IF transistor was removed from the circuit. The noise disappeared. So the trouble was localized to the RF, converter, first IF stage, or possibly the second IF stage. Replacing the second IF transistor restored the noise.

When the converter transistor was removed, the noise was still there, indicating the trouble was likely in the first IF transistor stage. The transistor was replaced, but this did not remedy the noise situation. Then, all of a sudden, the auto radio began to play. The radio was left to cook on the bench.

After several days of operation, the noise appeared once again. A circuit-cooler spray pinpointed the trouble to the first IF transformer. The transformer was dismantled, and we found that the center terminal lug (going to the first IF collector) was actually touching the metal transformer shield. Simply bending the terminal inward and wrapping plastic tape around the soldered connections cured the trouble.

Dead-Distorted Ford

When a 262-KHz IF signal was injected at the collector pin of the second IF transistor in this Ford Model 5TMF, the signal was loud and clear. However, placing a signal on the base element resulted in a weak output. The second IF transistor was checked with an in-circuit checker and found to be open.

Sometimes the replacement of a transistor soldered to a PC board is made easier by leaving intact ¼" of the wire leads of the old transistor. Just remove the excessive lead length from the new transistor and form a small loop in each lead. Slip the loops over the lead stubs of the old transistor and solder them in place. Of course, if it is possible, the new transistor should be soldered directly in place of the defective one.

Before reinstalling this particular auto radio, it is wise to check the converter and IF transistors; more than one transistor has been known to give trouble in this model. However, in the case being discussed, after the second IF transistor was replaced, the strong local broadcast stations appeared distorted. I checked the AVC limit diode, and sure enough, it was open.

Fading Motorola

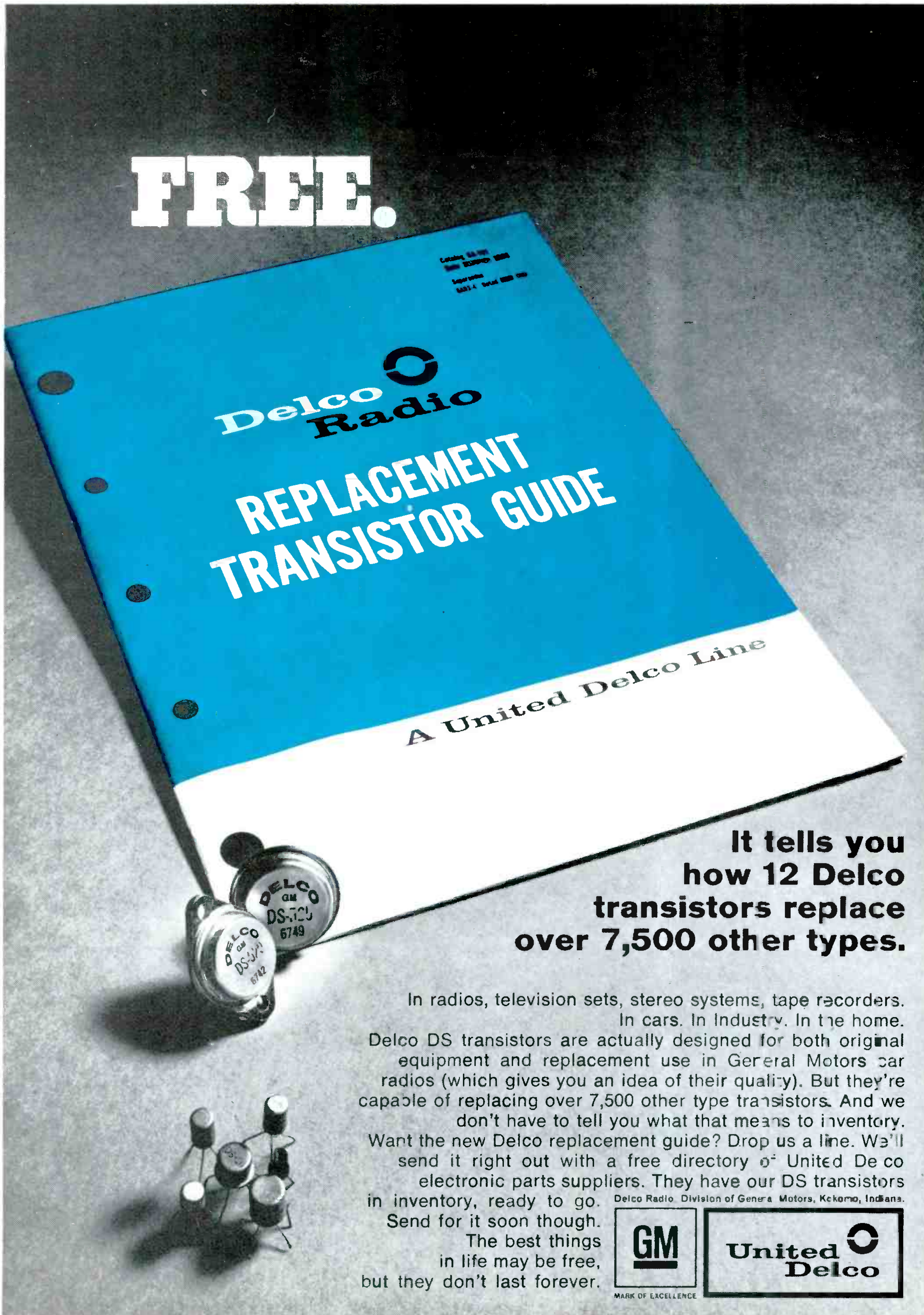
A Motorola Model GV800 came in with intermittent weak reception. This auto radio would start out normal, become weak, and then very weak across the entire broadcast band.

A 100-HZ audio signal was injected at the base of the audio output stage. Since the signal heard in the speaker indicated that the output stage was operating, the same signal was applied to the base of the audio driver stage, and again the signal came through loud and clear. But when the signal was applied to the collector terminal of the 1st AF stage, there was a great loss in signal.

Voltage and resistance measurements were made of the AF amplifier, and the readings matched those found in the service data. When a 25-mfd electrolytic capacitor was shunted across the coupling capacitor (C5 in Fig. 4), volume was restored. C5 had dried out and was intermittently opening. It is wise to check all electrolytics in radios that have been used several years.

Low, Low Volume

In this 1960 Chevy Model 988295, the complaint was very low volume. When the on-off switch was



Circle 12 on literature card

rapidly snapped off and on, there was no thumping indication in the speaker; indicating a possible defective audio output transistor.

After the power-output transistor was removed and checked, it was found open. Before replacing it with a new output transistor, silicone grease was applied to the wafer insulator and collector metal flange, as shown in Fig. 5. Whenever a power transistor tests open or shorted, check the bias and emitter resistors. Many times they will be burned and changed in value. This will cause improper bias and will probably destroy the new transistor in a short time.

Dead Rambler

A Rambler Model 5TMR was dead. An audio signal was applied to the middle terminal of the volume control, with no results. Next, the audio signal was injected at the collector terminal of the driver stage (Fig. 6), and plenty of volume was obtained. When the signal was injected at the base terminal of Q4, the receiver also appeared dead.

An in-circuit transistor tester was used to check Q4. High leakage was indicated by the tester, so the transistor was removed. When checked out of the circuit, the transistor tested okay. Returning to the driver circuit with an ohmmeter, a direct short from base to ground was discovered. Capacitor C24 was shorted, causing the in-circuit transistor tester to give an erroneous reading.

Intermittent Chevy

A Delco Model 986544 came into the shop with intermittent reception. The volume control appeared noisy and was replaced, hoping this would cure the intermittent condition. After two hours of operation, the intermittent conditions reappeared.

Fig. 5. Always apply silicone grease when replacing power transistors

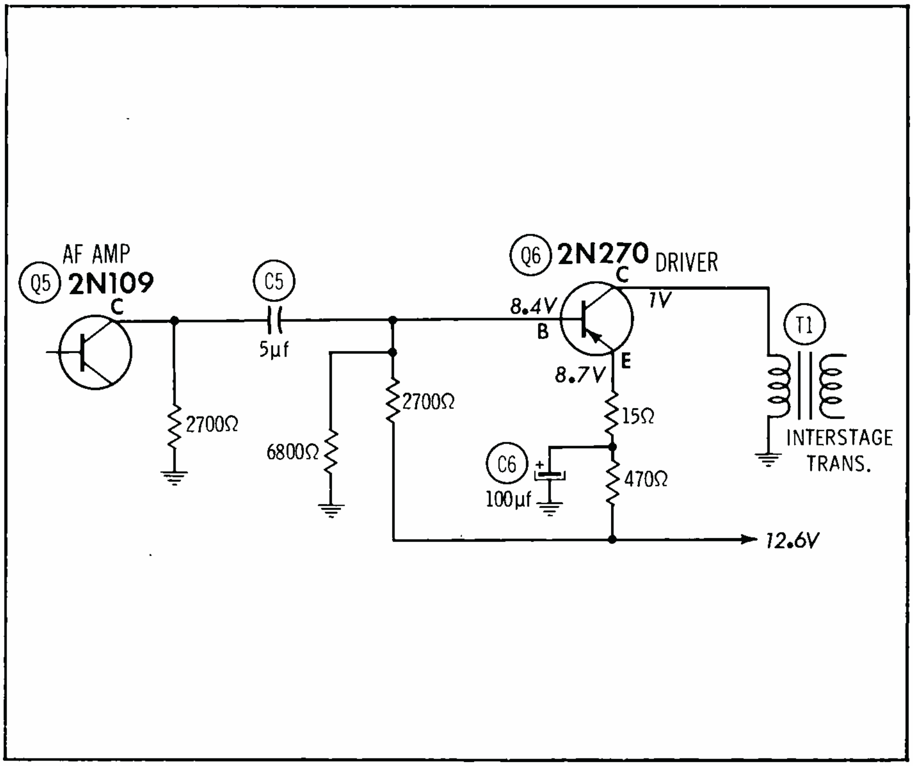


Fig. 4. Dried-out coupling capacitor caused fading.

When any portion of the 1st or 2nd AF transistor circuit was touched, the volume would vary. Both transistors were replaced, but the problem still existed. The PC board was checked for broken or poor solder connections.

When the volume of the radio decreased, a small hum and poor selectivity was noted. Prodding and pulling of wires traced the intermittent condition to a loose terminal on a power supply filter capacitor. The broken connection was inside the filter can, so replacement of the whole filter pack was necessary.

Conclusion

After repairs, and before buttoning up the solid-state auto radio, check the pilot light. Remove the front dial assembly cover and wash out any accumulated dirt and grease. Be sure to tune all push buttons to local broadcast stations. When installing the auto radio back in the car, check for possible loose wires. Also, check the antenna and adjust the antenna trimmer capacitor for maximum signal at the frequency suggested by the manufacturer (1000 KHz or 1400 KHz). ▲

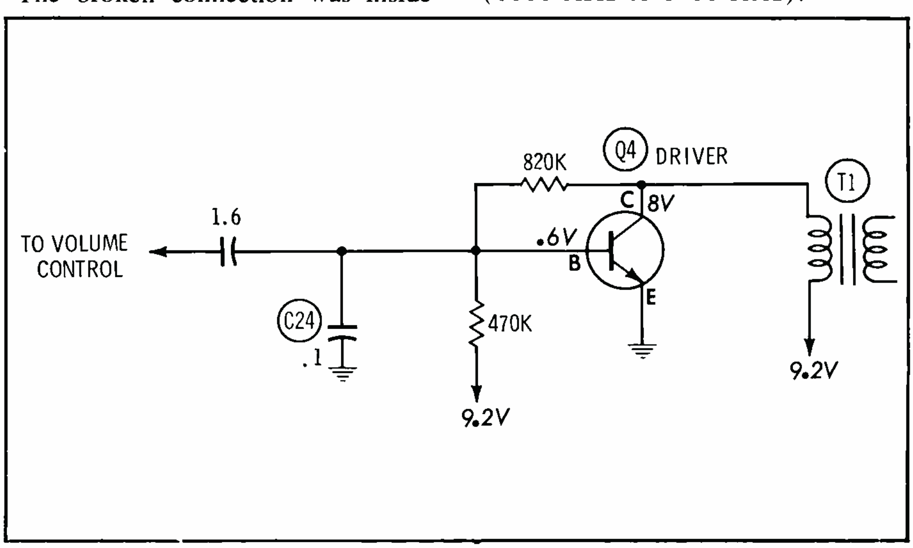
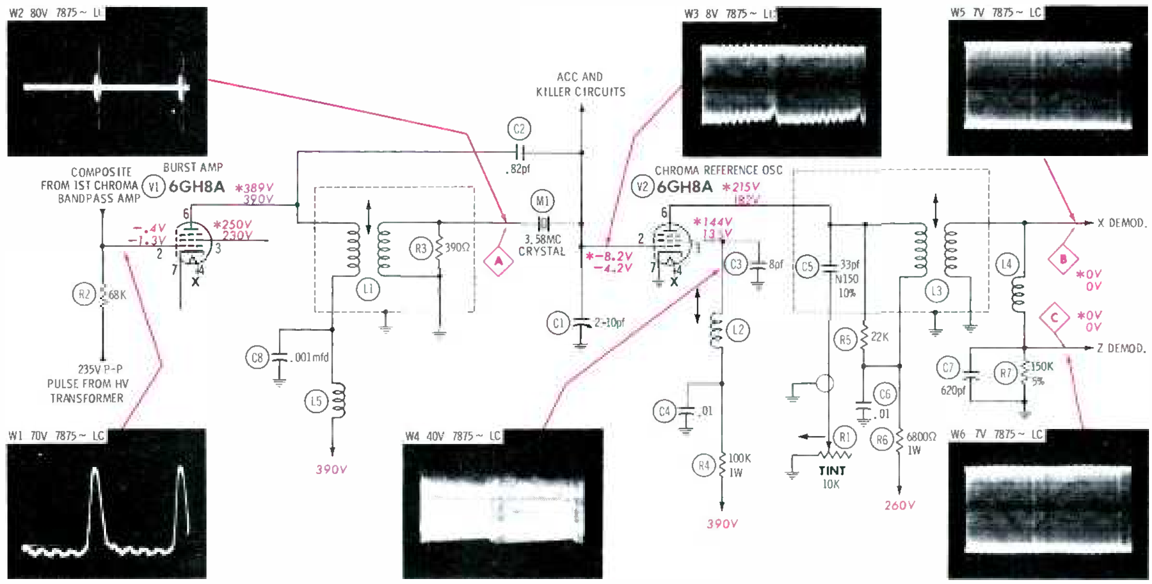


Fig. 6. Shorted C24 caused completely dead radio.

PF REPORTER Symfact®

Reference Oscillator

Injection—Locked



DC VOLTAGES **taken with VTVM—no color signal input. *Indicates voltage taken with color-bar input —see "Operating Variations".**

WAVEFORMS **taken with wide-band scope; TV controls set to product normal color-bar pattern. LC (low-cap) probe used to obtain all waveforms.**

Normal Operation

Function of chroma reference oscillator is to supply a CW signal of sufficient amplitude to chroma demodulators that is exactly same frequency (3.58 MHz) and phase as signal used for color modulator at broadcast station. Burst signal (sample of station modulation signal) is used for synchronization. Reaction-type oscillator control compares output phase with burst phase and develops proper control voltage. Injection-locked type oscillator is controlled directly with burst signal. Burst is removed from composite chroma signal and amplified in usual manner by burst amplifier stage (V1), then coupled through L1 to one side of 3.58-MHz crystal. Other side of crystal is connected to grid of tuned-grid, tuned-plate, electron-coupled oscillator (V2). Oscillator frequency is determined by crystal in conjunction with trimmer capacitor C1 shunted across it. In absence of burst signal, oscillator runs at reference frequency, but at random phase. Burst injected into tuned grid forces oscillator into burst phase. Oscillator is stable enough to hold phase through one horizontal trace. Phase is then corrected again—15,750 times per second. L2, in screen grid circuit of V2, controls amplitude of CW signal but has little effect on oscillator frequency. Adjustment of this coil sets the DC potential at the oscillator grid. DC level at this point is critical since it is reference voltage for ACC and killer circuits. Tint control R1, in plate circuit, changes CW phase for desired hues. 3.58-MHz CW signal is coupled through L3 directly to X demodulator—to Z demodulator through phase-shift network.

Operating Variations

V2 DC voltage at oscillator grid is critical—not to operation of oscillator, but to establish reference for ACC/killer circuitry. (Use 470K resistor in series with VTVM test lead for isolation—otherwise readings will be wrong since even small capacitance at this point changes oscillator frequency.) Refer to PHOTOFACT or manufacturer's information for complete alignment. Briefly: connect color-bar generator; turn killer control full counterclockwise; disable burst by connecting 22K resistor between pin 7 of V1 and 260-volt source; connect VTVM through 470K resistor to grid of V2 and adjust L1 for minimum; with tint control at midrange, adjust C1 for "zero beat" of the color patterns; adjust L2 for −3.5 volts at the grid; remove 22K resistor and readjust killer control. Grid reads approximately −4.2V without signal (due to noise coupled through burst amplifier). "With signal" voltage varies from about −6V (very weak signal) to near −8.5V (very strong signal). Plate and screen grid rise with signal input—plate from 180 to 215V, screen grid from 135V to 144V.

Waveforms W1 amplitude is constant with or without signal since waveform is mostly horizontal keying pulse. ACC maintains burst (W2) near 80V p-p with signal input and, in turn, W3 and W4 are constant. W5 and W6 content is same with or without signal since oscillator runs all the time phase locked with burst, and amplitudes varied by tint control from 5 to 10 volts p-p.

SYMPTOM 1

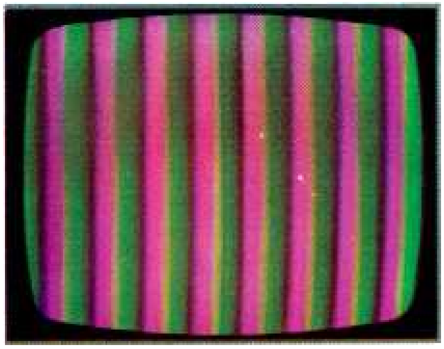
No Color

Incorrect Color

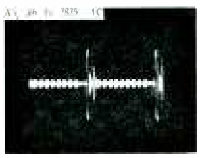
M1 Open

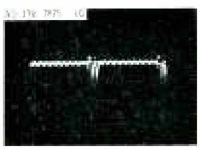
(3.58-MHz Crystal)

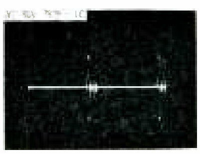
Symptom Analysis



Symptom may start as intermittent color—normal at times—none other times—color finally lost. Misadjusting killer brings incorrect color—flesh tones and all colors are purple to red according to tint control setting. Also, confetti off channel and on b-w.



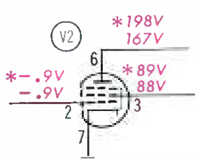




Waveform Analysis

W5 and W6 are same—both wrong—only 3V p-p "bursts" of information at horizontal rate. W4 (not shown) is similar to W5 and W6. W3 (V2 grid) shows only negative-going pulses of about 13V p-p at horizontal rate—normally CW signal. W2, burst input to oscillator, is near normal—amplitude and frequency are correct. Waveform indicates reference oscillator is not running—only coupling burst through stage to demodulators.

Voltage and Component Analysis



DC voltages also indicate oscillator is not running with or without chroma input—normally runs all the time, but at random phase with no burst input. Frequency of oscillator is set by crystal (M1) with trimmer (C1) across it—open M1 kills oscillator. Since killer operation is keyed to reference oscillator grid voltage, demodulators are cut off unless killer control is misadjusted. In this case, portion of burst is coupled through C2 to V2 circuitry, then to demodulators, producing wrong color if killer is misadjusted.

Best Bet: Scope, then component substitution.

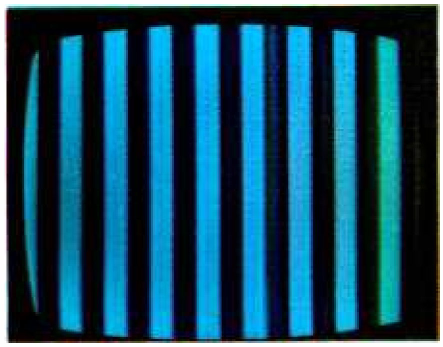
SYMPTOM 2

Weak Color

Color Sync Unstable

R4 Increased In Value

(V2 Screen Voltage Divider—100K, 1W)

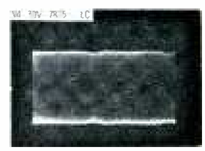


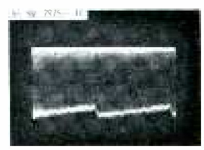
Symptom Analysis

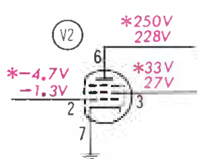
First symptom may be loss of color on weak stations—killer adjustment returns weak but unstable color requiring constant tint-control adjustment. Bar pattern is correct but weak. Level control acts more like tint control—hue changes as control is advanced.

Waveform Analysis

Comparision of chroma signal inputs and 3.58-MHz CW to demodulators isolates trouble to reference oscillator—chroma signal (not shown) is excessive (25V p-p, normally 5-10V) while CW amplitude is poor (1V p-p, normally 7V). W4 and W3 are near normal with chroma input, but only noise without. Content of waveforms normally similar with or without signal. Waveforms indicate weak CW to demodulators with chroma input.







