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FEBRUARY, 1968 | 75¢

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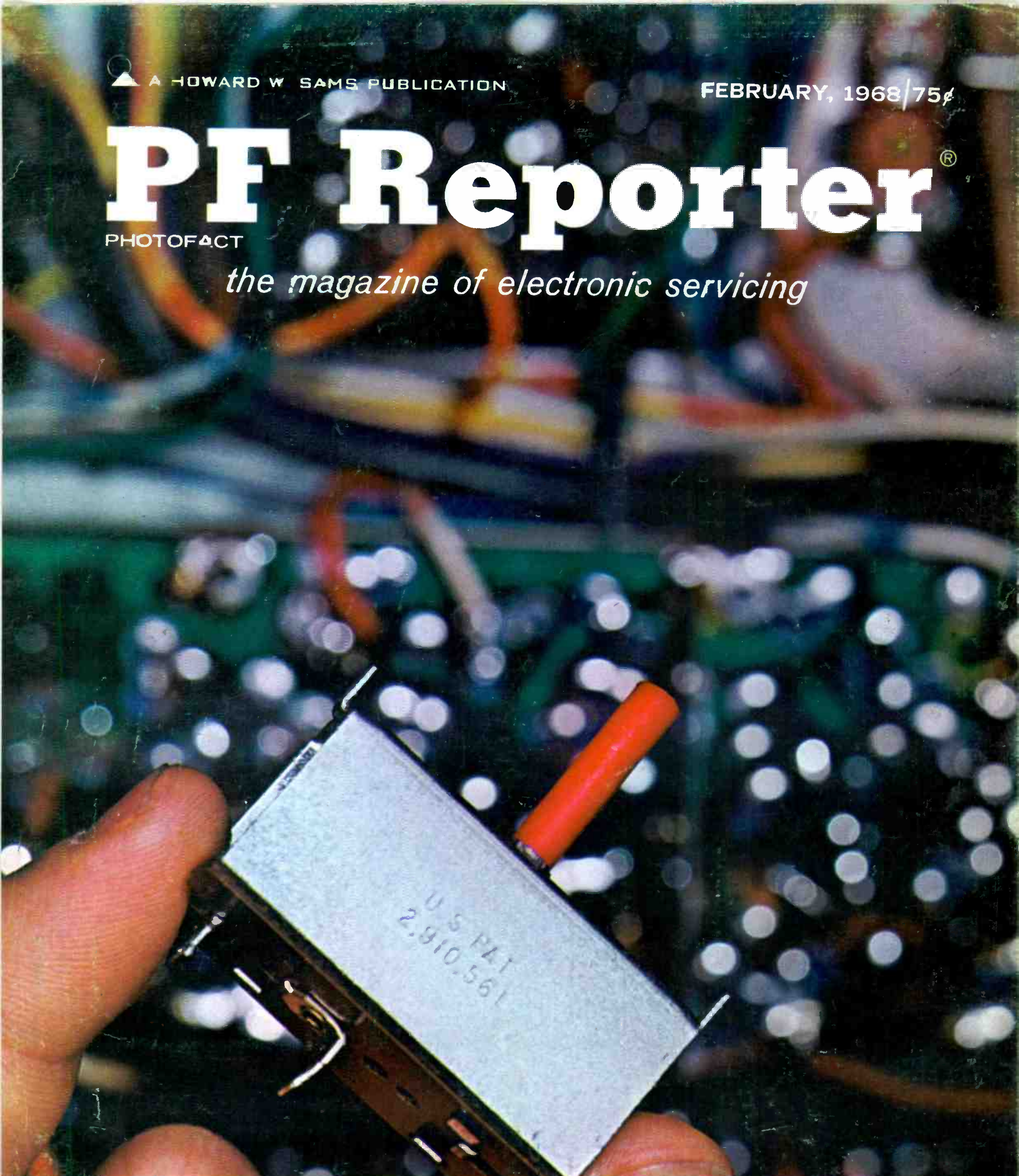

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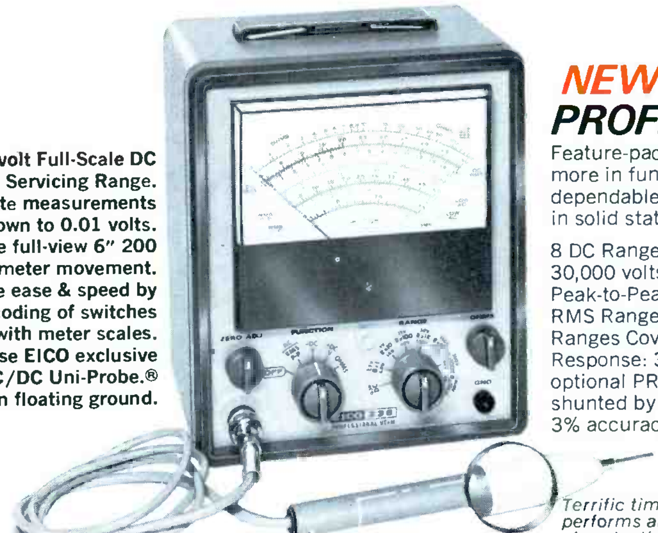

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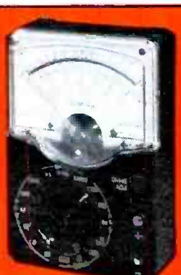

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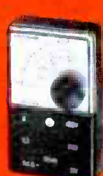

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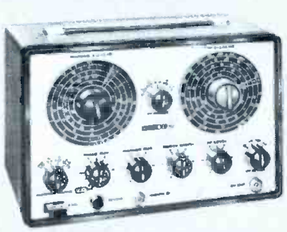

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VOLUME 18, NO. 2 FEBRUARY, 1968

CONTENTS

ABOUT THE COVER

Now in almost universal usage, the circuit breaker is one of the least understood parts of a color receiver. Our feature article this month helps clear up this misunderstanding, by clearly explaining many of the little-known facts about circuit breakers.

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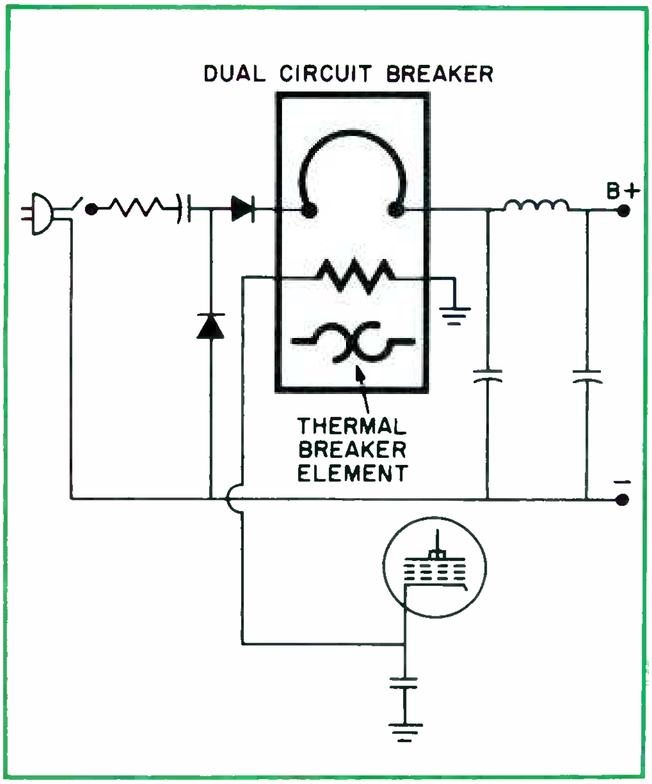
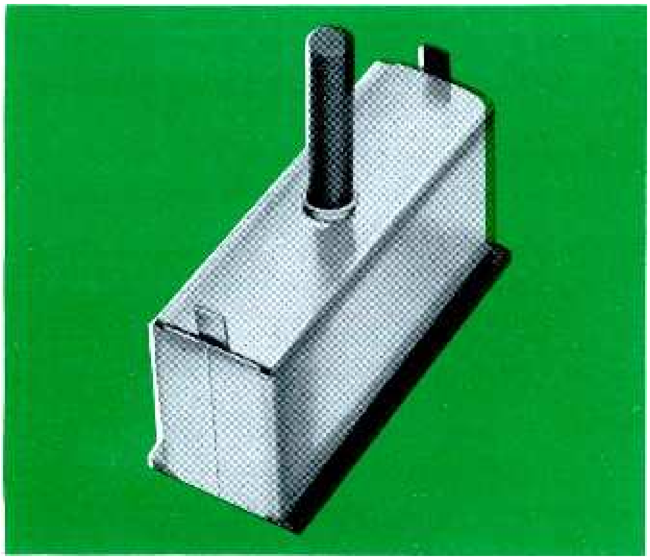
New circuit breakers for color TV



Typical hook-up for dual circuit breaker



Dual circuit breaker

Practically all the new color TV sets have a new kind of dual circuit breaker in them which you may not have run into before. Here's the story.

Remember back when black-and-white television used two fuses—one in the power supply input, and one in the horizontal output circuit? Next, in the interest of economy, the fuse in the horizontal output was eliminated. Then the designers switched to re-settable breakers, in the B+ line.

Along came color. Overload protection became necessary, because the horizontal circuits are more complicated, and more expensive components including the flyback transformer could be knocked out by a defect in the horizontal circuit.

The answer: a dual breaker which pops out from excess current in *either* the B+ or the horizontal output . . . in a single breaker case. It has two electrically isolated but thermally connected circuits, either of which can cause the B+ contacts to open.

The diagram shows a basic hook-up for the breaker. The thermal breaker element goes directly in the B+ line. A resistor inside the breaker, usually about 1.3 ohms, is connected between the cathode of the horizontal output stage and ground. This resistor is located so it will heat up the thermal breaker element.

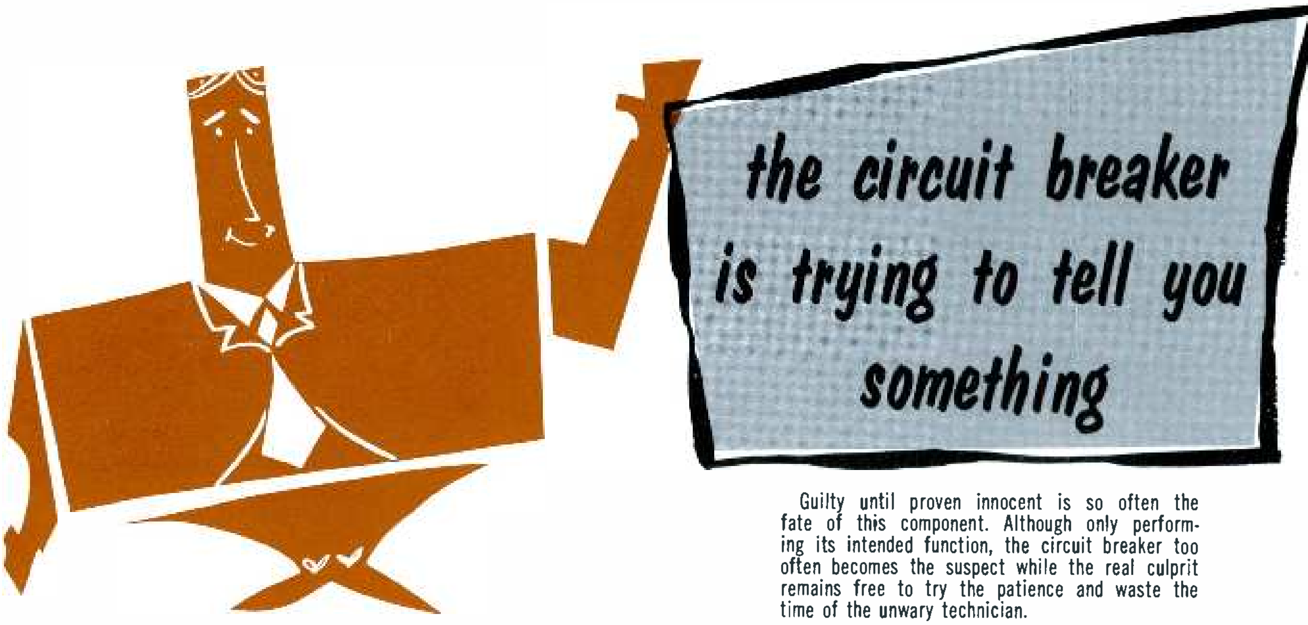
Along comes an overload in the B+. The thermal element pops the contacts open, in the usual manner. When there's excessive current in the horizontal output, the heating of the breaker's resistor has the same effect as a B+ overload, opening the contacts and removing voltage from the circuit.

Tip No. 1: breakers can fail because they get repeatedly reset into a fault. Check for gassy tubes and leaky capacitors before you replace the breaker, or you'll have the whole job to do over.

Tip No. 2: always replace with a Mallory breaker. We have three different dual breaker ratings in our line. They will replace the dual breakers in all existing color set applications. All are made to original equipment specifications. Your nearby Mallory distributor can supply you off the shelf. See him soon, or write to Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

REMEMBER TO ASK—*"What else needs fixing?"*

Circle 4 on literature card



the circuit breaker is trying to tell you something

Guilty until proven innocent is so often the fate of this component. Although only performing its intended function, the circuit breaker too often becomes the suspect while the real culprit remains free to try the patience and waste the time of the unwary technician.

BY M. F. MELVIN, PRESIDENT MEL-RAIN CORPORATION

In the history of components, probably none has been as misunderstood and unfairly judged as the circuit breaker. Approximately 80% of the units returned to the manufacturer are *not* defective! The circuit breaker has gained increased popularity in the electronics industry during the past several years; in fact, there are over 50,000,000 in use, which speaks well of the circuit breaker's acceptance. Of particular interest is the fact that its failure rate has been so low that only recently, and now only because of the large number of protectors in the field, has it been reasonable to establish a replacement program.

The fact that such a large number of good circuit breakers are mistakenly labeled defective indicates that we all need a better understanding of the unit and what it is designed to do. A close look at the circuit breaker (Fig. 1) and its function will permit us to view it in a new light.

The circuit breaker is a far cry from the simple fuse and must be considered as a relatively complex device, incorporated in the set at an *additional* cost to the manufacturer. Since manufacturers are continually trying to lower costs, there must be a reason for their willingness to accept this additional expense.

Design

The circuit breaker for a particular chassis is selected by first determining the amount of current the set normally draws. In order to be safe, the design engineer will measure several sets that are operating satisfactorily. In addition, he will also measure them at various line voltages, realizing that the set will be operated in areas where the line voltage can be as low as 105 volts, or as high as 130 volts. Once the maximum current load (I_{set}) is determined, the engineer then adds a safety factor of approximately 10 percent and, thus, arrives at the "operating current" (I_0). This is the maximum current level (and below) at which the circuit breaker must stay closed.

Once the "operating current" has been established, the "break current" is calculated by multiplying the "operating current" by slightly more than 1.5. For example, if the "operating current" is 1.45 amperes, the "break current" would be about 2.2 amperes. "Break current" is defined as the current at which the circuit breaker will *definitely* open. With these two levels established by the set manufacturer, the manufacturer of the circuit breaker adjusts the new units to open their contacts at a current somewhere between "operate" and "break." In the above example, one circuit breaker might open at 1.5 amperes while another opens at 2.1 amperes. A third unit might have 1.95 amperes as its actuating level.

A graphical representation of the preceding information is given in Fig. 2. In the previous example, 1.3 amperes (I_{set}) was the maximum line current drawn by the group of normally operating sets. Since a safety factor (10%) was desired to prevent unnecessary "nuisance" openings, the "operating current" (I_0) was established at 1.45 amperes. From this, the "break current" was calculated as being 2.2 amperes. Approximately 150 circuit breakers were adjusted for this range and then tested to find the actual current level at which they would open. The graph shows that most of them (23) opened at 1.9 amperes. Many more opened quite close to this level (20 at 1.95 amperes and 17 at 1.85 amperes). The opening level of the remaining circuit breakers tapered off so that all fell within the current range from "operate" to "break." It should be noted that the number diminished as the current approached the "break" current (2 opening at 2.2 amperes). Also note that none

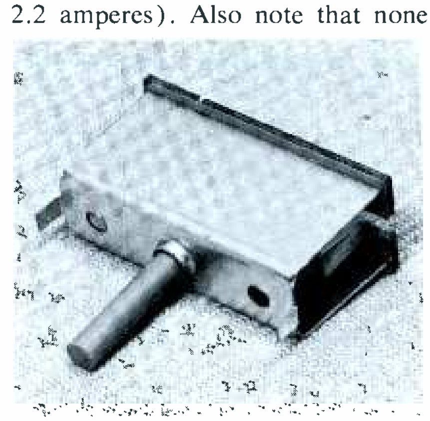


Fig. 1. Size does not reflect the circuit breaker's importance.

exceeded the specified "break" or "operate" levels.

Let's take a look at some of the problems that occur in TV sets returned for repair. One of the most common is that the protector keeps "popping out," or opening up, when there doesn't seem to be anything wrong with the set. The first analysis is that "the breaker is bad." This is possible, but this particular trouble symptom usually is caused by a change in circuit current attributed to the aging or changing of a component. This argument doesn't seem to stand up, however, if another circuit breaker of the same rating is substituted and the trouble symptom disappears. But wait—are all circuit breakers with the same rating actually the same? Not quite. Admittedly, they are quite close to being "peas in a pod"; however, remember Fig. 2.

Our analysis of 150 circuit breakers showed that some units opened near the "operating current," others opened at or near the "break current," while most opened somewhere in between. Let's say that the troublesome set we have been discussing has an electrolytic capacitor that is a bit leaky and the "normal" current changes from a figure at or below I_{set} to a level of 1.5 amperes. This is within the range between "operating" and "break." From the illustration it was determined that one of the 150 units would open at 1.5 amperes. It is possible that the protector in the troublesome set was one of the "low-limit" units. When the 1.5-ampere current level was attained, this "more sensitive" unit opened.

To follow our example further, suppose the serviceman replaced the circuit breaker with an "exact replacement." This identical unit would still be between limits, (I_o to I_B), but it might be one of those that would not open until the current reached 2.1 amperes. The "defective breaker" seemed to have been taken care of, because there were no longer any nuisance "popouts." However, the capacitor is still leaky, and the leak will increase with time. This probably will occur after the set has been returned to the customer, and he has just gotten over paying a repair bill for a "lousy breaker." The result: more trouble, and the set goes back to the shop—and probably not the same shop.

There have been many instances where the serviceman has understood only enough about circuit-breaker characteristics to cause him to replace it with one having a much higher current rating. Although the original circuit breaker should open at a point somewhere between 1.45 and 2.2 amperes, this fellow's solution to the problem is to replace the unit with a circuit breaker that opens at about 4 amperes. This is the same character who puts a penny behind the fuse in his fuse box. He doesn't mind seeing the smoke roll. By using an incorrect replacement, he has sacrificed all of the sensitive advantages of the circuit breaker and, in so doing, has created an extremely dangerous condition—not to mention the expense incurred by added damage to the set.

What should have been done in the above case? The serviceman should have consulted the available service literature and determined what current was considered to be normal. Such information is now available in PHOTOFACT schematics. Since the line current drain of the set was at or above the normal figure, he should have suspected a defective component or other trouble that would cause this symptom. Replacing the guilty part would have brought the current well below the "operating current" of the breaker, and the set could have been returned to a satisfied owner who would call the same serviceman in the event of other trouble(s).

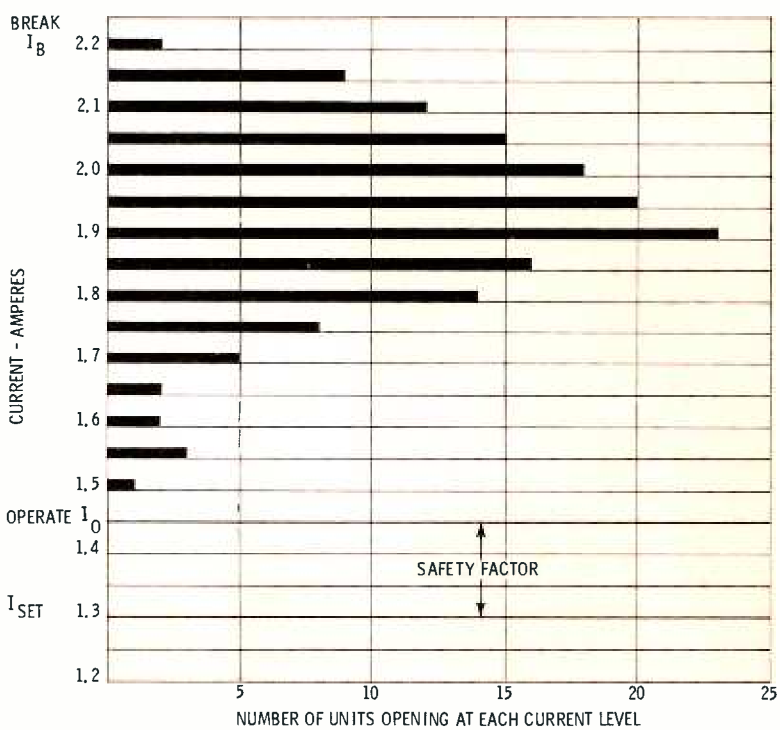


Fig. 2. An analysis of the actual operating range of a group of circuit breakers.

Fuses

In the preceding example, the repairman could have taken another approach and used a fuse. What kind of protection would this have provided the set? Let's examine the facts.

A fuse with a standard rating would have been used—probably 1.5 amperes. Fuse literature usually states that the fuse will carry 110% of rating without blowing. In this case, the 110% current would be 1.65 amperes — temporarily satisfactory; however, in time, some components could suffer.

Further interpretation of most fuse curves shows that the fuse has a "blow" rating of 135% within one hour. 135% of 1.5 is 2.025 amperes; a current which, if present for an extended time, could result in component deterioration.

For relatively quick action with a fuse, the overload must approach

200%. For the preceding case, the current would have had to be at least 3 amperes and persist for several minutes. In comparison, 90% of the circuit breakers in the graph in Fig.2 would have opened at 2.1 amperes—not in an hour, but in less than a minute. (Most circuit breaker opening times are around 15 seconds. Higher percentage overloads open the unit in even less time.)

From the examples given, it can be seen that *sensitivity* to trouble is sacrificed when using a fuse. The quick action of the circuit breaker to even slight overloads prevents a component from being "cooked," changing value, or being destroyed and, thus, necessitating expensive repairs.

Breaker Precautions

The circuit breaker, like most products, isn't 100% perfect —it does have a weak point or two. Understanding these limitations can be helpful and may lead to test procedures that will prevent unnecessary servicing problems.

The most important point to be remembered is that the circuit breaker will not successfully handle extremely high short-circuit currents. Remember, even the house circuit breaker has limitations!

The normal circuit breaker has a short-circuit current rating of 12 amperes or less. In some sets, this rating is not adequate, so special construction and a special contact are used to permit normal operation with currents as high as 25 amperes without circuit breaker or added set damage. Most circuits have sufficient internal impedance to prevent the current from even approaching 12 amperes.

Don't be surprised to learn that a circuit breaker can fall victim to its own actuating medium — current. Recall, however, that the units are engineered to be employed in circuits where excessively high current can't happen because of current limitations imposed by design. Something must be wrong then, because a high percentage of factory returns come back literally burned in two because of excessively high current. This condition can only occur when a lead or a screwdriver is inadvertently shorted from the line to ground. Remember, some wall outlets, if near enough to the junction box or transformer, can deliver as much as 5000 amperes. A screwdriver that has the point melted is proof of the power that is available. No wonder the inside of the circuit breaker suddenly looks like a blown fuse.

It should be pointed out that, although the protector is a low-power device, many times it will accommodate much higher currents than the specified 12 or 25 amperes. However, don't ask it to do so, because the power overload can't help but affect its calibration—and calibrated performance is the device's greatest asset. Some manufacturers of circuit breakers may claim considerably higher short-circuit current capabilities because of the use of a certain type of contact. Nevertheless, if the contacts must slide against each other, calibration suffers. The safe rule is to not poke that screwdriver into the innards of the set.

There are other points that should be kept in mind when servicing a receiver employing a circuit breaker. First, install a replacement very carefully. Don't allow solder to flow into the unit through a hole in the base; a short (or worse) can be the result. Also, be sure that the solder joint is satisfactory. A cold joint (high resistance) can generate considerable heat which will be conducted into the circuit breaker, thus causing the unit to open. Another point to remember is to not pull wires too tight, causing mechanical distortion of the circuit breaker. Such distortion can change the calibration and could result in a breakdown between the circuit breaker and its cover.

At this point it should be pointed out that it is practically impossible to readjust a circuit breaker without special equipment. Variation of the mechanism for only a few thousandths of an inch within the frame can change the current range considerably. Even an apparently satisfactory readjustment may not be proper after the set is warm, or at different control settings.

Possibly the most important point to remember when replacing a circuit breaker is to use a unit whose characteristics are comparable to those of the original unit. Fig. 3 shows pages from circuit breaker cross-reference charts that enable the user to select the proper unit if the set name and chassis or part number is known. The proper replacement is important; consider that much study and design effort has been spent in selecting the proper breaker range. The engineers involved have made an experienced decision—don't deviate from it.

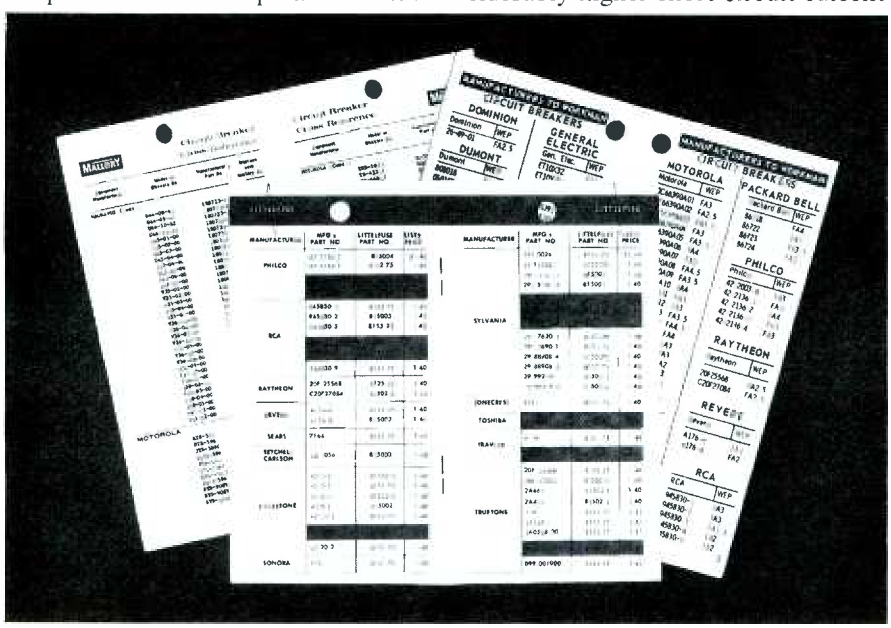


Fig. 3. A circuit breaker cross-reference chart aids replacement.

Conclusion

The information presented in this article should make the service technician more aware of the circuit breaker, its design and function, and most important, how to interpret the evidence of trouble so dramatically represented by a "popped-out" unit. ▲

WHAT'S NEW
in public-address systems

BY LOUIS M. DEZETTEL

Driver, horn, driver and horn combination, or column—they are all covered in this review of the speakers currently available for public address applications.

Most of the speakers which are available for public address systems fall into two general categories. One of these is the familiar driver and horn combination. Most of this year's offerings are in the 30-watt class and feature one-piece driver and horn construction, light weight materials, and ease of mounting. The other category is the increasingly popular column speakers. These are characterized by a small vertical angle of dispersion which provides the answer to many problems in acoustics. They are now available in higher power ratings than before.

New Horn Speakers

Since most of them use molded plastic horns, the new horn speakers are light in weight, between 5 lbs and 6½ lbs. They feature ease of installation by incorporating solderless connections and one-knob tightening of both the horizontal and vertical adjustments. All are available with provisions for a built-in, multitap transformer, and some have switches for selecting the taps.

The Atlas AP-30 series of horn speakers (Fig. 1) uses a lightweight, square horn measuring 10″ x 9½″ x 10½″. While it is a metal horn, it has a melamine coating for resonance damping. The dispersion angle is 100° both horizontally and vertically. A 30-watt driver is an integral part of the speaker. The basic AP-30 is availible with either an 8-ohm voice coil for public address use, or a 45-ohm voice coil for intercom applications. The AP-30T has a built-in transformer with a tap-selecting switch for operation from a 70-volt line. The AP-30T-25 has a built-in transformer for 25-volt lines.

Similar to the AP-30, but differing in horn contour, is the Atlas APC-30 shown in Fig. 2. Its flattened shape gives it a dispersion angle of 120° horizontally and 60° vertically. A 15-watt version of the AP-30 is the AP-15, available with built-in 70-volt transformer. Another model, the APT-34T is a "twin" version of the AP-30T for bi-directional paging.

An example of Electro-Voice's PA30 series is shown in Fig. 3. With a 30-watt rating, it is also available with a built-in 70-volt transformer (PAT30AT). The rectangular horn is made of molded plastic material. The dispersion angle is 120° in one plane and 90° in the other.

The Jensen VH-100 series of horns (Fig. 4) has a 32-watt rating and a 120° × 90° dispersion angle.

Fig. 1. The Atlas AP-30 is a reflex horn with an integral 30-watt driver and built-in line transformer.

