

# PF Reporter®

PHOTOFACT

*the magazine of electronic servicing*

Special Feature

## FACTS ABOUT X-RADIATION AND COLOR TV

Don't *you* be caught  
without a replacement.  
Use the TV Tube  
Stock Guide on  
page 22



- Multiple Trouble With a Combo Receiver
- The "Hotshot" Jumps To A Conclusion
- A "Way-Out" Hybrid Auto Radio Problem

**REMEMBER TO ASK—  
"WHAT ELSE NEEDS FIXING?"**

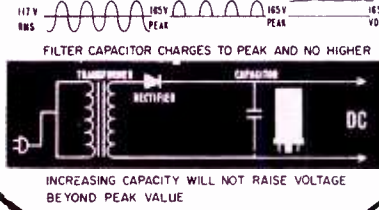
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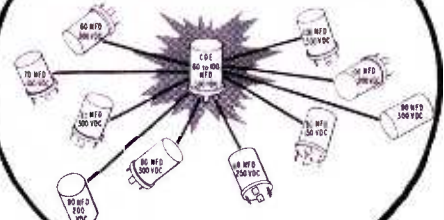


- A wet battery rated at 100 amp hours versus a dry cell rated at .01 to 1 amp hour.
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Circle 1 on literature card

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PHOTOFACT

*the magazine of electronic servicing*

VOLUME 18, No. 4

APRIL, 1968

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Subscription Prices: 1 year—\$5.00, 2 years \$8.00, 3 years—\$10.00, in the U. S. A., its possessions and Canada. All other foreign countries: 1 year—\$6.00, 2 years—\$10.00, 3 years—\$13.00. Single copy 75¢; back copies \$1.

Indexed in Lectrodex. Printed by the Waldemar Press Div. of Howard W. Sams & Co., Inc.

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## ABOUT THE COVER

The technician in this month's cover photo is explaining to the lady of the house that he doesn't have the replacement for a defective tube. Situations such as this are not only embarrassing, but also costly in terms of the time spent returning to the shop or distributor for a replacement. Both the embarrassment and the time could have been saved if the technician had maintained his caddy and shelf stock in accordance with the TV Tube Stock Guide beginning on page 22 of this issue.




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**DON'T FORGET TO ASK YOUR CUSTOMERS  
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65-8100R1





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Circle 4 on literature card



# THE ELECTRONIC SCANNER

## NATESA Training Programs

To meet the growing shortage and need for more technicians due to expanding consumer purchases of home electronic devices, the **National Alliance of Television & Electronic Service Associations (NATESA)** is conducting, in various affiliate cities, concentrated upgrading courses covering all aspects of TV, radio, and other home instruments.

NATESA is also seeking financing for a radically new technician creation program based on practical requirements. Entrance to the training will be only to those with genuine aptitude for electronics service, regardless of formal schooling. NATESA states that their approach “. . . challenges the sincerity of industry, and of government agencies . . .”

In addition to their previous safety standards, NATESA has launched a program of intensive training on the three systems of high-voltage regulation, followed by written exams. Each member proving his capability by passing the test and signing a pledge to fully check horizontal regulation on every service call, will be awarded a “NATESA Safe Servicer Certificate.” Failure to fulfill the pledge will void certification.

## Challenges FTC Decision

(Ed. Note—Last month we reported that the FTC had rendered an opinion concerning the use of a rate schedule by TV technicians. NATESA requested the advisory opinion and has written a letter of rebuttal to Betty Furness, the president’s special assistant on consumer affairs. Portions of that letter are reproduced here:)

“Frankly, then, we were confused when we recently asked another Federal agency, the FTC, for an advisory on the issuance of some form of rate schedule, which we suggested could take into consideration varying economic areas of the nation, and makes and models. We suggested as an alternative, a ‘time to complete operations’ schedule that could be translated into dollars and cents by applying the individual servicer’s own

hourly rate. The FTC, though seemingly in sympathy, coldly turned down any rate schedule because there might be a danger of going too far.

"The decision was despite our comments that a 'blue book' of service rates has long and almost universally been used in the auto trades. Further, almost simultaneously a trade paper reported that the FTC had apparently authorized a home improvement association to issue a rate schedule for that industry, which too has been plagued by 'phony bargain peddlers.'

"Yes, we are confused that a Federal agency should deny the public the right to guide lines on service of TV and other home electronics devices. Isn't this distinctly in your area of operation?"

Sincerely,  
**NATESA**  
 Frank J. Moch  
 Executive Director

### Donates Tubes

Historical TV tubes, among the world's first, were recently donated to the Smithsonian Institution by **Dr. Philo T. Farnsworth**, noted scientist of International Telephone and Telegraph Corporation (ITT). Five 40-year-old camera and picture tubes, plus all of his documents and laboratory notebooks of the time, were given upon invitation by the Smithsonian. Dr. Farnsworth earned the sobriquet "Father of Electronic Television" for his inventions in his late 'teens and early twenties, which triumphed in the patent courts. The tubes, dating from 1927, include (left to right on the table) the first image dissector, first projection oscilloscope, a primitive image orthicon with electron multiplier, and the first oscilloscope tube with a flat screen.



Victoria Lynch of ITT holds the world's first oscilloscope with internal deflection plates.

### NEA Board Meets

Among the highlights of the recent Board of Directors meeting of **The National Electronics Association** (NEA) was a decision to give Certified Electronic Technician (CET) Committee Chairman Howard Bonar

the last time you used a 'scope, did you really need more performance than these Heathkit® models provide?



**IO-17 SPECIFICATIONS** — **VERTICAL CHANNEL:** Input impedance: 1 megohm shunted by 25 pF; x 50 attenuator position 1 megohm shunted by 15 pF. Sensitivity: 30mV P-P/div. (uncalibrated). Frequency response: 5Hz to 5MHz ±3 dB. **HORIZONTAL CHANNEL:** Input impedance: 10 megohm shunted by 15 pF. Sensitivity: 300 mV P-P/div. Frequency response: 2Hz to 300 kHz ±3 dB. **HORIZONTAL SWEEP GENERATOR:** Sweep generator: Recurrent type. Frequency: 20Hz to 200 kHz in four overlapping ranges. Retrace: Blanked by a pulse from blanking amplifier. Synchronization: Automatic type. **GENERAL:** Tube complement: (1) 3RPI cathode ray tube, medium persistence, green trace; (3) 12AU7; (1) 12AX7; (1) 6GH8; (1) 6BH6; (1) 6BQ7. Power requirements: 105-125 volts 50/60 Hz or 210-250 volts 50/60 Hz. Power consumption: 60 watts. Overall dimensions: 9½" H x 5½" W x 14½" L. (Dimensions include handle, knobs, etc.). Net weight: 12 lbs.



**IO-14 SPECIFICATIONS** — **(VERTICAL)** Sensitivity: 0.05 V/cm AC or DC. Frequency Response: DC to 5 MHz — 1 dB or less; DC to 8 MHz — 3 dB or less. Rise time: 40 nsec (0.04 microseconds) or less. Input impedance: 1 megohm shunted by 15 pF. Signal delay: 0.25 microsecond. Attenuator: 9-position, compensated, calibrated in 1, 2, 5 sequence from 0.05 V/cm to 20 V/cm. Accuracy: ±3% on each step with continuously variable control (uncalibrated) between each step. Maximum input voltage: 600 volts peak-to-peak; 120 volts provides full 6 cm pattern in least sensitive position. **(HORIZONTAL)** Time base: Triggered with 18 calibrated rates in 1, 2, 5 sequences from 0.5 sec/cm to 1 microsecond/cm with ±3% accuracy or continuously variable control position (uncalibrated). Sweep magnifier: X5, so that fastest sweep rate becomes 0.2 microseconds/cm with magnifier on. (Overall time-base accuracy ±5% when magnifier is on.) Triggering capability: Internal, external, or line signals may be switch selected. Switch selection of + or — slope. Variable control on slope level. Either AC or DC coupling. "Auto" position. Triggering requirements: Internal; 0.5 cm to 6 cm display. External; 0.5 volts to 120 volts peak-to-peak. Triggering frequency response: DC to 2.5 MHz approx. Horizontal input: 1.0 v/cm sensitivity (uncalibrated) continuous gain control. Bandwidth: DC to 200 kHz ±3 dB. Power requirements: 285 watts. 115 or 230 VAC 50-60 Hz. Cabinet dimensions: 15" H x 10½" W x 22" D includes clearance for handle and knobs. Net weight: 40 lbs.



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Circle 5 on literature card

authority to turn over test grading responsibilities to **International Correspondence Schools (ICS)**.

NEA has been looking for an outside accrediting agency to take any "personalities" out of the certification system. They believe ICS is ideally suited to handle NEA's test papers, which involve 120 multiple-choice practical and theory questions concerning electronic service. Technicians in 19 states have been certified by NEA.

NEA has also been working with ICS concerning the apprenticeship and training program. NEA is recommending a new television service course by ICS (not a correspondence course) to its members and the trade in general to aid service dealers to train young men entering the service business.

Presently, apprenticeship and training is a four-year program leading to a journeyman TV service technician rating. Trainees are registered in Des Moines and Waterloo, Iowa; Akron and Columbus, Ohio; Detroit, Michigan, and Waterbury, Connecticut.

### Project Transition

An unprecedented Defense Department program to train military personnel who are awaiting discharge in civilian skills has begun with the cooperation of the Service Technician Development Program (STDP) of the **Electronic Industries Association's (EIA)** Consumer Products Division.

"Project Transition," DOD's name for the new venture, aims at preparing exiting servicemen for immediate entry into civilian occupations via specialized

short-term training courses. The STDP has been tapped to conduct one of the first of these programs and has already begun training Army and Navy short-timers in the Chicago area to be consumer electronics technicians.

The Service Technician Development Program is a long-term, manufacturer-sponsored program to increase the numbers and improve the training of consumer electronics service technicians.

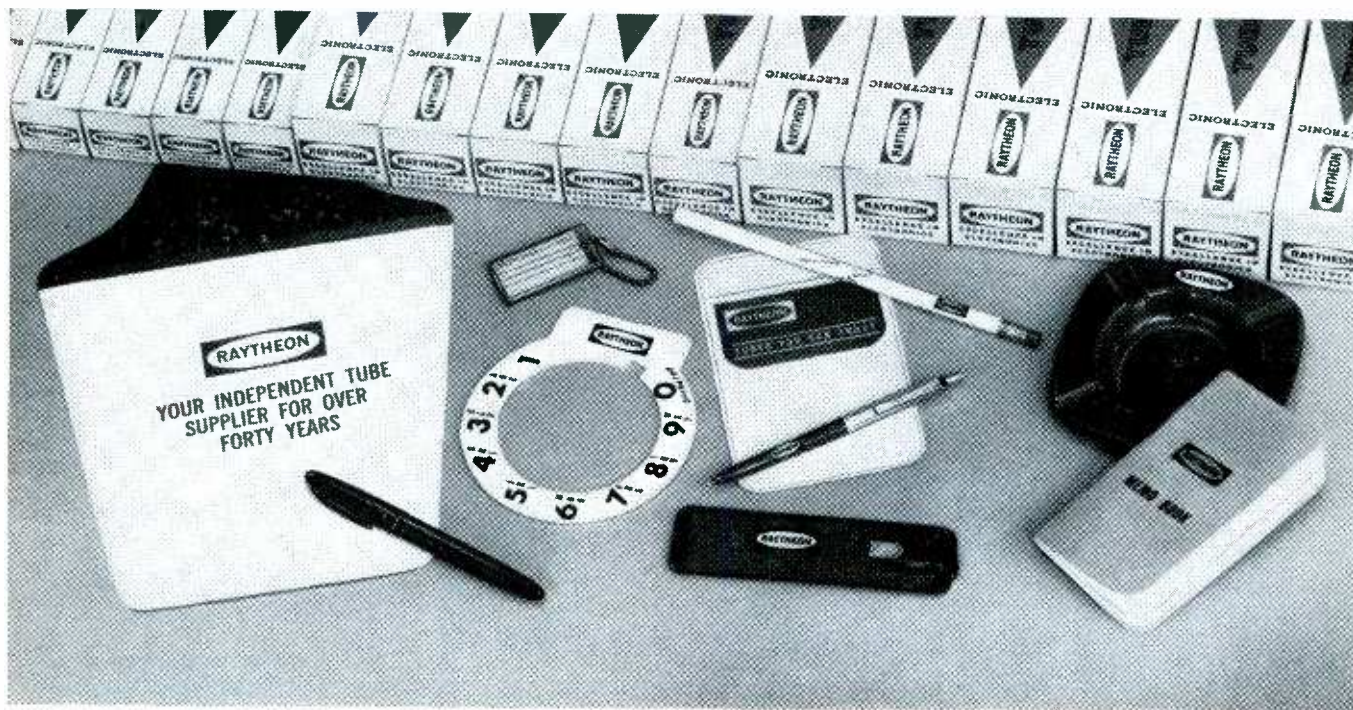
STDP Director of education and Training, Richard W. Tinnell, said expansion of the project to bases in New Jersey, Virginia, North Carolina, Texas, California, Indiana and Kentucky is being considered, since the Chicago pilot project has gotten under way.

"'Project Transition' will prove valuable for the STDP," Mr. Tinnell said. "We have learned a great deal about the design and effectiveness of short-term intensive curricula, information that will prove valuable in other areas."

The Consumer Products Division's STDP staff initiated and coordinated manufacturer cooperation in the venture. Arrangements were made for the industry to lend equipment to the project, with DOD providing facilities.

### Mergers and Expansions

**The Antenna Specialists Co.**, manufacturers of professional, citizens band, and amateur communications antennas and accessories, has executed an agreement to be acquired by Allen Electric and Equipment Company, according to an announcement by M. R. Friedman, Antenna Specialists president. ▲



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# \$975

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MFT-2	41.25 mc Sound 45.75 mc Video	3GK5	5LJ8	Series 450 MA
MFT-3	41.25 mc Sound 45.75 mc Video	2GK5	5CG8	Series 600 MA

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WEST..... SARKES TARZIAN, inc. TUNER SERVICE DIVISION  
 10654 MAGNOLIA BLVD., North Hollywood, California ..... TEL: 213-769-2720

Circle 7 on literature card

April, 1968/PF REPORTER 7

# radiation

## WHAT DOES IT MEAN TO YOU?

by **JOE A GROVES**, Manager, **PHOTOFACT Publications**

A year ago, if you had been asked as a TV technician what X-rays meant to you, chances are you would have said, "That's the pictures they take of your chest to see if you have TB, or of your leg to see if it's broken." Perhaps you'd have said, "That's what the dentist took of my tooth to see if it should be filled or pulled." It is almost certain that you would *not* have associated the term X-ray with color TV.

That is not so today, though. Today, virtually every adult in the country has heard or read something about TV sets and X-rays. Much of the information dispensed on this subject in the past year has been of the sensational variety. There have been exaggerated charges of danger, and over-simplified denials of no danger. What is a person to believe? More specifically, what is a TV technician to believe—one who works with these devices day in and day out? The aim of PF REPORTER is to clarify what X-rays mean to the technician and consumer, and to bring the whole realm of TV servicing safety into the proper perspective.

As you probably know, the subject of X-ray and TV sets came into the news in late spring of last year when General Electric Company started tracking down approximately 90,000 of their large-screen color TV's for modification. It was explained that the high-voltage regulator tube in some of the sets might emit soft X-radiation in excess of desirable levels. This announcement of preventive modification was similar in many respects to what we

have become accustomed to in the automotive industry where all major manufacturers have had occasion to call some of their cars back for modification in the interest of public safety. Lists of 41 models that might contain offending regulator tubes were widely circulated—identifying the tubes to be replaced as 6EA4, 6EF4, and 6LC6 tubes with white ink printing. It was recommended these tubes be replaced as follows:

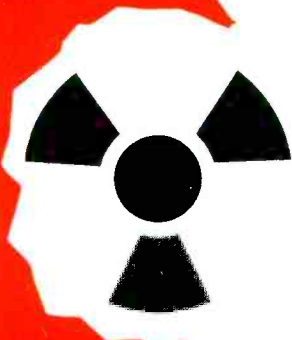
6EA4 use 6EH4

6EF4 use 6EJ4

6LC6 use 6LH6

Bonuses were offered, and within less than two months it was announced that the program was over 95% complete.

Perhaps the most significant aspect of this sequence of events is that attention was focused on the fact that there is a standard established for X-radiation levels for television sets. The existence of such limits has always been recognized by the equipment manufacturer's development and quality control departments. However, after the early '50's, there had been little attention directed toward X-radiation from TV sets. Now, however, information has been widely circulated that the National Council on Radiation Protection and Measurement (known as NCRP) has recommended that X-radiation levels for TV sets not exceed  $\frac{1}{2}$  (0.5) milliroentgens per hour, 5 centimeters (2") from the surface of the set. A milliroentgen is 1/1000 of the basic X-ray energy unit. Thus, the X-ray exposure from TV sets



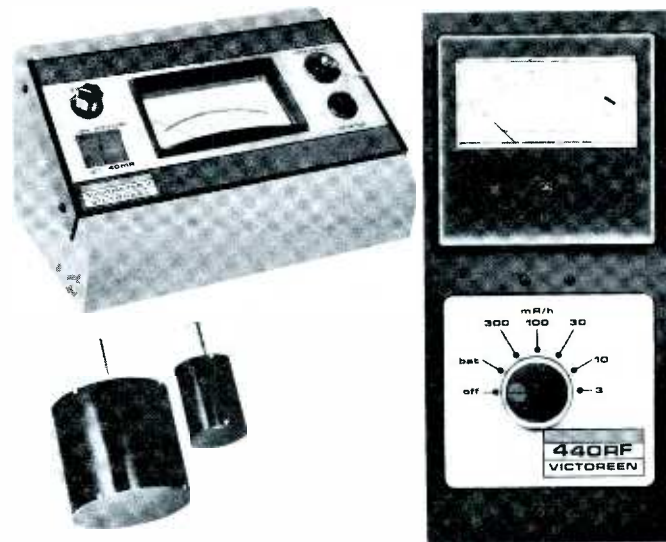


Fig. 1. One widely accepted standard for measurement of TV X-radiation.

under normal operating conditions represents a very small percentage of the natural "background" radiation that is a part of our everyday environment. This natural "background" radiation is all around us and is unavoidable since it comes from the ground we walk on, from the food we eat, from sources in outer space, even the bricks and stone in our homes, offices, etc.

The X-radiation from sources in outer space becomes more intense at higher altitudes. Consequently, the residents of a city several hundred feet above sea level receive greater amounts (up to 100 times) of background X-radiation than the residents of a city at sea level.

The phrase, "TV receivers under normal operating conditions," is of prime importance. It acknowledges that certain parts of a color TV may emit X-rays, but that appropriate steps have been taken in the design and manufacture of the set to make it safe for use. We will discuss what these steps are and what the technician's association with them are, a little later. However, let's look at where these X-rays may come from.

X-rays can be emitted from three possible sources in color TV receivers:

1. The high-voltage regulator tube.
2. The high-voltage rectifier tube.
3. The picture tube.

Emission of X-rays from the regulator tube will vary with voltage and tube current. Maximum radiation from the regulator will occur when the picture tube is dark. The

emission of X-rays from the rectifier tube occurs during that brief period when small reverse currents occur. X-ray radiation from the picture tube is dependent upon beam current and applied high voltage. Maximum emissions at rated CRT voltage will occur when there is a bright picture on the screen. It is possible for these emissions to increase if a condition exists where the picture does not completely fill the screen as a result of higher beam current.

At the present time, it is not practical for the TV technician to measure the radiation from a TV set. One measuring apparatus, accepted widely at the moment, is shown in Fig. 1. The apparatus includes a Victoreen Model 440RF doserate meter (electrostatically shielded), a model 208A ionization chamber, and a minometer, Victoreen II Model 687C.

During some recent tests in the Washington, D.C. area, the U.S. Public Health Service utilized a new measuring device. Details for the construction of this device have been released by the National Center for Radiological Health, and its circuitry is shown in Fig. 2.

Detailed instructions for making measurements of X-radiation from receiving tubes and display cathode ray tubes have been formulated by the JEDEC Electron Tube Council. These are identified as JEDEC publications No. 64 and 67 and are available from the engineering department, Electronic Industries Association, 2001 Eye Street, N.W., Washington, D.C., 20006.

A more familiar way of measuring radiation, especially to those former military personnel who serviced radar or were associated with nuclear devices, utilizes a film badge. The disadvantage of these devices is that they require skilled interpretation to determine the amount of exposure. In actual practice, there has been no indication of radiation when these badges were worn in television assembly areas or under rigidly-controlled bench service operations.

It is to the technician's advantage, therefore, to simply recognize that X-radiation does exist in and around color television receivers. However, there is no need to fear any ill effects from X-radiation if sound basic servicing procedures are followed. Just as the old pros can remember staying away from the metal bell of the picture tubes common in the early '50's, we must all learn to respect the potential of X-ray exposure while working around today's color sets.

To prove that it is possible to be exposed to X-rays if normal safety precautions are disregarded, we set up a very "unscientific" set of experiments in our lab under highly-controlled conditions. We took three pieces of ordinary film and sealed them in light-tight cardboard containers. Then, we took a normal operating color set with the high-voltage properly adjusted and operating at the rated line voltage, attached one of the film packages 2" below the shunt regulator and another directly to the top of the

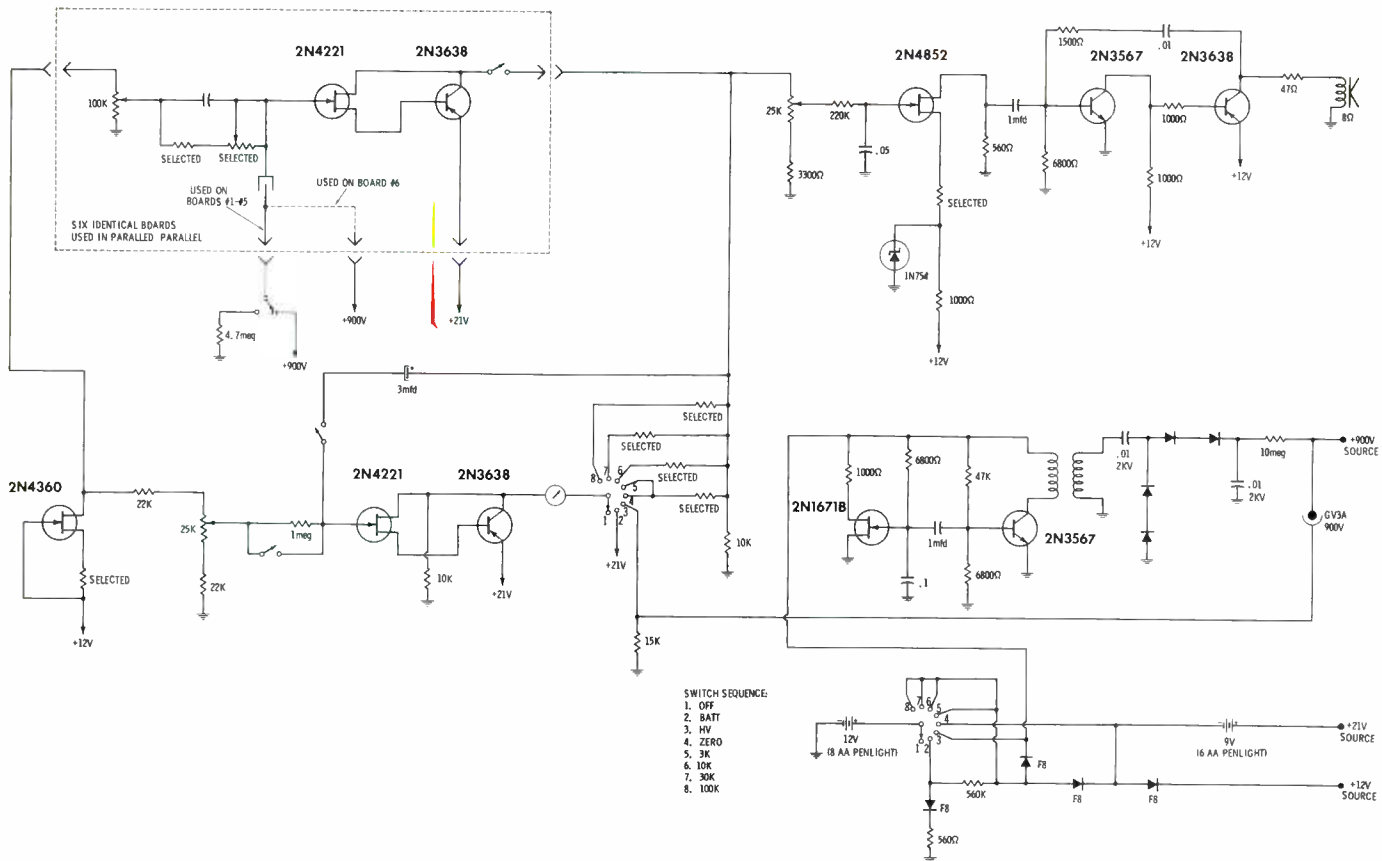


Fig. 2. Schematic for measuring device issued National Center for Radiological Health.

shield surrounding the shunt regulator. We operated the receiver under these "normal operating conditions" for a period of six hours as though we were "cooking in a chassis." At the end of this part of the experiment, we developed both

films and found absolutely no exposure on the film mounted directly below the regulator. The white areas visible in Fig. 3A show the amount of exposure at the top of the regulator. Contrast this with the result shown in Fig. 3B, which il-

lustrates the exposure that comes from a point 6" away from a regulator that has (1) had the shield removed, (2) the high voltage adjusted to a level above normal, and (3) the experiment conducted for a period of only one hour. Look



A. Radiation at top of regulator after 6 hours normal operation.



B. Radiation from side of regulator with shield missing, above normal high voltage, and only one hour of operation.

Fig. 3. Results of TV X-radiation experiment.

closely at Fig. 3B and you can see light streaks of various types and shapes. We packaged an extremely thin steel shield only .009" thick in the film container between the film and the regulator. The lack of penetration of X-ray in the darkened areas proves that even the thinnest of metal was sufficient to stop the X-rays. (Incidentally, three pages of PF REPORTER measure .009", so you can see the thickness of the shield we used.) *This experiment does not imply that unsafe levels of radiation existed, even under the abnormal conditions—only that you can expose yourself to more radiation than is necessary through unsound servicing procedures.*

After seeing the results of radiant energy from high-frequency X-rays in the preceding experiment, we decided to relate our findings to more familiar sources of radiant energy. The simplest way to do this, it seemed, would be to use an old fashioned alarm clock with a luminous dial and hands. Older clocks utilized radium in the fluorescent mixture; so we used one of these, exposed the clock face to light and then used the radiant energy to expose another film. The results of this experiment are shown in Fig. 4.

It must be noted that in this last experiment the frequency of the radiated energy is lower than that of X-rays and falls in the frequency range of light. Therefore, light energy also had a bearing on the exposure of the film. The results in Fig. 4 were produced after only 5 minutes of exposure.

*(Ed note: It must be noted here that the ordinary photo-type film used in the preceding experiments is not as sensitive to X-radiation as conventional X-ray film. Because the X-radiation from a radium-dialed clock or watch face is normally below .3 milliroentgens/hr, 2" from radiating surface (as compared to national standard for permissible radiation from TV, which is .5 milliroentgens/hr 2" from radiating surface) the film used in the preceding clock experiment was not sealed in a light-tight container. The low level of radiation would have been attenuated by the sealing material. Thus, light energy was also present and added to the exposure level of*

*the X-radiation energy. Therefore, the level of exposure of the film in Fig. 4 is not a direct indication of the amount of X-radiation present at the time the film was exposed.)*

X-rays are attenuated by any material placed in their path. Typical materials used to shield X-rays in TV sets include metal, glass, ceramic, etc. The amount of attenuation is determined by the type, density, and thickness of the material used in the shield and the energy of the X-rays involved. As pointed out in the foregoing experiment, even the thinnest of metal shields stopped the X-rays at a distance of 6" from the highest-energy point in the receiver under test. Therefore, it is important to make certain that all shields in the high-voltage and regulator circuits are firmly in place. When the door or lid of the high-voltage cage has to be opened for service, make certain the power is off before opening it, then perform whatever service is necessary and close the door again before apply-

ing power to the set. It is second nature, or at least it should be, to discharge the high-voltage lead to the high-voltage cage before opening the door and reaching inside. Therefore, make it normal practice to close the door again before applying power. This will permit you to establish a good habit—it's certain that we can all use more of them.

In addition to being sure that all shields are in place, the second most important step in controlling X-rays is to see that the high-voltage is adjusted to the proper level by using an accurate meter. It was mentioned previously that the energy of the X-rays involved had a bearing on attenuation. Higher voltages create higher energy X-rays which, in turn, require greater shielding. Also, the strength of the X-ray is inversely proportional to the distance from the point of emission. Translated, that means the further away from the radiating point the X-rays are, the weaker

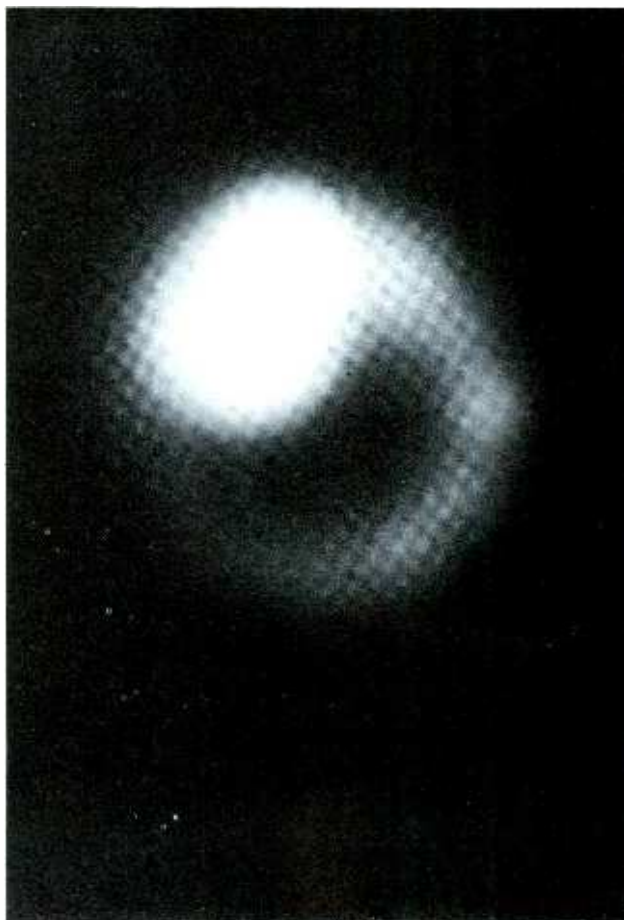


Fig. 4. Results of film exposed to clock with luminous dial.

they are. So, while servicing sets, physically keep yourself as far away as possible from high-voltage regulators, rectifiers, and picture tube bells. And, even more important, be sure to adjust the high-voltage to the amount stipulated in the service information for the particular chassis being serviced—making certain that brightness and contrast controls are set at minimum during the adjustment, and line voltage is regulated to the rated value indicated for the receiver. When these conditions are met, the shields, regardless of their material, will be adequate to hold X-radiation within the designed engineering limits. An additional word of caution is in order at this point: When the set is delivered to the customer's home, be sure to check the voltage supplied from the AC outlet. If it is at the rated value for the receiver or below, do not readjust the high voltage. If, however, it is above the rated value, check to see if the receiver has a different tap on the power transformer to make allowances for higher line voltages, or readjust the high voltage to a nor-

mal level with the higher line voltage and contact the power company to see about having the line voltage reduced to the standard rating. Incidentally, after the high voltage has been properly adjusted, it is a good servicing practice to turn the brightness up and down while monitoring the high-voltage reading on the meter to be certain that the regulator is functioning properly.

One other precautionary measure to be mentioned before going on to safety items other than X-rays: Consideration should be given to color test jigs and the replacement of color picture tubes. As you are aware, some picture tubes have bonded safety shields covering the faceplate. Others afford safety protection through the stress of metal bands, and some picture tubes have no built-in safety protection for the faceplate, relying on the use of an external safety glass. Be sure that the tubes used in color test jigs have implosion protection—not only to protect against an accidental bump with the chassis or tool, but also to provide additional X-radiation shielding through the

bonded safety shield or external safety glass. As of the date this was written, we have received no reports of appreciable X-radiation from the CRT screen of any television receiver. When replacing a picture tube, it is important for the same general reasons outlined above, to use the same type of tube. However, whenever picture tubes are handled, it is a good safety precaution to wear safety glasses and gloves, as well as taking particular care not to scratch the glass or knock the tip off of the neck. Before leaving the subject of CRT's, it should be noted that the bell of the picture tube used in a test jig should be protected by a magnetic shield to provide additional protection against X-radiation as well as restricting magnetic effects.

Hot chassis (those with the chassis common to one side of the power line) also call for extra precautions. This is true not only of in-shop handling, but also certain precautions need to be taken to protect the customer. In the shop it is a simple matter to use an isolation transformer to protect yourself as well as the test instruments. However, it is important that all protective devices—such as isolation networks, fish paper, plastic tubing, isolation capacitors and other such devices—be in place for the protection of the customer. Underwriters' Laboratories have established a simple test procedure to be sure minimum safety requirements are met in this regard. They stipulate that a 1,000-ohms-per-volt AC voltmeter should be shunted by a 1,500-ohm, 10-watt resistor and connected between an earth ground (such as a cold water pipe) and any portion of the receiver exposed to the consumer—such as cabinet trim, hardware, controls, knobs, etc. An AC voltage indicated on the meter should not exceed 7½ volts. If a higher reading is obtained, it indicates a potentially dangerous leakage path, and further troubleshooting to locate the defect is in order.