Voltage and Component Analysis

Reference oscillator plate (V2 screen grid) voltage is only about 25% of normal with or without chroma signal. Grid reflects this low reading—"with-signal" potential (−4.7V) is near normal "no-signal" level—barely enough to cause killer conduction. ACC "sees" weak signal—overamplifies chroma. Killer turns off demodulators if grid voltage drops much more. Burst input sustains oscillator action, and proper phase maintained even with reduced screen grid voltage, but amplification of CW signal to demodulators is reduced.

Best Bet: Scope isolates to stage; VTVM pinpoints.

SYMPTOM 3

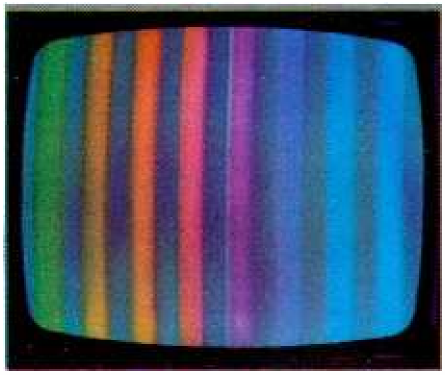
Color With No Sync

No Color

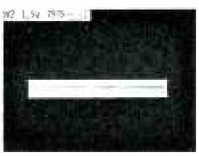
L1 Open

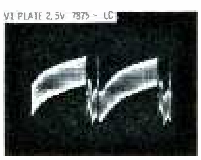
(Burst Tansformer—Primary)

Symptom Analysis



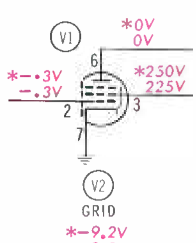
Symptom may be weak, out-of-sync color or no color on known color programs. Bar pattern same—may be no color—but out-of-sync color bars (bars correct but not locked in proper positions) can be obtained by adjusting C1.





Waveform Analysis

W2, burst amplifier output, good indication of trouble—no burst information, normally 80V p-p here. Burst signal missing at V1 plate (normally about 130V p-p). Normally, amplitude of waveforms similar with or without chroma signal. With no chroma signal, input waveform consists of noise bursts. Third waveform is tip of keying pulse (W1) expanded with scope controls to show burst signal. Analysis indicates burst is lost in burst amplifier.



Voltage and Component Analysis

Obvious voltage clue is complete loss of B+ at V1 plate—results in no burst at input of reference oscillator to lock phase. Oscillator grid circuit is upset—maintains strong chroma signal potential all the time—ACC "sees" this as strong signal—chroma input to demodulators is limited causing weak color. Reference oscillator may or may not run with no input to oscillator grid. C1 adjustment causes oscillator to run near proper phase, but is constantly changing without locking phase of burst signal.

Best Bet: Scope to isolate, VTVM to confirm.

SYMPTOM 4

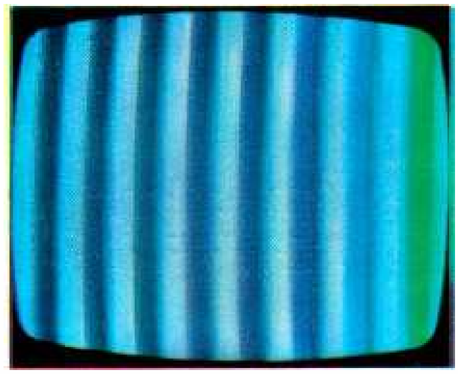
Color Weak

B-W Can Be Affected

R6 Increased In Value

(V2 Plate—6800 ohms, 1W)

Symptom Analysis

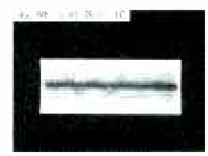


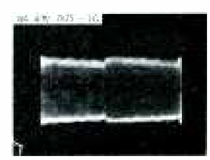
Symptom Analysis

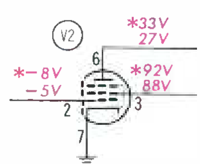
Colors correct but quite weak, even with color-level control at maximum. Little difference between local and fringe stations. Tint control operates. Color in b-w, and "confetti" off channel at times. Color-bar pattern shows same trouble—correct but weak color.

Waveform Analysis

W5 and W6 at CW input to demodulators show obvious reason for weak color—amplitude is very low (1.5 volts p-p, normally 7V). Although not shown in "Normal Operation", waveform at V2 plate normally about 80 volts p-p, now only 17V p-p. W4 (oscillator plate) at 40 volts p-p and W3 (oscillator grid) at 8 volts p-p are near normal amplitude. Waveform analysis indicates 3.58-MHz CW signal to demodulators is reduced in V2 plate circuit.







Voltage and Component Analysis

Best voltage clue is at V2 plate, only 33 volts compared to normal "with-signal" reading of 215 volts—screen also low (92V, normally 144V) due to limited tube conduction. Grid voltage affected—"with signal" near normal, but "no-signal" reading may not drop enough for killer action—causing color in b-w picture. Phase-locked 3.58-MHz signal is electron-coupled from screen grid to plate, then through phase transformer L3 to demodulators. Now phase is maintained, but V2 amplification not sufficient for proper demodulator action.

Best Bet: Scope first; then VTVM.

Symptom 5

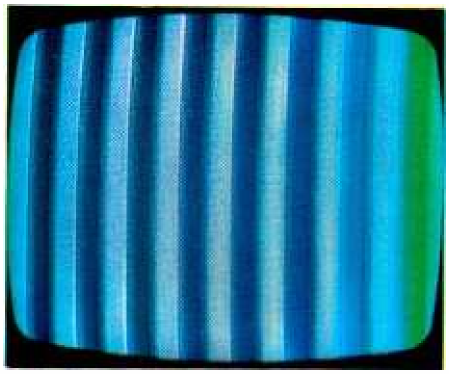
No Color

Overloaded Color

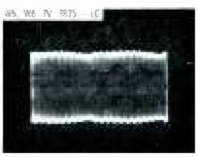
C4 Open

(Bypass Capacitor—.01 mfd)

Symptom Analysis



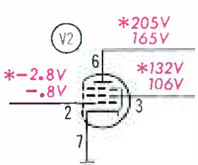
First symptom is no color on color programs—b-w normal. Adjusting killer control produces color, but overloaded even with color-level control near minimum. "Confetti" off channel, and random color on b-w programs. Similar symptoms with generator pattern.



Waveform Analysis

W5 and W6 amplitude normal 7 volts p-p—phase cannot be checked, but pattern indicates it is normal since bars are in correct order and tint control operates when killer control is misadjusted. Amplitude of W4 is good when entire waveform is measured, but about 75% of waveform is "noise" (doesn't show in photo). Content indicates trouble is in screen circuit. Waveform at junction of C4-R4 is similar to W4—normally only DC here.

Voltage and Component Analysis



V2 plate and screen voltages slightly low with signal, even lower without signal, but not good indication of trouble. Signal grid voltage shows reason for overloaded color with killer misadjusted—"with-signal" reading only −2.8 volts, even lower than normal "no-signal" potential. ACC "sees" this as weak signal and causes overamplification in 1st bandpass stage, resulting in overloaded color when killer control is misadjusted. Open C4 lowers reference oscillator action—changing operating potential at grid.

Best Bet: Scope and circuit analysis will solve.

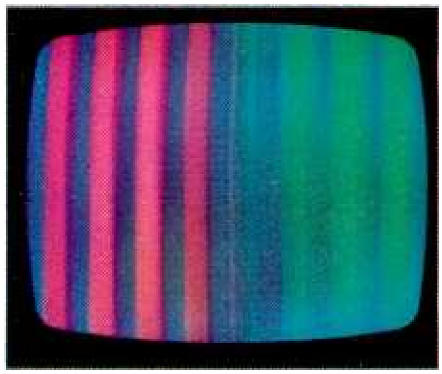
Symptom 6

Blue Lost

Green Weak

L4 Open

(Phase Shift Network)

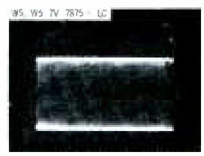


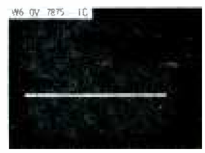
Symptom Analysis

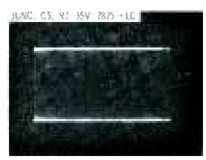
Flesh tones only different shades of red when tint control adjusted. Red is predominate in color picture—some green, no blues. Generator pattern shows correct reds, rest of pattern mostly green. Tint control changes position of red bars. Level control operates.

Waveform Analysis

Comparing W5 and W6 (3.58-MHz input to demodulators) isolates trouble—W5 (X input) is good (9V p-p normally 7V)—W6 (Z input) is nonexistent. Demodulators require two signals to operate: chroma information and 3.58-MHz CW of proper phase. Third waveform shows CW signal at center arm of tint control. R1-C5 network changes CW phase slightly to obtain desired hues. Amplitude varies from 0 to 70 volts p-p according to tint-control.







NO VOLTAGE CLUES

Voltage and Component Analysis

All DC voltages are near normal and offer no good clues. CW signal is coupled through RC network (not shown) to demodulator grids—approximately −1V normally developed at Z demodulator—now missing. Reference oscillator output (W5) is coupled directly to X demodulator where R-Y is recovered. and through phase shift network to Z demodulator where B-Y is recovered. G-Y developed in difference amplifier stage. Loss of CW to one demodulator causes loss of one primary color and partial loss of G-Y signal.

Best Bet: Scope will locate.

Impedence Matching and Power Distribution in PA Systems

by Louis M. Dezettel

An understanding of the facts presented in this article will help you design an effective public address system.

The output stage of an audio amplifier may be considered a generator, since it generates power and delivers it to a load. The rated power output of an amplifier is the maximum power it will deliver into a specific load without exceeding a certain percentage of distortion. The net impedance of a combination of speakers connected to the output of a public address amplifier must (or should) reflect that specified load. To make things easy, amplifiers have a number of taps on the output, such as 4, 8, 16, 250 and 500 ohms, and 25 and 70 volts. Some amplifiers have all of these taps, others have a combination of them. The values above are more or less standard in the industry.

In a public address installation, a number of speakers are located in various spots to provide coverage of selected areas in a plant or office, or uniform coverage as in an auditorium. In the case of a plant or office, the installation must accomplish two objectives: it must reflect the proper net load to the amplifier and supply the acoustic power needed to cover the particular area. Elementary arithmetic is all that is needed to accomplish both objectives. In the case of amplifiers with 25- and 70-volt outputs, it is simple addition, although amplifiers with impedance output taps require slightly more complex calculations.

Impedance Mismatch

The maximum power output of a vacuum tube is developed when the load impedance is equal to the internal impedance of the output tubes. However, a load equal to the internal impedance would result in considerable distortion, so engineering design effects a compromise for maximum power with reasonable low distortion. When working with transistor power ampliers, engineers must also consider maximum current and power dissipation in the output transistors. The resulting load impedance is usually an odd value, varying with the different tube or transistor parameters. The load also carries the DC collector or plate current; therefore, a transformer is used, both to keep the DC out of the speaker lines and to provide standard impedance values.

Increasing the load (reducing the load impedance value) might actually increase the output power a little, but at the cost of a big increase in distortion. Decreasing the load (increasing the load impedance value) cannot increase the actual power output, but does increase the distortion. Therefore, best results are obtained when the amplifier is loaded with the proper value. If the total rated power is not needed, it is best to decrease the input to the amplifier by reducing the gain control setting.

It is true that inverse feedback in the amplifier helps reduce distortion caused by impedance mismatch. That is to say, a slightly mismatched amplifier with inverse feedback has only a moderate increase in distortion (usually well within the acceptable practice levels). In fact, this is the basis of the so-called "constant voltage" outputs claimed for many amplifiers.

Some intercom/distribution systems accept speaker mismatching as a way of life. Many school intercom systems are designed for a low-impedance (3-ohm) load, yet use 45-ohm speakers. For example, when the "all-call" switch is thrown in a 15-speaker system, the fifteen 45-ohm speakers in parallel reflect a load of 3 ohms, and maximum power is produced by the amplifier. When only one or a few speakers are in the circuit, the amplifier is lightly loaded, but since very little power is needed for the one (or few) speakers, no attempt is made to assure an impedance match. The distortion produced may even add harmonic resonance and flatter the voice of the user.

Output Transformers

The output transformer can make a 500-ohm speaker line look like a 5000-ohm load to a vacuum tube amplifier. The impedance ratio between the primary and secondary of the transformer is the square of the turns ratio. Therefore, if the impedance ratio is 10 to 1, the turns ratio is the square root of 10 to 1 —about 3.16 to 1. It is important to know this when we work on speaker impedance combinations. Here is how it works:

First, assume that there are no losses in a transformer (there are actually very small losses), so the input power is the same as the output power. The primary-to-secondary turns ratio is the same as the primary-to-secondary voltage ratio. Now, if the secondary has one-half the turns of the primary, the output voltage will be one-half the input voltage. To obtain the same power, the secondary must develop twice the current of the primary ($P=EI$). To draw twice the current at half the voltage requires a load resistance of one-fourth that of the primary. Fig. 1 shows an example with 100 VAC across the primary of a transformer. It is a 2:1 stepdown transformer, so 50 volts appears across the secondary, two amperes of current will flow, and the power developed is 100 watts. With equal power in the primary, the current will be one ampere (at 100 volts), and the impedance will look like 100 ohms. Therefore, a 2:1 turns ratio looks like a 4:1 impedance ratio. It is well to keep in mind that the impedance ratio of a tranformer is equal to the square of the voltage ratio or turns ratio.

70-Volt Lines

The 70-volt line was devised to provide a convenient way of making a multiple speaker installation in which sound power may be distributed at various levels to various areas. Matching the amplifier impedance requires only simple addition. It is a fairly high-impedance line, so line losses are low. Transformers are required at each speaker, and the taps are marked in watts rather than impedance. The tap may be set for a different power level at each speaker. All that is necessary for a good impedance match is that the sum of all the speaker taps (in watts) equal the power rating of the amplifier. An impedance match is thus made automatically.

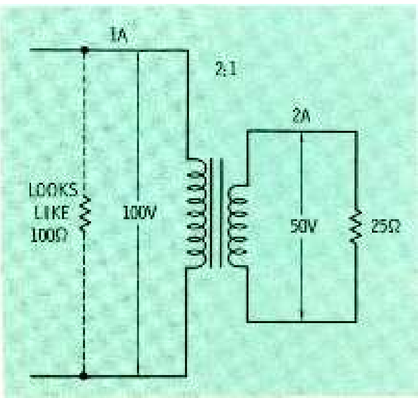


Fig. 1. A 2:1 voltage ratio equals a 4:1 impedance ratio.

For example: A 50-watt amplifier is used for paging in two production areas and one storage area in a plant. We want the production areas to each have twice as much sound as the storage area. By setting the taps at 20 watts for each production area and 10 watts for the storage area, we have the sound coverage we want. Since the total of all taps is 50, the amplifier is matched properly (Fig. 2).

This method will work for any number of speakers, even with powers down to a fraction of a watt. Speaker matching transformers come in various sizes, so if you know the power to an area is to be small, you can buy smaller, less expensive transformers and speakers for that area.

You can mix transformers marked in impedance with transformers marked in watts, in the event you have a stock of the former. To do so, it is helpful to understand the theory of the 70-volt line.

Evolution of 70-Volt Lines

Ohm's Law says $P=E^2 \div R$. Resistance and impedance may be used interchangeably in amplifier output consideration. The 70 used for amplifiers is really 70.7, which is the square root of 5000. This figure was chosen as a standard, merely because it allows fairly simple calculations. With 70 as a reference, the formula for Ohm's Law given above becomes:

$$P=\frac{70.7^2}{R}$$

$$P=\frac{5000}{R}$$

Therefore, on a 50-watt amplifier, the 70-volt tap is equal to an output impedance of 100 ohms:

$$R \text{ or } Z=\frac{5000}{50}$$

$$=100$$

Obviously, the 70-volt tap is a different impedance for amplifiers of different power ratings.

On speaker transformers, the mathematics are the same: A 10-watt tap is equivalent to 500 ohms ($5000 \div 10$). A 20-watt tap is 250 ohms, etc. To prove the example given for the 50-watt amplifier, each speaker location using the 20-watt tap will reflect an impedance of 250 ohms; the speaker with the 10-watt tap will reflect 500 ohms. Using the parallel resistor formula (the reciprocal of the sum of the reciprocals):

$$R=\frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}$$

$$R=\frac{1}{\frac{1}{250}+\frac{1}{250}+\frac{1}{500}}=100$$

We previously calculated the 70-volt tap on a 50-watt amplifier as being the same as a 100-ohm output. Therefore, the amplifier is matched. By dividing the impedance

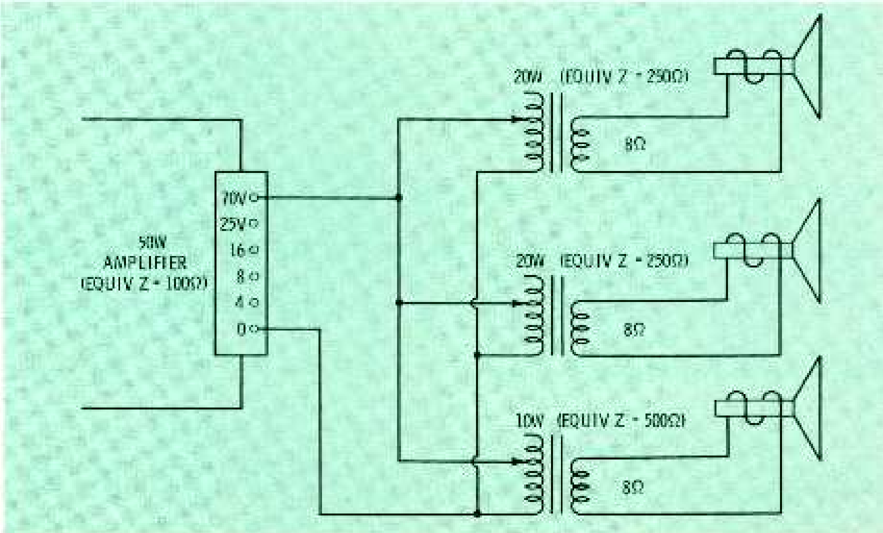


Fig. 2. Total of speaker taps should equal power rating of the amplifier.

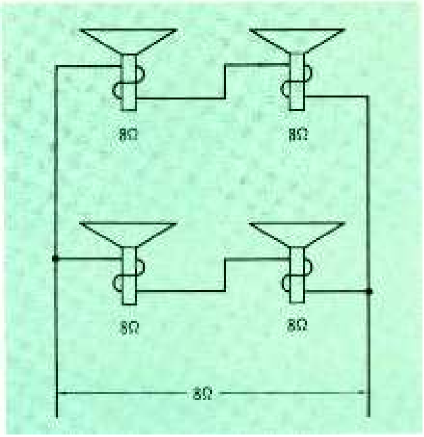


Fig. 3. Four 8-ohm speakers in series-parallel equal 8 ohms net impedance.

figures of impedance-marked transformers into 5000, you will have the equivalent wattage tap figures. During some spare moments, take the transformers you may have on hand and mark them in watts; then you'll be ready to use them on 70-volt outputs if it becomes necessary. Be sure that the transformer is of sufficient size to handle the power for which it is marked.

25-Volt Outputs

Most electrical codes permit PA speaker lines not exceeding 70 volts to be run without the use of conduit protection. It is interesting to note that this provision of the code was added after the 70-volt line was established by RETMA (predecessor of EIA). Since the Underwriter's Lab considers voltages above 25 as having potential shock and fire hazard, some codes limit non-conduit lines to 25 volts or under. For this reason, the 25-volt output was added to amplifiers.

The magic number for the 25-volt output on amplifiers is 25^2 or 625. By dividing 625 by impedance you get watts, and by dividing 625 by watts you get impedance. Calculations are otherwise the same as for the 70-volt output. Wattage taps on speaker transformers for 25-volt lines are not the same as transformers for 70-volt lines. Though similarly marked, they are not interchangeable. They can be made interchangeable by remarking them. The ratio of 5000 to 625 is 8, so merely divide tap markings on 70-volt transformers by 8 and they will be right for 25-volt lines. Multiply tap markings on 25-volt transformers by 8 for use on 70-volt lines.

500- and 250-Ohm Lines

Power distribution and impedance matching on 500- and 250-ohm lines is not as simple as adding transformer tap markings, but it really isn't much more complicated. It is only necessary to remember that impedance is inversely proportional to power, and from that point on it is simple arithmetic. Let's use the same example of the 50-watt system with 20 watts in one area, 20 watts in another and 10 watts in a third, but this time using a 500-ohm line. To get inverse impedance ratios, we divide the total power by the power figures for each area: $50 \div 20 = 2.5$; and $50 \div 10 = 5$. Multiply 500 (the output impedance of the amplifier) by these ratios, and we have the impedance value for each speaker transformer tap: 1250, 1250, and 2500. Speaker transformers set at these taps will deliver 20, 20, and 10 watts, and the net reflected impedance to the amplifier will be 500. This may be proved with the "reciprocal of the sum of the reciprocals" formula:

$$R = \frac{1}{\frac{1}{1250} + \frac{1}{1250} + \frac{1}{500}} = 500$$

The same arithmetic applies to 125-ohm amplifier outputs.