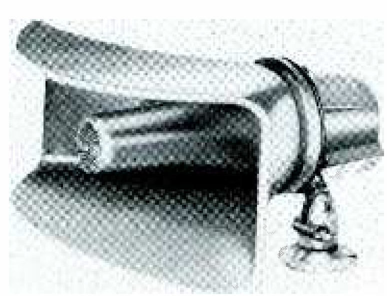


Fig. 2. The Atlas APC-30 has a different coverage pattern; otherwise, it is like the AP-30 series.

The horn is a nonmetallic molded unit and has the driver built in. The VH-100 has an 8-ohm voice coil, the VH-100V a 45-ohm voice coil, and the VH-100T a built-in 70-volt transformer. The transformer taps are brought to a screwdriver-operated switch so adjustments are easy to make after the unit is installed. This speaker is designed for solderless installation and has the terminals in the base of the mounting foot.

Oxford's contribution to the lightweight, integrated type of horn speaker is their OP-8 shown in Fig. 5. The basic unit weighs 6 lbs. and includes an 8-ohm driver built into the "Implex" plastic horn. It has a 30-watt power rating. A transformer with 70- and 25-volt taps is built in, and a 45-ohm tap to adapt this speaker to intercom use is also available. The OP-6 is a 15-watt version of the same speaker.

With the addition of three sound-deflection vanes, the OP-8 speaker becomes the COP-8 series (Fig. 6). The vanes give it a 120° × 60° dispersion angle instead of the 100° × 100° angle of coverage of the OP-8. Otherwise, the electrical and mechanical specifications are the same as for the OP-8.

The availability of these speakers with a 45-ohm voice coil makes them convenient for use as paging speakers in an intercom system. Since intercom amplifiers usually have low power, the high efficiency of the horn speakers makes them ideal for paging service. The speakers can be used for talk-back when answering the page, if they are not located too high.

New Drivers

Although they are not in the two categories of speakers reported here, two new series of drivers by Electro-Voice are worth mentioning. The 1828 series (Fig. 7) has a 30-watt rating, and the 1829 series is rated at 60-watts. The manufacturer's literature describes them as having lower distortion and flatter frequency response than older units. The suffix "T" in the series stands for a built-in, 70-volt transformer. They have the standard throat with a 1⅜″–18 thread for use with all horns.

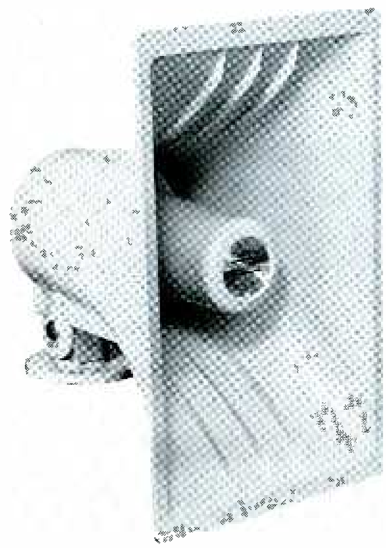


Fig. 3. The Electro-Voice PA-30 features a molded plastic horn and a 30-watt, integral driver.

Column Speakers

In the past ten years, a revolution in public address speakers has been taking place in the development of the column speaker. Now, nearly all manufacturers of speakers and enclosures have some column speakers in their line. The most outstanding advantage of the column speaker is its small vertical angle of radiation. When the column is properly installed and directed, this small radiation angle makes possible a fairly even blanket of sound over an entire audience, without blasting those in the front rows.

A stacked Yagi TV antenna has greater sensitivity than a single unit because the angle of the vertical lobe is decreased. In the same manner, by stacking a number of speakers, in phase, the vertical dispersion angle decreases, but the horizontal angle is the same as for a single speaker. This is ideal for covering an audience situated in a horizontal plane, as in a theatre. So, a column speaker is a long, narrow box standing on end, with a large number of cone-type speakers installed in a vertical row and connected in phase.

To get the best coverage of an audience with column speakers, it is important to use the vertical sound pressure curves which manufacturers of this type speaker supply with their literature. Jensen makes available large, clear plastic charts of equal sound pressure contours for their speaker columns, which they call "Isosonic" contour charts. By placing the appropriate chart over an elevation view of the auditorium, it is easy to predetermine the exact height and tilt of the speaker that will give the best coverage. Unlike the more familiar polar pattern which shows the relative sound levels at various vertical angles from the major axis, the "Isosonic" curves locate the points at which the sound has a constant level.

Sound columns use several speakers with soft-cone suspension to produce a husky amount of total power with good frequency response. A single speaker column over the center of a stage, or two, one on each side of the stage, can cover an audience with a sound level that varies no more than $\pm$ 1.5 dB from front to back.

It is very important to an effective stage presentation to give the illusion that the sound is coming from the stage. If it doesn't seem to come from the stage, it isn't natural. This dictates the use of high-power speakers placed at or near the stage

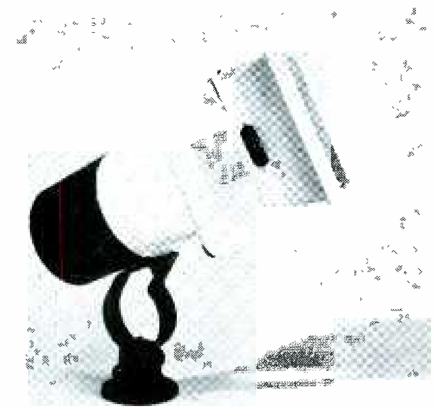


Fig. 6. The Oxford COP-8 series has deflection vanes to alter the dispersion angle.

rather than placing small speakers around the perimeter of the audience area. This is another advantage of high-power column speakers—good audience coverage, yet the illusion that the voice and music are coming from the actual source is retained.

No less important are some of the other results of the small angle of vertical dispersion. Proportionately less sound from the speaker reaches the microphone on the stage and acoustic feedback is reduced. This means that higher amplifier levels may be used without spillover. There is also less reverberation from the ceiling, contributing to reduced microphone feedback, as well as more pleasant sound in the listening area. Column speakers are not confined to the reproduction of music. Their flat frequency response (no "peaks") and good low-frequency response improve speech articulation, making them excellent for speech paging.

Another advantage of column speakers is appearance. While they are rather tall, they are neither wide nor deep. When mounted against a

Fig. 4. Available with either an 8- or 45-ohm voice coil, the Jensen VH-100 series is rated at 32 watts.

Fig. 5. The Oxford OP-8 has a 30-watt rating. 70-volt and 25-volt built-in transformers are available.

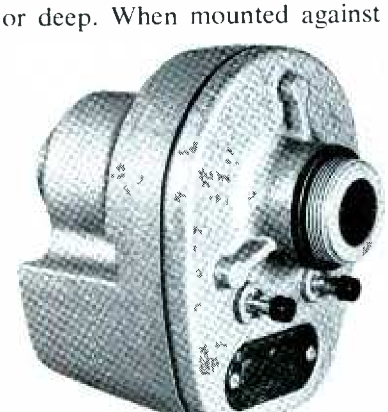
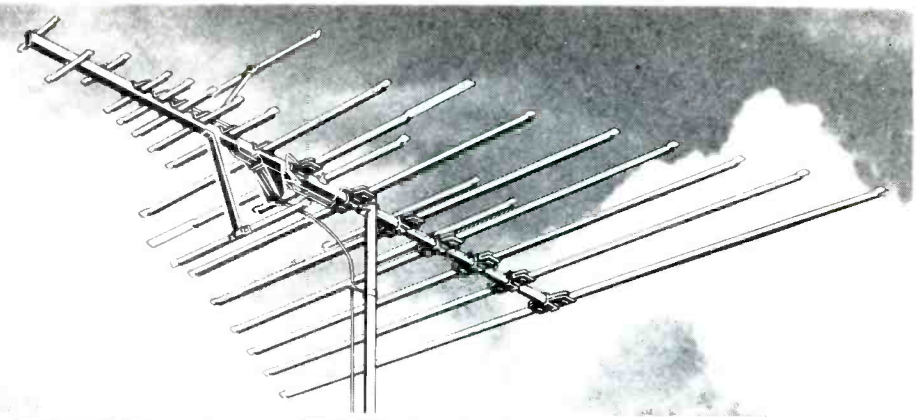
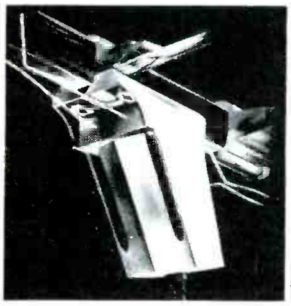


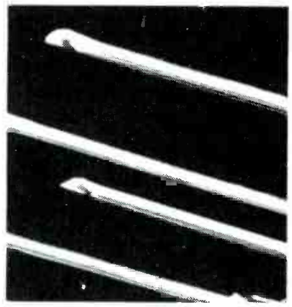
Fig. 7. The Electro-Voice 1828 is a new driver with a 30-watt rating and built-in transformer.

Winegard put these features in to bring the best color out

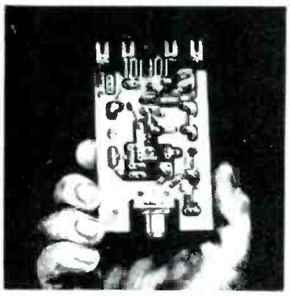




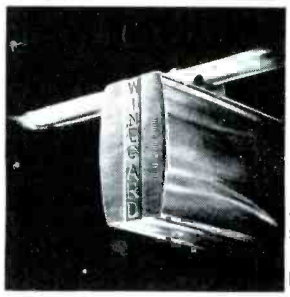
Download and Pre-Amplifier Housing—permanent housing is built-into the antenna; provides complete weather-proofing for downlead connector cartridge or pre-amp cartridge.



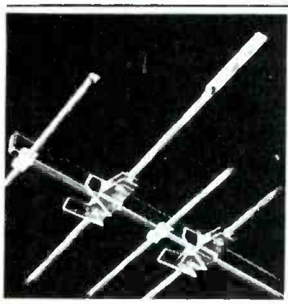
High Tensile Aluminum Elements; with Gold Anodizing—aluminum alloy has PSI rating of 38,000 compared to 27,000 PSI for alloys used in other antennas. More than 49% stronger and 29% more resistant to bend and wind distortion. Elements and boom are gold anodized for the only permanent protection against corrosion and fading.



Solid State Pre-Amplifiers—incorporate revolutionary new silicon overlay transistors, the best performing and most powerful transistors available for antenna use. Drop into pre-amplifier housing at point of signal interception.

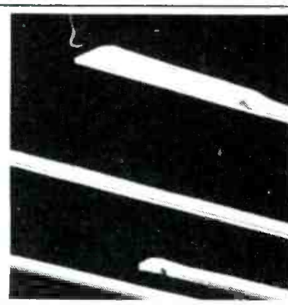


Ellipsoidal Boom—the only aluminum shape engineered especially for antenna use; proved far stronger than any other boom design.

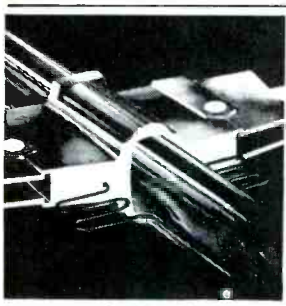


Electro-Lens* Director System—patented system absorbs entire signal and focuses it directly onto driven elements for pinpoint directivity.

*U. S. Patent No. 2700105
Canada No. 511984

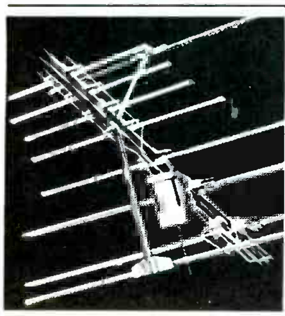


FM Control Element—provide exceptionally high gain on FM bands and provide for the attenuation of FM bands in areas where strong FM signals interfere with tv reception.

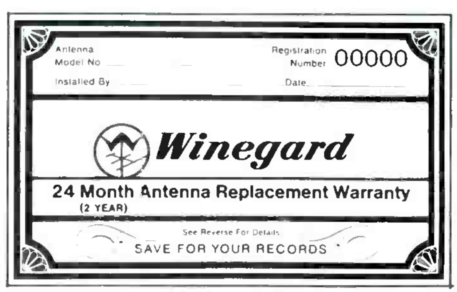


Impedance Correlators—patented correlators automatically increase 75 ohm driven elements to 300 ohms to provide 100% signal transfer from antenna to set.

CS-285 Band Separator (with printed circuit)—comes at no additional cost with all 82 channel Super Colortrons to separate UHF and VHF signals. Attaches easily to terminals on back of set.



Vertical Resonant Reflectors—UHF reflectors achieve highest realizable gain on channels 14 to 83 because of exceptionally large vertical capture area; more UHF gain than any other 82-channel design.



2-Year Antenna Replacement Warranty—the only antenna in the industry that gives your customer a 2-year replacement privilege.

No wonder so many dealers are selling so many Winegard Super Colortrons so fast.

You're right, that's a lot of features. A lot more than any other antenna ever designed.

But what's really important is what happens when all those features are sandwiched into one super-performing, super-compact antenna.

And just in case you don't know yet, we'll tell you what happens.

First off, you get an antenna so powerful and with such pinpoint directivity (even without solid state pre-amps) that it eliminates ghosts and snow more effectively than anything you've ever seen before.

And when you drop-in an instant-loading pre-amplifier (there are eight to choose from not counting the color spectrum filter) you've got yourself an antenna that does just about anything you want it to do, just about anywhere—especially when it comes to color tv.

The solid state pre-amplifiers enable you to instantly increase gain on all channels. They let you custom match the Super Colortron to any reception requirement in seconds, using either 75 ohm coax or 300 ohm downlead—and with all connections completely enclosed and protected against the weather.

You can take your choice. There are ultra high gain, low noise 82-channel UHF-VHF-FM pre-amplifiers... VHF-FM pre-amplifiers... UHF pre-amplifiers... and FM pre-amplifiers. And then there's that color spectrum filter. It shuts out electro-magnetic interference... lets only pure TV signals come through for the clearest color pictures ever.

So you see, there's really a lot to talk about when it comes to Super Colortron antennas, all 14 models—with 7 patents and patents pending.

And that's why we're doing a lot of talking in Life and Newsweek and Sunset. 17 ads, between now and Christmas, telling more than 60,000,000 prospects exactly how remarkable the "transistorized" Super Colortron is.

No wonder so many dealers are selling so many Super Colortrons so fast.

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wall, they can be quite inconspicuous in a theatre or auditorium, especially if they are painted to match the decor of the room. Most enclosures are vinyl covered and are easily painted.

The big move lately in column speakers has been to higher and higher power. Jensen has just announced three new ones, each with a rating of 100 watts. Their HFC-84, shown in Fig. 8, is a high-fidelity speaker for indoor use. It contains four 8″ speakers of husky design. The cones have resilient-edge suspension, and a supplementary high-frequency radiator is attached to the apex of the cone. The overall frequency response is 50 to 15,000 Hz, and the speaker coverage angles are 100° horizontally, but only 30° in the vertical plane. The input impedance is 8 ohms, but a well in the top of the enclosure accommodates a matching transformer, if one is required. Screw terminals within the well permit installing the transformer without solder.

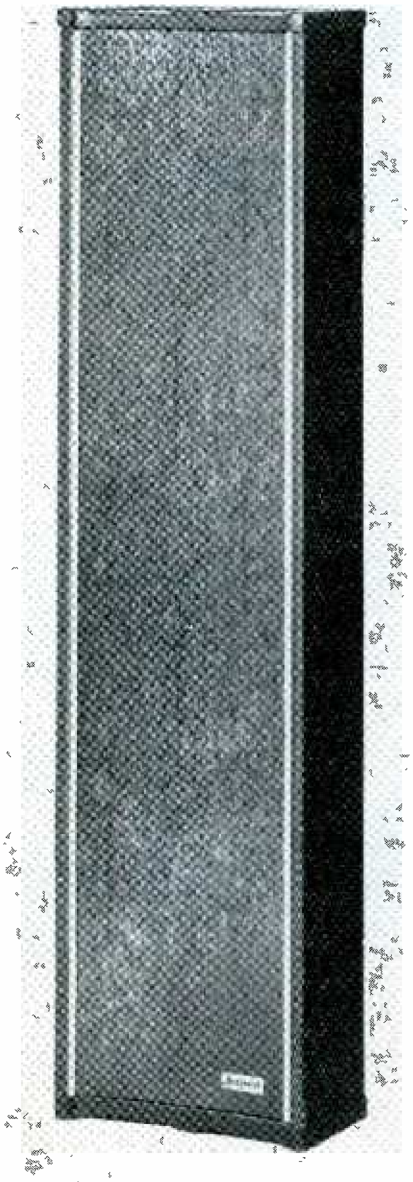

Fig. 8. The Jensen HFC-84 is a 100-watt column speaker with a 30° vertical angle of sound radiation.

The Jensen TXC-56 and TXC-84 "total exposure" loudspeaker systems are designed to withstand the extremes of any climate or weather conditions. The TXC-56, the smaller of the two, is designed for outdoor paging purposes where wide-area paging from a single source is required. It contains six 5¼″ speakers and has horizontal and vertical coverage angles of 120° and 50°, respectively. The TXC-84 is the size of the HFC-84 (52⅝″ h., 13⅛″ w., and 7¼″ d.) and is ideal for outdoor concert areas. It has a 95° × 30° dispersion angle and good frequency response, from 50 to 10,000 Hz.

Also in the power race is the Argos "Thunder Column" (Fig. 9), designed specifically for electrically amplified musical instruments. It has a 150-watt rating and contains four Jensen 10″ speakers, each with a magnet weight of 1¾ lbs. This column speaker has a handle for portability.

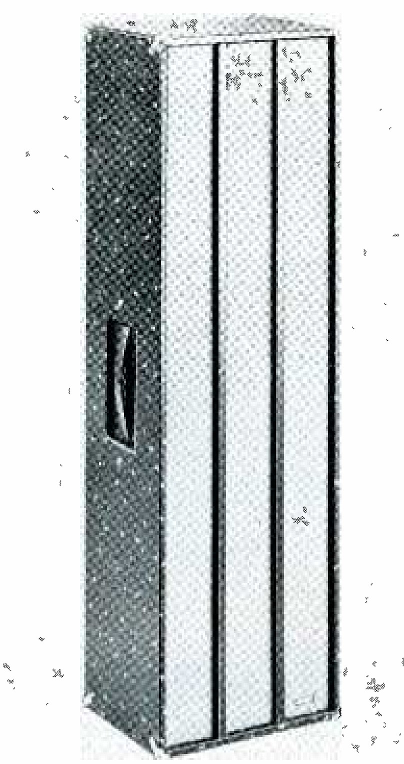

Fig. 9. The Argos "Thunder Column" has a 150-watt rating. It is designed principally for use with electronically-amplified musical instruments.

Summary

The column speakers described here are only a few of the newer ones. Literally dozens of models are available with a wide variety of coverage angles, frequency response, power ratings, etc. You should definitely look into the use of speaker columns for many of your PA installations, and when you do, look over the entire literature of the lines available in your areas. Your local radio and TV parts distributors probably carry several makes.

A review of the latest lines of speakers indicates that there is a trend toward smaller and lighter, horn-and-driver type speakers in which ease of installation is an important feature. Horns with integral drivers are becoming more and more popular, and in column speakers, the trend is in the direction of higher power.

Of course, the requirements of each specific installation are the important considerations, and the regular lines of PA speakers should be considered at all times. It is still true that the reflex horn and driver is the most efficient type of speaker for industrial sound. The electrical-to-acoustical conversion efficiency of a horn is several times that of cone-type speakers and it is not unusual for a 30-watt reflex horn and driver to produce more acoustic energy than a 100-watt sound column using cone speakers. However, horn speakers have one drawback, the low-frequency-cutoff point is a function of the area of the horn mouth.

$$F = \frac{1140}{2\sqrt{3.14Am}}$$

where,

F = low-frequency cutoff, and
Am = Area of horn mouth

Air loading on the driver is poor below this frequency and unless a capacitor is connected in series to attenuate low-frequency voltage delivered to the driver, the voice coil may be damaged. Nevertheless, when confined to voice paging or oscillator alarm systems, reflex horns are often the best choice. ▲

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BRIDGE CIRCUITS

A REVIEW/PART 1

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 two-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.

The basic bridge circuit was invented by S. H. Christie, an Englishman, who described it in a paper in the February 28, 1833, issue of *Philosophical Transactions*. But the device attracted little attention until 1843, when it was publicized by Sir Charles Wheatstone, from whom it came to be called the Wheatstone bridge, despite Sir Charles's painstaking credit to Christie.

The bridge enables an unknown quantity to be checked directly against a standard which is permanently contained in the circuit. Bridges are used for accurate measurement of such properties as resistance, capacitance, inductance, impedance, and frequency.

The Basic DC Bridge

In the dual voltage-divider circuit shown in Fig. 1, voltage divider R1 supplies a selected fraction (E1) of voltage E_S, while R2 similarly supplies a selected fraction (E2) of voltage E_X. Both E1 and E2 are positive; therefore, the meter deflects downscale when E1 is more positive than E2, upscale when E1 is less positive than E2, and reads zero when E1 = E2.

A disadvantage of this design is that both E_S and E_X are constantly under load and therefore may not be able to put out their true open-circuit voltages.

The dual voltage-divider circuit shown in Fig. 1 can be used to compare resistances as well as voltages. Thus, in Fig. 2A, batteries E1 and E2, which are exactly equal in voltage, force currents I1 and I2, respectively, through voltage dividers R1 and R2. The resultant voltage drops E3 (=I1R3), E4 (=I1R4), E5 (=I2R5), and E6 (=I2R6) are proportional to resistances R3, R4, R5 and R6, respectively. At null, E3/E4=E5/E6, so R3/R4=R5/R6. From this relationship, any one of the resistances may be determined in terms of the other three: R3=(R4R5)/R6. R4=(R3R6)/R5, R5=(R3R6)/R4, and R6=(R4R5)/R3. In this way, one unknown resistance may be determined from the values of three accurately known resistances.

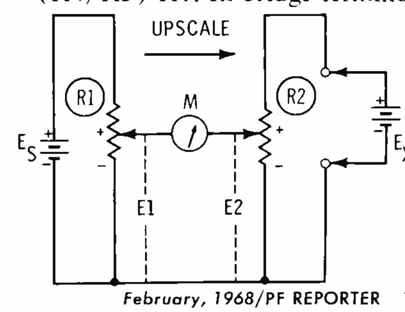

Fig. 1. The dual voltage-divider circuit measures resistance and voltage.

Resistance determinations may be made without the two separate batteries; the voltage dividers may be connected in parallel and operated from a single DC source, as shown in Fig. 2B. Here, the current, voltage, and resistance relations are the same as in the preceding example. With Fig. 2B, the basic configuration of the bridge emerges.

Usually, a bridge circuit is drawn in the diamond shape shown in Fig. 2C. Here, R1, R2, R3, and R4 are separate arms of the bridge and correspond to the selected resistances R3 and R4 of potentiometer R1, and to R5 and R6 of potentiometer R2 in Fig. 2A. One arm, such as R1, may be made continuously variable for balancing the circuit to null, and one (such as R2) may be the unknown. The two remaining arms, R3 and R4, then are accurate resistances whose ratio determines the ratio of the unknown (R2) to the standard (R1). Thus, at null the unknown R2 = (R4/R3) R1. In bridge terminology, the power source (such as the battery in Fig. 2C) is termed the *generator*, and the null indicator (such as the center-zero galvanometer in Fig. 2C) is the *detector*.

Basic AC Bridge

As a test instrument, a DC bridge can be used only for the measurement of resistance. Capacitance, inductance, and impedance measurements, however, require that the bridge be powered by alternating current.

Fig. 3 shows the basic configuration of an AC bridge. Note that the circuit is essentially like the DC bridge, except that an AC generator (GEN) has replaced the battery, and an AC null detector (DET) has replaced the center-zero DC galvanometer. The AC detector may be a vacuum-tube (or transistorized) voltmeter, oscilloscope, magic-eye tube, or headphones (with or without an amplifier). Also, the resistance arms of the DC bridge have been replaced with corresponding impedance arms Z1, Z2, Z3, and Z4. Calculations of unknown impedance in terms of standard impedance and ratio arms may be made in the same way described previously for resistance, simply by substituting Z's for R's in the formula.

At low (audio) frequencies, an AC bridge also may be used to measure resistance in the manner described for the DC bridge, with the same R formula being used.

Generator and Detector Requirements

For the most efficient bridge operation, the generator (whether AC or DC) must have good output-voltage regulation, and its maximum output voltage must be held low enough to prevent damage to the bridge arms. Moreover, if the generator is of the DC type, its output must be free from ripple. If the generator is of the AC type, its output should exhibit a constant frequency and low distortion.

The detector (whether AC or DC) should have provision for adjusting the response, so that its sensitivity may be increased as null is approached, thereby increasing the closeness to which the bridge may be set. Closeness of setting is enhanced also by a very high detector-input resistance (impedance) with respect to that of the bridge arms. To sharpen the null response of the bridge, the detector must be sharply tuned to the fundamental frequency if the generator output has significant harmonic content.

In AC bridges, performance is improved by using an isolating transformer between the generator and bridge, and between the bridge and detector. For best performance, these transformers must be well shielded internally.

For a given combination of resistances or impedances in the arms, the sensitivity of a bridge may be increased by raising the generator voltage (bridge signal). However, there is a safe limit beyond which the bridge current becomes excessive and damages the arms. It is for this reason that moderate generator output often is preferred, and the detector sensitivity is increased proportionately, as through AC or DC amplification. But some amplifiers tend to become unstable and susceptible to stray pickup when operated at high sensitivity, so a compromise must be reached between generator voltage and detector sensitivity.

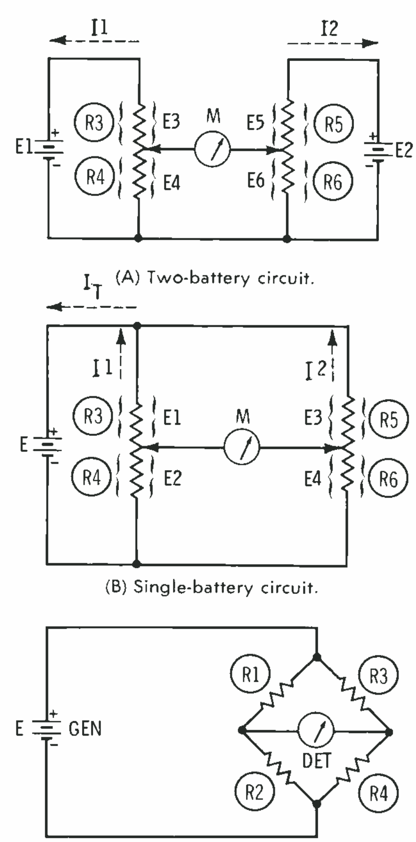

Fig. 2. Evolution of the bridge from two-battery circuit to present design.

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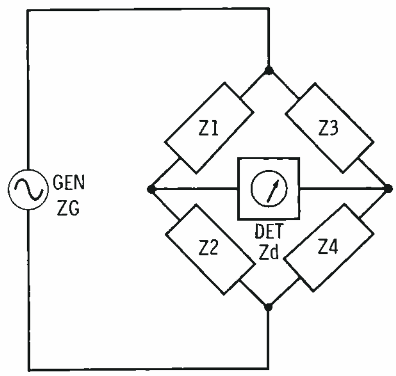


Fig. 3. The basic AC bridge employs AC generator and null detectors.

Maximum sensitivity with a given fixed-output generator and fixed-sensitivity detector is obtained when $R1 = R2 = R3 = R4 = R_G = R_D$ in the DC bridge, and when $Z1 = Z2 = Z3 = Z4 = Z_G = Z_D$ in the AC bridge. (The symbol R_G or Z_G is the generator output resistance or impedance; R_D or Z_D is the detector input resistance or impedance.)

Resistance Bridge

Although bridges are used today to measure many different quantities, such as resistance, capacitance, inductance, and frequency, the original bridge was strictly a resistance-measuring device. At present, resistance measurement remains a major function of the bridge. Modern resistance bridges as a group cover the range from 0.01 milliohm to 1000 teraohms—a spread of 10^{20} to 1; and, depending on make, model, and technique, their accuracy can be as close as 0.0001 percent of the indicated resistance value.

Described below are representative resistance bridges from the rudimentary slide-wire type to more complicated varieties.

Basic Slide-Wire Bridge

Fig. 4 shows the most rudimentary resistance bridge circuit. In this arrangement, the variable balancing resistor is a single strand of resistance wire (the slide wire) tautly stretched between points A and B (or wound around a form having a circular cross section) and provided with a sliding contact (the slider). The wire is of uniform cross section and purity, so its resistance is directly proportional to its length.

As the slider is moved along the wire, it divides the latter into two parts; D1, the length from point A to the slider, which has a resistance of R3; and D2, the length from point B to the slider, which has a resistance of R4. Thus, the resistance increases on one side of the moving slider and decreases on the other side.