In summary, regardless of potential hazards involved in servicing color television, be they real or theorized hazards, prudent self-discipline and the development of safe servicing techniques provide safeguards for every technician. ▲



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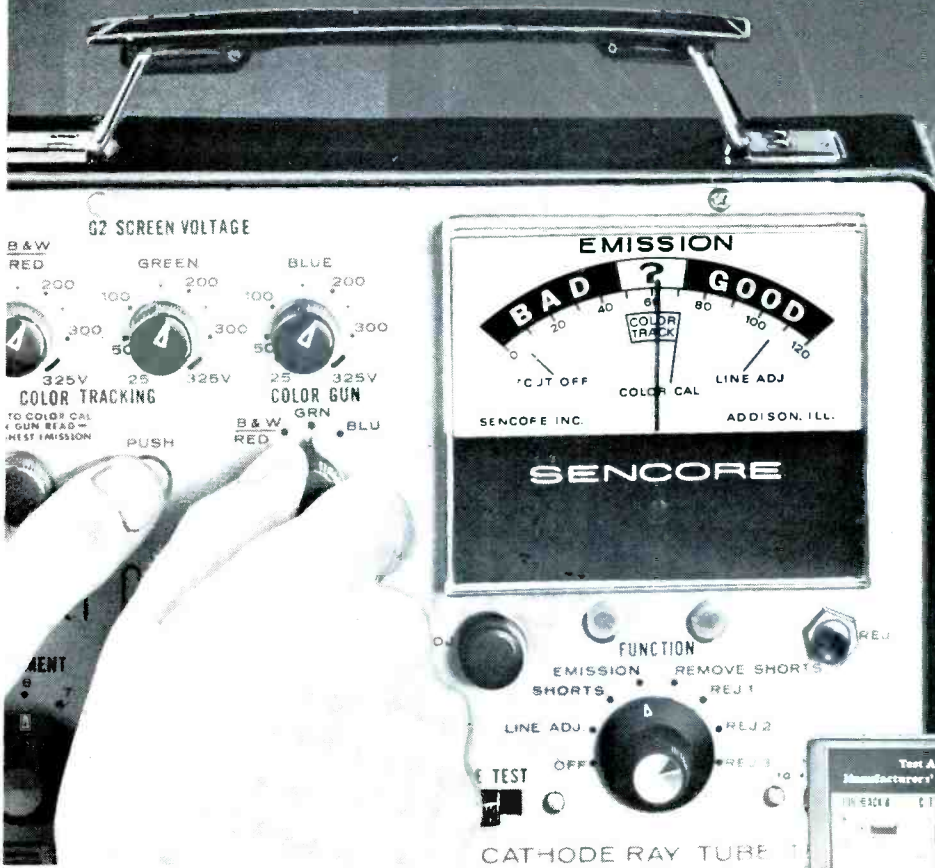
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# COLOR SYNC

## alignment or defect?

*Your scope and a careful analysis of the symptoms will provide the answer.*

by STAN PRENTISS

Sometimes it's better to have just a little color than no color at all, particularly if the color lies in faint horizontal bands across the face of the CRT during a colorcast.

Often, a quick fix for this symptom is to tune in the color program, substitute a new reactance-oscillator tube, and touch up the reactance tube plate coil so that adequate color sync returns. Switch back and forth from black-and-white programming to color a few times to check stability, and let it go at that.

But what if you have an old CTC7A that specifically requires grounding a couple of test points, then using a gated color-bar gen-

erator to "float" the color bars for correct reactance coil alignment? And what if you pull the chassis and perform all these steps, and then during a color broadcast the set still falls out of color sync? Do you try the usual troubleshooting approach (whatever that is), or do you immediately step into AFPC and demodulator phasing adjustments? It all depends on what your oscilloscope (but not your DC voltmeter) tells you during your preliminary investigation.

Why not a voltmeter? Let's take an example. With the antenna disconnected, measurement of the screen grid and plate of the 1st

chroma bandpass amplifier, V17B (Fig. 1), may show 225 volts on the screen and 150 volts on the plate, proving that the tube is still conducting. The only correct way to measure the DC voltage on this tube—and on several others in the chroma section—is to completely disconnect the RF link. Then, you'll find the screen and plate voltages on V17B measure 120 to 125 volts.

The DC voltmeter readings can be even more confusing when a color signal is received. The entire chroma section is turned on by a color signal, and the reactions of the various impedances and non-linear elements can cause currents

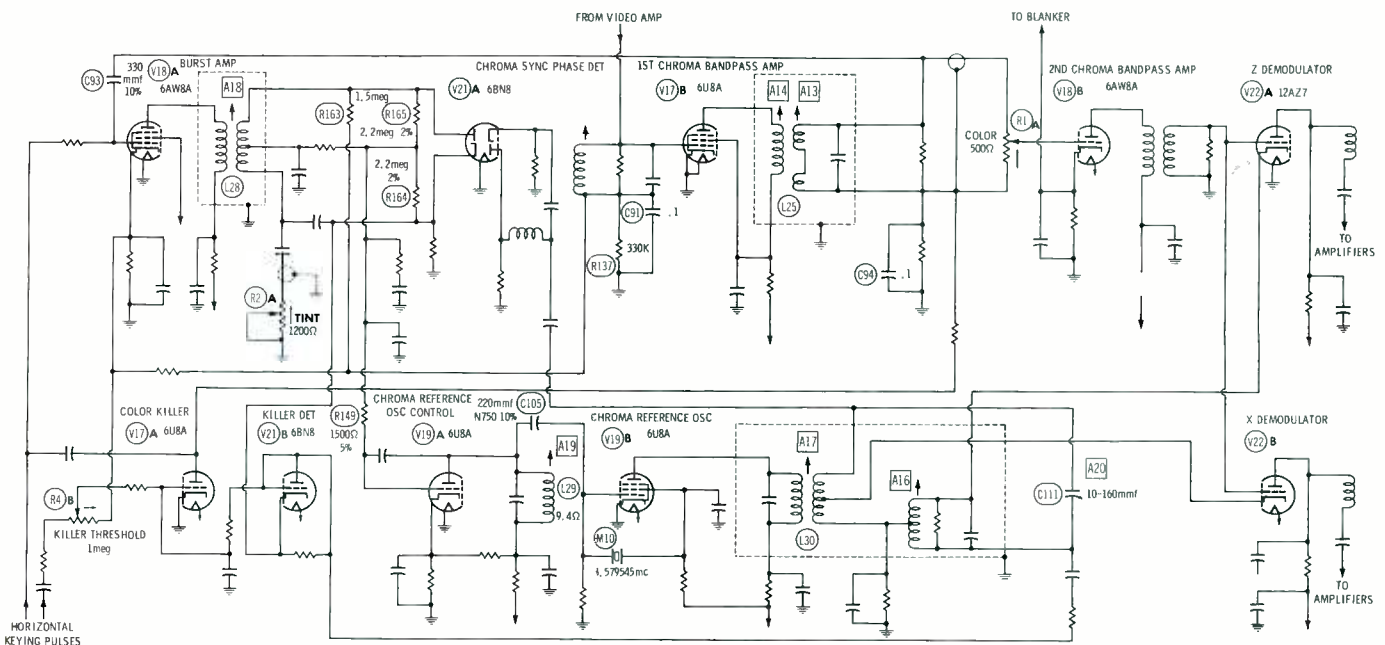


Fig. 1. Chroma stages employed in RCA CTC7 chassis.

and voltages to behave in many peculiar ways. Let's go back and study Fig. 1 to find the most logical approach to troubleshooting these circuits.

As you remember, the color sync section is comprised of burst amplifier V18A, color killer V17A, chroma sync phase detector V21A, killer detector V21B, chroma reference oscillator control V19A, and chroma reference oscillator V19B. A pulse from V17B is applied through C93 to the grid of the burst amplifier, along with a delayed pulse from a tap on the horizontal output transformer. These signals coincide, and the burst amplifier is driven into conduction, placing 180° out-of-phase signals on terminals B and C of L28 (Fig. 2) and thence to phase detector V21A. On the other side of the chroma sync phase detector are similar 180° out-of-phase signals from the 3.58-MHz chroma reference oscillator.

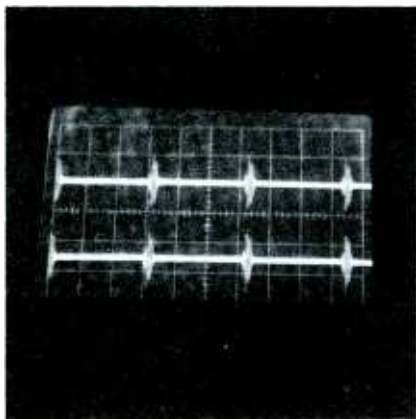


Fig. 2. Phase detector waveforms.

If the signals from the burst amplifier and the reference oscillator are exactly on time and in phase, equal but opposite DC voltages are developed across matched pair R164 and R165, so their net output is zero. But if there is a phase shift, more DC will be generated by one phase detector than by the other and a difference voltage will appear at the intersection of R164 and R165. This voltage feeds through R149 to the grid of the control tube, V19A.

Another DC reference voltage feeds from the plate of the phase detector through R163 to the grid of the 1st chroma bandpass amplifier. The amplitude of this voltage is relative to the burst amplitude,

and controls the gain of the 1st chroma bandpass amplifier. This is called Automatic Chroma Control (ACC).

A third DC reference voltage is fed from the cathode of the phase detector to the cathode of killer detector V21B. This tube is also AC-operated. When the plate becomes more positive than the cathode, the "diode" (here a triode with plate and grid tied together) conducts, putting a less negative voltage on the grid of the color killer, V17A. Therefore, as the DC voltage from the phase detector cathode decreases toward zero, the plate of the killer detector becomes relatively more positive, until, with no color burst signal arriving, the killer detector conducts, turning on the killer. This, in turn, increases the bias on the grid of the 2nd chroma bandpass amplifier, turning this tube off and preventing passage of any signals to the demodulators. Hence, there is no color in the picture during a b-w broadcast.

With the reception of any burst transmission, the exact reverse is true: An increase in the positive DC voltage at its cathode cuts off the killer detector, and, in turn, the color killer is biased off, permitting the 2nd chroma bandpass amplifier to amplify the chroma signal.

Chroma reference oscillator control V19A conducts more or less according to the negative or positive reference voltage coming from the junction of R164 and R165. This variation in conduction is reflected as a variation of capacitive current in tuned circuit A19, which, in turn, keeps the 3.58-MHz crystal oscillator locked to the phase of the burst signals from the broadcasting station. The output of the 3.58-MHz oscillator feeds to the cathodes of the demodulators. This reinserts the carrier (suppressed at the broadcasting station) on the chroma information so that the demodulators may function.

Now back to our problem set. Just to insure the proper signal was getting to the color circuits as well as the burst amplifier, we made a measurement at the plate of the 1st bandpass amplifier. The scope waveform obtained is shown in Fig. 3. (You can see a steady stream of

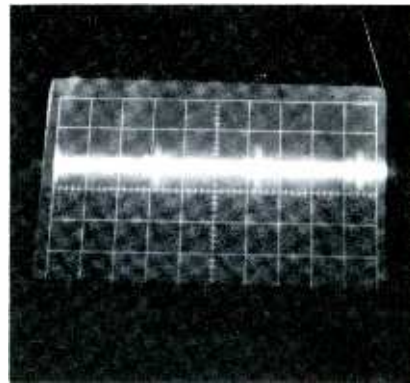


Fig. 3. Waveform at the plate of the first bandpass amplifier.

color information, with the burst pulse appearing approximately every 60 microseconds). So now we knew that both chroma and sync information were getting to their respective color circuits. (The chroma reference oscillator had already been shown to be operating).

Things were beginning to shape up a bit. As far as we could tell, there was nothing wrong with any of the circuits, other than a minor detail or two. However, these minor details can be annoying and often difficult to cure. Take, for instance, the wax-impregnated paper capacitor (C94) in the secondary of the 1st chroma band pass amplifier transformer. Since it has very little DC swing applied, it is inclined to leak simply from lack of exercise—and this one did. Next, we examined the two matched phase detector resistors, R164 and R165. If they changed value, they could produce a distorted output voltage. In this case, there was enough change in their values to warrant replacement; this time we used 1-watt units to be reasonably sure that there would be no change in the future.

Pulling the RF link, we made a few DC voltage checks with the

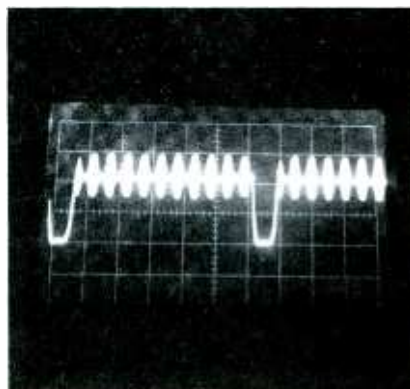


Fig. 4. Waveform at the plate of the R-Y amplifier shows oscillation.

scope to assure that the bypass capacitors in the affected circuits weren't attenuating any voltages. All were within reasonable tolerance. Since all tubes had already been checked and substituted, there was no help from that corner. After realignment of the chroma reference oscillator control stage, a check of the R-Y output (Fig. 4) with a station signal indicated oscillation.

The next logical step was to proceed with the automatic frequency and phase control (AFPC) and demodulator adjustments. By doing this, we might dig up some additional information.

Actually, AFPC and demodulator adjustments aren't nearly as difficult as they sound, particularly if you use a DC oscilloscope and a low-capacitance (L-C) probe. The L-C probe loads these circuits very little and produces exceedingly uniform results.

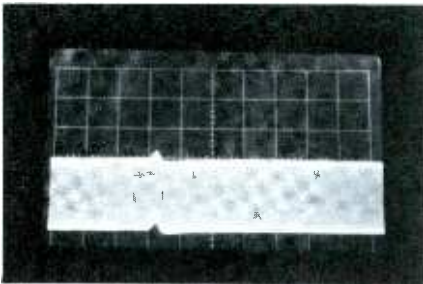


Fig. 5. Waveform taken with a DC scope at the killer detector plate.

The first step is to adjust A17-A16, the chroma reference oscillator transformer, for maximum negative DC at the plate of the killer detector. This amounts to approximately 20 volts as shown by the waveform in Fig. 5 (zero-volts DC is at the top of the waveform). Use a color bar generator for the most steady reference signals.

The next step is to adjust the burst amplifier transformer, A18, for maximum negative DC at the junction of R137 and C91. (The waveforms appear approximately as in Fig. 2, although in Fig. 2 the oscilloscope was set on AC to conveniently show both phases of the burst transformer waveforms.) The third step is to ground the junction of R164 and R165, and also terminal "D" of L25. Then tune chroma reference oscillator control A19 for a steady pattern, as illustrated in Fig. 6. The fourth step

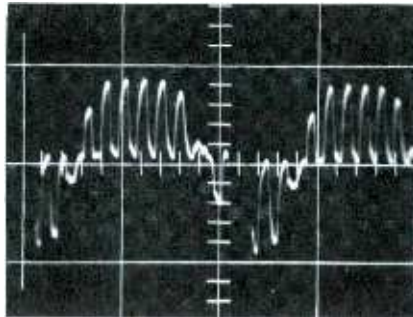


Fig. 6. Waveform at color amplifier with A19 properly synchronized.

is to ground the grids of the color burst amplifier (V18A, Pin 7) and color killer (V17A, Pin 9), and adjust C111 for zero volts at pin 7 of killer detector V21B.

This completes adjustment of the AFPC circuits—and this must be done before attempting any adjustment of the demodulator phasing. This latter adjustment is easily accomplished with an oscilloscope connected through a low-capacitance probe to the plates of the R-Y and then the B-Y amplifiers. Before attempting phasing adjustments, be sure that the tint and color controls are set to midrange and the color control is not overdriving the color amplifiers.

Connect the low-capacitance probe to the plate of the R-Y amplifier and touch up the burst amplifier transformer (L28) so that the 6th bar is at zero reference level (Fig. 7). The final operation is to connect the L-C probe to the plate of the B-Y amplifier and touch up the top core of the chroma reference oscillator transformer (core-A16). Adjust so that the 3rd and 9th bars go to zero reference. If there are no circuit defects, the G-Y amplifier signal will show zero reference level at the 1st and 7th bars (this signal is matrixed from the R-Y and B-Y demodulators).

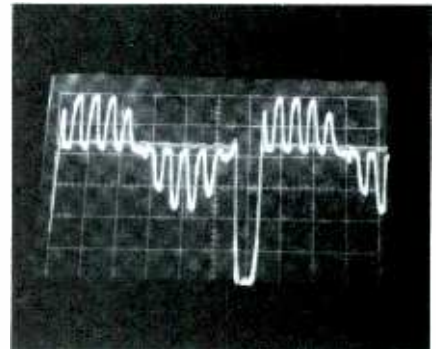


Fig. 7. R-Y amplifier properly aligned with 6th bar at null.

After performing the above alignment procedure, we connected an on-the-air signal to the antenna terminals of the CTC7. Color showed uniformly for a while; but then switching channels, it again slipped out of sync. However, a turn or two of the chroma reference core (A19) brought back the color solidly, with the core at about midpoint of the coil.

A horrible thought began to dawn. What if the color-bar generator itself was out of frequency or phase? Couldn't this be the basis of our troubles? A look at the serv-



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ice manual for the particular generator being used increased suspicion. This generator produced the usual 10 color bars during one horizontal scan by using a crystal controlled oscillator operating at 3,563.795 KHz. Since this is exactly 15,750 Hz lower than the color oscillator in the television receiver, the difference between the two oscillators produces a signal equivalent to a continuous 360° phase variation of the color subcarrier. The generator oscillator is keyed into 12 color bars, one of which is blanked in the color-bar generator. A second bar is the color sync reference burst. The remaining 10 bars (you usually see 9 because of horizontal overscan) then appear on the CRT in hues ranging from yellow-orange on the left to bluish green or green on the right. An unusual generator will actually exhibit blending of colors in the bars as it covers the spectrum in bursts every 30°.

We immediately checked the 3.56-MHz oscillator tube and the power-supply voltage and ripple. Both the latter were all right, but the tube was weak. We substituted a new 6AZ8 and, following the manufacturer's instructions, set the video-level adjustment for proper sync pulse height. We then adjusted the burst pulses so that their amplitude was nearly equal to the sync pulses. Finally, we soldered a small trimmer capacitor across the 3.56-MHz crystal.

There may have been a slight foul-up in the step-by-step adjustments, however, for when we attached the generator to the color set, there wasn't much brightness to the crosshatch and horizontal bars. By eye, we increased the video level adjustment to a fairly bright crosshatch. Then we carefully adjusted the trimmer capacitor across the crystal for clean color bars.

Both the 1st chroma bandpass amplifier grid and the junction of R164, R165 were grounded through clip leads, and the chroma reference oscillator control was adjusted again. This time, the color bars momentarily locked with the core about midway in the coil, and we knew positively that our difficulties were over. Although we had to repair a generator and a receiver, we now can depend on both. ▲

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April, 1968/PF REPORTER 19

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- RCA Transistor Manual—SC-13. This book contains over 500 pages with technical data on more than 600 RCA solid-state devices.
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# RCA

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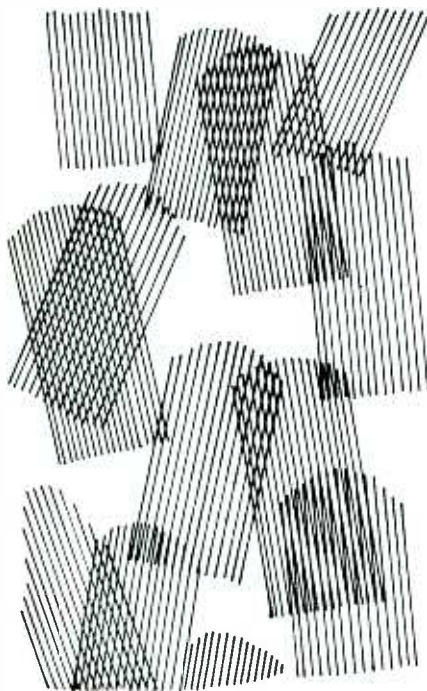
RCA Solid-State Replacement Guide



RCA Transistor Servicing Guide



Circle 46 on literature card



# TV TUBE STOCK GUIDE



This list omits more than 100 of the rarest TV tube types, which many shops find impractical to stock. To simplify the chart as much as possible, common radio and hi-fi tube types used in TV combinations are omitted.

New tube types introduced this year are listed in the separate chart; to help you decide whether to stock these tubes, each listing specifies receivers using that particular type. If you're specializing in one or two brands, you'll pick new tubes listed for those sets and stock your shelves and caddy accordingly.

In the main chart, the figures under "Caddy Stock" suggest a stock of approximately 400 tubes (other than tubes for color sets) which should account for close to 90% of your re-

placement needs. As with the rare-tube listings, you may want to carry more of a particular type if it is used in receivers you service often. We've removed some of the older types, such as 6V6, 6W4, and 6BZ7, and replaced them with more current types; also included are some that appeared in last year's new-tube list—if they were used in sets again this year. Most used UHF tubes are also included. Tubes marked with an asterisk (\*) are used also in color sets.

The figures under "Shelf Stock" are a suggested backup stock, if you're located near a parts distributor. If you can replenish your tube supply only once a week, you may wish to stock extra of the more common types. Your volume of business will naturally determine your actual shelf stock, too.

Keep in mind three main factors that will influence the demand for various tubes:

1. Relatively high failure rate of power-output and similar tubes.
2. Your specialization in certain makes of sets.
3. Average age of sets containing a particular tube type.

Temporary substitution of available

types for rare types, are outlined in the Howard W. Sams book, *Tube Substitution Handbook, No. 11*, can also help you reduce stock requirements.

Another way to ease tube-stock headaches is to use only the latest -A or -B versions of various tubes. Types in common use are listed in the chart.

TUBE TYPE	SHELF STOCK	CADDY STOCK	TUBE TYPE	SHELF STOCK	CADDY STOCK	TUBE TYPE	SHELF STOCK	CADDY STOCK
1AD2*	1	1	3AF4B	1	1	4BQ7A	1	1
1AU2*	1	1	3AJ8	1	1	4BZ6*	5	2
1B3GT	4	2	3AT2*	2	2	4CB6	2	1
1G3GT	4	2	3AU6	1	1	4CS6	1	1
1J3A	2	1	3AW3	1	1	4DK6	2	1
1K3	4	2	3BN6	1	1	4DT6*	2	1
1N2A	1	1	3CB6	2	1	4EH7*	3	2
1S2A	1	1	3DG4	1	1	4EJ7*	3	2
1V2*	2	2	3DK6	2	1	4GK5*	1	1
1X2B*	3	2	3DT6A*	1	1	4HA5*	1	1
2AF4B	1	1	3DZ4	1	1	4HM6	1	1
2AH2	1	1	3EH7	1	1	4HS8	1	1
2AS2	1	1	3EJ7*	1	1	4HT6	1	1
2AV2*	1	1	3GK5*	4	2	4JC6A*	2	1
2CW4	1	1	3HA5*	2	1	4JD6	2	1
2DS4	1	1	3HM6	1	1	4KN8	1	1
2DZ4	1	1	3HQ5*	1	1	5AQ5A*	2	1
2GK5*	1	1	4AU6*	1	1	5AT8	1	1
3A3A*	3	2	4BL8*	1	1	5BC3A	1	1



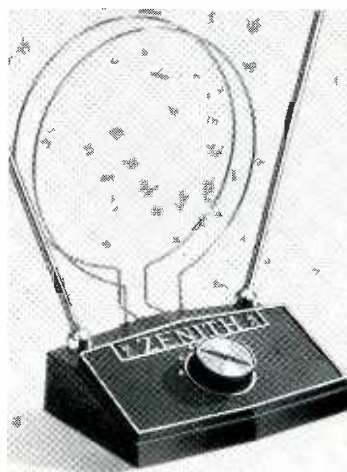
TUBE TYPE	SHELF STOCK	CADDY STOCK	TUBE TYPE	SHELF STOCK	CADDY STOCK	TUBE TYPE	SHELF STOCK	CADDY STOCK
5BR8	1	1	6DE6*	1	1	6JH8*	3	1
5CG8*	2	1	6DE7	1	1	6JM6A*	1	1
5CL8A	1	1	6DK6*	2	1	6JN6A	1	1
5DJ4	1	1	6DM4A	2	1	6JN8	1	1
5EA8	1	1	6DN7	1	1	6JS6B*	1	1
5EW6	1	1	6DQ5*	1	1	6JT8*	1	1
5FG7	1	1	6DQ6B*	3	2	6JU8A*	4	2
5GH8A*	1	1	6DR7	1	1	6JV8	1	1
5GM6	1	1	6DS4*	2	1	6JZ8	1	1
5HG8	1	1	6DT5	1	1	6K6GT	1	1
5JV8	1	1	6DT6A*	3	1	6KA8*	2	1
5KD8	1	1	6DV4*	1	1	6KD8	1	1
5KE8	1	1	6DW4B*	4	2	6KE8*	1	1
5LJ8*	1	1	6DX8*	1	1	6KT8*	3	1
5U4GB*	6	3	6DZ4*	1	1	6KU8	1	1
5U8	2	1	6EA8*	3	2	6KZ8*	2	1
6AF3	1	1	6EB8	1	1	6LF8*	1	1
6AF4A*	2	1	6EH7*	5	3	6LN8*	1	1
6AF11	1	1	6EH8	2	1	6LU8*	1	1
6AH5	1	1	6EJ7*	6	3	6Q11	1	1
6AL3	1	1	6EM5*	1	1	6RK19	1	1
6AL5*	2	1	6EM7*	2	1	6SN7GTB*	1	1
6AL11*	1	1	6ES8	1	1	6U8A*	1	1
6AM8A	1	1	6EW6*	5	3	6U10*	2	1
6AN8A*	1	1	6EW7*	2	1	7GU7*	1	1
6AQ5A*	5	3	6EZ5*	1	1	7GV7	1	1
6AR11	1	1	6FD7	1	1	8AW8A*	2	1
6AS8	1	1	6FG7*	1	1	8B8*	1	1
6AU4GTA*	1	1	6FM7*	2	1	8B10*	1	1
6AU6A*	3	2	6FQ7*	8	4	8BE8	1	1
6AU8A*	1	1	6FV8A	1	1	8BQ5	1	1
6AV6*	2	1	6FY5	1	1	8CG7	1	1
6AW8A*	4	2	6FY7	1	1	8CW5A*	1	1
6AX3	1	1	6GB5	1	1	8CW8	1	1
6AX4GTB	2	2	6GC5*	1	1	8DX8	1	1
6AY3B	3	2	6GE5	1	1	8EB8	1	1
6AZ8*	1	1	6GF7A*	4	2	8EM5	1	1
6B10*	1	1	6GH8A*	14	7	8FQ7*	6	3
6BA6*	2	1	6GJ5A	1	1	8JV8*	2	1
6BA11*	2	1	6GJ7*	2	1	8JZ8	1	1
6BC8*	1	1	6GK5*	3	1	8KA8*	1	1
6BD11	1	1	6GK6*	1	1	9GV8	1	1
6BE3A*	2	1	6GL7*	1	1	10AL11	1	1
6BE6	1	1	6GM6*	5	2	10CW5*	2	1
6BF11	1	1	6GN8	2	1	10DE7	1	1
6BG6GA	1	1	6GT5A	2	1	10DX8	1	1
6BH11*	1	1	6GU5	1	1	10EG7	1	1
6BJ3	1	1	6GU7*	5	3	10EM7	1	1
6BJ8	1	1	6GV5	2	1	10EW7	1	1
6BK4B*	4	3	6GW6	2	1	10GK6*	1	1
6BK7B	1	1	6GX7*	1	1	10HF8	1	1
6BL7GTA	1	1	6GY5	2	1	10JA8	1	1
6BL8*	3	1	6GY6*	4	2	10JY8	1	1
6BM8*	1	1	6GZ5	1	1	10KU8	1	1
6BN4A	1	1	6HA5*	3	1	11AR11	1	1
6BN6*	2	1	6HA6	1	1	11JE8	1	1
6BN8*	1	1	6HB5	2	1	11KV8	1	1
6BQ5*	3	2	6HB6*	1	1	12AF3	2	1
6BQ6GTB*	4	2	6HB7*	2	1	12AL11	1	1
6BQ7A*	1	1	6HD5	1	1	12AX4GTB	2	1
6BR8A	1	1	6HE5*	3	2	12AX7A*	1	1
6BU8A	2	1	6HF5*	2	1	12AZ7A*	1	1
6BX7GT	1	1	6HF8	1	1	12B4A	1	1
6BZ6*	10	4	6HG5	1	1	12BE3A	1	1
6C4*	1	1	6HG8	1	1	12BH7A*	2	1
6CB5A*	1	1	6HJ8	1	1	12BQ6GTB	1	1
6CB6A*	2	2	6HK5	1	1	12BY7A*	3	2
6CD6GA	1	1	6HL8*	1	1	12C/CU5	2	1
6CG3*	1	1	6HQ5*	2	1	12CA5	1	1
6CG7*	5	2	6HS8*	2	1	12DB5	1	1
6CG8A*	6	3	6HZ6*	5	3	12DQ6B	2	2
6CL6*	1	1	6HZ8*	1	1	12DT5	1	1
6CL8A*	1	1	6J6A	1	1	12FX5	1	1
6CM7	1	1	6J10*	1	1	12GC6*	1	1
6CQ8*	1	1	6JB6A	2	1	12GN7A*	2	1
6CS6*	2	1	6JC6A*	4	2	12GT5A	1	1
6CU5	1	1	6JC8	1	1	12GW6	2	1
6CW4*	1	1	6JD6*	1	1	12RK19	1	1
6CW5*	2	1	6JE6B*	5	3	13CM5	1	1
6CX8	1	1	6JE8	1	1	13DE7	1	1
6DA4A*	1	1	6JG6A	1	1	13DR7	1	1
6DE4	1	1	6JH6*	4	2	13EM7	2	1

NEW TUBE TYPES  
INTRODUCED IN '68 TV

TUBE TYPE	SHELF STOCK	CADDY STOCK				
13FD7	1	1	1R-K41	Panasonic	6MD8*	Magnavox
13GB5	2	1	2BA2*	Admiral		Packard Bell
13GF7A	2	1	2EG4*	RCA		Sylvania
13J10	1	1	3BN2*	Motorola	8JU8A*	Westinghouse
14BR11	1	1	3CN3*	General Electric	8KR8*	Sears
15BD11	1	1	3JC6*	RCA	9GH8A*	Arvin
15CW5*	1	1	3KT6*	RCA	9JW8*	Delmonico
15DQ8*	1	1	4KE8*	RCA	9KC6*	Sears
15HB6*	2	1	4LJ8*	General Electric	10GF7*	RCA
15KY8A	2	1	5HZ6*	RCA	10LE8*	Delmonico
16A8*	1	1		Sears		Olympic
16AQ3	1	1	6AG9*	General Electric		Sears
17AX4GTA	1	1	6AQ8*	Sears	11HM7*	RCA
17AY3A	3	1		Toshiba	12BV11*	Sylvania
17BE3A	2	1	6BA3	Packard Bell	12DW4A*	Airline
17BF11A	1	1	6BV11*	Sylvania		Sears
17BS3A	2	1	6BW11*	General Electric		Sharp
17CU5	1	1	6BZ3	Philco-Ford	12FQ7*	Arvin
17DE4	1	1	6CE3*	Sylvania		Panasonic
17DM4A	1	1	6CJ3*	Zenith	12HL7*	Zenith
17DQ6B	2	1	6CL3*	RCA		Sylvania
17GJ5A	2	1	6DT8*	Olympic	12MD8*	Sylvania
17GV5	1	1	6GM8*	Philco-Ford	16Y9	Panasonic
17JB6A	1	1	6GS7*	Coronado	17DW4A*	Olympic
17JZ8A*	4	2		Magnavox		Toshiba
19AU4GTA*	1	1	6HD7	Sears	17H-B25	Sears
21GY5	2	1	6HS5*	Symphonic	17KV6*	RCA
21HJ5	1	1	6HU6*	Zenith	23JS6A*	Airline
22BH3A	2	1	6J11	Zenith		Sears
22DE4	1	1	6JK6*	Philco-Ford	24JE6A*	RCA
22JF6	1	1	6JZ6	Airline	26DQ5*	Airline
22JG6A	2	1	6KG6*	Sylvania		Sharp
33GT7	1	1	6KN6*	Philco-Ford	29KQ6*	Arvin
33GY7A	2	1	6KT6*	Admiral		Panasonic
38HE7	1	1	6LB6*	Olympic	30KD6*	Sears
50C5A	2	1		Sylvania	31JS6A*	Olympic
			6LJ6*	RCA		Sears
				Motorola	40KD6*	Westinghouse
				Zenith	7247*	Hitachi
				General Electric		Pilot

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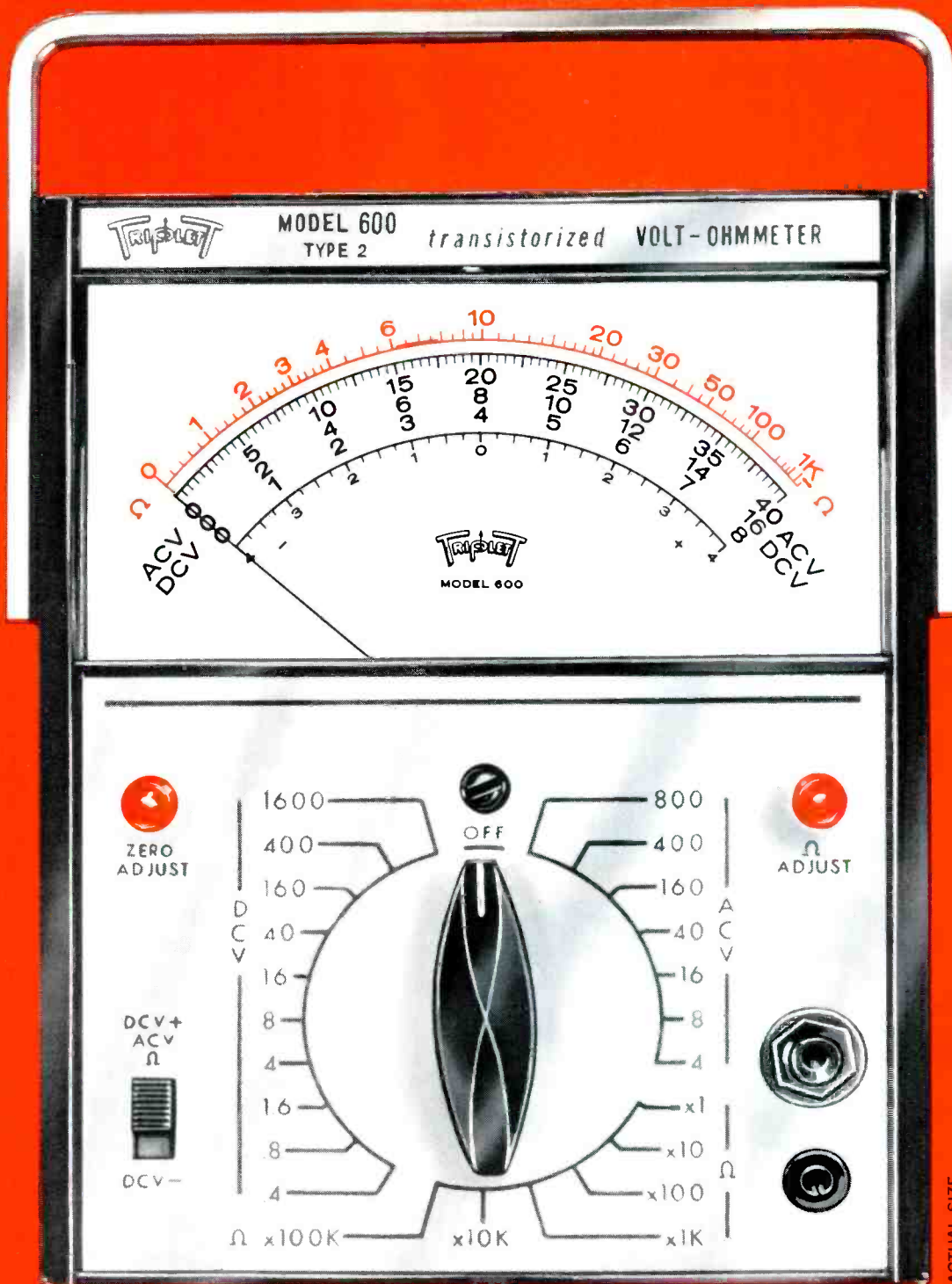
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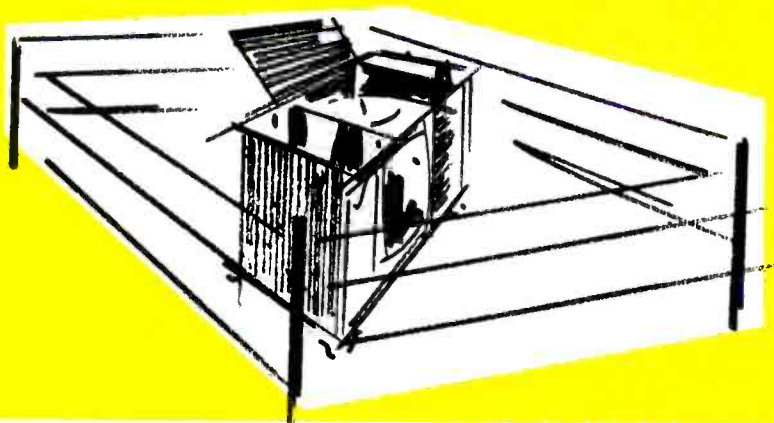
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# ONE

# ROUND

# TO GO



Nine rounds with a combination model color receiver almost persuaded this technician to hang up his test leads

by HOMER L. DAVIDSON

Did you ever have a new color receiver that caused trouble from the minute it was turned on? Yes, I am sure you have, and so have we. While the service technician refers to this type of set as a dog, the customer calls it a lemon. I never did like the word lemon—perhaps because it is too sour. Yet the customer may not be too far off in his name calling, as some color receivers built in the past have been difficult to keep in operation.