4-, 8-, and 16-Ohm Taps

Some of the newer amplifiers do not not have 500- and 250-ohm outputs, but all have retained the low-impedance taps (4, 8, and 16 ohms). These are used for direct connection to speakers; no speaker transformers are needed. However, the low-impedance taps should be used only where the distance from the amplifier to speakers is comparatively short, otherwise resistance losses in the line may be excessive. AWG-18 wire has a resistance of 6.385 ohms per thousand feet, and AWG-20 has 10.15 ohms per thousand. For example, 1250 feet of AWG-18, commonly employed in speaker lines, has a resistance of 8 ohms. Since there are two wires to a speaker, 625 feet of AWG-18 wire has a resistance equal to the impedance of the speaker. Half the power starting out for that speaker gets lost in the lines. Losses are negligible for short lengths, so your judgment is needed to determine whether or not to use higher impedance lines and speaker transformers.

A combination of parallel, series, and series-parallel connections is needed to maintain a match with a number of speakers. Two 8-ohm

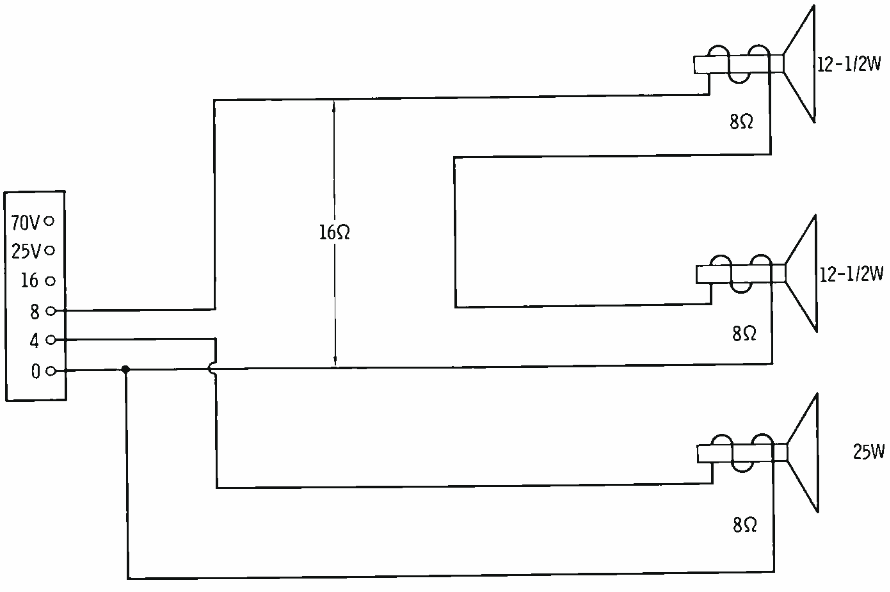


Fig. 4. Speakers can be juggled to match a low-impedance output.

speakers may be connected in parallel to the 4-ohm tap. Two 8-ohm speakers may be connected in series to the 16-ohm tap. Four 8-ohm speakers connected in series-parallel (Fig. 3) reflect an 8-ohm load. Calculations are the same as for resistors in parallel, series or series-parallel. This calls for using speaker quantities in doubled increments, such as 1, 2, 4, 8, 16, etc. The same power is delivered to each speaker equally.

There is a method for distributing different powers to different locations on low-impedance speaker lines, but it requires rather complex mathematics. The method is based on considering the output taps as voltage taps. Ohm's Law may also be written $RP = E^2$. Let us assume an E^2 figure for each tap, determined by multiplying the tap impedance by the power of the amplifier. For example, a 50-watt amplifier can be given E^2 figures of 800 for the 16-ohm tap ($50 \times 16 = 800$), 400 for the 8-ohm tap, and 200 for the 4-ohm tap. By dividing any of these figures (in any combination) by the speaker impedances (one alone, two in parallel, or two in series etc.), we arrive at power figures which must add up to a total equal to the power rating of the amplifier. Inverse feedback permits some mismatch, so a ±20% variation is permissable.

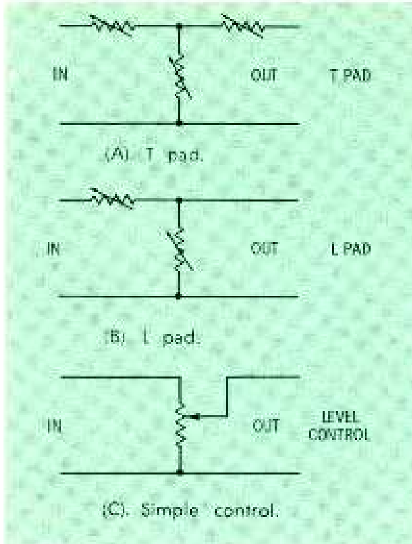


Fig. 5. Types of level controls.

In our example (Fig. 4.) we will connect an 8-ohm speaker to the 4-ohm tap (which we have called "200"). 200 divided by 8 is 25, so that speaker will receive 25 watts of power. Connect two 8-ohm speakers in series to the 8-ohm tap (which we have labeled 400). Now 400 divided by 16 (two speakers in series) also equals 25 watts, but the power is divided between the two speakers. So we have two speakers with 12½ watts of power to each, and one with 25 watts, and the amplifier is matched (Fig. 4).

Speaker Pads

Special level controls are made to connect at the speaker voice coils to permit reducing the level at any speaker location. Three types are shown in Fig. 5. The "T" pad has three variable resistance elements and provides the most constant value of reflected impedance, regardless of its setting. Next lower in constancy of impedance is the "L" pad, with two variable resistance elements. Very acceptable and lower in cost is a simple one-element level control. Even though the reflected impedance is not so constant in this last type, the use of inverse feedback in the amplifier considerably reduces the adverse effects of any resulting mismatch. When using speaker level controls, be sure they have the necessary power rating. ▲

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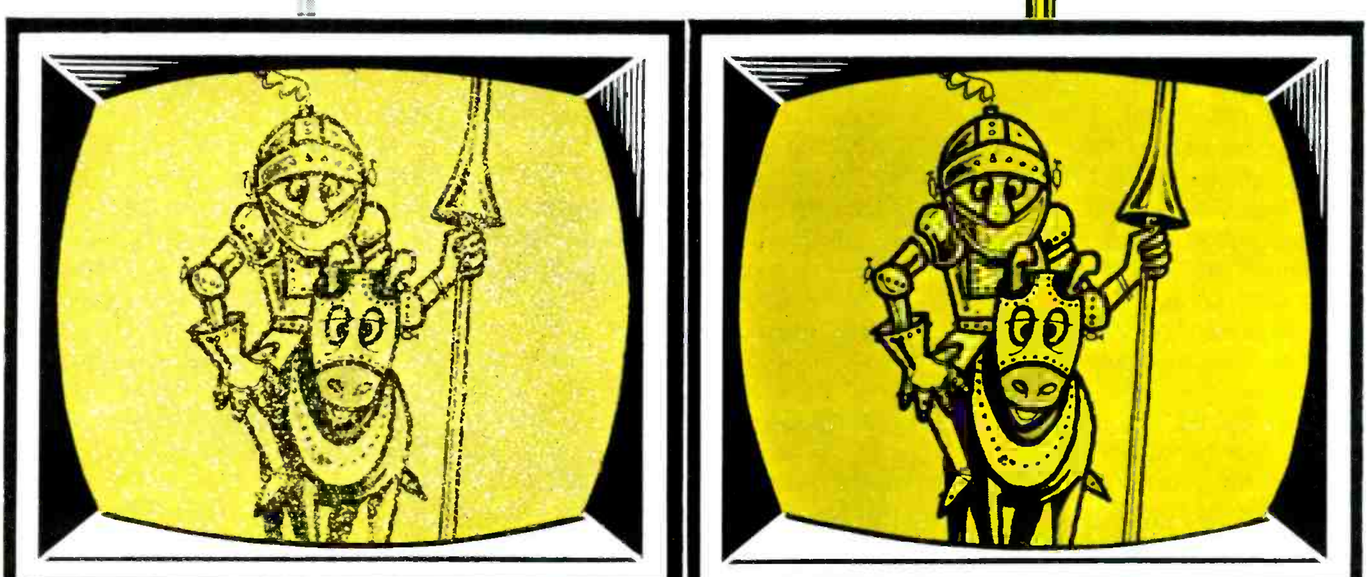

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Short Story About An Auto Radio

by Jim Houseknecht

A little logic saves a service technician a lot of time.

A Mercury Model 4TBM auto radio looked innocent enough when first placed on my bench, but oh the grief that followed. There was only a thud from the speaker when the radio was turned on. This looked like a job for my harmonic generator. I clipped one lead of the generator to the chassis, and with the other lead, I injected a signal at the base of Q6, the audio output transistor (Fig. 1). The generator tone was heard in the speaker. This indicated Q6 was passing the signal. Next, I moved the generator lead to the base of Q5, the 2nd AF amplifier. Again I heard the tone from the speaker. When I moved the generator lead to the base of Q4, the 1st AF amplifier, no tone was heard. However, when I moved the generator lead to the collector of Q4, the tone came from the speaker. This indicated that either Q4 was defective, or the voltages applied to it were incorrect.

Examining the schematic, it is evident that audio amplifiers Q4 and Q5 are stacked (that is, no capacitor or transformer is used between stages to completely isolate the DC voltages of the two circuits); therefore, voltages or conditions in one circuit can affect the voltages or conditions in the other circuit.

Testing the voltages on the emitter, base, and collector of Q5, I found that they were very near the specified amount. However, about 10 volts was present at each element of Q4. It appeared that Q4 was shorted. I removed Q4 from the circuit board, and it checked good with the ohmmeter.

With Q4 removed from the circuit, I checked the voltages on the board itself. The emitter and base readings were identical to those indicated on the schematic (10.8 and 10.6, respectively), but the collector voltage was very low—about .5 volts.

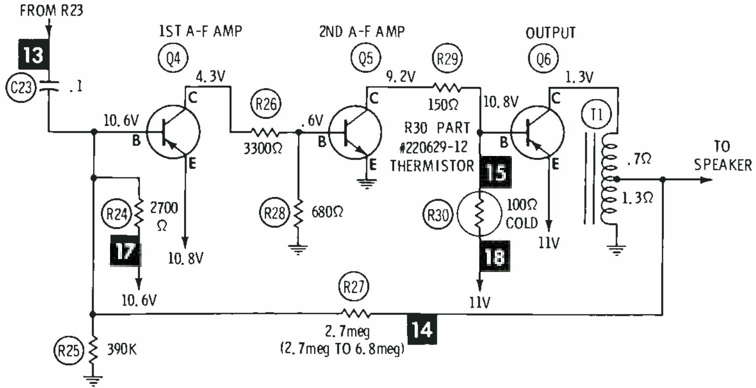


Fig. 1. Audio section of Mercury Model 4TBM auto radio.

At this point, I decided to reinstall Q4. Knowing that stacked amplifiers can be misleading at times, I lifted Q5 from the board and then checked the voltage on the collector of Q4. It was now normal. Next, I removed Q5 from the circuit and checked it with an ohmmeter; the emitter-base junction read the same in both directions—about 100,000 ohms. This indicated that Q5 was partially shorted, but not shorted enough to restrict passage of the signal through it. Replacing Q5 cured the dead radio complaint, but brought to light a multitude of other symptoms.

The next symptom appeared in the form of an intermittent circuit condition. When the circuit board was tapped, the sound would cut off and on, and the sound was noisy when it was present. Also, the volume would slowly rise, then disappear with a thud and varying degrees of squealing and whistling.

When I am confronted with a multiple trouble situation, I tackle the worst, or most pronounced, symptom first, and often, after this defect is corrected, I find the other defects have also disappeared. So, I tackled the microphonic, or loose connection, problem first.

I turned the volume control down and tapped the circuit board, but no noise was heard. So I knew the cause of the trouble was ahead of the volume control. I turned up the volume control, and again tapped the entire board and components. At this point I decided to concentrate on the tuning unit, since the terminal connections appeared to be the noisiest point. I couldn't inspect the soldered coil wires, so I decided to take the tuning assembly apart.

I turned the tuning knob in the direction required to move the slugs forward out of their coils. Next, I removed the three screws that secure the coil assembly to the tuning unit, and gently lifted the three coil forms straight off of their respective tuning slugs. Upon inspection of the various wires at the terminals, I found the two wires on coil L3 (Fig. 2) laying on top of one another. I redressed the leads, checked the other soldered joints, reinstalled the coil assembly, then tuned the radio on and confidently started tapping. No improvement. At this point I tried to isolate the problem to one stage of the receiver by zero biasing Q3, Q2, and Q1, in turn (temporarily shorting emitter to base with a clip lead). (Ed. note—This procedure is safe for transistors employed in small-signal, low-power circuits; however, it should never be attempted with power-output transistors.)

With Q3 zero biased, I tapped the board, but no noise was heard from the speaker. So I knew the trouble was ahead of Q3. The clip lead was removed from Q3 and attached between the emitter and base of Q2. The board was again tapped, but no noise. With X1 zero biased, tapping the board produced a snapping and popping in the speaker. I removed Q1 from the board to eliminate it as a possible source of noise, but the noise persisted. Based on the same reasoning, I substituted the converter transistor, Q2. Even though the zero biasing technique indicated Q2 was good, this technique would not indicate a noisy base-emitter junction within Q2. However, with a new transistor substituted for Q2, the noise was still heard in the speaker when the chassis was tapped.

Checking the circuit board and schematic for other possible sources of noise, I noted dual trimmer capacitor C13. Such units have a history of creating noisy and intermittent operation. I substituted C13, but with no success; so I reverted to my previous tapping procedure. I very gently tapped all the components in and near the converter circuit; by then I realized the defective part must be located between Q1 and Q2. The most sensitive spot appeared to be around C12, a .0082-mfd capacitor connected between the base of Q2 and ground. Lifting one end of C12 from the printed circuit board and tacking a new capacitor in its place cured the problem of intermittent operation. Tapping anywhere on the chassis did not interrupt the signal, but the motor-boating, squealing and whistling were still present.

Realizing that improper AVC action can cause all these symptoms, I lifted one end of X2, the AVC diode, and checked it with an ohmmeter. It read infinity in both directions, indicating it was open. Replacing it with a new unit cured the last of the trouble symptoms. I realigned the dual trimmer capacitor, the IF transformers, and the antenna trimmer, and the receiver was returned to normal operating operation.

Conclusion

Repairing this receiver without step-by-step procedures would have been almost an impossibility—and very time consuming. In this case, as in nearly all troubleshooting situations, a little logic payed big dividends. ▲

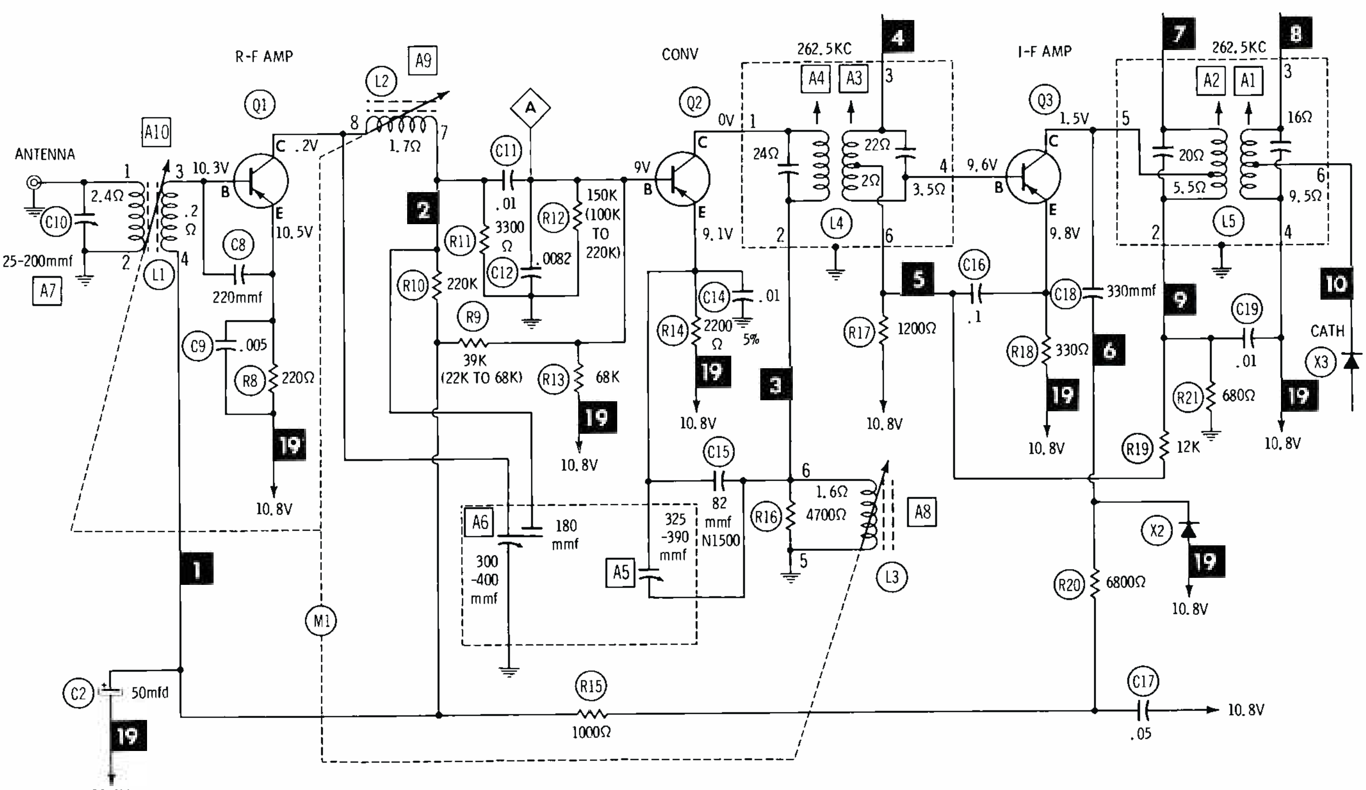


Fig. 2. Front end of trouble-plagued auto radio.

A Look At A Portable Color Chassis

An analysis of **RCA's CTC22** *chassis,* including case histories and troubleshooting techniques.

by
Homer L. Davidson

There are several new circuits and interesting features found in the RCA 14" portable color receiver. The CTC 22 chassis employs twenty tubes, one transistor, and fifteen diodes. All tube filaments, except the picture tube, are in series, as shown in Fig. 1. Since it does not use a power transformer, this color portable weighs only 40 lbs.

You will find diodes all over the printed-circuit boards in the CTC22 chassis. Seven diodes are found in the color circuits alone. A pulse clipper and voltage doubler diode are used in the burst amplifier and 3.58-MHz oscillator stages. Three pulse clamp diodes are tied to the R-, G-, and B-Y amplifier output stages to establish a DC reference level for the grids of the color CRT.

Hanging in front of the yoke assembly on the neck of the CRT is a convergence board. All convergence board circuit components are mounted around the neck of the tube on this circular board (Fig. 2).

The regulation system employed in the high-voltage circuit replaces the common 6BK4 with a pulse regulation system employing a 17KV6 tube.

Color Circuits

Some of the color circuits found in the CTC22 chassis are quite familiar. A horizontal pulse from an auxiliary winding on the flyback transformer is fed to the grid of the burst amplifier (Fig. 3) to trigger this stage during horizontal retrace or color sync time. The same pulse is coupled through C110 and R174 to the screen-plate circuit of the burst amplifier. Diode X13, in the screen-grid circuit, acts as a switch and clamper. During retrace time diode X13 is cut off. Thus, the 250-volt p-p pulse is added to the plate and screen voltages. During scan time, the diode conducts, decreasing the plate and screen voltage to the level of the source (280 volts). This circuit helps eliminate scan ripple and provides clean, a high-level burst signal to the 3.58-MHz oscillator.

The 3.58-MHz oscillator circuit employs a voltage-doubler diode (X11) in the grid circuit. When X11 becomes leaky or shorts during a color broadcast, only a green cast is seen with the color control fully clockwise. In some instances there may only be a few green shaded bars at the top of the TV screen. The same symptoms may prevail when the 3.58-MHz oscillator becomes inoperative.