The bridge is composed of unknown resistance R1 (connected to terminals X-X), standard resistance R2, and the two sections (R3 and R4) of the slide-wire variable resistor. Battery B is the generator, and the center-zero DC galvanometer, M, is the detector. The on-off switch,

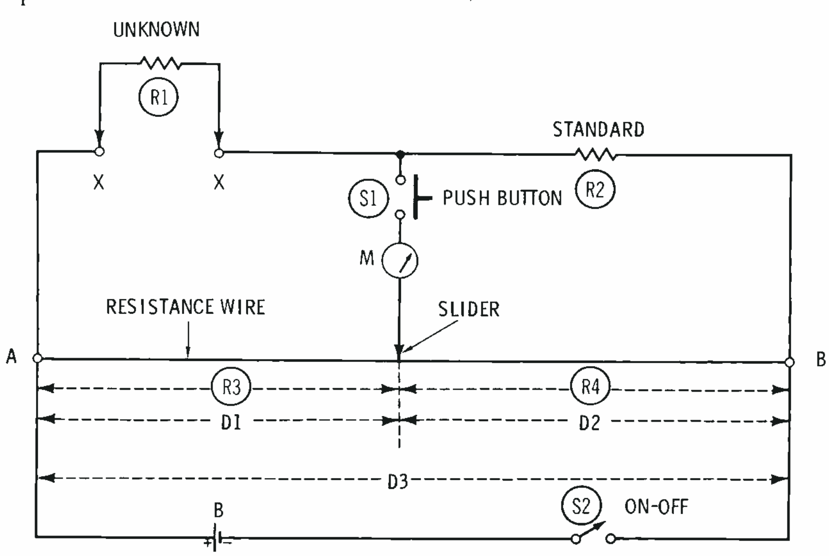


Fig. 4. Basic slide-wire bridge designed for resistance measurements.

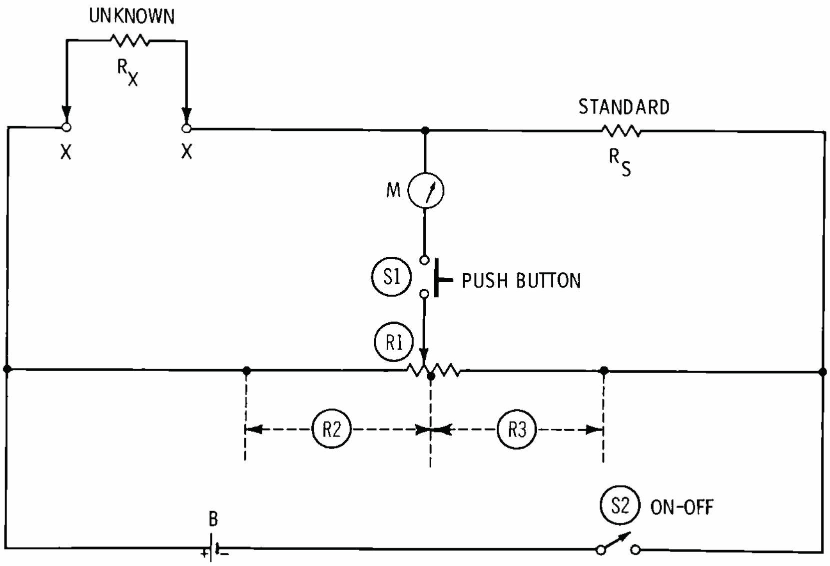
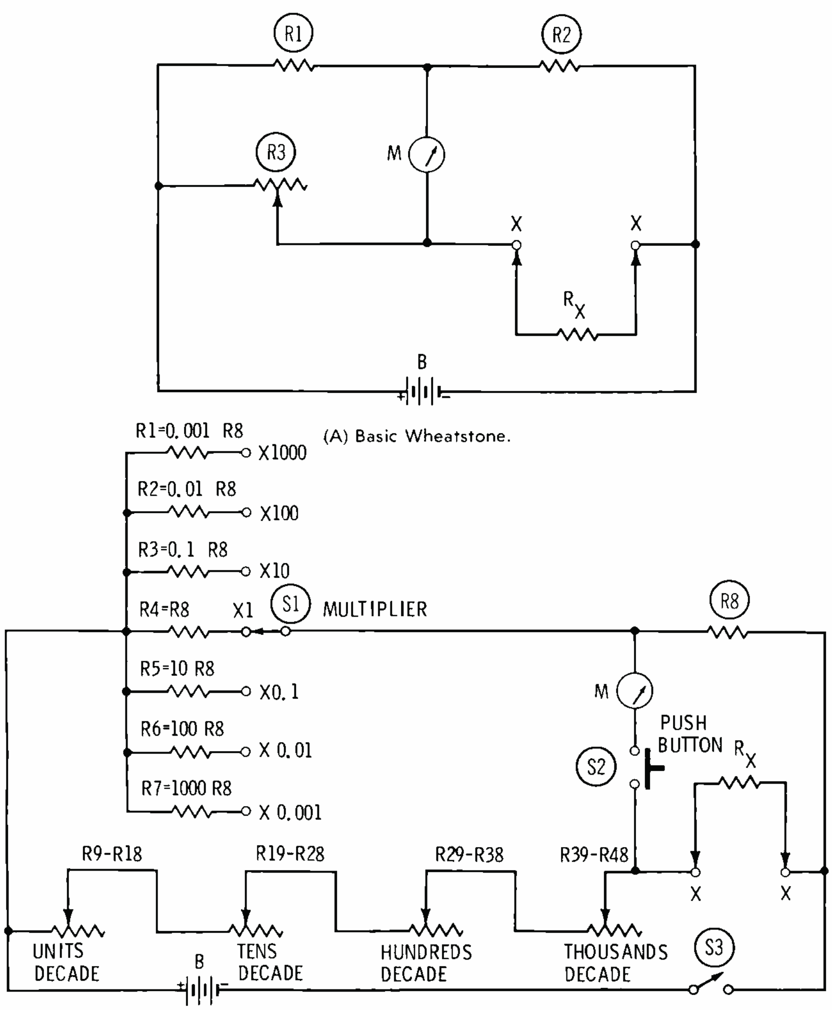


Fig. 5. Slide-wire resistance bridge employing a potentiometer.

S2 permits disconnection of the battery when the bridge is idle. The pushbutton switch, S1, allows the galvanometer to be cut into the circuit momentarily to check the state of balance, thus protecting the galvanometer from continuous exposure to excessive unbalance current.

With the unknown resistance (R1) connected to terminal X-X, the bridge is balanced by moving the slider along the wire until zero deflection is shown on the galvanometer. At this null, R1/R2 = R3/R4, and from this relationship the unknown may be determined in terms of the standard: R1 = R2(R3/R4). From this, it is clear that the slide wire provides the ratio arms of the circuit.



(A) Basic Wheatstone.

(B) Practical Wheatstone.

Fig. 6. The Wheatstone bridge is suitable for general purpose applications.

The total resistance of the slide wire is unimportant to the calculation. So also are the two resistance values on each side of the slider. Distances D1 and D2 may be measured in inches or centimeters and used in the calculation in place of the actual resistances R3 and R4. Thus: R1 = R2(D1/D2). For this reason, the basic slide-wire bridge is convenient for emergency measurements of resistance, since it requires only a standard resistor and a length of bare resistance wire stretched along a meter stick or yardstick, in addition to a battery and DC meter.

Sometimes it is more convenient to read the position of the slider with respect to the total length (D3) of the wire than to measure D1 and D2 separately. In such an instance: R1 = R2 [D1/(D3−D1)].

It is apparent from the preceding equation that the unknown (R1) is equal to the standard (R2) when null occurs with the slider halfway between A and B (i.e., D1 = D2, and D1/D2 = 1). Also the slider must move to the right of center when R1 is greater than (>) R2, and to the left of center when R1 is less than (<) R2. In practice, a meter stick or similar linear scale is usually mounted under the wire for reading D1 and D2 from the position of the slider.

If the wire is long (say 1 meter), little difficulty is experienced in measuring resistance over the range 0.01R2 to 100R2, provided a sensitive galvanometer is used. Unless the wire has reasonably high resistance, however, the current may heat it and impair the accuracy of measurement.

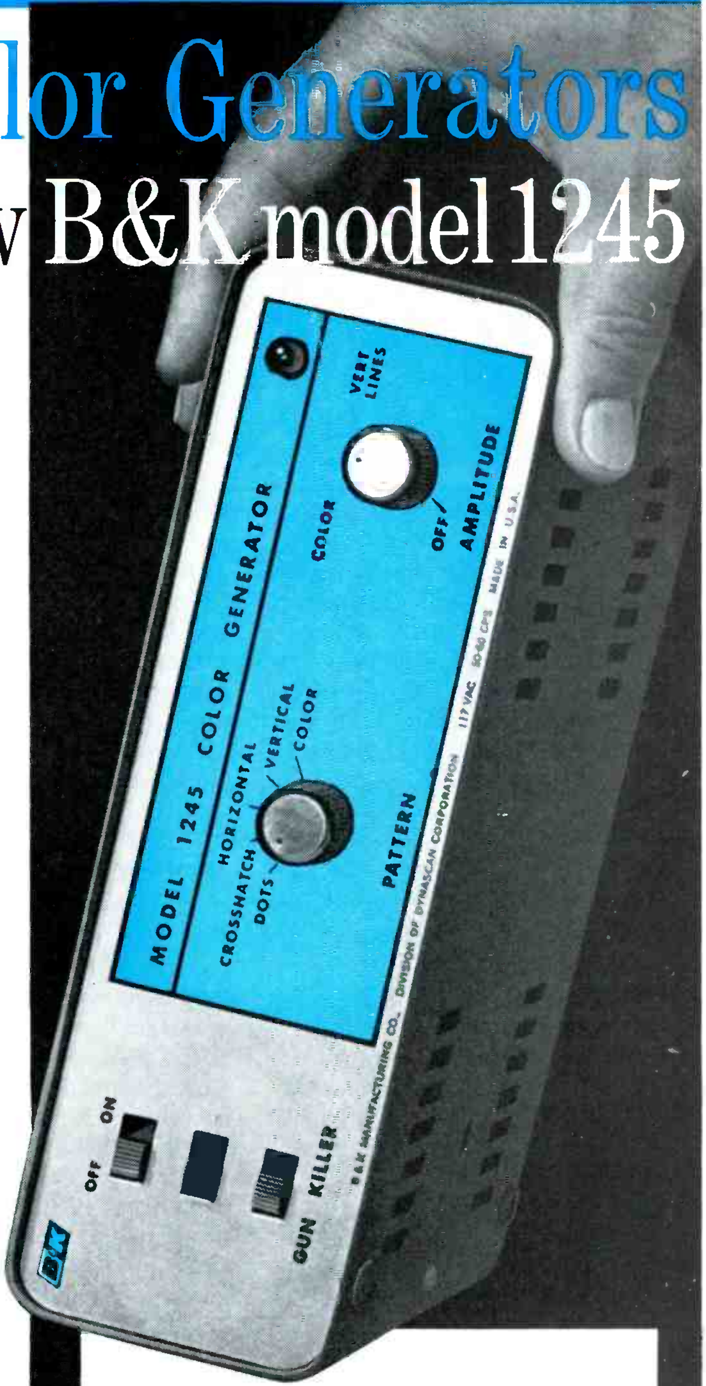
Slide-Wire With Potentiometer

The modern slide-wire bridge substitutes a potentiometer for the single strand slide wire of the basic circuit. Otherwise the circuit is unchanged. In Fig. 5, for example, potentiometer R1 is the "slide-wire" element, and its slider divides the total resistance R1 into the bridge ratio arms R2 and R3.

As before, at null the unknown (R_X) is determined in terms of the standard: $R_X = R_S$ (R2/R3.)

Compare Color Generators

look at the rest . . .
and you'll buy the best, new B&K model 1245



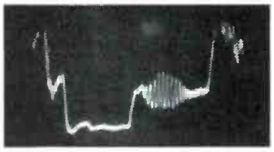
The all solid-state B&K Model 1245 Color Generator duplicates the waveforms transmitted by a color TV station.

Adherence to these waveforms makes it easy to converge the color tube, check sync and make other raster adjustments . . . and the color generator with station quality signal will be able to sync next year's sets. Generators with compromise waveforms do not give you this obsolescence protection.

Here are oscilloscope photographs from the outputs of two typical competitive color generators, one transistorized and one tube type, and the B&K Model 1245. The detailed analysis with each photograph shows a few of the reasons why you'll save time and effort with B&K.

COLOR **CROSSHATCH**

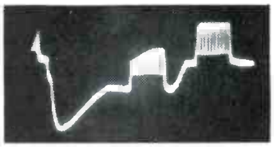
STANDARD STATION SIGNAL



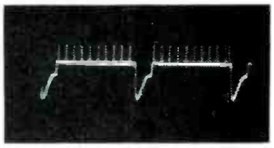
One horizontal sync pulse with its color burst.

Two lines showing horizontal sync pulse with black and white tv signal,

TRANSISTORIZED B&K MODEL 1245

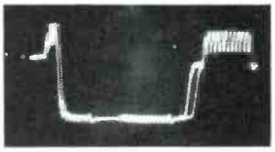


Good duplication of station signal including back porch. If the set won't sync, the set is defective.

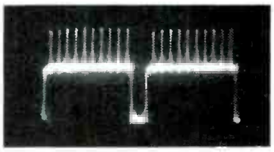


Well defined back porch on horizontal sync pulse permits accurately setting color killer and almost eliminates need to adjust brightness and contrast.

TRANSISTORIZED GENERATOR A

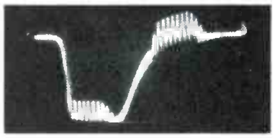


No back porch causes unstable color sync. Burst amplitude compression may permit sync on wrong color bar.

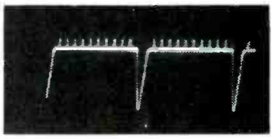


Square wave horizontal sync pulse with no back porch and poor dc coupling forces adjustments of brightness, contrast & fine tuning to obtain usable pattern.

GENERATOR B



No back porch; color information on top of sync-pulse makes sync difficult on some sets.



Complete absence of any back porch necessitates readjustment of brightness, contrast and fine tuning to obtain a usable pattern.

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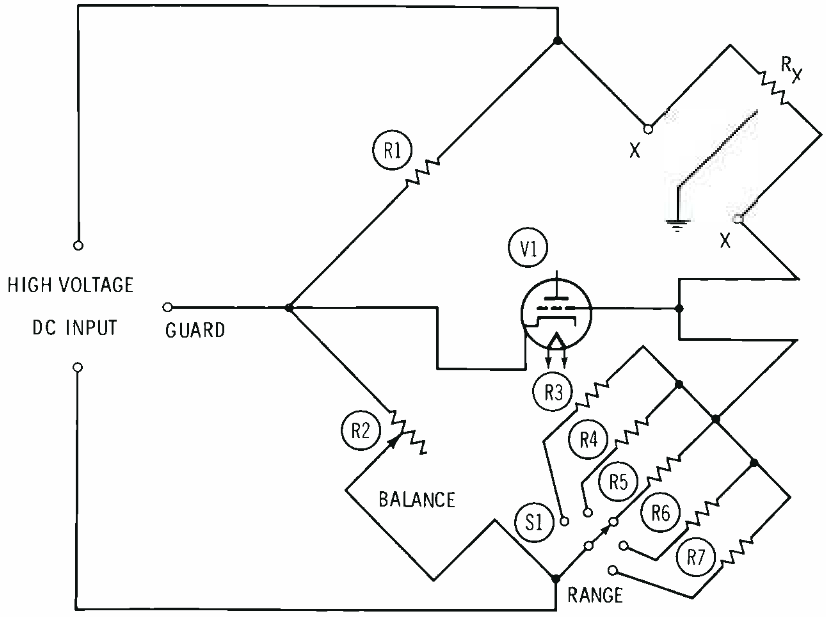


Fig. 7. Bridge design for measuring resistances in the megohm range.

A dial reading directly in ohms, based upon the preceding equation, usually is attached to the potentiometer and calibrated by means of a number of accurately known resistors connected successively to the circuit in place of R_X. When, instead, the dial reads the resistance setting (R2) of the potentiometer (as is usual with modern 10-turn potentiometers), $R3 = R1 - R2$, and the unknown resistance is determined from a modification of the equation:

$R_X = [R2/(R1 - R2)]R_S$

where,

R_X is the unknown resistance,

R_S is the standard resistance,

R1 is the total resistance of the potentiometer,

R2 is the resistance setting of the potentiometer at null.

The slide-wire bridge has the advantage of simplicity, since it requires a minimum of parts. However, with a single-turn potentiometer of commercial grade, its resistance coverage with any given standard resistor (R_S) is restricted for accurate reading, to 100:1 (i.e., from $0.1R_S$ to $10R_S$—thus, 0.1-10 ohms, 10-1000 ohms, 1K-100K, etc). Also, the divisions tend to become crowded in some parts of the dial.

The Wheatstone Bridge

Many of the disadvantages of the slide-wire bridge are resolved by the modern Wheatstone bridge. This is the classic bridge for general-purpose resistance measurement.

Fig. 6A shows the basic Wheatstone circuit. In this arrangement, a rheostat, R3, has been substituted for the potentiometer of the slide-wire bridge. A dial attached to R3 reads directly the resistance setting of this rheostat. R1 and R2 are the ratio arms of the bridge. The unknown resistance, R_X, is connected to terminals X-X. At null, $R_X/R3 = R2/R1$, from which: $R_X = R3(R2/R1)$.

Thus, the setting of rheostat R3 simply is multiplied by the bridge ratio (R2/R1) to determine the value of R_X. In practice, various values of R1 and R2 are switched into the circuit to provide standard multipliers from X0.001 to X1000.

The total resistance of the rheostat usually is 10,000 ohms, but other values, such as 1000 or 5000 ohms, sometimes are used. A logarithmic taper for the rheostat winding provides a dial having uniform spacing throughout its range.

Fig. 6B shows a typical circuit of a practical Wheatstone bridge. Here, the rheostat has been replaced with a set of resistance decades (R9 to R48). This type of balance control allows closer settings and readings than are possible with a dial-calibrated rheostat; it covers the rane from 1 ohm to 11111 ohms in 1-ohm steps.

The bridge ratio is established by resistor R8 in combination with any resistor in the R1-R7 group selected by means of switch S1. At null, the resistance setting of the decades is mulitiplied by this ratio to obtain the unknown resistance, R_X. The multipliers provided are 0.001, 0.01, 0.1, 1, 10, and 1000; and these multipliers applied to the full resistance range of the decades (1-11,111 ohms) gives the bridge a measurement range of 0.001 ohm to 11.111 megohms.

Various commercial bridges use other methods of ratio-arm switching than that shown in Fig. 6B. In some instruments, for example, the ratio resistors are switched in pairs, rather than against single resistors such as R8.

The Megohm Bridge

Very high resistances (several megohms to several teraohms) may be measured with special bridges While the coverage of a standard bridge may be extended into the megohm range, the very high resistance standards required for each extension are usually less accurate than lower resistance ones, and the extreme division of voltage between at least two of the bridge arms demands

• *Please turn to page 58*

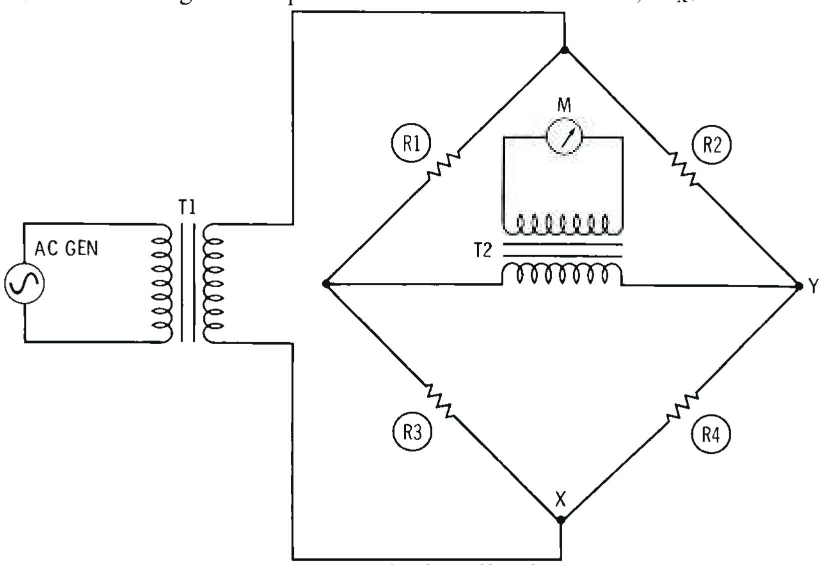
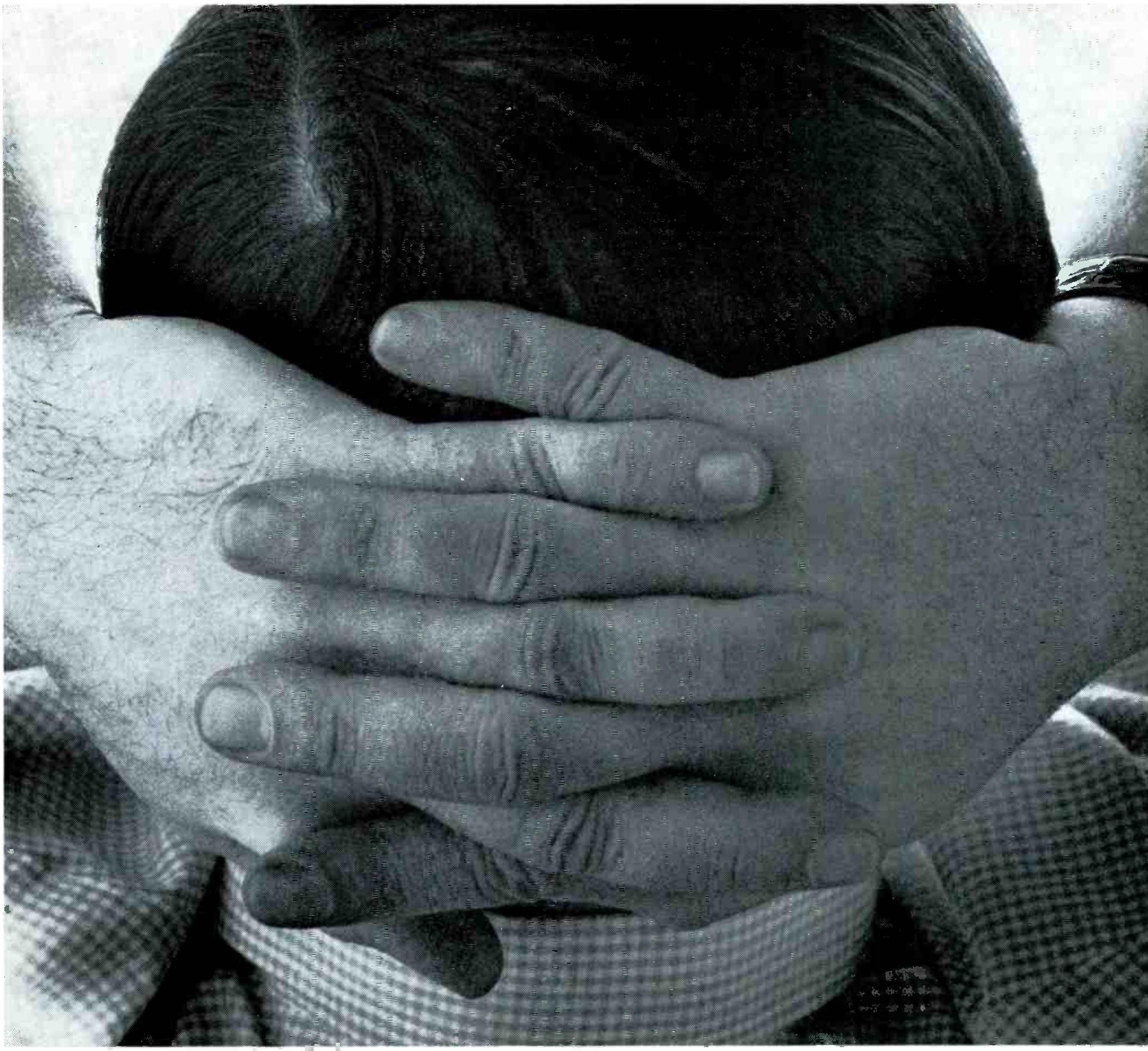


Fig. 8. The AC resistance bridge offers high sensitivity.



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2	32	62	92	122	152	182	212	242	272	302	332	362	392	422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872	902
3	33	63	93	123	153	183	213	243	273	303	333	363	393	423	453	483	513	543	573	603	633	663	693	723	753	783	813	843	873	903
4	34	64	94	124	154	184	214	244	274	304	334	364	394	424	454	484	514	544	574	604	634	664	694	724	754	784	814	844	874	904
5	35	65	95	125	155	185	215	245	275	305	335	365	395	425	455	485	515	545	575	605	635	665	695	725	755	785	815	845	875	905
6	36	66	96	126	156	186	216	246	276	306	336	366	396	426	456	486	516	546	576	606	636	666	696	726	756	786	816	846	876	906 Sept.
7	37	67	97	127	157	187	217	247	277	307	337	367	397	427	457	487	517	547	577	607	637	667	697	727	757	787	817	847	877	907 Sept.
8	38	68	98	128	158	188	218	248	278	308	338	368	398	428	458	488	518	548	576	608	638	668	698	728	758	788	818	848	878	908 Sept.
9	39	69	99	129	159	189	219	249	279	309	339	369	399	429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879	909 Sept.
10	40	70	100	130	160	190	220	250	280	310	340	370	400	430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880	910 Sept.
11	41	71	101	131	161	191	221	251	281	311	341	371	401	431	461	491	521	551	581	611	641	671	701	731	761	791	821	851	881	911 Sept.
12	42	72	102	132	162	192	222	252	282	312	342	372	402	432	462	492	522	552	582	612	642	672	702	732	762	792	822	852	882	912 Oct.
13	43	73	103	133	163	193	223	253	283	313	343	373	403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853	883	913 Oct.
14	44	74	104	134	164	194	224	254	284	314	344	374	404	434	464	494	524	554	584	614	644	674	704	734	764	794	824	854	884	914 Oct.
15	45	75	105	135	165	195	225	255	285	315	345	375	405	435	465	495	525	555	585	615	645	675	705	735	765	795	825	855	885	915 Oct.
16	46	76	106	136	166	196	226	256	286	316	346	376	406	436	466	496	526	556	586	616	646	676	706	736	766	796	826	856	886	916 Oct.
17	47	77	107	137	167	197	227	257	287	317	347	377	407	437	467	497	527	557	587	617	647	677	707	737	767	797	827	857	887	917 Oct.
18	48	78	108	138	168	198	228	258	288	318	348	378	408	438	468	498	528	558	588	618	648	678	708	738	768	798	828	858	888	918 Nov.
19	49	79	109	139	169	199	229	259	289	319	349	379	409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859	889	919 Nov.
20	50	80	110	140	170	200	230	260	290	320	350	380	410	440	470	500	530	560	590	620	650	680	710	740	770	800	830	860	890	920 Nov.
21	51	81	111	141	171	201	231	261	291	321	351	381	411	441	471	501	531	561	591	621	651	681	711	741	771	801	831	861	891	921 Nov.
22	52	82	112	142	172	202	232	262	292	322	352	382	412	442	472	502	532	562	592	622	652	682	712	742	772	802	832	862	892	922 Nov.
23	53	83	113	143	173	203	233	263	293	323	353	383	413	443	473	503	533	563	593	623	653	683	713	743	773	803	833	863	893	923 Nov.
24	54	84	114	144	174	204	234	264	294	324	354	384	414	444	474	504	534	564	594	624	654	684	714	744	774	804	834	864	894	924 Dec.
25	55	85	115	145	175	205	235	265	295	325	355	385	415	445	475	505	535	565	595	625	655	685	715	745	775	805	835	865	895	925 Dec.
26	56	86	116	146	176	206	236	266	296	326	356	386	416	446	476	506	536	566	596	626	656	686	716	746	776	806	836	866	896	926 Dec.
27	57	87	117	147	177	207	237	267	297	327	357	387	417	447	477	507	537	567	597	627	657	687	717	747	777	807	837	867	897	927 Dec.
28	58	88	118	148	178	208	238	268	298	328	358	388	418	448	478	508	538	568	598	628	658	688	718	748	778	808	838	868	898	928 Dec.
29	59	89	119	149	179	209	239	269	299	329	359	389	419	449	479	509	539	569	599	629	659	689	719	749	779	809	839	869	899	929 Dec.
30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870	900	930 Jan.

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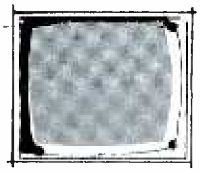
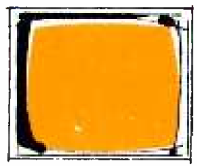
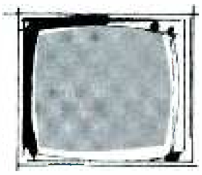
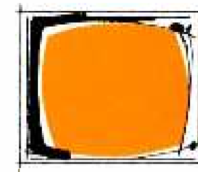



Now you see them, now you don't. Although many intermittent troubles appear to be related to the supernatural, you do not have to be a magician to cure them—simply follow the servicing methods outlined here.

BY DAVID HELD AND J. W. PHIPPS

A lot of valuable service time can be consumed in locating the defect that is causing an intermittent trouble symptom. Much of this time can be saved by employing a few test procedures that have proven particularly successful for uncovering intermittent defects. In the following paragraphs, we'll discuss those procedures, along with test equipment requirements and case histories of intermittent trouble symptoms.

Most service shops already possess the test equipment necessary for coping with intermittents: A VTVM or VOM for voltage and resistance measurements, an oscilloscope for waveform checking and monitoring, a signal generator for signal substitution, and a variable-voltage isolation transformer.

In addition to the normal test equipment, there are other gadgets and devices that can aid in the solution of an unusually difficult intermittent trouble. These aids will be mentioned next as we analyze the general test procedures for uncovering intermittent defects.