### Round 1—Too Bright

When this new Citrus Model 73 (*name changed to protect the guilty—Ed.*) color combination was checked out before delivery, we definitely had problems. The AM-FM multiplex receiver and the phonograph worked perfectly, but the brightness on the CRT could not be turned down. In fact, the brightness control had little effect at all. So off came the long, long back of the TV combination. (About 20 screws.)

We made a quick inspection of the brightness control terminals and all were intact. From previous experience we knew that a defective video output tube often causes this trouble, and sure enough—the 12BY7 video amplifier had a white spot on top, indicating air had seeped into the tube. After replacing the video amplifier, the set worked fine.

### Round 2—No Brightness

The next morning, the color combination was delivered to Mrs. Berg. After a complete convergence and purity check, it was time for the color demonstration.

We went through the complete color set operation with Mrs. Berg and then asked her to turn the knobs and adjust it. At first she didn't want to touch any knobs. (Her husband always operated the television set.) After assuring her that she couldn't possibly damage the color receiver, she fiddled with a few knobs. Again we went over the complete operation of the color combination and, before leaving,

handed her the instruction book to read.

Things began to happen the following Sunday afternoon. Mr. Berg was watching the Bears play Green Bay on the new color set, when out she went. The screen went black, but he could still hear the voice. We couldn't be reached on the telephone at home because of an unlisted number, and no one answered the business phone. (If Mr. Berg doesn't work on Sundays, why should we?) So Mr. Berg tried turning a few red and green controls at the rear of the color chassis. Nothing happened and he disgustingly snapped the set off. I can assure you that Monday morning the shop phone was red hot.

We soothed Mr. Berg on the phone and then went directly out to his house. Upon entering the door we heard many acid comments on color receiver performance. We apologized for the set's behavior and proceeded to remove the back (with those 20 screws).

Things didn't turn out too badly; only the horizontal output tube had konked out. Replacing the tube brought back the brightness, but a complete gray-scale adjustment was necessary to get the color receiver back into shape. Well, I guess you couldn't blame Mr. Berg for turning a few knobs in his attempt to get the Green Bay game back again.

We apologized for the breakdown and assured Mrs. Berg that this could happen to any set. We went over the one-year guarantee on parts and the ninety-day service policy and said we were sure all bugs in the color receiver would work out during the ninety-day period. She was smiling as we went out the door.

### Round 3—Dead Phono

On a busy Saturday morning, Mrs. Berg was on the phone explaining that her daughter was home from college for the weekend, and the phonograph wouldn't play. She was going to have a teenage party, and the record player just had to work. Well, somehow we managed to work the call in.

On this trip I noticed the color of the house was pink instead of beige, and it had a lighted door bell button. A bouncing blonde co-ed answered the door and led me to the set. "Mother has gone to the grocery store," she explained. (Already the day seemed brighter.)

No wonder the record player would not perform—the crystal cartridge was hanging loose from the tone arm, and the stylus was missing. Checking out the record compartment did not turn up the missing culprit, either. The daughter could not explain where the needle had gone, and she looked at me as if I had taken it. Well, perhaps the maid had cleaned the record player with a dust cloth and snapped out the needle.

Naturally, I didn't have a replacement stylus with me, so back to the shop I went. Since the needle and cartridge were fairly new, we did not have a replacement in stock. But being "a cunning thief", I swiped one from another set in the show room and returned to the scene.

Well, the day didn't turn out too badly. The phonograph was soon blaring and I took a squint at the color TV reception while I was there. The daughter was happy, go-

ing through a wriggling trance as the sound blasted against the living room wall. Slowly, almost regretfully, I sneaked out as quietly as I could.

### Round 4—Loose Knobs

This trip would not have been necessary if I had explained to Mrs. Berg the correct action of the UHF tuner. But she just knew that those tuning knobs were too loose. Sometimes the station tuned in easily, and other times the knobs turned hard. She was afraid she just might break something.

We sandwiched this trip between other calls. Everything seemed to be normal to me, but Mrs. Berg knew that something was wrong with the thingumajig.

The tuner was dropped down for a closer look. (There goes those 20 screws.) All of the gears meshed properly, and there wasn't any excessive shaft play. Convinced the tuner was A-okay, I replaced it and slipped the knobs on their respective shafts. Both VHF and UHF tuners were rotated through all channels.

I tried to explain the possibility that the ratchet take-up gear might seem hard to turn when in the fine-tuning position. Mrs. Berg then

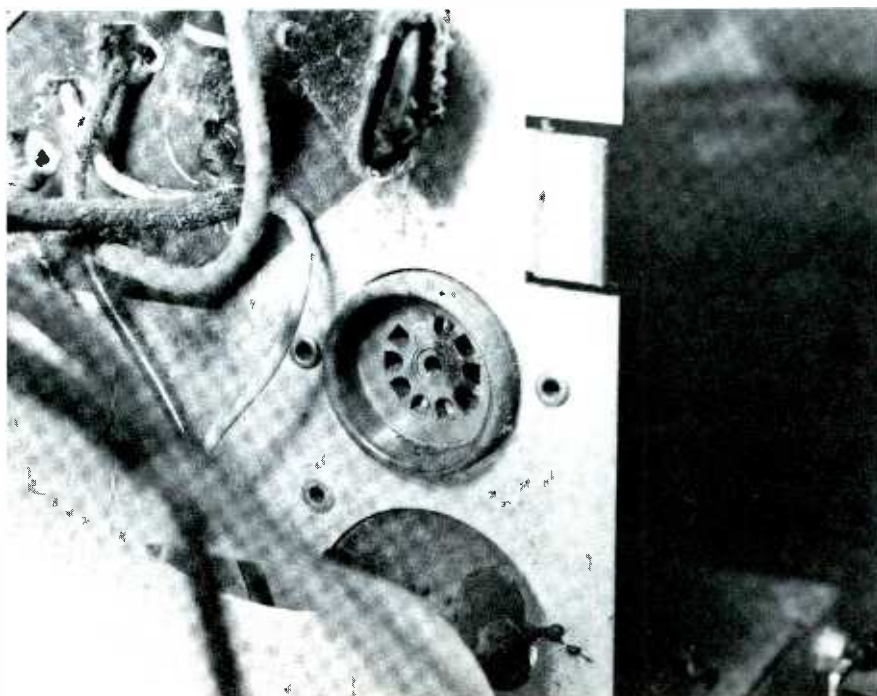


Fig. 1. Focus tube socket shows evidence of heavy arcing.

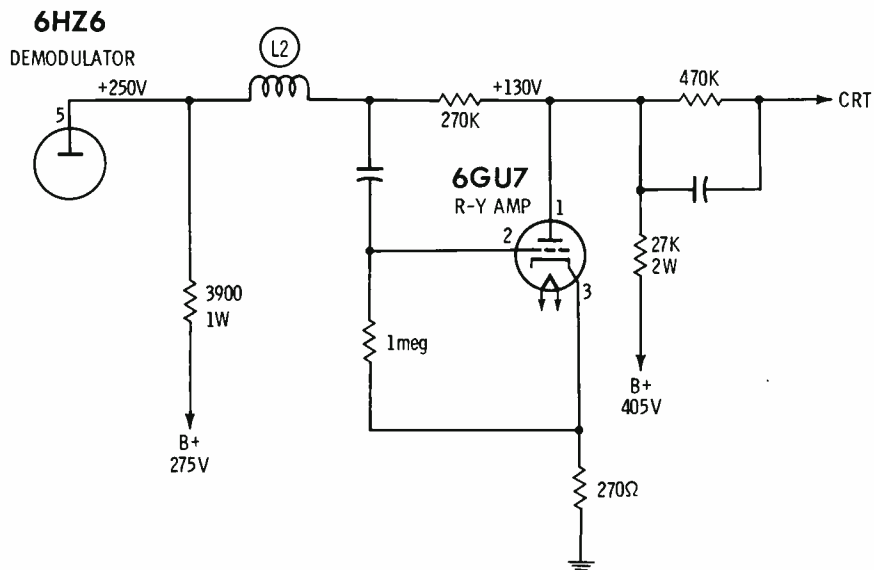


Fig. 2. Open L2 caused slightly lower R-Y amplifier plate voltage.

grasped the UHF knob and tuned in a local morning-exercise broadcast. She sighed, "Oh, this is much better! Thank you so much."

#### Round 5—Poor Focus

Tuesday morning the phone was ringing as I unlocked the front door. This just couldn't be a call from the Berg residence. But it was. She explained the color set was "real blurry and had one black side." Yes, we would try to get there today. (Probably only the focus control needed setting.)

Well things didn't work out that easy. After removing those 20 screws, the focus tube was replaced. No help. Both the 6JE6 and the damper tube were replaced, and still we had the same blurry picture. When I opened up the high-voltage cage and started to replace the high voltage rectifier, I noticed that there was carbon on the focus tube socket. Fig. 1 shows a similar condition in a different chassis.

I fired up the chassis and watched a wormy arcing between pins on the focus tube socket and the ground pin. This chassis had to go to the shop. I left a portable for Mrs. Berg to use for a couple of days and took off. I began to wonder if I was in the right business.

In the shop, the focus socket mounting rivets were drilled out, and a new socket bolted in place. When wiring up the focus socket, or any high-voltage terminal, always leave a smooth ball joint by adding

a little more solder than usual and letting it form into a round connection. Do not leave any sharp points, as corona and arcing will surely result.

After two days of cooking on the bench, we returned the chassis. This time we took an automatic screwdriver.

#### Round 6—No Red

Several weeks went by, and then one afternoon, as we returned from lunch, our secretary informed us that Mrs. Berg called and left word that the red color was missing from the color picture. The whole screen was greenish-blue. She also said she would not be home that afternoon. How could we be so lucky. One

thing for sure—we didn't have to face the customer this time. So we hurried out.

Replacing the "X" demodulator and the R-Y amplifier did not restore the missing red color. The service switch was then switched to the service position, and all screen controls were turned down to minimum. As the controls were advanced one by one, both blue and green screens would register in a thin horizontal line, but we still didn't have any red horizontal line, even with the blue and green screens turned all the way down.

This time I left a note and lugged the chassis to the shop. When the color chassis was "fired up" on the test jig, we had plenty of red. Resisting the impulse to go back out and check the CRT, we let the chassis cook.

In ten minutes the red color disappeared. Lucky me. Rapidly, I took voltage measurements on the R-Y amp (Fig. 2), and they were close to the schematic diagram, though the plate measured 110 volt, but should have read 130 volts. Then I checked the voltages on the 6HZ6 "X" demodulator tube, but everything seemed quite normal there. The trouble had to be either a defective demodulator, R-Y amplifier, or color picture tube. When we hooked up the chassis to the test jig, we had red in the picture so that ruled out the CRT.

Then the VTVM probe brushed across L2, on top of the color PC

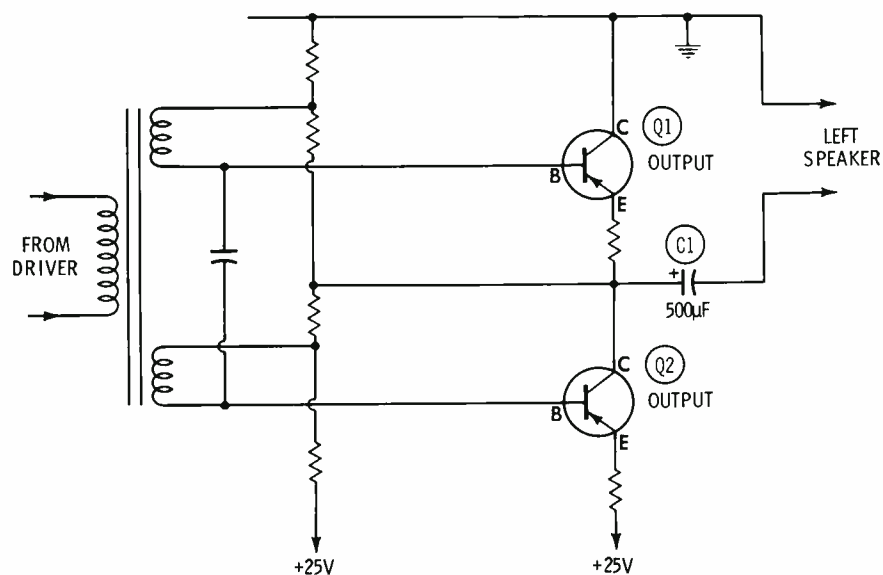


Fig. 3. Open C1 killed all sound in left channel

section, and the red picture flickered momentarily.

An ohmmeter was placed across L2, and the coil measured open. By moving the coil terminal at the top of the coil, continuity was restored. After resoldering the terminal, the set worked fine; so we cooked it the rest of the day and delivered it the next morning.

### Round 7—Black Screen

By this time we hated to face up to the Bergs. Maybe they felt sorry for us too; for when Mrs. Berg called the seventh time, she sounded rather casual. Well, at least the sun was bright this morning, and we could talk about the weather. I wonder why Mr. Berg never got around to trimming those two red rose bushes?

Another new 6JE6 tube was replaced. This call was our fault! I guess we were in such a big hurry the last time that we forgot to set the high-voltage and current adjustments. We explained to her that it was our fault, but she turned her head and left the room. I had a feeling she actually didn't believe us anymore.

The high-voltage adjust control was set at 25kv using a VTVM and high-voltage probe. We slipped a test adapter under the 6JE6 and hooked up the current meter. The color chassis was "fired up" and we measured 245 ma, but after adjusting the horizontal efficiency coil, the meter dipped to 220 ma. We turned the slug until another 5 ma was added to the minimum current reading. Now she was about right. We stripped only two screws replacing the back.

### Round 8—Dead Left Channel

We had about a week breather, and then Mrs. Berg called again. You could actually hear the tears dripping on the telephone. She said the left channel of the radio was dead. Well, at least the trouble was not in the TV section this time. (How could there be any color problems left?)

Arriving at the Berg residence, we fired up the stereo section of the combo. To pin point the trouble, the receiver was first turned to the FM-multiplex position. The left

channel was stone dead. Then I switched to the phonograph and played "Shaggy-Haired Baby." (The record is not my favorite piece; it just happened to be on the turntable.) Again the left channel was lifeless. This proved that the left-channel amplifier section was probably defective.

I pulled the whole AM-FM chassis out of the cabinet (all 20 screws again) and lugged it to the shop. I wonder what the neighbors think of that TV truck parked there all the time?

A quick method to locate the defective stage in any solid-state amplifier is by signal injection. When the dead stage is found, the transistor can be checked with an in-circuit beta checker. A test speaker was clipped to both right and left channels, and a schematic diagram was dug up.

To make sure the AM-FM chassis was properly hooked up, I injected a 1-kHz square-wave signal to the right channel. The tone was loud and clear. Then starting at the left-channel volume control, I pro-



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ceeded to trace the signal toward the speaker. The whole left channel seemed to be dead, including the push-pull output stage. Things didn't add up.

We took a few voltage measurements on the final output stages (Fig. 3), and all voltages were close enough. Checking the schematic for possible slip ups, I found the trouble staring right back. C1, a 500-mf capacitor in the emitter circuit, could be open. I shunted a 100-mfd capacitor across it, and the tone blasted the test speaker.

Before the chassis was returned, we cooked it two days on the test bench. We couldn't stand another call-back on this TV combination.

### Round 9—Snowy Channel 5

We had not been to the Berg residence for three months, but Mrs. Berg hadn't forgotten our phone number. This time the complaint was a snowy picture. First, I checked channel 5—the picture was very snowy. Channel 21 and 70

were switched in, and there was not a flake of snow in sight. The trouble had to be in either the VHF tuner, the lead-in, or the outside antenna. I had a choice—20 screws or get out the ladder. I tossed a coin and then got out the screwdriver.

First I changed the RF tube, but the snow was still piled up. I knew the UHF was feeding through the oscillator-mixer stage, but I changed that tube anyway. Still a snowy picture. The two antenna coils checked okay, so the trouble had to be outside. (We hoped.)

The antenna lead-in was fairly new and looked good from a distance, though this didn't prove a thing. The antenna was aimed in the right direction, so I pulled the extension ladder from the truck and climbed on the roof.

All of the rods were still in place on the conical antenna. We dropped the ten-foot mast to take a closer look. Everything was snug and tight on the antenna assembly.

Shorting one end of the lead-in with the ohmmeter at the other end confirmed that continuity was good. Where did the signal go? Somewhere along the line (no pun) we had missed something.

The lead-in went through a basement window and up through the living room floor, so down below I went. Naturally, in the darkest corner of a catch-all room I found the trouble. Another lead-in wire was poorly hooked into the antenna transmission line. At the other end of this second lead-in was a brand-new portable TV. Perhaps they didn't have much hope for the color set anymore.

Mrs. Berg admitted that her husband had wired up the new portable. They never dreamed of lousing up the color reception. I suggested a two-set booster amplifier, but was out-voted. So I installed a VHF two-set coupler and was on my way.

### Round 10


After six weeks, our fingers are still crossed. If I ever make another trip back to that pink house again, I'll drop a rabbit's foot beside the AM-FM radio and an elephant's ear beside the color chassis. ▲

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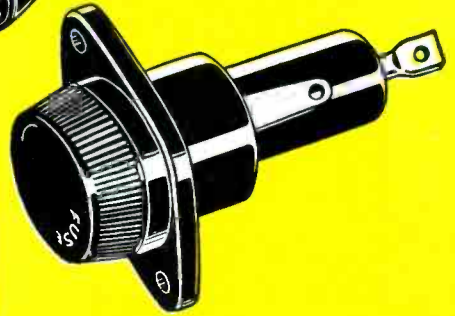
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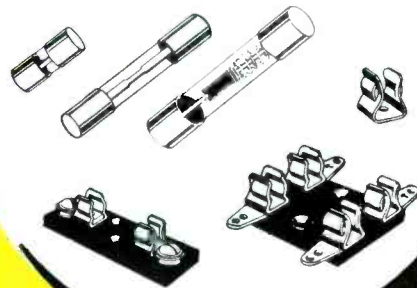
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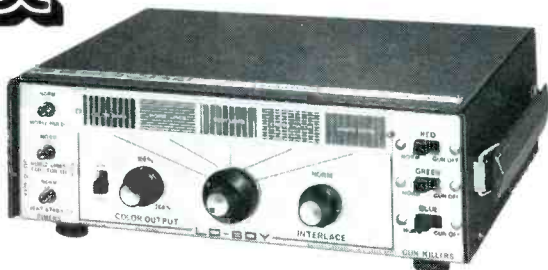
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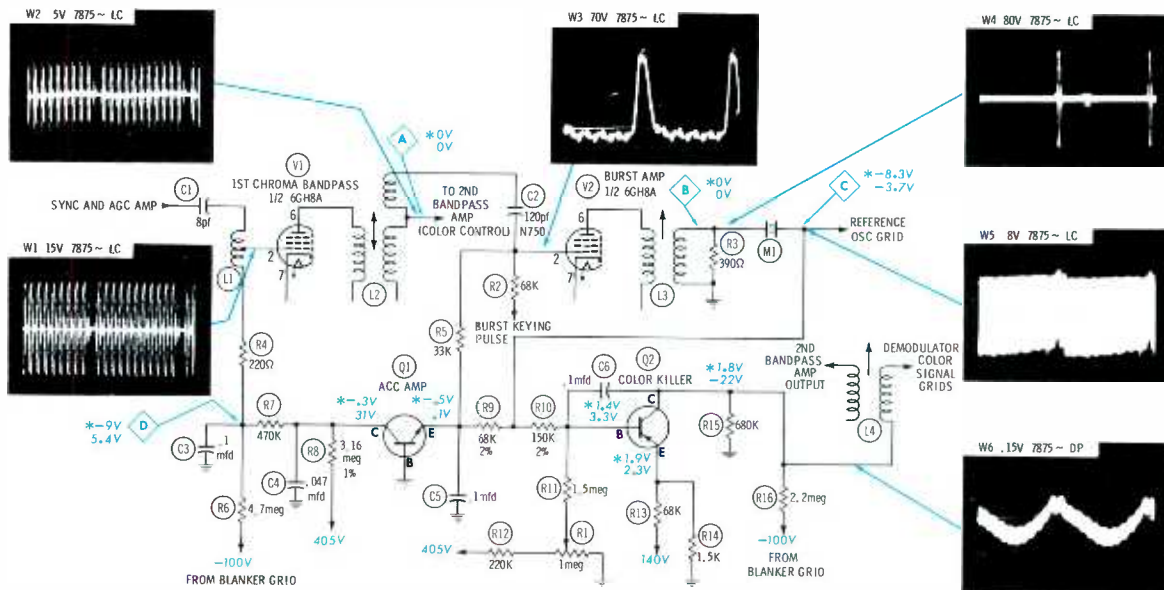


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DC VOLTAGES taken with VTVM—no color signal input. \*Indicates voltage taken with color-bar input—see "Operating Variations".

WAVEFORMS taken with wideband scope, TV controls set to produce normal color-bar. LC (low-cap) or DP (direct) probe use to obtain waveforms.

**Normal Operation**

In basic closed-loop circuit, any deviation of the signal to be controlled from a nominal reference is fed back to an amplifier which controls the gain of that signal. Operation of ACC (automatic color control) closed-loop system (RCA CTC31) is based on fact that burst portion of composite chroma signal is a relatively constant value compared to constantly changing chroma signal, which varies with scene information. Thus, the amount of ACC voltage is determined by burst amplitude. Composite chroma signal is applied to input of first bandpass amplifier as usual; however, burst amplifier receives signal from output of stage instead of input. Burst amplifier output controls 3.58-MHz injection-locked reference oscillator. Level of DC voltage developed in oscillator grid circuit is direct result of, and varies with, burst amplitude. System is designed to maintain 80-volts p-p burst signal at point B; this produces oscillator grid potential of about -8 volts and is center of ACC range. Less than -8 volts (reduced burst) decreases Q1 error amplifier conduction—voltage at D (V1 grid bias) becomes less negative—gain of V1 is increased to return burst to 80 volts p-p. Action is opposite if burst rises above 80 volts p-p. The control signal (burst) passes through the controlled stage (first bandpass amplifier)—hence, closed-loop ACC. With burst portion controlled, level of entire composite chroma signal is controlled. Color killer base threshold is set by R1 so that transistor does not conduct—high negative voltage at collector (demodulators cut off)—until reference oscillator grid voltage increases (burst present). Q2 then conducts—collector potential becomes slightly positive—demodulators conduct.

**Operating Variations**

**C** With no color signal input, reference oscillator grid is set to -35 volts by oscillator adjustments. With burst present, voltage developed in oscillator grid circuit increases to about -8 volts and maintained at that level by ACC action.

**Q1** With no color signal, Q1 is idling—little oscillator grid current through R9 and Q1—collector about 31 volts. As grid current increases (color signal present), emitter voltage becomes more negative (about .1 volt) causing large change in collector voltage—zero or slightly negative on strong signal, about 4 volts on very weak signal. Voltage changes constantly with signal level to maintain proper V1 grid bias.

**D** Q1 collector voltage combines with negative source to set V1 grid bias. No signal potential is about 5V, but will vary from set to set and is no indication of gain with chroma input. With chroma signal, reading varies from about -9 volts (strong signal) to near -6 volts (weak signal) and changes with burst to maintain proper bandpass output.

**Q2** Collector voltage is -22 volts with no color signal (demodulators cut off) or 1.8 volts with color (demodulators conducting).

**Waveforms** Amplitude of all waveforms is constant on generator signal. W1 (also W2 to extent) varies according to station signal strength—W1, 5 to 15 volts p-p—W2, 3 to 10 volts p-p. Burst of nominal 80 volts p-p is maintained at point C.

## Color Overloaded

Color Unstable

R9 Increased in Value

(Q1 Emitter Load—68K, 2%)

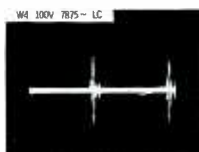
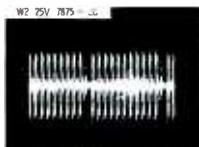
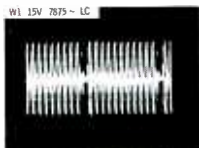
SYMPTOM 1



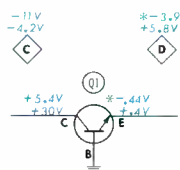
Excessive color with color control at normal setting. Color near normal at times with control near minimum, but color comes and goes—at times, color overloaded—other times, no color. Color-bar pattern overloaded with less than 50% output.

### Waveform Analysis

Bandpass stage more of limiter to strong signals—amplification not needed since demodulators require only 5 to 10 volts p-p signal. W1 shows normal input. Content of W2 good but amplitude excessive—approximately 500% over required signal. Signal at output of burst amplifier, W4, is also higher (100V) than 80 volts p-p ACC should maintain. Waveform analysis indicates V1 amplification excessive—probably due to defective ACC.



### Voltage and Component Analysis



All no-signal readings near normal, but readings wrong with good color signal—reference oscillator grid nearly 3 volts too negative; Q1 collector 5 volts positive (normally near zero); V1 bias at point D very low. Strong signal indicated at point C, but ACC circuit reacts as though signal were weak. Small errors in voltage at Q1 emitter (here only about .06V) produces comparatively large change of potential at collector—causes high positive collector voltage, which results in wrong V1 grid bias at point D.

Best Bet: VTVM for voltage and resistance measurements.

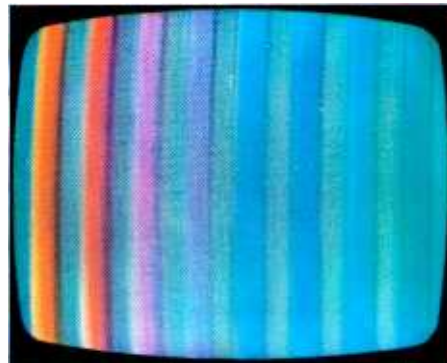
## Weak, Intermittent Color

No Color AT Times

R8 Increased in Value

(Q1 Collector Load Resistor—3.16 meg, 1%)

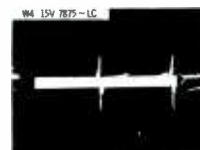
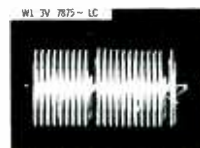
SYMPTOM 2



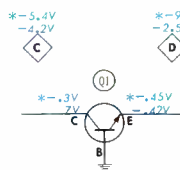
Customer complaint is no color on color programs from fringe stations, intermittently weak color on strong stations—or “color comes and goes”. Color good on generator signal—generator output may be higher than normally needed, but probably not noticeable.

### Waveform Analysis

With generator output set for 3 volts p-p reading at input (W1) to simulate weak signal, W2 at output of stage is almost nonexistent. Normally ACC action regulates V1 gain so that output is sufficient to supply good signal to burst amplifier and other color circuits. Burst (W4) also weak (15 volts p-p, normally 80 volts). Waveform analysis indicates insufficient bandpass amplification possibly caused by ACC circuit malfunction.



### Voltage and Component Analysis



Reference oscillator grid reacts normally—low burst decreases negative potential. Resultant decrease in voltage at Q1 emitter should cause more positive collector potential and lower negative bias of V1 grid to increase amplification and return burst to nominal 80 volts p-p. Now Q1 collector does not react properly (only -.3V, normally about 3 volts with weak signal; V1 bias about -6V). Again, operating point of Q1 is upset due to relatively small (20%) increase of close-tolerance resistor.

Best Bet: Careful symptom analysis; scope; then VTVM.

### SYMPTOM 3

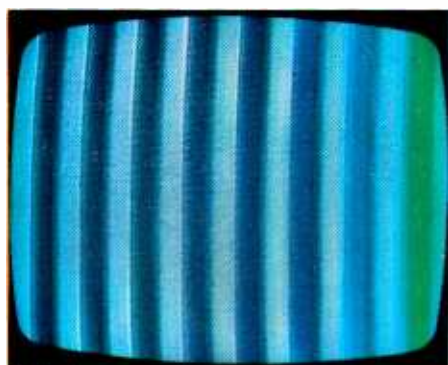
## No Color

B-W Normal

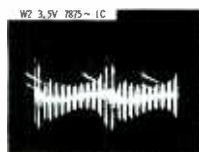
### C3 Decreased in Value (Towards Open)

(Bypass Capacitor—.1mfd)

Symptom  
Analysis



Color with station signal is very weak—even on strong local signal with color control at maximum. Tint control seems to operate, but hardly enough color to tell. Color-bar pattern is weak with center (blue-purple) area almost completely lost.



### Waveform Analysis

W1 amplitude and content appears to be good keyed rainbow generator output, except portion around burst pulse is accented. Burst portion of W2 is near normal, but rest of waveform severely suppressed. W4 (not shown) is near normal. W1 and W2 appear to be distorted by positive-going pulse at horizontal rate. Blanker grid waveform fills the bill. Scope check at point D confirms pulses at horizontal rate where only DC should be.

### Voltage and Component Analysis

NO VOLTAGE CLIPS

All DC voltages check within expected tolerances, whether strong, weak or no-color signal is received. This is because ACC circuit operates on burst portion of composite chroma signal, and is, therefore, not affected. Open C3 allows portion of horizontal blanking pulse to be coupled to grid circuit of V1 through R4. V1 then emphasizes only sync pedestal portion of chroma signal. DC voltages no help, waveforms are best clue to trouble. Leaky C3 would cause excessive color since V1 grid would be less negative.

**Best Bet:** Scope will solve.

## Weak or No Color

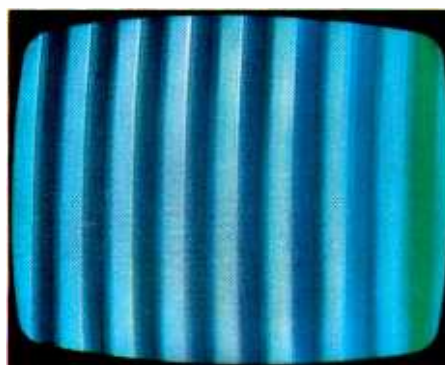
Color On Generator Signal

### C5 Decreased In Value (Towards Open)

(Q1 Emitter Bypass—.1 mfd)

### SYMPTOM 4

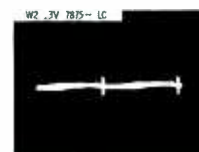
Symptom  
Analysis



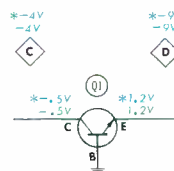
Complaint may be no color except on strong stations, or no color. Color may have deteriorated over period of time—necessary to increase color control more and more. Fine tuning critical for color reception. Good color bars with increased generator output.

### Waveform Analysis

Nearly impossible to troubleshoot chroma circuits with station signal since amplitude and content change constantly. Station signal used here to show relationship of burst to chroma signal—burst limited to sync pulse amplitude  $\pm 10\%$ . W1 shows sufficient amplitude for good color; W2 only a trace. Burst at point C (not shown) only about 6 volts p-p—killer cuts off demodulators. Waveform at Q1 emitter explains erroneous DC reading.



### Voltage and Component Analysis



Near no-signal reading at point C ( $-4V$ ) since burst nearly lost—only  $-6V$  on generator signal. V1 bias (point D) remains at strong signal potential both with and without chroma input. Reading at Q1 emitter is relatively high positive voltage both with and without chroma signal ( $1.2V$ , normally near  $-0.5V$ ). Scope finds source of trouble: positive-going burst keying pulse coupled through R5. R5 is for noise protection—portion of V2 grid current flows through Q1 emitter and R5. ACC will not respond to reduced burst.

**Best Bet:** VTVM for voltage; then scope.

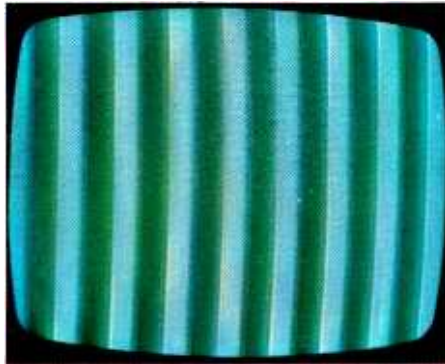
## No Color

Color May Be Intermittent  
**R10 Increased In Value**

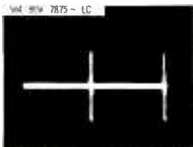
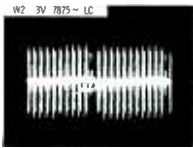
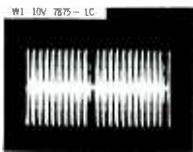
(Q2 Base—150K, 2%)

### Symptom 5

#### Symptom Analysis



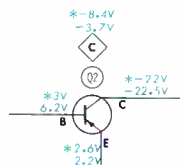
Symptom may be of continuing type—customer complaint is no color, intermittent color, or color is restored by killer control adjustment—color lost again later, etc. Finally killer control range is gone—color off channel and on b-w programs.