Adjustable coil L26 is an "oscillator strength" adjustment and is included in the color AFC alignment instructions. The location of L26 is just to the left of the 3.58-MHz oscillator tube and directly below the color oscillator trimmer capacitor. It is a small, encapsulated coil

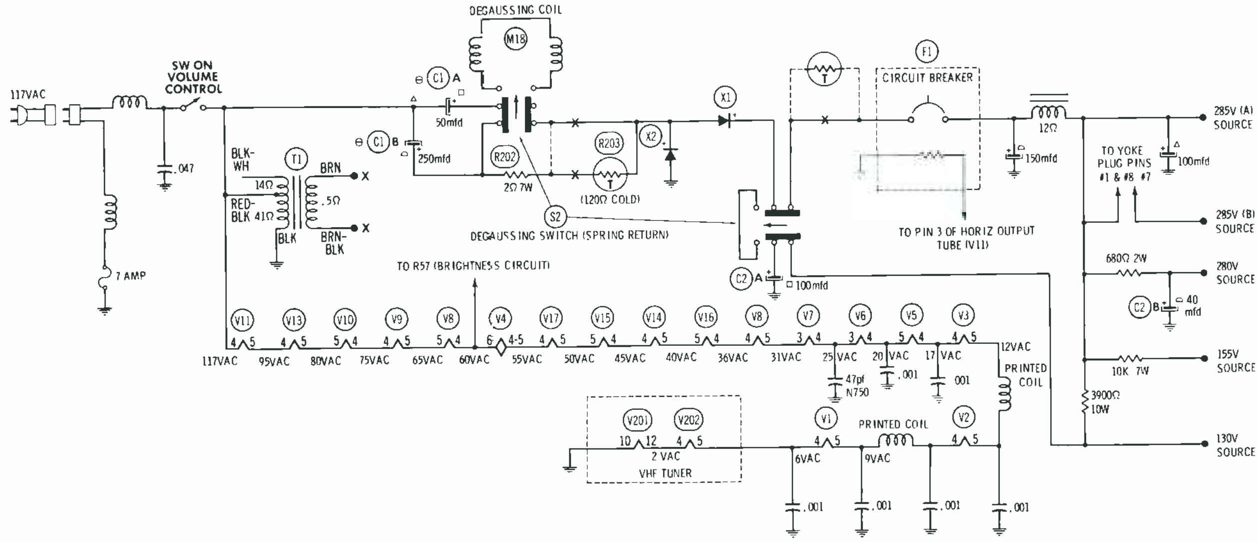


Fig. 1. Low-voltage power supply circuitry employed in RCA CTC22 chassis.

(shaped like a peaking coil) that is adjusted with the aid of a small-hex alignment tool. The burst transformer, 3.58-MHz oscillator transformer, color oscillator trimmer, and oscillator strength adjustment components are mounted in a row at the right-hand side of the color printed-circuit (see Fig 4).

Color Output Circuits

The "X" and "Z" demodulator circuits, which are quite similar to those in the RCA CTC19 chassis, use capacitance coupling to the difference amplifiers. Grid bias for the grounded-cathode difference amplifiers is taken from the blanker circuit. Capacitance coupling is employed to couple the difference amplifier output directly to the grids of the CRT.

A DC reference level is established in the CRT grid circuit through the use of clamping diodes (X14, 15, 16-Fig. 5). The same type of clamping diode circuits are found in both the RCA CTC28 and CTC31 chassis. The input and output circuits of the three difference amplifiers are identical.

When a change of color is noted in the grey scale, check the R-, B-, and G-Y amplifiers and corresponding clamping diodes. In the event the screen goes completely green, suspect the clamping pulse diode in the G-Y amplifier circuit. Likewise, check the corresponding pulse diode in the R-Y and B-Y circuits for predominate red or blue screens. The results are the same when these diodes become either shorted or open. All diodes are silicon types and can be replaced with a regular silicon diode. These diodes should read about 10 ohms in one direction, and with reversed test leads, they should read in the megohm scale (when tested out of the circuit).

CRT Circuitry

The 15LP22 color picture tube is mounted with the blue gun at the bottom—just the opposite of most other color receivers. Although the picture tube number indicates a 15″ screen, according to the new government regulations it is a 14″ color

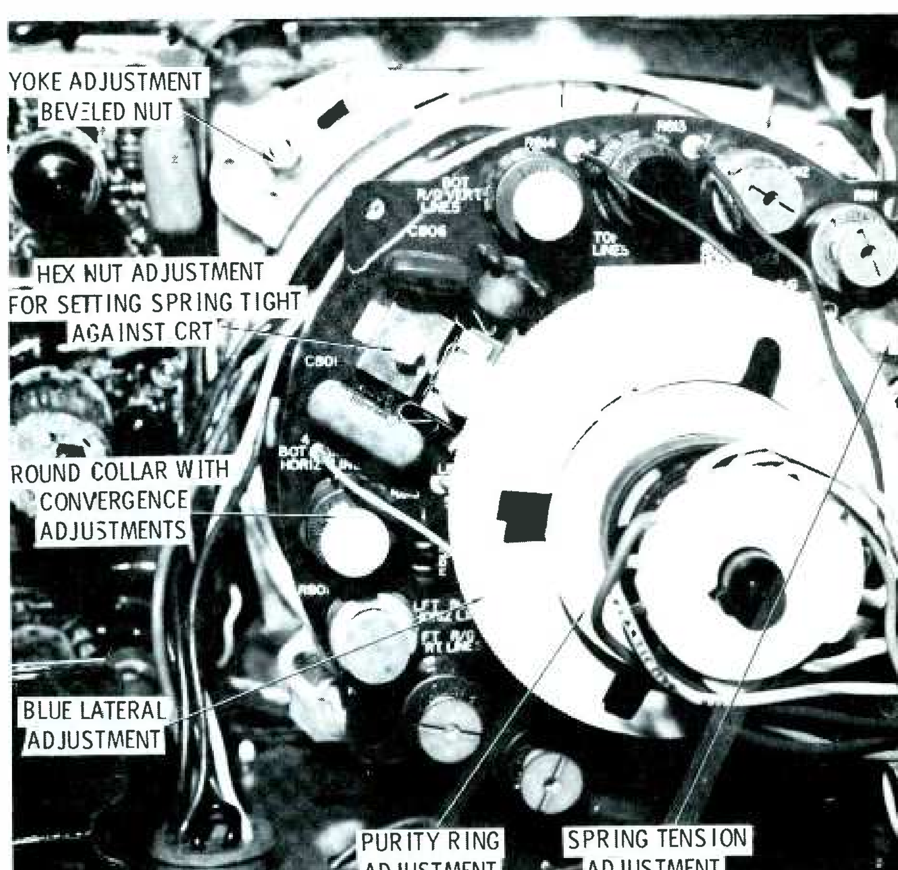


Fig. 2. CTC22 convergence adjustments in circular board around neck of CRT.

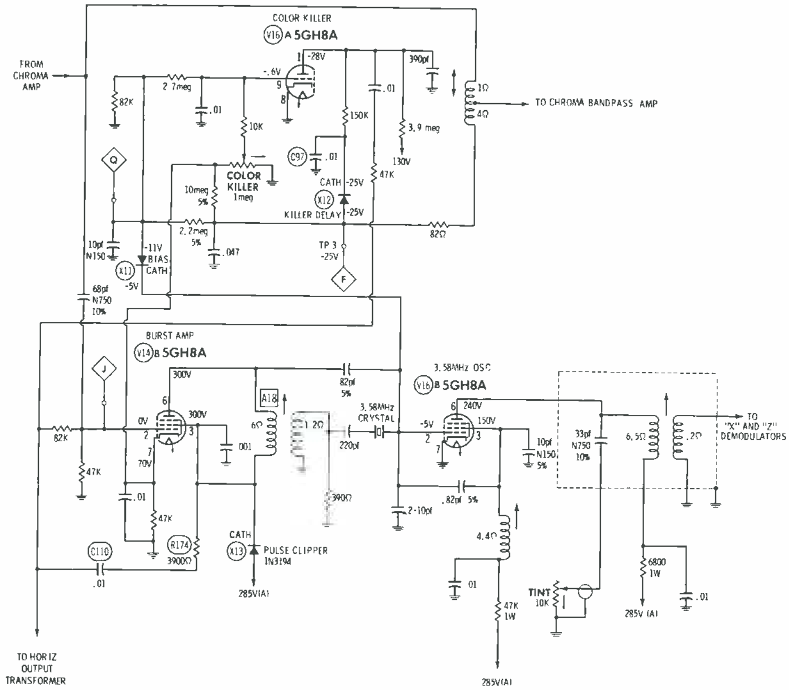


Fig. 3. Partial schematic of CTC22 chroma circuits.

receiver. Better pincushion correction is incorporated at the top and bottom of the CRT, while the anode connection is still mounted at the top. With new and better phosphors, the picture is brighter than any previous RCA color CRT.

Good focus is accomplished with the einzel-lense focus system. It is less sensitive to changes in the high voltage and maintains good focus with variations in picture brightness. The CRT does not have a separate focus control, as found in most color receivers. Proper focus is obtained by changing three connection points—L, P, and Z. Normally, the best focus position is at ground potential (Z). A slip on connector (like that found in some black-and-white focus circuits) provides selection of two voltage tap points labeled L and P on the circuit board.

Horizontal-Output Circuit

The 24JE6 horizontal-output tube (Fig. 6) is identical to the 6JE6, except for the filament voltage and current requirements. However, the horizontal-output transformer, type of high-voltage regulation, and damper circuit employed in the CTC22 chassis are noticeably different.

The type of construction used in the flyback transformer in the CTC 22 allows isolation of the high-voltage winding to provide direct beam current control.

The familiar 6BK4 shunt regulator tube is replaced with a 17KV6 pulse regulator type. The pulse regulator tube acts as a variable load across the primary winding of the flyback transformer. Since the pulse regulator system operates at less voltage (3kv), no x-ray shielding is required. The high-voltage rectifier tube (3A3A) should have a longer life since it no longer conducts continuously at full-load current.

The damper tube has been replaced with a plug-in silicon diode (X3, Fig. 6). When replacing the damper diode, be sure to observe polarity.

When setting up a receiver using the CTC22 chassis, be sure to measure the high-voltage applied to CRT anode. Adjust the high-voltage control for 21.5kv. Insert a 0-300 ma. current meter in series with the cathode of the horizontal-output tube and adjust the horizontal efficiency coil, L35, for a dip in current.

Power Supply Circuits

The power supply employs two silicon diodes in a half-wave, voltage-doubler circuit. Be sure to use caution when servicing the CTC22 chassis since one side of AC line is connected to the chassis.

As mentioned previously, all tube filaments except the CRT are connected in series. A stepdown transformer provides filament voltage to the CRT. Thus, when one tube filament is open, all tubes will be dark, except the picture tube.

The circuit breaker (F1, Fig. 1) employed in the CTC22 chassis is unique; it trips on two separate functions. F1 can be tripped by excessive current in either the low-voltage power supply or horizontal-output circuit. The cathode current of the horizontal-output tube passes through one leg of F1 (internal resistance of 1.3 ohms), which com-

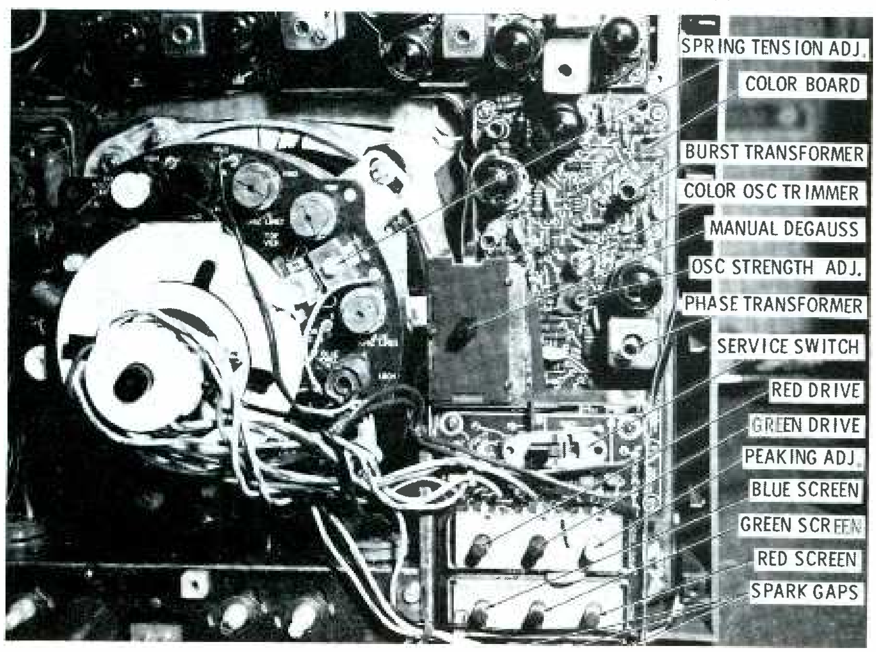


Fig. 4. Rear view of CTC22 chassis showing location of various parts.

pletes the cathode ground return circuit.

Degaussing Operation

Manual degaussing is employed in the CTC22 chassis and is located in the low-voltage power supply circuit (S2, Fig. 1). The degaussing switch is spring loaded and will return to normal operation after being depressed. To check the degaussing coil circuit, a regular service degaussing coil is turned off while being held against the TV screen. This will magnetize the aperture mask inside the CRT. Then, the degaussing switch is depressed, and the impurities should disappear. To further check the degaussing circuit, connect a VTVM at the positive end of X1. When the degaussing switch is depressed, a 330-volt reading should be indicated by the VTVM.

CRT and Purity Adjustments

The usual 12 controls are used for convergence; however, the physical location of the controls and other particulars related to convergence demand discussion. The blue lateral magnet, purity ring, and convergence boards are in one assembly. To remove this assembly from the neck of the CRT, it is necessary to release the spring tension holding the coils against the tube (see Fig. 2). The three plastic shafts associated with this function can be loosened with a 1/4″ spin-tight or regular screwdriver. When reinstalling this assembly, be sure the spring tension is applied to bring the pole pieces in contact with the neck of the tube.

The deflecion yoke is held in position with a beveled-nut and lock-nut assembly. To release the yoke for adjustment, it is necessary to turn the 3/8″ beveled nut counterclockwise, loosen the 5/16″ lock-nuts, and turn the thumb-wheel nuts forward. A coarse adjustment of the stationary yoke housing is provided with a Phillips-head screw mounted just to the right of the beveled nut.

For purity adjustments, the yoke must slide *forward* to adjust the center purity. Physical limitations will not allow the yoke to slide *back* far enough for center purity.

Since the 15LP22 picture tube is operated with the blue gun down, the correct procedure for convergence is to converge, or adjust, the blue convergence first and then the red and green dots. This is a reversal of previous color convergence procedures.

When the service switch is placed in the service position to adjust the screen controls, a slightly bowed blue line will sometimes be visible. In some instances, the blue line will also be lower than the red and green line. This is caused by the fact that the horizontal blanking pulse is inserted in the grid of the second video amplifier. Therefore, with the service-normal switch in the "service" position, no horizontal blanking pulse is applied to the cathodes of the CRT. This is a normal reaction, and the extra line should be disregarded.

Case Histories

The following brief discussions of problems experienced with color models employing the CTC22 chassis indicate that the new chassis is no more difficult to service than former designs.

Short-Lived Brightness

A CTC22 color portable was adjusted in the shop before the customer started on vacation. Three days later, brightness and picture disappeared. Stopping enroute at a small southern town, the customer took the receiver to a local shop for servicing. The horizontal-output tube (24JE6) was found to be defective, but the dealer did not have one in stock. When the customer arrived at his destination he took the TV to another shop, and a new horizontal-output tube was installed. The color receiver played perfectly for two nights, after which the raster again disappeared. Another 24JE6 was installed; this one lasted three days.

Upon returning from his vacation, the frustrated customer dropped the receiver off at the service shop near his home. The 24JE6 was checked, and another new horizontal-output tube installed. The high voltage was also checked at this time and found to be 22.2kv. It was adjusted to the normal 21.5 kv. When the cathode current of the horizontal-output tube was checked it was found to be drawing excessive current. The horizontal-efficiency coil was adjusted for a

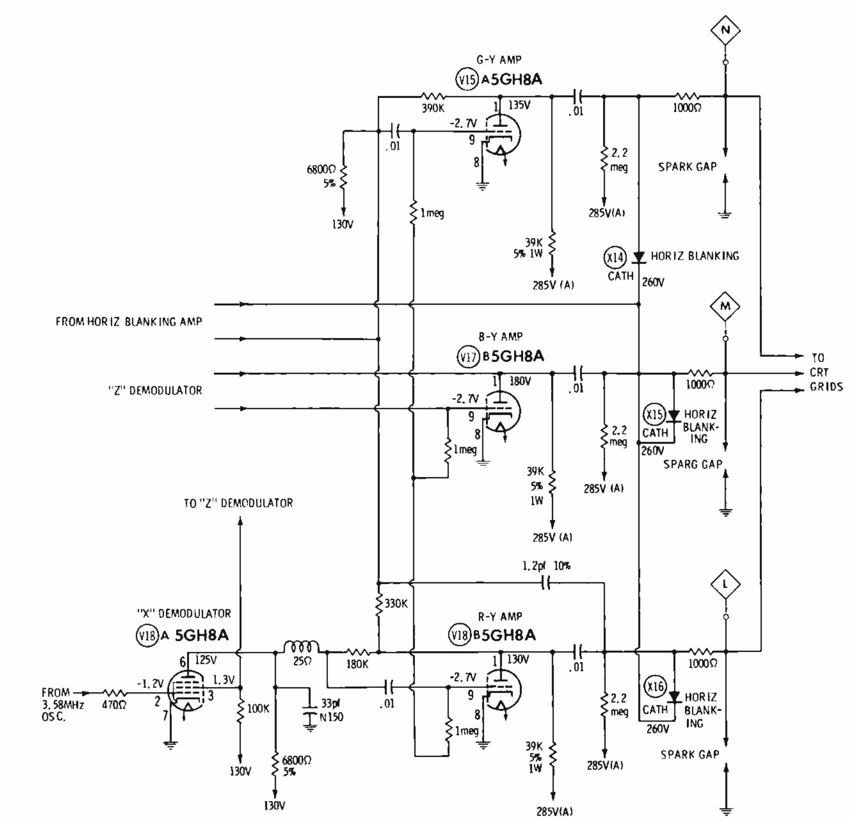


Fig. 5. Difference amplifiers employ clamping diodes in plate circuit.

dip. This corrected the problem, and the receiver was returned to the customer.

Red All Over

Another CTC22 color portable was brought into the shop with a deep red screen. The picture was good, except for a red tint over the entire screen. A check of the schematic revealed that the R-Y amplifier and "X" demodulator were both in the same tube envelope (V18, Fig. 5). V18 was replaced, but the receiver still displayed a red screen. At this point, clamping diode X16 came under suspicion.

Both forward and reverse polarity readings indicated a shorted diode. (The resistance should be about 10 ohms in the forward direction; reversing the leads should give a reading in the megohm range.) Replacing the pulse diode restored a black-and-white screen.

As mentioned previously, when either of the three clamping diodes becomes shorted or leaky, the CRT screen will be the same color as the corresponding difference amplifier. In other words, if X16 becomes leaky, the TV screen will be completely red—as in the cast history we have just discussed. In case the raster is a mixed color, the trouble could be in the difference amplifier circuits.

Another indication of a leaky or shorted clamper diode shows up in the tint of the color picture. It may be difficult to get good flesh tones, especially with a leaky diode in the R-Y amplifier. Be concise when checking a color chassis with clamper diodes. The picture may be good enough to get by, but a quick ohmmeter check of the diodes takes only a few minutes and could save a call back.

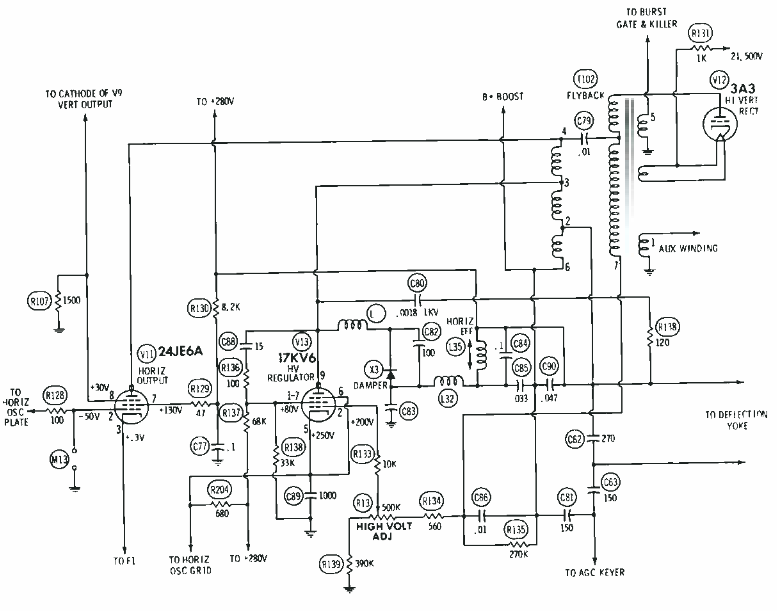


Fig. 6. Horizontal-output stage is controlled by pulse-type high-voltage regulator.