General Test Procedures

Nearly all intermittent defects fall into one of two categories: either the symptom appears immediately or shortly after the receiver is turned on, or it does not appear until the receiver has operated for an hour or longer. In either case, the first step is to localize the defect to a specific section or circuit by carefully analyzing the trouble symptom and then performing such troubleshooting functions as voltage and waveform checks, signal substitution, etc.

Although the customer may have given a detailed account of the trouble symptom, it is usually advantageous to witness the symptom(s) yourself before doing any troubleshooting. Often, a single detail that has been overlooked or left out of the customers description of the trouble symptoms can be the one that pinpoints the trouble. In any event, have a look yourself.

To save time and prevent unnecessary monitoring of intermittent defects that appear only after extended receiver operation, speed up the process by focusing a heat lamp on the chassis or suspected circuit area, or place a blanket over the cabinet while the receiver is operating. Either method will increase the ambient temperature of the circuitry and cause "premature" breakdown of a heat-sensitive component. Slow intermittent defects can also be speeded up or triggered by increasing the line voltage applied to the receiver—a function of the previously mentioned, variable-voltage isolation transformer. No matter which method you use, the primary purpose is to produce the defect so that you can analyze the sympton(s) and, thus, more accurately localize the cause of the trouble to a specific section or circuit. If necessary, supplement your analysis with signal tracing (scope is best) and/or signal substitution (signal generator).

Once you have tentatively localized the trouble to one particular section or circuit, you may wish to add weight to your conclusion by performing a few preliminary comparative voltage and/or waveform checks within the suspected section or stage before attempting to isolate the trouble to a specific component. Obviously, when dealing with intermittent defects that appear almost immediately after the receiver is turned on, you must perform measurements very quickly before the defect occurs. Once the trouble symptoms appear, perform the same voltage and/or waveform checks again; then compare the "before" and "after" measurements, carefully noting the implications of any differences in the readings.

Concurrent with voltage and/or waveform checks, perform a quick but thorough visual examination of the suspected section or circuit looking for obvious indications of trouble such as burned resistors, loose wires, poor solder connections, leakage from electrolytics, etc. Also, be alert for the usual odors asssociated with the failure of such components as selenium rectifiers, thermistors, transformers, etc.

Assuming that you have accurately localized the intermittent defect to one particular circuit, you are now ready to isolate the trouble to the defective component. This can occasionally be accomplished by voltage and resistance measurements alone; however, such readings normally only confirm that the defect lies within a specific circuit, leaving more than one component as the possible suspect. Also, in many instances, the application of the VTVM or VOM probe to the circuit will temporarily "cure" the intermittent, thus hiding it. Although the scope will disturb the circuit conditions less than the VTVM or VOM in most situations, it too can only confirm that you are searching for the defect within the correct circuit. At this point you can replace all suspected components in the circuit, or further isolate the defective component by applying the techniques discussed in the following paragraphs.

Capacitors

Probably the most effective method for pinpointing a defective capacitor is to either heat or cool the capacitor within the circuit—the choice depending on whether or not the trouble symptom is present. If the trouble symptom is present, applying some form of cooling mist

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to the suspected capacitor will cause the symptom to disappear if the capacitor is heat-sensitive and actually intermittently defective. If the trouble symptom is not present, applying the heat of a soldering iron near the suspected capacitor will produce the symptom if the capacitor is the culprit causing the trouble. Of course, care must be exercised so that excessive heat does not destory capacitors that were *not* originally defective. Suspected electrolytic capacitors should be replaced with a known good capacitor and the receiver then operated under controlled, excessive ambient temperature for a short period of time. If you have selected the correct defective electrolytic, the trouble symptom will not reappear.

Resistors

Intermittently defective resistors can best be uncovered by measuring the voltage across them and then calculating the resistance using Ohm's law (provided the current is known). If the current in the circuit is not known, an alternate method is to turn the receiver off after the trouble symptom has appeared and quickly check the value of the resistor before it cools down. Open or increased values are the most common intermittent defects displayed by resistors.

Tubes and Transistors

Intermittent defects within tubes can be uncovered by checking the tube in a mutual conductance-type tube tester. This usually involves monitoring the testing for a period of time. Emission-type tube testers are useful only for uncovering intermittent shorts. It is much quicker to substitute the suspected tube and then "cook" the receiver.

Perhaps the quickest check of a suspected intermittently defective transistor is to connect it to an in-circuit transistor tester while the trouble symptom is present (many times this will cause the symptom to disappear, thus quickly pinpointing the trouble). Switch the function switch to "AC Beta" and monitor the meter reading while applying cooling mist to the transistor. Either the meter reading will change drastically toward a high beta reading, or the trouble symptom will disappear. Both results indicate that the transistor is defective and should be replaced. An out-of-circuit transistor tester and cooling mist can be used in the same manner (Fig. 1) except, of course, you don't have the double (and more positive) check of the actual trouble symptom disappearing while the meter reading changes.

Often, while trying to localize the intermittent trouble to a section or stage, touching the generator lead to a transistor's base will cause the trouble symptom to disappear. In many instances this can indicate a bad transistor, while in others it merely confirms a bad component in the transistor base circuit. The same results are obtained when a scope probe is applied to the element of a transistor.

Transformers

Defects related to IF transformers can usually be isolated by careful probing and/or wiggling of the wiring lugs and shield can while monitoring voltage and/or resistance readings. Of course, in some cases such careful manipulations can also cause the trouble symptom to to disappear, thereby pinpointing the actual defect without the aid of voltage or resistance readings.

With other type transformers, troubleshooting for intermittents is usually limited to voltage and/or resistance checks and close visual inspections supplemented by careful probing of terminal connections, etc. Any suspected solder joints and connections should be resoldered, paying particular attention to those on printed-circuit boards.

Fig. 1. Set up for checking intermittent transistor.

Case Histories

The foregoing paragraphs have been devoted to a general discussion of intermittent defects. Now, let's direct our attention to more specific problems by reviewing a few case histories.

Intermittent Radio

Mr. Allen, a gray-haired retired railroader, set the clock radio down on the shop counter and bellowed "They just don't build these things the way they used to. I remember when you could buy one that . . . ."

Not wishing to hear Mr. Allen's often-repeated tales of the "good ole bargain days," shop owner Ed Staggley interrupted him with "What's the trouble with your radio Mr. Allen?"

"If I knew what was wrong with the thing, I'd open up an establishment down the street and run you out of business," retorted Mr. Allen, with a twinkle in his gray eyes that betrayed his joy at poking barbs at Ed. "I was listening to the 6 o'clock news and the thing just went dead. I fiddled around with the knobs, banged on it a couple of times, and the silly thing came back on and then went off again. You know how these mass-produced things carry on. It's gettin' so . . . ."

"You've probably been listening to too much of that 'rock' music" interjected Ed with a chuckle. "Did the pilot light go out when the sound quit?"

"Yes, I believe it blinked off and on. Say how much is this thing going to cost me? I didn't pay much for it to begin with and I'm not figgerin' on . . . ."

"I'll try to keep the damages below forty or fifty dollars," laughed Ed. "I know how you hate to let go of the moldy green stuff you got stashed away in those fruit jars."

Mr. Allen grunted something about wild rumors and asked if Ed thought he'd be able to muster up enough ambition to have the thing fixed by five o'clock.

Ed replied he'd try, and Mr. Allen left after stating he'd phone around four to make sure it was fixed.

Ed carefully laid the AC-DC radio down on a drop cloth and contemplated the problem while he removed the chassis from the cabinet. From his conversation with Mr. Allen, he had received two clues to the trouble: (1) The receiver went dead suddenly, and (2) the pilot light blinked off and on. Although several components could cause the same intermittent sound symptom, the blinking pilot light narrowed the possibilities down to the series heater string that also supplied voltage to the pilot light. One of the tubes had a filament that was opening and closing.

After removing the Admiral 5E3 chassis from the cabinet, Ed turned it over so he could get to the tube socket connections. Next, he connected power to the chassis and turned it on. Most thermal-heater intermittents open at once, or in only a very few minutes. Sure enough, all tube filaments and the pilot light went out in a short time. Using a VOM, Ed started at the tube having the highest filament voltage—in this case a 50C5—and measured across each filament (Fig. 2). When he placed the meter leads across the 12AV6 filament, the meter indicated the full AC line voltage—a sure indication of an open filament. After replacing the 12AV6, the receiver returned to normal operation.

The quick repair of Mr. Allen's radio contrasted with another intermittent situation Ed had recently had the misfortune of experiencing. The trouble had begun with a call from a customer who complained that the set (an Admiral 20X5B chassis) Ed had fixed with a damper tube replacement a couple of days ago had suddenly developed the same symptom: increasingly reduced width that finally resulted in a black raster.

So Ed had obligingly returned, checked the set out and decided to pull the chassis for a bench check at the shop. Back at the shop, the chassis had refused to display any trouble symptoms whatsoever. Three days went by and the thing just sat there and stubbornly acted normal. Meanwhile, the customer had developed a telephone dialing habit and constantly pressured Ed for information concerning the status of the set.

At this point, Ed decided to give the problem a little mental exercise. It wasn't long before Ed was tripping off to the customer's house to retrieve the cabinet. With the chassis reinstalled in the cabinet and a blanket thrown over the whole thing, the raster turned black within four hours.

Peeking under the blanket, Ed discovered that the 6AX4 damper tube was as dark as its immediate environment. A new damper tube was installed in place of the seemingly defective 6AX4, the blanket was removed, and within three minutes the receiver was operating normally once again.

However, Ed's mood of satisfaction began to dwindle when the supposedly defective 6AX4 checked normal in the tube tester—even with the filament supply increased to 8 volts. Obviously, the tube was good.

Ed replaced the blanket over the operating receiver and occupied himself with converging a recently repaired color set. Having completed the convergence procedure and repaired two b-w receivers, Ed returned to the blanket job. He wasn't too surprised to see a dark raster again. Nor was he surprised to see the new 6AX4 dark when he lifted off the blanket. However, Ed did experience surprise when he wiggled the 6AX4 and witnessed a slight flickering of the filaments. After removing the tube from the chassis and the chassis from the cabinet, he inspected the heater pins on the socket. Both appeared normal, with good solder connections. That left only the tube socket itself. Sure enough, after the damper tube socket was replaced, the set cooked for two days without the old dark-raster symptom reappearing.

When an open tube filament appears to be the cause of an intermittent trouble, but the tube checks normal, don't overlook the tube filament pins—corrosion or arc scars can cause intermittent symptoms. It is also possible for solder to melt out of the tube pin holes. Replacing the tube may temporarily solve the problem. Also, don't overlook the socket pins themselves. Replace the socket if in doubt. It can save you a costly call back. Remember: low-voltage rectifiers, dampers, and horizontal output tubes usually provide the most tube-to-socket intermittent troubles.

Intermittent Sync

From the preceding paragraphs, it is obvious that Ed Staggley has had his share of intermittent problems. Let's have a look at a few more and see how he handled them.

One involved an RCA CTC16XA color chassis that appeared to exhibit either intermittent sync or AGC trouble. First, the raster would pull horizontally, and then break into a vertical roll. Sometimes large black horizontal bars would roll vertically through the picture. Replacing the triode-pentode 6KA8 that served the AGC keying, noise inverter, and sync separator functions cured the

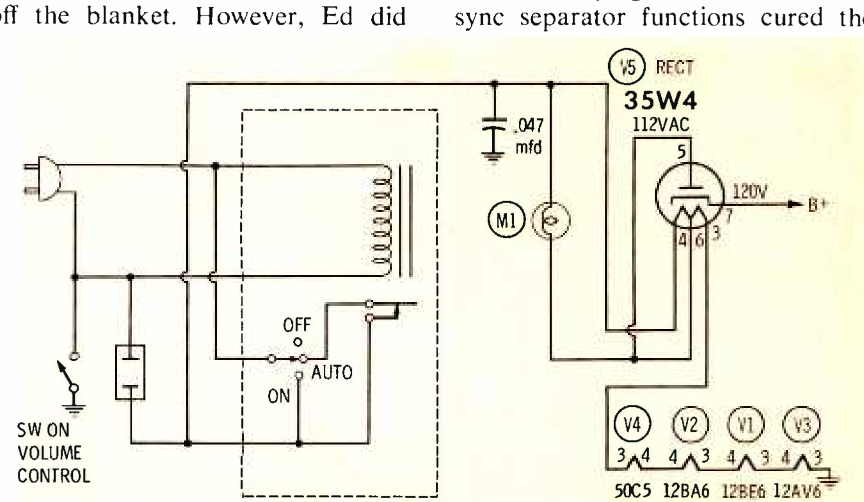

Fig. 2. Partial schematic of clock radio that suffered intermittent filament.

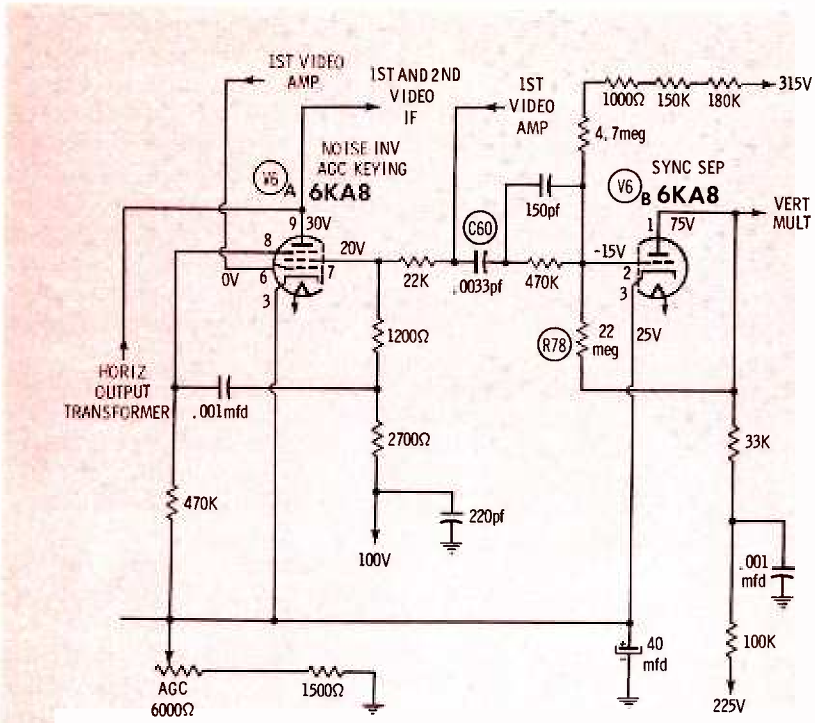

Fig. 3. Heat sensitive capacitor caused intermittent defect.

sync problem for a few minutes, then the same old symptoms returned for approximately three minutes. Ed decided to remove the chassis for a shop checkout.

Upon arriving back at the shop, Ed immediately checked the voltages on the 6KA8 (Fig. 3). However, all voltages were within normal tolerance of those indicated on the PHOTOFACT. Using the variable-voltage isolation transformer, Ed attempted to trigger the trouble symptom by increasing the line voltage; however, this failed to produce even a slight pull or roll. So Ed decided to let the thing cook until the symptom returned; meanwhile, he focused his attention on the small backlog of ailing sets whose owners were missing out on all the summer reruns.

Four days passed before the intermittent symptom popped up again. But Ed was ready with the VTVM and quickly took some voltage readings on V6 while the symptom was present. All voltages on V6A, the AGC section, were normal. However, the readings on V6B were significantly abnormal. The reading on the plate, pin 1, was 50 volts—down 15 volts from that listed in PHOTOFACT. Pin 2, the control grid, indicated a positive 22 volts instead of the normal −15 volts. The cathode voltage was the only element voltage of V6B that measured normal.

Checking over the schematic (Fig. 3) Ed reasoned that the most probable cause for the high positive voltage on pin 2 of V6B was either a change in the value of R78 or a leaky C60. Ed unsoldered one end of R78 and checked the resistance; it was within tolerance—no help there. Next, Ed disconnected the sync separator side of C60 from the circuit and applied a VTVM between the open end and ground—no reading. Leaving the VTVM connected, Ed held a heated soldering iron near the capacitor—the meter reading gradually climbed to a high positive voltage, indicating that C60 was breaking down (leaking) under heat. As a double check, Ed resoldered C60 and R78 back into the circuit and then, once again, held the heated soldering iron near C60. Sure enough, the raster lost both horizontal and vertical sync. Ed replaced C60, and the receiver was returned to the customer—who was overjoyed at being able to once again view the reruns.

Intermittent Ford Radio

We'll continue Ed Staggley's experiences with intermittent problems by relating an encounter he had with a Ford Model 6TBF car radio.

The customer, a traveling salesman who lived near Ed's shop, came into the store one morning and stated that the radio in his car was behaving sort of funny (as he put it). "Every once in a while the thing just goes off and stays off for two or three hours," he explained. "Then, just as suddenly, the thing will come back on."

Ed asked if the radio was in a playing mood at the present time.

"No. It quit about an hour ago."

Ed went out to the car, slid across the seat and turned the receiver's on-off control to the on position; as he did so, a loud thump was heard in the speaker. When he rotated the volume control, the barely audible rushing noise in the speaker changed in intensity. Both checks—the thump and the changing noise—indicated that the receiver's audio section was operating properly.

Next, Ed performed a few preliminary checks of other suspected items, including the antenna lead-in connection. When nothing appeared wrong externally, Ed decided to pull the radio out for a bench check. The customer agreed to this course of action, and once Ed had the radio out, left to continue his business.

• *please turn to page 50*

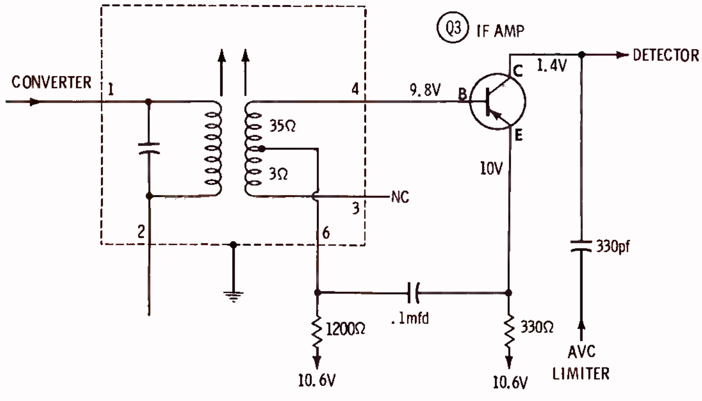

Fig. 4. Defective IF amplifier stage in Ford Model 6TBF car radio.

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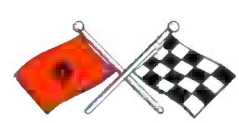

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CHROMA CIRCUITS

Burst Amplifier
Reference Oscillator
Difference Amplifier
Demodulators
Color Killer

Since the function of the chroma bandpass amplifier (or amplifiers) is simply one of increasing the level of the chrominance signal, there is very little to be said about it. The bandpass considerations were discussed in Part 4 of this series. The means by which it is gated by the color killer and controlled by the ACC circuit were covered in Parts 4 and 5.

Malfunction in the chroma bandpass amplifiers will normally result in insufficient color or no color at all. If the gain of the amplifier is reduced, color saturation will be decreased; if the amplifier fails completely, there will be a complete loss of color. Improper alignment of the amplifier will cause color smearing or "grainy" color, but alignment problems are more likely to be the result of tampering than drift. Realignment should be attempted only if the necessary test equipment is available. "Eyeball" alignment will usually result in further degradation of picture quality.

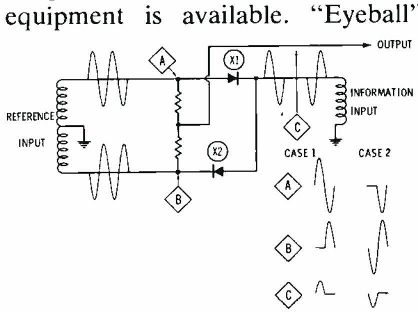


Fig. 1. Simplified phase-sensitive detector using diodes.

Diode Chroma Demodulators

In essence, a chroma demodulator is simply a phase-sensitive detector —no more, no less. Although phase-sensitive detectors (PSD) have been used in the majority of b-w receivers built in the past 20 years, the use of a pair of phase detectors to extract the color-difference signals from the chroma sidebands seems to excite a great deal of interest. Thus, a thorough discussion of each of the four popular types of chroma demodulators is included here. Since the circuit which utilizes diodes is perhaps the most easily explained, we will begin this discussion with it.

Fig. 1 shows a simplified phase-sensitive detector and associated waveforms. The input from the reference transformer is constant, while the phase of the information input varies. Cases 1 and 2 show the information signal at two possible phase angles. In case 1, diode X1 cannot conduct since the instantaneous cathode and anode voltages are equal throughout the cycle. Consequently, the voltage at point A is a simple sine wave whose first excursion is positive.

During the first half of the cycle, X2 conducts because its cathode is negative with respect to its anode, and the instantaneous voltage at point B is equal to the sum of the two applied voltages. These are equal in amplitude, but opposite in polarity; the potential at point B is 0 during the time that X2 is conducting. During the second half-cycle, X2 is cut off because the cathode is positive with respect to the anode. The voltage at point B is the positive excursion of a sine wave.

The voltage at point C, the output, is the sum of the instantaneous voltages at points A and B. During the first half of the reference sine wave, the voltage at point A completes a positive half-cycle while the voltage at point B is clamped to zero. Therefore, the voltage at point C is a positive half-cycle having an amplitude equal to one-half the amplitude of the half-cycle at point A. During the second half of the sine wave, the voltages at points A and B are equal in amplitude but of opposite polarity, and the voltage at point C is zero. Thus, if the input signals are in phase, the circuit func-

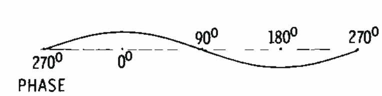


Fig. 2. Typical output curve for a phase-sensitive detector.

tions as a half-wave rectifier with a positive output.

Case 2 shows the instantaneous voltages that are present when the information signal is 180° out of phase with the reference signal. Now it is X2 which never conducts, and X1 acts as a half-wave rectifier. But, X1 is connected in the opposite polarity from X2, so its output is negative instead of positive. Thus, if the input signals are out of phase, the circuit functions as a half-wave rectifier having a negative output.

Additional waveforms to show the output of the PSD for intermediate phase relationships could be included, but they add little to the discussion. Instead, Fig. 2, showing the output for various phase relationships, is presented. Notice that the curve has the form of the familiar sine wave.

The polarity of the output from a PSD may be reversed by two means: reversing the diodes or reversing either of the transformers that supply the signals. Another characteristic which is of particular interest is this: With the exception of the positive and negative maximums, any output amplitude (including zero) may be the result of two different phase relationships. These statements become meaningful when the PSD we have been discussing is renamed a chroma demodulator and placed in a TV set.

Since the phosphors used in a color CRT are red, blue, and green, a minimum amount of circuitry will be used if one demodulator produces a maximum output when a red chroma signal is received. If we arrange the circuits preceding the demodulator so that a chroma signal representing red reaches the demodulator *in phase with the reference signal,* we have a red (R−Y) demodulator. (The red axis is at 76.6° and the R−Y axis is at 90°. This discrepancy is more apparent than real since the color difference amplifiers shift the axis slightly and also because the various red phosphors in use have slightly different colors. Depending on these variables and the position of the "tint" control,the true axis of operation of the R−Y demodulator may be any angle from, perhaps, 60° to 120°).

In actual practice, the R−Y demodulator of a TV receiver may be followed by an amplifier. This inverts the signal so that the R−Y demodulator output must be maximum negative, instead of maximum positive, to produce red on the CRT. To be absolutely correct, we must refer to an R−Y demodulator followed by a difference amplifier as a −(R−Y) demodulator.

A second demodulator might well be connected so that its maximum outputs occur when the chroma signal is "all blue" and "no blue." Notice that we may cause this demodulator to have either a positive or negative output (for an "all-blue" signal) merely by reversing the phase of the reference signal.

Fig. 3 shows the chroma demodulators and difference amplifiers of the General Electric HC chassis. Consider the R−Y demodulator. The phases of the two inputs are such that a "red" (R−Y) chroma signal produces a negative output. This output is fed to the R−Y color-difference amplifier where it is amplified and inverted. The output from the R−Y difference am-

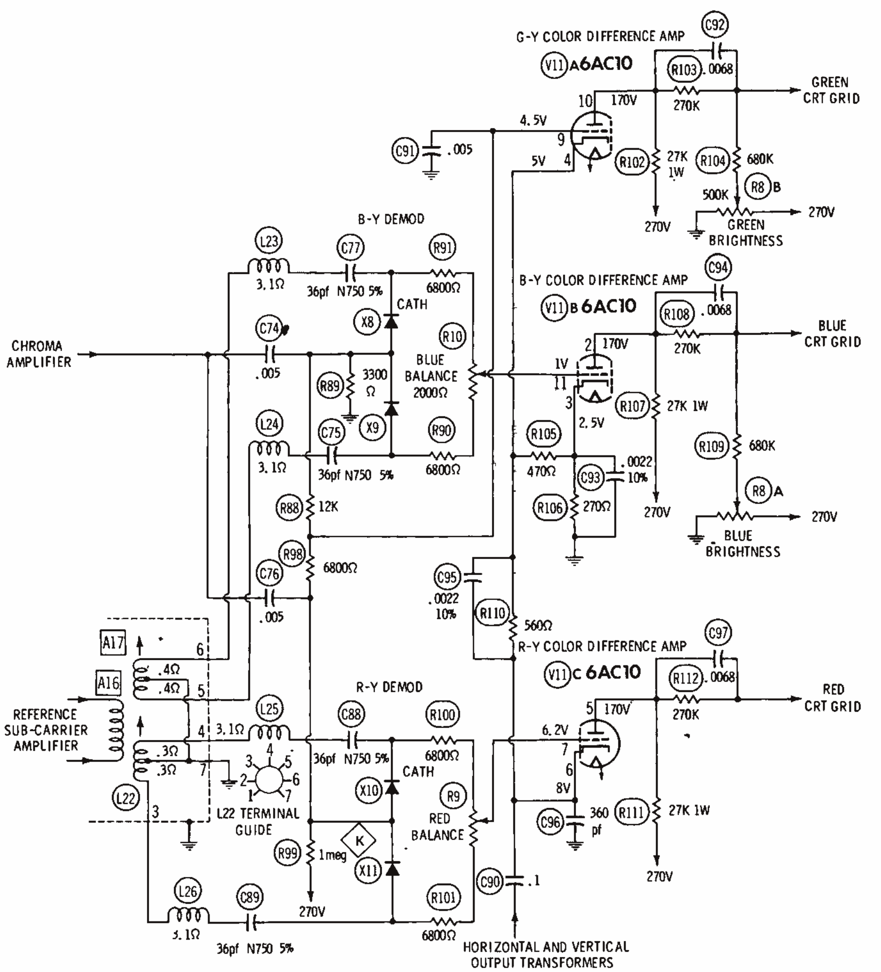
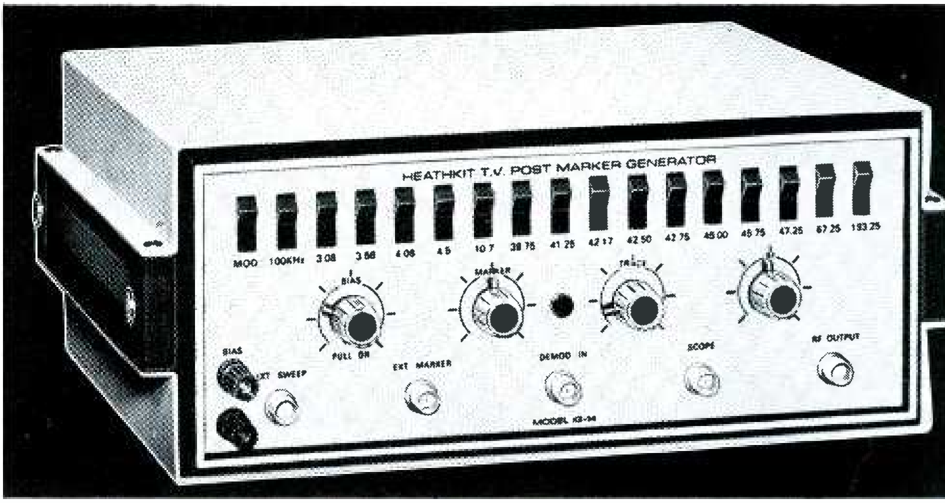


Fig. 3. Chroma demodulators and color-difference amplifiers of the General Electric HC Chassis.



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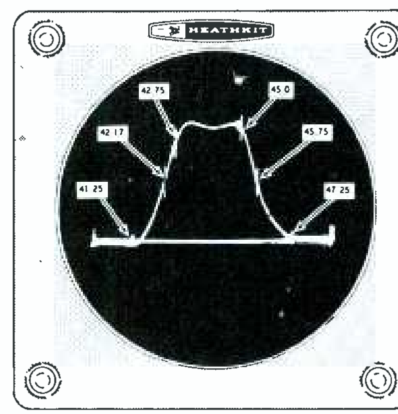
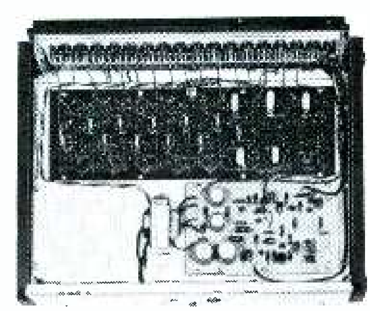


SIX MARKERS SIMULTANEOUSLY. The scope trace above shows how six markers can appear at the same time. Note the trap markers, 6 dB points, and picture and sound carriers . . . all on one trace with the IG-14.