#### Waveform Analysis

All waveforms are well within normal expected tolerances to produce color bars—but only b-w bars on screen. While not shown, waveform at input to demodulators is sufficient (5 to 8 volts p-p) for good color. Analysis indicates demodulator or difference amplifier trouble—except that color killer controls demodulators (prevents noise from 2nd bandpass amplifier and demodulators reaching screen) instead of 1st bandpass stage.

#### Voltage and Component Analysis



Killer circuit is simple electronic switch using reference oscillator grid bias as keying voltage. Emitter bias fixed at about 2.5 volts. Base voltage set by R1 under no-color signal conditions so that collector potential (and demodulator grids) is -22 volts and demodulators can't operate. Burst forces reference oscillator grid more negative—portion of this voltage coupled through R10 to Q2 base allows Q2 conduction—collector and demodulator becomes slightly positive and demodulators operate producing color.

**Best Bet: VTVM and careful circuit analysis.**

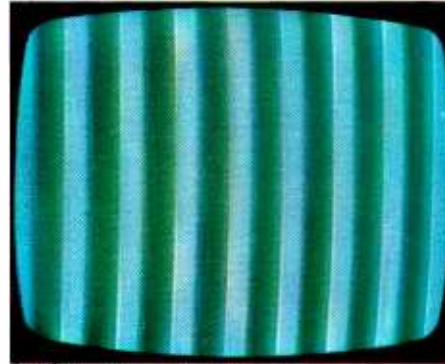
## No Color

B-W Normal  
**C2 Open**

(Chroma Coupler to  
 Burst Amplifier—120 pf)

### Symptom 6

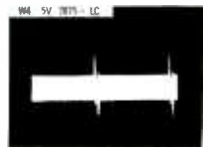
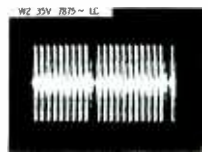
#### Symptom Analysis



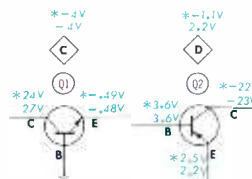
No color picture; only good black-and-white on known color programs. Station strength makes no difference—no color on fringe or local stations. Symptom started as overloaded color, but then all color lost. Generator pattern shows only shaded bars, no color.

#### Waveform Analysis

While not shown, W1 at input of first bandpass has sufficient amplitude and content to produce good color. W2, output of stage, has good content but excessive amplitude (-35 volts p-p normally 3 to 5 volts)—picture should be saturated with color. Clue to trouble at point B—practically no burst (5 volts p-p normally 80 volts) — isolates trouble to burst amplifier circuitry. W3 further isolates—no chroma riding on keying pulse.



#### Voltage and Component Analysis



DC voltages remain at no-signal potential with or without color signal. ACC operates on burst amplitude—keeps burst at set level to maintain constant chroma level. Here reference signal burst lost—ACC and killer react as though entire chroma signal lost—killer turns off demodulators. Partial loss of burst by C2 value change or burst amplifier defect would allow killer to conduct—ACC would bias bandpass amplifier for heavy conduction in an attempt to bring burst back to 80-volt p-p level—resulting in color overload.

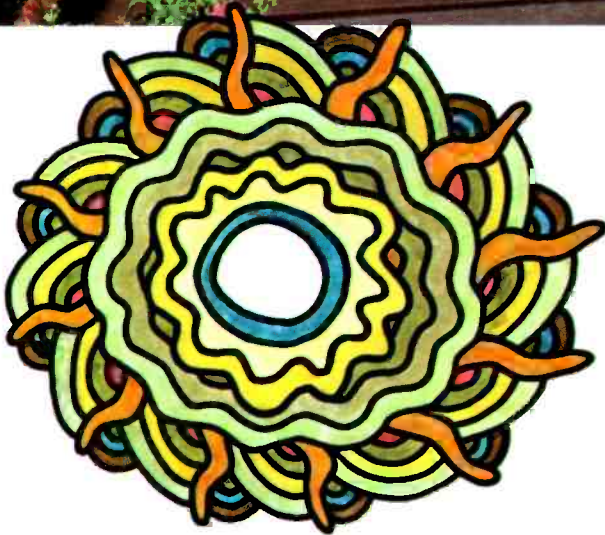
**Best Bet: Scope; VTVM; component substitution.**

RCA helps you  
**make way  
 for spring**

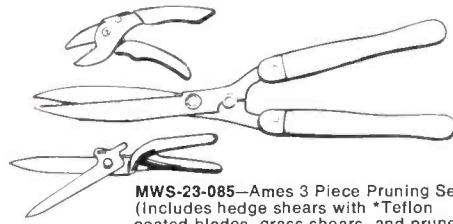


**TELESCOPE OUTDOOR FURNITURE.**

**MWS-381**—Poly Varnish Folding Armchair, (Overall width 23"). **MWS-361**—Poly Varnish Folding High Back Rocker, (Overall width 23"; height of back from seat 22"). **MWS-391**—Poly Varnish Folding Chaise, (Overall length 74", Overall width 25", back adjusts to 4 positions, has 2" built-in head pillow). **MWS-167**—Drape Style Umbrella Tango Pat. 67 Green. **MWS-291**—Umbrella Table.



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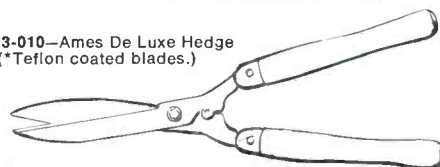


**MWS-23-085**—Ames 3 Piece Pruning Set. (Includes hedge shears with \*Teflon coated blades, grass shears, and pruner with \*Teflon coated blade.)

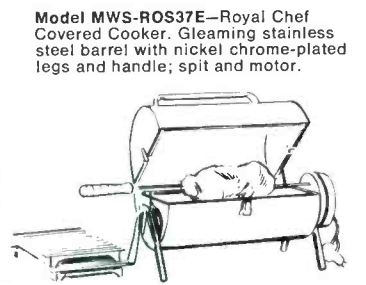


**MWS-23-021**—Ames Standard Lopping Shears.

**MWS-23-010**—Ames De Luxe Hedge Shear (\*Teflon coated blades.)

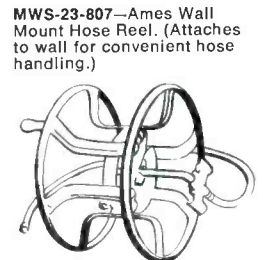


\*Teflon is a DuPont approved finish



**Model MWS-ROS37E**—Royal Chef Covered Cooker. Gleaming stainless steel barrel with nickel chrome-plated legs and handle; spit and motor.

**Model MWS-ROS28**—Royal Chef Covered Cooker. Baked-on enamel finish over bonderized steel.



**MWS-23-807**—Ames Wall Mount Hose Reel. (Attaches to wall for convenient hose handling.)

Available with your purchases of RCA Entertainment Receiving Tubes from your participating RCA tube distributor. RCA Electronic Components, Harrison, N. J.



# THE DIAGNOSIS THAT WASN'T

A preconceived idea about the cause of a trouble symptom is usually good, but not always—as the “hotshot” learns in the following paragraphs.

by JACK DARR

Now and then, you get lucky. I did; I was all alone in the shop when two boys from the dealer down the block came in, lugging a big console set. They put it on the floor in the middle of the shop, said, “Jim says ‘Fix It,’” and took off. I got one of them by the shirt-tail just before he escaped, and said, “Whoa! Wait a minute, Mass of Muscle. Put this monster up on the cart before you go.”

Reluctantly, they came back, lifted it onto the service cart, and started again. “Hey! Wait one. What’s the matter with it?”

“You’ll find out. We changed all the tubes, but that didn’t help,” and they shot off toward the nearest coffee shop.

I yanked the back off, hooked it up, and looked at it. Sure enough. Picture narrow by about an inch on each side, pretty bad blooming when the brightness was turned up, and a loss of focus. “Ho, hum,” I said to myself in my most supercilious manner. “Such cases are very

simple for an expert such as me. Probably a bad 6JE6 tube that got back into the tube caddy. However, leave us apply some highly scientific tests and run up a diagnosis, just for fun.”

Pulling the 6JE6 horizontal-output tube, I inserted a cathodebreak adapter and read the cathode current. Sure enough; about 160 ma instead of the normal 220 ma. That’s one. Screen-grid voltage: 250 volts instead of normal 130 volts. That’s two. The tube isn’t drawing enough current, and this includes the screengrid. Well, let’s check the grid drive. Scope shows a nice clean 220-volt p-p waveform, which is exactly what it should be. So, everything I see points straight toward my original, flash-of-inspiration-type diagnosis. Ho, hum. Things are just too simple these days, especially for a genius like me. If this isn’t a weak 6JE6 tube, you can call me Igor Murtschnikelnokov.

Three new 6JE6 tubes later—. Well, Igor, now what? (Wonder



how long it'll take me to get some new stationery printed? I could call it "IG's Radio-TV Service.") Deary me. All three new tubes show exactly the same readings. I still have a narrow raster, etc. So, I walked over to the edge of the stool, climbed down one of the rungs, and got the schematic. (Fig. 1A, Curtis-Mathes CMC22, chassis, PHOTO-FACT Folder 833-3).

Now then. Instead of relying on your feeble memory, look it up. Well! Just what I'd thought. All voltages high, all currents low, and here I was right where I started. While rechecking the voltages for the third or fourth time, I decided to read the grid voltage. Hmm, -78 volts? Let's see. Schematic shows -55 volts. Too much negative voltage? Yes indeed.

Now what? Wait a minute. Too high a negative grid voltage would give me symptoms just like those I have—current down, voltage up. But why? Too much grid-drive? No, the scope showed exactly the right amount of p-p drive, 220 volts. Now, I can't see for the life of me why I get too much negative voltage on that gr---WHOA!

Look at the schematic again. See the 6JE6 grid resistor? Instead of 470K ohms, etc, to ground that you thought it was, it's 10 megohms, and it goes back to B+, 180 volts! (In some versions of this chassis, it goes to 130 volts.) Well, well, this was put in there for a reason. But what—if this is open, the grid will be floating, and it surely won't work. Okay Igor, trace it. The grid-to-ground circuit has another branch R131, R54, the 1-meg color-killer control, and, finally, to ground through the burst-amplifier cathode resistor, R157. There's your ground-return.

Now, what's the 10-meg resistor for? And, is it okay? Well, there's one way to find out. Check it. It's easy to find; just follow the grid-lead from the socket to the terminal strip, through R130, and there it is. Brown-black-blue, 10 megs. Except for one thing, the ohmmeter says infinity. A new one out of the drawer does read 10 megs, so in it goes.

Now, things look a lot better. Plenty of width, no blooming, etc.

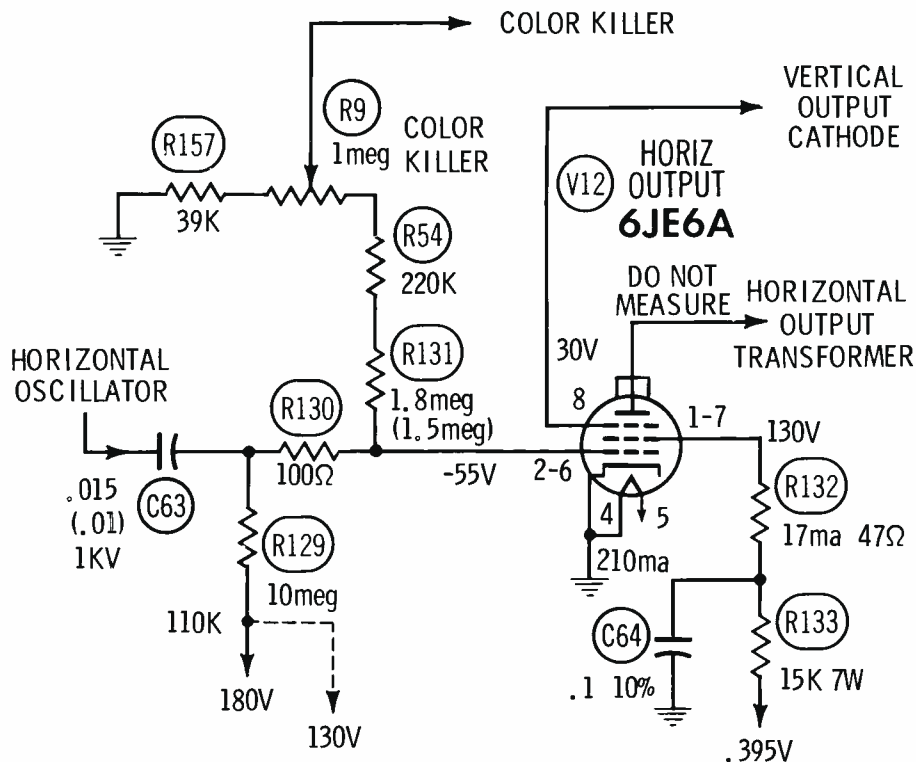


Fig. 1 Horizontal output circuit employed in Curtis Mathes CMC22 chassis.

Well, well, you fixed it, genius, but how? What happen? This: In color sets, the horizontal-output tube is pushed, hard. So, everything must be just right to get maximum efficiency out of it. In the familiar grid-to-ground circuit, it's possible

for the grid to develop too much negative voltage by grid-leak action, which cuts down the output. So, in this circuit, the designers fed in a very small, positive bucking voltage which keeps the grid from going too far negative.

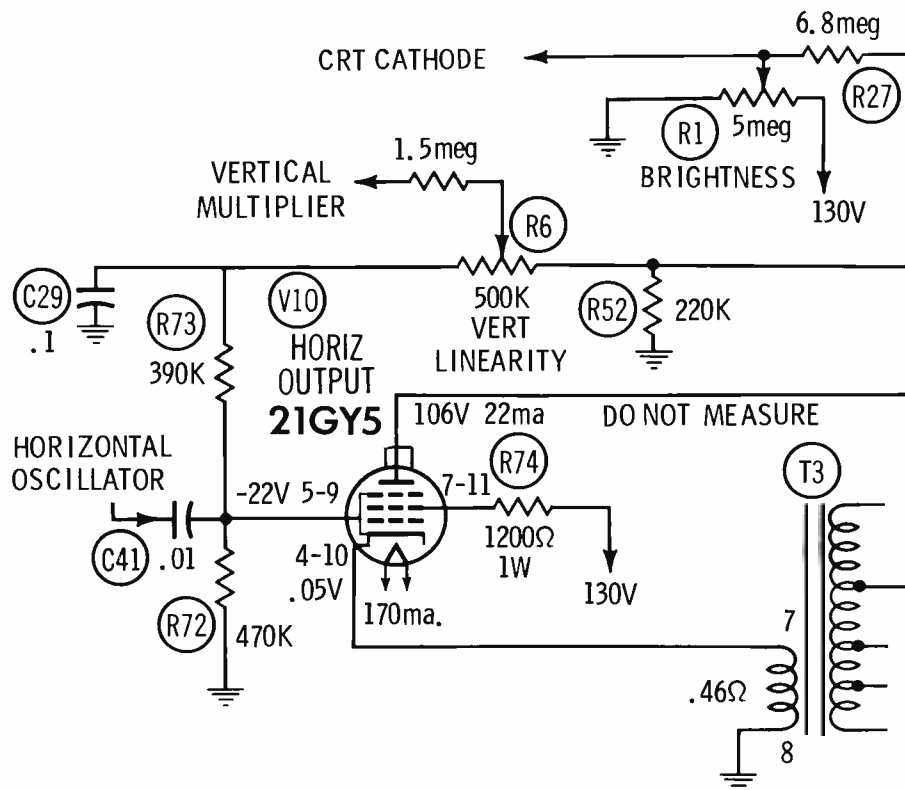


Fig. 2 Horizontal output grid returned to B+ in Truetone 2DC1605 chassis.

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how many ways  
you can use this  
handle?



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Circle 19 on literature card

40 PF REPORTER/April, 1968

By "balancing" the negative and positive voltages on the grid, they can drive the tube to a greater output than before, with safety. Of course, all of the resistors in the network must be right on the nose. If any of them change, the voltage balance will be upset, and you have a nice obscure trouble! (No thanks, just had one!)

Later, I found that the voltage-regulator wasn't working quite right. I had noticed the lack of control, but since the high voltage was down to about 15 kv at the time, I had ignored it. However, the 12-megohm resistor from the top of the high-voltage control to the grid was open. There is also a 15-megohm resistor from the 6BK4 grid to the video amplifier plate, so this was checked, too. (In some sets, this resistor is replaced by a 12-megohm resistor from the regulator grid to the CRT cathode). Of course, this one was good; it's easy to get to it.

#### Epilogue

The next morning, when I got to the shop, I found a Truetone 2DC-1605 chassis (PHOTOFACT Folder 810-4) on the bench (Fig. 1B). Same symptoms: narrow raster, blooming, etc. Still stinging a little from the day before, I got out the schematic and checked. Measure the voltages, cathode current, etc. Hmm. Well, looky there! 6.8-megohm resistor from +130 volts at the brightness control right back to the horizontal-output tube control grid. Ah, ha! Trying to slip one past me, huh? Can't fool this old fox twice in a row.

So, the following steps were taken: (1) unhook 6.8-megohm resistor, (2) measure resistance, (3) reconnect perfectly good 6.8-megohm resistor, (4) replace horizontal-output tube, (5) Get clean paper towel, wipe egg off face, and go get a cup of coffee.

#### Moral

No matter how much you need exercise, don't get too much of it by jumping to conclusions. Look at the whole circuit before you out-stick the neck. And, above all, don't freeze on a diagnosis! Keep an open mind at all times. ▲

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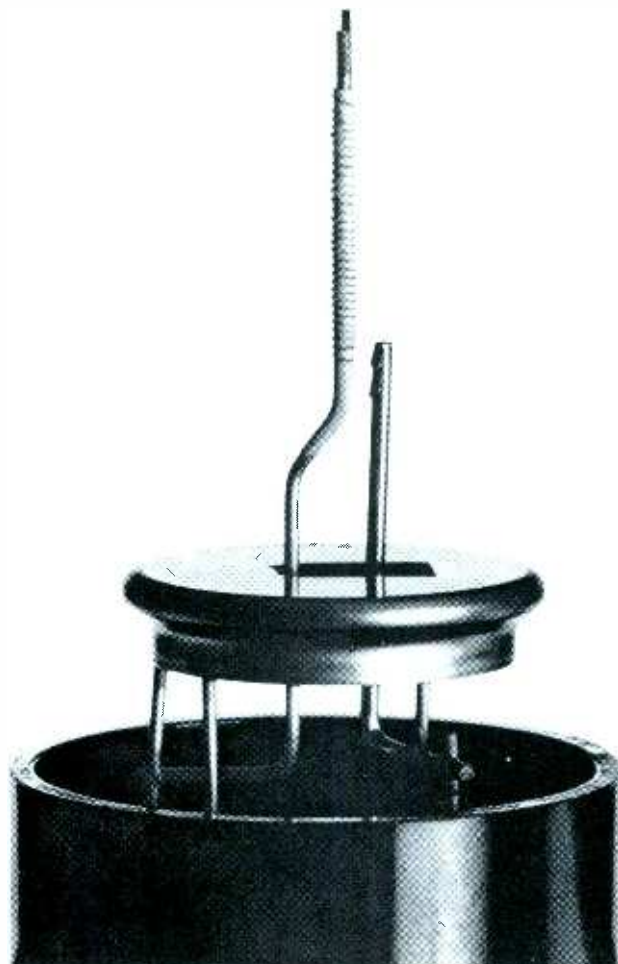
It takes less than a second for the 3CU3 to start rectifying full swing.

In case of a break, there's no way for the 3CU3's filament to fall against the anode, creating a short and knocking out other components in the circuit.

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The 3CU3 is interchangeable with 3A3 and 3A3A

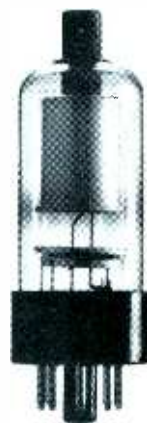


Our new 3CU3

high voltage rectifiers. And it's made exclusively by Sylvania.

The 3CU3 is just one of a new "posted filament" family which includes the new 3BL2 and 3BM2. They're designed for use in new color TV sets. These tubes are especially good for transistorized TV where their fast warm-up fits in with the "instant on" feature of solid state circuitry.

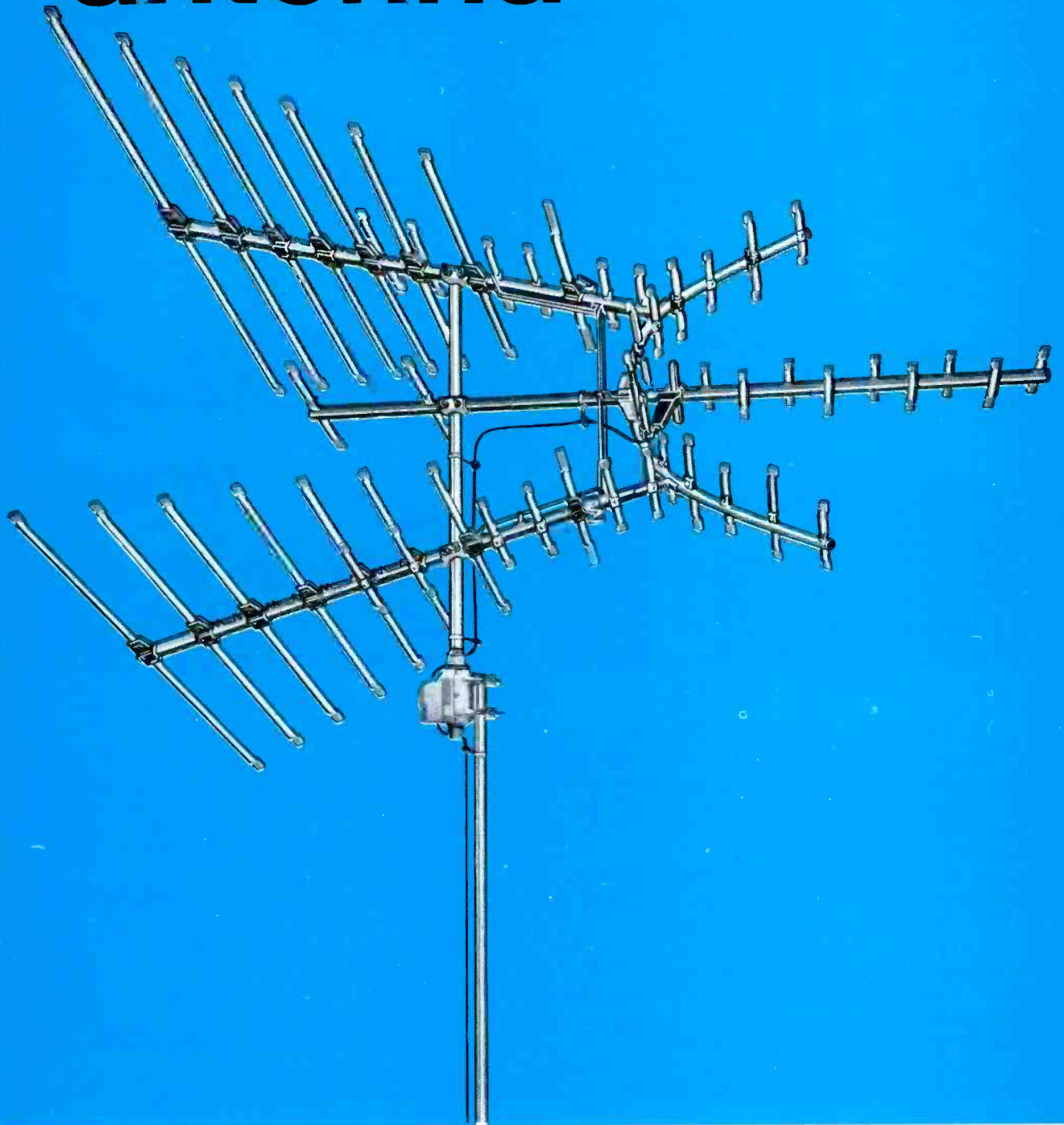
The new construction has higher reliability and longer life and should give you fewer and less troublesome callbacks.



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# introducing the hundred dollar antenna



# plus a not so short story about why Winegard's new SC-1000 is worth every penny...why it's the most powerful 82-channel antenna ever created for civilian use...and how it can change your antenna business.

Every once in a while a new antenna comes along that's more than just "new" and "different looking" and "bigger" and "better" and "more powerful". Once in a while, maybe once in a lifetime, an antenna is created that makes all the "usual claims" and then supports every one of the claims with *performance*. That's our hundred dollar antenna. The SC-1000. The top of our Super Colortron line. The top of any antenna line ever created.

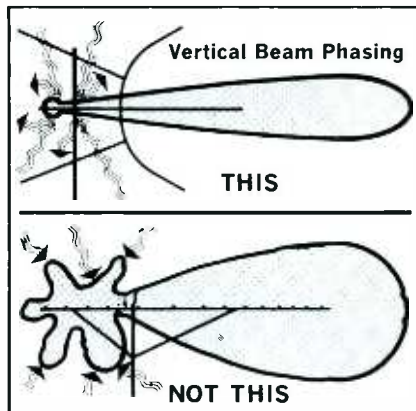
This VHF-UHF-FM super fringe antenna has undergone exhaustive testing and tuning refinements—and proved that it delivers performance worthy of its name, and it's price. Take, for example, an installation in Houston—41-feet above ground, equipped with rotor and 75 ohm download (no preamplifier.) The owner\* writes that with the SC-1000 he is now receiving superior reception on stations ranging from 60 miles away (Bryan, Texas) to 200 miles away (Alexandria, La. and Lafayette, La.) Now that's what we call results. And it's why the SC-1000 is already being called "the long distance antenna." Because it pulls in the farthest away, toughest channels—and always better than ever before.

Yes, feature for feature and dollar for dollar (even a hundred dollars) there has never been an antenna like the SC-1000. Let's take a look at the features.

\*Name supplied upon request.

**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-1000, 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-1000.

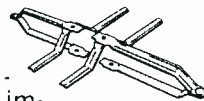


**New "Constant Focus" UHF Screen.** Concentrates all signal on Tetrapole collector element, provides as much signal capture area as an 8-foot parabolic, and at a fraction of a parabolic's size and weight.

**New "Interlaced UHF Resonant Reflectors".** Form a high density magnetic screen with all current fields in phase and working together for a new high in parabolic reflector efficiency.

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# BRIDGE CIRCUITS

## A REVIEW/PART 3

A continuing need for exceptionally accurate measurement of such electrical quantities as resistance, capacitance and inductance has sustained the use of this relatively old circuit. This three-part article will refresh your knowledge of the various designs and applications of the bridge.

BY RUFUS P. TURNER

*Material for the following article was adapted from a Howard W. Sams book titled "Bridges and Other Null Devices" by Rufus P. Turner.*

Our discussion of inductance—measuring bridges, begun in Part 2, is continued in this, the final installment on bridge-type measuring circuits.

### Slide-Wire With Potentiometer

A more compact version of the slide-wire inductance bridge, like the similar version of the resistance and capacitance bridges, substitutes a wirewound potentiometer for the slide wire. Fig. 19 illustrates this arrangement.

In this circuit, R3 is the balancing potentiometer. At any setting,  $R3 = R1 + R2$ , the sum of the resistances between the contact blade and the low end, and the contact blade and the high end, respectively, of the resistance element. Resistances R1 and R2 determine the bridge ratio.

At null, the unknown inductance ( $L_X$ ) is determined from the standard inductance ( $L_S$ ) and the resistance ratio:  $L_X = L_S (R1/R2)$ . The potentiometer dial may be calibrated to read directly in microhenrys, millihenrys, or henrys by locating the null points for a number of known inductances connected successively at  $L_X$ . It may also be calibrated with the aid of the preceding equation, in terms of measured R1 and R2 values. If the potentiometer dial already reads directly in resistance setting (as the dial of a multiturn

potentiometer often does), the unknown inductance may be calculated with reference to that setting:  $L_X = L_S [R1/(R3 - R1)]$  where,

R1 is the resistance setting indicated by the dial. R3 is the total resistance of the potentiometer.

Like the basic slide-wire inductance, the potentiometer-type circuit is simple and economical. However, it has three disadvantages: (1) because of stray reactances in the circuit,  $L_X$  values lower than 100  $\mu$ h often cannot be measured accurately; (2) unless the potentiometer has a special taper, such as logarithmic, the graduations will crowd at one end of the dial, seriously impairing readability and accuracy—and for that reason, the inductance range with any standard inductor  $L_S$  should not exceed 0.1 to 10 times  $L_S$ , even though the potentiometer affords a wider range; and (3) a complete null occurs only if losses in the unknown inductor equal those in the standard inductor.

The degrading effect of stray reactances in the useful ranges of the bridge may be reduced somewhat by keeping the potentiometer resistance, R3, reasonably low—say, 5000 ohms. The wasted ends of the potentiometer in the simple circuit may be saved by means of extension arms (such as R1 and R3 in

Fig. 20) which allows the useful 100:1 inductance range to be spread over the entire resistance range of the potentiometer.

### Practical Slide-Wire

Fig. 20 shows the circuit of a practical bridge using a 5000-ohm wirewound potentiometer (R2) as the balance control. This bridge covers the range from 100  $\mu$ h to 100 hy in three steps: 100  $\mu$ h-10 mh, 10 mh-1 hy, and 1-100 hy. The inductance ranges are selected by switching in standard inductors (L1, L2, L3). The 100-ohm non-inductive resistors, R1 and R3, provide the extension arms.

Any convenient test frequency may be employed, up to about 5

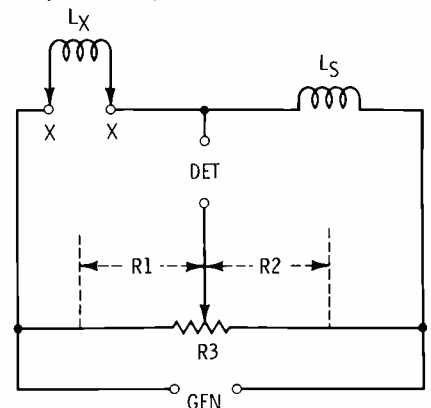


Fig. 19. Inductance bridge using potentiometer in place of slide wire.

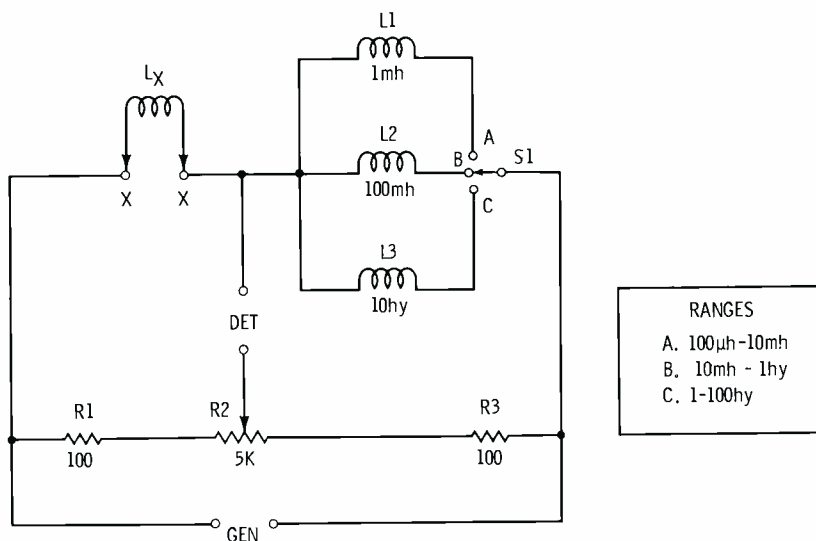


Fig. 20. Practical inductance bridge employing potentiometer.

KHz. Best stability is obtained, however, when the generator is coupled to the bridge through a shielded transformer. It is advisable also to insert a transformer between the bridge and detector, but this second transformer may be omitted if the first one is used, especially if the lower DET terminal is grounded.

This bridge may be calibrated by balancing it with a number of accurately known inductors connected successively to terminals X-X, and inscribing the potentiometer dial accordingly. Only one range need be calibrated in this manner; the others will track if the values of L1, L2, and L3 are all accurate. Thus, the lowest range (0.0001-0.01 hy) may be calibrated and the A, B, and C settings of switch S1 then used to multiply this basic range by 1, 100, and 10,000, respectively.

The null balance is sharp if losses in the inductor under test ( $L_x$ ) equal those in the standard inductor ( $L_s$ ). Since low-loss inductors customarily are used as the standards, this usually—but not always—means that a sharp null indicates low loss in the inductor. However, a broad null can also reveal that the standard inductor is inferior to the test inductor.

#### Q Balance

It was mentioned previously that a complete null is impossible with a simple slide-wire bridge unless the losses in the unknown and standard inductors match. The reason for this is the complex nature of the practical inductor as an impedance network (inductance and resistance in com-

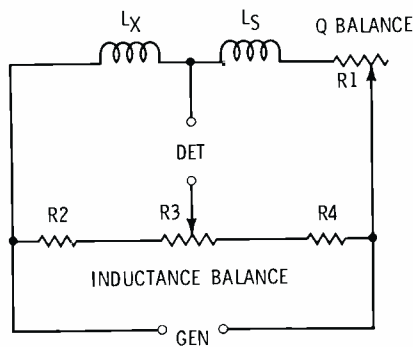
bination, the resistive component representing the losses). In order to obtain a complete null in most practical situations, separate balances are required for the resistive and reactive components, and this makes the bridge somewhat more complicated.

It is convenient to express the relationship between losses (resistive component) and inductance (reactive component) as the figure of merit or Q of the inductor. Numerically,  $Q = XL/R = \text{tangent of the}$

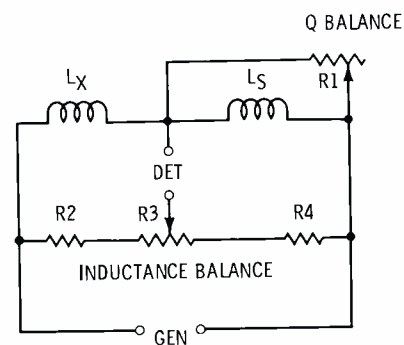
phase angle of the equivalent LR-network. A low-loss inductor has a high Q.

In somewhat more specific terms, the original statement may be rephrased thus: A complete null is obtained only when the Q of the unknown inductor equals that of the standard inductor. When the Q's are unequal, as they almost always are in practice, enough resistance must be added in series (sometimes in parallel) with the lower-loss inductor to reduce its Q to that of the higher-loss inductor. Addition of resistance to one or the other of the inductors will complete the balance of the bridge.