Instant Color

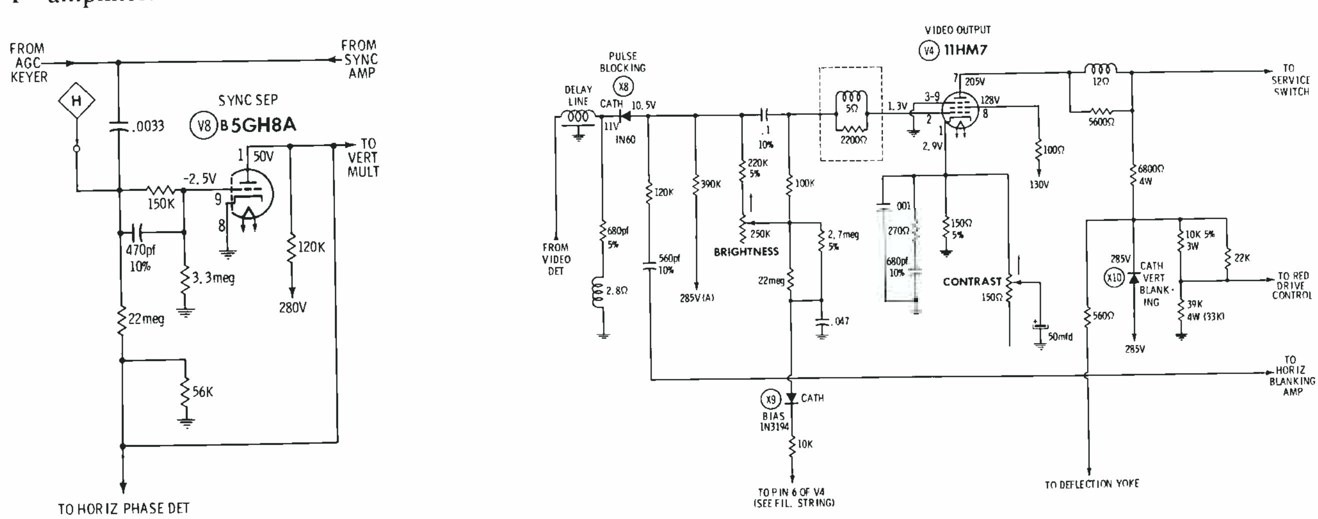
CTC22 color portable was being demonstrated to a young married couple. Adjustment of the color was extremely difficult; there was either too much color or none at all. At one setting of the color control, one could wiggle the control shaft and the color would go off and on.

The chassis was pulled out and placed on the repair bench. Obviously, the trouble was a defective color control. Removing and checking the color control with an ohmmeter proved the technician's first impression was right. Of course, the portable could not be sold for a few days until a new control was received and installed.

Loss of Sync

When brightness was turned down on a CTC22B chassis, the picture would loose vertical and horizontal sync. At the same time, the technician noticed pulling on the left-hand side of the picture. This chassis should have been repaired in one hour; however, it took about three hours to locate and repair the trouble.

All tubes were checked and substituted in the sync and video stages. When voltage measurements were



(A) Control-grid voltage varied.

(B) Diodes in video-output stage were good.

Fig. 7. CTC22 circuitry involved in discussion of case histories.

taken, the only voltages that were not normal were those in the sync separator stage. On pin 9 of V8 (Fig. 7A), the voltage would vary from −2.5 to −20 volts as the brightness control was rotated from minimum to maximum.

In the process of eliminating various components as the source of the trouble, the pulse blocking diode (X8), bias diode (X9), and vertical blanking diode (X10) were checked and found to be good (Fig. 7B). The AGC circuit was checked, and all associated voltages were normal. The trouble had to be common to the brightness circuit.

The only remaining circuit common to both the brightness and sync circuits was the low-voltage power supply. The low-voltage to all three circuits was furnished by the 280-volt power source (Fig. 1). The voltage at the source appeared to be normal, but when C2 (the 40-mfd filter capacitor) was checked, it was found to be open. Replacing C2 restored normal operation.

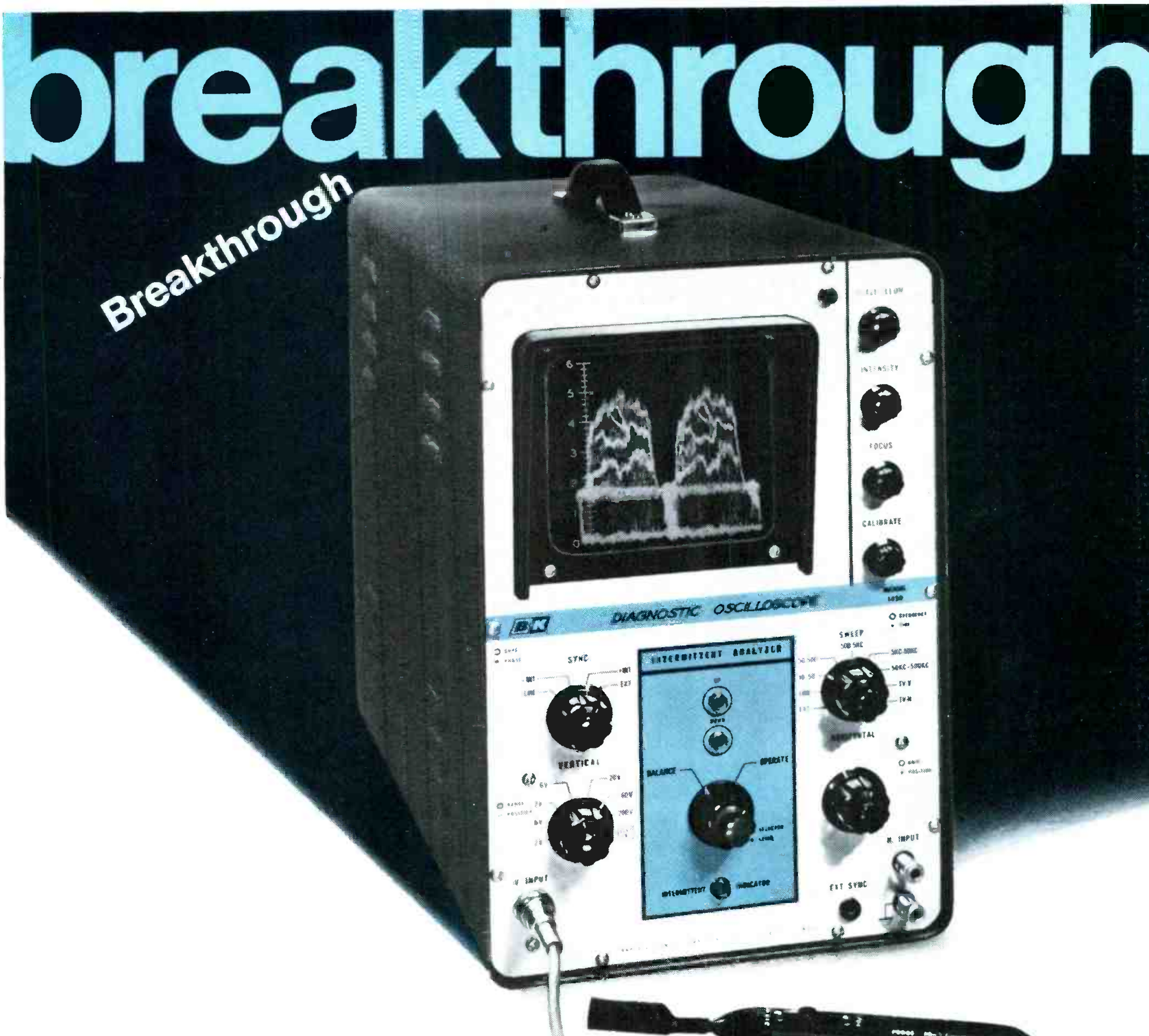
Green Lines

Another CTC22 chassis came in with color problems in the form of a few green lines at the top of the raster. The black-and-white picture was perfect, but no color. When the color control was turned clockwise, the green lines would appear at the top of the screen.

In other color chassis, this same symptom would indicate a defective tube or component in the 3.58-MHz oscillator circuit. Replacing all tubes in the chorma circuits did not restore a normal color picture. Voltages in the color stages appeared to be very close to proper values. Checking the resistance of bias diode X11 (Fig. 3), the technician found a very low forward-to-reverse ratio. Replacing X11 restored the color to the picture.

Miscellaneous Troubles

A picture with low brightness and containing hum bars may indicate a defective pulse blocking diode (X8, Fig. 7B). The same symptoms may also appear with a defective bias rectifier (X9, Fig. 7B). A defective damper diode (X3, Fig. 6), may be indicated by fluctuations in the high-voltage and pulse regulator stages. ▲



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Color TV Service Training—Part 8

The final installment in this series discusses the operation, application, and servicing of solid-state devices in Color TV.

Efforts to determine whether or not solid-state receivers will dominate the color-television market in the near future have been fruitless. Nevertheless, it seems reasonable to assume that solid-state techniques will be adapted to color receivers to a greater degree each year. One major producer of color receivers predicts that 3% of the 1968 production will be solid-state and that an additional 14% will be hybrids, some solid-state circuits and some vacuum-tube circuits.

The same producer predicts further that by 1970 12% of the sets produced will be solid-state and another 40% will be hybrids. In other words, slightly over half of the sets produced two years hence will incorporate at least some solid-state circuits.

At the time when this final part of the series is being written, only one major manufacturer, Motorola, has entered the market-place with an all-solid-state color receiver, although several manufacturers are using some transistor circuitry in at least some of their models. For simplicity of treatment, the Motorola solid-state chassis will be used as the basis for this article.

The Editor

Regardless of whether transistors or vacuum tubes are used in a color receiver, the functions of the several circuit systems remain unchanged. That is, a solid-state set still has a tuner, IF strip, horizontal and vertical deflection systems, chroma system, etc. Thus, the radical changes brought about by the adaptation of transistors to color-receiver circuitry occur in the circuits themselves, not in the overall design concept. There is one exception to this statement; the use of solid-state devices makes modular construction much more feasible than it was in vacuum-tube designs. A vacuum-tube color receiver of modular construction has been marketed (Setchell-Carlson), and at least one manufacturer is contemplating a solid-state color receiver which does not have modular construction. The relative merits of the two types of construction are not an appropriate subject of discussion here.

Review of Transistors

In presenting this article, we assume that the technician has some prior knowledge of transistor circuitry. For this reason, we will not dwell on the theory of their operation. The physical laws which govern the operation of solid-state devices have been published many times and the interested reader may pursue the subject by studying any of a host of books. For our present purposes, we will consider most of the transistors used in a color receiver as "black boxes" which amplify.

It is worth noting that some of the characteristics of transistors dictate significant changes from conventional tube circuitry. In their most usual configuration, transistors exhibit very low input impedance. For this reason, resistors in the circuit are usually relatively small and capacitors have relatively large values.

Fig. 1 will help to illustrate this important point. Assuming that each circuit must operate at 1 kHz, we will calculate the value of C1 which will allow reasonably good energy transfer from the first stage (represented by a generator) to the second stage. As a general rule of thumb, the impedance of the coupling capacitor should not exceed 1/10 of the impedance of the input circuit of the following circuit. In the vacuum-tube circuit (Fig. 1A) the maximum impedance of C1 may be no greater than 50K ohms and the capacitance may be calculated by

$$C = \frac{1}{2\pi F X_C}$$

$$= \frac{1}{6.28 \times 10^3 \times 5 \times 10^4}$$

$$= \frac{1}{3.14 \times 10^8} = 3.18 \times 10^{-9}$$

$$C = .0032 \text{ mfd}$$

To maintain the same impedance ratio between coupling capacitor and input, the value of C1 in the transistor circuit (Fig. 1B) may not exceed 47 ohms.

$$C = \frac{1}{2\pi F X_C}$$

$$= \frac{1}{6.28 \times 10^3 \times 4.7 \times 10^1}$$

$$= \frac{1}{2.95 \times 10^5} = 3.39 \times 10^{-6}$$

$$C = 3.4 \text{ mfd}$$

Because large coupling capacitors are necessary, it is sometimes more practical to eliminate them entirely and couple successive stages directly. This is also done in vacuum-tube circuitry where response to very low frequencies is desirable, but each direct-coupled stage requires, roughly, at least 100 additional volts from the power supply, a serious limitation. Transistors operate from more moderate voltages than tubes, and several stages may be direct coupled even though the power supply produces only 100 volts or less. By using alternate NPN and PNP transistors in a direct-coupled cascade, an almost unlimited number of stages may be direct coupled without increasing the power-supply voltage.

While the use of direct-coupled transistor stages is desirable from the point of view of economy and design simplicity, it may introduce a troubleshooting problem. A direct-coupled amplifier will pass DC as well as any other frequency, and so any change in emitter-to-base DC potential of the first stage is amplified in each following stage. Thus, if a shift in bias of 0.1 volt should occur at the front end of a string having a gain of 100, a change in output of 10 volts would result.

In practical applications, a DC swing of 10 volts is nearly impossible because some transistor in the string probably would either saturate or cut off at a smaller shift in bias. The result is the same—the problem area is in front of the circuit where the symptoms are most likely to be detected.

DC feedback loops and current limiters are often used in transistor circuits to prevent the runaway condition just described. The circuit shown in Fig. 2 has such a feedback path. (The circuit is not in the Motorola receiver.) Assume that the positive base voltage of Q9 decreases for some reason. The conduction of Q9 will decrease, causing the base voltage of Q10 to rise. The increased conduction of the collector of Q10 causes an additional drop across R51, and the base of Q11 becomes less positive. This causes increased collector current in Q11 and the collector swings positive because of the increased drop across T1.

Without a feedback loop, a small decrease in bias at the base of Q9 might well cause such a large increase in collector current through Q11 that the transistor would be damaged. The feedback loop consists of R55, C19, and R54, connected between the collector of Q11 and the base of Q9. By virtue of this loop, as the collector voltage of Q11 tends to rise, a portion of this positive-going voltage is coupled back to the base of Q9 to increase its conduction. Thus, the action of the feedback loop is always to oppose any change in the DC operating potentials of the transistors. Note that C19 acts as a low-pass filter in the feedback loop. Because of it, only DC, or low-frequency AC, is fed back to Q9.

In our discussion about the DC feedback loop, we assumed that the potential at the base of Q9 changed for some unspecified reason. While idle conjecture about the cause of this shift is pointless, it is true that changes within Q9 itself, or variations among transistors in a production run, are a major source of the variations. Thus, we may conclude that DC stabilization is required for two reasons: the DC instability of direct-coupled amplifiers, and the inherent DC instability of transistors themselves.

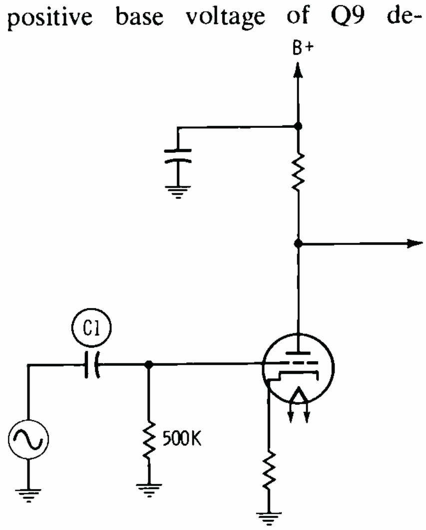
In general, it is also true that the gain stability of transistors is poorer than it is for vacuum tubes. For this reason, an AC feedback loop also may be incorporated in an amplifier string. Referring again to Fig. 2, the AC feedback network consists of R53 and C49. A portion of the amplifier output is fed back to the input in phase opposition. Thus, if the gain of the overall circuit increases, so does the amplitude of the inverted signal fed to the input, and the gain is maintained constant. Note that this feedback circuit incorporates a high-pass filter so that it is insensitive to DC.

Another characteristic of transistors which is sometimes confusing to the technician is the manner in which they fail. Although a triode with a grid-to-plate short is quite rare, a base-to-collector short in a transistor is a distinct possibility. Furthermore, while a grid-plate short probably would be destructive to associated components, a base-collector short may cause no external damage. A transistor with a base-collector short may pass the signal (without amplifying it, of course) but there will be no inversion of the waveform.

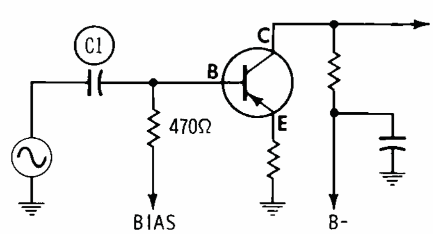
Typically, vacuum tubes fail because of gradually decreasing cathode emission and lowered transconductance. This is unlike transistors which usually maintain a nearly constant gain throughout their lives; failures are due to shorts or excessive leakage.

Solid-State Chroma Circuit

Fig. 3 is a block diagram of the chroma circuits used in the Motorola 23TS-915 and 919 chassis.



(A) Tube amplifier.



(B) Transistor amplifier.

Fig. 1. Comparison of transistor and vacuum-tube amplifiers.

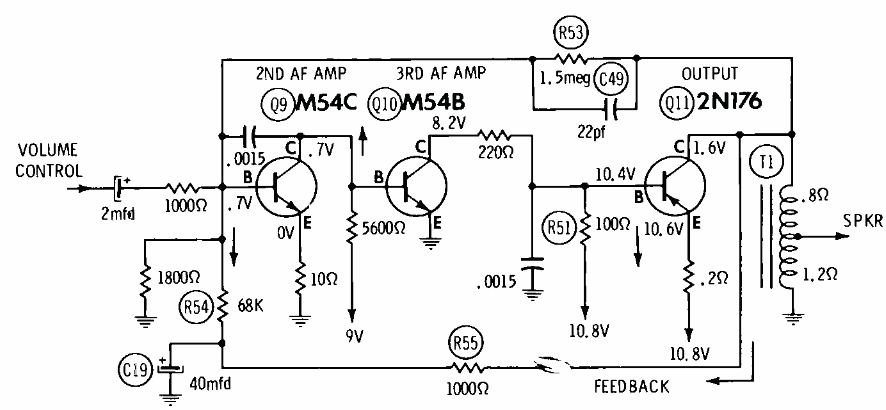


Fig. 2. Feedback loops in a transistor amplifier.

Although most of us are accustomed to only about half this number of blocks, the functions performed by this chroma circuit and one using vacuum tubes are essentially the same. With the exception of the demodulators and color amplifiers, which are rather novel, the entire chroma circuit is quite similar to a vacuum-tube design.

Reference Circuits

Following the same sequence that was used in Part 4 of this series, we shall examine the reference-signal circuits first. Video from the first video amplifier is fed to the first chroma-bandpass amplifier, which has two outputs. One of these outputs, consisting of the chroma sidebands and the color burst, is fed to the chroma-sync amplifier. The chroma-sync amplifier is the equivalent of the burst amplifier of conventional designs and is a coincidence gate. Also fed to the chroma-sync amplifier is an enabling pulse from the burst amplifier and pulse limiter. This pulse gates the sync amplifier on at the time when the color burst is present at its input, allowing it to pass. During the remainder of the scanning interval, the sync amplifier is gated off, removing the chroma sidebands from its output.

The color burst from the sync amplifier is developed across the 3.58-MHz crystal, causing it to ring from one burst to the next. The crystal is amplified by Q53 and the output of this stage is a CW signal which is rephased at the start of each horizontal scan.

The chroma-reference oscillator, Q54, is a Colpitts oscillator which free runs during black-and-white reception. However, if a color burst is present, the output from the crystal amplifier phase locks the oscillator, causing its output to be in phase with the color burst.

The chroma-reference phase inverter is actually a splitter which develops two out-of-phase signals from the single input. A potentiometer across these outputs, the hue control, selects the specific phase of reference signal required for correct hue of the picture.

Finally, the reference signal is amplified by Q56 and fed to the three demodulators. The phase of the signal from Q56 is correct for the green demodulator, and phase shifting networks develop the correct phase for the blue and red axes.

ACC and Color Killer

A portion of the output from the 3.58-MHz crystal amplifier is rectified and fed to the ACC amplifier. If the amplitude of the burst increases, the output of the crystal amplifier increases, and this, in turn, causes the bias developed in the ACC amplifier to increase. This decreases the gain of the first chroma bandpass amplifier to maintain a constant-amplitude output with a varying input. (See "Closed-Loop ACC" in Part 5 of this series.)