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plifier is the R−Y signal which is fed to the red control grid of the CRT gun.

The B−Y demodulator is identical to the R−Y demodulator but the phase of the reference signal has been changed. In the B−Y demodulator, a "blue" (B−Y) chroma signal produces the maximum negative output. This is amplified and inverted in the B−Y color-difference amplier and finally appears as a positive signal at the blue grid of the CRT, turning on the blue gun and causing a blue field.

It was stated previously that a specific amplitude and polarity of output from a demodulator may be the result of either of two phase relationships. For example, observe from Fig. 2 that phase relationships of 160° and 200° each produce a negative output which is 94% of the 180° output. However, since the reference signal applied to the B−Y demodulator is shifted 90° from the reference signal at the R−Y demodulator, the 160° signal at the R−Y demodulator becomes a 70° signal at the B−Y demodulator. Again referring to Fig. 2, this signal will produce an output from the B−Y demodulator which is positive with an amplitude that is 34% of maximum. By the same token, the 200° signal at the R−Y demodulator becomes a 110° signal at the B−Y demodulator, and a negative output with an amplitude which is 34% of maximum is produced.

From the above, it is apparent that even though two chroma signals having different phase angles can produce the same output from a single demodulator; when these same chroma signals are fed to the second demodulator, they cause radically different outputs. Therefore, any phase of chroma signal may be described in terms of the outputs it produces from the two demodulators. Stated another way, two demodulators are sufficient to extract all of the color information from the chroma signal.

In spite of this, three color difference signals are necessary to operate the color CRT because the colors from three phosphors are required to produce all the visible hues. There are two methods of producing control voltage for the excitation of the third phosphor. A third demodulator operating on the color axis of the third phosphor (green) may be used, or this voltage may be derived from the outputs of the R−Y and B−Y demodulators. This latter method is more popular although the former method is often used.

The generation of the G−Y signal by combining portions of the R−Y and B−Y signals is the method used in the General Electric HC chassis shown in Fig. 3. Since the signals at the plates (pins 5 and 2) of V11 are the R−Y and B−Y color-difference signals, respectively, the grid signals of these two triodes are the −(R−Y) and −(B−Y) signals. These signals also appear at the cathodes of the respective triodes since C96 and C93 have significant impedance at the frequencies contained in the color difference signals. (At .5 MHz, C93 has an impedance of 145 ohms.)

In part 1 of this series it was stated that

$$G-Y = -.51(R-Y) - .19(B-Y)$$

Thus, by combing suitable portions of the cathode signals of V11B and V11C, a G−Y signal is fed to the cathode of V11A. Since the V11A is operated as a grounded-grid amplifier, there is no inversion and the G−Y signal at its plate may be connected directly to the green grid of the CRT.

Since the cathode-to-ground resistance of each section of V11 is different, the bias present on each cathode is also different. To develop the desired bias on each section of V11, the grids are returned to a bias-bleeder network, consisting of R89, R88, R98, and R99, which is connected between ground and the B+ supply.

R8A and R8B are the blue and green brightness controls, respectively. Since the red phosphor is the least brilliant, the red grid is operated at the maximum positive potential and no adjustment is required. R8A and B are used to set the blue and green conduction to produce reference white.

Blanking of the CRT during horizontal and vertical retrace is accomplished by the signals fed through C90 to the cathodes of V11. These signals are negative pulses taken from the horizontal and vertical output transformers. Since there is no signal inversion in a driven-cathode amplifier, the amplified pulses at the plates of V11 are negative and cut off the three guns of the CRT.

Low-Level Triode Demodulators

Any attempt to prove that the use of the diode phase-sensitive detector is inferior or superior to the use of amplifying devices in a phase-sensitive detection system is inconclusive. Each system has inherent advantages and limitations. The use of amplifying devices (tube or transistor) has the advantage that some gain is contributed to the system, but increased complexity and lowered gain-stability is the price of this amplification. Similar arguments apply in choosing from among the various types of amplifying detectors: triode, pentode, sheet-beam, and twin-pentode. The use of transistorized demodulators offers some interesting possibilities, although no such circuits were used in the 1967 and early 1968 product lines that we examined.

The demodulator and difference-amplifier circuits used in the Philco 17QT85A chassis are shown in Fig. 4. Although pentodes are used as demodulators, they are connected as triodes, the plates and screens being tied together. Fig. 5 is a plot of the combined plate and screen currents of the pentode section of a 6BL8 when it is connected as a triode. The circuit used in developing the curve was quite similar to the Z demodulator of Fig. 4 although bias was applied to the grid instead of the cathode. This has the effect of increasing the plate potential 8 volts, which effectively increases the steepness of the curve a slight amount.

In the Z demodulator (V14A of Fig. 4) the reference signal which drives the cathode has a p-p amplitude of 4.5 volts. In the absence of any other signal, the conduction of V14A and V15A produces a positive bias of 8 volts on each tube. Since this is the approximate cutoff bias of the tubes, V14A conducts

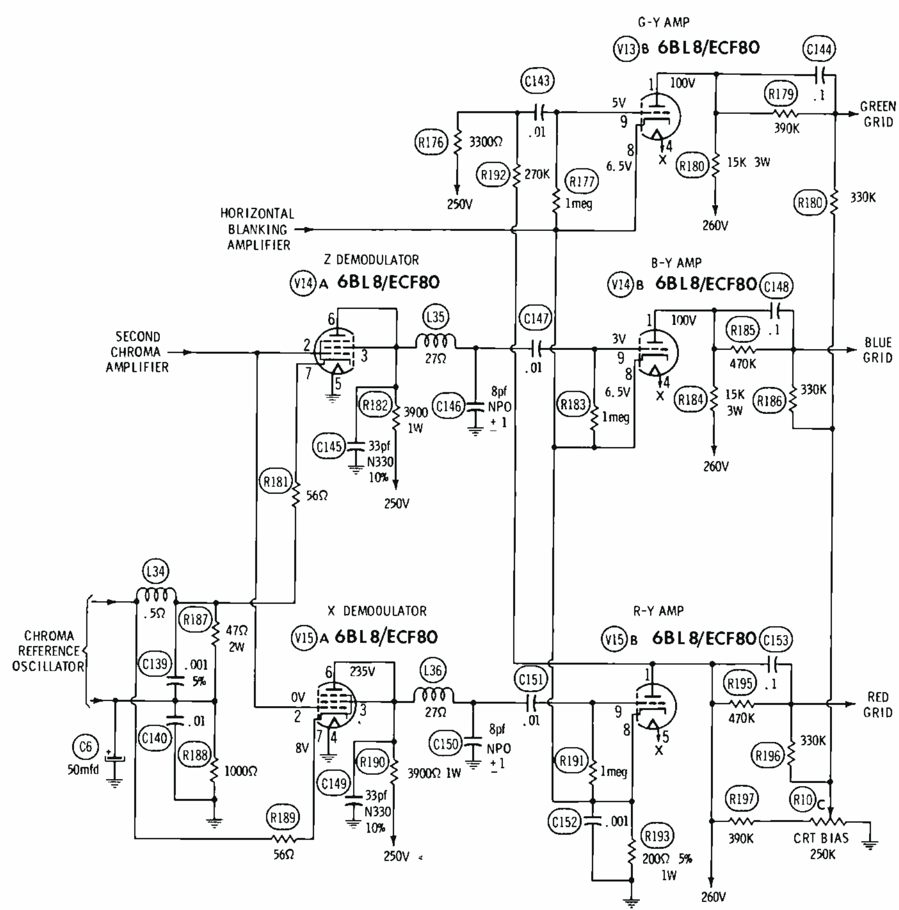


Fig. 4. Chroma demodulators and color-difference amplifiers of the Philco 17QT85A chassis.

only during the negative half-cycles of the cathode signal. At the instant when the reference voltage is peak negative, the tube bias is reduced to 3.5 volts and the tube current is about 8.2 ma. The unfiltered plate waveform would consist of negative-going half-cycles. However, the pi filter (C145, L35, and C146) integrates the pulses, and the voltage at the output of the pi filter is at a DC level of 235 volts.

When a chroma signal is fed to the grid of V14A, the instantaneous current is determined by the instantaneous grid-cathode voltage. This voltage is the sum of three potentials: (1) the cathode bias, (2) the instantaneous reference-signal voltage, and (3) the instantaneous chroma-signal voltage. For example, if the chroma and reference signals are 180° out of phase, the control grid is nominally 1.25 volts positive at the same instant that the cathode potential is + 3.5 volts (bias less the peak reference signal of 4.5 volts.) Thus, the total grid-cathode voltage is −2.25 volts. From Fig. 5, the tube current is about 12.7 ma at this instant. This is an increase of about 4.5 ma from the peak current with no chroma signal applied. After a number of cycles of voltage, the plate voltage will stabilize at a new voltage which is less positive than it was when no chroma signal was applied.

In the example just cited, the instantaneous peak tube current reaches its maximum value. The minimum instantaneous peak current may be approximated by considering the effect on tube conduction of in-phase chroma and reference signals. In this case, the grid is maximum negative at the same instant that the cathode is maximum negative (minimum positive) and the instantaneous grid-cathode potential is −4.75 volts. Again referring to Fig. 5, the current is approximately 4.5 ma. A third condition which is easily described is the 90° or 270° phase relationship. In this case, the chroma signal is passing through zero when the reference signal is maximum negative, and the peak tube current is the same as if no chroma signal were applied, 8.2 ma.

From the above examples, we find that the maximum and minimum instantaneous peak tube currents are 12.7 and 4.5 ma, respectively. Since the plate load resistor is 3.9K ohms in the actual circuit of Fig. 4, the swing in plate voltage may be predicted to be 32 volts. Since the chroma reference-signal amplitude at the grid of V14A is 2.5 volts, p-p, during normal operation with a keyed-rainbow generator as a signal source, the predicted "gain" is 12.8. Actual observations showed this "gain" to be 10.

Bear in mind that the above examples are an oversimplification of the operation of the circuit since only the instantaneous peak currents were considered. In actual practice, the tube conducts throughout approximately 180° of the reference-signal sine wave, and the magnitude of the current may be represented by the positive half of a sine wave. Nevertheless, we can conclude that the tube conduction is proportional to the sum of the instantaneous amplitudes of the reference signal and chroma signal during the intervals when the tube is out of cutoff. In the circuit of Fig. 4, these intervals correspond to the negative half-cycles of the reference signal. The operation of the X demodulator of Fig. 4 is similar to that of the Z demodulator just described.

Now, consider the operation of the two demodulators if the signal source is an unkeyed-rainbow generator. Using an unkeyed-rainbow signal, there is a constant rate of change of phase difference between the chroma signal and the reference signal. Since the chroma signal is fed to both demodulators at the same phase angle, the outputs of the two demodulators differ in phase by the same amount as the phase difference of the reference signals applied to the two demodulators. In a system using X and Z demodulation, the phase of the reference-oscillator signal applied to the two demodulators differs by 63.9°. Observations of the outputs of the two demodulators when an unkeyed-rainbow generator is used as a signal source confirm that the sinusoidal output of the Z demodulator passes through zero about 64° later than the output of the X demodulator passes through zero.

The operation of the color-difference amplifier shown in Fig. 4 is typical of most color-difference amplifiers used in conjunction with low-level, vacuum-tube demodulators. The difference signals from the demodulators are coupled through C147 and C151 to the B−Y and R−Y amplifiers, respectively. These signals are amplified and fed to the respective control grids of the CRT.

Notice that there are two apparent discrepancies in the foregoing discussion. First, since the signals at the red and blue control grids of the CRT are R−Y and B−Y respectively, the signals at the inputs to the difference amplifiers must bear the negative sign, −(R−Y) and −(B−Y) Hence, the demodulators are actually −X and −Z demodulators. However, it is common practice to ignore this reversal of polarity.

Also observe that while the demodulators operate on the X and Z axes, the difference amplifiers operate on the R−Y and B−Y axes. Although this seems unlikely, it is actually the case. Since the difference amplifiers have a common cathode circuit, a portion of the −Z signal which is fed to the B−Y amplifier appears at the cathode of the R−Y amplifier and vice versa. Thus, a small portion of the −Z signal is added vectorially to the −X signal, shifting the true axis of the difference amplifier to R−Y. Also, a portion of the −X signal is added vectorially to the −Z signal in the B−Y amplifier to establish its true axis.

The means of deriving the G−Y signal is similar to the method described in the explanation of the General Electric circuit. In the circuit of Fig. 4, an additional portion of the R−Y signal is fed from the plate of V15B to the grid of V13B where it is added to the −(R−Y) signal being fed to the cathode of V13B. A sample of the −(B−Y) signal is also fed to the cathode of V13B. The total of these three signals produces a voltage at the plate of V13B which is −.51 (R−Y) −.19(B−Y), equal to G−Y.

Low-Level Pentode Demodulators

The operation of a low-level pentode demodulator is quite similar to the triode demodulator just discussed. The demodulator circuit used in Packard-Bell Chassis 98C15 is shown in Fig. 6. The 6GY6 tubes used as demodulators belong to the family of tubes having two independent control grids. That is, both the suppressor grid and the control grid have considerable effect on the plate current.

The plate current of V18 and V19 are controlled by the instantaneous values of chroma and reference signals and detection takes place at the plate of the tube. The operation of the color-difference amplifiers is essentially the same as the ones discussed previously.

Sheet-Beam Demodulator

The sheet-beam demodulator used in Zenith receivers is actually

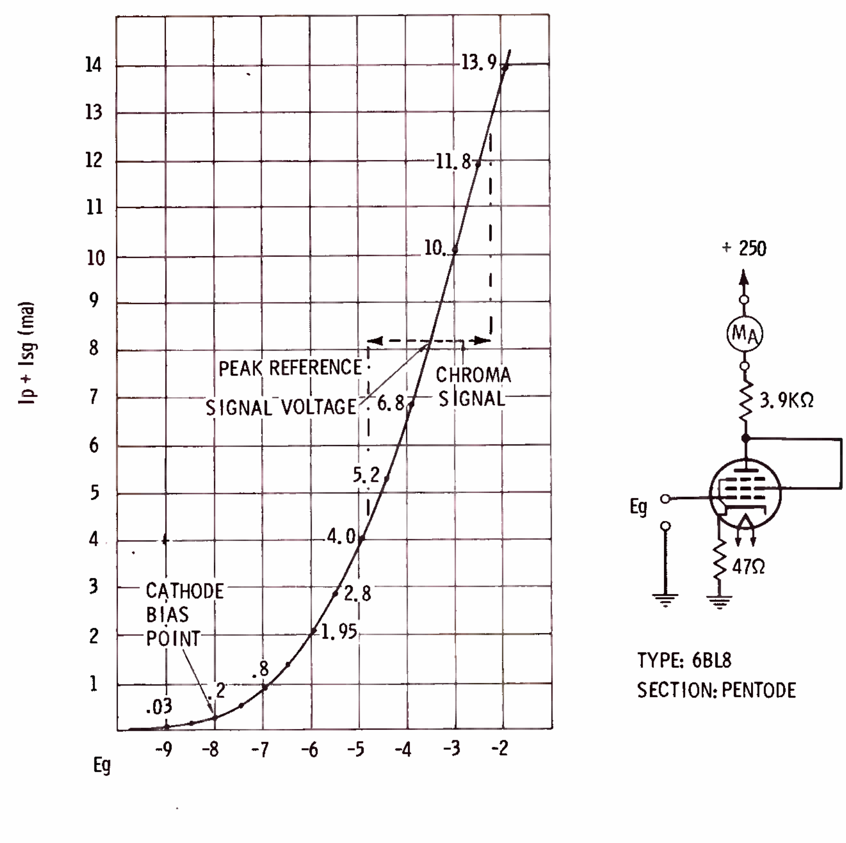


Fig. 5. Characteristics of the 6BL8.

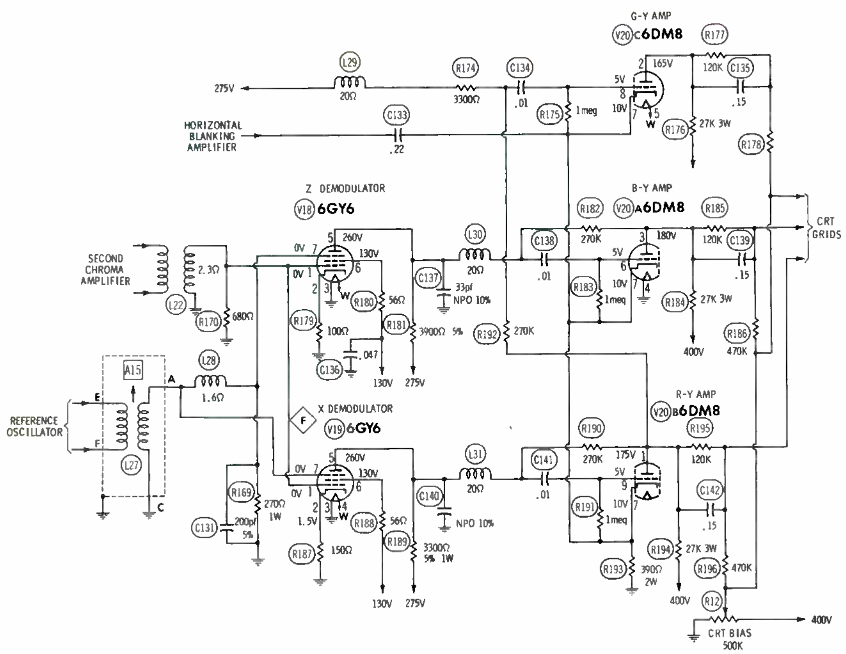


Fig. 6. Chroma demodulators and color-difference amplifiers of Packard-Bell Chassis 98C15.

a variation of the pentode demodulator. However, there are two significant departures from the conventional design. Since the amplitude of the output from sheet-beam demodulators is sufficient to drive the CRT directly, they are known as high-level demodulators. The more important difference is the means by which detection of the chroma signal is accomplished. In the triode and pentode circuits just discussed, the amount of cathode current is controlled jointly by the chroma and reference signals. In the sheet-beam demodulator, cathode current is controlled solely by the chroma signal, but the selection of which plate receives the current is controlled by the reference signal.

Fig. 7 shows the demodulators used in the Zenith 24MC32 and 42 chassis. Consider the B − Y demodulator under no-signal conditions. The reference signal is fed to the two deflection plates in opposite phases and so the cathode current is directed alternately to each of the plates. Since the amplitude of the reference signal is considerably greater than the minimum required to deflect all of the current to one plate, the current at each plate consists of a series of square-wave pulses of constant amplitude.

During color reception, the chroma signal is fed to the control grid and determines the amount of instantaneous current that is available to the plates. Assume, for example, that the left deflection plate, pin 1, is maximum positive at the same instant that the control grid is maximum positive. In this case, the current of the left plate is maximum and the plate voltage is minimum. Since the right deflection plate is positive one-half cycle later, the control-grid voltage is negative during the time that the right plate is gated on. Thus the current of the right plate is minimum and the voltage is maximum.

A 90° phase difference between reference and chroma signals causes one plate to be gated on while the chroma signal swings from peak positive to peak negative. The other plate is gated on while the chroma signal swings from peak negative to peak positive. Therefore, the average of all the values of instantaneous grid voltage present while one plate is gated on equals zero and the average value of plate current is equal to the amount of current under no-color conditions. For intermediate phase relations of the reference and chroma signals, the current of a specific plate varies in the same manner as in any of the other demodulators described. The curve shown in Fig. 2 applies to this circuit except that the phase relationship is shifted 180°.

The phase of the reference signal is established so that the left side of V21 demodulates on the R − Y

• *Please turn to page 47*

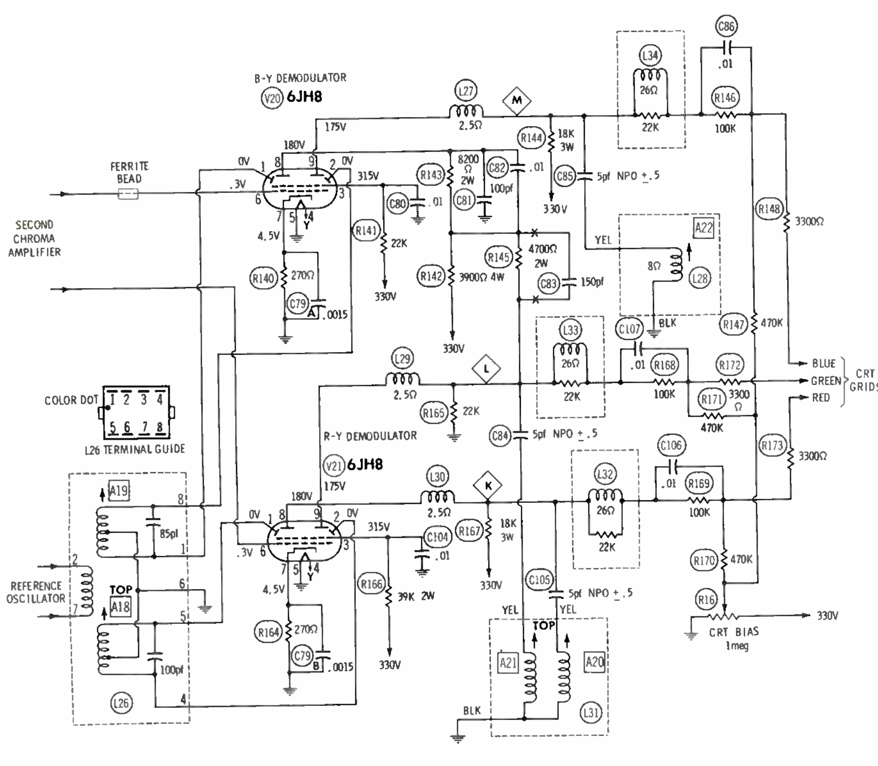


Fig. 7. Sheet-beam demodulator of Zenith Chassis 24MC32.

See PHOTOFACT Set 826, Folder 1

Mfr: General Electric

Chassis No: CA

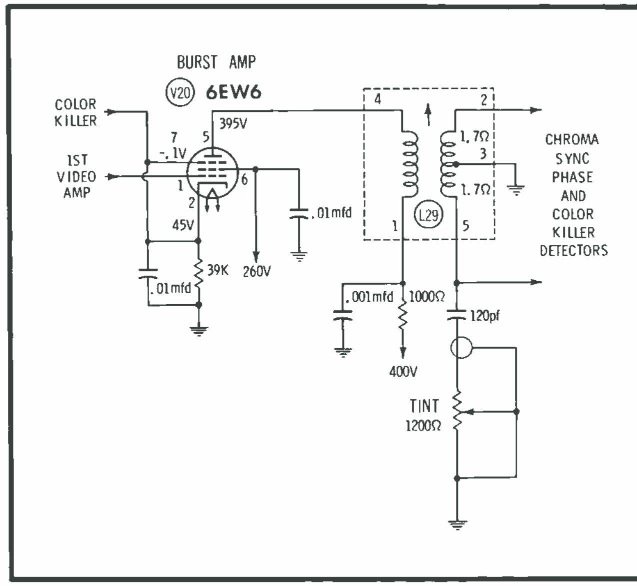
Card No: GE CA-1

Section Affected: Color sync.

Symptom: Intermittent color sync; black-and-white pix normal.

Cause: Poorly soldered connections on burst phase detector transformer (especially terminal 3).

What To Do: Resolder connections to L29.



Mfr: General Electric

Chassis No: CA

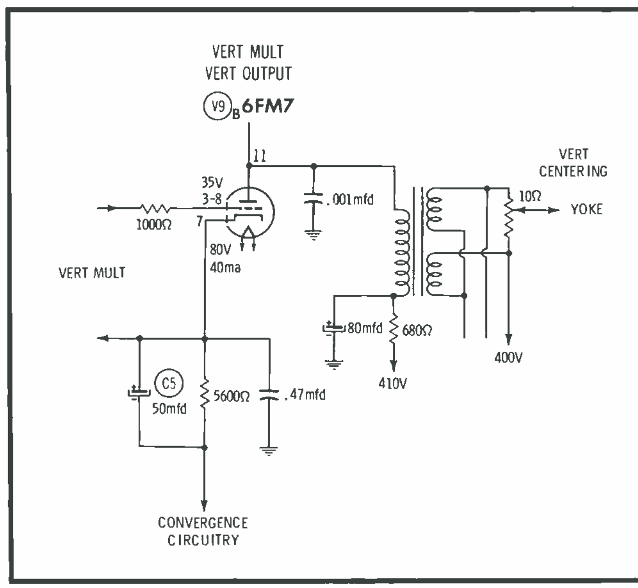
Card No: GE CA-2

Section Affected: Pix.

Symptom: Vertical foldover and insufficient height.

Cause: Open vertical cathode bypass capacitor.

What To Do: Replace C5 (50 mfd, 150V).



Mfr: General Electric

Chassis No: CA

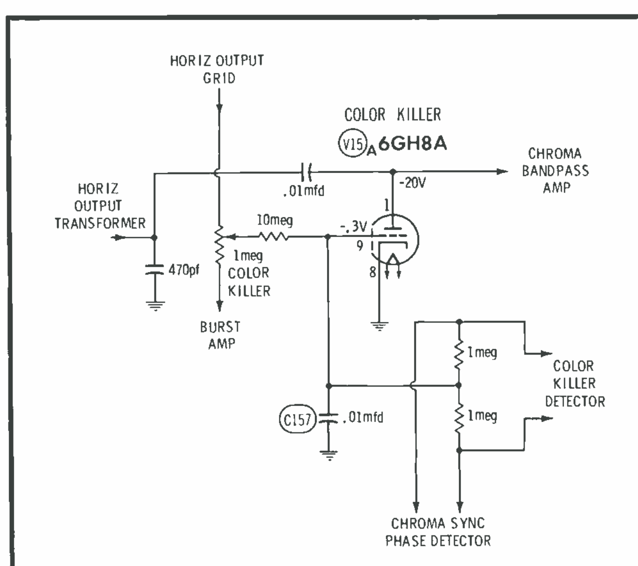
Card No: GE CA-3

Section Affected: Color uix.

Symptom: No color pix; black-and-white pix normal.

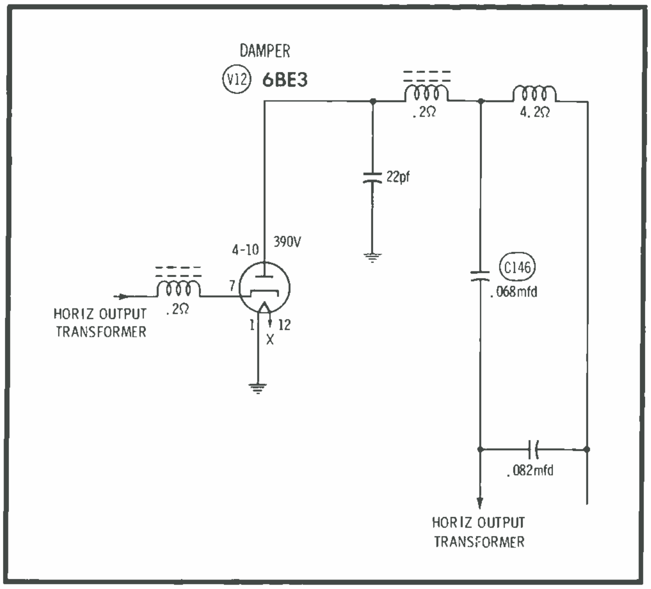
Cause: Shorted bypass capacitor in grid circuit of color killer.

What To Do: Replace C157 (.01 mfd).



VIDEO SPEED SERVICING

See PHOTOFACT Set 826, Folder 1



See PHOTOFACT Set 826, Folder 1

Mfr: General Electric

Chassis No: CA

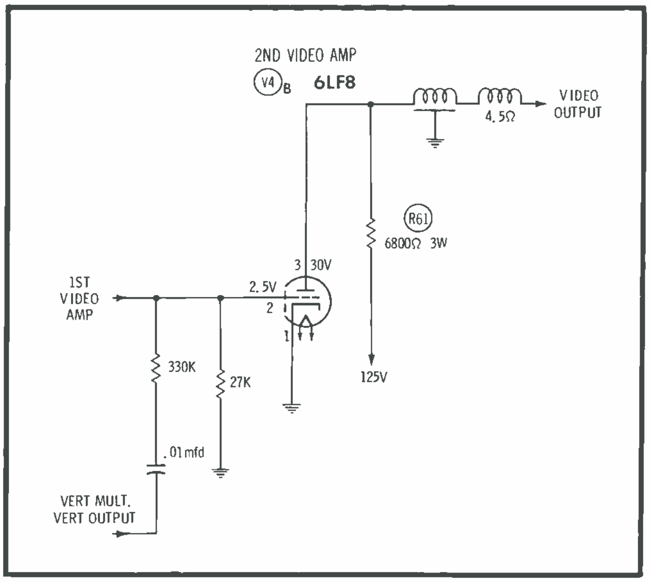
Card No: GE CA-4

Section Affected: Raster.

Symptom: No raster; no high voltage.

Cause: Shorted bypass capacitor in damper plate circuit.