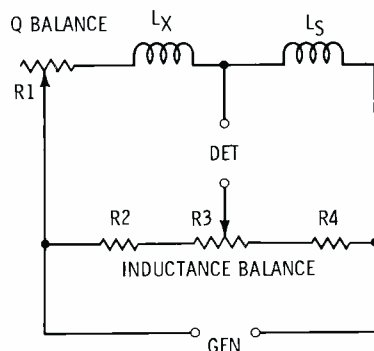
Fig. 21 shows how a Q-balance rheostat may be added to the slide-wire inductance bridge. In Figs. 21A and 21B, the standard inductor ( $L_s$ ) is the higher-Q component, and the resistance-balance rheostat (R1) is added in series (Fig. 21A) or parallel (Fig. 21B) with  $L_s$ . In Figs. 21C and 21D, the unknown inductor is the higher-Q component, and the resistance-balance rheostat (R1) is added in series (Fig. 21C) or parallel (Fig. 21D) with  $L_x$ . In use, the bridge is balanced first for inductance by adjusting potentiometer R3 for minimum response of the detector. Then, rheostat R1 is ad-



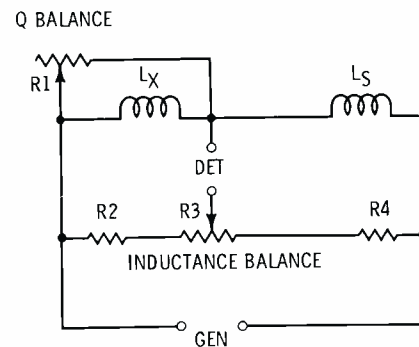
(A) Series compensation of standard



(B) Parallel compensation of standard



(C) Series compensation of unknown



(D) Parallel compensation of unknown

Fig. 21. Circuit designs for obtaining Q balance in the inductance bridge.

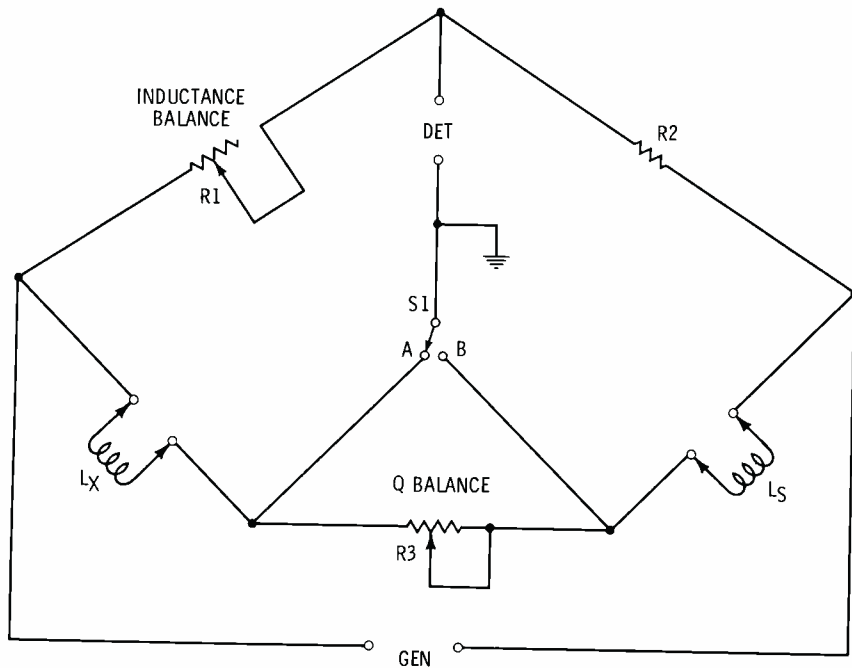


Fig. 22. Universal inductance bridge with Q balance.

justed to improve the null. Additional adjustments of R1 and R3, alternately, will give complete null (zero detector output). The resistance of R1 does not enter into the calculation of unknown inductance. Nor does the resistance of R3 enter into the calculation of Q.

For complete null, the resistance of R1 must be adjustable to the equivalent resistance of the opposite inductor. A dial attached to this rheostat may be calibrated to read directly in Q; however, this dial will read correctly only at the calibration frequency. All complete inductance bridges are equipped with such a Q balance.

Fig. 22 shows how a Q-balance rheostat is included in a universal bridge so that it may be switched in series with either the unknown or standard inductor, whichever has the higher Q. This bridge is convenient for checking an unknown inductor ( $L_x$ ) against any available inductor ( $L_s$ ) whose inductance, but not necessarily its Q, is known. When switch S1 is in position A, the Q-balance rheostat (R3) is in series with standard inductor  $L_s$ ; when S1 is in position B, rheostat R3 is in series with unknown inductor  $L_x$ .

#### Inductance Comparison Bridge

A common inductance bridge merely substitutes inductance arms for two of the resistance arms in the Wheatstone bridge, retains the other two resistance arms—the ratio arms

—to complete the basic circuit, and adds a Q balance. Because of the similarity of the two bridges, the inductance type is sometimes called a "Wheatstone inductance bridge," but the term "inductance comparison bridge" appears most often in technical literature.

The inductance comparison bridge, like the capacitance comparison bridge, overcomes many of the shortcomings of the slide-wire bridge, principally the dial crowding and lower-inductance limit of the latter instrument. Fig. 23 shows the basic circuit of the comparison bridge. Here, the bridge ratio ( $R_2/R_3$ ) is established by fixed resistor R3 and the inductance-balance rheostat. R2. A second rheostat (R1) provides the Q balance. With switch S1 at position A, rheostat R1 is in series with standard inductor  $L_s$ ;

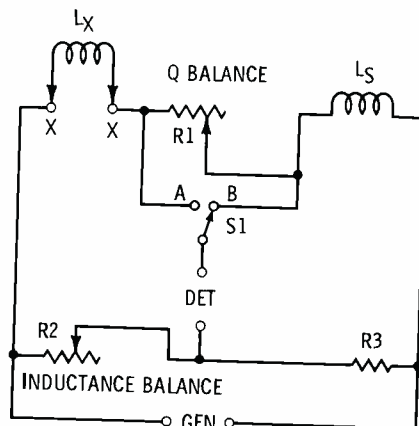


Fig. 23. Basic inductance comparison bridge employing Q balance.

with switch S1 at position B, rheostat R1 is in series with unknown inductor  $L_x$ . At null:  $L_x = L_s(R_2/R_4)$ .

#### Inductance Bridges With Capacitance Standards

The bridge circuits described in the foregoing sections compare an unknown inductance ( $L_x$ ) with a standard inductance ( $L_s$ ). This method is readily apparent, for it involves the basic AC bridge comparison of two similar impedances. Bridges of another group, however, compare an unknown inductance with a standard capacitance ( $C_s$ ). This latter procedure is advantageous, since highly accurate standard capacitors are often more readily obtainable than are standard inductors; and generally the capacitors do not have the bulk of inductors, especially at the higher values; nor are they ordinarily susceptible to interfering hum fields. The Hay bridge is representative of the various bridge designs that employ capacitance standards to measure inductance.

Fig. 24 shows the basic circuit of the Hay bridge. Here, unknown inductance  $L_x$  is compared with standard capacitance  $C_s$ . The bridge is balanced in the conventional manner by adjusting inductance-balance rheostat R2 and Q-balance rheostat R3 for null.

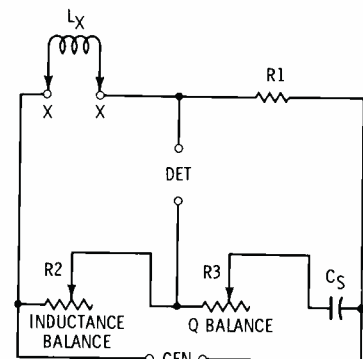


Fig. 24. Basic Hay bridge.

At null:

$$L_x = \frac{C_s R_1 R_2}{1 + (R_3^2 \omega^2 C_s^2)}$$

where,

$C_s$  is in farads,

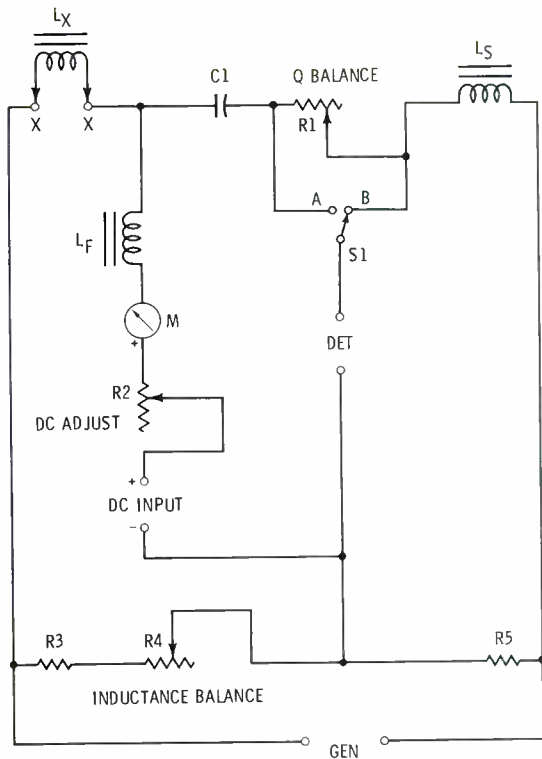
$L$  is in henrys,

$R$  is in ohms,

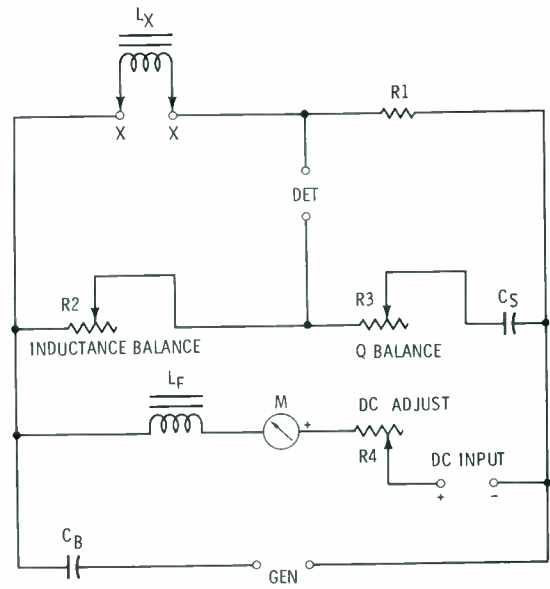
$\omega$  equals  $2\pi f$  ( $f$  is in Hz)

Since R3 appears in the denominator of the fraction, the inductance balance of this bridge is not independent of the Q balance. Also, since





(A) Comparison bridge



(B) Hay bridge

Fig. 25. Circuits for measuring inductance with rated DC applied.

$\omega$  also appears in the equation, the balance is frequency dependent. However, if the Q of the test inductor,  $L_X$ , is higher than 10, the frequency may be ignored, and the preceding may be simplified, with an error of less than 1 percent:  $L_X = C_S(R_1R_2)$ .

At null, the equivalent resistance of the unknown inductor also may be determined:

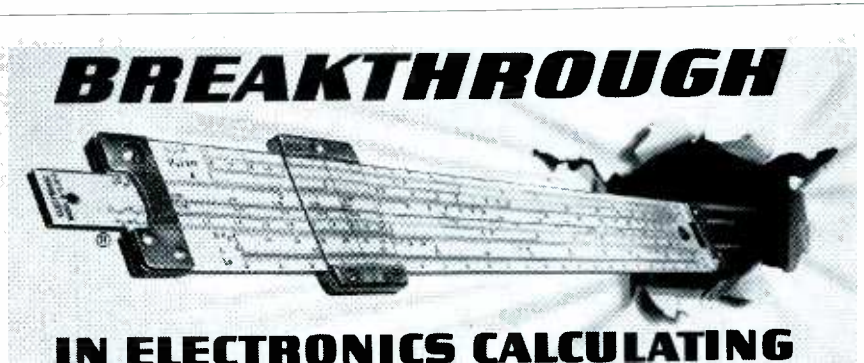
$$R_X = \frac{\omega^2 C_B^2 R_1 R_2 R_3}{1 + (\omega^2 C_B^2 R_3^2)}$$

From this, the Q of the unknown inductor may be determined:  $Q_X = (\omega L_X)/R_X$ . Again, note that the settings of both the inductance-balance and Q-balance rheostat enter into the calculation, and that the  $R_X$  determination, like that of  $L_X$ , is frequency dependent. However, if the Q of inductor  $L_X$  is higher than 10, the equation for figuring  $R_X$  may be simplified:

$$R_X = (R_1R_2)/R_3$$

#### DC Polarization

The inductance of an iron-core inductor (and of some inductors having cores of magnetic material other than iron) has a different value when the coil is carrying direct



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current simultaneously with the AC signal than when no direct current is present. Moreover, the inductance varies with the amount of direct current. This situation necessitates that the inductance of such coils be measured while they are conducting rated DC operating current.

Fig. 25 shows two bridge circuits for measuring inductance under conditions of DC polarization. In Fig. 25A, the conventional inductance comparison bridge has been equipped for this application by applying direct current to inductor  $L_X$  through filter choke  $L_F$ , DC ammeter or milliammeter  $M$ , current-adjusting rheostat  $R_2$ , and extension-arm resistor  $R_3$ . In all other respects, the circuit is identical to the inductance comparison bridge shown earlier in Fig. 22. The direct current is set to the required operating level by adjustment of rheostat  $R_2$ , and is indicated by current meter  $M$ . Filter choke  $L_F$ , whose inductance must be many times that of unknown inductor  $L_X$  and which must be able to carry the maximum direct current safely and without saturating, prevents short circuit of the AC bridge signal by the DC supply. Similarly, blocking capacitor  $C_1$  prevents short circuit of the DC supply by the bridge circuit. In this arrangement the direct current passes through the inductance-balance rheostat ( $R_4$ ) and extension-arm resistor ( $R_3$ ).

In Fig. 25B the Hay bridge has been adapted by applying the DC voltage in parallel with the AC signal voltage. The direct current is set to the required operating level by means of rheostat  $R_4$  and direct-current meter  $M$ . Filter choke  $L_F$ , whose inductance must be much higher than that of unknown inductor  $L_X$  and which must be able to carry the maximum direct current without saturating, prevents short circuit of the AC signal by the DC supply. Similarly, capacitor  $C_1$  prevents short circuit of the DC supply by the AC generator. The direct current passes through bridge resistor  $R_1$ , so this resistor must be rated to carry this current safely.

#### Mutual-Inductance Measurement

Mutual inductance, as well as self-inductance, may be measured by the bridge method. Fig. 26 shows two bridge circuits used for this purpose.

In the comparison bridge shown

in Fig. 26A, unknown mutual inductance  $M_X$  is compared with standard self-inductance  $L_S$ . Here, coil  $L_M$  of the mutual inductor constitutes the lower right arm of the bridge. (Inductance  $L_M$  must be known.) The bridge is balanced by adjustment of rheostat  $R_2$ . At null:

$$M_X = \frac{(L_M R_1 / R_2) - L_S}{1 + (R_1 / R_2)}$$

where,

$L_M$ ,  $L_S$ , and  $M_X$  are in henrys,  
 $R_1$  and  $R_2$  are in ohms.

In the Carey-Foster mutual-inductance bridge in Fig. 26B, unknown mutual inductance  $M_X$  is compared with standard capacitor  $C_S$ . In this circuit, the lower right arm (D) of the bridge has zero resistance, which frees the null from frequency dependence. The bridge is balanced by adjustment of rheostat  $R_2$ . At null:

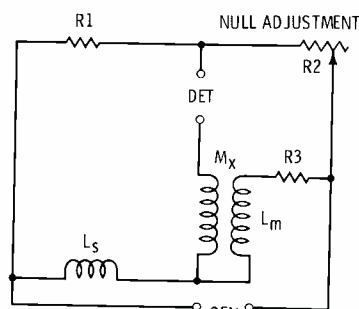
$$M_X = C_S (R_2 R_3)$$

where,

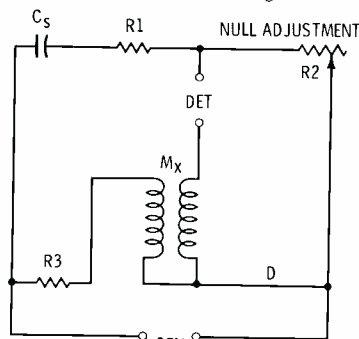
$C_S$  is in farads  
 $M_X$  is in henrys,  
 $R_2$  and  $R_3$  are in ohms.

#### Substitution Method

The same kind of trouble experienced in measuring small capacitances is also encountered in



(A) Comparison bridge



(B) Carey-Foster bridge

Fig. 26. Bridge circuits used for measuring mutual inductance.

measuring small inductances. That is, residual inductances in the bridge wiring and components, being of approximately the same magnitude as the small unknown inductance, restrict the smallest value which can be measured. They also make erroneous those values which can be measured. This difficulty is overcome by the substitution method, which resembles the similar method of capacitance measurement.

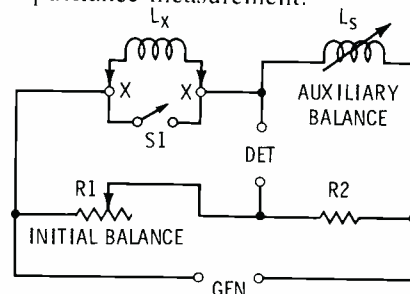


Fig. 27. Substitution method permits measurement of low inductance values.

Fig. 27 shows a bridge employing the substitution method. This circuit employs a calibrated variable inductor ( $L_S$ ), which may be several series-connected inductance decades or a continuously variable laboratory inductor (either one will be direct reading in henrys, millihenrys, or microhenrys). Unknown inductor  $L_X$  is connected to terminals X-X by the shortest possible leads. The bridge is operated as follows:

1. Switch  $S_1$  first is closed to short-circuit unknown inductor  $L_X$ . The standard inductor,  $L_S$ , is set to its lowest value (recorded here as  $L_1$ ), and the bridge is balanced by adjustment of rheostat  $R_1$ . This rheostat then need not be disturbed.
2. Next, switch  $S_1$  is opened. This inserts  $L_X$  into the circuit and unbalances the bridge.
3. Variable inductor  $L_S$  then is adjusted to restore the bridge balance, and its new inductance setting recorded as  $L_2$ .
4. Finally, the unknown inductance is calculated from the two settings of the variable inductor:  $L_X = L_2 - L_1$  where the  $L$ 's are in the same units: henrys, millihenrys or microhenrys.

Inductance values of  $0.1 \mu\text{H}$  or lower may be accurately measured by means of the substitution method. This method automatically takes into account the residual inductances of the circuit. ▲



# stubborn the hybrid

*Every once in a while we run across a real unusual problem. See if you agree with the "cause and cure" in this story.*

by H. L. COVER

You think a mule is stubborn? Well, there is now a fellow in my home town who will tell you, over and over, that the most obstinate cross-breed known to mankind is an auto radio with transistor output.

Some time ago on a beautiful autumn night, the old service bench was beginning to look pretty clean. The phone jingled, and a friendly competitor, snowed under with back work, asked whether I would tackle a knotty car-radio problem. I agreed to give it a try, so shortly thereafter a late model Buick pulled up to my shop. It was driven by a coverall-clad service station attendant named Bill, and he had the frustrated look of a man who had fought an all day battle and lost. I slipped into the front seat beside him, said a friendly hello, and asked him what seemed to be the trouble.

"Six times," he muttered, "Six times I have had this blankety-blank radio out of the car, and it still won't work." He stared at the radio with disgust. It was about eight o'clock, and he said he had been messing around with that radio since early in the morning and had not even had supper yet.

I felt a little like a psychiatrist, because this guy looked as if for two cents he'd put his foot through the windshield. I leaned back and said, sympathetically, "Tell me all about it."

Well struggling to remain calm, he poured out the sad history: A salesman, with the day off, had left the car at his station that

morning with a list of things to be done, including a battery charge and a request to get the radio fixed. It seemed that the slightest jar caused the music to go on and off, and it was expected that the repair would be pretty simple. Bill had pulled the radio and had taken it to a downtown shop where a loose connection had been soldered. After a bench test, the radio had been pronounced perfect. By then, the other maintenance items were completed so Bill had picked up the radio and installed it only to find that it was very, very dead. Suspecting all sorts of installation mistakes, he had worked and worked to no avail. Back across town to the shop he went, and when the whole staff could not find the trouble, Bill pulled the radio one more time. On the bench it had again performed perfectly; so when Bill went after it he and the servicemen did a bit of theorizing and decided it was bound to play now. Back to the station he went, with the music still ringing in his ears. He reinstalled the radio, and almost fell off the seat when again he found it to be absolutely mute. Now here is a grown man who can not cry and scream and kick the floor, but he said he sure felt like it. You might guess how the rest of the day must have gone, with this happening another time or two, until the down-town shop finally closed and the owner headed for the peace and quiet of an unlisted phone number. Bill had kept struggling, aided by kibitzers, and to add to his troubles, the car owner

was beginning to badger him. Finally, someone had recommended my night-working colleague, and thus, here was Bill at my shop, tired, hungry, discouraged, and mad, but still determined to see it through.

"Well, let's turn it on," I said.

At once there was the characteristic thump in the speaker, and Bill said, "There! You hear that? That's all I can get."

The thump was clear enough, and while giving the tubes time to warm up, I was thinking—it is getting getting power for sure, and the dash-mounted speaker is probably OK; the only possible thing left is the antenna. But surely any of these would have been caught earlier, and besides, there is no noise of any description.

Clicking it on would always give the thump, but nothing else could be heard, not even a trace of scratch as I rotated the volume control rapidly back and forth. I put my head under the dash and looked in vain through the ventilating holes for a dark tube. Everything looked fine, but now I could smell an overheated resistor. That was news to Bill, and a few minutes later we noticed that we had even lost the thump when the radio was turned on.

"Well," I said, "Can you pull it one more time?"

"In two and a half minutes," he growled, "I've certainly had enough practice."

I went inside and prepared to work on the radio, and when we

got it hooked up, it was still dead. Remembering the smelly resistor and the lost thump, I headed for the .39-ohm fusible resistor. It was wide open. After this was replaced, the radio played as if it were trying to make up for lost time. Stations came in all over the dial—loud, clear, and steady. Always the optimist, I began theorizing and explaining to Bill that it looked as if he had arrived at my shop just in time for the final crystallization of symptoms, resulting in the burned out resistor.

"Man," I told him, "Your worries are over now. This radio will play anywhere." Bill didn't look too impressed—he had been through this all day—but he was at least happier than he had been while it was dead. "You throw her back in the car," I went on. "And I'll work on some stuff here."

He went on outside, and I was busy on another item by the time he reappeared at the door. One look told me, but he said, anyway, "It won't play."

I could hardly believe him. "Come on," I said, "that thing has got to play." He shook his head sadly, and I followed him out. It wouldn't for love or money. "Pull her again," I told him, as he shuddered and I silently vowed to find out the answer to this one if it took me all night.

Back on the bench it was perfect, and he and I looked at each other a while in a futile, speechless way. Finally, I said, "My friend, we've got ourselves some kind of phenomenon here, but there has got to be a logical answer." Not being able to think of anything else to do, I decided to monitor the input voltage and to gradually decrease it from 12.6 volts to zero. That crazy radio played all the way down to 6 volts, and since the Buick had started OK and the headlights were bright, the voltage in the car was okay. "All right," I told him. "Let's take the radio, the shop speaker and antenna we are now using, the voltmeter, and a pair of double alligator hook-ups. We'll hook this dude up on the car floor, and the only difference between here and there will be the power source—and by George, we'll monitor that."

We gathered everything up, assembled it on the front floor hump, and as he turned the radio on, I attached the crocodile clips of my voltmeter. Boy! That voltmeter really read downscale! I quickly checked my +DC setting—black lead to car dash—red lead to hot wire of radio—all OK. Flipping the voltmeter to -DC resulted in a nice 12.6-volt reading. "Turn her off," I yelled. "We'll ruin the radio." He had it off in a second. "The polarity in the car is wrong for the radio," I told him. "But I don't see how that can be unless you put the battery in backwards."

"Didn't have it out," he said. "Charged it in the car."

We got out and raised the hood. Sure enough, the smaller terminal, clearly marked NEG, went to the engine head.

"Battery is in right," I said, "so how can it possibly be wrong up in the front seat?"

In desperation I set the voltmeter for +DC, pushed the black lead against the NEG terminal and was astonished to find that putting the red lead on the POS terminal gave me a down-scale reading. Reversing the probes resulted, of course, in a 12.6-volt reading, and the awful truth finally dawned on me. *The battery had been charged backwards!*

Now Bill's day-long adventures made sense, as is always the case when you have really come up with the answer. Bill sputtered a while about how careful he always was when he put the charger leads on a battery. "Besides, you can't even charge one backwards," he protested.

But there sat an impartial voltmeter telling the truth to both of us. "There is no electrochemical reason why you can't," I assured him. "And, in any case, here sits one. You have got to believe the voltmeter, and the only thing that's bothering me at this point is what we are going to do now."

Gotta give Bill credit, I reckon. He consulted me, rejected my in-decision, put his magnetic flashlight at the right spot, and with a screwdriver and some pliers, he had soon turned the battery end for end. I lent him a hammer, and watched,

not necessarily approving, as he beat the small split-ring onto the larger battery terminal. Then, placing the larger split-ring on its side, he pounded it until the split was about closed, which made it fit the smaller terminal fairly snugly. Needless to say, the radio now played as if happy days were here again. The car even seemed to start more smoothly. Bill now had a smile which almost encircled his head. He paid my modest charge enthusiastically, pronounced me a genius for solving his problem, and sped off into the night.

As I watched the tail-lights disappear, I couldn't help feeling a bit sorry for the present car owner. But even worse, how about the poor soul who eventually is going to have to decide why a negative-ground Buick has an ill-fitting, supposedly positive ground? If anyone replaces the battery as it now reads, he is wrong, and then that poor hybrid radio is going to have to weather another spell of reversed polarity. What happened, if anything, to the alternator and voltage regulator during Bill's travels that day will just have to be explained by an automotive engineer.

The main lesson to be learned here is already known to the wise serviceman—absolutely never take anything for granted. Many a good TV man has wasted valuable time, squatting like a back-catcher, peeping around with his flashlight and trying to figure why a series-set is stone dead when the complaint was "good picture-no sound." Finally, he thinks out loud that he will test and see if the wall socket is OK; and about then the lady of the house crosses the room, points to a wall switch and says sweetly, "I guess I should have told you that you have to flip this so the TV will come on." Boy!

Something else I learned is where to go if I should ever need a battery charge. I am going to Bill's service station with a request that he tend to it personally. You say in view of what he did you want to know why? That's easy—because I know it will be done right. After the day Bill put in because of doing it backwards, it is my opinion that this is one mistake he will never make again. ▲

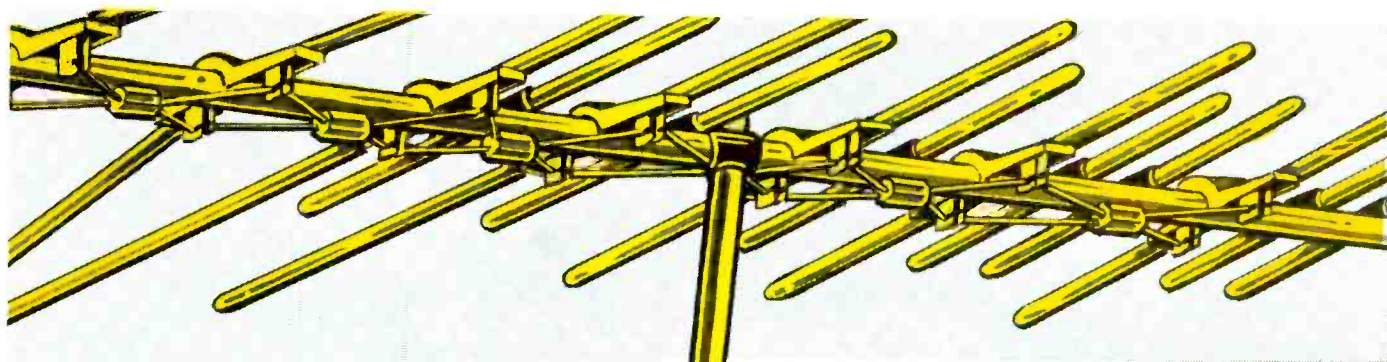
# The people puller



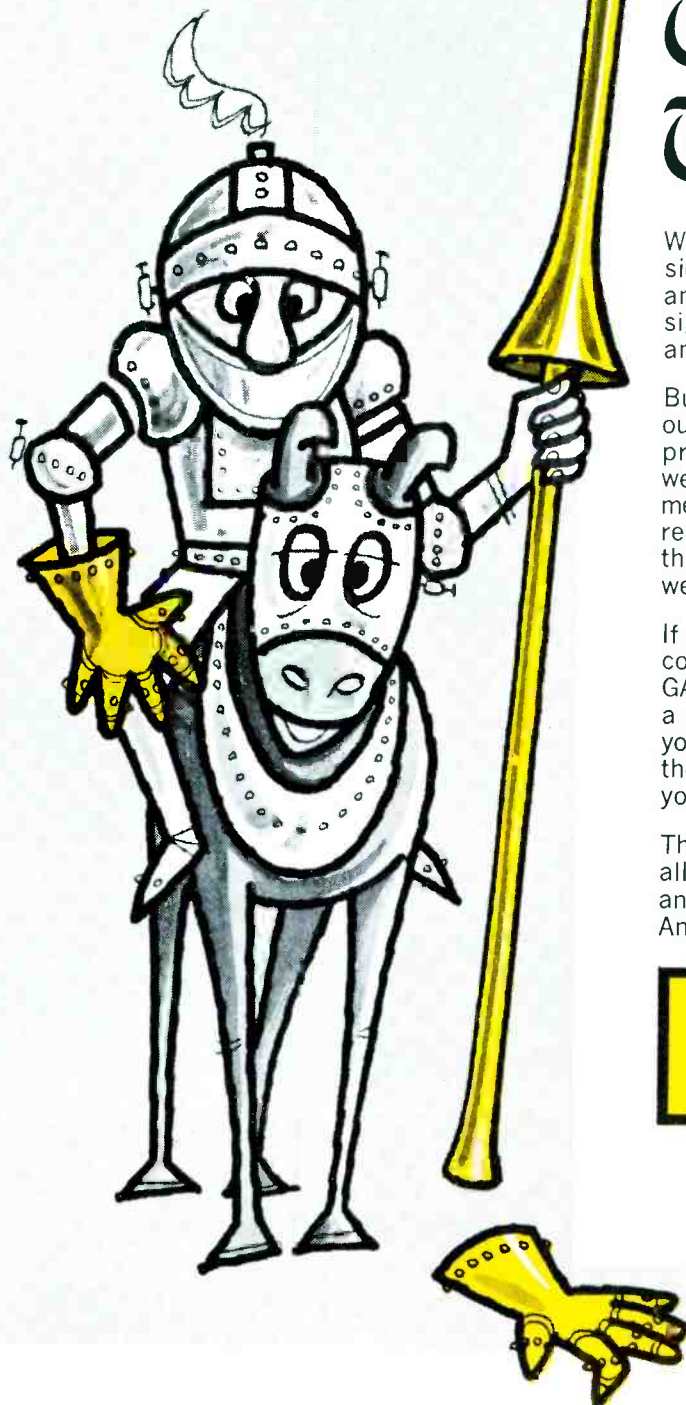
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Circle 26 on literature card

SEE PHOTOFAC Set 779, Folder 3

Mfr: RCA

Chassis No: CTC17 E/F/J/K

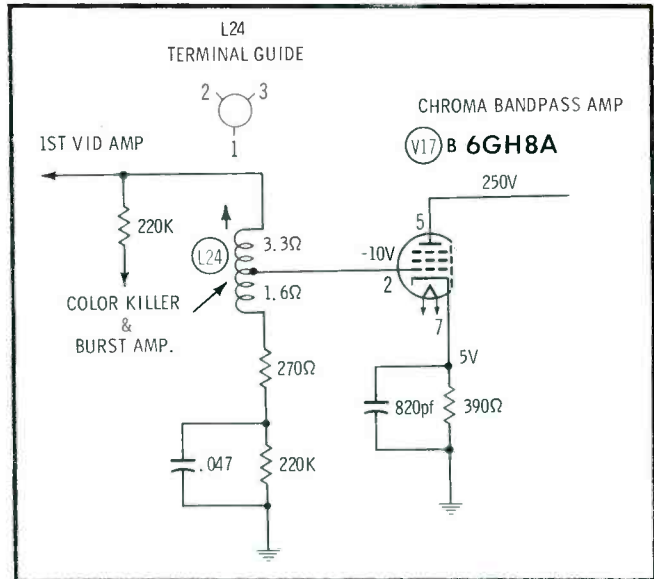
Card No: RCA CTC17-1

Section Affected: Pix.

Symptoms: No color in pix; b-w pix normal.

Cause: Open chroma takeoff coil.

What To Do: Repair or replace L24 (chroma takeoff coil).



Mfr: RCA

Chassis No: CTC17 E/F/J/K

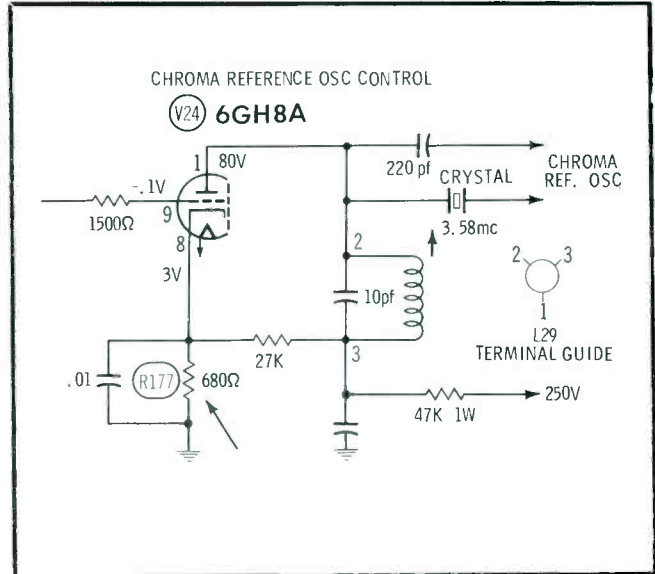
Card No: RCA CTC17-2

Section Affected: Color sync.

Symptoms: Intermittent color sync.

Cause: Overheated resistor in cathode circuit of chroma reference oscillator control.

What To Do: Replace R177 (680 ohms, 5%).



Mfr: RCA

Chassis No: CTC17 E/F/J/K

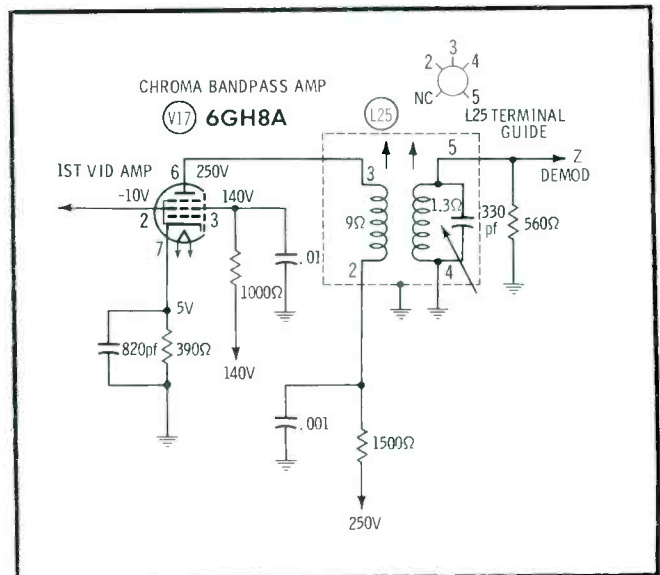
Card No: RCA CTC17-3

Section Affected: Pix.