The output of the ACC amplifier also is supplied to the killer amplifier, Q43. In conjunction with Q44, the killer output stage, Q43, operates as an electronic switch. That is, the circuit is either cut off or saturated—there is no "in between." In the absence of a color burst, the

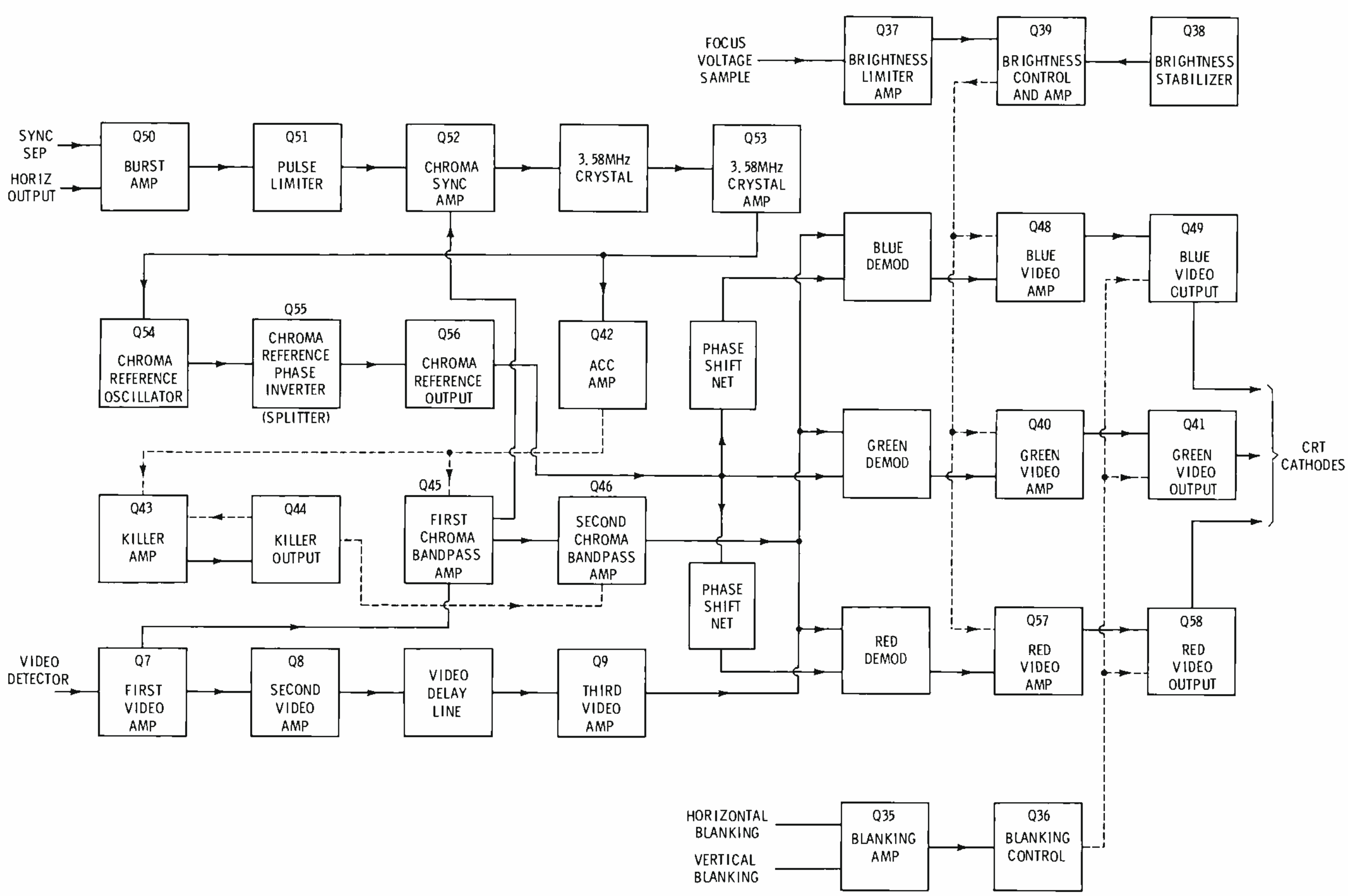


Fig. 3. Detailed block diagram of the Motorola solid-state chroma circuits.

killer cuts off the second chroma-bandpass amplifier; when a burst is present, the second chroma-bandpass amplifier is turned on. The color intensity control is located in the network between the killer and the second bandpass amplifier.

Bandpass Amplifiers

The two chroma bandpass amplifiers, Q45 and Q46, are straightforward in design. As stated above, the gain of the first stage is controlled by the ACC amplifier and the second stage is cut off during monochrome reception by the color-killer circuit. The color intensity control also is incorporated in the input of the second bandpass amplifier. The two stages are tuned to pass sidebands having frequencies up to 500 kHz above or below the burst frequency.

Chroma Demodulators

The diode chroma demodulators used in this receiver are similar in many respects to the ones used in some General Electric receivers. The essential difference is that a third input, the luminance (or Y) signal is also fed into the three Motorola demodulators.

Today, the majority of color receivers recombine the luminance signal and the three color-difference signals within the CRT. (See Part 7 of this series.) This practice was adopted because of its relative simplicity and economy, but it makes the ability of the receiver to track the gray scale dependent on the degree of nicety with which the three guns of the CRT can maintain identical transconductances. The concept of recombining the luminance and chrominance information outside the CRT allows more accurate adjustment of gray-scale tracking and the possibility of correcting for long-time variations in CRT parameters and also for changes in the external circuits. Time will tell whether or not this second-generation external matrix will fulfill expectations.

The three demodulators of Fig. 3 are identified simply by the color (not color-difference) signals which they produce. This is entirely proper, since color-difference signals never appear in this chassis; chrominance and luminance information are recombined (matrixed) in the demodulators. One of the demodulators will be examined in detail later in this article.

Color Amplifiers

Each of the color demodulators is followed by a pair of amplifiers which raise the signal level to an amplitude sufficient to drive the CRT cathodes. These amplifiers are direct coupled, allowing the brightness control to be connected to the emitters of the first stages of each amplifier string. Making the emitters of Q40, Q48, and Q57 more positive causes the collectors to swing in the same direction. This swing is inverted in the output stages, driving the CRT cathodes negative and increasing the brightness.

The emitters of Q41, Q49, and Q58 (NPN types) return to ground through the blanking-control transistors Q36. When Q36 is cut off during horizontal and vertical retrace, the video-output transistors also are cut off, driving the CRT cathodes positive into cutoff.

Brightness Circuit

The brightness circuit, Q37, Q38, and Q39, includes the manual brightness control and also an automatic brightness limiter (ABL). The purpose of the ABL circuit is to maintain constant CRT beam currents (for a given brightness-control setting) even though shifts in video-amplifier gain, line voltage, horizontal-output voltage, etc. might tend to change the brightness. Also, the ABL control allows the technician to preset the maximum brightness for optimum operation.

A sample of the focus voltage is used as a control voltage for the

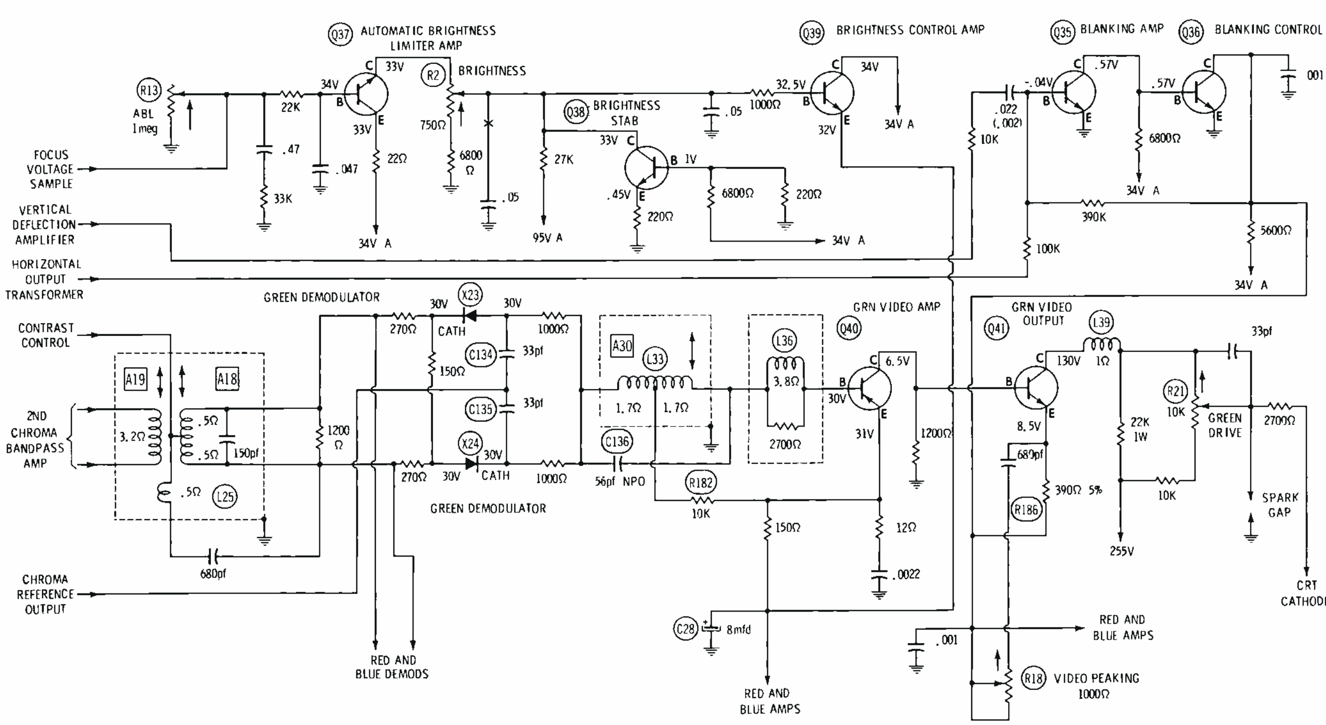


Fig. 4. Motorola demodulator and color amplifiers.

ABL. Any shift in brightness will shift the level of the control voltage. For example, if the CRT brightness decreases for some reason, the focus voltage will increase. A positive-going control voltage increases conduction of the video amplifiers, video outputs, and the CRT guns to increase brightness.

Blanking Circuit

Positive pulses derived from the vertical sweep amplifier and from the horizontal-output transformer are coupled to the blanking-control stage, Q36, by the blanking amplifier. These pulses cut off the video-output transistors during retrace.

To reduce the load on the horizontal-output circuitry, the horizontal retrace time of this chassis is longer than usual and the CRT is overscanned slightly. The width of the horizontal-blanking pulse is increased accordingly, and it is normal for a portion of the first color bar from a keyed-rainbow generator (yellow-orange) to be partially blanked and off the left side of the raster.

Chroma-Circuit Analysis

The three demodulators are practically identical, with the exception of the phase of the reference input and the value of the input attenuation. Since it serves no useful purpose to treat them separately, only the green demodulator is shown in Fig. 4.

During reception of a black-and-white signal, there are two inputs to the demodulator. A free-running, 3.58-MHz signal is fed to the junction of C134 and C135. Positive video from the contrast control, situated in the output circuit of the third video amplifier, is fed to the center of the secondary of L25. There is no input from the chroma-bandpass amplifier, since it is cut off by the color killer.

The reference signal produces no output at the base of Q40 because of the traps, L33 and C136, between the demodulator and the video amplifier. These same traps remove the 3.58-MHz ripple during color reception.

Positive video (a positive signal makes a black raster) passes through X24 and is developed across R182. The video passes through the trap and is duly amplified by the two video amplifiers and fed to the CRT cathode. Of course, the same things take place in each of the other demodulators and their amplifiers. Thus, the luminance signal is amplified and fed to the three CRT cathodes to produce a monochrome picture.

The operation of diode chroma demodulators is discussed in detail in Part 6 of this series (February, 1968, PF REPORTER) under the heading "Diode Chroma Demodulators." To summarize, if the reference and chroma signals are in phase, a maximum output of one polarity is realized; if they are out of phase, a maximum output of the opposite polarity results; if they are 90° out of phase, the output is zero. In the demodulator of Fig. 4, in-phase signals produce a negative voltage at the base of Q40 and increase the CRT conduction.

So far, we have considered the chrominance and luminance signals separately, but, since both of these signals are developed across the same resistor, R182, they are effectively added at this point. This sum (or difference) of the two signal voltages passes through the traps, which remove the 3.58-MHz ripple, to the base of Q40 and, ultimately, to the CRT.

Blanking Control

The blanking and brightness-control circuits also are shown in Fig. 4, not because the functions they perform are novel, but because the use of transistors results in unusual circuit configurations

The emitter currents of the three color-video output transistors must all flow through the blanking-control transistor, Q36. During scanning time, Q36 is forward biased and the complete circuit path of the collector current of Q41 is from ground, through Q36, R186 and Q41 to the CRT cathode and the 255-volt supply.

During retrace, Q35 is driven to saturation by the positive pulse on its base. This removes the forward bias from the base of Q36, cutting it off. This effectively opens the low-resistance path from ground to the emitters of the video-output transistors, cutting them off.

Automatic Brightness Limiter

The level of the sample of focus voltage taken from the low end of

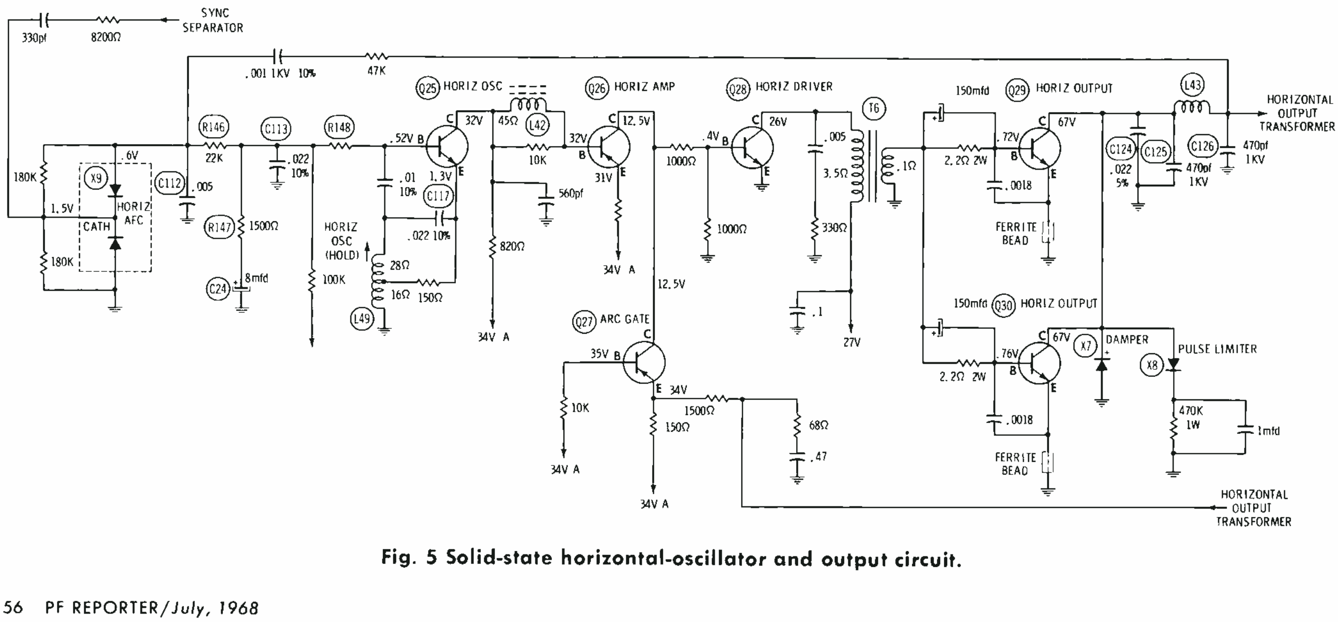


Fig. 5 Solid-state horizontal-oscillator and output circuit.

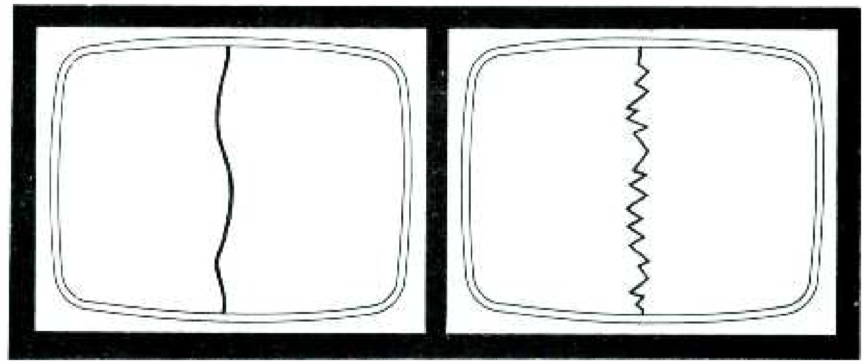
the CRT screen-control potentiometer indicates the total load on the high-voltage and focus-voltage supplies, and hence, the amount of CRT conduction, or brightness. The adjustment of R13, the ABL control, determines the size of the sample (control voltage) taken and acts somewhat as a coarse control of the brightness.

Q37 is connected as an emitter follower, roughly equivalent to a cathode-follower tube configuration, and the emitter voltage is dependent on the amplitude of the control voltage. Because of Q37, the voltage at the top of the brightness control cannot become more positive than the 34-volt supply at the collector of Q37. This limits maximum brightness of the CRT.

The voltage on the base of Q39 is determined by the setting of the control voltage. Q39 also is connected as an emitter follower, and the voltage on its base controls the bias on the video amplifiers, Q40, Q48, and Q57. Notice that the base voltage of Q39 is stabilized by Q38, which acts as a regulator for the circuit.

Analysis of Horizontal-Deflection Circuits

Space is not available for an analysis of all circuits in the Motorola solid-state chassis, so this discussion is necessarily limited to those of greatest significance. In addition to the chroma circuits already covered, the design of the horizontal deflection system is sufficiently different from designs using tubes to justify an analysis.



(A) Hunting. (B) Jitter.

Fig. 6. Appearance of horiontal hunting and jitter

Horizontal Oscillator and AFC

The horizontal oscillator and the AFC circuit (Fig. 5) which controls its frequency are very similar to designs using tubes. The AFC circuit compares the phases of the horizontal sync pulse and the output of the horizontal-output transistors, Q29 and Q30, to develop a control voltage. This control voltage is integrated by R146, R147, C24, C112, and C113, and it is used at the base of Q25 to control the oscillator frequency.

The function of the integrating circuit between the AFC detector and the oscillator is not particularly mystifying, but it appears, from the number of letters we receive, that malfunctions in this circuit cause a great number of problems to our readers. The following comments apply to nearly all sets, vacuum-tube or solid-state.

Failures in the integrator fall into four general categories: (1) Loss of control voltage caused by R148 going open, for example. In this case, there is no horizontal sync. (2) Radical change in the DC level of the control voltage which causes a radical change in horizontal frequency, or may cut off the oscillator. (3) Too much integration of the control voltage. (4) Not enough integration of the control voltage.

The first two categories named above are generally not too difficult to diagnose, but the last two seem to cause many difficulties. If the control voltage is integrated too much, the response time of the system becomes too great. Therefore, the raster appears to slowly move back and forth across the CRT. The complete raster will not necessarily float the same amount, and so a

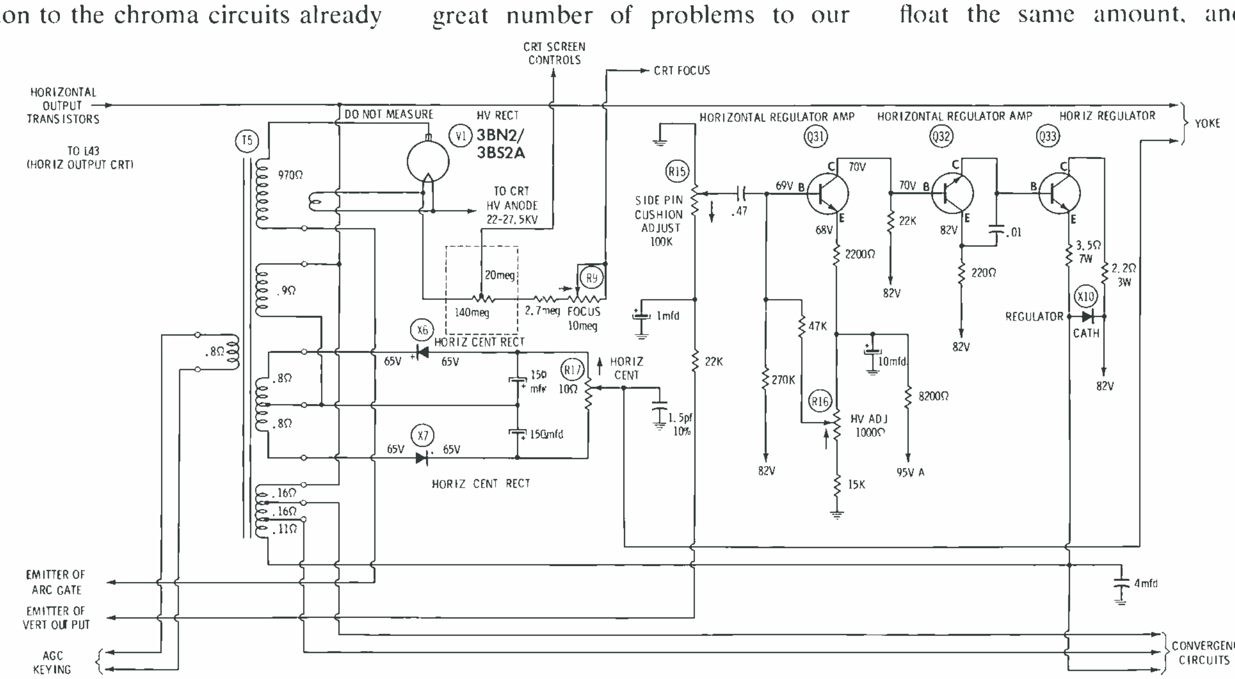


Fig. 7. Horizontal regulator circuit.

vertical line on the CRT may curve back and forth from top to bottom (see Fig. 6A). This is called horizontal hunting.

Too little integration causes the oscillator frequency to be overcorrected. With insufficient integration, the control voltage at the oscillator (or AFC tube) shifts slightly during each scan. This causes the scanning time of each horizontal line to be slightly different and a vertical line on the CRT appears ragged or broken as shown in Fig. 6B. This is called horizontal jitter. Jitter is usually caused by a decrease in value of C24 (or its counterpart in another set), hunting is usually caused by an increase in resistance of R146 or R147, or their counterparts.

Referring again to Fig. 5, the horizontal oscillator is a Hartley oscillator; L49 and C117 determine the frequency. When the top of the tank is negative, Q25 is cut off. As the top of the tank swings positive, the transistor begins conduction at some point on the sine wave. This point is determined by a combination of fixed bias and the control voltage from the AFC. The collector current of Q25 is a series of pulses and the waveform at the base of Q26 is approximately a square wave.

Amplifier, Driver and Output

The train of pulses is fed to the driver through the horizontal amplifier, and the output of the driver is coupled through T6. The phasing of T6 is such that the output transistors are turned on when the driver is cut off. Deflection of the trace from center to the right edge of the CRT occurs while Q29 and Q30 are conducting. At the instant that Q29 and Q30 are cut off, the sweep retraces, the damper begins conduction, and the left side of the raster is scanned.