What To Do: Replace C146 (.068 mfd, 600V)



Mfr: General Electric

Chassis No: CA

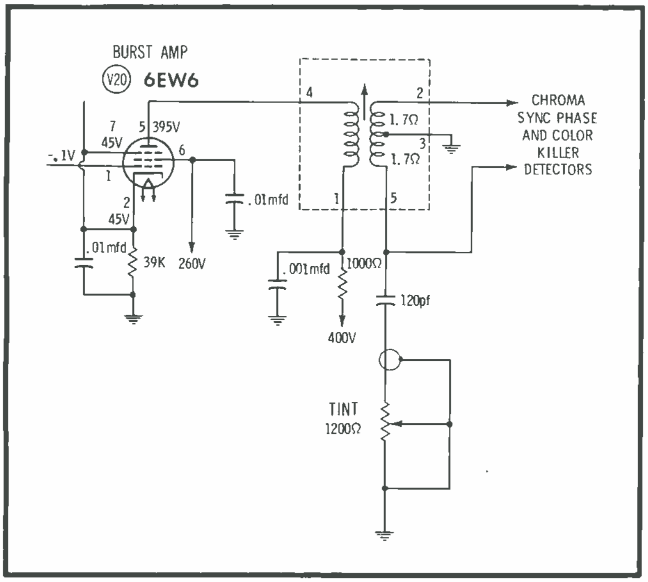
Card No: GE CA-5

Section Affected: Pix.

Symptom: Black-and-white and color pix smeared.

Cause: 2nd video amplifier plate load resistor reduced in value.

What To Do: Replace R61 (6800 ohms, 3W).



Mfr: General Electric

Chassis No: CA

Card No: GE CA-6

Section Affected: Color pix.

Symptom: Tint control has no effect on hue.

Cause: Shorted cable in tint control circuit.

What To Do: Replace tint control cable.

See PHOTOFACT Set 759, Folder 4

Mfr: Sylvania

Chassis No: 580-1, -2

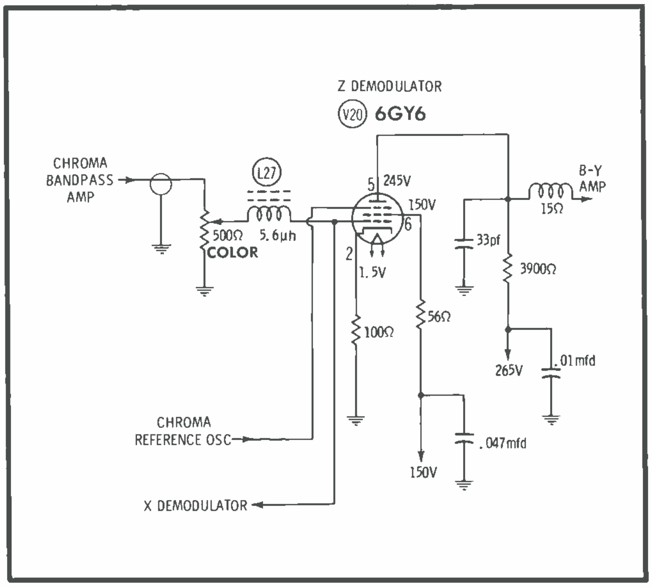
Card No: SY 580-1-1

Section Affected: Color pix.

Symptom: No color pix; black-and-white pix normal.

Cause: Open coil in grid circuit of Z demodulator.

What To Do: Replace L27 (5.6 μh).



Mfr: Sylvania

Chassis No: 580-1, -2

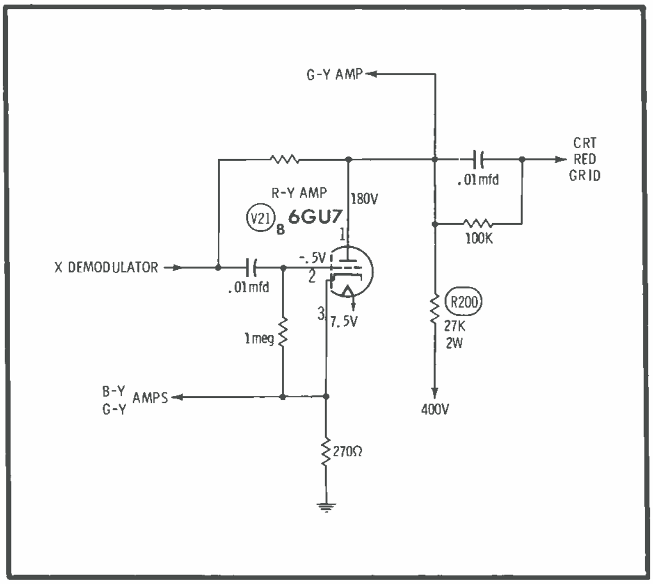
Card No: SY 580-1-2

Section Affected: Raster.

Symptom: Raster shaded red; shading increases as operating period of receiver lengthens. Voltage on plate (pin 1) of R-Y amplifier increases.

Cause: Resistor in plate circuit of R-Y amplifier decreases in value.

What To Do: Replace R200 (27K, 2W).



Mfr: Sylvania

Chassis No: 580-1, -2

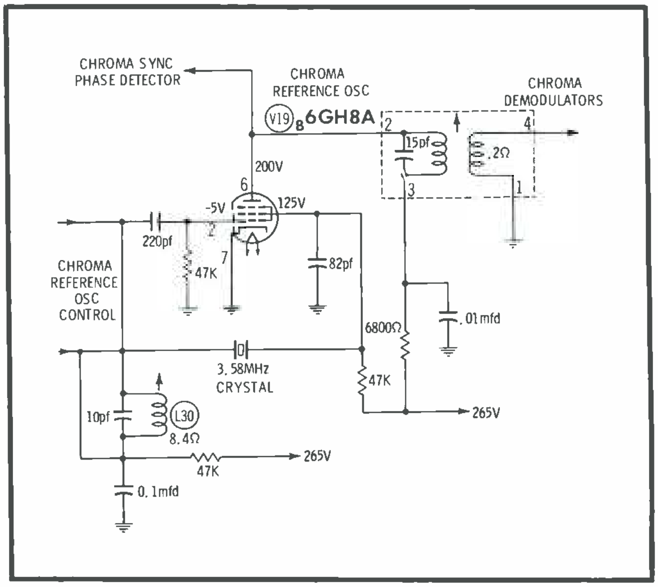
Card No: SY 580-1-3

Section Affected: Color sync.

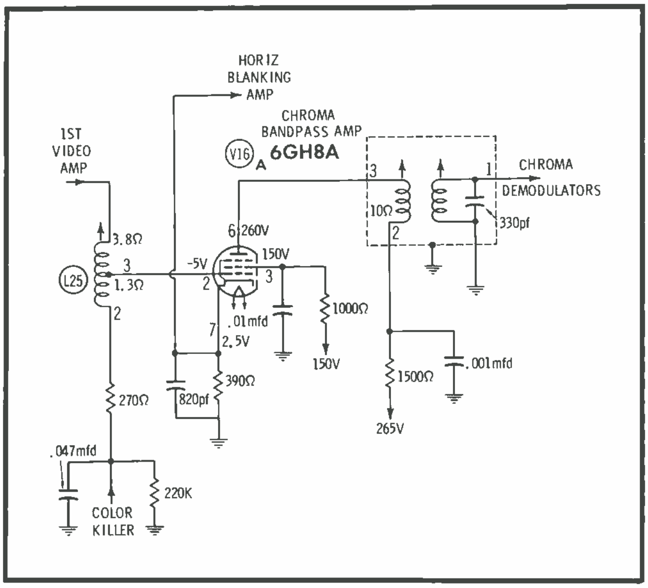
Symptom: Intermittent color sync; black-and-white pix normal.

Cause: Poorly soldered connection on chroma reference oscillator control coil.

What To Do: Resolder connections on L30.



See PHOTOFACT Set 759, Folder 4



See PHOTOFACT Set 759, Folder 4

Mfr: Sylvania

Chassis No: 580-1, -2

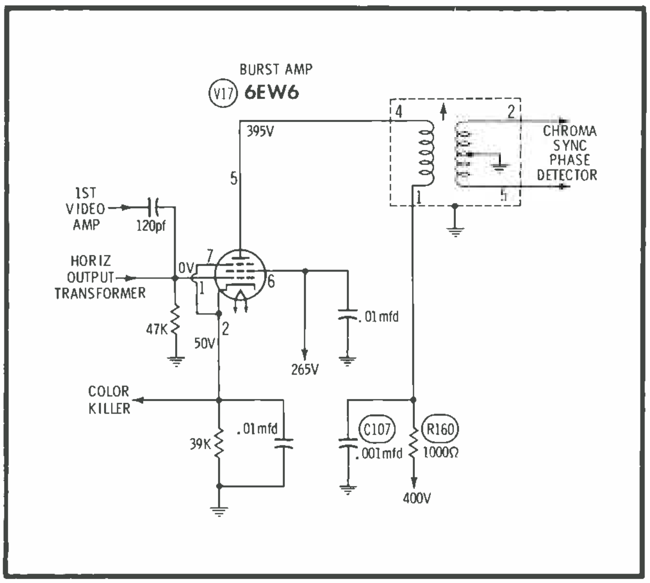
Card No: SY 580-1-4

Section Affected: Color pix.

Symptom: No color pix; black-and-white pix normal.

Cause: Open chroma takeoff coil.

What To Do: Replace L25.



Mfr: Sylvania

Chassis No: 580-1, -2

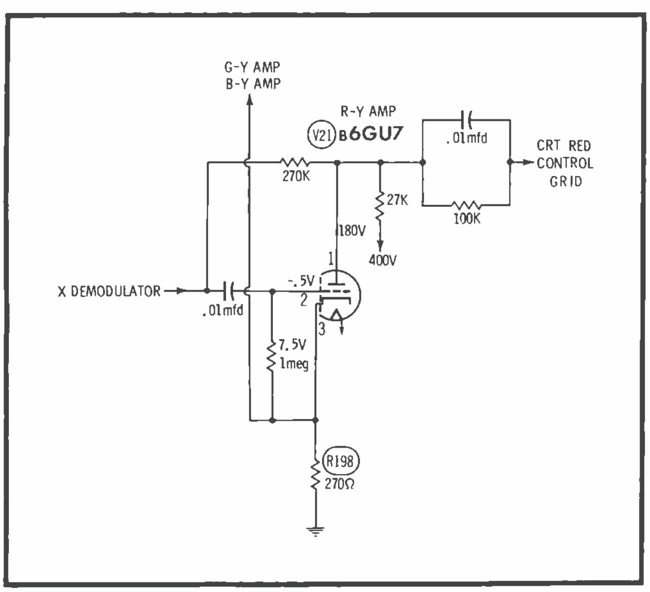
Card No: SY 580-1-5

Section Affected: Color pix.

Symptom: No color pix; black-and-white pix normal. Voltage low on screen grid (pin 6) of burst amplifier.

Cause: Leaky screen-grid bypass capacitor causing overload of screen-grid resistor in burst amplifier.

What To Do: Replace C107 (.001 mfd) and R160 (1K).



Mfr: Sylvania

Chassis No: 580-1, -2

Card No: SY 580-1-6

Section Affected: Raster.

Symptom: Raster predominantly red. Voltage high at cathode (pin 3) of R-Y amplifier.

Cause: Open cathode resistor in R-Y amplifier.

What To Do: Replace R198 (270 ohms).

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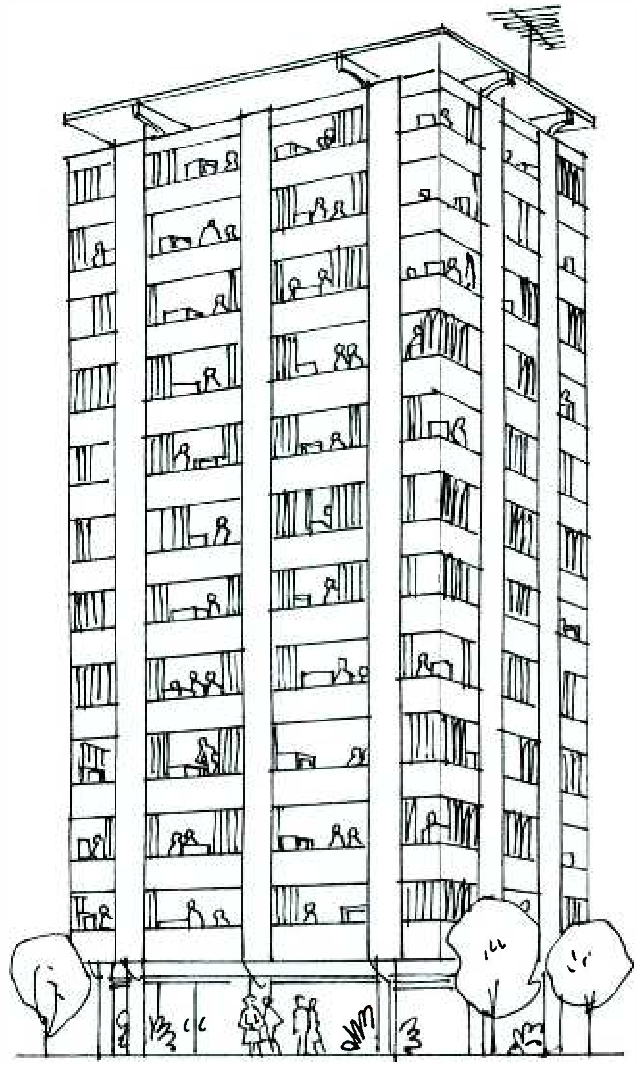

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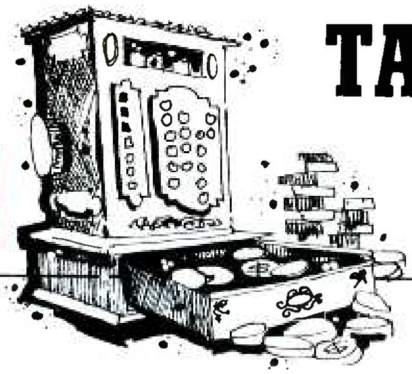


BY ERNEST W. FAIR

If you have a good crystal ball or your sister-in-law is a fortune teller, you don't need the information contained in this article. However, if you do not have either service, and you are a shop owner who would like to continue prospering in the future, the following information is for you.

Whether or not you have a profitable electronic service business in future months and years can be determined, in part, by the day-to-day planning you make toward those profits now. Tomorrow does not take care of itself in any type of business. Future profits depend on what is being done in one's business today. Here are some of the steps which, taken now, can make those profits in distant tomorrows much more certain.

Keep today profitable. Doing so is always an assurance that business strength will be present in the future. Sacrificing profit today, with the hope that such a step will pay off in the future, usually results otherwise. Bankruptcy court records are overflowing with data on business firms whose management felt that shaving profit to the bone was the surest way to obtain customers from which real profits could be made in the future.

Worthwhile business does not come from the type of customer whose loyalty depends solely on the depth of profit-cut offered him in order to obtain his business. Just as the lure of drastically reduced prices dragged him away from some other shop to your business, so will the same inducement coming from another shop eliminate him as your customer tomorrow.

Find top-notch employees. Locating and holding onto such men and women so that they will be present in the future is a must for profitable operation, both today and tomorrow. The lack of such foresight could leave one's firm in a desperate condition should a skilled employee shortage develop—a possibility at any time in the future. This type of individual may cost a few more dollars per month than others, but the contribution he will make to the business is just one more assurance that it will be a profitable service shop in the future.

Guard the small customer. Take care of the smallest and least important customer today, for he may be the most important one in the area in just a few years. If this man is neglected at present in favor of the more affluent individual, the slight will quickly become apparent to him. Long experience in the field points out that every successful business has been built upon the care exercised in serving these small customers through the years.

Look for better lines and services. Every study of this phase of business operation has revealed that continuous profitable growth of any business depends on keeping this principle in sight. The shop which keeps searching for and adding better lines and services today, while at the same time it weeds out those that are unprofitable, creates a far more favorable competitive situation as each year goes by. Any service business that has the best of everything already working for it when tomorrow comes around will have an important advantage over its competition.

Guard financial resources. The service business that seeks continued growth toward a very profitable future must insure that its financial resources have not only held their own, but have shown a slight gain. The desired strong position of any firm in the distant future can only be assured when it has ample financial resources. When one depends on "providence," "good luck," or any other similar intangibles, the future is always questionable.

Look for management skills. A profitable future for any business is invariably dependent upon how successful its management has been in maintaining staff personnel with management talent and skill. Such people can seldom be found on a moment's (or a month's) notice. As the need arises for them, they will have to be there on the staff, or the opportunities which are presenting themselves may never be grasped. Scores and scores of surveys have shown that too many business concerns suffer because the management has neglected to provide a constantly available source of employees with management skill. They have completely overlooked the important fact that as any firm grows older, so does its present personnel. Depending on being able to "pick up" such individuals as they are needed can be the undoing of a service business operation.

Protect against hazards. It is always best to provide the maximum protection the budget will allow against every possible business hazard. Too often, such protection is scaled down or management "takes a chance" in the early days of the business. These are invariably the concerns which never build to leadership. All the gains of any business can be wiped out overnight when such protection is absent, and that is usually what happens to inadequately protected business firms. There is never a tomorrow, profitable or otherwise, for such firms.

Watch your own health. Failure to follow this rule has accounted for the demise of far more business firm's (or failure to grow and prosper from small beginnings) than is commonly imagined. The shop owner should make it one of his cardinal business principles to protect his own health as carefully as he protects that of his business. The chance for growth and success can pass him by—as it has many others—because it came at a time when his health was bad.

Finally, *it pays to keep the number of long-range fixed commitments of all kinds to a minimum.* Too many of these can tie a shop owner's business hands so tightly that he will be unable to grasp forthcoming opportunities as they appear. ▲

(Continued from page 40)

axis and the output is fed to the red grid of the CRT. The right side of L31 is a filter which attenuates the 3.58-MHz ripple. Since the right deflection plate of V21 is driven 180° out of phase with the left deflection plate, the right side of V21 is operating on the $-(R-Y)$ axis, another way of saying that its output polarity is reversed. In the same fashion, the right side of V20 operates on the $B-Y$ axis and drives the blue grid of the CRT while the left side produces the negative or $-(B-Y)$ output.

As we have pointed out previously, the $G-Y$ signal is composed of $-.51(R-Y)$ and $-.19(B-Y)$. The signals from the left side of V20 and the right side of V21 are combined in the proper proportions and the $G-Y$ signal which results is fed to the green grid of the CRT.

Twin-Pentode Demodulators

The twin-pentode demodulator used in Admiral and Motorola receivers is still another significant variation of the conventional pentode demodulator. The circuit shown in Fig. 8 is used in the Admiral 1G1155-1 chassis.

Insofar as demodulation of the $R-Y$ and $B-Y$ signals is concerned, the operation of this circuit is not greatly different from the operation of a circuit employing a pair of pentode demodulators. The reference signal is fed to the suppressor grids at the correct phase to cause the left and right halves of the tube to demodulate on the $B-Y$ and $R-Y$ axes, respectively. After the 3.58-MHz ripple has been filtered, these plate signals are used to drive the blue and red grids of the CRT.

Before attempting to explain the method used to develop the $G-Y$ signal, we must digress somewhat to consider the distribution of the cathode current between the screen grid and plate of a pentode. An oversimplified explanation may be developed by considering what happens if the plate voltage is removed from a pentode having a low-impedance screen supply. There is an immediate increase in screen current followed by a gradual decrease as the screen-grid structure melts and flows to the bottom of the envelope. While this demonstration is, perhaps, more dramatic than useful, it does indicate that the screen current increases if the plate current decreases.

Actually, the screen current depends to a great degree on the velocity of the electrons passing between its conductors. If the electrons are travelling at very high velocities, the positive potential of the screen grid deflects them from their path only slightly. Thus, the only electrons which impinge on the screen grid are the ones which happen to be travelling directly towards the wires of the grid. However, if the velocity is decreased, the screen grid causes more deflection of the electrons. Since the screen grid is positive, the electrons are deflected toward its conductors and more of the electrons actually strike the wires. This, of course, causes an increase in screen current.

Now, consider the electron velocity with various suppressor grid potentials. If the voltage on the suppressor is driven negative, electrons in the region between the screen and the suppressor are decelerated to a lower velocity and the screen current increases. Conversely, if the suppressor is driven positive, electrons are decelerated a lesser amount, and the screen current is reduced.

A positive suppressor voltage which decreases the screen current also increases the plate current, and, while the plate swings negative, the screen swings positive. Thus, a signal on the suppressor grid may be amplified in both the plate circuit and the screen circuit. The signal is inverted between suppressor and plate, but, since a decrease in plate current is attended by an increase in screen current, the signal at the screen is in phase with the suppressor grid and out of phase with the plate.

Returning to the circuit of Fig. 8, since the signals at the two plates of V16 are $B-Y$ and $R-Y$, the common screen grid has elements of the $-(B-Y)$ and $-(R-Y)$ signals on it. However, the suppressor-to-screen transconductance is comparatively low and the $G-Y$ signal at the screen grid is insufficient to drive the green grid of the CRT. To increase the $G-Y$ signal at the screen, portions of the $R-Y$ and $G-Y$ signal from the plates of V16 are coupled back to the control grid. This signal is amplified in the control-grid/screen-grid circuit and

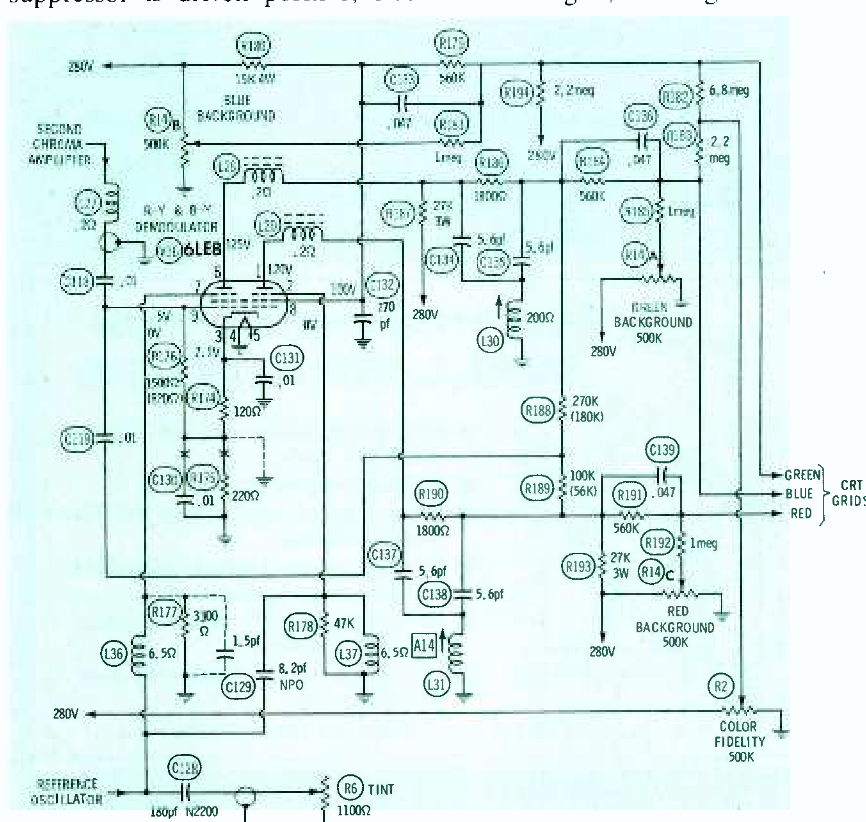


Fig. 8. Chroma demodulator of Admiral Chassis 1G1155-1.

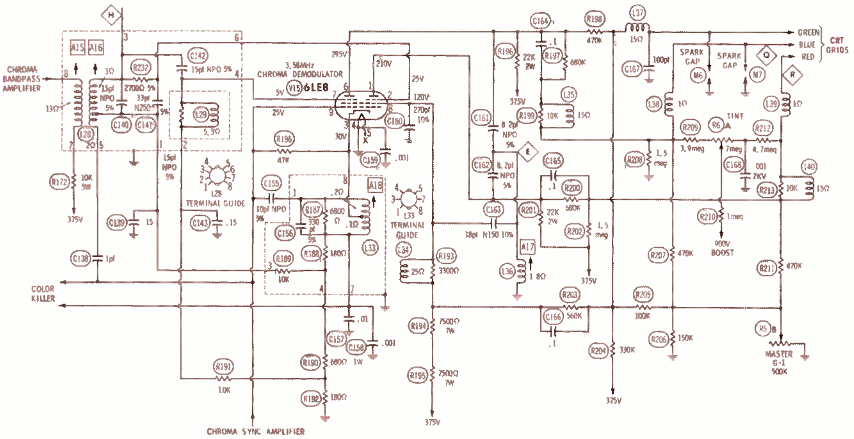


Fig. 9. Chroma demodulator of Motorola Chassis A22TS-918A.

the amplified signal adds to the G − Y signal already present at the screen. Since the (R − Y) + (B − Y) signal at the control grid is a video frequency and the chroma-signal frequency is much higher, the interaction between them is too small to be objectionable. The concept of amplfying two dissimilar signals in the same tube (reflex amplification) is by no means a new one. For example, a single tube is used as the second video IF amplifier and first sound IF amplifier in the Muntz J chassis (PHOTOFACT Folder 444-2).

The demodulator used in Motorola chassis A22TS-918A (Fig. 9) uses the twin-pentode which serves as the reference oscillator to demodulate all three color axes. The explanation of the division of current between plate and screen grid which was given above also applies to this circuit.

In Part 5 of this series, it was pointed out that the cathode, control-grid, and screen-grid circuits of V15 (Fig. 9) function as a reference oscillator in a Hartley configuration. In considering V15 as a demodulator, we need only remember that a high-level reference-oscillator signal is being fed to the control grid.

Since this control grid is common to both pentode sections, the reference signal cannot be split prior to demodulation. Consequently, the phase of the chroma signal is shifted between the two suppressor grids. Since the axis of a particular demodulator depends on the *relative* phases of the reference and chroma signals fed to it, it is not important where in the reference or chrominance circuits the phase-shifting network is located. In Fig. 9, the phases of the chroma signal are established by L28 and its associated components so that the left plate of V15, pin 6, demodulates on the B − Y axis and the right plate, pin 1, demodulates on the R − Y axis.

Because the division of current between plate and screen grid is determined by the instantaneous voltage of the suppressor grid, elements of the −(R − Y) and −(B − Y) signal are present on the screen grid of V15. A portion of the B − Y signal from the junction of R208 and R207 is added to the screen-grid signal, reducing the −(B − Y) content. The total of the three signals is the G − Y voltage fed to the green grid of the CRT. C161, C162, and C163 in conjunction with L36 are used to attenuate the 3.58-MHz ripple which is present on the plates and screen grid of V15.

 Circle 18 on literature card

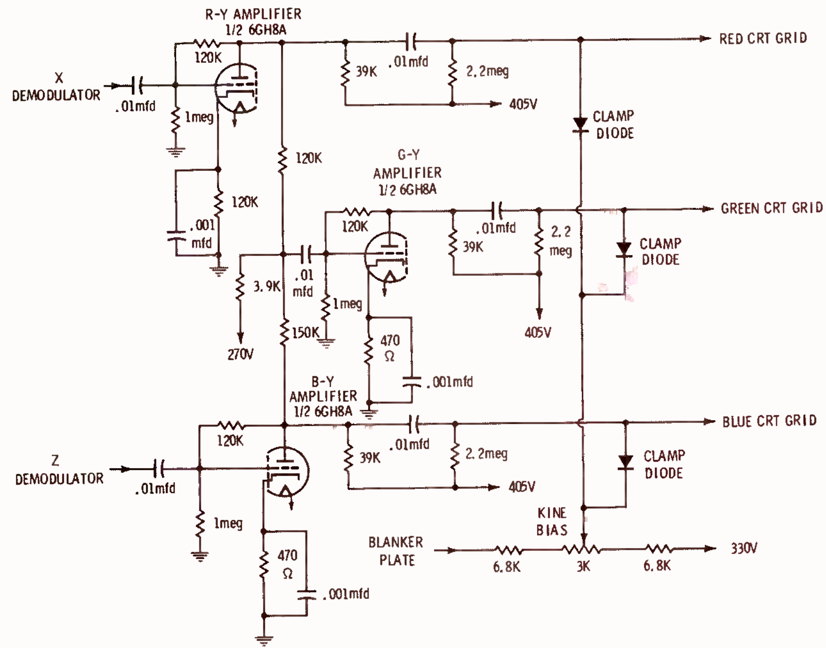


Fig. 10. CRT grid clampers of RCA Chassis CTC27.

Miscellaneous Circuits

Three circuits which are being used more frequently are CRT grid clampers (DC restorers), color tracking circuits, and tint controls. Fig. 9 shows an example of the latter. R6A is connected between the red and blue grids of the CRT and allows the customer to adjust the relative conduction of these two guns.

Fig. 10 shows the CRT grid clampers used in the RCA CTC27 and CTC31 chassis. By inserting coupling capacitors between the plates of the difference amplifiers and the CRT grids, it is possible to operate these two elements at nonrelated DC potentials. This allows simplification of the circuits and also precludes changes in color temperature caused by changes in the static conduction levels of the difference amplifiers. Thus, the CRT grids are not affected by aging of the difference-amplifier tubes and components.

Although the use of coupling capacitors is desirable for the reasons stated above, a means of maintaining the correct CRT grid voltages during b-w reception had to be devised. Otherwise, the right sides of the coupling capacitors would slowly charge through the 2.2-megohm resistors to 405 volts, saturating the CRT. To prevent this, a negative-going pulse with a negative peak of 180 volts positive above ground (refer to waveform in Fig. 10) is fed through the clamper diodes to the CRT grids during horizontal-retrace time. Between pulses, the CRT grid voltages rise from 180 volts to about 181 volts, but this is insufficient to cause a noticable change in brightness across the screen.