Symptoms: No color in pix; b-w pix normal.

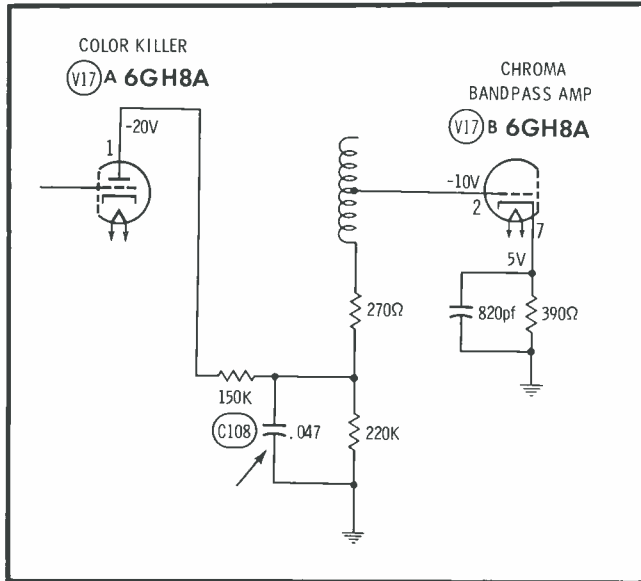
Cause: Open secondary in chroma bandpass amplifier transformer.

What To Do: Repair or replace L25 (chroma bandpass amplifier transformer).



SEE PHOTOFAC Set 779, Folder 3

SEE PHOTOFACT Set 779, Folder 3



SEE PHOTOFACT Set 779, Folder 3

Mfr: RCA

Chassis No: CTC17 E/F/J/K

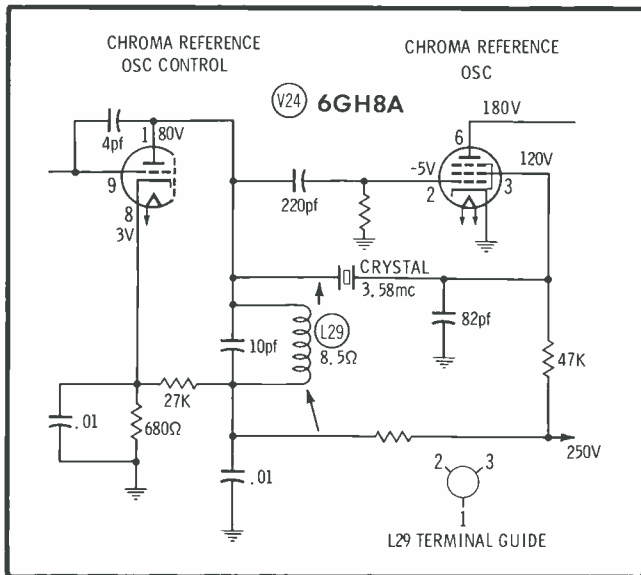
Card No: RCA CTC17-4

Section Affected: Pix.

Symptoms: Color interference in b-w pix; color pix normal.

Cause: Shorted bypass capacitor in voltage divider of color killer plate circuit removes killer bias from bandpass amplifier.

What To Do: Replace C108 (.47 mfd 200V).



Mfr: RCA

Chassis No: CTC17 E/F/J/K

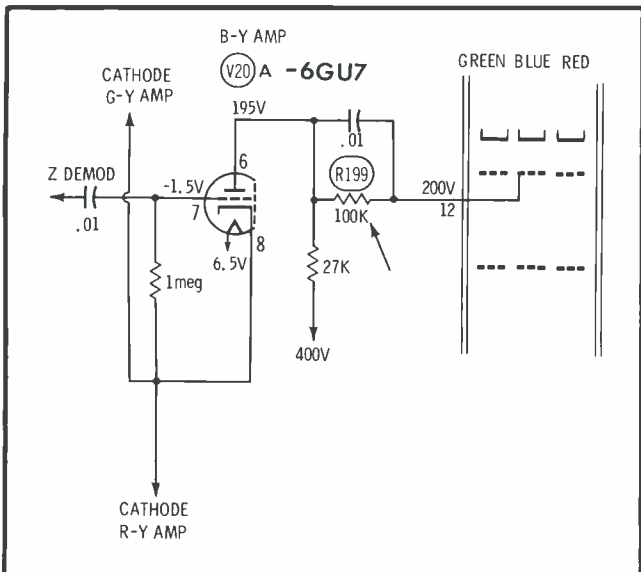
Card No: CTC17-5

Section Affected: Pix.

Symptoms: No color in pix; b-w pix normal. No plate voltage on pin 1 of V24-6GH8A, chroma reference oscillator control.

Cause: Open coil in plate circuit of chroma reference oscillator control.

What To Do: Repair or replace L29.



Mfr: RCA

Chassis No: CTC17 E/F/J/K

Card No: RCA CTC17-6

Section Affected: Raster.

Symptoms: Greenish-red raster. No grid voltage on blue control grid of CRT.

Cause: Open resistor between plate of B-Y amplifier and blue control grid of picture tube.

What To Do: Replace R199, 100K.



SEE PHOTOFAC T Set 812, Folder 3

Mfr: Truetone

Chassis No: 2DC1695A

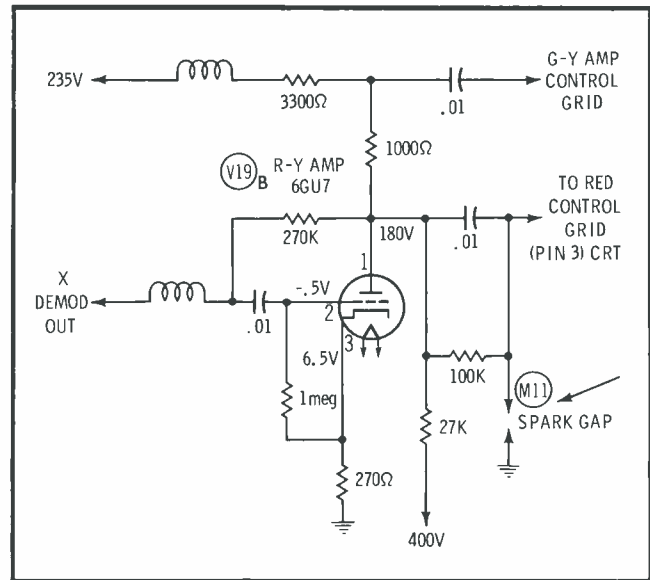
Card No: TR 2DC1695A-1

Section Affected: Raster.

Symptoms: No red in raster.

Cause: Shorted spark gap in R-Y amplifier plate circuit.

What To Do: Repair or replace M11 (spark gap).



SEE PHOTOFAC T Set 812, Folder 3

Mfr: Truetone

Chassis No: 2DC1695A

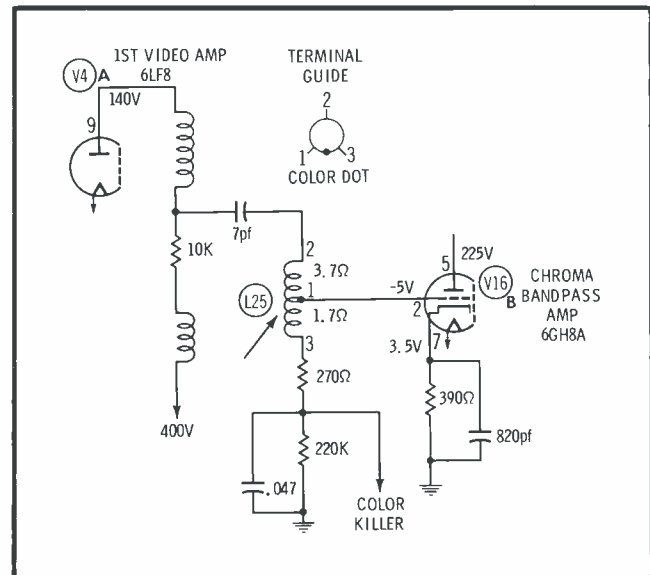
Card No: TR 2DC1695A-2

Section Affected: Color pix.

Symptoms: No color pix; b-w normal.

Cause: Open chroma takeoff coil.

What To Do: Repair or replace L25 (chroma takeoff coil).



Mfr: Truetone

Chassis No: 2DC1695A

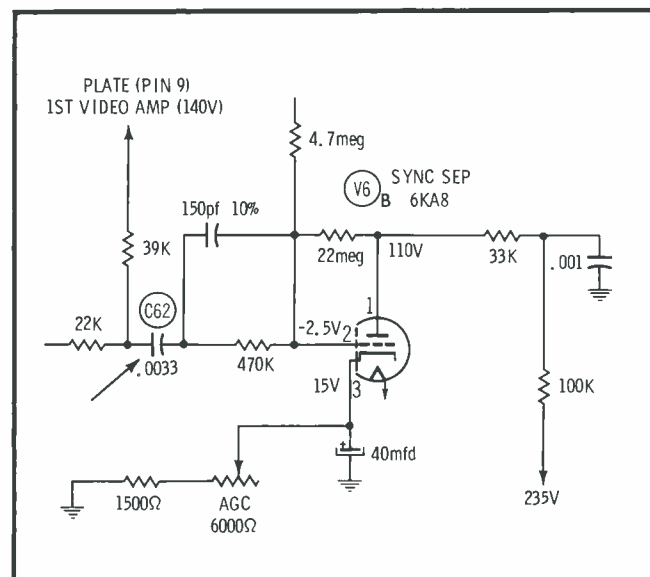
Card No: TR 2DC1695A-3

Section Affected: Sync.

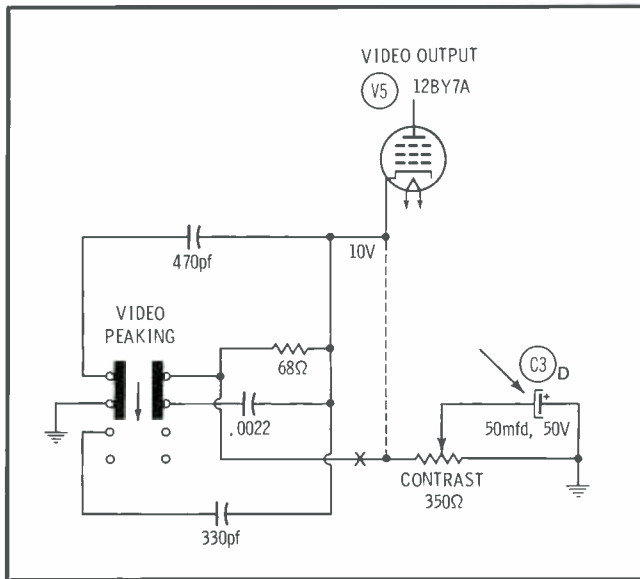
Symptoms: No vertical or horizontal sync.

Cause: Shorted sync circuit coupling capacitor.

What To Do: Replace C62, .0033 mfd.



SEE PHOTOFACT Set 812, Folder 3



SEE PHOTOFACT Set 812, Folder 3

Mfr: Truetone

Chassis No: 2DC1695A

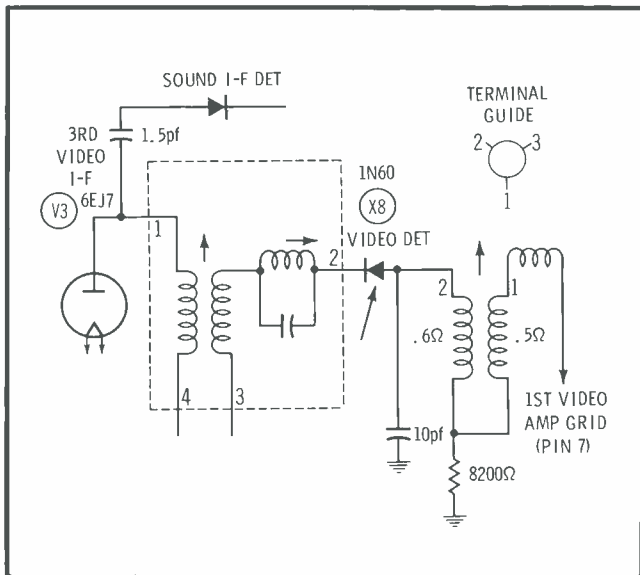
Card No: TR 2DC1695A-4

Section Affected: Pix.

Symptoms: Contrast varies intermittently on both b-w and color programs.

Cause: Defective bypass capacitor across contrast control.

What To Do: Replace C3D (50 mfd, 50V).



Mfr: Truetone

Chassis No: 2DC1695A

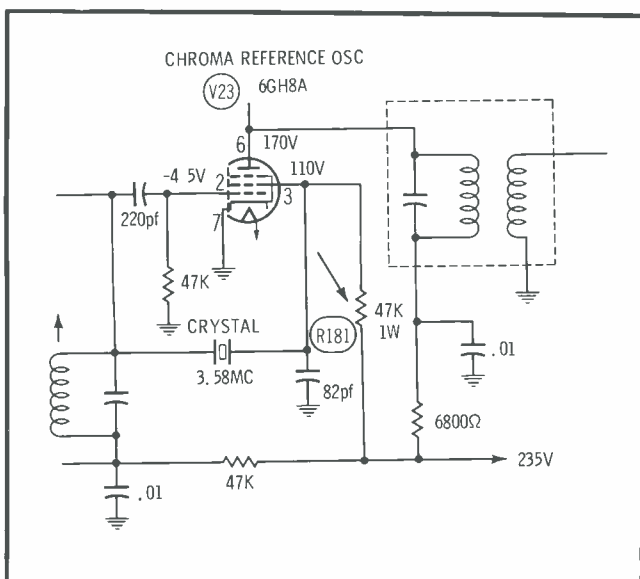
Card No: TR 2DC1695A-5

Section Affected: Pix.

Symptoms: No pix; sound normal.

Cause: Open video detector.

What To Do: Replace X8 (1N60).



Mfr: Truetone

Chassis No: 2DC1695A

Card No: TR 2DC1695A-6

Section Affected: Pix.

Symptoms: No color; b-w pix normal.

Cause: Open screen grid resistor in 3.58-MHz oscillator.

What To Do: Replace R181 (47K, 1W).

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

# NOTES ON TEST EQUIPMENT

by T. T. JONES

### Stereo System Analyzer

One of the most interesting new test instruments recently marketed is Amphenol's Model 880 Stereo Commander. With this one instrument, it is possible to completely evaluate the performance of an FM-stereo receiver, from antenna to speaker, with one exception. The exception is that the RF output is at

a fixed level, and it's impossible to check a receiver's RF sensitivity. However, the Model 880 does make all other necessary checks by incorporating many different instruments in one case. These instruments include:

1. Sine-wave generator.
2. Square-wave generator.
3. Multiplex generator.
4. RF oscillator. This section may be modulated by the MPX generator, or swept, up to 1.5-MHz deviation.

5. A marker oscillator, to be used in conjunction with the sweep signal.
6. An AC voltmeter.
7. An impedance bridge.
8. An intermodulation distortion analyzer.

All those instruments in one box seem like a tall order, but Amphenol's engineers managed to put the whole business in a 12" x 9" x 5" case, with room to spare (Fig. 2.) This was accomplished by using printed circuits, solid-state compo-



Fig. 1. Amphenol's New Stereo Commander is compact.

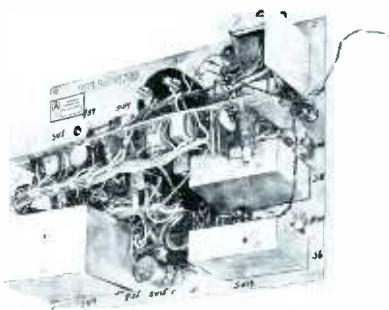


Fig. 2. Interior view shows high-density construction of Model 880.

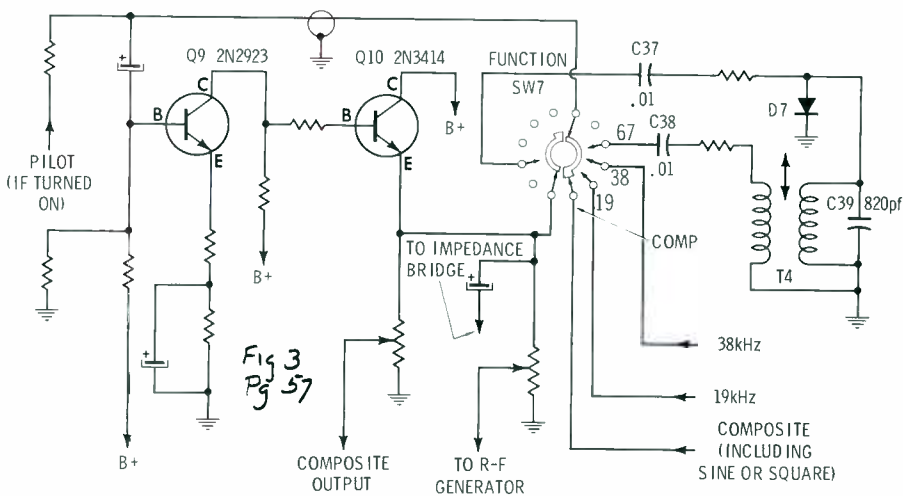


Fig. 3. Composite amplifier performs double duty.

nents, some really outstanding mechanical planning, and in at least one case, we suspect, a greased shoehorn.

The electrical engineering, though, is where the model 880 really shows its innovations. A large percentage of the circuits are "double duty." That is, a given stage performs in more than one mode of operation, and in some cases, even the stage function is changed. As an example, see the circuit shown in Fig. 3. This circuit performs as a composite amplifier in

the MPX generator mode, an audio amplifier in the sine-wave and square-wave generator modes, and as a 67-KHz oscillator when switched to that mode.

Here's how it works: In the various amplifying functions, Q9 and Q10 operate as a straight forward 2-stage amplifier. The various input signals are applied through SW7 to the base of Q9, amplified, and then Q10 operates as an emitter follower to provide a low-impedance output. When SW7 is switched to the 67-KHz oscillator position, the emitter

### Amphenol Model 880 Specifications

#### Outputs

##### Composite:

Stereo; 3 volts p-p, 35 dB separation to 10 KHz.  
L-R; 2.5 volts p-p.  
Mono; 3 volts p-p.

##### Pilot:

Sine-wave; 3 volts p-p.  
Square-wave; 10 volts p-p.  
Both outputs variable from 35 Hz to 18 KHz, less than 1% distortion.

##### Audio:

10% or 5% in-phase.  
45° out of phase.  
Accuracy  $\pm 2$ Hz.

##### 19 - , 38 - , 67-KHz

3 volts p-p.

##### RF Oscillator:

FM; Modulated by composite signal, 75-KHz deviation for full stereo signal.  
Sweep; 0-1.5 MHz sweep width, 60-Hz sweep rate.  
Oscillator is adjustable from 95 to 105 MHz.

##### Marker Oscillator:

10.7 MHz, crystal controlled.

##### Scope Horizontal:

Phasing adjustable, from special winding on power transformer.

#### Measurements

##### Voltmeter:

0-.1V-1000V RMS, in a 1-3 sequence. Impedance 1 meg-ohm.

##### Impedance Bridge:

Measures impedances, resistive or nearly resistive, 1 ohm to 20K ohms.

##### Intermodulation Analyzer:

Measures IM distortion from .1% to 100%, using SMPTE standard signal.

##### Power Source:

117 VAC.

##### Size (HWD):

12" x 9" x 5".

##### Weight:

9½ pounds.

##### Accessories:

All necessary cables included.

##### Price:

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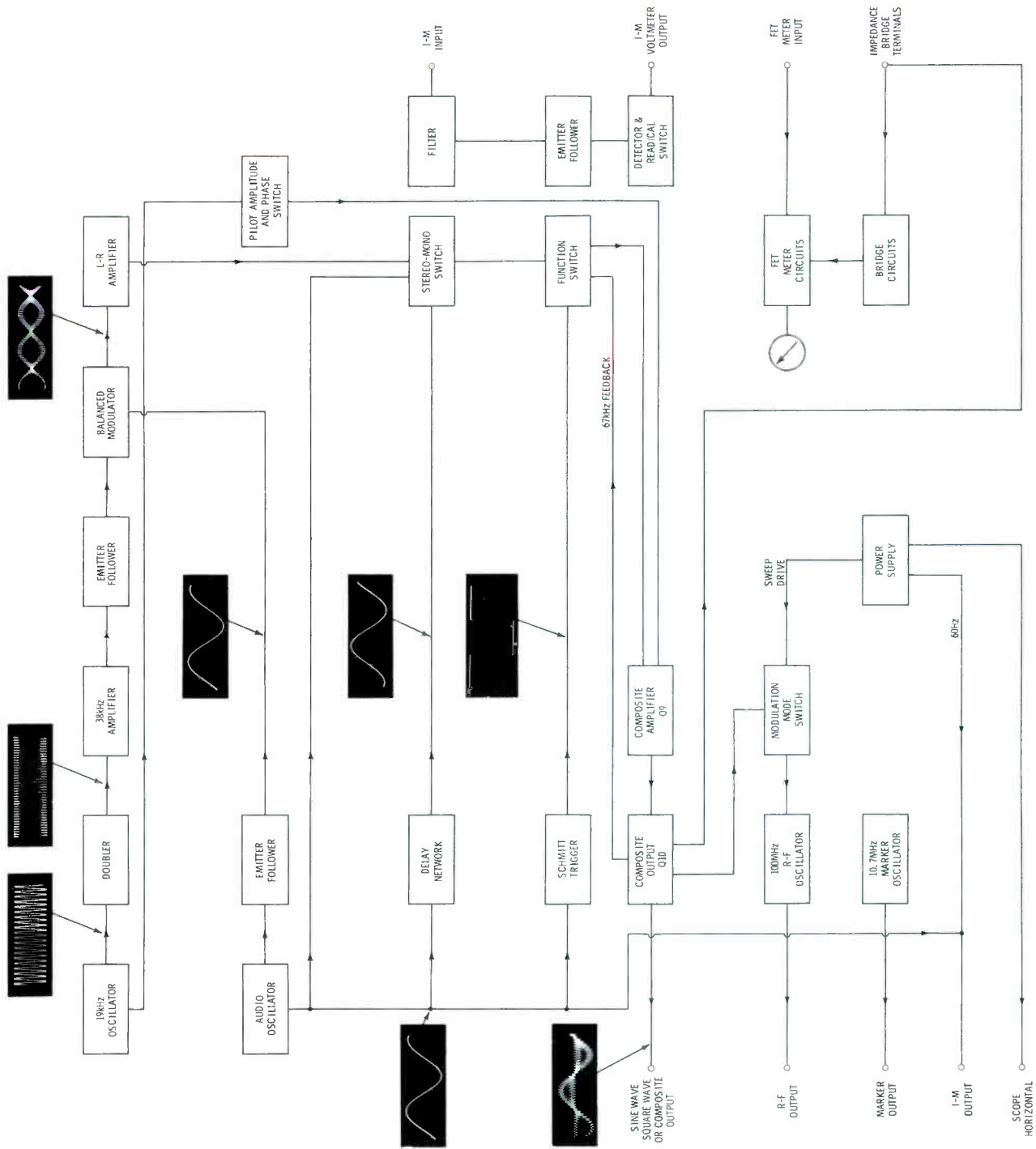


Fig. 4. Amphenol Model 880 overall block diagram.

of Q10 is connected through C37 to a tank circuit consisting of C39 and the primary of T4. The output signal is picked off at T4's secondary and fed back through C38 to the base of Q9. This forms a very effective feedback, or self-controlled oscillator. D7 clips the output signal applied to T4, to keep the feedback from rising to a dangerous level.

The position of Q9 and Q10 in relation to the overall circuitry can be seen more clearly in the block diagram, Fig. 4. Note also, that the audio oscillator is the real heart of the Model 880. It is internally connected, either directly or through switches, to the MPX generator in two places (left and right channels.) The audio oscillator also feeds through Q9 and Q10 to appear as the sine-wave output, feeds the Schmitt trigger to produce the square-wave output, provides the drive signal for the impedance bridge, and can be switched through to modulate the RF oscillator. In addition, the sine-wave output is used as one of the test signals for the intermodulation distortion tests.

The AC meter is of the FET type, and the circuit is nearly identical with that of the Amphenol Model 870 FET meter, less the DC and ohms scales. The Model 870 was covered in this column in the October 1967 PF REPORTER.

The stereo-MPX section of the Model 880 is a rather straightforward circuit. Referring to Fig. 4, we see that the 19-KHz (crystal) oscillator generates the pilot tone which is available at the composite output jack. The 19-KHz signal is also doubled in a full-wave rectifier circuit, amplified, and applied to the balanced modulator. Audio is also applied to the balanced modulator, providing a suppressed-carrier DSB signal—the L-R subcarrier. This signal is amplified and applied to a matrix in the stereo-mono switch.

Audio is simultaneously applied to the delay network. This network produces a delay in the L+R component which is equal to the delay undergone by the L-R signal in the balanced modulator and amplifier. This delayed L+R signal is applied to the matrix, and the output of the matrix (stereo-mono

switch) is a complete stereo signal, less than the 19-KHz pilot. The pilot tone is added to Q9 after its phase and level have been adjusted. The waveforms included in Fig. 4 may help in following the signals through the MPX generator.

In operation, we found the Model 880 was not a particularly simple instrument, but the instruction manual is well-written and the operation is quickly learned. It proved most helpful to study the setup chart on the last page of the manual. We just hooked up a scope to the output jack and went through all the various steps. After doing this, and actually seeing on the scope what signals were present, the Model 880 became easy to operate.

The same procedures can be used in learning the operation of IM distortion analyzer, the sweep oscillator, and the bridge. Try a little practice in your spare time—before you actually need the instrument on a particular job. After a little practice, IM distortion readings become as simple to make as resistance readings. ▲

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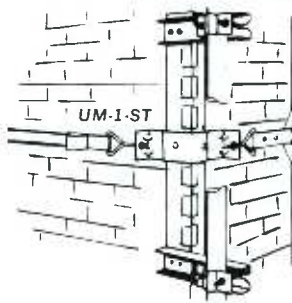
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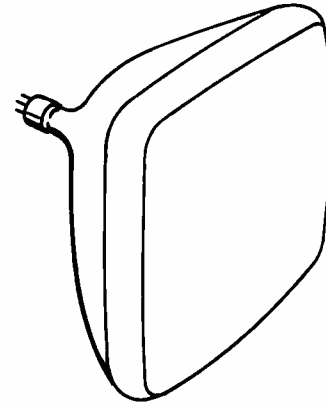
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April, 1968/PF REPORTER 61

## THE COLOR CRT



The circuitry used to extract the luminance and chrominance information from the composite video signal has been explained in parts 2, 5, and 6 of this series. From these discussions, we learn that there are four video inputs to the color CRT: (1) the luminance, or Y, signal which contains only brightness information; (2) the R-Y signal containing, essentially, only the red information without any brightness information, (3) the B-Y signal containing the blue information, and (4) the G-Y signal which contains the green information only.

It is customary to assign a notation of polarity to each of the last three of these signals. Thus we have the quantities  $-(R-Y)$ ,  $-(B-Y)$ , and  $-(G-Y)$  as well as their positive counterparts expressed above. These arbitrary designations can become confusing when considering the operation of the CRT itself since a specific gun, red for instance, conducts even when a  $-(R-Y)$  signal is fed to its grid. Actually, the quantity 0 ( $R-Y$ ) is defined as the amount of conduction of the red gun which, when the G-Y and B-Y signals are also at zero level, will produce reference white. Stated another way, zero levels of R-Y, B-Y and G-Y are present during b-w reception. Negative R-Y, B-Y, or G-Y refers to an amount of conduction of the specific gun which is less than that which is required to produce reference white.

Notice that the conduction of a specific gun is not entirely dependent on the color-difference signal fed to its grid. Conduction is determined by the grid-to-cathode voltage of the gun, and since the cathode is being driven by the luminance, Y, signal, the absolute value of conduction of each gun is determined by the sum of the color-difference and Y signal being fed to it. But, the cathodes of the three guns receive the same signal; therefore, brightness is determined by the total conduction of all three guns, but hue is determined by the relative conduction of each of the three.

Unlike the picture tube used in a monochrome TV, which must reproduce only brightness information, a color CRT must also translate the various input signals into colors as well as brightness. In the earliest color TV's, the color-difference signals (R-Y, B-Y, and G-Y) were recombined with the luminance (Y) signal outside the CRT, but nearly all modern sets depend on the CRT itself to perform this function. This, of course, makes the design of the color CRT even more critical. The Y signal is fed to the three cathodes of the CRT in phase and at approximately the same amplitude. The three color-difference signals are fed to the control grids of the red, blue, and green guns. Therefore, the beam current from the blue gun is controlled by combining the B-Y signal with Y to obtain blue (B) information, R-Y is combined with Y in the red gun,

and G-Y is combined with Y in the green gun.

The no-signal conduction of each gun is preset by adjusting the grid No. 2 (screen) voltages of each gun for reference white. If the characteristics of the three guns were identical, no further adjustments would be necessary. However, the trans-

conductance,  $\frac{\Delta \text{ beam current}}{\Delta \text{ grid voltage}}$ , of

the three guns may vary slightly, causing the overall tint of the picture to change with changes in brightness. This condition (known as improper gray-scale tracking) is corrected by inserting gain controls in the cathode circuits of two of the guns. These are adjusted so that the hue of the picture is not affected by its brightness.

Fig. 1 is a graph showing the brightness produced by each of the three guns in a hypothetical CRT. These curves show no specific quantities but only a relationship between the three guns. In this hypothetical tube, if white were produced at 12 brightness units, the screen would tend to become blue with increased brightness. At brightness levels less than 12, it would be predominantly green. By decreasing the transconductance of the blue gun and increasing the transconductance of the green gun, reference white can be obtained at all brightness levels. This, of course, is known as gray-scale tracking.



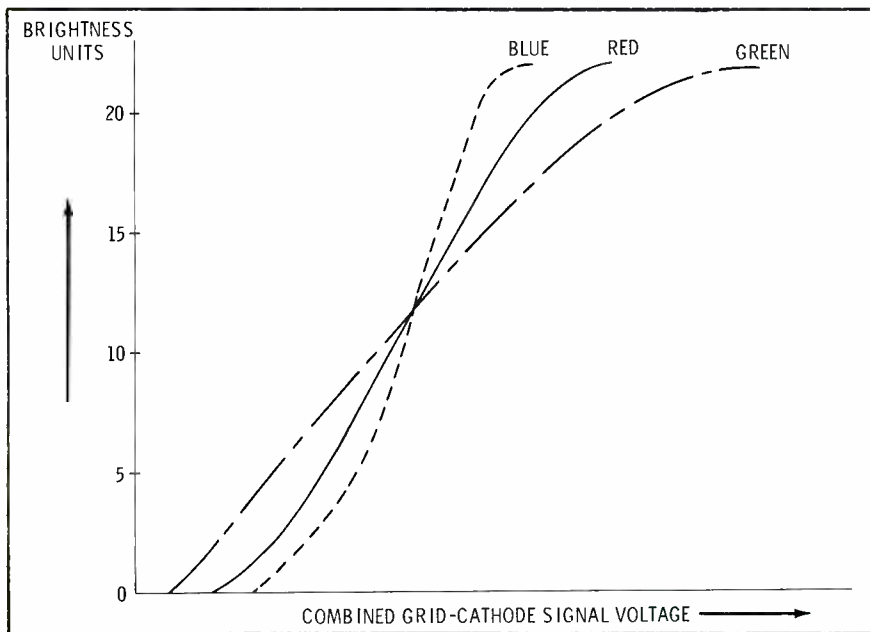


Fig. 1. Possible gain variations of the three CRT guns.

### CRT Geometry

At the present state of the art, the color tube most commonly used has three guns spaced at equal angles around the axis of the tube, a shadow mask with color-dot triads, electromagnetic deflection and convergence, and electrostatic focus.

Fig. 2 is a cross section of the neck of a CRT showing the position

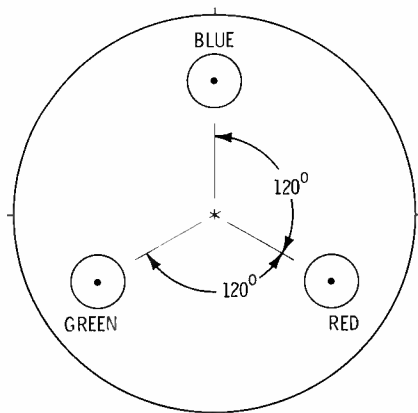


Fig. 2. Cross section of CRT neck.

of the three guns. Notice that the red and green guns share a common horizontal plane while each gun lies in its own vertical plane. A view of two gun assemblies is shown in Fig. 3. A close examination of these gun assemblies would show that each of the three guns is tilted so that the three beams will converge at a common point at the center of the shadow mask. This simplifies the convergence circuitry associated with the tube.

As shown in Fig. 3, each gun

consists of a heater, cathode, control grid (No. 1), accelerating grid (No. 2), focusing grid (No. 3), and a final accelerating grid (No. 4) which, since it is connected to the neck coating and shadow mask, is part of the ultor or high-voltage anode of the tube. A pair of pole pieces are located at the end opposite the cathode of each gun. These are used in conjunction with external fixed magnets and electromagnets to position the beams to provide proper convergence. In some CRT's, an additional set of pole pieces are situated adjacent to the focusing grid of the blue gun. These, too, are used in conjunction with an external magnet (the blue lateral magnet) to aid in converging the blue beam with the other two.

Fig. 4A shows a side view of a typical 23V color CRT with the deflection components in place, and Fig. 4B is a cutaway view of a 19V tube. Of particular interest is the arrangement of the shadow mask and phosphor screen. The shadow mask is a thin sheet of metal which has been perforated with a series of very small holes by a photoengraving process.

For each hole in the mask, three bits of colored phosphorescent material are deposited on the face plate of the tube in a pattern called a triad. These dots are arranged so that electrons emanating from the red gun pass through a specific hole in the mask and excite the red phosphor dot. At the same time, electrons from the blue gun pass through the same hole in the shadow mask to excite the blue phosphor dot; and, of course, the electron beam originating at the green gun at this same instant passes through the identical hole and excites the green phosphor dot.

### Color Purity

The degree of color purity depends on how well the beams from the guns actually pass through the holes in the shadow mask to strike the phosphor dots. The two variables which affect purity are the distance from the deflection plane to the shadow mask and the points on this plane through which the beams pass. Fig. 5 illustrates these two variables.