The network consisting of C124, C125, C126, and L43 is a low-pass filter which prevents any high-frequency transients which may be generated in the amplifier, driver, or output stages from being coupled to the horizontal-output transformer. The pulse-limiter diode, X8, limits the amplitude of the collector pulses of Q29 and Q30 to protect them.

In case of a high-voltage short, a positive pulse is developed at the emitter of Q27, causing it to conduct. This clamps the base of Q28 to the base of Q27, causing it to conduct and cutting off the horizontal-output transistors until the arc clears.

Horizontal Regulator and Pincushion Circuit

The circuit which includes Q31, Q32, and Q33 (Fig. 7) performs the two functions of injecting a portion of the vertical deflection signal into the horizontal sweep system for pincushion correction, and it also regulates the high voltage. Both of these functions are accomplished by controlling the supply voltage for the horizontal-output transistors.

A parabolic voltage derived from the emitter of the vertical-output transistor is amplified by Q31 and Q32 and added to the supply for the horizontal output transistors. The supply voltage is increased when the vertical sweep is at the center of the tube, causing the horizontal scan to expand at this time to correct for pincushion effect. R15 picks off the amount of vertical-sweep voltage which is required for optimum correction.

At the same time, the relative values of the 82-volt supply and the 95-volt supply are compared in the emitter-base circuit of Q31. As CRT beam current increases, the load on the horizontal-deflection circuit increases and the output of the 82-volt power supply drops. This decreases the forward bias of Q31, causing the collector voltage to increase. This increase in collector voltage increases the conduction of Q32 and Q33, which tends to raise the supply voltage to the horizontal-output transistors, thereby regulating the high voltage.

Conclusion

The chroma circuits and the horizontal deflection circuitry of the Motorola solid-state receiver were discussed rather intensively, to the exclusion of the remaining circuits, for two reasons. From our own experience, these two areas are the most complex and are the source of a great many of the service problems in all color receivers; and these circuits are the most novel of all the circuits in the solid-state receivers.

Several additional stages are used in the chroma and horizontal-deflection circuits. For example, the color-killer uses two transistors instead of one tube, each demodulator is followed by two color amplifiers instead of the usual single-tube, color-difference amplifier, there is an amplifier and a device between the horizontal oscillator and the horizontal-output transistors, etc. In general, this increased number of stages is true in converting any vacuum-tube device to solid-state.

The method used by Motorola to demodulate the chroma sidebands and matrix the color-difference signal with the luminance signal in the demodulator is unique in present-day designs. It is interesting to note that the chrominance and luminance signals were matrixed outside the CRT in very early designs; however, in more recent years, matrixing within the CRT has become stadard practice. It will be interesting to see if Motorola's new method of external matrixing will establish a trend to be followed by other manufacturers.

At the present time, Motorola's servicing policy discourages repair of these circuit modules by the service technician. Accordingly, an intimate knowledge of how each circuit functions is probably not essential. Nevertheless, it is a near-certainty that other solid-state color receivers that are not of modular construction will soon be introduced. Thus, it behooves every technician to acquaint himself with solid-state color-receiver design so that he will be prepared to service them when they do appear.

We recall the technicians of the 40's who said they wouldn't bother to learn servicing of those "new-fangled" TV's, the technicians of the 50's who decided that they would leave transistor service to somebody else, and another crop in the 60's that decided that they could leave color alone and do okay. Those who stuck to their intentions are surviving—most wear patches, eat beans, and drive a 1954 service truck. Those who prefer steak keep abreast of new developments—like solid-state color in the 70's. ▲

analysis of test instruments . . . operation . . . applications

NOTES ON TEST EQUIPMENT

by T. T. JONES

Color Generator

The latest color generator from Amphenol has many interesting features. Some of these are not new to the industry, but others are. Amphenol has incorporated the best features available in previous generators, and added a few new ones to make the Model 865 an extremely versatile instrument.

One feature of great convenience is the dual power supply. The generator is AC-powered if line power is available, but also has internal batteries and provisions for automatic switchover. If the instrument is plugged into the line, it will draw line power. If it is not plugged into the line, it will automatically draw power from the batteries. Though the battery supply is 18 volts, the B+ is regulated at 12 volts; therefore, the batteries have considerable reserve power.

The power supply is shown in Fig. 2. Notice that diode X2 blocks reverse voltage from getting into the battery source. X5 is the AC rectifier, and X3 and X4 set the reference voltage for Q18, the voltage regulator.

In addition to the usual dot, crosshatch lines, and rainbow patterns, the Model 865 has the movable single dot and crossbar feature, plus two unique color patterns. The first is a three-bar pattern consisting of red, blue, and blue-green bars. These correspond to the 3rd, 6th, and 9th bars of a 10-bar keyed rainbow. Since these are the only bars normally used when aligning color demodulators, the task is greatly simplified. (There's little possibility of nulling the wrong bar when there are only 3 from which to choose.)

The second unique color pattern is a single color bar which may be moved to any position between 30° and 300° on the vector. This corresponds to any position from the 1st bar to the 10th bar. The position of this bar is calibrated in 15° steps, which makes it a natural for aligning 105° demodulators.

The schematic in Fig. 3 shows the portion of pulse generator circuitry that keys the color gate, producing the single bar pattern. An incoming 15.75-kHz pulse, developed in the timer chain, is coupled into the circuitry by C62. The positive portion of the pulse is clipped by X9 and X10 so that only negative pulses pass through C64 to the

Fig. 1. Amphenol's new Model 865 color generator.

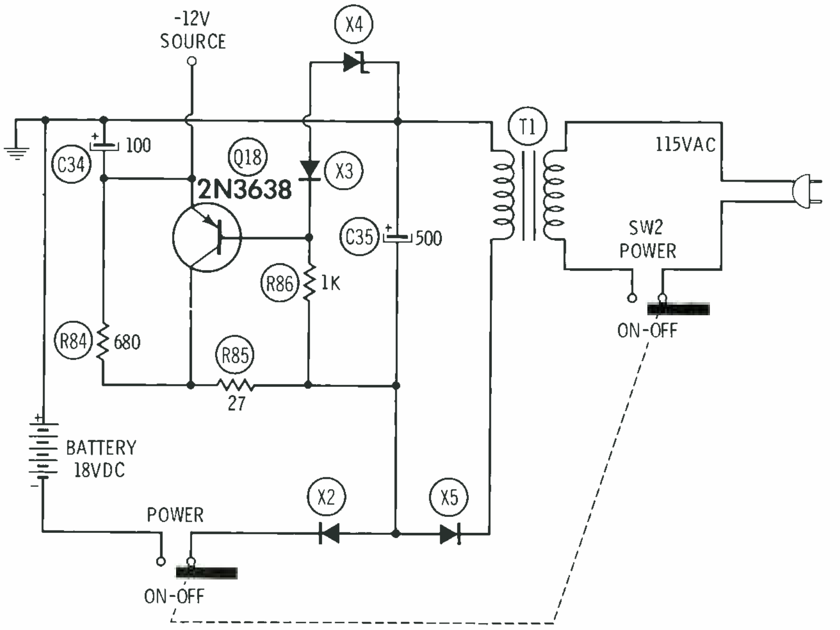


Fig. 2. Two-way power supply is transistor-regulated.

Note also, that though the pulse may have a fast rise time for a 30° bar, or a slower rise time for a 150° bar, the peak amplitude of the pulse is the same. This *sync* pulse, at the junction of C64 and R135, keys the pulse generator made up of Q26 and Q27.

base of Q26. Note that in the waveform photos there are two pulses at the junction of X10 and C64 for each horizontal sweep. The first and largest pulse is the incoming sync. The second pulse is reflected back from C64.

As the sync passes through C64 it is integrated, and the time constant is variable by the Horizontal Position control. Two waveforms are shown: one with the control at the 30° position; the other at 150°. These figures correspond to the position of the color bar on the vector. The 30° bar would be yellow-orange, on the left edge of the screen. The 150° bar is reddish-blue, near the center of the screen. The peak of the pulses are correspondingly near the left or center of the horizontal sweep.

The *output* pulse occurs when the trigger pulse reaches an amplitude determined by circuit parameters (the peak of the sync pulse in the waveform photos). The width of the output pulse is determined by R142 and C65, and controlled slightly by L4. This output pulse controls the color gate, which gates the 3.56-MHz oscillator. The net result is a pulse of burst frequency occuring on the horizontal sweep at a position controlled by the Horizontal Position control.

The circuit also keys the pattern generator in the single crossbar mode so that the vertical line may be moved across the screen. A similar circuit keys the horizontal pulses on the vertical sweep so that a horizontal line may be moved up and down on the screen.

The Model 865 has a variable-level RF output on either channel 3 or 4, as determined by the selector switch on the front panel.

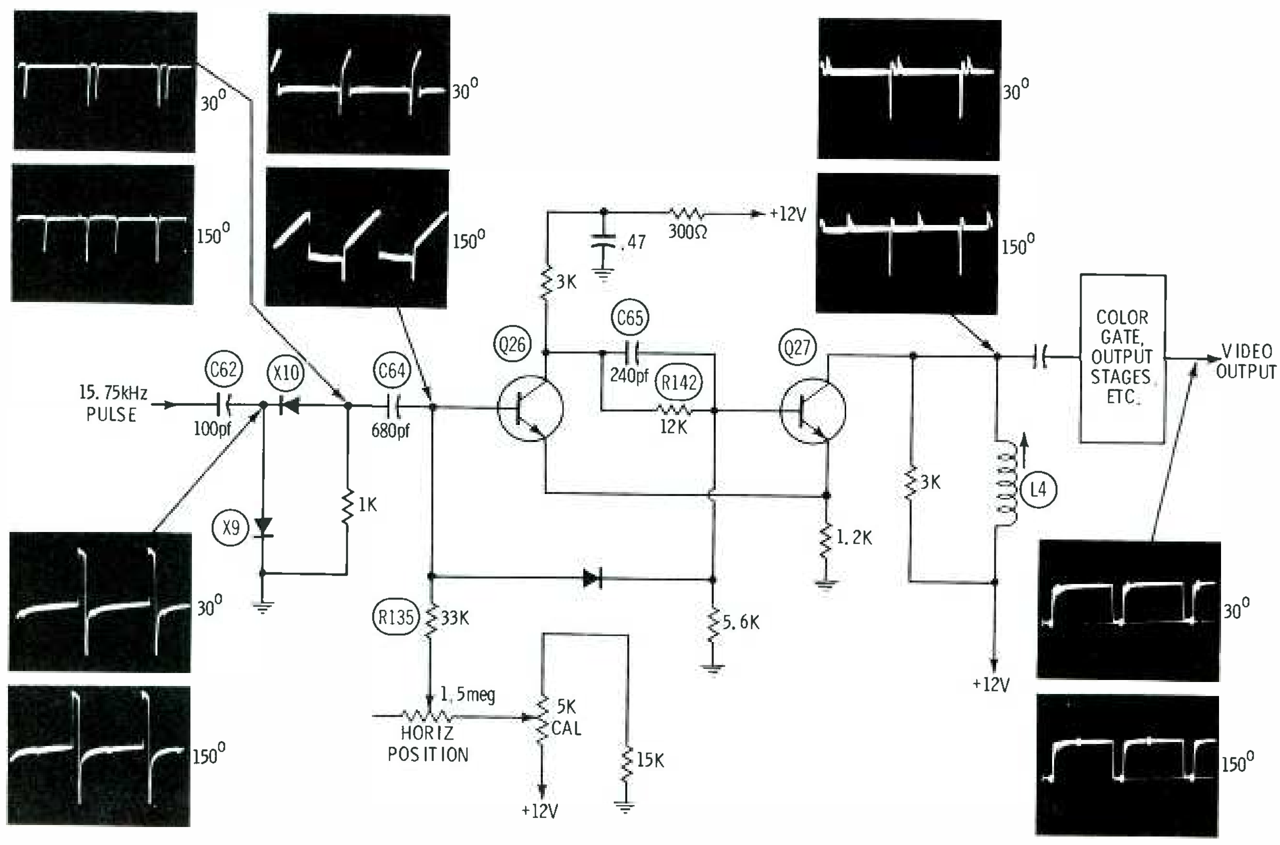


Fig. 3. Partial schematic of CTC22 chroma circuits.

Amphenol Model 865 Specifications

Patterns

Color:

Standard keyed rainbow.
Three-bar (90°, 180°, 270°).
Single Bar, variable between 30° and 300°.

Convergence:

Single crossbar, movable.
Single dot, moveable.
Crosshatch, 20 × 15 lines.
Dots, 300 in 20 × 15 array.
Vertical lines.
Horizontal lines.

Outputs

RF:

All patterns, channel 3 or 4, level variable to about 50 mv p-p.

Video:

All patterns, black positive, level fixed at about 1V p-p.

Dividers

Multivibrator, locked from 315-kHz crystal.

Chroma

Offset-carrier, level variable 0-200%.

Power Requirements

Battery—12 AA cells.
Line—115 VAC, 60 Hz.

Size (HWD)

6-5/8" x 9-1/4" x 5".

Weight

4 lbs.

Price

$18.95.

The maximum output level is about 50,000 microvolt into a 300-ohm load. There is also a video-output jack on the front panel, with a fixed output of 1 volt peak-to-peak. The chroma modulation level is variable from 0 to 200%. ▲

MOVING?

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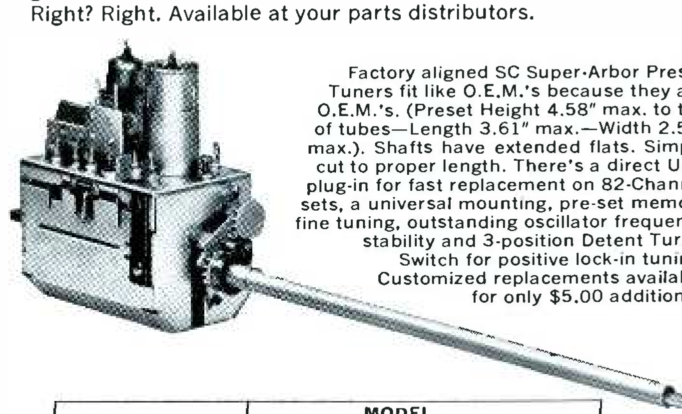
PF REPORTER
CIRCULATION DEPT.
4300 W. 62nd St.
Indianapolis, Ind. 46206

Circle 65 on literature card

It costs you less to repair a tuner than to buy a new one. Right?

Wrong!

Figure it out. Repairing costs about $9.75. New tubes cost around $3.00. Now add your time and cost for packing and shipping to say nothing of the money you're out while waiting for it to be returned. (And who pays for your call back if another part of the tuner fails.) A brand new SC Super Arbor Preset Tuner with mounting brackets and tubes costs $12.95. And you can pick it up in whatever time it takes you to get to the distributor—5, 10, 15 minutes. You get a new tuner warranty—1 year from date of purchase. The new tuner costs you less in time and money. Your customer gets a brand new tuner instead of a used one. Everybody's happy. Right? Right. Available at your parts distributors.



Factory aligned SC Super·Arbor Preset Tuners fit like O.E.M.'s because they are O.E.M.'s. (Preset Height 4.58" max. to top of tubes—Length 3.61" max.—Width 2.50" max.). Shafts have extended flats. Simply cut to proper length. There's a direct UHF plug-in for fast replacement on 82-Channel sets, a universal mounting, pre-set memory fine tuning, outstanding oscillator frequency stability and 3-position Detent Turret Switch for positive lock-in tuning. Customized replacements available for only $5.00 additional.

	MODEL		
13 Position Switch	SBR-250	SBRS-252	SBR4S-251
Antenna Input	300 ohms balanced to ground.......		
Intermediate Frequency	41.25 mc sound 45.75 mc video		
RF Amplifier Tube	6HQ5	2HQ5	3HQ5
Oscillator-Mixer Tube	6GJ7	5HB7	5GJ7
Heater	6.3 volts	600 ma	450 ma
B Plus	125-145 volts dc....................		

sk *Standard Components*

DIVISION OF STANDARD KOLLSMAN INDUSTRIES, INC.
2085 North Hawthorne Ave. • Melrose Park, Illinois 60160

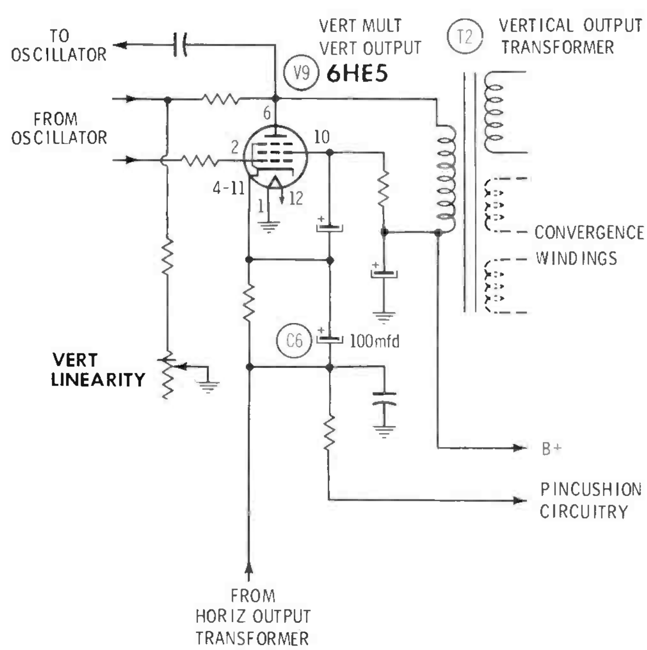
Circle 30 on literature card

THE TROUBLESHOOTER

Shifting Convergence

We had a Zenith 23XC36 (PHOTOFACT Folder 863-3) in the shop which would not hold convergence. The vertical size and linearity also shifted a little bit, which directed our attention to the vertical stages. The trouble was finally traced to C6 in the vertical-output cathode circuit. This capacitor intermittently had a small amount of leakage.

L. W. BOWERS
Opa-locka, Fla.



This could have been a dog to troubleshoot if you hadn't noticed the slight vertical size problem. Usually, it pays to look for all the symptoms, and fix the easiest ones first.

Watch The Shield!

We have found a couple of Philco Q1214 receivers (PHOTOFACT Folder 866) with soft vertical hold. When the chassis was removed from the cabinet, the symptom disappeared. The trouble was finally traced to the shield on the left side of the yoke, between the yoke terminals and the IF terminal board. Bend it so that there is at least 1/8" clearance from the terminals, and the trouble is cured.

GLENN SCHAEFER

Peoria, Ill.

Thanks for the tip, Mr. Schaefer. We're sure this tip will save a lot of time for the next fellow who runs into the problem. Troubles of this sort can be real dogs since there actually is no defective component.

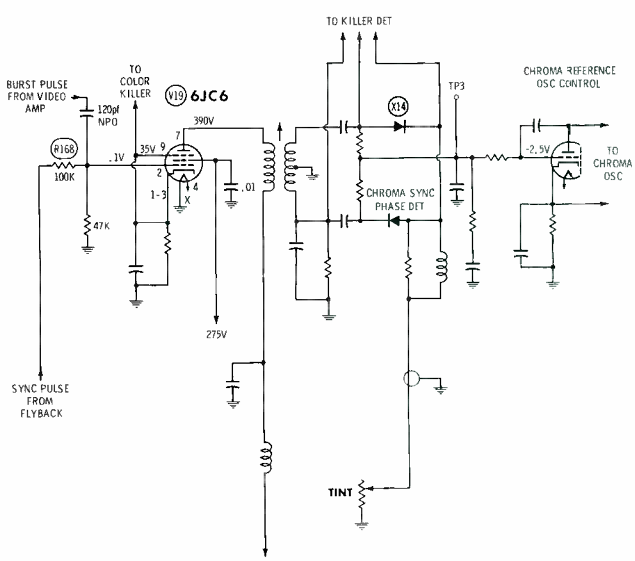
Barber Pole

An RCA CTC25X (PHOTOFACT Folder 879-3) came into the shop with good b-w reception, but a bad case of barber pole on color programs. Tube changing did not improve conditions, so we hooked up the color generator for further tests.

We grounded TP3, and the color bars would float, which indicated trouble ahead of the reactance stage. Scope checks at the phase detector revealed that the burst signal was missing. Moving over to the burst amplifier plate, there was still no burst, but at the grid, the burst pulses were present. However, the keying pulses on the burst amplifier grid were absent. Scoping at the hot side of R168 showed good keying pulse, and an ohmmeter confirmed that R168 was open. Replacing the resistor restored the color sync.

CHARLES E. RAMBO

Elkton, Md.



Score another point for the scope team. This particular trouble could have been uncovered eventually with a VTVM, since the burst amplifier cathode voltage would be much lower than usual. But Mr. Rambo found the trouble with four quick peeks with the scope.