A method of increasing color saturation, as well as contrast, with a single control is illustrated in Fig. 11. As the contrast control is adjusted for greater contrast, the forward bias on Q1 is increased. The increased current through Q1 causes the collector voltage to decrease, reducing the positive cathode bias of the chroma bandpass amplifier and increasing its gain. Positive blanking pulses are also fed to the cathode of the chroma-bandpass amplifier. ▲

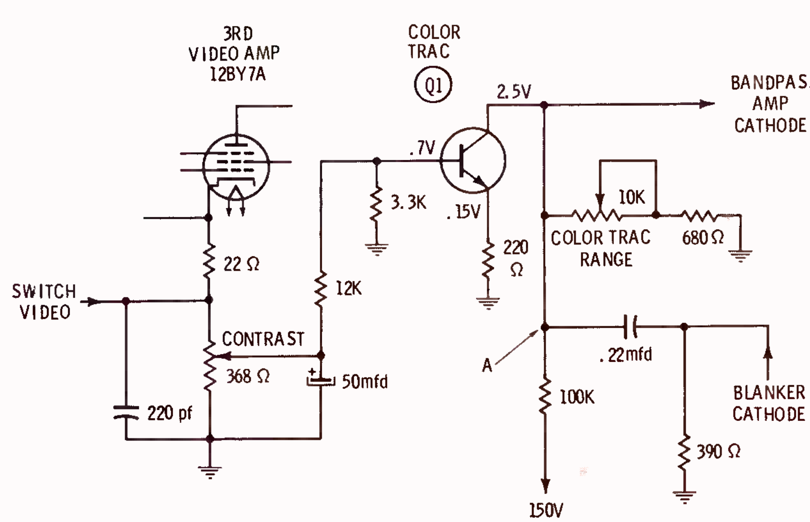


Fig. 11. Color-tracking circuit of Hoffman Chassis 913-187486.

Intermittents

(Continued from page 30)

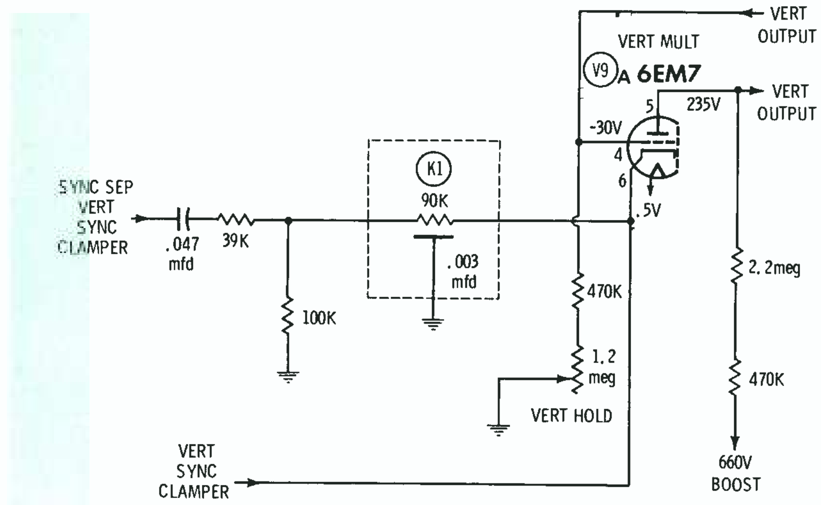


Fig. 5. Printed component caused intermittent defect in this circuit.

Back inside the shop, Ed warmed up the RF-audio signal generator, and starting at the receiver volume control, began a signal substitution procedure, working his way back toward the receiver's front end. When the generator probe was touched to the collector of Q3, the IF amplifier transistor (Fig. 4), the modulated signal was heard; however, when the probe was placed at the base of the same transistor, nothing happened. Obviously, Ed had found the defective stage.

Since the only transistor tester Ed had was an out-of-circuit checker, he removed the transistor from the circuit and clipped the tester leads to the proper transistor elements. Pressing the beta switch on the tester, Ed watched as the meter hand began to fluctuate wildly. After releasing the beta switch, Ed quickly sprayed the transistor with a cooling mist. When checked again, the transistor tester indicated a high beta reading—proof that the transistor was intermittently defective. Replacing Q3 cured the receiver's fickle playing habits.

Intermittent Vertical Roll

After a few year's experience and several intermittent trouble situations later, Ed has found that these come-and-go symptoms can be conquered in short order by proven techniques and just a little patience.

Our last account of Ed's experiences with intermittents deals with an intermittent rolling condition displayed by an RCA KCS136Y chassis. Tube substitution and control adjustments performed in the customer's home had no effect on the symptom, so Ed transported the chassis to the shop.

Because the rolling lasted for only a short period each time it occurred, Ed moved quickly. Using the scope, he traced the sync signal from the separator, through to the vertical oscillator. The sync signal at the cathode (pin 6) of V9A (Fig. 5) appeared to be reduced in amplitude. Just as Ed removed the scope probe from the cathode, the rolling stopped. Quickly, Ed checked the waveform at pin 6 of V9A again—it had returned to normal. Carefully probing around in the vertical multiplier input circuit, Ed pryed against printed component K1; the rolling suddenly started again. By moving and twisting K1, Ed could start and stop the vertical rolling.

Ed unsoldered K1 from the printed-circuit board and clipped ohmmeter leads across the resistance terminals. By twisting K1, Ed could make the meter fluctuate from 230K ohms to 90K ohms. According to the PHOTOFACT, the normal reading should be 90K ohms. Replacing K1 with a new printed component solved the intermittent rolling, and Ed could begin cooking the set within two hours of the original service call.

Conclusion

Intermittents can be tough to analyze and pin down—but they don't have to be. Logic and a few proven techniques can transform those intermittents from pains to challenges —well, almost. ▲

THE ELECTRONIC SCANNER

news of the servicing industry

Admiral Predicts 1968 Even Better

Prospects for the consumer electronics and appliance industry for 1968 are tied more closely than ever to general economic conditions, Ross D. Siragusa, chairman of the board, Admiral Corporation, said in his recent yearend statement.

"Despite such uncertanties as higher taxes next year, inflation, the prospects for escalation of the Viet Nam War, and the restlessness of labor, I am conservatively optimistic for the future," he said.

"Many of the economic perplexities of 1967 have been resolved and business generally is in a good position to move ahead, although the competitive pressures of higher labor and material costs will continue. Inventories have been reduced and brought into proper perspective.

"While this year's industry distributor sales of color television receivers will show an increase of 12% over 1966 volume, we expect 1968 movement to increase about 14% to 6,000,000 sets. While any industry would be gratified with an annual sales increase of 12% over the preceding year, the rate of increase in 1966 was so abnormal—about 70%—that it makes the color TV growth in 1967 seem pale by comparison.

"Color TV sales will surpass black-and-white business for the first time, since we are estimating sales of approximately 4,700,000 monochrome receivers in 1968 for a total of nearly 11,000,000 sets." The Admiral chairman said he believes that future expansion of color television sales will be at a more normal level and will enable the industry to grow in a less hectic manner with fewer problems.

Mr. Siragusa said that radio business continues at a high level and attributed this to the expansion of FM radio and increasing acceptance of multi-band models. Distributor sales of 13,500,000 American-branded radios are anticipated next year, compared with an estimated 12,800,000 in 1967. This does not include imported brands which should add up to a total of approximately 20,000,000 radios.

Portable and console stereo phonograph sales are expected to increase 10% to a total volume of 5,800,000 units.

Mergers & Expansions

Belden and **Complete-Reading Electric Co.,** of Chicago, announced an agreement in principle for Belden to acquire Complete-Reading and its subsidiaries. Terms of the negotation provide for the issuance of approximately 65,000 shares of Belden stock. Complete-Reading is a diversified distributor with sales divisions in Chicago, Cleveland, Kansas City, Houston, Pittsburgh and Mexico City. Its sales for the fiscal year ended October 31, 1967 were $9 million.

The Pink ribbon to **EICO**'s new headquarters plant was officially cut at the recent ceremonies by Brooklyn Borough President Abe Stark, in the presence of members of the press and company officials.

The new air-conditioned EICO building is a one-level 100,000-square feet high-efficiency manufacturing structure. In addition to management offices, it houses enlarged facilities for engineering, quality control and consolidated production of both wired and kit equipment—and provides amply for future expansion.

General Telephone & Electronics International announced the formation in Venezuela of a new subsidiary, Sylvania Venezolana, C.A., and the start of construction on a plant which will manufacture black-and-white television picture tubes. The new company was formed to consolidate and expand Sylvania marketing efforts in Venezuela and to manufacture TV picture tubes and sets. Sylvania sets presently are assembled in Caracas.

Jensen Manufacturing Division, The Muter Company started to move into its new plant facilities in late December. The 174,000 sq. ft. plant more than doubles Jensen's previous facilities in Chicago. The corporate offices of the Muter Company will be housed in the new building as well as Jensen's offices, engineering staff and manufacturing operations.

Chamberlain Manufacturing Company and **Perma-Power** have signed an agreement providing for the acquisition by Chamberlain of substantially all the assets and business of Perma-Power in exchange for common stock of Chamberlain. The closing is scheduled for early in 1968. Perma-Power will continue it operations, under the same management, as a division or subsidiary of Chamberlain. Perma-Power's garage door openers make a natural combination with the garage doors manufactured by Chamberlain.

STDP Gets Exposure

The **Electric Industries Association's** Consumer Products Division began implementing the first phase of its Service Technician Development Program (STDP) by means of an intensive "win friends and influence people" effort at the recent American Vocational Association (AVA) annual convention at the Sheraton-Cleveland Hotel. The AVA represents some 45,000 vocational education teachers and counsellors and is considered a major factor in that field.

The STDP is the EIA Consumer Products Division's long-range effort aimed at increasing the number of qualified service technicians for consumer electronic products. Over half a million dollars has been earmarked for this manufacturer-sponsored effort over the next five years. One thrust of the program will seek to work closely with vocational educators and counsellors at the secondary school level.

The STDP eventually intends to influence and improve electronics teaching at the classroom level all over the country through teacher training seminars and institutes, curriculum upgrading programs and consultation services. In conjunction with a public relations and career guidance program, these activities are intended to gradually bring more and more well-trained and well-motivated young people into consumer electronics servicing as a career.

New Camera Tube

A new television camera tube developed at **Bell Telephone Laboratories** combines the best features of the vidicon with the highly developed silicon technology used in integrated circuits. This marriage of tube and semiconductor technologies removes certain shortcomings of present camera tubes and promises a more rugged and longerlived, more sensitive camera tube. The new tube is being used in the Model II PICTUREPHONE® set.

The heart of the tube is a new type of target structure consisting of a self-supporting silicon wafer the size of a nickel, containing over half a million silicon photodiodes in an area less than one-half inch square. The target, only 2 mils thick, is fabricated using techniques identical to those used in making silicon integrated circuits.

One advantage of the silicon target in the new camera tube is that its performance is not degraded or modified by exposure to bright light sources or by electron beam bombardment. In conventional camera tubes bright lights or long exposure to fixed scenes can cause optical burn-in, resulting in a lingering ghost pattern superimposed on the displayed images. Image defects caused by optical burn-in are so severe that the lifetime of standard television camera tubes is reduced. Conventional television camera tubes also exhibit a similar defect known as raster burn-in, which is produced by the scanning electric beam. Neither form of burn-in occurs in the silicon camera tube because the electrical and optical properties of crystalline silicon are not modified by exposure to intense light or by bombardment from a low energy electron beam. ▲

LETTERS TO the EDITOR

How to Use Signal Generators in Color TV Servicing: John D. Lenk; John F. Rider Publisher, Inc., New York, N.Y., 1967; 97 pages, 8⅞" x 6", soft cover; $3.25.

Although it is possible to operate a piece of test equipment without a thorough understanding of its basic circuitry, the lack of such knowledge can limit the versatility and, in some instances, the accuracy of the instrument. Also, when trouble develops within the instrument, the technician must rely on someone more familiar with the circuitry to repair it.

It is the obvious intent of this text to overcome such shortcomings, as they relate to color generators, by completely familiarizing the technician with the signal generators commonly employed in color TV servicing.

The text begins with a block diagram presentation of the operating principles associated with keyed and unkeyed rainbow generators, NTSC-type generators, and the flying spot scanner video generator. The operating controls and basic operating procedures of these instruments are outlined in Chapter 2. Chapter 3 discusses the testing and calibration of color generators, including percentage-of-modulation, output, chroma- and Y-signal, shading-bar, and burst-signal checks of NTSC-type generators.

Specific applications of color generators are described and analyzed in Chapters 4 through 7, including purity, convergence, and linearity adjustments; and testing of color sync, chroma demodulation, and matrix circuit characteristics. In addition, Chapter 8 discusses a variety of uncommon and miscellaneous generator applications such as picture-detector output, IF signal, and bandpass amplifier output checks; as well as various methods of localizing color troubles.

An understanding of color TV theory is essential to the understanding of the content of this text. ▲

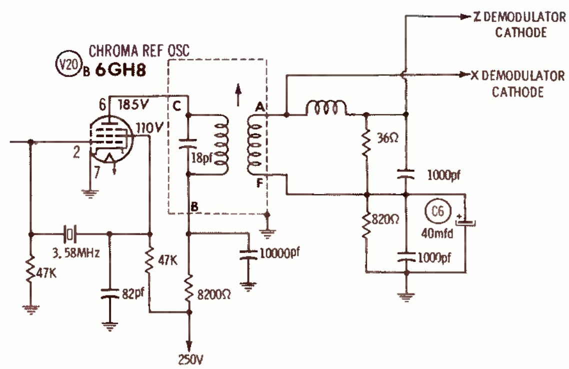
PHOTOFACT™ BULLETIN

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.

AMC	C402A, C406A, C408A	934-1
Catalina	122-757A, 122-762A, 122-763A,	935-1
	122-780A, 122-782A	930-1
Delmonico-Nivico		
	P-112	932-1
	P-119	930-2
Motorola	Chassis 12TS-458B-04	930-3
Panasonic	CT-66N	931-1
	TR-228D, TR-921, TR-922D	932-2
RCA Victor		
	Chassis KCS168A	935-2
Toshiba	C1G, C1S	933-1
Westinghouse		
	Chassis V-2490-8/-10/-11	934-2
Zenith	Chassis 14N33Z, 14Y33	933-2
	Chassis 14Y21, 14Y21Z	931-2
	Chassis 14Y26	934-3
	Chassis 20Y1C37	932-3

COLOR COUNTERMEASURES

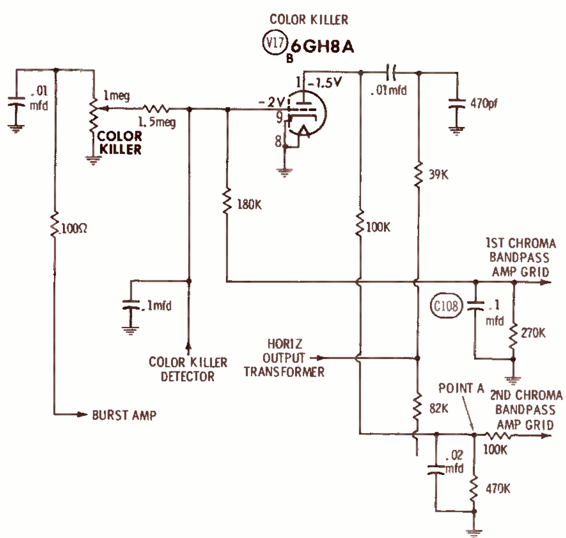
SYMPTOMS AND TIPS FROM ACTUAL SHOP EXPERIENCE



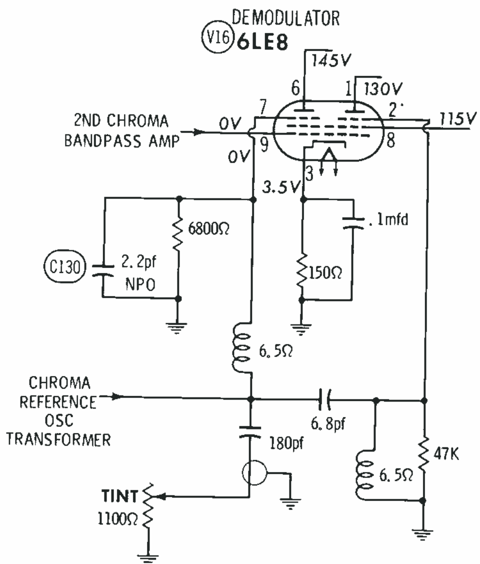
Chassis: RCA CTC10

Symptom: Spaces between color bars of keyed rainbow color pattern are predominantly green instead of neutral.

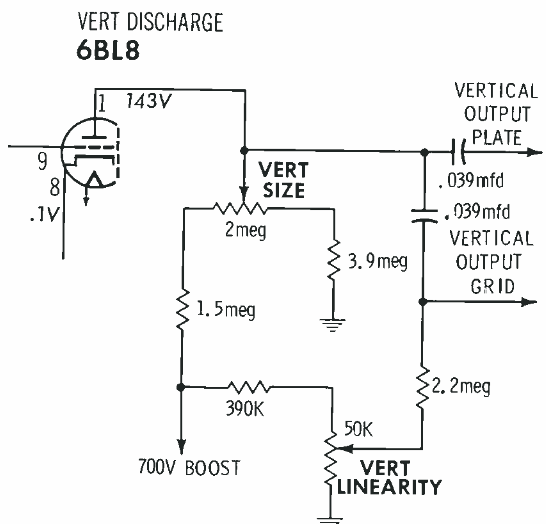
Tip: Possible cause of trouble is open C6 in common cathode circuit (phase shifting network for output of chroma reference oscillator) of chroma demodulators.



Chassis: Admiral G11 and G13
Symptoms: No color or intermittent color.
Tip: Possible cause of trouble is leaky C108. If this is trouble, grounding point A should restore color. Replace defective capacitor.



Chassis: Admiral G11
Symptoms: Poor reproduction of greens (not caused by a component defect).
Tip: Condition can be improved by removing C130 from circuit. (After removal of C130, it may be necessary to readjust the chroma reference oscillator plate transformer for correct tint control range).



Chassis: Motorola TS-914
Symptoms: Raster height reduced.
Tip: Before performing routine troubleshooting of vertical section, check horizontal output tube for gassy condition. Defective horizontal output tube reduces boost voltage that is supplied to plate of vertical discharge tube via vertical size control and to grid of vertical output tube via vertical linearity control. Vertical trouble symptom usually appears before horizontal trouble symptom is obvious. ▲

Circle 26 on literature card

Circle 27 on literature card

a detector so sensitive as to be unstable and susceptible to noise. For these and other reasons, a special megohm bridge is advisable.

Fig. 7 shows the basic circuit of a megohm bridge typified by the General Radio Type 544-B. This arrangement is seen to be similar to the conventional Wheatstone bridge except for guard terminals and paths (to minimize the effects of surface resistance of the unknown and standard resistors and of leakage between the unknown terminals and from terminals to ground) and the inclusion of a sensitive DC VTVM-type of null detector (triode V1) in the bridge.

The dial of balance-control rheostat R2 is direct reading in megohms, and standard resistors R3 through R7 are switched by means of S1 to change range (i.e., to multiply the reading of R2). In the General Radio bridge, these standard resistors extend from 10K ohms to 100 megohms; R1 is 100K ohms; and R2, 12K ohms.

The DC input voltage often is high (say, 500 volts) to permit testing R_X under actual working conditions and to provide an off-balance output voltage high enough to ensure accurate null adjustment.

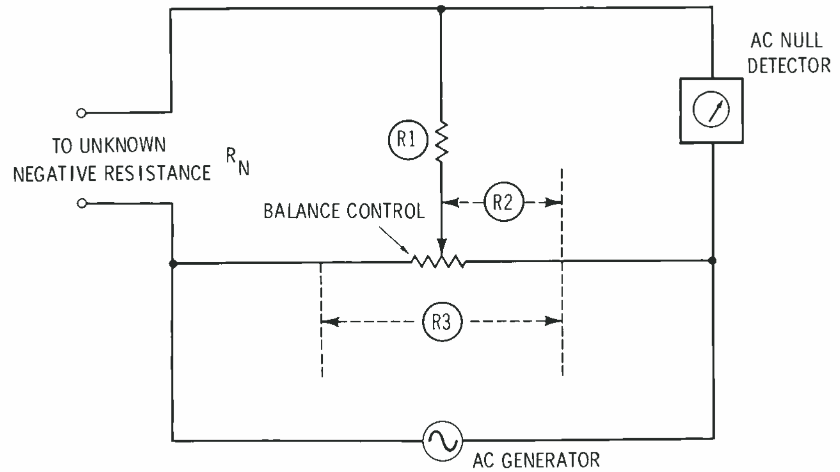


Fig. 9. Negative resistance bridge displays unconventional design.

AC Bridge

Where desired, a resistance bridge may be used with an AC generator and an AC detector. One reason for choosing the AC procedure is the easily obtained high detector sensitivity in such high-input-impedance indicators as vacuum-tube millivoltmeters, amplifier-type meters, and oscilloscopes.

From Fig. 8, the bridge is seen to be conventional. While, for simplicity, a meter (M) is shown as the null detector in this circuit, the detector may be any one of the devices mentioned earlier. The generator usually is an oscillator (conventional test frequencies are 120, 400, 500, and 1000 Hz). For a sharp null, either the bridge signal must be harmonic-free or the detector must be sharply tuned to the fundamental frequency of the signal.

Problems of isolation and strays are more pronounced here than in DC bridge circuits, and are solved in various ways. For example, well shielded isolating transformers (T1 and T2) are inserted between the generator, bridge, and detector. (In some instances, one of these transformers —often T-2—is omitted). In addition, either point X or point Y(but not both) may be grounded. The shortest practicable leads (preferably shielded) must be employed between generator, bridge, and detector. Additionally, efficient high-frequency operation (20 KHz and beyond) requires that each bridge arm be individually shielded. Reactive components in the bridge arms must be minimal; otherwise, the bridge will be balanced for complex impedance instead of simple resistance. (Standards, ratio arms, and balance control therefore are designed for extremely low inductance and capacitance). The harmful effects of stray reactance are most pronounced at high frequencies and high resistance values.

A standard Wheatstone bridge may be adapted for AC measurement of resistance by replacing its battery and galvanometer with an AC source (of suitable voltage output) and an AC detector. Isolating transformers enhance the accuracy of measurement and should be used unless they are already provided in the generator and detector.

Negative Resistance Measurement

Although the circuit shown in Fig. 9 is not a conventional bridge, it permits measurements of negative resistance by the null method which is common to bridge operation. An AC test signal (e.g., 1000 Hz) is supplied by the generator, and the null is indicated by a high-impedance detector such as a vacuum-tube millivoltmeter.

The unknown negative resistance, R_X, is connected to terminals X-X, and the balance-control potentiometer, R3, is adjusted for null. At null: $R_X = R1\ (R3/R2) + (R3 - R2)$.

To prevent swamping the negative resistance, the positive resistance (R_T) of the measuring circuit must be significantly higher than the negative resistance. For best results, $(R3 - R2) + 1/R1 + [1/(R2 + R_D)]$ must be much higher than $10R_X$.

Part 2 of this article will continue our review with a discussion of capacitance and inductance measuring bridges. ▲

BOOK REVIEW

Understanding and Using Your Oscilloscope: Edited by William A. Stocklin; Allied Radio Corp., Chicago, Illinois, 1967; 128 pages, 8½" × 5½", soft cover; 75c.

If you need to know how an oscilloscope works—and how to use it for everyday servicing—this book should fit your needs. Written for students and apprentice technicians, it also will be valuable to the many service technicians who have never really learned how to get the most out of their scopes.

Starting with a brief history of cathode-ray tubes, Chapter 1, the text proceeds logically to the circuit analysis of a simple oscilloscope in Chapter 2. Chapter 3, entitled "Interesting Applications for an Oscilloscope," shows how to use the scope to measure AC voltages and currents, and introduces signal-tracing techniques in radio and TV service. Chapter 4 presents a detailed analysis of the formation of Lissajous patterns, square waves, and peaked waves, followed by a discussion of how these various waveforms are modified by distortion, phase shifts, and nonlinearity.

Chapter 5 should be of special interest to anyone who is contemplating the purchase of a scope. A number of circuit features, such as DC, wide-band, dual-trace, and differential-input vertical amplifiers, are explained. Several pages are devoted to explaining the advantages of using a triggered-sweep oscilloscope, particularly for servicing TV chroma circuits. The final pages of this chapter summarize the requirements for a scope to be used in each of several service applications: audio, AM radio, FM radio, TV, and industrial electronics.

Chapter 6, "Auxiliary Equipment" discusses the use of sweep generators, marker generators, pulse generators, color-bar generators, and probes, and should be of interest to anyone. Chapter 7 covers kits and will interest only those who are planning a construction project. ▲

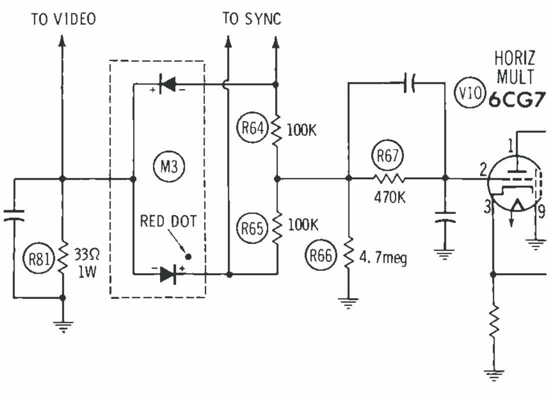
THE TROUBLE-SHOOTER

Wrong Resistance?

I have an Admiral Model 14YP3C, covered in PHOTOFACT 350-1. The PHOTOFACT resistance table gives a value of 5.2 megohms from pin 2 V10 to ground. I read only 1.3 megohm. When I unsolder the grounded end of R66, I read 5.2 megohms from the unsoldered end to Pin 2 V10. I have substituted all parts on the line, and the results are the same. All other readings on the tube are normal, and the tube operates OK in another set. What am I doing wrong?

ROBERT HEMPHILL SR.

Cleveland, Ohio



Unfortunately, there was an error in the PHOTOFACT. *As can be seen the actual resistance will be 470K ohms plus the resistance made up of R66 in parallel with R64, R65, M3, and R81. Since the resistance of M3 can vary widely, depending on the ohmmeter used, the reading could be anything from about 600K ohms to several megohms. The 1.3 megohms you measure sounds reasonable.*

We have entered a correction in the records, and future printings of PHOTOFACT *350-1 will contain this change. Thank you for drawing our attention to this error.*

No Boost

I'm having trouble with HV, boost, and raster in a Westinghouse V2372-27 (PHOTOFACT 388-3). The horizontal output transformer was open, and I replaced it with a Merit HV-168. Since the replacement, the set has had low HV and low boost. I can get a raster at about ½ rotation of the brightness control, but the raster rapidly fades out. The boost reading is 350V, and should be 660V. Is it possible the Merit HVO-168 is not an exact replacement for this set?

HENSEL LYONS

Baltimore, Md.

The Merit HVO-168 should serve fine in your set. Though the DC resistance and inductances are slightly different than the original flyback, the ratios between windings are the same. Like all PHOTOFACT *Folder recommended replacements, the Merit flyback was actually tried in the chassis in question, and it functioned properly. We suggest you thoroughly recheck your wiring, especially the boost-forming capacitor. If this fails to turn up the trouble, look for defective components in the boost, damper, and yoke circuits.*

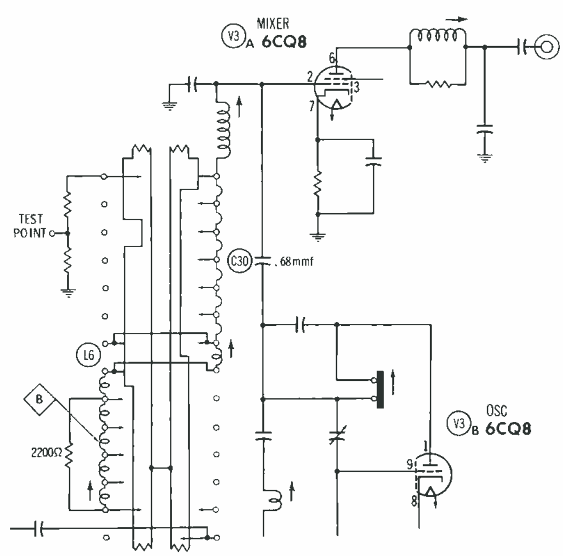
Another Inch of Width

The PHOTOFACT alignment procedure for the RCA KCS109 (PHOTOFACT 392-3) seems rather difficult. To get to the overall alignment check point "B", it is necessary to remove and dismantle the tuner. Is there an alternative method?

On another KCS109, I just barely was able to fill the screen, after replacing the rectifiers and handpicking the horizontal output and damper tubes. Any suggestions?

C. R. WILLIAMS

Baltimore, Md.



As an alternative to the injection point "B", you may clip pin 9 from the 6CQ8, and inject the signal at the test point (it's in a hole in the chassis), or through an ungrounded tube shield. Clipping pin 9 disables the oscillator. A slightly weak or used 6EA8 or 6U8 with pin 9 clipped will work equally well in this case, since the operating frequency and amplification are of slight importance. The main thing is to couple a signal to the plate.

Wayne Lemon's book "Servicing Horizontal Sweep Circuits" (Sams catalog No. 20225) has a section titled "How to get another inch of width."