The relative positions of the phosphor dots and the holes in the mask

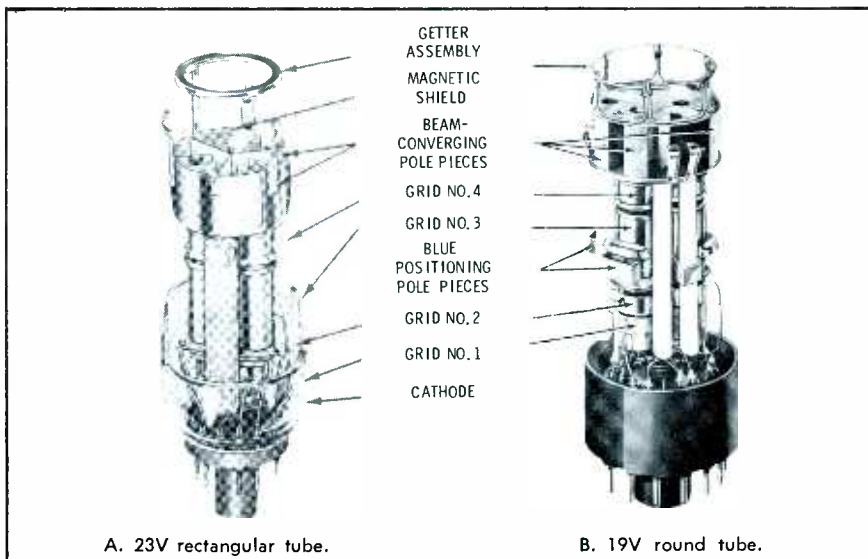


Fig. 3. Typical electron-gun assemblies.

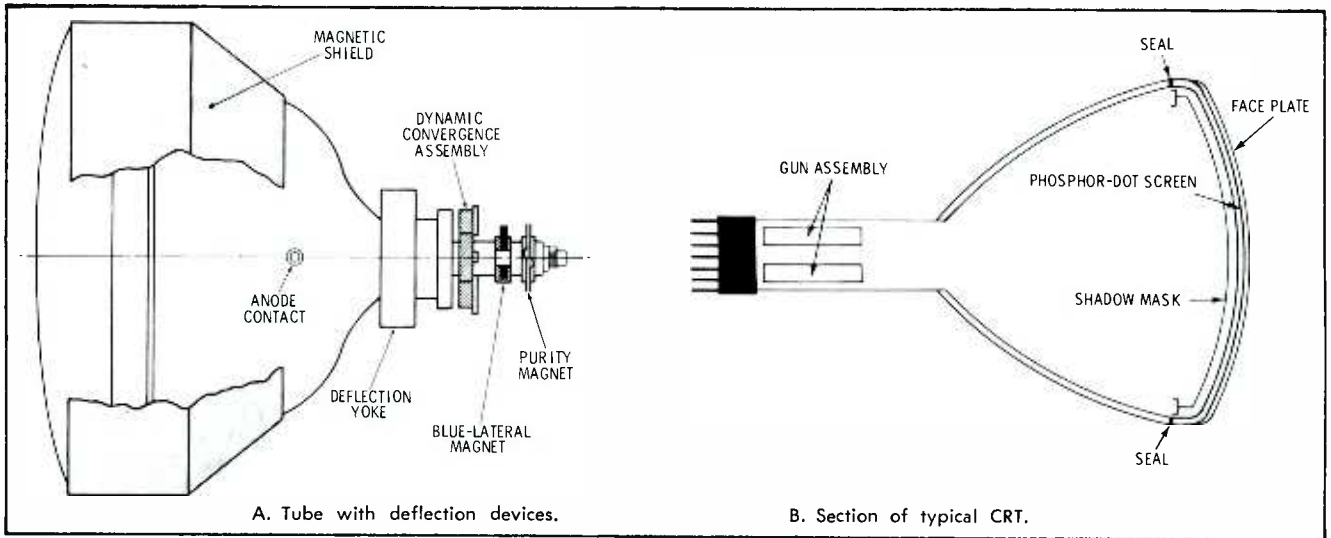


Fig. 4. Details of CRT construction.

were fixed at the time of manufacture of the CRT. These positions are such that if lines were to be drawn from each red dot, toward the neck of the tube, all of the lines would come together at one precise point. In making the purity adjustments, the beam from the red gun is made to emanate from this same point, which is somewhere on the correct deflection plane.

Referring to Fig. 5, notice that the correct point and two incorrect

points of apparent beam origin are shown. If the beam emanates from an incorrect point on the proper deflection plane (point A), it will miss the red phosphor dots at the edges of the screen and also at the center. On the other hand, even though the deflection plane is incorrect, if the point of origin is correct (point B), the beam will hit the red dots near the center of the screen but miss them at the edges.

The correct procedure for adjusting purity may be inferred from this discussion. If the deflection-yoke

is moved toward the rear of the CRT as far as possible, it will be in the vicinity of the incorrect deflection plane shown in Fig. 5. This allows the purity magnet to be adjusted for the proper point of apparent beam origin (point B of Fig. 5), as evidenced by a pure red area at the center of the raster. Then the yoke is moved forward until red purity is obtained over the entire raster.

The purity magnet must be capable of producing a uniform magnetic field of adjustable intensity

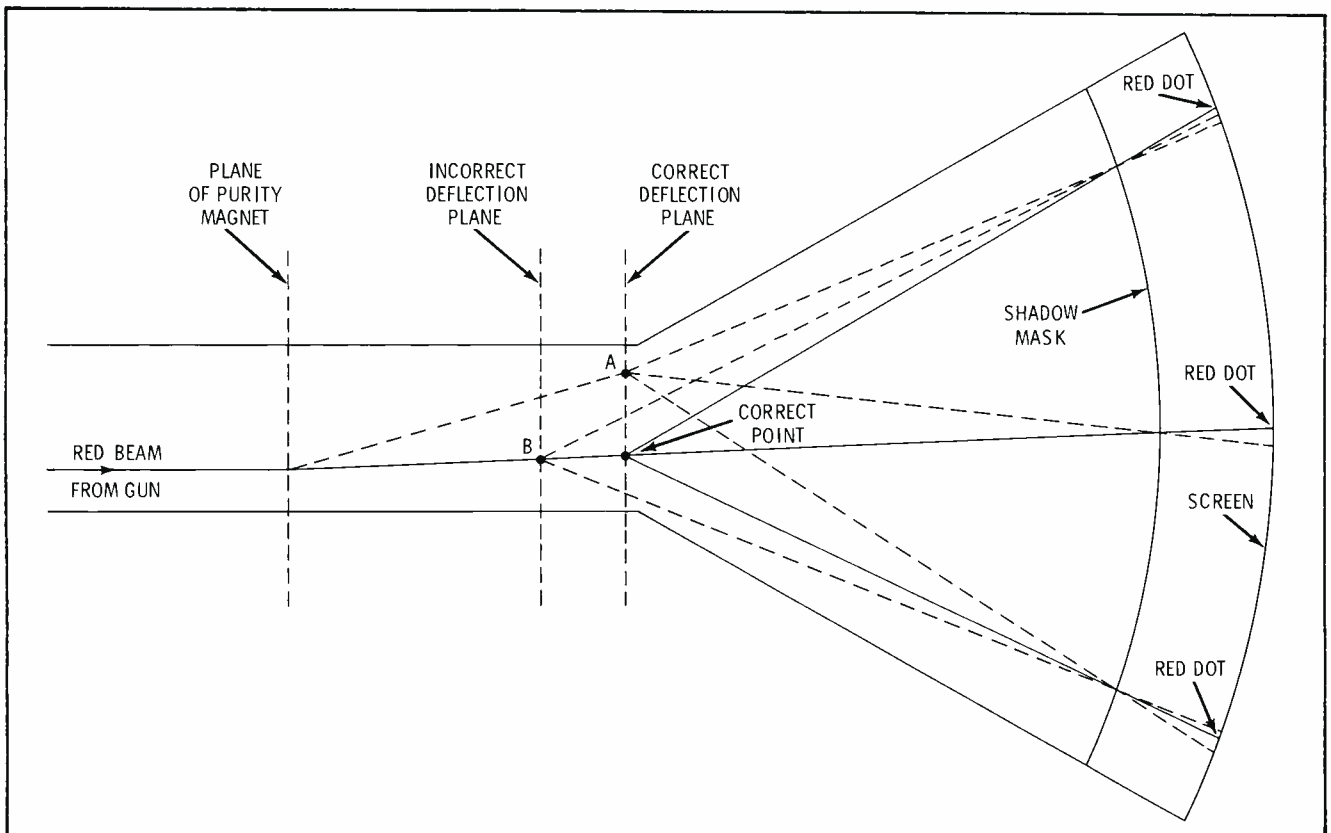


Fig. 5. Deflection geometry showing effects of purity adjustments.

perpendicular to the neck of the CRT. Also, this field must be capable of being oriented in any direction. To accomplish this, two magnetic rings, each polarized as shown in Fig. 6, are mounted on the CRT neck. Depending on the relative position of the two rings, their fields will either aid or oppose each other to determine the intensity of the field. To determine the direction of the field, the two rings are rotated together.

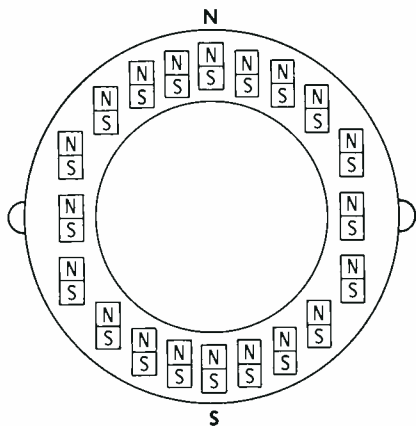


Fig. 6. A typical purity magnet.

In discussing purity, we have considered only the red beam and phosphor dots and, in fact, the blue and green guns are normally disabled while making purity adjustments.

This procedure is acceptable since the blue and green beams are deflected the same amount by the purity magnet as was the red beam and, consequently, are automatically positioned at approximately the correct points on the deflection plane. The subsequent convergence adjustments position the points precisely to their correct locations.

#### Static Convergence

Fig. 7 is a distorted view of a color CRT which illustrates some of the geometrical aspects of convergence. The distance from the shadow mask to the phosphor screen has been increased while the distance from the tube neck to the shadow mask has been decreased so that the divergence of the beams after they pass through the mask may be seen. The plane depicted in Fig. 7 is horizontal, that is, the observer is looking down at the CRT and the center horizontal line of the CRT is being scanned by the electron beams. In actual practice, the plane of the convergence yoke is to the rear of the plane of the deflection yoke; however, for the purposes of this discussion the two planes are assumed to coincide. This greatly simplifies the explanation

and, from a qualitative point of view, has no effect on the operation of the convergence system.

Consider the moment when the triad at the center of the screen is illuminated. The beam from the green gun crosses from left to right (looking from the guns toward the screen), the red beam crosses from right to left and the blue beam goes straight ahead. (Actually the red and green beams are aimed upwards slightly and the blue beam is slightly depressed, but this cannot be observed from the present point of observation). When the three beams actually behave as shown, the tube is correctly converged at the center. This is called static convergence, since there is no horizontal- or vertical-deflection field acting on the beams at this instant.

From the above, it may be inferred that static convergence consists simply of aiming all three guns at the center of the CRT screen. This is accomplished by adjusting the three permanent magnets which are part of the convergence yoke so that the electron beams are correctly aimed. Fig. 8 shows the red and blue positioning magnets and the blue lateral magnet, soon to be discussed. The positioning magnets

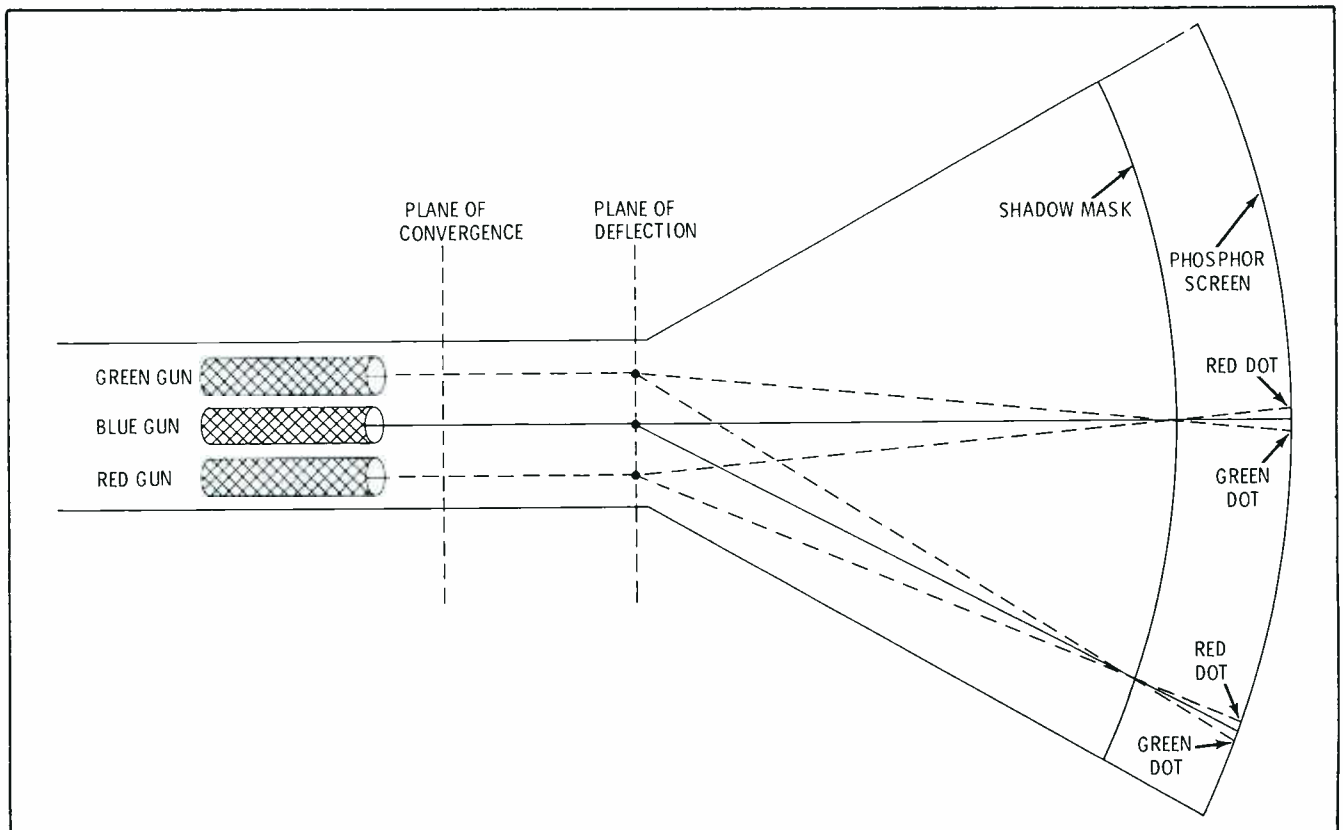


Fig. 7. Deflection geometry showing correct convergence.

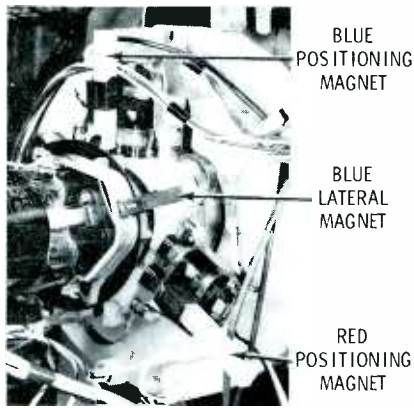


Fig. 8. Convergence components.

themselves are imbedded in a plastic sleeve, and these sleeves may be pushed in closer to the CRT neck to increase the effect of the fields. The sleeves may be rotated 180° in their holders to reverse the magnetic field if necessary. Of course, other magnet configurations are possible, but the operation is essentially the same.

Fig. 9 shows the effect of the positioning magnets on their respective beams. As the red and green positioning magnets are repositioned, the respective beams scan the screen in the direction shown by the arrows. Since the guns are aimed, roughly, at the center of the CRT during manufacture, the

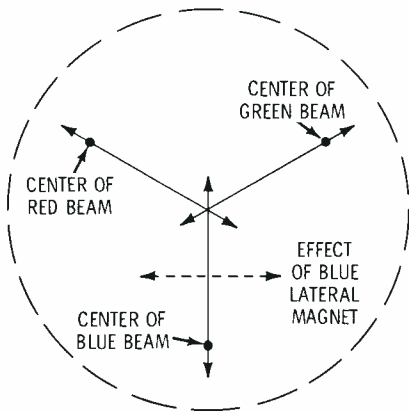


Fig. 9. CRT screen section shows effects of static-convergence magnets.

landing points of the red and green beams can be made to coincide at some point near the center of the screen. The blue positioning magnet causes the blue beam to fall at some point along a vertical line on the screen (also near the center), which point is determined at will by adjusting the positioning magnet. When the blue spot is directly alongside the spot illuminated by the red and green beams, the blue

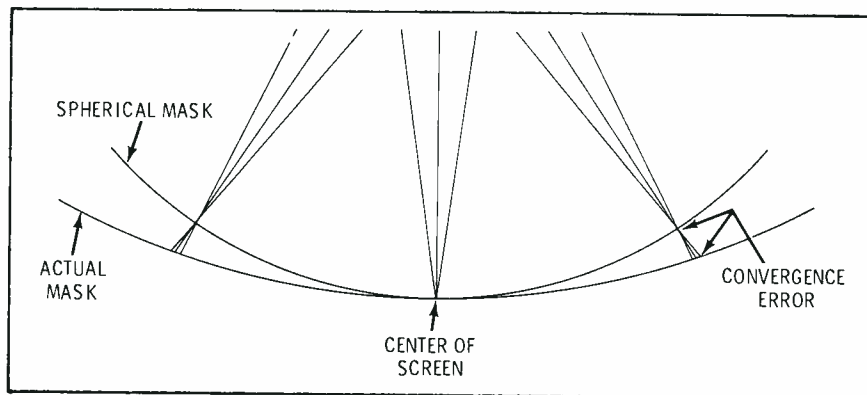


Fig. 10. Dynamic-convergence error due to non-spherical mask.

lateral magnet (also pointed out in Fig. 8) is adjusted to move the blue spot horizontally until all three spots coincide.

The blue lateral magnet is mounted on the CRT neck to the rear of the convergence yoke and is situated at right angles to the blue positioning magnet. Because of its position, the only one available, it has a slight effect on the red and green beams as well as on the blue beam. Accordingly, the position of all four magnets must be "roughed in" first and then retouched for best convergence.

#### Dynamic Convergence

Unlike static convergence, which may be accomplished by permanent magnets, dynamic convergence requires the generation of fairly complex magnetic fields. Before examining the circuitry required to produce these fields, let's define dynamic convergence and describe the magnetic fields which are required to accomplish it.

The major factor which affects dynamic convergence is the curvature (or rather, the lack of it) of the shadow mask and screen. If the screen were a sector of a sphere whose center was on the convergence plane, dynamic convergence would be relatively simple. However, the screen has a radius much greater than the distance to the deflection plane and, if nothing is done to correct it, a beam which is converged at the center of the screen will converge behind the mask at every other deflection angle. This is illustrated in Fig. 10. Accordingly, progressively less convergence field is required as the deflection field increases. Notice, too, that dynamic convergence is required for the vertical sweep as well as the horizontal sweep.

Fig. 11 shows the effect of no dynamic convergence on vertical and horizontal lines passing through the center of the raster. In considering the effects of convergence, these lines are of particular interest because the dynamic horizontal-convergence field is zero when these vertical lines are being produced, and the dynamic vertical-convergence field is zero when the center horizontal lines are being produced. The total dynamic-convergence field when any other point on the raster is being scanned is a sum of both the horizontal- and vertical-convergence fields.

Notice that three vertical, but only two horizontal, lines are

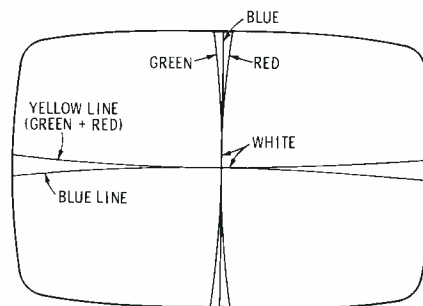
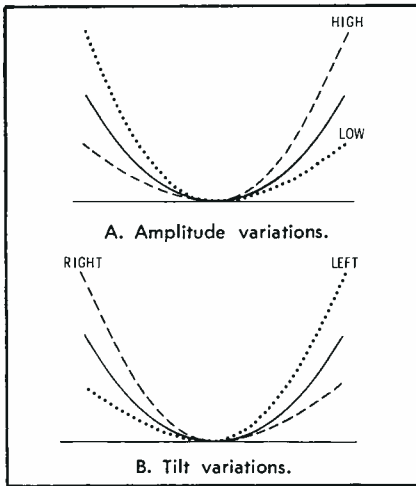


Fig. 11. Raster with dynamic-convergence circuits disabled.

produced. This is easily understood if one considers that each gun is in a separate vertical plane, but that the red and green guns are in the same horizontal plane. Thus the red and green beams track each other in a horizontal scanning line.

The curves produced on the raster by unconverged beams are parabolic in shape, and so a parabolic correction current through the convergence coils will straighten the lines. Although it is possible to dynamically converge all three beams with a single device, it is standard practice to use independent electromagnets for each gun and to



**Fig. 12. Parabolic-current waveforms.** generate separate currents for each of them. By doing this, the amplitude and the tilt (angle of the axis of the parabola relative to the vertical axis of a graph) of the current in each convergence coil may be adjusted for the best possible appearance of the raster. Fig. 12 relates the terms "tilt" and "amplitude" to a parabola.

Referring to Fig. 8, the red and blue dynamic-convergence electromagnets may be seen immediately in front of the red and blue positioning magnets. Fig. 13 shows a single convergence electromagnet and illustrates the relative size of the horizontal- and vertical-convergence coils. Since the horizontal- and vertical-convergence currents have the same repetition rate as the horizontal- and vertical-deflection oscillators, the vertical-convergence coils must have many more turns

VERTICAL-CONVERGENCE COILS



HORIZONTAL-CONVERGENCE COILS

**Fig. 13. Typical dynamic-convergence electromagnet.**

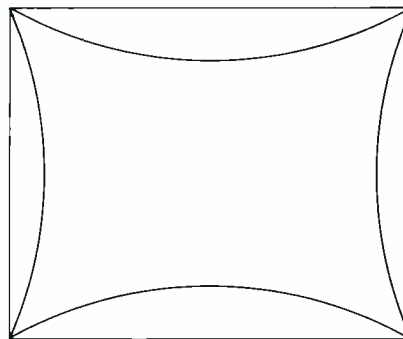
to obtain a reasonable impedance. The circuitry used to develop the convergence currents will be discussed later in this article.

**Pincushion Effect**

Those who were in the TV servicing business a generation ago will

recall when the effects of pincushion distortion first became a problem. In the earliest black-and-white sets, using a small deflection angle and a near-spherical screen with a fairly short radius, pincushion distortion was no problem. Then, as wider deflection angles and flatter screens became popular, pincushioning became objectionable. Fig. 14 shows a raster with severe pincushioning. Actually, pincushion distortion is aggravated by the use of cosine or cosine-squared yokes, necessary to maintain focus over the surface of the flat-screen, wide-deflection CRT.

In b-w sets, pincushion correction is fairly simple. By positioning small



**Fig. 14. Pincushion distortion.**

permanent magnets around the CRT, just forward from the deflection yoke, the beam is caused to move outward as it crosses the horizontal and vertical center lines, straightening the scan lines on the CRT. Unfortunately, the use of pincushion magnets in a color set is

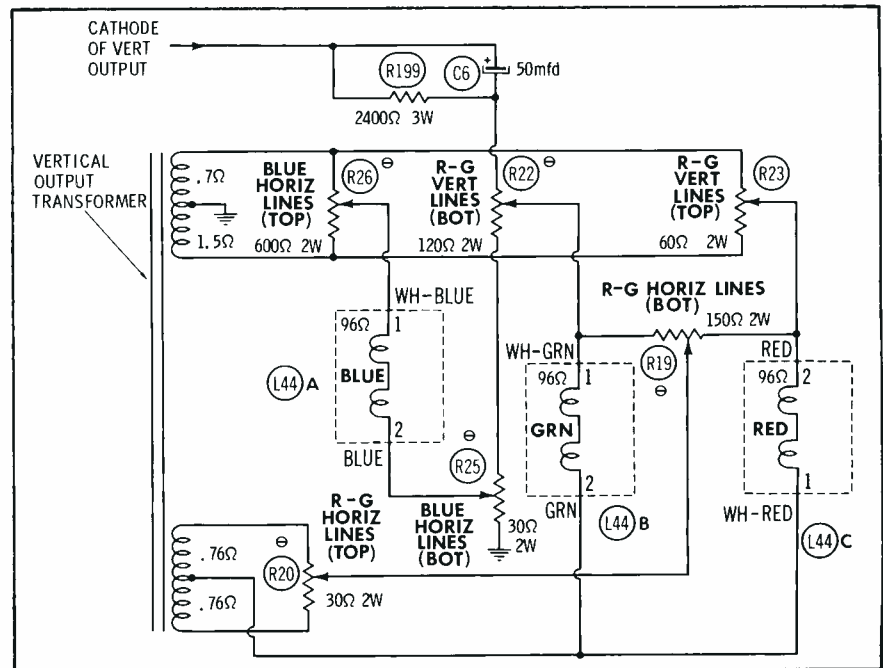
not possible. As we all know, it is problem enough to get rid of magnetic fields around the CRT bulb without introducing any additional magnets. Secondly, since the three beams have different points of origin on the deflection plane, pincushion magnets would not affect the three beams equally, making convergence at the edges of the CRT very difficult.

Since the use of pincushion magnets is precluded, the correction field must be generated electromagnetically. Small correcting currents are generated in the pincushion circuit and added to the deflection currents in the yoke. A typical circuit will be examined under a separate head in this article.

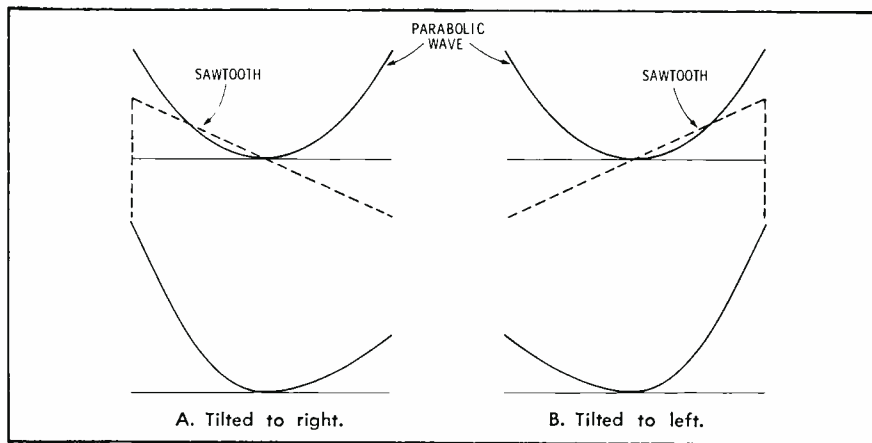
**Dynamic-Convergence Circuits**

As pointed out previously, the currents through the dynamic-convergence electromagnets must be parabolic in shape and have controllable amplitude and tilt. This is true of both the horizontal and vertical dynamic-convergence currents; however, since the circuits used to generate these currents are different, they will be discussed separately.

Fig. 15 shows the vertical dynamic-convergence circuit used in the Admiral 2G1156-1 chassis. The sawtooth from the cathode of the vertical-output tube is fed through C6 and R199 to the top of a bleeder,



**Fig. 15. Typical vertical-dynamic-convergence circuit.**



**Fig. 16. Result of adding parabolic and sawtooth currents.**

consisting of R22 and R25, and thence to ground. A portion of this voltage is picked off by the slider of R25 which connects to one end of the blue convergence coil, L44A. The opposite end of L44A is connected to the slider of R26 which, in turn, is across a winding of the vertical output transformer. Thus, the parabolic current waveform produced by the action of R199, C6, and L44A is modified by the sawtooth current from the transformer winding. This is illustrated in Fig. 16. Since the ends of the transformer are out of phase, either a positive-going or negative-going current may be picked off by the slider of R26; and the parabola may be tilted in either direction.

In considering the currents through L44B and C, we will first trace the current produced by the lower winding of the vertical-output transformer of Fig. 15. The amplitude and phase of voltage taken from this winding is determined by the setting of R20. The relative amplitudes of this voltage which are fed to L44B and C is determined by the position of the slider of R19. Notice that as more current is caused to pass through one coil, less passes through the other; but that if current flow through one coil is from terminal 1 to terminal 2, it is from 2 to 1 in the other.

A second sawtooth is taken from the upper winding of the vertical-output transformer. This is tapped by R23 and fed through L44C, then L44B, to the slider of R22, and ultimately back to ground. Since the setting of R23 determines the phase of this sawtooth, current may be in either direction, but if it passes from

2 to 1 of L44C, it also passes from 2 to 1 of L44B. In either case this sawtooth modifies the tilt of the parabolic current supplied from R22. Depending on the positions of the various controls, R23, R19, R20, and R22, the amplitude and tilt of the parabolic currents through the red and green coils may be adjusted over a wide range.

Fig. 17 shows a typical horizontal-convergence circuit. Although the current waveforms are very similar to the ones developed in the vertical-convergence circuits (except for frequency), the circuitry is somewhat different. These circuit differences are present because a suitable sawtooth input is not available and also because the red and green guns are in the same horizontal plane and require approximately the same convergence current.

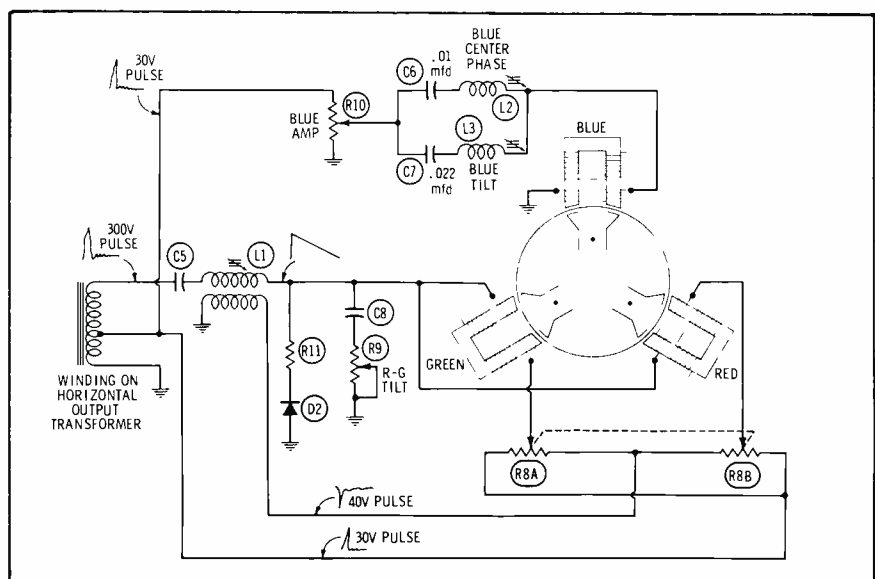
The input for red and green convergence is a 300-volt pulse from

the horizontal-output transformer. This is shaped into a sawtooth by L1 and a parabolic current is caused to flow through the coils. The ganged potentiometers, R8A and B, are connected so that the current returns to ground through either of two windings. These windings are out of phase, and so the parabolic current may be tilted in either direction, depending on the setting of the potentiometers. Notice that the potentiometers are connected so that the currents in the two coils tilt in opposite directions. R9 changes the loading on the sawtooth at the top of C8 and has the effect of tilting the parabolic current in each of the two coils in the same direction.

Blue horizontal convergence is accomplished by a parabolic current developed by the network consisting of L2, L3, C6, and C7. A portion of the 30-volt pulse fed to R10 is fed to the network. L3 and C7 are tuned to 15,750 Hz while L2 and C6 are tuned to the second harmonic, 31.5 kHz. The combination of these impedances causes a parabolic current in the convergence coil. By tuning L2 above or below its center frequency, the current may be tilted in either direction at will.

### Pincushion Circuit

To correct pincushion distortion at the top and bottom of the screen, it is necessary to decrease the vertical-deflection current in the yoke when the horizontal scan is at the



**Fig. 17. Typical horizontal-dynamic-convergence circuit.**

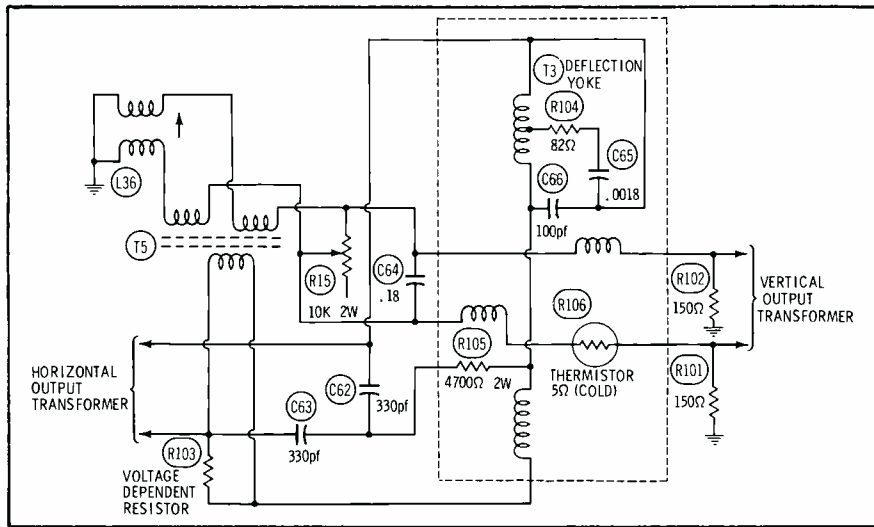


Fig. 18. Typical pincushion-correction circuit.

extreme right and left edges of the screen. Correcting pincushion distortion at the sides of the screen is accomplished by decreasing the amplitude of the horizontal deflection current when the vertical deflection is at its maximum upper and lower limits. The circuit in Fig. 18 shows one way of accomplishing this.

In Fig. 18, a portion of the horizontal deflection current flows through the bottom winding of T5, inducing a current in the two secondaries. The phase of this induced current is adjusted by the slug in

L36 so that it opposes the vertical sweep current at the time when the horizontal scan is at the edges of the screen. Thus, the vertical deflection is reduced only at the edges of the raster. The amount of reduction of the vertical sweep is determined by the setting of R15.

Side pincushioning is also corrected by the same circuit. A portion of the vertical-deflection current passing through the two upper windings of T5 induces a voltage in the lower winding which opposes the horizontal deflection current. This opposing voltage must be present

only when the top and bottom of the CRT are being scanned. This is accomplished by using a saturable core in T5. The core saturates when the vertical sweep is near the center of the raster and, consequently, there is only a small transfer of energy in the transformer. As the core comes out of saturation, more and more vertical-sweep energy is coupled to the horizontal-deflection system so that the scan lines are shortened at the top and bottom of the picture.