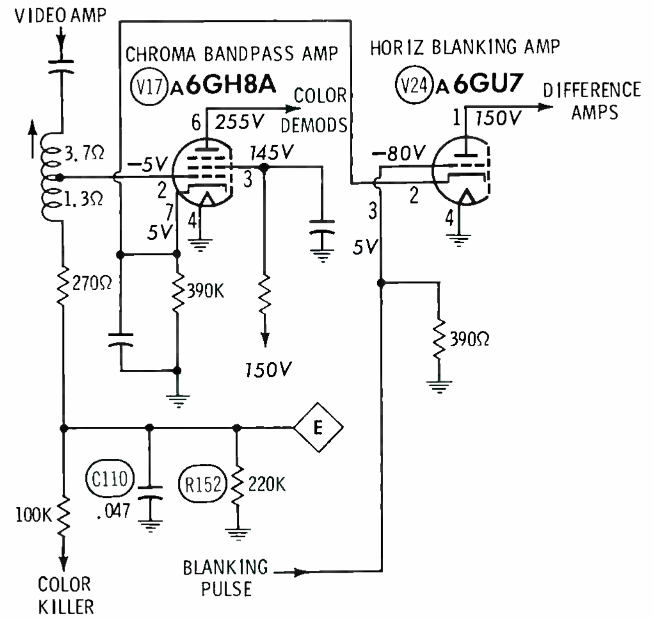
Blanking Trouble

I had an RCA CTC16 (PHOTOFACT 736-4) that displayed a very bright raster, but only on the right side of the screen. After several preliminary tests, the trouble was narrowed to the blanking stage—and pinpointed in the chroma bandpass stage.

The trouble turned out to be a shorted C110 in the grid circuit. This condition allowed the bandpass to nearly saturate, disabling the blanker.

BERNARD SEROTA

Philadelphia, Pa.



Problems like this help keep a technician on his toes. So many circuits are interdependent in the color set that a thorough knowledge of circuit theory is a "must".

Circle 19 on literature card

PHOTOFACT BULLETIN

PHOTOFACT BULLETIN lists new PHOTOFACT coverage issued during the last month for new TV chassis. This is another way PF REPORTER brings you the very latest facts you need to keep fully informed between regular issues of PHOTOFACT Index Supplements issued in March, June, and September.

Arvin Chassis 1.38001, 1.38101 962-1
78K39 964-1

General Electric
Chassis S-2 965-1

Magnavox Chassis T927-01-AA 963-1

Motorola Chassis C23TS/ D20TS/ E20TS/E23TS/F20TS/ F23TS/20TS-921 960-1

Panasonic CT-61P 963-2

Sears Silvertone
Chassis 456.71120/21, 528/529.71120 Thru 41 960-2
Chassis 456/528/529.72370 thru 380, 528/529.72386 thru 392, 528/529.72600/620 965-2
Chassis 456/528/529.72440 thru 528/529.72581 961-1
Chassis 564.80020 962-2

Sony TV-500U 964-2

Sylvania Chassis B09-1, B09-2 960-3

Symphonic TPT800 962-3

Zenith Chassis 14Z26, 14Z27 961-2
Chassis 14Z33, 14Z34, 14Z43 964-3

Production Change Bulletin

Admiral Chassis H12NC74-1, H1257-1/-3, H1261-1/-3, H1297-2, 1H1256-3, 1H1297-1, 2H1261-1 960-4

General Electric
Chassis LY (Code 332 to 406) ..963-3

Magnavox Chassis T/U908-01 thru -07 Series, T/U908-10 thru 12 Series, T/U908-14 Series 964-4

Motorola Chassis DTS-/NDTS-/SKTS-489, KTS-/VKTS-588Y, SKTS-/VKTS-588 961-3
Chassis STS-/TS-914Y, TS-914YB Coded B-03 thru B-14 962-4

Sears Silvertone
Chassis 456/528/529.61720 thru 885 965-3
Chassis 562.10161 962-4
Chassis 528.70330 964-4
Chassis 562-10121 961-3

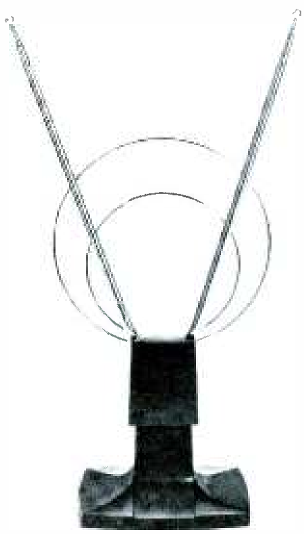
Sylvania Chassis 571-1/-2/-3/-4 960-4

PRODUCT REPORT

for further information on any of the following items, circle the associated number on the Catalog & Literature Card.

Indoor Antenna
(50)

An 82-channel antenna featuring a rotating scanner has been introduced by **Gavin Instruments, Inc**. The rotating scanner enables the user to aim



for best picture without moving the base. The Model "Monitor 500" includes separate leads for VHF and UHF. Price is $9.95.

Citizens-Band Antenna
(51)

A Model RTB-27-L CB antenna is designed for roof-top or any flat-surface mounting. The **New-Tronics** antenna features an adjustable impedance matching device and is pretuned at the factory. Price is $26.95.

Multimeter
(52)

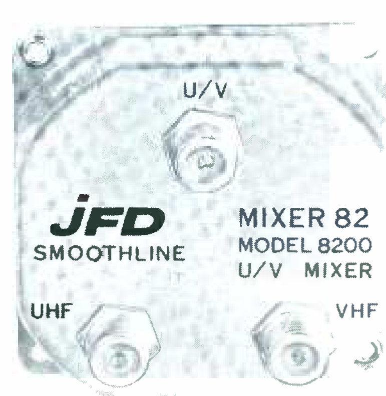
This volt-ohm-milliameter features burn-out protection for the amplifier and meter and has 16 voltage ranges: DC from .15 to 1500 volts, full scale; AC from 1.5 to 1500 volts, full scale: The unit has seven current ranges covering 1.5 micro amps to 1.5 amps, full scale, and six resistance ranges to cover 10 ohms through 1 megohm, midscale. Input impedance is 2 megohms/volt on low ranges and 36 megohms/volt on high ranges, while the AC input impedance is 250,000 ohms/volt shunted by 200 pf.

The **Julie Research Laboratories** unit is powered by one 9-volt battery and one 1.5-volt penlite battery. Weighing only 2 lbs., the unit measures 5¼" wide by 6⅞" high by 2¼" deep. Price of the Model TVM 4A is $69.95.

U/V Mixer
(53)

A coaxial mixer capable of combining or splitting UHF and VHF television signals has been announced by **JFD**. The unit is designed for indoor use but can be used outside when encased in a weatherproof housing.

The Model 8200 features a .5-dB maximum loss with 20-dB isolation between UHF and VHF signals. Im-



pedance is 75 ohms with a 1.2 VSWR. The unit measures 2 5/16" x 2 5/16" x 1½". Price is $12.50.

Nutdriver
(54)

A 4-in-1 nutdriver which adjusts to fit any hex nut size from ¼" to 7/16" has been introduced by **Upson.** The handle is unbreakable, shock-proof,

and fire resistant, and the tool is fully UL approved. Each nutdriver is individually carded and packed 10 per box.

Wide-band Scope
(55)

This solid-state oscilloscope by **Telequipment** is the first addition to the low-priced product line being marketed by Tektronix. The unit is intended for use in education, radio, TV, hi-fi/audio and industrial applications.

The many features include: triggered sweep, DC to 10-MHz bandwidth at .1V/cm deflection factor, calibrated vertical voltage and horizontal time with a 5% accuracy, sweep rates of .2μs/cm to 2S/cm in standard switch sequency steps and variable between positions, selectable sweep triggering with TV frame/line capability, and a 6cm x 10cm rectangular CRT. The manufacturer includes a one year warranty against defective materials and workmanship.

Weighing only 17 lbs., the unit measures 9" high by 7" wide by 16" deep. Price of the Model S54 is $350.

Minimum Current Indicator
(56)

A method for adjusting horizontal-output tubes for minimum cathode current is made possible with this unit

by **Eby Sales Corporation.** It can be used with novar, compatron, octal and noval tubes. Price is $3.00.

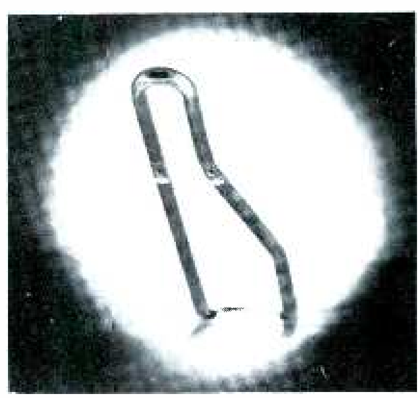
Intercom Amplifier
(57)

This central amplifier by **Fisher Berkeley Corporation** permits the user

to call all 12 stations or only a single station with a telephone handest. The unit provides 10 watts continuous power with 16 watt peaks. The price of the CM-12 master amplifier is $69.50.

Desoldering Tip
(58)

This soldering tip is designed for the purpose of removing excess solder and defective parts from printed-circuit boards. The tip has a small hole in the center to provide a means of capillary attraction. The **Desolderette**



unit can be used with most popular soldering guns to enable the user to have complete control of the heat. Price is $1.86.

Color-Bar Generator
(59)

This color-bar generator is a new addition to the line of test equipment offered by **RCA.**

Incorporating solid-state circuitry, the unit is a portable, battery-operated test instrument designed to provide signals required for convergence, color-phasing, matrixing, purity, and linearity adjustments of color television receivers. The patterns generated include color bars, dots, crosshatch, vertical lines, horizontal lines, and blank raster. It also includes a slide switch for shorting out the CRT control grids, with leads provided for connection to the color picture tube socket, thus making it possible to kill the red, blue, or green gun as required for convergence or purity adjustments.

Circle 27 on literature card

Circle 28 on literature card

The unit is crystal controlled with a 4.5-MHz sound carrier added to the color-bar pattern. RF output is provided for channel 3, with the generator output cable connected to the antenna terminals of the receiver. The unit is powered by a 4.2 volt mercury battery, with provisions for indicating battery condition and switching in an alternate battery when the first one becomes weak.

The WR-502A Chro-Bar weighs only 4 lbs. and measures 6½" x 7" x 4". Price is $168.00.

Tuner Care

(60)

A new product developed for the purpose of cleaning and protecting tuner contacts has been introduced by **Tech Spray.**

The aerosol product, called Blue Stuff, is a thick concentrated foam that does not evaporate or run-off. The cleaning agent clings to the contacts and continues to clean or polish contacts each time the tuner is turned Price of an 8 oz. can is $1.99.

Inverter
(61)

This portable inverter delivers 110 volts AC 60 Hz at 140 watts maximum from a 12 volt DC source. The **ATR Electronics, Inc.** unit is "frequency stable" and automatically controlled, making it suitable for operating most 11" and 13" portable TV sets in automobile, boat, mobile home or aircraft. Price of the Model 12T-RME-1 is $39.95.

Mobile Public Address
(62)

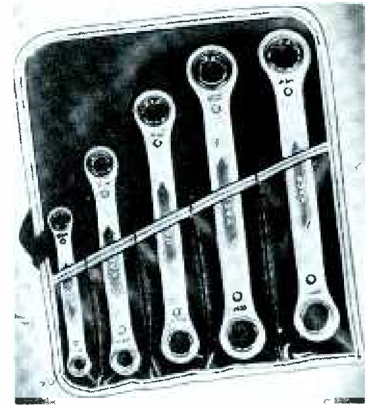
The mobile public address system introduced by **Bell P/A Products Corporation** is intended for use in sports events, parades, political campaigns, civil defense, traffic safety, general fire and police duty, and for outdoor promotions and special events.

The system includes a 30-watt amplifier, microphone, twin speakers and car-top mounting assembly. A bracket for mounting the amplifier under the dash allows the unit to be plugged into the cigarette lighter or connected to a 12-volt battery for permanent installation. Separate microphone and phono/auxilliary gain controls enable the user to mix voice and music. The dynamic, low-impedance microphone has a frequency response of 100-7000 Hz and is equipped with a hang-up bracket and press-to-talk switch. The speakers have a frequency response of 250-1400 Hz and a dispersion of 120° by 90°. The 8-ohm speakers measure 11" x 6½" x 8½" each and are mounted on universal swivels. The car-top mounting assembly is supported by neoprene suction cups and vinyl coated clamps.

The Model TM-30 amplifier measures 5⅞" high by 8½" wide by 5" deep, including the mounting bar. Price of the complete system is $180.00.

Wrenches
(63)

A set of ratchet box end wrenches will come in handy for repairs in any trade. This set by **Vaco Products Company** is nickel-chrome plated and can be purchased as a set or singly. Hex openings range from ⅜" to ¾",



and length from 8⅝" to 4½". The price for a set of five in a leatherette pouch is $20.

Advertisers' Index

FREE Catalog and Literature Service

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

ANTENNAS

100. *BLONDER-TONGUE*—24-page product guide to TV-FM reception products.
101. *DELHI*—Twelve-page catalog introducing a complete new line of home TV, ham, and Citizens-Band towers, masts, and telescoping masts.
102. *FINNEY* — 4-color brochure with description and technical details on new Finco Color Spectrum frequency-dependent antennas for UHF-VHF-FM, VHF-FM, and UHF. Form 20-413.*
103. *GAVIN INSTRUMENTS* — 6-page folder illustrating the complete outdoor antenna line, converters, and accessories with technical data.*
104. *JERROLD*—Complete catalog on antennas, reception aids, and TV distribution equipment (Form No. DS-C-1054).
105. *JFD*—Catalog SYS-68 about Smoothline MATV components, active and passive—from antennas to coaxial cable.
106. *MOSLEY*—Catalogs on CB, amateur radio, and TV/FM antennas.*
107. *RMS*—Illustrated specification sheets describing Direction Finder antennas new gold "Secure-lock" masts, and new antenna mounts.*
108. *WINEGARD*—Fact-finders on "Color-Tracker" UHF antennas and a solid-state, 4-set booster-coupler.*

AUDIO

110. *ATLAS SOUND*—Circular 2535 describes the "Banshee" music horn for music groups.
111. *ELECTRO-VOICE*—Pocket-size guide-books for microphones, hi-fi loudspeakers, and hi-fi systems.*
112. *JENSEN*—Brochure 250 gives full information about Model SEM-225 and SEM-222 musical instrument speakers.

COMMUNICATIONS

114. *AMPHENOL*—2-color spec sheets on new Model 650 CB transceivers and Model C-75 hand-held transceiver.
116. *PEARCE-SIMPSON* — 16-page color brochure includes illustrations and specs on complete line of CB and business/industrial radios.

COMPONENTS

117. *BELDEN*—Catalog 867, a 56-page catalog of the complete Belden line.
118. *BUSSMANN* — New 1968, 16-page car and truck fuse list. Shows what fuse protects—proper fuse to use and where fuse is located. Also shows what BUSS fuse to use in servicing foreign cars and trucks. Ask for BUSS Form AWC.*
119. *CENTRALAB*—24-page replacement parts catalog 33GL.
120. *CORNELL-DUBILIER*—New 120 page Electronics Component Selector catalog, describes the complete CDE line.*
121. *GC*—Giant wall chart with complete pictorial and cross-reference of phono and tape drives, belts, and pulleys.
122. *IRC* — Brochure describing new "Snap Pak" resistor package.
123. *LITTELFUSE* — Pocket-sized TV circuit-breaker cross-reference, CBCRP, gives the following information at a glance: manufacturer's part number, price, color or b-w designation, and trip ratings.*
124. *MALLORY*—Bulletin 4-82 describes radial- and axial-lead tantalum capacitors.*
125. *MILLER*—Catalog 167, a 156-page general catalog with complete cross-reference guide.
126. *QUAM-NICHOLS* — Catalog No. 67 has information on the entire line.
127. *SPRAGUE*—C-618, a new, complete, general-line catalog.*
128. *TEXAS CRYSTALS*—12-page catalog of crystals including engineering data, specifications, and prices.*
129. *TRIAD* — Engineering bulletin on toroidal and power inductors.
130. *WORKMAN* — New cross-reference for VDR's and thermistors used in color TV.*

SERVICE AIDS

131. *CASTLE TUNER*—Fast overhaul service on all makes and models of television tuners. Shipping instructions, labels, and tags are also included.
132. *COLUMBIA*—Bulletin C503 about Humiseal Protective Coatings.
133. *INJECTORALL* — Literaure describing line of electronic chemicals and tools.*
134. *PERMA POWER* — Technical information on isolation briteners for color TV.

SPECIAL EQUIPMENT

136. *EUPHONICS*—Catalog sheet MA-2 about Ultrasonic Intrusion Alarm, for boats and trucks.
137. *STANDARD KOLLSMAN*—Flyers describe replacement TV tuners, built-in UHF converters, external UHF-to-VHF and VHF-to-UHF converters, and contact cleaner kits.*
138. *VECTOR* — Literature about new "Micro-Klip" terminal for use on plugboards.

TECHNICAL PUBLICATIONS

140. *CLEVELAND INSTITUTE OF ELECTRONICS* — Free illustrated brochure describing electronics slide rule, four-lesson instruction course, and grading service.*
141. *RCA INSTITUTES*—New 1968 career book describes home study programs and course in television (monochrome and color), communications, transistors, and industrial and automation electronics.*
142. *SAMS, HOWARD W.*—Literature describing popular and informative publications on radio and TV servicing, communication, audio, hi-fi and industrial electronics, including special new 1968 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

143. B & K — Brochures about the B & K, Precision Apparatus, and "Cobra" lines.*
144. *EICO*—New specification sheet describes model 100A4 multimeter with DC sensitivity of 100K ohms per volt.
145. *HICKOK*—Specification sheets covering Models CR-35 CRT analyzer, 860 Injecto-Tracer, GC-660 color generaor, 677 wide-band scope, and 661 NTSC color-bar generator.
146. *LECTROTECH* — Two-color catalog sheet on new Model V6-B color bar generator gives all specifications and is fully illustrated.
148. *SECO*—Operating manual for Model 240 SCR Analyzer.
149. *SENCORE* — New 12-page catalog on all Sencore products.
150. *SIMPSON*—New 16-page catalog on all Simpson Test Equipment.
151. *TRIPLETT*—Literature sheet on completely new FET VOM with 11-megohm input impedance.

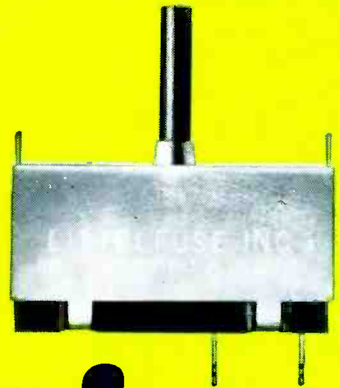
TOOLS

152. *ARROW*—Catalog sheet showing 3 staplegun tackers designed for fastening wires and cables up to ½" diameter.
153. *CHANNELLOCK*—Brochure describing new curved jaw pliers.
155. *ENTERPRISE DEVELOPMENT*—Brochure from Endeco demonstrates improved desoldering and resoldering methods for speeding and simplifying operations on PC boards.
156. *JENSEN*—66-page catalog 368, includes over 1700 items with technical data and specifications.
157. *SWING-O-LITE* — Catalog sheet on Models BBM-9 and BB-45 bench lamps.
158. *XCELITE*—Bulletin N867 describes hollow-shaft nutdrivers which speeds locknut/screw adjustments.

TUBES AND SEMICONDUCTORS

159. *GENERAL ELECTRIC*—Entertainment semiconductor almanac, ETR-4311C, and picture-tube replacement guide, ETR-702K are offered.
160. *IR*—Flyer sheet about a new universal replacement transistor (type TR-27) for vertical- and horizontal-output applications.
161. *MOTOROLA* — HEP cross-reference guide lists approximately 12,000 semiconductor types.
162. *RCA*—1D1304, a 12-page brochure on RCA's line of all-new HI-LITE color picture tubes for the replacement market. Explains latest technological advances, such as brightness, Perma-Chrome and unity current ratios.* ▲

Give yourself a break you can depend on!



actual size
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#094077

CIRCUIT BREAKER CADDY

10 ratings, one each 2-1/4, 2-1/2, 2-3/4, 3, 3-1/4, 4, 4-1/2, 5, 6 and 7 amps.

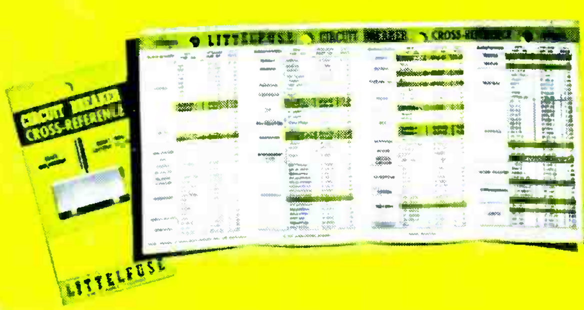
Designed for the protection of television receiver circuits, the Littelfuse Manual Reset Circuit Breaker is also ideally suited as a current overload protector for all types of electronic and electrical control wiring such as model railroads and power operated toy transformers, hair dryers, small household appliances, home workshop power tools, office machines and small fractional horsepower motors.

#094076

SERVICE CADDY
Breakers and Fuses

One service call is all —8 breakers—one rating each 2-1/4, 2-3/4, 3, 3-1/4, 4, 4-1/2, 5 and 7 amps and 30 fuses—five each type C3/10, C1/2, C3-1/2, N3/10, N7/10 and N1.

Available individually packaged one breaker per display card; or 5 breakers of same rating per unit pack or as complete, versatile assortments for shop use or replacements in the field.



Included with each assortment:
Pocket size cross reference on color and black/white TV circuit breaker applications.
Form No. CBCRP-1266H

LITTELFUSE

DES PLAINES, ILLINOIS