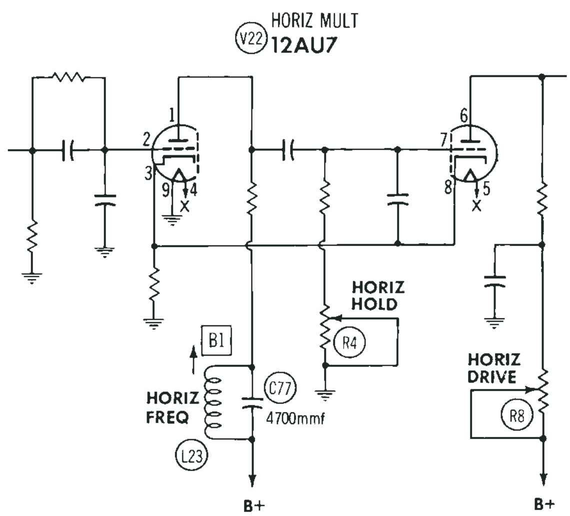
Among the points he mentions are: Check the drive, check B+, check screen voltage on output tube, check for open screen bypass, etc. etc. He also gives some novel tips, including: Remove the width coil entirely, or add a 33 pf, 4KV capacitor from plate to cathode on the damper. A complete explanation on the whys and wherefores of these "unauthorized modifications" is included in the book. It's interesting reading!

Kind Words

I would like to take this opportunity to thank you for helping me solve an intermittent horizontal sync problem. I followed your advice, using a freezing spray on the parts you suggested. The 4700-pf capacitor shunting the ringing coil proved to be the culprit. Troubleshooting time—about 3 minutes. Many thanks for your kindness.

J. F. Daly

New York, N.Y.



*Thanks to you, too, Mr. Daly, for confirming our diagnosis. The original problem was an RC-101 TV receiver (*Photofact *142-10) that would drop out of sync during warmup. Our advice: "The trouble is probably caused by a thermal drift of one of the frequency determining components in the horizontal oscillator.*

"Several parts could cause this problem and it is usually easiest to locate these defects with one of the freeze sprays obtainable at your distributor. Just perform a quick horizontal alignment from a cold start, and when the set drops out of sync, spray the suspected components one-by-one until the set falls back into sync."

As can be seen, there are more troubleshooting tools than just meters and scopes. Problems of this nature can often be ferreted out with freeze spray in less time than it takes to hook up the scope. ▲

Precision Sound Alignment — The Easy Way

by Robert F. Heaton

Sometimes, not often mind you, experienced service technicians fail to pass along valuable tips to younger technicians. For example, few electronics schools teach "time-saving" troubleshooting procedures. Usually, actual servicing experience or "old pro" training is necessary after graduation—the information isn't available in schools for it would make the course of training prohibitively long.

Alignment of sound systems in television receivers could be a typical example. There are many acceptable procedures for sound alignment, used by various technicians. Many, I'm sure, use the method outlined herein—and have for years! However, let's see if your present method matches mine. We'll use a typical sound system as illustrated (simplified) in Fig. 1.

Assume, regardless of reason (circuit repair, transformer replacement, or normal aging) sound alignment is needed. Here's a method which is quick and easy, yet highly accurate. The method can be used on service calls in the home or in the shop. The only equipment needed is a bias box, alignment tools, and a station signal.

Preliminary Steps

Tune in on a local channel and set the volume control to normal. Connect a variable negative bias supply to the IF stages, set for −8V; another variable negative bias to the RF stage, set for −6V.

Step 1

If background noise or distorted sound is heard, decrease RF bias towards zero until sound is relatively noise-free. If zero RF bias is reached and sound is still distorted, reduce IF bias (from −8V) until sound clears. Now, carefully increase IF bias until sound just becomes noisy (buzz is heard on peaks).

Step 1 is performed to attentuate the incoming signal just to the point of sound distortion. Under these conditions, the passband of the tuned circuits in the sound stages are indirectly narrowed, demanding accurate tuning to produce clear sound. This will be evident when adjustments are made, for sound "breakout" (noise and/or distortion) will occur with only a fraction of a turn of any coil slug.

Step 2

Adjust sound takeoff coil for clearest sound. Distortion will occur (sharply) on either side of the correct setting. If necessary, increase IF bias slightly to further narrow adjustment.

Step 3, 4

Adjust sound IF transformer for clearest sound (both top and bottom cores). Again, distortion should occur on either side of the correct setting. For best accuracy, alter IF bias as necessary to narrow slug range.

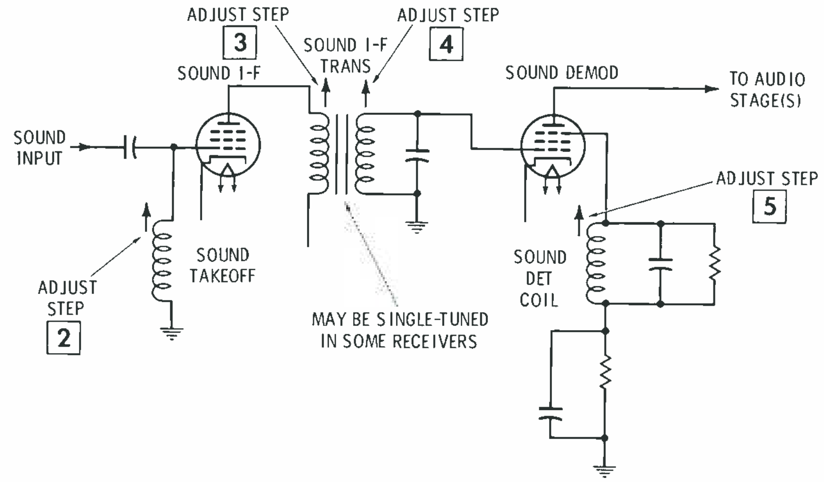


Fig. 1. Typical sound system in current color TV receivers.

Some receivers will have a single-tuned transformer, rather than a double-tuned, as in our example. However, the procedure remains the same. The accuracy of this alignment method can be demonstrated using the sound IF transformer as an example. Remove the RF and IF bias, then try adjusting the sound IF transformer. You'll find both slugs can be turned to different settings with very little change in the sound. In other words, the transformer acts like an open "barn door" when a strong signal is received. However, on weak signals the sound will probably be noisy and/or distorted. Regardless, you can't tell when the transformer is properly tuned.

Step 5

Remove RF and IF bias; disconnect antenna. Now, adjust sound detector coil (quadrature) for maximum sound and quieting.

Disconnecting the antenna attenuates the signal sufficiently to permit accurate adjustment of the quadrature coil. Distortion and noise will occur on either side of the correct setting.

Points to Remember

The alignment method just outlined is adaptable to most TV sound systems. If desired, the adjustments can be made in either order—takeoff coil, interstage, detector—or reverse. However, even though you elect to touch up the detector coil first, make sure you also adjust it as the final step.

Try juggling IF bias slightly during adjustments, to narrow the range over which the cores can be turned. This results in a more exacting alignment. If any adjustment does not respond as outlined above, a check on associated circuitry is indicated. ▲

NOTES ON TEST EQUIPMENT

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

by T. T. Jones

New Color Generator

The latest entry into the color generator market is Leader's Model LCG-387 pictured in Fig. 1. We were dubious when we ordered a sample, since the market really is somewhat saturated, and just about any feature you can imagine is already available in American-made generators, at competitive or better prices.

The advertisements from Leader didn't indicate too much, because every feature mentioned in the ads is available in one or another of the American generators. Why then, we wondered, would the Japanese attempt to penetrate this difficult market?

When we unpacked the sample, the most interesting features readily apparent were that the instrument comes in a nice little leather case, and has a miniature screwdriver and a diddle-stick packed with it. Incidentally, it's a very good stick, with a reversible hex bit in a plastic handle that provides a firm grip. The smaller bit fits tuner slugs just right.

After a quick glance over the externals, we unscrewed the cover (2 screws) for a peek inside. It then became apparent why Leader challenged the U.S. market. This quick peek took several hours before we even plugged in the generator for a trial. Under the cover, the LCG-387 is one of the most fascinating instruments we've seen (Fig. 2). The most striking thing is the number of components they've managed to cram into the case, which is about the size of the average VTVM. There's 50 transistors, 78 diodes, and more resistors and capacitors then we would care to count.

This high-density packaging is made possible by the use of plug-in, computer-style PC boards. Fig. 3 is typical of one of these boards. This particular board includes most of the synthesizing circuits, and the horizontal countdown stages. The vertical countdown are on the center board (Fig. 2), and the RF, color, and 189-kHz oscillators are on the rear board.

The color oscillator is the standard offset-carrier type, but the output goes through a buffer stage before passing on to the keying stages. Again there are buffers and shapers after the 10-bar keying, so the chroma signal passes through 6 transistors in all before reaching the video stages.

The RF oscillator is a modified Hartley, operating on channel 5 or 6. A slide switch at the rear of the instrument selects either of two trimmer capacitors in the tank circuit, to arrive at the proper operating channel. We tried readjusting the channel 5 trimmer to channel 4, but it did not have sufficient range. However, the basic oscillator circuit is quite simple, and it appears as though it could easily be padded down to reach channel 4, or even 3 with a possible reduction in output level. The RF carrier is matrixed with the video in a simple diode modulator, and then feeds directly

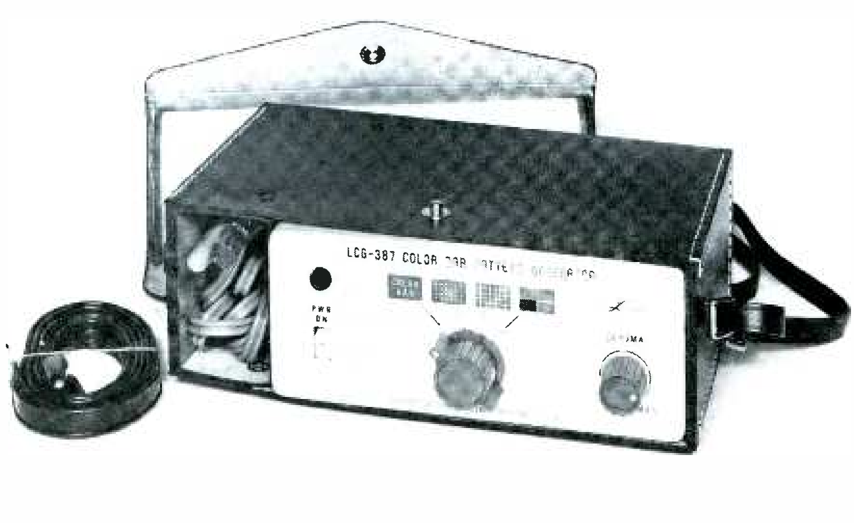


Fig. 1. New color generator has leather case.

Fig. 2. Top view with cover removed.

to the output terminals through an impedance matching network. The output impedance is 300Ω, so the output cable furnished is twinlead, rather than coax. The level is approximately 10 mV.

The output of the 189-kHz crystal oscillator is fed to multi-vibrator-buffer stage, which produces a 189-kHz squarewave. A portion of this signal feeds to the color circuits to key the rainbow. The rest of the signal feeds to the horizontal countdown circuits. The horizontal chain is made up of 4 identical bistable multivibrators such as Fig. 4, and a buffer stage. The overall block diagram is shown in Fig. 5.

As can be seen in Fig. 5, the hori-

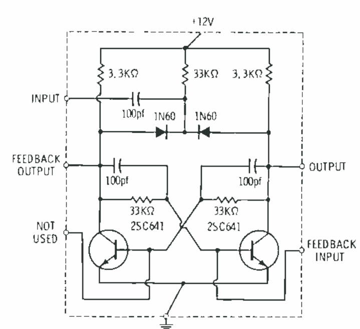


Fig. 4. Typical divider stage.

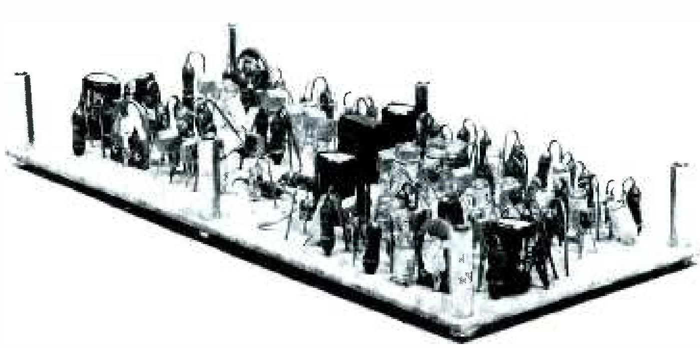


Fig. 3. Sync and horizontal board.

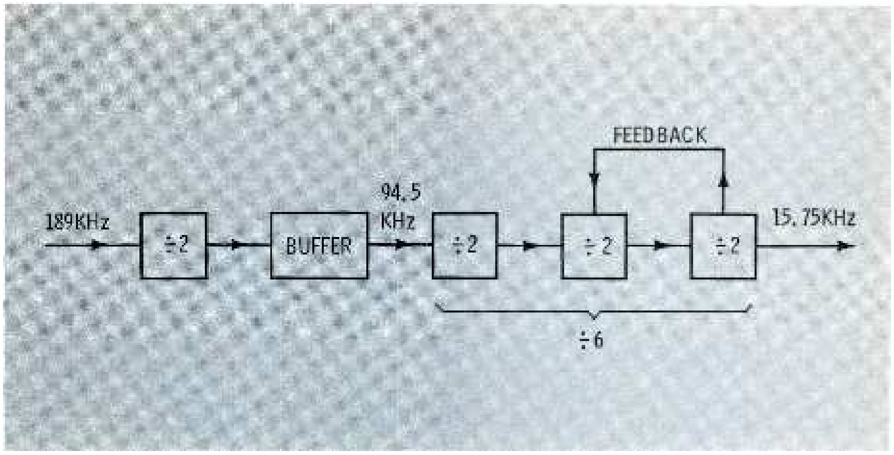


Fig. 5. The horizontal divider chain.

zontal chain achieves a division of 12 using 4 stages dividing by 2. Since the normal sequence would be ÷2−4−8−16, feedback is used to acquire the proper output.

The incoming 189-kHz squarewave signal is differentiated and results in positive and negative pulses. The dividers are multivibrators with two stable states and respond only to negative pulses; each successive negative pulse flips the multivibrator to the other of the two stable states. The output therefore is a squarewave of 94.5 kHz. The basic block then, of the divider chain, is a binary which divides by two.

The buffer isolates the first divider from the subsequent stages; these latter stages must be treated as a single block which divides by 6. Here's how it works: If we were to arrange a three-stage chain so that each time the output stage rose it would feed back a pulse to the input stage and cancel an incoming pulse, we would have a seven count. This is because 1 out of every 8 pulses is cancelled. If the feedback is applied to the second stage, as in Fig. 5, we have a six count.

The rule then is when feedback is taken from the Nth stage the count will be $2N - \frac{2M}{2}$ where N is the total number of stages and M is the stage into which the feedback is introduced.

The vertical countdown chain, again on a different board, divides the 15.750 kHz by 263 to arrive at the 59.89-Hz vertical sweep. Each of the 9 vertical stages also divides by 2, so again it is necessary to use an intricate feedback arrangement in the vertical chain to arrive at the proper countdown factor.

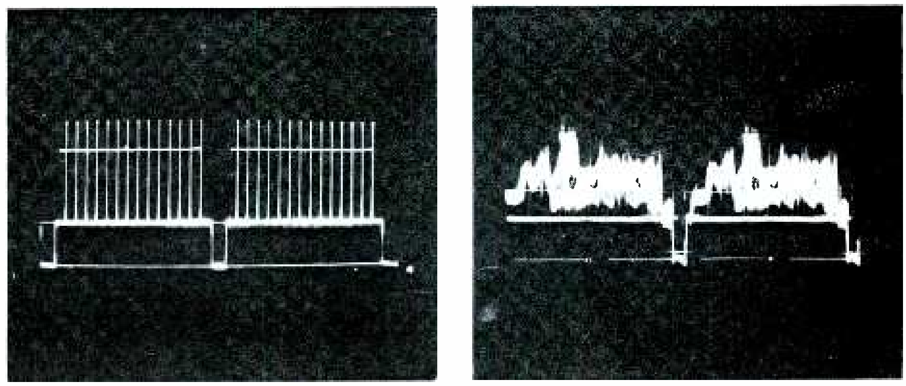
Because the dividers use silicon transistors and divide by 2, the whole countdown chain is extremely stable. The only adjustment in the chain is a trimmer for the 189-kHz crystal oscillator.

The many diodes are necessary for pulse shaping circuits, and the end result is the squarest sync pulses we've seen outside a laboratory instrument. Fig. 6A is a photo of the generator signal in the crosshatch mode, with Fig. 6B showing a station signal for comparison. The pattern appears instantly when the

LCG-387 is turned on, and it is as stable as a station signal. There is absolutely no jitter nor crawl on the dot or line patterns. The color bar pattern shows a slight vertical crawl which is unavoidable in the standard 10-bar signal derived from an offset subcarrier.

Using the LCG-387 is a real pleasure, because of the stable pattern. Other conveniences include the single-cross pattern (also available on several American generators) and the small size and light weight. ▲

For further information circle 56 on literature card



(A) LCG-387 crosshatch. (B) Station signal.

Fig. 6. Waveforms at 7875 Hz.

Leader Model LCG-387 Specifications

RF Output

Frequency:
Channel 5 or 6 ± .5%, switch selectable.

Voltage:
10 mV on open circuit.

Impedance:
300 Ω balanced.

Patterns

Color:
Standard keyed rainbow.

Crosshatch:
11 H x 14V. Horizontal bars are one scan line wide, with blanking. Vertical bars are 0.2 μs wide with 4 μs spacing.

Dots:
At crosshatch intersections.

Single Crossbar:
Centered on raster.

Blanking

Horizontal:
Interval 0.16H, Front porch .02H, Back porch 0.6H.

Vertical:
Interval 15H, Back porch 12H. H = one scan line or 63.5 μs.

Power Supply:
Fullwave bridge, transistor regulated in both series and shunt modes, zener regulated output is 12V, adjustable.

Power requirements:
115 VAC, 2 watts.

Size (HWD):
2¾″ x 6¾″ x 4¾″.

Weight:
3½ pounds with all accessories

Accessories:
300 Ω output cable, screwdriver, alignment tool, leather carrying case.

Price:
$134.50.

PRODUCT REPORT

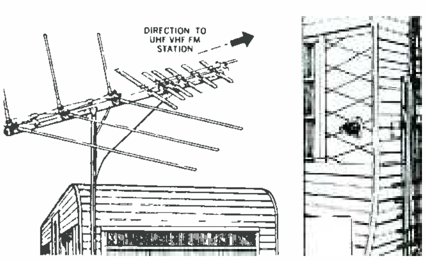
for further information on any of the following items, circle the associated number on the Catalog & Literature Card.

Antennas For Mobile Use
(60)

Two new antenna kits for use on travel trailers and mobile homes have been introduced by **The Finney Company**. The FINCO model TTR-1 (shown here) consists of an all-channel UHF-VHF-FM antenna mounted on a telescoping mast and rotator mechanism which allows the antenna to be rotated from inside the vehicle through a full 360°. When traveling, the antenna is folded down, closed up and locked in a safe travel position below the vehicle roof top. It is not necessary to disconnect the transmission line or do any disassembly.

Model TTW-1 consists of an all-channel UHF-VHF-FM antenna mounted to the vehicle on a wall mount. The antenna and top mast section are removed for travel, and the fully preassembled antenna elements are closed for storage.

Both models come complete with all transmission line, hardware and accessories needed to complete an installation using simple tools. Both models use a new FINCO model CS-A1 Color Spectrum frequency-dependent antenna designed to receive color or black-and-white signals from all channel frequencies—UHF-VHF, plus FM—on a single transmission line, and include a behind-the-set splitter to deliver the respective signals to the proper antenna terminals on the set. The antennas are gold corodized to provide corrosion protection from weather and road dirt. Model TTR-1 is priced at $54.95 and Model TTW-1 at $29.95.

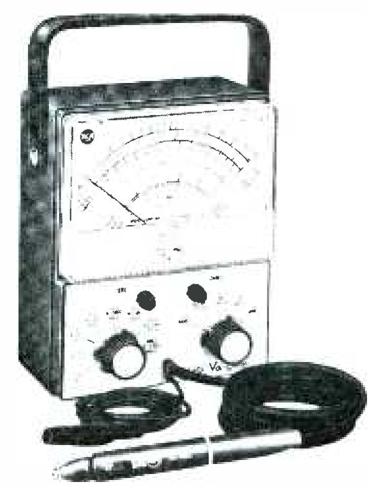


Transistorized VOM
(61)

This solid-state, battery-operated voltmeter and ohmmeter requires no warm-up time and eliminates the zero-shift that can occur in tube-operated units. The **RCA** WV-500A VoltOhmyst is completely portable, making it ideal for home and shop servicing or industrial and laboratory applications.

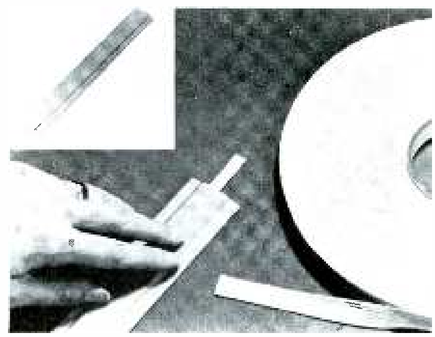
Seven overlapping resistance ranges are provided to allow measurements from 0.2 ohm to 1,000 megohms. Eight overlapping DC-voltage ranges measure from 0.02 volt to 1,500 volts (including a special 0.5-volt DC range), AC p-p voltages of complex waveforms from 0.5 volt to 4,200 volts, and AC rms voltages from 0.1 volt to 1,500 volts. The input impedance of all DC ranges is 11 megohms.

All measurements are made with a wired-in, single-unit probe (WG-410A) equipped with a fully-shielded input cable. The probe is quickly adapted to either DC measurement or AC and resistance measurement by means of the built-in switch near the tip of the probe. A new slip-on high-voltage probe (WG-411A) can be used with the WG-410A probe to make possible measurements up to 50,000 volts DC. Price is $75.00.



Rigid Cable Cover
(62)

A new rigid cable cover for telephone, intercom and other low-voltage wire installations has been announced by **3M Company.** Called "Scotchflex" brand No. 724 Cable Cover, it comes

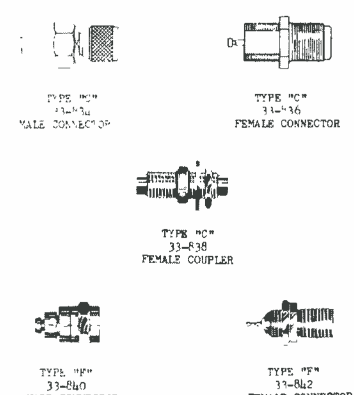


in 4′ lengths measuring ⅛″ high by 1½″ wide. Narrow strips of foam adhesive are applied to the edges along the length of the duct. The foam adhesive adheres to nearly any clean, relatively smooth surface and eliminates the need for drilling holes or using mechanical fasteners.

Suggested commercial applications include wire protection for telephone extensions, intercom systems, remote control hookups and paging systems. The duct is useful for protecting wiring on the floor along well-traveled areas. Price is $1.65 per unit.

Antenna Fittings
(63)

A new series of solderless, coaxial-cable TV antenna fittings, designed for use with RG-59/U, 75-ohm cable, has been reelased by **GC Electronics.** The new fittings are available in two types, Type "C" and Type "F", to

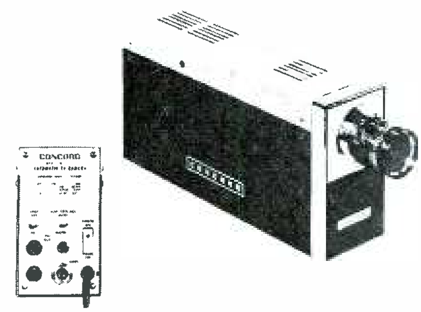


facilitate all commonly encountered antenna hook-up problems. The Type "C" fittings include a male and female connector for cable and chassis mountings, and a female coupler for cable splicing or chassis feed-through applications. The Type "F" fittings, adaptable to the newer cable antenna systems, provide a male connector for crimp-on connection to the incoming cable, and a female connector, complete with hardware for chassis mountings. The Type "F" fittings will also accommodate all antenna couplers and splitters. While designed primarily for TV antenna cable systems, the new fittings can also be used in closed circuit television camera installations.

The new parts are supplied in standard packs of 10 fittings each, with discounts on quantities of 30 or more of each type.

TV Camera
(64)

A new, solid-state television camera designed for video tape recorder use and CCTV applications where fixed (2 to 1) interlace is desired has been introduced by **Concord Communications Systems.** The new MTC-18 camera provides its own sync and operates as a sync generator for other MTC-18 cameras, or will accept sync from an extrnal sync generator.



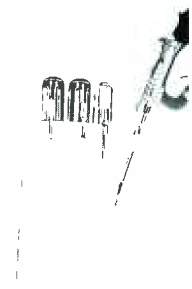
The sync output feature allows video tape recorder users to design or expand their system, permitting switching from camera to camera and sharp scene changes without loss or distortion of picture image. The added feature of a light-control selector on the camera permits either totally automatic or manual compensation for varying light conditions. Video tapes with fades, titles, and superimposed images may be created economically with the addition of the Concord TCP-1 television control panel.

The new camera is completely solid-state with silicon transistors. The camera may be used with any standard monitor or Concord video tape recording system. The signal output level permits longer distances between camera and video recorder without amplification.

The MTC-18 camera measures 5½" x 3" x 11" and weighs 7.5 lbs. Video resolution is 550 lines. The unit comes equipped with a 25-mm. f 1.9, adjustable iris lens, with other lenses available. Price is $450.00.

Mini Tools
(65)

Four "mini"tools for professional servicemen and home workshop buffs have been introduced by **Vaco Products Company.** One tool is the TK-500 Circuit Tester Screwdriver which is handy for testing 100- to 500-volt circuits simply by inserting the blade into the hot side of the socket and holding a finger on the metal cap of the trans-



Circle 40 on literature card

Circle 41 on literature card

parent handle. If the circuit is alive, the handle will light up.

Another tool in the miniature group is the K-21 1/8" x 3" Screw Launcher. This too will hold, start and drive miniature screws. Because of these features, plus its small size, the Launcher is particularly suited for hard-to-reach places. The two-bladed bit grasps the screw when the user slides a gripping sleeve forward on the shaft.

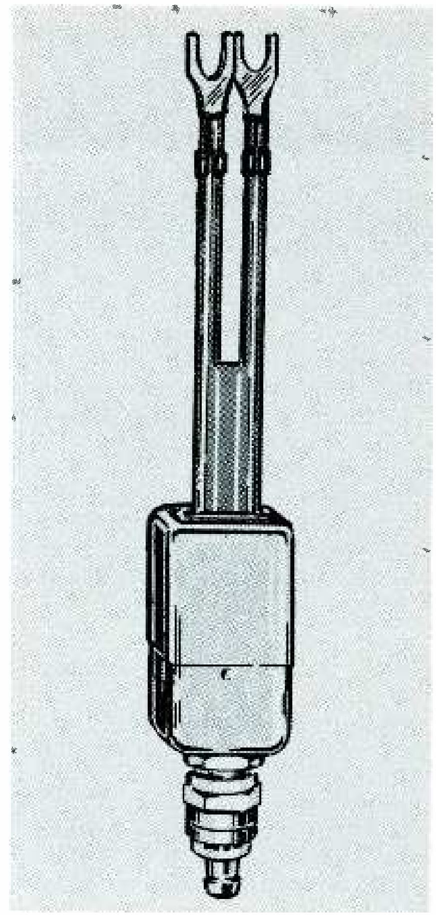
The third tool is a miniature reversible screwdriver (No. DU-1) with a 1/8" square blade at one end of the shaft and a No. 1 Phillips blade at the other end. The fourth tool is the K-14, a Phillips screw launcher only 5" long. It is useful for starting or retrieving all cross-slot screws in awkward, hard-to-reach places.

Each of the four tools may be purchased separately—the TK-500 Circuit Tester Screwdriver at $1.00; the K-21 Screw Launcher at $1.50; the DU-1 reversible screwdriver at $1.25 and the K-14 Phillips screw launcher at $2.30.

Matching Transformer
(66)

This new transformer matches 72-ohm coax to 300-ohm TV sets and 300-ohm antennas.

The **Workman** unit features an all-aluminum case, with double crimp-



in of both wire and insulation to the connectin lugs. Price is $1.80. ▲

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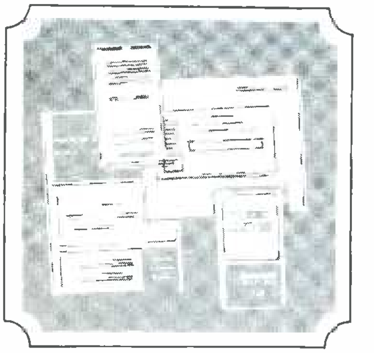

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145. *LECTROTECH* — Two-color catalog sheet on new Model V6-B color bar generator, the latest improved model of the V-6. Gives all specs and is fully illustrated.*

146. *MERCURY* — All-new 16-page test instrument catalog.

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149. *SIMPSON* — Reprint: "A Guide to the Selection of Multitesters." Explains how to evaluate multitesters before you buy.

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151. *ARROW* — Catalog sheet showing 3 staple gun tackers designed for fastening wires and cables up to ½" diameter.*

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157. *RCA* — Pix-300, a 12-page product guide on RCA picture tubes covering both color and black-and-white. Includes characteristics chart, terminal diagrams industry replacement, and interchangeability.*

At RCA our new corporate symbol is really a minor change compared with the innovations it will signify in decades to come.

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