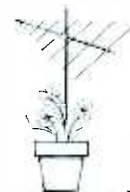
### Conclusion

This part of the series was written to explain how the geometry of the color CRT places certain requirements on the circuitry associated with it. After these requirements were pointed out, typical circuits which perform the various functions were described. Since specific circuits vary widely from one make of set to another, generalized setup procedures are almost pointless and no attempt has been made to formulate them. Through careful attention to the appropriate service data, and experience in making the various adjustments, you will evolve the techniques best suited to your specific requirements. ▲

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## Book Review

**AM-FM-TV Alignment:** Robert G. Middleton; Howard W. Sams & Co., Inc., Indianapolis, Ind., 1967; 176 pages, 8½" x 5½", soft cover; \$3.50.

An up-to-date book for the practical technician, *AM-FM-TV Alignment* explains in detail the new alignment techniques which are made possible by modern test equipment. The author covers much ground in what seems like a small number of pages, but each point is thoroughly explained. This is accomplished by substituting pictures for words wherever a picture would more effectively explain the point under discussion. Nearly 150 photos, schematics, charts, and graphs are used in this manner.

Chapter 1 covers the many aspects of AM receiver alignment including such procedures as loading and neutralizing. Included are tests for image rejection, selectance ratio, and other tests not commonly covered in technician's textbooks.

The second chapter continues with radio alignment, but the subject is switched to FM receivers. In addition to bandpass and detector (or discriminator) alignment procedures, the most basic and advanced principles of sweep alignment are thoroughly investigated.

Chapter 3 covers the black-and-white television receiver. In addition to the common IF bandpass alignment tests, the full treatment is given to the RF and video stages. Also included is a section on alignment of remote control systems.

Chapter 4 logically follows the alignment tests through the stages of a color receiver. With the information previously given in Chapter 3, the important differences in bandpass response between a b-w and a color receiver become apparent. The chroma stages are treated in depth.

The fifth chapter covers FM-stereo multiplex stages. The first half of the chapter covers multiplexing theory and waveform analysis, and the next portion covers the actual procedures and tests. Included is a section on de-emphasis considerations—a point often overlooked when marrying an adapter to an FM mono system.

The final chapter is a short treatise on audio amplifiers. Here the basic information about bandpass learned in the previous chapters is applied to hi-fi amplifiers; the reader is taught how to make frequency response and distortion tests. ▲



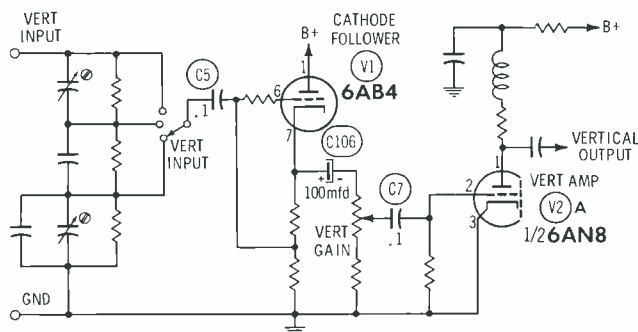
# THE TROUBLESHOOTER

## Scope Troubles

I have a Heathkit Model 10-12 oscilloscope, and I'm not sure if it's operating properly. If I apply horizontal sync pulses through a low-capacitance (L-C) probe, the waveforms reproduced are very distorted. But a square-wave signal at horizontal frequency is reproduced perfectly. If I bypass the cathode follower in the scope, the horizontal sync pulses displayed are nearly perfect. The trimmers are aligned okay. What's the problem?

JOHN TAPLEY

Houston, Texas



First of all, the fact that the scope properly displays a 15.75-kHz squarewave is confusing you. A horizontal sync pulse can be roughly compared to  $\frac{1}{2}$  of a square-wave. Since the pulse duration is about 0.475 microseconds, the corresponding frequency is about 10 MHz. Quite a difference from 15.75-kHz.

Undoubtedly the problem in the 10-12 is high-frequency attenuation in the cathode follower. It's really a simple circuit and should be easy to troubleshoot. We would suspect the coupling capacitors—C5, C7, or C106.

## Suspicious Confirmed

I'm having trouble with a Westinghouse V2650 (PHOTOFACT Folder 857-4). The 6BK4 high-voltage regulator would arc when the set was warm. Replacing

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the 6BK4 cured the trouble for about 1 week, and then the same thing happened again. The high voltage read 24 kv cold and rose to 26 kv in about 10 minutes. I reset the high voltage to 24kv, and it rose again to 26 kv as the set continued to warmup. After being reset one or two more times, it finally stabilized at 24 kv.

Next morning the high voltage read 21 kv from a cold start. I set it to 22 kv, and have had no more 6BK4 arcover. Why is the high voltage unstable?

MONTY HUCKLE

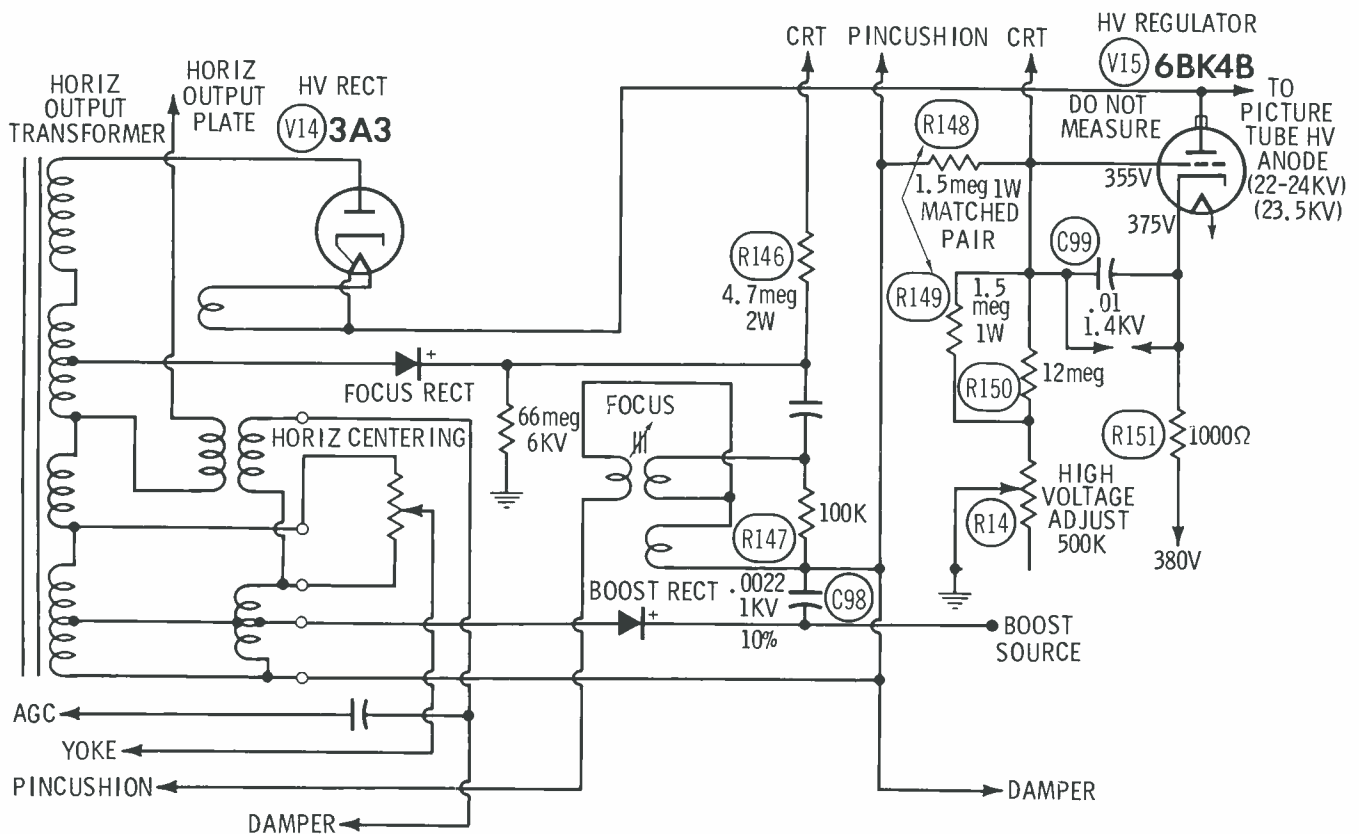
Tahoe City, Calif.

*The high voltage is probably unstable because of varying grid bias on the 6BK4. Check and/or replace the following parts: R151, R148, R149, R14, R147, R150, C99, and C98. We strongly suspect R151.*

*The parts may be checked by monitoring the high voltage after warm up, while spraying the suspected part with a freeze-spray. After your repairs are completed, set the high voltage to 23 kV with a normal picture.*

*Ed. note: After the above correspondence, Mr. Huckle was kind enough to send us the following letter:*

Following your suggestions, I was tracing the lead of R150 when a piece of solder fell off the PC board. Fixed? No, the 6BK4 still arced. Next, I checked R151. It read 1400 ohms cold, 1600 ohms hot. I replaced R151, but after a few hours warm up, the 6BK4 again arced. I removed R148 and R149, and measured them with an ohmmeter. They both read 1.5 megohms right on the nose. But when I heated them with a soldering iron, one increased in value, while



the other decreased. After replacing these two resistors, the HV runs steady. Thanks a lot for your help.

MONTY HUCKLE

Thanks to you too, Mr. Huckle, for confirming our suspicions. This is especially interesting because R148 and R149 are a matched pair. If they were temperature sensitive, one would expect them to both behave in the same manner. If they both increased or decreased in value, they would still be a 2-to-1 voltage divider and cause little trouble. Since the resistor values moved in opposite directions, the grid bias was greatly upset.

### Brightness Troubles

We had an interesting problem with an Emerson 120517E (PHOTOFACT Folder 502-1) which we thought we'd pass on for what it's worth.

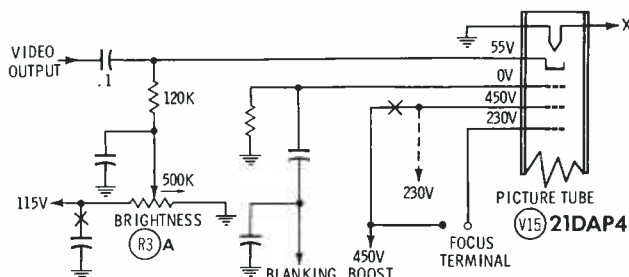
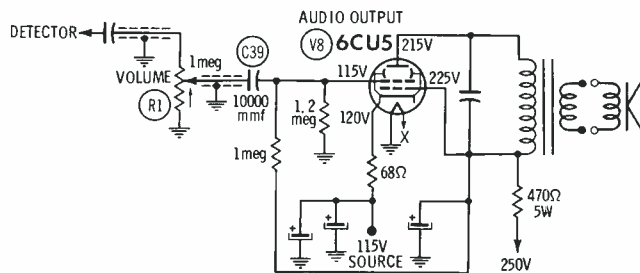
The set played perfectly when the volume control was set to a very high level. As the sound was turned down, the picture decreased in brightness until at zero volume we had no picture.

The defective part turned out to be C39, the audio coupling capacitor. Since V8 operates with +115 volts on the grid, if C39 shorts, the 115 volts will be across the volume control. Reducing the volume reduces the grid voltage, so that V8 is finally cutoff.

Since the 115-volt source is on the cathode of V8, cutting off the tube will kill the 115-volt source. Following the 115-volt line we see that the top of the brightness control is connected to the line. If we lose the 115-volts, the CRT cathode goes to zero, and the CRT is cutoff.

JOHN H. WILLIAMS

Pompano Beach, Florida



We agree—it's an interesting problem. Your circuit analysis is correct in all details. Similar circuits are used in many TV receivers, so we're sure this tip will be useful.

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Without obligation, rush me free information on the following RCA Home Training Course:  COLOR TV  TRANSISTORS  MOBILE COMMUNICATIONS  AUTOMATION ELECTRONICS

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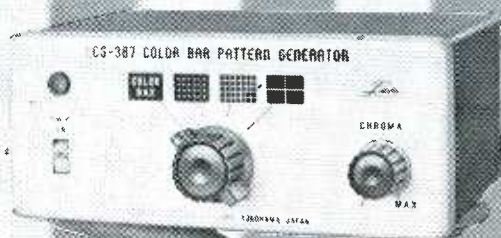
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# LEADER TEST INSTRUMENTS

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*New!*



**\$13450**

**LCG-387**

## COLOR BAR PATTERN GENERATOR

Here it is LEADER's new color bar pattern generator which includes the keyed rainbow, SQUARE crosshatch, dots, AND the single cross bar. In fact, this cross pattern will speed up adjustments on raster centering, purity at the center and dynamic convergence. Sharp and clear lines, both vertical and horizontal, produced by return trace blanking. Two switchable channels, 5 and 6, with 10mV output. Solid state, of course, with voltage regulated supply. Compact and sturdy construction for field use—supplied with carrying bag for convenience. Size only 2½ H × 6¾ W × 4¾ D in., and weight 3.3 lbs approx.

**LEADER ELECTRONICS CORP.**

NEW YORK OFFICE

101-103 ROME ST., FARMINGDALE, L.I., N.Y. 11735

TEL (516) 694-1534 541-5373

Circle 24 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.

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# PRODUCT REPORT

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

## Color Generator

(50)

A solid-state TV alignment generator capable of generating the familiar 10-bar gated rainbow—plus new single-bar and three-bar test patterns—has just been developed by **Amphenol Corporation**. Known as the Model 865 "Deluxe Color Commander," the generator combines convergence and centering display capability with a variety of popular crystal-controlled color-bar patterns.

For protection against obsolescence, the instrument is equipped with a unique single color-bar pattern capability that permits the pattern to be adjusted for any present—or future—demodulator phase angle. Another feature of this color generator is the unit's three-bar color pattern provision that eliminates all but the three bars used for color demodulator alignment. The

first bar, red (R-Y), is at 90 degrees; the second bar, blue (B-Y), is at 180 degrees; and the third bar, green (—R-Y), is at 270 degrees.

A single-dot pattern is also included in the new unit. This can be moved vertically or horizontally to the exact center of the picture tube for accurate alignment of static convergence. In addition, a movable, single-cross pattern for constant reference during purity adjustments is included in the design. This feature can also be used for making center vertical and horizontal top-bottom-center dynamic and right-left-center dynamic convergence checks.

A calibrated crosshatch display provision affords use of a pattern with a 3:4 aspect ratio (15 horizontal and 20 vertical lines). By making an adjustment for equal brightness of both vertical and horizontal lines, proper position of video carrier for color

alignment is assured. Other patterns featured in the generator are: 10-bar gated rainbow (each bar spaced at 30 electrical degrees, for complete range of spectrum color), 300-dot pattern, multiple vertical bar, and multiple horizontal bar.



The unit measures 4 $\frac{7}{8}$ " x 9 $\frac{1}{2}$ " x 5 $\frac{1}{4}$ " and weighs less than 4 lb. Housed in a luggage-type case that features a large storage area for probes, tubes,

## Save Time on PC Board Repairs!



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## Check color chassis on black and white CRT!



## NEW LECTROTECH Color Jig

Double your shop capacity for only 24.50!

Designed for • Trouble shooting of non-color troubles: no sync, poor linearity, no high voltage, intermittent picture, etc.

• Cooking sets for intermittents • Aging shop repairs before delivery

For the shop without a color tube set-up, the Color Jig eliminates need to pull set, cabinet and all, to shop for servicing. For the shop with a color tube set-up, the Color Jig eliminates tie-up of costly color test set-up for non-color troubles. Gun selector feature permits viewing of all 3 color outputs on black and white tube. Operates with any standard black and white tube or most 12 pin duo-decal base tubes.

Complete kit **\$24.50**  
MADE IN U.S.A.



See your distributor or write for details.

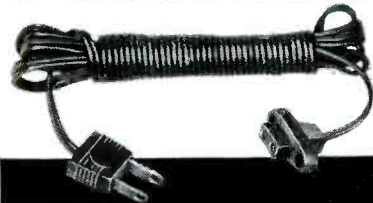
**LECTROTECH, INC.** DEPT. PF-4  
1221 W. DEVON AVENUE, CHICAGO, ILLINOIS 60626

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Plug in  
with a  
winner...

TV  
SERVICE  
CORDS by

Columbia



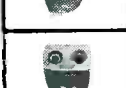
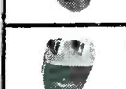
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Chicago 60618

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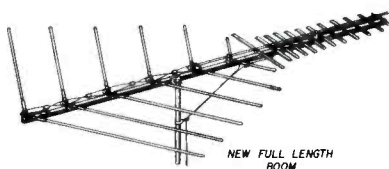
etc., the unit is automatically turned off when the lid is closed.

Requiring no additional power packs for battery operation, the color generator contains its own built-in AC/DC power supply; or it can be plugged into any convenient 117-volt AC outlet. When unplugged for field service, self-contained batteries power the unit. Price is \$189.95, without batteries.

### Color Antenna Series

(51)

With the addition of four new models to the FINCO Color Spectrum Series of Frequency Dependent Antennas, the Series is now available in 35 basic models and with kit packs for special applications, for a total of 45 Color Spectrum model antennas.



The new models are the CS-B2, an 82 channel TV and FM combination 300-ohm impedance antenna, designed for those areas where the VHF signal is of moderate strength and the UHF signal is relatively weak. The model XCS-B2 is the same in a 75-ohm version. The new model CS-C2 is also an all channel TV plus FM 300-ohm antenna, designed for those reception areas where both the UHF and VHF signals are relatively weak. The new XCS-C2 is the 75-ohm version of this model. Manufacturer's suggested list prices for the new models are \$39.95 for the CS-B2, \$48.45 for the XCS-B2, \$51.95 for the CS-C2, and \$60.45 for the XCS-C2.

### Splitter/Mixers

(52)

Two new resistive-type splitter/mixers designed for color and b-w TV reception as well as stereo-FM applications have been developed by Mosley Electronics, Inc. Intended for use in large or small distribution systems, both units feature solderless crimp-on ferrules for easier installation.

The two-set splitter (M-22) divides one 75-ohm VHF/FM line into two 75-ohm outputs and provides 12 dB of isolation with an SWR of 1.2. Three crimp-on ferrules for secure connections are supplied with the M-22.

The four-set splitter (M-24) divides one 75-ohm VHF/FM line into four 75-ohm outputs. Characteristics of the M-24 include 18 dB of isolation and an SWR of 1.5. Five solderless crimp-on ferrules are supplied with the M-24.

“and not only that, but they took his INJECTORALL SUPER 100 TUNER CLEANER as well.”

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MULTICORE

NEW EASY DISPENSER PAK ONLY 69¢

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Circle 38 on literature card



Both models are housed in metal containers and may be combined to provide any number of lines for larger amplified systems. Price of Model M-22 is \$4.92, while Model M-24 is priced at \$7.08.

### Semiconductor Courses (53)

Two new courses designed to upgrade and update technician's knowledge of transistors and their application have been introduced by the Extension Division of ITT Educational Services, Inc.

"Semiconductor Fundamentals" updates the technician's knowledge of semiconductors and circuits through a semiprogrammed text. The 8-lesson course also stresses testing techniques applicable to transistor circuits.



"Practical Application of Transistor Basics" offers a means of upgrading the technician's knowledge through 10 practical laboratory-type experiments. The two courses are complementary and may be taken at the same time, if desired.

The courses are available separately at \$37.50 each or may be purchased together for \$69.00.

### Circuit Tester (54)

A 6- and 12-volt circuit tester for automotive electrical systems, low-voltage lawn and garden lighting systems, and model raceways is an-

# GENUINE BEL FUSES

## UL Approved



**Maroon**  
Catalog No. 25-995-S  
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**Blue**  
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Suggested Net...45c



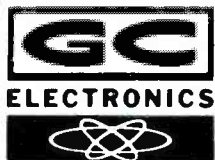
**White**  
Catalog No. 25-976-S  
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everything  
in

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Suggested Net ...32c



FUSE RESISTOR  
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ceramic, Universal  
replacement fuse  
Catalog No. 25-330-1  
Suggested Net ...56c



FUSE RESISTOR  
7.5 ohm, 15 watt,  
giant heavy-duty fuse  
Catalog No. 25-308-1  
Suggested Net ...59c



# The Transistor Testers that really work in circuit



TR139

NEW TR15A

Locate defective transistors in circuit in seconds with a true AC signal gain test (BETA) . . . without disconnecting a single lead . . . what a time saver. Also measure AC beta and  $I_{cbo}$  leakage out of circuit for complete analysis of the transistor. It's easy, fast and accurate. Also checks diodes and rectifiers in and out of circuit.

**TRUE BETA MEASUREMENTS:** the transistor's AC gain factor. Set the CAL knob, press the beta test button and read the actual AC gain on the meter. This is the ratio of AC signal on the base of the transistor to that obtained on the collector and is a standard of measurement in the industry.

**$I_{cbo}$  LEAKAGE MEASUREMENTS.** An important check since many transistors have good beta but don't work because the leakage current has become too high. Both instruments show the leakage current ( $I_{cbo}$ ) in microamps right on the meter.

**OUT-OF-CIRCUIT TESTS.** Test procedure is the same for in or out-of-circuit testing. Out of circuit, transistors may be sorted, selected and matched for specified values of beta and  $I_{cbo}$ .

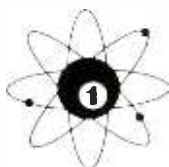
**COMPLETE PROTECTION.** Special circuitry protects even the most delicate transistors and diodes, even if the leads are connected incorrectly. No possibility of damage to the transistor, circuit or instrument. Zener regulated power supply.

**NO SET-UP BOOK.** No need for a set-up book or manual. Just refer to the handy transistor checking guide on the back of the instrument. Even unknown transistors can be checked. PNP and NPN types can be determined at the flick of a switch.

**ALL STEEL CASE.** Vinyl covered, with brushed chrome panel. Beta range, 2 to infinity;  $I_{cbo}$ , 0 to 5000 microamps.

**DELUXE TR139.** "Howard W. Sams" transistor manual included for beta and  $I_{cbo}$  reference. 9" x 7 1/2" x 6", with large 6" meter, 8 lbs. ----- **\$89<sup>50</sup>**

**COMPACT TR15A.** Only 5" x 7-3/16" x 3-1/16" — just right for easy handling. Easy-to-read 4 1/2" meter. 4 1/2 lbs. ----- **\$64<sup>50</sup>**



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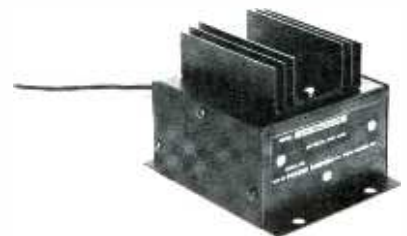


nounced by **Vaco Products Company.** Consisting of a pointed prod attached to a transparent *Comfordome* handle which, in turn, has a ground wire with alligator clip, the circuit tester is a practical tool for locating shorts in low-voltage circuits involving lamps, bulbs, wire connectors, field coils, switches, battery cables, etc.

If voltage is present, the handle of the tester will light up when the prod pierces the insulation of the wire being tested. If the handle fails to light, the trouble spot in the circuit has been located. The bulb in the handle of the tool is replaceable. The Circuit Tester and Probe (No. TK-550) is priced at \$2.50.

### 32-Volt Converter (55)

This unit converts 32-volt and/or 24-volt electrical systems to 12 volts. It handles loads of up to 30 watts. The **Pearce-Simpson** 32-volt power match convertor makes electronic communication equipment adaptable to many fishing craft and to a wide variety of industrial equipment and rolling stock.



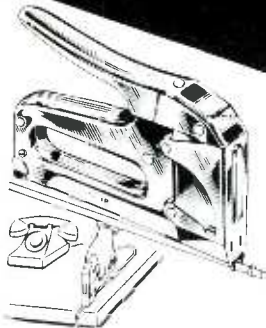
The unit measures 4 1/2" long by 3 1/2" wide by 3" high, weighs 1 lb., 9 oz., and can be installed in 10 minutes. Price is \$29.95. ▲



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Uses round crown  
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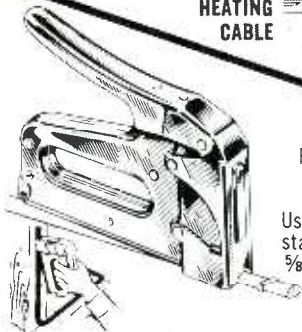
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INTERCOM, BURGLAR  
ALARM and other  
low voltage  
wiring.



**No. T-25**  
For wires up to  
1/4" in dia.  
Uses round crown  
staples in 9/32",  
3/8", 7/16", and  
9/16" leg.

Fastens same wires  
as No. T-18

Also  
used for  
RADIANT  
HEATING  
CABLE



**No. T-75**  
For wires and  
cables up to  
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Uses tack-pointed  
staples in 9/16",  
5/8" and 7/8" leg.

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TUNER CLEANER**

*Specially*  
**FORMULATED  
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USING NUVISTORS &  
TRANSISTORS  
**NO TUNER DRIFT**

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\$1.98  
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Nuvistors and Transistors are highly sensitive to drift from ingredients in most ordinary TV tuner cleaners. Drift has been found to cause call backs and expensive tuner repairs. For over 18 months CHEMTRONICS has been formulating and testing this new cleaner in both the lab and field. Under the most critical test, there has been NO DRIFT on scope patterns. We invite you to try this test yourself.

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# Catalog and Literature Service

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

## ANTENNAS

100. *ALLIANCE* — Colorful 4-page brochure describing in detail all the features of Tenna-Rotors.
101. *BLONDER-TONGUE* — Colorful flyer describes a line of indoor TV/FM signal amplifiers for both color and black-and-white TV sets.
102. *DELHI* — Twelve-page catalog introducing a complete new line of home TV towers, main towers, citizens-band towers, masts, and telescoping masts.
103. *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.\*
104. *JERROLD* — New 4-page full-color catalog describes the new Paralog Plus antennas.
105. *JFD* — Color Laser and LPV antenna brochures. New 1968 dealer catalog covering complete line of log-periodic, outdoor antennas, rotators, and accessories.
106. *MOSLEY* — Catalogs on CB, amateur radio, and TV/FM antennas.\*
107. *WINEGARD* — Data sheet on Color-Tracker UHF antenna; folders on complete antenna line and MATV products.\*
108. *G. F. WRIGHT STEEL AND WIRE CO.* — Flyer gives specifications and packaging data for steel and aluminum guy wire.

## AUDIO

109. *ACOUSTIC RESEARCH* — Booklet details specifications on a new AR amplifier.
110. *ACTION SYSTEMS CO.* — Brochure 715A, "Sound Business," tells how to enter paging and intercom business.
111. *ATLAS SOUND* — Form #PP-2537 describes the Banshee voice speaker for music groups.
112. *ELECTRO-VOICE* — Pocket-size guide-books for microphones, hi-fi loudspeakers, and hi-fi systems.
113. *SWITCHCRAFT* — New product bulletin 173 describes 2 new audio adaptor connectors.
114. *UNIVERSITY SOUND* — New 28-page catalog lists over 100 speakers, horns, drivers, microphones, sound columns, plus a wound system design chart, formulas and technical data.
115. *UTC* — Brochure describes Maximus line of hi-fi speakers.

## COMMUNICATIONS

116. *AMPHENOL* — 2-color spec sheets on new model 650 CB transceivers and Model C-75 hand-held transceiver.
117. *HY-GAIN* — Literature describing a new line of mobile antennas for citizens and 2-way radio.
118. *PEARCE-SIMPSON* — 16-page color brochure includes illustrations and specs on complete line of CB, business and industrial radios.

## COMPONENTS

119. *BELDEN* — Catalog 867, a 56-page catalog of the complete Belden line.
120. *BUSSMAN* — 12-page bulletin, SFUS, listing the complete line of BUSS and FUSETRON small-dimension fuses by size and type also indicates proper fuse-holder and shows list prices.\*

121. *CENTRALAB* — 24-page replacement parts catalog 33GL.
122. *CORNELL-DUBILIER* — New 4-page Color-lytic list.\*
123. *DUOTONE* — Wall-chart has cross-reference by cartridge number, maker's needle number, tip size, and Duotone number.
124. *INDUSTRIAL ELECTRONIC HARDWARE* — Brochure about a new socket for 14-pin indicators.
125. *JENSEN MFG.* — Product prospectus sheet on Models VH-100/TV rectangular horn speakers.
126. *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.\*
127. *MALLORY* — Bulletin 4-82 describes radial- and axial-lead tantalum capacitors.
128. *MILLER* — Catalog 167, a 156-page general catalog with complete cross-reference guide.\*
129. *QUAM-NICHOLS* — Catalog No. 67 has information on the entire line.
130. *SPRAGUE* — C-618, a new, complete, general-line catalog. This 156-page catalog includes the new Econoline transistors, a new line of Printed Circuits and many other component types, including replacement electrolytics, paper and film capacitors, resistors and test instruments.\*
131. *TEXAS CRYSTALS* — 12-page catalog of crystals including engineering data, specifications, and prices.
132. *UNION CARBIDE* — Complete line catalog of "Eveready" batteries, plus a replacement guide.
133. *WORKMAN* — 46-page catalog #100 of resistors, fuses, circuit breakers, brighteners, adaptors, and test accessories. Cross-reference charts are included.

## SERVICE AIDS

134. *CASTLE TUNER* — Fast overhaul service on all makes and models of television tuners. Shipping instructions, labels, and tags are also included.
135. *ELECTRONIC CHEMICAL* — Catalog sheet of chemical products.
136. *GC* — FR-67, the full-line catalog.\*
137. *INJECTORALL* — Literature describing a line of electronic chemicals and tools.\*
138. *MM BUSINESS FORMS* — Brochures about and samples of new professional service contract forms designed to earn extra money.
139. *MID-STATE TUNER SERVICE* — Flyer describes 24-hour tuner service.
140. *OELRICH PUBLICATIONS* — 16-page catalog of service orders, job tickets, phone message books, stock rubber stamps and many other items for use in the radio-TV-two-way radio service business.
141. *PERMA POWER* — Technical information on isolation briteners for color TV.
142. *PRECISION TUNER SERVICE* — Free mailing kit and tuner replacement list.
143. *RAWN* — Bulletins on repair ideas using Plas-T-Pair knob and plastic repair kits. Also, bulletins on tuner cleaners and circuit coolers. Includes price sheets.
144. *TV TUNER SERVICE* — Brochure lists cost and mailing instructions for 24-hour

service on any make tuner. Repair tags and shipping labels included.

## SPECIAL EQUIPMENT

145. *ATR* — Literature about DC-AC inverters up to 600 watts load.
146. *COMPONENTS SPECIALTIES* — Flyer on SPECTO Fire Guard is offered.
147. *SETCHELL CARLSON* — Brochures about monochrome and color TV monitors.
148. *STANDARD KOILSMAN* — Flyers describe replacement TV tuners, built-in UHF converters, external UHF-to-VHF and VHF-to-VHF converters, and contact cleaner kits.
149. *TERADO* — Flyer describes voltage booster for portable electric tools.

## TECHNICAL PUBLICATIONS

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

## TEST EQUIPMENT

154. *B & K* — Brochures about the B & K, Precision Apparatus, and "Cobra" lines.\*
155. *FICO* — New spec sheet describes model 100A4 multimeter with DC sensitivity of 100K ohms per volt.\*
156. *HICKOK* — Quick-reference catalog No. 67D gives brief descriptions and prices for complete test equipment line.
157. *LECTROTECH* — Two-color catalog sheet on new Model V6-B color bar generator gives all specs and is fully illustrated.\*
158. *MERCURY* — All-new 16-page test-instrument catalog.
159. *SECO* — Service manual for the Seco Model 1100 deluxe self-service tube tester.
160. *SENCORE* — New 12-page catalog on all Sencore products.\*
161. *SIMPSON* — Reprint, "A Guide to the Selection of Multitesters" explains how to evaluate multitesters before you buy.
162. *TRIPLETT* — New catalog 52-T describes complete line of VOM's, test equipment, and accessories. The Model 600, transistorized volt-ohmmeter is featured.\*

## TOOLS

163. *ARROW* — Catalog sheet showing 3 staplegun tackers designed for fastening wires and cables up to 1/2" diameter.\*
164. *DIAMOND TOOL AND HORSESHOE* — 16-page, pocket-sized booklet W-68 about Diamond, Diamolloy and Copaloy wrenches, pliers, snips and electronic tools.
165. *ENTERPRISE DEVELOPMENT* — Brochure from Endeco demonstrates improved desoldering and resoldering methods for PC boards.\*
166. *LUXO* — General line catalog plus price sheet.
167. *SWING-O-LITE* — Catalog sheet on Models BBM-9 and BB-45 bench lamps.
168. *UNGAR* — Information sheets and technical data for various soldering irons and equipment.
169. *VACO* — Catalog SD-119 describes Snap Driver kit featuring 30 blades that fit one handle.
170. *XCELITE* — Bulletin N867 describes hollow-shaft nutdrivers which speed locknut/screw adjustments.\*

## TUBE AND TRANSISTORS

171. *GENERAL ELECTRIC* — Entertainment semiconductor almanac, ETR-4311C, and picture-tube replacement guide, ETR-702K are offered.
172. *IR* — Flyer sheet about a new universal replacement transistor (type TR-27) for vertical and horizontal output applications.
173. *KSC* — New short-form catalog listing over 1200 germanium power transistors
174. *MOTOROLA* — HEP cross-reference guide lists approximately 12,000 semiconductor types.
175. *RCA* — Pix-300, a 12-page product guide for RCA picture tubes covering both color and black-and-white.\*

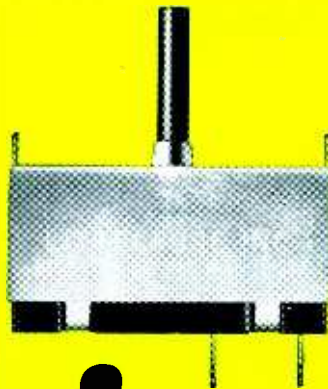
# RCA HI-LITE... the replacement picture tube with “new set” quality

Offer your customers a replacement color picture tube that truly meets OEM specs! RCA HI-LITE picture tubes are RCA's best... the same quality... the same tubes... that go into original equipment sets... with **all new glass, gun, the works.** And because they incorporate the latest technological advances of the world's leading color picture tube manufacturer, they offer picture brightness and color fidelity at its finest. Serving your needs with the broadest line of types in the industry, including 15-inch, 19-inch, 22-inch and 25-inch rectangular and 21-inch round tube types. RCA Electronic Components, Harrison, N. J.

## RCA



# Give yourself a break you can depend on!



actual size  
1 3/4" x 1 3/8" x 1 1/2"



#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.

## 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.



#094076

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.

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

Circle 43 on literature card